



*Basic knowledge everyone should
have*

ASTRONOMY



Astronomy: Basic knowledge everyone should have

Thousands of years inquisitive mankind turned their views on the world, sought to understand it, to break out of the microcosm in the macrocosm.

The majestic picture of the heavenly dome, studded with myriads of stars, since stars are worried about the mind and the imagination of scientists, poets, all living on the Earth, and enchanted admiring the solemn and wonderful picture, in the words of Lermontov.

What is the earth, the Moon, the Sun, the stars? Where the beginning and the end of the Universe, how long it exists, what it consists of and where its boundaries of knowledge?

In his essay I outlined all of what is known to date, the science of the structure and evolution of the Universe.

The study of the Universe, even if only known to us part is a huge task. To obtain those data available to modern scientists, it took the labor of many generations.

The universe is infinite in time and space. Every particle of the universe has a beginning and an end, both in time and in space, but the whole universe is infinite and eternal as it is eternally self-moving matter.

The universe is everything that exists. The smallest particles and atoms to large clusters in the Islands of the starry worlds and star systems. So it is not wrong to say that any science anyway studies the Universe, or rather, the fact or otherwise of her. Chemistry studies the world of molecules, physics – the world of atoms and elementary particles, in biology, phenomena of nature. But there is a scientific discipline, the object of the study which is the universe itself or "the universe as a whole". This special branch of astronomy so-called cosmology. Cosmology – the study of the Universe as a whole, including the theory all covered by astronomical observations of the region, as part of the Universe, by the way, you should not confuse the concept of the Universe as a whole and observed (visible) Universe. In the second case we are talking it is only to that limited region of space that is available to modern

methods of scientific research. With the development of Cybernetics in various areas of scientific research have become increasingly popular methods of modeling. The essence of this method is that instead of one or the other of the real object studied his model, more or less just repeating the original or its most important and essential features. The model is not necessarily a real copy of the object. The construction of approximate models of various phenomena helps us all a deeper understanding of the world around us. For example, for a long time astronomers have been studying homogeneous and isochronous (imagined) Universe in which all physical phenomena occur in the same way, and all the laws remain the same for all regions and in all directions . Studied as models in which these two conditions were added to the third, the immutable picture of the world. This means that in whatever era we contemplated the world, he should always look in General the same. These largely conditional and schematic model helped to highlight some important aspects of the world around us. But! As difficult as it is one or the other theoretical model, which would be diverse facts it may consider any model is not the phenomenon itself , but only more or less exact copy, so to speak, the image of the real world. Therefore, all the results obtained with models of the Universe, it is necessary to check by comparison with reality. It is impossible to identify the phenomenon with the model. It is impossible without a thorough scan , to ascribe to nature those properties possessed by the model. None of the models can claim to the role of accurate "snapshot" of the Universe. This suggests the need for in-depth development of models of heterogeneous and nastroenny Universe.

The stars in the Universe combined into giant Star systems called galaxies. Star system. Which, as an ordinary star, our Sun is called a Galaxy.

The number of stars in the galaxy is about 10^{12} (trillion). The milky way, the bright silver band of stars encircles the whole sky, forming the main part of our Galaxy. The milky way most bright in the constellation Sagittarius, where the most powerful clouds of stars. The least bright in the opposite part of the sky. From this it is easy to deduce the conclusion that the solar system is not at the center of the Galaxy, which is visible from us in the direction of the constellation Sagittarius. The farther away from the plane of the milky Way, the less there faint stars and the less far in these areas stretches star system. In General, our Galaxy is a space, resembling a lens or lentil, if you look at it

from the side. The size of the Galaxy was scheduled and the stars that are visible at great distances. It zeidy and hot giants. The diameter of the Galaxy is approximately equal to 3000 PC (Parsec (PC) is the distance with which the semimajor axis of earth's orbit, perpendicular to the line of sight, visible angle 1"). 1 Parsec = 3.26 light years = 206265.e. = $3 \cdot 10^{13}$ km) or 100,000 light years (light year – distance traveled by light in one year), but clear boundaries she is not, because the star density gradually eroding.

In the center of the galaxy is located - with a diameter of 1000-2000 PC – giant compacted cluster of stars. It is from us at a distance of almost 10000 PCs (30000 light years) in the direction of the constellation Sagittarius, but almost entirely hidden by a dense veil of clouds, which prevents ordinary visual and photographic observations of this interesting object, of the Galaxy. In the kernel includes a lot of red giants and short-period cefid.

Stars top of the main sequence and supergiants and classical Zeidi is more than young people. It is located further from the center and forms a relatively thin layer or disc. Among the stars of this disc is dust matter and clouds of gas. Substarlike and giants form around the nucleus and disk of the Galaxy spherical system.

The mass of our galaxy is now estimated in different ways, equal to $2 \cdot 10^{11}$ solar masses (mass of Sun is $2 \cdot 10^{30}$ kg) and 1 / 1000th is enclosed in interstellar gas and dust. The mass of a Galaxy in Andromeda is almost the same as the mass of a Galaxy in the Triangle is estimated at 20 times menshe. The diameter of our galaxy is 100,000 light-years. Due to the hard work of the Moscow astronomer V. V. Kukarin in 1944 found the instructions on the spiral structure of the galaxy, and it turned out that we live between two spiral branches, the poor stars.

In some places in the sky through a telescope, and some where even the naked eye can distinguish close groups of stars that are associated by mutual gravitation, or star clusters.

There are two types of star clusters: scattered (Fig.) and ball (Fig.).

Scattered clusters usually consist of tens or hundreds of main sequence stars

and supergiants with a weak concentration to the center.

All the same clusters usually consist of tens or hundreds of main sequence stars and red giants. Sometimes they contain short-period Cepheids. The size of open clusters – a few parsecs. An example of their accumulation is the Hyades and the Pleiades in the constellation Taurus. The size of globular clusters with a strong concentration of stars towards the center to tens of parsecs. There are more than 100 ball and hundreds of open clusters, but in the Galaxy must be tens of thousands.

In addition to stars in the galaxy, composition further includes a scattered matter, extremely diffuse substance composed of interstellar gas and dust. It forms a nebula. Nebulae are diffuse (ragged shapes (Fig.)) and planetary (Fig.). Light from them, that their light of nearby stars. Example: gas-dust nebula in the constellation Orion and the dark dust nebula Horse head.

The distance to the nebula in the constellation Orion is 500 PC, the diameter of the Central part of the nebula – 6 PC, a mass of about 100 times the mass of the Sun.

In the Universe there is nothing unique in the sense that there is no such body, the phenomenon of basic and General properties of which would not be repeated in the other body, other phenomena.

The appearance of galaxies is extremely diverse, and some of them are very picturesque. Edwin Powell Hubble (1889-1953), an American astronomer observer, chose the simplest method of classifying galaxies by their appearance, and I must say that though other prominent researchers have made reasonable assumptions according to the classification of the original system derived by Hubble, still remains the basis for the classification of galaxies.

Hubble suggested to divide all galaxies into 3 types:

Elliptic is denoted by E (elliptical);

Helical (Spiral);

Wrong – abbreviated (irregular).

Elliptical galaxies (Fig.) looks unimpressive. They have the appearance of smooth ellipses or circles with a circular gradual decrease in brightness from the center to the periphery. Any additional parts they have, because Elliptical galaxies are composed of second type stellar population. They are constructed from stars of red and yellow giants, red dwarfs and yellow and some white stars not very high lordship. No blue-white supergiants and giants of groups can be observed in the form of bright clumps that give structure to a system, no dust matter which, in those galaxies where it is available, creates dark bands shading in the form of a star system .

Externally elliptical galaxies differ from each other mainly on one feature – more or less compression (NGC 636, NGC 4406, NGC 3115, etc.)

With more monotonous in contrast to elliptical galaxies spiral galaxies (Fig.) is maybe even the most spectacular objects in the Universe. U elliptical galaxies the appearance says about the static, steady-state Spiral relactate Vice versa exemplify the dynamics of form. Their beautiful branches emerging from a Central core and, as if losing shape outside of the galaxy, points to a powerful swift motion. Also striking is the diversity of forms and patterns of branches. As a rule, the galaxy has two spiral arms originating at opposite points of the core, developing a similar symmetrical way and losing in opposite areas of the periphery of the galaxy. However, the known examples more than two number of spiral branches of the galaxy. In other cases, spiral two, but they are unequal, one much more developed than the second. Examples of spiral galaxies: M31, NGC 3898, NGC 1302, NGC 6384, NGC 1232, etc.

I have listed so far, the types of galaxies were characterized by forms of symmetry in a certain style. But there are a large number of galaxies of irregular shape (Fig.). Without any regularity in the structure. Hubble gave them the designation from the English word irregular is wrong.

The irregular shape of the galaxy may be the result of the fact that she didn't have time to make the right shape due to the low density of matter or due to young age. There is another possibility: the galaxy may be incorrect the result

of the distortion as a result of interaction with another galaxy. Apparently both cases occur among irregular galaxies and can be related to the separation of irregular galaxies 2 subtype.

Subtype II is characterized by a comparatively high surface brightness and complexity of irregular structures (NGM 25744, NGC 5204). French astronomer Vaucouleurs in some galaxies of this subtype, for example Magellanic clouds, found indications of a spiral structure is destroyed.

Wrong galaxy another subtype denoted by III, are of very low surface brightness. This trait makes them stand out from among the other galaxies of all types. At the same time, it prevents the detection of these galaxies, as a result was able to identify only a few galaxies subtype III is located relatively close to (the galaxy in the constellation of the Lion.).

Only 3 galaxies visible to the naked eye, a Large Magellanic cloud, Small Magellanic cloud and the Andromeda galaxy. In the table the data about the ten brightest galaxies in the sky. (BMC, MLC Large cloud and Small cloud Magellanic.).

Non-rotating star system after a certain period should take the form of a ball. This conclusion follows from the theoretical studies. It is confirmed by the example of globular clusters, which are rotating and have spherical shape.

If the stellar system is flattened, it means that it is rotating. Therefore, have to be rotated and elliptical galaxies, except those of them which are spherical, have no compression. The rotation occurs around axis that is perpendicular to the main plane of symmetry. Galaxy is compressed along the axis of its rotation. For the first time the rotation of galaxies was discovered in 1914, the American astronomer Hubble.

Of particular interest are galaxies with dramatically increased luminosity. They are called radio galaxies. The most prominent galaxy Lebedev. This is a faint double galaxy with extremely closely spaced to each other components, which is a powerful discrete source. Objects like galaxy Lebedev I certainly very rare in the Metagalaxy, but Lebedev not the only such object in the Universe. They should be at enormous distance from each other (more

200Mpc).

The flux of radio emission from them in view of the large distances weaker than Cygnus.

When the English and Australian astronomers, using the interference method in 1963, has defined with great precision the situation of the large number of discrete radio sources, they also identified other angular sizes of the radio sources. The diameters of most of them was estimated in minutes or dozens of seconds of arc, but 5 sources, namely from 3C48, 3C147, 3C196, 3C273 and 3C286, the size was less than one second of arc.

But the stream of their radio emission is not inferior patki radio other firms of discrete sources, superior the radiation area of tens of thousands of times. These starlike sources of radio emission were called quadras. Now, more than 1000. Shine Quadra-power generation does not remain constant. Mass blocks reach one million solar masses. Isocnet energy blocks is still not clear. There are suggestions that the Quadra is extremely active nuclei of very distant galaxies.

Theoretical modeling is essential to determine past and future of the observable Universe. In 1922, A. Friedman engaged in the development of an original theoretical model of the Universe. He suggested that the average density is not a constant, but varies over time. Friedman concluded that any sufficiently large part of the Universe, uniformly filled, the matter is not in equilibrium: it must either expand or shrink. In 1917, V. M. Slider discovered the "red shift" of spectral lines in the spectra of distant galaxies. A similar shift is observed when the light source is removed from the observer. In 1929 E. Hubble explained this phenomenon in a mutual divergence of these star systems. The phenomenon of "red shift" observed in the spectra of almost all galaxies except the nearest (few). And the farther from us a galaxy is, the greater the shift of lines in its spectrum, i.e. all the stellar system is receding from us with enormous speeds in the hundreds, thousands, tens of thousands of kilometers per second, more distant galaxies have greater speeds. And after the effect of "red shift" was discovered in the radio band, then left, no doubt in the fact that the observed universe is expanding. Currently the known galaxy, receding from us with speeds of up to 0.46 the speed of light.

And sverdsvette and Quadra – 0.85 times the speed of light. But why they are increasing? On galaxy are constantly acting some force. In the distant past, matter in our region of the Universe was in surplanted condition. Then came the "explosion", which started the expansion. To find out the fate of the Metagalaxy, it is necessary to estimate the average density of interstellar gas. If it is above 10 protons per 1m^3 , the total gravitational field of the Metagalaxy is large enough to gradually stop the expansion. And it shifts the grip.

There were two opinions about the state of the Metagalaxy to the start of the expansion. According to one of the original substance of the Metagalaxy consisted of a "cold" mixture of protons, i.e. nuclei of hydrogen atoms, electrons, and neutrons. According to the second, the temperature was very high, and the density of radiation exceeded density of matter. But after the discovery in 1965 of the microwave background radiation A. Tecnom and R. Wilson there was a preference for the second theory. After was presented the attempt to present the course of events in the first stages of expansion of the Metagalaxy: 1s after the beginning of the superdense initial plasma density is decreased to 500 kg/cm^3 , and $t=10^{13}$. Over the next 100C density decreased to 50 g/cm^2 , the temperature dropped. Teamed up protons and neutrons => helium nucleus. At $t=40000$, it lasted several hundred thousand years. Then, after the formed hydrogen atoms, a gradual formation of hot hydrogen clouds which formed galaxies and stars. However, the enlargement process could be saved blobs to ultra-dense stellar matter and in the process of decay formed stars and galaxies. It is not excluded that he had acted both mechanisms. The concept of the Metagalaxy is not entirely clear. It was formed based on the analogy with stars. Observations show that galaxies, like stars, scattered and grouped in globular clusters, also in groups and clusters of different sizes. All covered by modern methods of astronomical observations of the Universe called Metagalaxy (or our Universe). In the Metagalaxy space between galaxies is filled with extremely rarefied intergalactic gas, is penetrated by cosmic rays, it has magnetic and gravitational fields, and possibly the invisible mass of the substances.

From the most remote metagalactic objects light goes before us many millions of years. But still there is no evidence to suggest that the Metagalaxy is the entire universe. Perhaps there are others, not yet izvetsiya us

Metagalaxy.

In 1929 Hubble discovered a wonderful pattern which was named the "Hubble law" or "law of the red shift": the lines of galaxies are shifted toward the red end, and the offset is greater the farther the galaxy.

Explaining the red shifts of the Doppler effect. Scientists came to the conclusion that the distance between our and other galaxies is continuously increasing. Although the galaxies do not fly in all directions from our galaxy, which does not occupy any special position in the Metagalaxy, and there is a mutual destruction of all the galaxies. Therefore, the Metagalaxy is not stationary.

The opening of the expansion of the Metagalaxy shows that in the past, the Metagalaxy was not like now and the other will be in the future, i.e. Metagalaxy evolves.

From the redshift determined by the speed of removal of galaxies. In many galaxies they are very large, comparable to the speed of light. The high speeds (more than 250 000 km/s) have some quadras, which are the most remote from us the objects of the Metagalaxy.

We live in an expanding Metagalaxy; the expansion of the Metagalaxy is manifested only at the level of clusters and superclusters of galaxies. The Metagalaxy has one feature: there was no centre from which the scatter of the galaxy. Managed to calculate the time interval from the beginning of the expansion of the Metagalaxy.

Gap extension is equal to 20-13 billion years. The expansion of the Metagalaxy is most notable at the present time the phenomena of nature. This discovery has produced a fundamental change in the views of philosophers and scientists. Indeed some philosophers have put an equal sign between the Metagalaxy and the universe, and tried to prove that the expansion of the Metagalaxy confirms the religious idea of the divine origin of the universe. But the Universe of known natural processes, in all probability it bursts. There is speculation that the expansion of the Metagalaxy also began with the appearance reminiscent. The tremendous explosion of matter, of enormous

temperature and density.

Calculations done by astrophysicists indicate that after the beginning of the substance of the Metagalaxy had a high temperature and consisted of elementary particles (nucleons) and their antiparticles. As expansion has changed not only the temperature and density of the substance, but the composition part of the particle, i.e. a particle-antiparticle manipulated, giving rise to electromagnetic rays, radiation which, in the modern Metagalaxy was more than the atoms that make up stars, planets, diffuse matter.

This theory is called the theory of "hot Universe" to superdense matter and turned into a substance with a density close to the density of water. After several hours, the density almost equal to the density of our air, and now, after billions of years, the estimation of the average density of matter in the Metagalaxy leads to a value of the order of 10^{-28} kg/m^3 .

But all these data could only be obtained through a unique complex of equipment allowing to expand the boundaries of the Universe. Until now, mankind perfects it, inventing more ingenious devices, but at the dawn of civilization, when the inquisitive human mind appealed to dizzying heights, the great philosophers thought in their view of the Universe as something infinite. The ancient Greek philosopher Anaximander (VI BC) introduced the concept of a common obscurity, did not have any of the usual observations, the qualities, the fundamental principle of all – the Apeiron.

The elements were conceived first as a semimaterial, semi-divine, spiritual substance. View customarily the basis of everything in ancient Greek basis, reached its peak in the doctrine of atomism of Leucippus and Democritus (V-IV centuries BC) on Vselennoi consisting of unqualified atoms and the void.

Ancient Greek philosophers own a number of brilliant insights about the Universe. Anaximander expressed the idea of the isolation of Earth in space. Alali first described the Pythagorean system of the world, where the Earth as the Sun revolved around a "giant of fire." Arrowbreeze Land claimed another pitagoras Parmenides (VI-V century BC) and Heraclides of Pontus (V-IV

century BC) claimed its rotation around its axis and brought to the Greeks more ancient idea of Egyptians that the sun itself can serve as a center of rotation of some planets (Venus, mercury).

The French philosopher and scientist, physicist, mathematician, physiologist Rene Descartes (1596-1650) created the evolutionary theory of the vortex model of the Universe based on heliocentrism. In his model he considered the heavenly bodies and their systems in their development. To XVII centuries his idea was extremely daring. According to Descartes, all heavenly bodies were formed as a result of vortex motion occurring in a uniform at the beginning, the world of matter. Exactly the same material particles being in constant movement and interaction, change their shape and size, which led us to observe the rich diversity of nature.

The solar system according to Descartes, is one of such vortexes of the world of matter. Planets do not have their own motion – they move, dragged by global vortex. Descartes made a new idea for the explanation of gravity: it is believed that the vortices generated around the planets, the particles press against each other and cause the phenomenon of gravity (e.g. on Earth). Thus Descartes was the first to consider the severity, not as innate, but as a derived quality tel.

The great German scientist , philosopher Immanuel Kant (1724-1804) created the first universal concept of an evolving Universe, enriching the picture of its smooth structure and represented the Universe is infinite in a special way. He explained the opportunities and the significant probability of the occurrence of such a Universe solely under the action of mechanical forces of attraction and repulsion and tried to find out the fate of this Universe at all scales – from planetary system to the world of nebula.

Einstein made a radical scientific revolution, introducing his theory of relativity. It is relatively simple, as all ingenious. He didn't have to pre-open a new phenomena, to establish quantitative laws. He just gave a fundamentally new explanation.

Einstein revealed the deeper meaning of installed dependencies, and effects are already related to some physico-mathematical system (in the form of

postulates of Poincare). Replacing in this case the theory of absolute space and time of ideas, their relativity "Poincare", which is now not linked with the idea of absolute space, absolute reference system. Such a revolution removed the basic contradiction that created the crisis in the theoretical comprehension of the action. Moreover opened the way for further insight into the properties and laws of the world, so much so that Einstein himself did not immediately realize the extent of his revolutionary ideas.

In the article from 30.06.1905 G., laid the foundations of the special theory of relativity Einstein, summarizing the principles of relativity of Galileo, proclaimed the equality of all inertial reference systems, not only mechanical, but also electromagnetic phenomena.

Special or special theory of relativity was the result of a generalization of Galilean mechanics and Maxwell's electrodynamics Lorentz. It describes the laws of all physical processes at speeds close to the speed of light.

First fundamentally new kosmologicheskies a consequence of the General theory of relativity revealed an outstanding Soviet mathematician and theoretical physicist Alexander Friedman (1888-1925.). Speaking in 1922-24. he criticised the findings of Einstein that the universe is finite and has the form of a four-dimensional cylinder. Einstein made a conclusion based on the assumption of stationarity of the Universe, but Friedman showed the invalidity of his original postulate.

Friedman brought two models of the Universe. Soon, these models found a remarkably accurate confirmation of direct observations of the movements of distant galaxies to the effect of "red shift" in their spectra.

This Friedman proved that the substance in the Universe may not be alone. Their findings Friedman theoretically contributed to the discovery of the need for a global evolution of the Universe.

There are several theories of evolution: the Theory of pulsating Universe says that our world was the result of a giant explosion. But the expansion of the universe will not last forever, because it will stop gravity.

According to this theory our universe is expanding for 18 billion years from the time of the explosion. In the future, the extension will completely slow down and will stop, and then it will begin to shrink until the matter is again compressed and there will be another explosion.

The theory of a stationary explosion: according to it the universe has no beginning, no end. She arrives in the same condition. Constantly is the formation of a new vortex to replace the substance of receding galaxies. That's the reason the universe is always the same, but if the universe started by the explosion will expand indefinitely, it will gradually cool down and fade away completely.

But so far none of these theories has not been proved, because at the moment there is no accurate evidence of at least one of them.

The discovery of diverse evolutionary processes in various systems and bodies that compose the Universe, has allowed to study the regularities of cosmic evolution based on observational data and theoretical calculations.

As one of the major challenges deals with the age determination of space objects and their systems. Because in most cases it is difficult to decide what should be considered and understood under the "birth" of a body or system, that setting the age characteristics mean two assessments:

The time during which the system is already in the monitored state.

Full life time of the system from the moment of its appearance. Obviously the second feature can be obtained only on the basis of theoretical calculations.

Usually the first of the expressed value is called the age, and the second is a life time.

The fact of mutual removal of galaxies that make up the Metagalaxy suggests that some time ago she was in a qualitatively different state and was more dense.

The most probable value of the Hubble constant (the proportionality factor relating the rate of removal of extragalactic objects and distances of 60

km/sec – MPC), which yields the value of the expansion of the Metagalaxy to the current 17 billion years.

Of all the above and the evidence that was not included in my summary because of its bulkiness and mathematical-physical problems it is safe to conclude that the universe evolution, rapid changes have occurred in the past, happen now and will happen in the future.

The problem with living in space is one of the most exciting and popular problems in the science of the Universe, which have long been concerned about not only the scientists but all people. Still John. Bruno and M. Lomonosov was suggested on the plurality of inhabited worlds. The study of life in the Universe – one of the greatest challenges with which ever mankind. We are talking about the phenomenon that the humanity faced. We are talking about the phenomenon that people essentially have not had to face. It is all about life beyond Earth, are purely hypothetical in nature. So deep into the biological patterns and cosmic phenomena does scientific discipline – "astrobiology".

So of extraterrestrial research, space life forms would help people to understand the essence of life, i.e. what distinguishes living organisms from inorganic nature, and secondly, to find out the path of the emergence and development of life and, thirdly, to determine the place and role of man in the Universe. Now can be considered a firmly established fact that on our own planet life has emerged in the distant past from inanimate, inorganic matter under certain external conditions. Among these conditions, there are three main. First of all, the presence of water, which is part of the living substance, the living cell. Secondly, the presence of the gas atmosphere required for the gas exchange of the organism with the external environment. However, it is possible to imagine any other environment. The third condition is the presence on the surface of the given celestial bodies suitable temperature range. Also require external energy for the synthesis of the molecules of living matter from the source of organic molecules the energy of cosmic rays or UV radiation or energy of the electronic level. The external energy necessary for the subsequent life of living organisms. The conditions necessary for the origin of life, at the time, happened naturally during the evolution of the Earth, but they have no reason to believe that they cannot

emerge and the process of development of other celestial bodies. Was put forward many hypotheses about this. Academician A. I. Oparin, said that life was supposed to appear when the surface of our planet was a solid ocean. In the result of joining C_2H_2 and N_2 appeared the simplest organic compounds. Then, in the waters of the primary ocean of the molecules of these compounds, United and strengthened, forming a complex solution of organic substances in the third stage of this environment stood out complexes of molecules that gave rise to the primary living organisms. Oro and Fesenkov noticed that the original vector if not life itself, at least its initial elements can be comets and meteorites. However, if you do not enter into the area close to the fiction, and stay motivated a fairly firmly established scientific facts, when you look for life on other celestial bodies we must first of all proceed from what we know about the earthly life.

As for our solar system, different planets move at different distances from the Sun and receive different amounts of solar energy. In connection with this. In the solar system can be allocated a heat zone of life, which includes Earth, Mars and Venus, and the Moon at first glance, the physical conditions on the moon does not completely rule out the possibility of the existence of living organisms: on the moon is no atmospheric envelope, there is no water, the temperature changes from $-1500^{\circ}C$ to $+1300^{\circ}C$, the lunar surface is exposed to a constant bombardment of meteorites, cosmic rays, ultraviolet radiation from the Sun etc.. And while you can speculate on whether there is in nature highly organized forms of life, able to grow in such conditions. An exception may be only microbes and bacteria, which are known to be able to adapt to the most adverse conditions: deep heating and cooling; ultraviolet and radioactive radiation: the intensity of radiation, etc. currently, a number of scientists believe that the moon has organic matter . They could be formed here in the early days of the moon, or to be covered with meteorites . It has been suggested that over the layer of lunar soil (10m) is a powerful layer of complex organic compounds. As Venus, if the temperature on its surface is high, despite the presence of the atmosphere , the conditions for life on this planet is of little use. Much more promising in this respect Mars.

In our days astronomers primarily interested in the question of the physical conditions on Mars. Living organisms living on a celestial body, continually interact with the environment. For example, on the surface of Mars, there are

dark spots "seas". They change color in accordance with the change of seasons. This phenomenon is reminiscent of the seasonal changes in green vegetation. The atmosphere of Mars is much rarefied than earth's. In the air the shell of the seas still have not discovered available oxygen. In this regard, we can assume that Martian plants produce oxygen in the atmosphere and in the soil, or retain it in the roots, or plants so small that they emit a small amount of oxygen to be detected from Earth. Water. It is known that on Mars, no open water surfaces. But researchers believe that the planet's surface is water: this was evidenced by the reduction in spring-summer periods of white spots, polar caps. Under the physical conditions existing on Mars, water in liquid state is there. It should immediately evaporate and freeze settling in a thin layer of frost. The soil is a layer of ice or permafrost. Liquid water can exist at a considerable depth. It was noted that Martian plants have no chlorophyll, it replaces carotenoid, pigment red. Of special interest are the Martian channels. American astronomer Lovell believes that this irrigation system of intelligent inhabitants of Mars. They look like dark veins of irregular shape and combinations of individual spots. For decades, however, there was a number of hypotheses:

Zone of vegetation

Education of tectonic nature

Cracks in the permafrost

The results of the meteorite impact.

But only on the basis of hypotheses to make conclusions prematurely. But there is no doubt that quite curious, which leads to the theory of graphs: a thorough statistical analysis of the formation of different types of networks encountered in terrestrial conditions, has led scientists to the conclusion that artificial networks differ from natural sites. Artificial origin is dominated by nodes with four converging lines, and a network of canals of Mars has mostly nodes 4-th order, the network also has considerable percentage of these nodes; doing to determine the nature of the mysterious Martian transformation even more fascinating problem.

Qualitative characteristics of stars

Luminosity

The luminosity of the star L is often expressed in units of solar luminosity, which equals $4 \cdot 10^{33}$ erg/s. Luminosity of its stars are very different. There are white stars and blue supergiants (they are, however, relatively little), the luminosity over the luminosity of the Sun in the tens and even hundreds of thousands of times. But most of the stars are dwarfs, the luminosity of which is much less than the solar, often thousands of times. The characteristic luminosity is the so-called "absolute magnitude" of a star. The apparent magnitude depends, on the one hand, from its luminosity and colour, on the other — from a distance before her. The stars of high luminosity have a negative absolute values, such as -4, -6. Stars of low luminosity are characterized by large positive values, such as +8, +10.

Temperature

The temperature determines the color of the star and its spectrum. For example, if the temperature of the surface layers of stars 3-4 thousand K., the color reddish, 6-7 thousand K. — yellowish. Very hot stars with temperatures above 10-12 thousand K. have a white or bluish color. In astronomy there are quite objective methods of measuring the color of stars. The latter is determined by the so-called "color index" equal to the difference between photographic and visual, and visual magnitude. Each value of the color index corresponds to a certain type of spectrum.

The cold red stars spectra are characterized by absorption lines of neutral metal atoms and strips some of the simplest compounds (for example, CN, SP, H₂O, etc.). As you increase the temperature of the surface in the spectra of stars disappear molecular bands, a weak line of neutral atoms and neutral helium. The shape of the spectrum changes radically. For example, hot stars with temperatures of the surface layers exceeding 20 thousand To occur mainly lines of neutral and ionized helium, and a very intense continuous spectrum in the ultraviolet part. In stars with temperatures of the surface layers is about 10 thousand To the most intense line of hydrogen, while stars with a temperature of about 6 K. thousand lines of ionized calcium, is located on the border of the visible and ultraviolet part of the spectrum. Note that this species I has a spectrum of our Sun.

Spectra of stars

Extremely rich information allows the study of the spectra of stars. Spectra has long been the vast majority of stars are divided into classes. The sequence of spectral classes is denoted by the letters O, B, A, F, G, K, M. the present system of classification of stellar spectra so accurate that it allows to determine range with an accuracy of one tenth of the class. For example, part of the sequence of stellar spectra between classes B and A, denoted as B0, B1 . . . B9, A0 and so on. Range of stars in a first approximation similar to the spectrum of a radiating black body with a certain temperature T . These temperatures gradually changing from 40-50 thousand degrees for stars of spectral class a to 3000 degrees for stars of spectral class M. In accordance with this, the main part of the radiation of stars of spectral classes O and b occur in the ultraviolet part of the spectrum, unobservable from the earth's surface.

A characteristic feature of stellar spectra is the presence of a huge number of absorption lines belonging to various elements. Subtle analysis of these lines allowed us to obtain particularly valuable information about the nature of the outer layers of stars.

The chemical composition of stars

The chemical composition of the outer layers of the stars where we "directly" comes their radiation is dominated by hydrogen. In second place is helium, and the abundance of other elements is quite small. Approximately every ten thousand atoms of hydrogen have thousands of helium atoms, about 10 atoms of oxygen, a little less carbon and nitrogen and only one atom of iron. The abundance of other elements is quite negligible. It is no exaggeration to say that the outer layers of stars is a giant hydrogen-helium plasma with a small admixture of heavier elements.

Although the number of atoms of the so-called "heavy metals" (i.e. elements with atomic mass greater than helium) in the Universe occupy a very modest place, their role is very large. First of all, they determine the nature of stellar evolution, since stellar opacity of the bowels to radiation significantly depends on its opacity.

The presence in the Universe (particularly the star) of heavy elements is important. Obviously, a living substance can only be built in the presence of heavy elements and their compounds. The well-known role of carbon in the structure of living matter. No less important are other elements such as iron, phosphorus. Kingdom living is a complex clutch of heavy elements. We can, therefore, clearly to formulate the following provision: if it were not for the heavy metals, there would be no life. Therefore, the problem of chemical composition of cosmic objects (stars, nebulae, planets) is of paramount importance for analysing the conditions of emergence of life in different layers of the Universe.

Radius of stars

The energy emitted by the element surface of unit area per unit time is determined by the Stefan-Boltzmann law. The stellar surface is $4 R^2$. Hence the luminosity is equal to:

Thus, if we know the temperature and luminosity of the star, we can calculate its radius.

The mass of stars

In fact, astronomy does not have and does not have currently a method of direct and independent determination of the mass (that is, not part of a multiple system) of an isolated star. And this is quite a serious drawback of our science about the Universe. If such a method existed, the progress of our knowledge would be much faster. Masses of stars vary in relatively narrow limits. Very few stars, the mass of which is more or less solar in 10 times. In this situation, astronomers tacitly accept that stars with the same luminosity and color have the same mass. They are defined only for binary systems. The assertion that a single star with the same luminosity and color has the same weight as her "sister", a member of the binary system, should always be taken with some caution.

It is believed that the objects with masses less $0.02 M$ are not stars. They lack internal energy sources and their luminosity is close to zero. Typically, these objects belong to planets. The largest directly measured mass does not exceed

60 M .

Diagram Hertzsprung Russell.

For understanding the nature of stars, it is important to identify dependencies between their individual characteristics. Such relations are found by matching the corresponding values. So, in the beginning of XX century the Danish astronomer E. Hertzsprung and American astrophysicist G. Russell installed one of these relationships, and presented it in the form of a diagram that bears their names.

On the horizontal axis of the diagram of Hertzsprung Russell (figures G — P) postpone the temperature of the star and the vertical — the luminosity in arbitrary units (relative to the luminosity of the Sun). Each star on the graph corresponds a well-defined point. It is usually said that the place on the graph is a star, and not the corresponding point, and when discussing the evolution of stars write: "the star is moving on the graph", implying that in the process of the evolution of stars because of changes in the temperature and luminosity of the star, and the corresponding point on the graph G. — R. change its position.

From this diagram it follows that the luminosity of the star and its spectral class is linked to a specific, although not unique addition. Most stars are located along the line going from hot and bright to cold and weak (dim) stars. This is known as main sequence, and belong to her stars of the main sequence. This sequence belongs to the vast majority of stars, including our Sun (spectral class G2). The main sequence in the location marked with a vertical bar is divided into upper and lower parts. Stars bottom of the main sequence are called yellow or red dwarfs (depending on temperature). The sun — a typical yellow dwarf.

Above the main sequence in the region of temperatures below 6000 K are the stars that make up the group of red giants (luminosity of the order of 10^2 - 10^3 , and a radius of about 10 - $60 R_{\odot}$) and a group of red supergiants ($10^4 L_{\odot}$, 200 - $300 R_{\odot}$). Stars are hot ($T \sim 30000$ K) and luminous ($10^4 L_{\odot}$ — $10^6 L_{\odot}$, $40 R_{\odot}$) are white supergiants. Note that cold and faint stars is much more than hot and bright.

In the lower left corner of the diagram are white dwarfs ($T \approx 10000 \text{ K}$, $L \approx 10^{-4} L_{\odot}$, spectral classes O, B, A, F, G, K, M).

So we see that the luminosity of the star and the spectral class are interrelated. One of the first tasks of theory is to explain this dependence, to find the physical phenomena behind it. How did modern astrophysics, we will see later. Here only note that immediately after the construction of this chart she attributed an evolutionary significance: it was assumed that stars evolve along the main sequence, from hot and bright to cold and weak. It turned out that the evolution of stars has a more complicated character, and still stars the images of which are located in the upper left of the chart called "early" and the other end of the main sequence — "late".

Stars are nuclear reactors

In most fusion reactions the energy released in the fusion of four protons into one helium nucleus. This coupling of protons in a helium nucleus can go different ways, but the end result will be the same.

Let us describe the proton-proton reaction.

This reaction begins with such collisions between protons, which produces a nucleus of heavy hydrogen — deuterium. Even in the face of the star depths it occurs very rarely. As a rule, collisions between protons are elastic: after the collision the particles simply scatter in different directions. To the collision of two protons are merged into one nucleus of deuterium, it is necessary that such a collision was performed by two independent conditions. First, it is necessary that one of colliding protons kinetic energy is twenty times superior to the average energy of thermal motions at a temperature of the star's interior. As mentioned above, only one one hundred millionth part of protons has a relatively high energy needed to overcome the "Coulomb barrier". Secondly, it is necessary that during the collision one of the two protons would be able to turn into a neutron, emitting a positron and a neutrino. Because only the proton and neutron can form the nucleus of the deuterium! Note that the duration of a collision is only about 10^{-21} seconds (it is of order the classical radius of the proton divided by its speed). If all this

into account, it turns out that each proton has a real chance of becoming this way in the deuterium only once in several tens of billions of years. But as the protons in the interiors of stars quite a lot, such reactions, and, moreover, in the right quantity, will take place.

Different is the fate of the newly formed deuterium nuclei. They are "greedy", just a few seconds, "swallow" some near proton into a helium isotope ^3He . Then there are three possible paths (branches) nuclear reactions. Most often the isotope of helium will interact with the similar core, resulting in a - "ordinary" helium, and two protons. As the concentration of the isotope is Not extremely small, it will happen in a few million years. Now let's create the sequence of these reactions and are released by them energy.

Here, the letter ν is a neutrino and gamma quantum. Not all freed from this chain of reactions the energy is transferred to the star, as part of the energy is carried away neutrinos. With this in mind, the energy released in the formation of one helium nucleus, equal to 26.2 MeV or $4.2 \cdot 10^{-5}$ erg.

The second branch of the proton-proton reaction begins with the coupling kernel is Not with - "ordinary" helium, ^4He , and then formed the nucleus of beryllium ^7Be . The nucleus of the beryllium in turn can capture a proton, after which formed the nucleus of a boron ^8B , or capture an electron and become a lithium nucleus. In the first case, the resulting radioactive isotope ^8B undergoes beta decay:

Note that neutrinos formed in this reaction, discovered with the help of unique, expensive installation. Radioactive beryllium ^7Be is very unstable and quickly decays into two alpha particles. Finally, the third branch of the proton-proton reaction includes the following sections: ^7Be after the capture of the electron is transformed into ^7Li , which, after capturing a proton, is transformed into the unstable isotope ^8Be , disintegrating, as in the second circuit, into two alpha particles.

We note again that the vast majority of reactions goes on the first chain, but the role of side chains is not all that small.

We now turn to the consideration of carbon-nitrogen cycle. This cycle

consists of six reactions.

Explain the contents of this table. Proton colliding with the nucleus of carbon, is transformed into a radioactive isotope of nitrogen ^{13}N . In this reaction is emitted is the quantum. The isotope ^{13}N , undergoing decay by emitting a positron and a neutrino, is converted into an isotope of carbon ^{13}C . The latter, faced with the proton is transformed into a nitrogen nucleus ^{14}N . In this reaction also emitted is the quantum. Further, the nitrogen nucleus collides with a proton, whereupon a radioactive isotope of oxygen, ^{15}O and is the quantum. Then this isotope by decay is converted into an isotope of nitrogen ^{15}N . Finally, the last Annex during the collision, the proton decays into ordinary carbon and helium. The whole chain of reactions is a consistent weighting of the carbon nuclei by the addition of protons with the subsequent -decays. The last link in the chain is the recovery of the initial nucleus of carbon and the formation of new helium nuclei by four protons, which at different times one after the other joined ^{12}C and formed from it the isotopes. As you can see, no change in the number of ^{12}C nuclei in the substance in which this reaction does not occur. Carbon is the catalyst of the reaction.

The second column lists the energy released at each stage of the carbon-nitrogen reaction. Part of this energy is released in form of neutrinos produced in the decay of radioactive isotopes ^{13}N and ^{15}O . Neutrinos freely leave the star out of the depths, therefore their energy goes into heating the substances of the stars. For example, the decay of ^{15}O , the energy of the resulting neutrinos is on average around 1 MeV. Finally in the formation of a single helium nucleus by a carbon-nitrogen reaction released (excluding neutrinos) 25 MeV energy, neutrinos carry approximately 5% of this value.

In the third column of table II shows the values of the velocities of the various links of the carbon-nitrogen reaction. For processes that just half-life. Much harder to determine the reaction rate when the weighting kernel by addition of the proton. In this case, it is necessary to know the probability of penetration of a proton through the Coulomb barrier and the probability of the relevant nuclear interactions, as the mere penetration of a proton into the nucleus are not of interest to us nuclear transformation. Probability of nuclear reactions are obtained from laboratory experiments or calculated

theoretically. For reliable analysis took years of hard work of nuclear physicists, both theoreticians and experimentalists. The numbers in the third column are given the "life time" of the various cores for the Central regions of a star with a temperature of 13 million degrees Kelvin and a density of hydrogen of 100 g/cm³. For example, in order under such conditions - ¹²C, capturing a proton, turned into a radioactive isotope of carbon, to "wait" 13 million years! Consequently, each "active" (i.e. participating in the cycle) nucleus reactions proceed extremely slowly, but the fact that the cores enough.

The main source of energy the Sun, the temperature of the Central regions which is close to 14 million Kelvins, is the proton - proton reaction. For more massive, and therefore hotter stars essential carbon-nitrogen reaction, which dependence on temperature is much stronger.

Continuously running in the Central regions of stars nuclear reactions "slowly but surely" change the chemical composition of the star's interior. The main trend of this chemical evolution—the transformation of hydrogen into helium. In addition, the process of carbon-nitrogen cycle changes the relative concentrations of different isotopes of carbon and nitrogen until then, until a certain equilibrium. In this equilibrium the number of reactions per unit time, leading to the formation of some of the isotope, equal to the number of reactions that it would destroy. However, the time of the establishment of such an equilibrium can be very large. But until equilibrium is established, the relative concentrations of various isotopes may vary within a wide range.

Nuclear processes play, as we have seen in this paragraph, a fundamental role in the long, quiet evolution of stars, located on the main sequence. But, in addition, their role is decisive in rapidly occurring transient processes of explosive character, which is rotatable stages in the evolution of stars. Finally, even seemingly to be highly trivial and very "quiet" stars, like our Sun, nuclear reactions open the possibility to explain phenomena, which seem very far from nuclear physics.

The birth of stars

Modern astronomy has a large number of arguments in favor of the claim that stars are formed by the condensation of clouds of gas and dust the interstellar

medium. The process of star formation from that environment continues at the present time. The elucidation of this fact is one of the greatest achievements of modern astronomy. Even relatively recently it was thought that all stars were formed almost at the same time many billions of years ago. The collapse of these metaphysical views is primarily, the progress of observational astronomy, and the development of the theory of structure and evolution of stars. In the result, it became clear that many of the observed stars are relatively young objects, and some of them appeared when on Earth was a man.

An important argument in favor of the conclusion that stars are formed from interstellar gas and dust environment is the arrangement of groups of obviously young stars (so-called "associations") in the spiral branches of the Galaxy. The fact that according to radio astronomical observations of the interstellar gas is concentrated mainly in the spiral arms of galaxies. In particular, this takes place in our Galaxy. Moreover, from a detailed "radio image" of some close to us galaxies, it follows that the highest density of interstellar gas is observed on the inner (towards the center of the galaxy) the edges of the coil, which finds a natural explanation, the details of which we here are not going to stop. But in these parts of spirals are observed by methods of optical astronomy "zone N of N", i.e. clouds of ionized interstellar gas. The reason for the ionization of these clouds can only be the ultraviolet radiation from massive hot stars objects obviously young.

Central to the issue of evolution of stars is the question about the sources of their energy. In the last century and early this century have proposed various hypotheses about the nature of the energy sources of the Sun and stars. Some scientists, for example, believed that the source of solar energy is a continuous deposition on the surface of meteors, others were looking for a source of continuous compression of the Sun. Liberated in this process the potential energy could, under certain conditions" to the radiation. As we will see below, this source at an early stage of the evolution of stars can be quite effective, but it can not provide the Sun's radiation for a desired time.

The successes of the nuclear physicists have solved the problem of the sources of stellar energy in the late thirties of our century. This source is thermonuclear fusion reactions occurring in the bowels of stars when the

dominant there is a very high temperature (of the order of ten million degrees).

As a result of these reactions, the rate of which depends strongly on temperature, the protons turn into a helium nucleus and energy is released slowly "seeps" through the interior of stars and in the end, much transformed, is emitted in world space. This is an extremely powerful source. If we assume that initially the Sun consisted only of hydrogen, which as a result of thermonuclear reactions is entirely transformed into helium, the released amount of energy will be about 10^{52} erg. Thus, to maintain the radiation at the observed level for billions of years enough to the Sun "spent" not more than 10% of its initial stock of hydrogen.

We can now present a picture of evolution of some stars in the following way. For some reason (you can specify several) start to condense a cloud of interstellar gas and dust environment. Pretty soon (of course, on an astronomical scale!) under the influence of forces of gravity of the cloud formed a relatively dense opaque ball of gas. Strictly speaking, this ball cannot be called a star, as in its Central regions the temperature is not sufficient enough to start thermonuclear reactions. The pressure of the gas inside the balloon was not able to balance the force of attraction of its individual parts, so it will continuously shrink. Some astronomers used to think that such a protostar observed in individual nebulae in the form of a very dark compact formations, the so-called globules. The success of radio astronomy, however, forced to abandon this rather naive point of view. Usually at the same time not one formed protostar and a more or less numerous group of them. In the future, these groups become stellar associations and clusters, are well known to astronomers. Very likely (at this very early stage of the evolution of stars around it formed clumps of smaller mass which are then gradually transformed into planets.

Compression protostar its temperature increases and a significant portion of the released potential energy is radiated into the surrounding space. Since the size of the compressible gas ball very high, then the radiation per unit of its surface will be negligible. As soon as the radiation flux per unit surface is proportional to the fourth power of temperature (Stefan — Boltzmann law), the temperature of the surface layers of the star are relatively low, whereas its

luminosity is almost the same as that of normal stars with the same mass. So in the diagram "spectrum — luminosity", the star will be located to the right of the main sequence, i.e. fall in region of the red giants or red dwarfs, depending on their initial masses.

In the future, the protostar continues to shrink. Her razmery be smaller, and the surface temperature increases resulting spectrum is becoming more early. Thus, moving down the diagram "spectrum — luminosity", the protostar very quickly "sit" on the main sequence. In this period the temperature of the star depths is already sufficient for that, so there began a fusion reaction. The pressure of the gas in the future of the star balances the gravity and the gas balloon stops shrinking. The protostar becomes a star.

Evolution of stars

To pass the early stage of its evolution, protostars have relatively little time. If, for example, the mass of the protostar more solar, you need only a few million years, if less than several hundred million years. As the time evolution of the protostars is relatively small, this very early phase of star development can be difficult to detect. All the stars in a stage, apparently, observed. We have in mind is a very interesting stars like the T Tauri, usually shipped in a dark nebula.

B 5966 G. unexpectedly revealed the opportunity to observe the protostar in the early stages of their evolution. Great was the surprise of the radio when the view of the sky on the wave of 18 cm corresponding to the radio HE was discovered bright, extremely compact (i.e. having small angular dimensions) sources. It was so unexpected that at first refused even to believe that such a bright radio may belong to the molecule hydroxyl. The hypothesis was expressed that these lines belong to some unknown substance, which immediately gave a "suitable" name "Mysterium". However, the "Mysterium" very soon shared the fate of their optical "brothers" — "nebulium" and "corona". The fact that for many decades the bright lines of the nebulae and the solar corona was incapable of identification with any known spectral lines. Therefore, they were attributed to some unknown on the earth, hypothetical elements "nebulium" and "coronia". In 1939-1941 it was convincingly shown that the mysterious line "Caronia" belong multiply

ionized atoms of iron, Nickel and calcium.

If "debunking" the "nebulium" and "Caronia" it took decades, then a few weeks after opening, it became clear that the line "Mysterium" belong to ordinary animals, but only in extraordinary circumstances.

So, sources of "Mysterium" — a giant, natural cosmic masers operating in the Wake of the hydroxyl lines, the length of which 18 see in the masers (and at optical and infrared frequencies — in lasers) achieved a huge brightness in the line, and the spectral width is small. As is known, the gain of the radiation in the lines due to this effect is possible when the environment in which the radiation propagates, in some way "activated". This means that some "outside" source of energy (the so-called "pumping") makes the concentration of atoms or molecules in the initial (upper) level abnormally high. Without a permanent "pump" the maser or laser is impossible. The question of the nature of the mechanism of "pumping" cosmic masers, while the food is not completely solved. However, most likely "pumped" is powerful enough infrared radiation. Another possible mechanism of "pumping" may be some chemical reaction.

The mechanism of "pumping" of these masers is not yet entirely clear, it is still possible to obtain a rough idea about the physical conditions in the clouds emitting maser mechanism line 18 see First of all, it turns out that these clouds are quite dense: a cubic centimeter there are at least 10^8 - 10^9 particles, and substantial (and maybe large) part of their molecule. Temperature is unlikely to exceed two thousand degrees, it's probably about 1000 degrees. These properties contrast with the properties of even the most dense clouds of interstellar gas. Given the still relatively small size of the clouds, we unwittingly come to the conclusion that they are more like long, rather cold atmosphere of the stars — the supergiants. It seems that these clouds are nothing like the early stage of the development of protostars immediately following their condensation out of the interstellar medium. In favor of this assertion (which the author of this book made in 1966) and others say the facts. In the nebulae, where the observed cosmic masers, visible young hot stars. Consequently, there has recently ended and, most likely, continues at the present time, the process of star formation. Perhaps the most curious is that, as shown by radio-astronomical observations, cosmic masers of this type as if "immersed" in a small, very dense cloud of ionized

hydrogen. In these clouds there are a lot of cosmic dust, which makes them unobservable in the optical range. These "cocoons" insults young, hot star within them. In the study of star formation processes proved extremely useful in infrared astronomy. Because infrared rays the interstellar absorption of light is not significant.

We can now present the following picture: the clouds of the interstellar medium, by its condensation, the formation of several clusters of different masses, evolving into a protostar. The rate of evolution is different: for the more massive clusters it will be more. Therefore, sooner of all will become a hot star is the most massive cluster, whereas the rest will be more or less long stay in the stage of protostar. They are something we see as sources of maser emission in the vicinity of "newborn" hot star insulsa not skondensirovalas in clumps hydrogen of the cocoon. Of course, this rough diagram will be further refined, and, of course, it will be substantially amended. But the fact remains that suddenly, some time (likely relatively short) newborn protostar, figuratively speaking, a "shout" about their appearance in the world, using the latest methods of quantum Radiophysics (i.e. masers).

Once on the main sequence and ceasing to burn, the star radiates long almost without changing his position on the diagram "spectrum — luminosity". Its radiation is supported by thermonuclear reactions occurring in the Central regions. Thus, the main sequence represents the locus of points on the diagram "spectrum — luminosity", where the star (depending on its mass) can long and steadily radiate through thermonuclear reactions. Place the stars on the main sequence determined by its mass. It should be noted that there is another parameter that determines the position of equilibrium of the radiating stars in the diagram "spectrum - luminosity". This parameter is the initial chemical composition of stars. If the relative content of heavy elements decreases, the star of "lie" in the diagram below. This explains the sequence of subcortical. As mentioned above, the relative content of heavy elements in these stars are dozens of times less than that of main sequence stars.

Stay stars on the main sequence determined by its initial mass. If the mass is large, the radiation of the stars has a huge power and she quickly spends stocks of the hydrogen "fuel". For example, the stars of the main sequence with a mass in excess of solar a few dozen times (this is the hot blue giants of

spectral class O), can steadily emit, in this sequence only a few million years, while stars with a mass close to the sun, are main sequence 10-15 billion years.

"Burning out" of hydrogen (i.e., turning it into helium in thermonuclear reactions) occurs only in the Central regions of stars. This is because stellar matter mixed only in the Central regions of stars, where nuclear reactions, while the outer elephant retain the relative hydrogen content unchanged. Since the amount of hydrogen in the Central regions of stars is limited, sooner or later (depending on the mass of the star) he was there almost the entire "burn out". Calculations show that the mass and radius of the Central region that is going through a nuclear reaction, is gradually reduced, thus the star moves slowly in the diagram "spectrum — luminosity" to the right. This process occurs much faster in relatively massive stars.

What happens to a star when all (or nearly all) the hydrogen in its core, "burn out"? Since the energy release in the Central regions of the star stops, the temperature and pressure cannot be maintained there at a level needed to counter the force of gravity compressing the star. The core of the star starts to shrink and its temperature will rise. Is formed very hot, dense region, consisting of helium (which become hydrogen) with a small admixture of heavier elements. Gas in this state is called "degenerate". He has a number of interesting properties. In this hot dense nuclear reactions do not occur, but they are pretty intense leaking to the periphery of the nucleus, in a relatively thin layer. Star would "swell" and will "go" with the main sequence, becoming red giants region. Further, it appears that the stars are giants with a lower content of heavy elements will have the same dimensions higher luminosity.

The end of the star

What happens to stars when the reaction of the "helium — carbon" in the Central regions are exhausted, as well as the hydrogen reaction in a thin layer surrounding the hot dense core? What stage of evolution comes after the red giant stage?

White dwarfs

The combination of these observations and some theoretical considerations suggests that at this stage of the evolution of stars whose mass is less than 1.2 solar masses, a substantial part of its mass that forms their outer shell, "reset". This process we are witnessing, apparently, as the formation of so-called "planetary nebulae". After the stars are separated with a relatively small speed of the outer shell, "naked" of her inner, very hot layers. At the same time separated the shell will expand further and further departing from the stars.

Powerful ultraviolet radiation from the star — kernel of planetary nebulae will insulate atoms in the shell, arousing their glow. Few tens of thousands of years the shell will dissipate and will only have a very small hot dense star. Gradually, slowly cooling down, it will turn into a white dwarf.

Thus white dwarfs like "Mature" inside red giant stars and "see the light" after the separation of the outer layers of giant stars. In other cases, the shedding of the outer layers may not occur through the formation of planetary nebulae, and by the gradual expiry of the atoms. Anyway white dwarfs, in which all the hydrogen is "burned" and the nuclear reaction stopped, apparently, represents the final stage of evolution of most stars. The logical conclusion is the recognition of the genetic link between the late stages of stellar evolution and white dwarfs.

Black dwarfs

Gradually cooling down, they emit less and less, turning into invisible "black" dwarfs. This is a dead, cold stars of very high density, millions of times denser than water. Their sizes are less than the size of the globe, although mass comparable to the sun. The cooling process of white dwarfs goes back many hundreds of millions of years. So ends its existence most of the stars. However, the ending of the life of a relatively massive stars can be much more dramatic.

Neutron stars

If the mass of the collapsing star exceeds the mass of the Sun is more than 1.4 times, such star, reaching the stage of a white dwarf, that will not stop. The gravitational forces in this case are very high that the electrons into the

atomic nuclei inside. As a result, the isotopes become neutron is able to fly to each other without any gaps. The density of neutron stars is even greater than the density of white dwarfs; but if the mass of the material does not exceed 3 solar masses, neutrons, and electrons, are able to prevent further compression. A typical neutron star has a diameter only about 10 to 15 km, and one cubic centimetre of its matter weighs about a billion tons. In addition to the unheard of huge density, neutron stars have two special properties that allow them to detect, despite the small sizes: it's rapid rotation and strong magnetic field. In General, revolve all the stars but when a star shrinks, the speed of its rotation increases, just as the skater on the ice spinning much faster when holding a hand. Neutron star makes several revolutions per second. Along with this extremely fast rotation of the neutron star have a magnetic field millions of times stronger than Earth.

Pulsars

The first pulsars were discovered in 1968 when radio astronomers discovered the regular signals coming to us from the four points of the Galaxy. Scientists were struck by the fact that some natural objects can radiate radio pulses in a right and fast rhythm. First though, for a while astronomers have suspected the involvement of some intelligent beings living in the depths of the Galaxy. But it was soon found a natural explanation. In a strong magnetic field of the neutron star moving in a spiral the electrons generate radio waves that are radiated by a narrow beam, like a ray of light. The star spins and the radio beam crosses the line of our observations, like a lighthouse. Some pulsars emit not only radio waves but also light, x-rays and gamma rays. The period of the slowest pulsars for about four seconds, and the fastest — thousandths of a second. The rotation of these neutron stars was for some reason even more accelerated; they may enter the dual system.

Supernova

The stars, the mass of which does not reach 1.4 solar, die quietly and peacefully. And what happens to more massive stars? As there are neutron stars and black holes? The catastrophic explosion that ends the life of a massive star is a truly impressive event. This is the most powerful of natural phenomena occurring in stars. In a moment released more energy than it

radiates our Sun for 10 billion years. Luminous flux sent from one dying star, the equivalent of an entire galaxy, but visible light is only a small fraction of the total energy. The remains of exploded stars fly away with velocities of 20 000 km per second.

Such enormous stellar explosions called supernovae. A supernova is a rare phenomenon. Every year and other galaxies find 20 to 30 supernovae, mainly as a result of systematic search. Per century in each galaxy there may be from one to four. However, in our own Galaxy, not the supernova observed since 1604, Maybe they were, but remained invisible due to the large amounts of dust in the milky Way.

Black holes

FROM stars having mass greater than three solar, and a radius greater than the 8.85 kilometre, the light will not be able to leave her in space. The outgoing from the surface the beam is bent in a gravity field so much that comes back to the surface. Quanta of light — photons — emitted by the body back, as thrown up rocks on earth. No radiation erupts to the outside world to convey the message about the sad fate of the star.

Turned into a black hole, the celestial body does not disappear from the Universe. It makes itself known to the outside world due to its gravity. The black hole absorbs the rays of light coming from it at a greater distance. The black hole may enter into the gravitational interaction with other bodies: it can hold around a planet or to form with another star in a binary system.

We have repeatedly stressed that the speed of evolution of stars is determined by their initial mass. As in a number of ways since the formation of our solar system, the Galaxy, took about 15-20 billion years, for it is the finite (albeit enormous) time, the described evolutionary path were only the stars, the mass of which exceeds some value. Apparently, this "critical" mass of only 10-20% greater than the mass of the Sun. On the other hand, as already stressed, the process of star formation from interstellar gas-dust environment occurred in our Galaxy continuously. It is happening now. That is why we are seeing hot massive stars in the upper left of the main sequence. But even the stars formed in the beginning of the formation of the Galaxy, if their weight is less

than 1.2 solar, have not had time to go out of the main sequence. Note, incidentally, that the rate of star formation are currently much lower than many billions of years ago. The sun formed about 5 billion years ago, when the Galaxy has already formed and in its main features was similar to "modern". Now, at least 4.5 billion. years, it "sits" on the main sequence, steadily radiating through nuclear reactions convert hydrogen into helium occurring in its Central regions. How long will it last? Calculations show that our Sun will become a red giant after 8 billion years. In this case its luminosity will increase by hundreds of times, the radius is in the tens. This stage of evolution of our sun will take a few hundred million years. Finally, one way or another swollen Sun will shed its shell and become a white dwarf. Generally speaking, we are not indifferent to the fate of the Sun, as it is closely linked with the development of life on Earth.

For centuries the only source of information about the stars and the Universe was for astronomers visible light. Watching with the naked eye or with telescopes, they used only a very small interval of waves from the variety of electromagnetic radiation emitted by celestial bodies. Astronomy was transformed with the mid of our century, when the progress of physics and technology gave her new tools and instruments that allow observations in the broadest range of wavelengths from meter radio to gamma rays where the wavelengths are billionth of a millimeter. This caused a rising tide of astronomical data. In fact, all the major discoveries of recent years – the result of the modern development of the latest areas of astronomy which has now become full spectrum. Since the early 30-ies, as soon as there is theoretical understanding of neutron stars, it was expected that they should manifest themselves as cosmic x-ray sources. These expectations were met in 40 years, when it was discovered the busters and was able to prove that their emission comes from the surfaces of hot neutron stars. But first open a neutron star was still not bursters, and pulsars proved themselves — quite unexpectedly — as sources of short pulses of radio emission following each other with amazingly strict periodicity.

Opening

In the summer of 1967 at the University of Cambridge (England) has commissioned a new radio telescope specially constructed E. Huysum and his staff to one of the Supervisory tasks — studying the scintillation of cosmic

radio sources. This phenomenon is known like all the twinkling of the stars arises from the random inhomogeneities of density in the medium, through which pass electromagnetic waves on the way to us from the source. New telescope allows observation of large areas of the sky, and apparatus for signal processing has been capable of detecting the level of radio stream every few tenths of a second. These two features of their tool and allowed Cambridge radio astronomers to discover something totally new pulsars.

The first is clearly distinguishable series of periodic pulses were seen on 28 November 1967, Cambridge graduate student group J. Bell. Impulses followed one another with precisely the maturing period of 1.34 s. It was quite unlike the usual chaotic pattern, a random irregular flashes of light. The received signals resemble the hindrance of earthly origin. For example, the ignition system in a passing car. But this and other simple explanations soon had to leave. Was eliminated and the signals of the aircraft or spacecraft. Then, when there was reason to believe that the pulses have a cosmic origin, there was an assumption about extraterrestrials, sending to the Ground. Made serious attempts to recognize any code in the received pulses. This proved impossible, though, as the story goes, to it were attracted the best professionals. Besides, soon found three more similar pulsating radio source. It became evident that sources of radiation are natural celestial bodies.

The first publication of the Cambridge group appeared in February 1968, and in as probable candidates for the role of sources of pulsed light refers to the neutron star. The frequency of the signal associated with rapid rotation of the neutron star. The source is rotated as the lantern of the lighthouse, and this creates a discontinuity of the visible radiation coming to us individual pulses. The discovery of pulsars awarded the Nobel prize for physics in 1978

Interpretation: the neutron star

In astronomy there are many stars whose brightness is continuously changing, growing, falling. There are stars called Cepheids (for the first of these, discovered in the constellation Cepheus), with a strictly periodic variations of sheen. The strengthening and weakening of the brightness occurs at different stars in this class with periods from several days to a year. But pulsars have never met the stars with such short period, as the first

"Cambridge" pulsar.

Behind him in a very short time it was opened a few tens of pulsars and the periods some of them were even shorter. So, the period of the pulsar, discovered in 1968 in the center of the crab nebula, was 0,033 s. there are Now about four hundred pulsars. The vast majority—up to 90% have periods in the range from 0.3 to 3, so that the typical period of a pulsar can be considered a period of 1 s. But particularly interesting pulsars-Champions, the period of which is less typical. The record of the pulsar of the crab nebula lasted almost a decade and a half. At the end of 1982 in the constellation Chanterelles was discovered a pulsar with a period of 0,00155 s, i.e. of 1.55 MS. Rotation with such remarkably short period means 642 R/s. Very short periods of pulsars was the first and most compelling argument in favor of the interpretation of these objects as rotating neutron stars. Star with such rapid rotation must be extremely dense. Indeed, its very existence is possible only under the condition that the centrifugal forces associated with rotation, less than the gravitational forces that bind the matter of the star.

Such a compact, compressed to such a high degree can only be neutron stars: their density is really close to nuclear. This conclusion is supported by the entire fifteen-year history of the study of pulsars .But what is the origin of the rapid rotation of neutron stars-pulsars? It is undoubtedly caused by the strong compression of a star during its transformation from a "normal" neutron stars. Stars always have a rotation with varying speed or period of the Sun, for example, rotates around its axis with a period of about a month. When a star shrinks, its rotation is accelerated. With it, the same happens with the dancer on the ice: holding her hand, the dancer accelerates its rotation. Here is one of the fundamental laws of mechanics — the law of conservation of moment of momentum (or angular momentum).

A neutron star is formed by compressing the Central region, the cores of stars that have exhausted the nuclear fuel reserves. - Manages plan to shrink to a white dwarf, will continue to shrink to the size of the neutron star means reduction of the radius a thousand times. Accordingly, a million times should increase speed and at the same time needs to decrease its period. Instead of, say, a month star now makes one revolution around its axis in just three seconds. Faster initial rotation gives an even shorter periods. Now known not

only for pulsars that emit in the radio band, — they are called radio pulsars, but the x-ray pulsars, emitting regular pulses of x-rays. They also turned out to be neutron stars; the physics is much that unites them with the busters. But radio pulsars, and x-ray pulsars differ from busters in one fundamental respect: they have very strong magnetic fields. The magnetic field — along with the rapid rotation and create the effect of surges, though these fields are different in radio pulsars and x-ray pulsars.

We will talk first about the x-ray pulsars, the mechanism of radiation which is more or less clear and then the radio pulsars that have been studied yet to a much lesser extent, although they are open early x-ray pulsars and bursters.

X-ray pulsars

X-ray pulsars is a close binary system in which one star is a neutron, and another bright star giant. There are about two dozen of these objects. The first two x-ray pulsar in the constellation of Hercules and constellations of Centaurus — opened in 1972 (three years before detection busters) with the help of American research companion "Uhuru"). The pulsar in Hercules sends pulses with a period of 1.24 s. Is the period of rotation of the neutron star. In the system there is another period of the neutron star and its companion orbit around their common center of gravity with a period of 1.7 days. The orbital period was determined in this case due to the fact (accidental) circumstance that "normal" star in its orbital motion is provided along the line of sight between us and a neutron star, and because it obscures for a time the x-ray source. It is possible, obviously, when the plane stellar orbits is only a small angle with the line of sight. X-ray radiation is terminated for about 6 hours, then reappears, and so every 1.7 days.

(Incidentally, the observation of x-ray eclipses to bursters until recently was not possible. And it was strange: if the orbits of binary systems are oriented in space randomly, then you need to expect from more than three dozen bursters at least a few have the plane of the orbital motion, approximately parallel to the line of sight (like of the pulsar in Hercules) to ordinary star could periodically close the us neutron star. Only in 1982, i.e. 7 years after the opening of the busters, one example satmanage Buster was finally detected.)The long observation allowed to install another third — period x-ray pulsar in Hercules: this period is 35 days, of which 11 days source shines,

and 24 days. The reason for this phenomenon remains unknown. Pulsar in the constellation of Centaurus has a period of pulsation 4.8 seconds. The period of the orbital motion is 2,087 day—he, too, was found in the x-ray eclipses. Long-period changes, such 35-day period of the pulsar in the constellation Hercules this pulsar does not find. Companion neutron star in a binary system that a pulsar is the brightest visible star is a giant with a mass of 10-20 Suns. In most cases, the companion of the neutron star x-ray pulsars is a bright blue star giant. This is different from the bursters, which contain weak stars are dwarfs. But as with bursters in these systems it is possible to blend material from a normal star to a neutron star, and their emission also occurs due to heating of the surface of the neutron star flux excretion substances. This is the same physical mechanism of radiation, as in the case of the background (not flare) radiation Buster. Some of x-ray pulsars substance flows to the neutron star in the form of jets (in bursters). In most cases, star-giant loses its substance in the form of a stellar wind emanating from its surface in all directions of the plasma flow, the ionized gas. (The phenomenon of this kind is observed in the Sun, although the solar wind and weaker, the Sun is not a giant, and dwarf.) Part of the stellar-wind plasma enters in the vicinity of the neutron star, in the zone of the predominance of its gravity, where it is captured.

However, when approaching the surface of the neutron star charged plasma particles begin to experience the effects of another force field magnetic field of a neutron star—a pulsar. The magnetic field is able to rebuild the accretion flow, to make it non-spherical-symmetric and directional. As we shall see, that an effect of pulsations of radiation, the effect of the lighthouse. There is every reason to believe that neutron star x-ray pulsars have very strong magnetic field, reaching values of the magnetic induction that is greater than the average magnetic field of the Sun. But such fields naturally result from strong compression in the conversion of an ordinary star into a neutron.

A magnetic field comparable to the field of the Sun, is considered more or less typical of ordinary stars; some "magnetic" stars discovered in the field a few thousand times bigger, so we can expect that a certain (not too small) fraction of neutron stars should really have a very strong magnetic field. To this conclusion came the Soviet astrophysicist N. S. Kardashev in 1964

In its structure, i.e. the geometry of the lines of force, magnetic field of a pulsar looks like, as you might expect, the magnetic field of the Earth or the Sun: it has two poles of which diverge in different directions, the lines of force. Such a field is called a dipole.

Substance accretive neutron star is a stellar wind, it is ionized, and therefore interacts with its movement, with its magnetic field. It is known that the movement of charged particles across field lines is hindered, and the motion along the field lines is seamless. For this reason, accretive substance moving near a neutron star practically force lines of its magnetic field. Magnetic field of a neutron star would create a crater near its magnetic poles, and sent the accretion flow. This possibility is pointed out in 1970, Soviet astrophysics G. S. Bisnovatyj-Cogent. A. M. Fridman. Due to this heating of the surface of the neutron star is uneven: at the poles the temperature is much higher than in all the rest of the surface. Hot spots near the poles have, according to calculations, an area of about one square kilometer; they create mainly the radiation of the stars, because the luminosity is very sensitive to temperature — it is proportional to temperature to the fourth power.

Like the Earth, the magnetic axis of the neutron star is inclined to the axis of rotation. Because of this, there is an effect of the lighthouse: a bright spot that is seen is not visible to the observer. Radiation rapidly rotating neutron star is presented to the observer intermittent, pulsating. This effect was predicted theoretically by Soviet astrophysicist VF Schwartzman a few years before the discovery of x-ray pulsars. In fact, the radiation hot spots are happening, of course, continuously, but it is not uniform in the directions is not isotropic, and x-rays from it is not directed at us all the time, their beam rotates in space around the axis of rotation of the neutron star, running on the Ground once during the period.

From x-ray pulsars have never observed outbreaks, such outbreaks bursters. On the other hand, from bursters have never observed a regular pulsation. Why bursters do not pulse, but pulsars are not ignited? The whole thing is probably the fact that the magnetic field of neutron stars in bursters is much weaker than in pulsars, and because it is not affected by any noticeable on the dynamics of accretion, assuming more or less uniform heating of the entire surface of the neutron star. Its rotation, which can be as fast as the pulsars, x-

ray does not affect the flow since the flow is isotropic. On the other hand, assume that the field magnetic induction

capable as it is though, however, not quite clear yet, how exactly to suppress thermonuclear explosions in the polar regions of neutron stars. The difference in magnetic field is probably connected with the age difference bursters and pulsars. About the age of the binary system can be judged by the ordinary star-the companion. Neutron stars in x-ray pulsars have companions of bright stars are giants; the same companions bursters neutron stars are weak the glitter of stars of small masses. Age bright giants does not exceed a few tens of millions of years, while the age of the weak dwarf stars may have billions of years: the first is much faster consume their nuclear fuel than the second. It follows that bursters is an old system in which the magnetic field had eventually in some degree to weaken, and the pulsar is a relatively young system, because the magnetic field in them. stronger. Maybe busters sometime in the past was pulsing, a pulsar has yet to erupt in the future.

It is known that the youngest and brightest stars in the Galaxy are in the disk close to the galactic plane. It was natural therefore to expect that x-ray pulsars with their bright stars-giants are located mainly in the galactic plane. Their total distribution on the celestial sphere must be different from the distribution of bursters, old things which — like all the old stars of the Galaxy — don't concentrate to its plane and to the galactic center. Observations confirm these considerations: x-ray pulsars are in the disk of the Galaxy, in a relatively narrow layer at both sides of the galactic plane. The same distribution on the sky, detects and pulsars, emitting radio — pulsars.

Radio pulsars

The distribution of pulsars on the celestial sphere allows us to conclude first of all that these sources belong to our Galaxy: they are obviously concentrating to serving its plane, the equator of the galactic coordinate grid. Objects that have nothing to do on the galaxy, never would show no preferential orientation of this kind. The distribution of the directions says in this case about the actual spatial location of the sources: this pattern can arise only when the sources are in the disk of the Galaxy. Some of them lie considerably above or below the equator; but they are also located in the disk about the galactic plane, only closer to us than most other pulsars. After all,

with the Sun we are almost exactly in the galactic plane, and therefore the direction from us to close objects within at least a narrow layer can be generally any. Close pulsars are relatively few and they do not obscure the overall picture. If the radio pulsars located near the galactic plane, among the youngest stars of the Galaxy, it is reasonable to assume that they are young. One of them, the pulsar of the crab nebula, and definitely know that there are only about a thousand years is a remnant of a supernova in 1054; its age is much less than the life time of bright giant stars, 10 million years, not to mention the star-dwarfs, whose average age is still 1000 times more. Strict periodicity of the pulse, the location in the galactic plane, and youth — all this brings the pulsars x-ray pulsars. But in many other respects they differ sharply from each other. It is not only the fact that some emit radio waves, and other x-rays. The important thing is that radio pulsars are single, not double stars. There are only three of the pulsar with the star-companion. All the rest, and there are over three hundred and fifty, no sign of the duality is not observed. From here immediately follows that the physics of pulsars must be very different from that of x-ray bursters or pulsars. Fundamentally different must be the source of their energy is in any case not accretion. Another important fact: the radiation spectrum of radio pulsars is very far from any semblance of universal cernuella spectrum, which is typical for radiation of hot bodies. This means that the radiation of radio pulsars has nothing to do with the heating of the neutron star, with a temperature of the thermal processes on its surface. The radiation of electromagnetic waves, not associated with heating of the body, called non-thermal. Such radiation is not uncommon in astrophysics, physics and engineering. Here is a simple example. Antenna radio or television station as a conductor of a certain size and shape. There are free electrons which under the action of the special generator making a concerted motion along the conductor back and forth with a given frequency. As the electrons oscillate "in unison", and they radiate coherently: all radiated into space electromagnetic waves have the same frequency — the frequency of electron oscillations. So the spectrum of radiation of the antenna contains only one frequency or wavelength. Information about the radiation spectrum of radio pulsars managed to obtain, primarily due to observations of the brightest of them is the pulsar of the crab nebula. It is remarkable that its radiation is registered in all ranges of electromagnetic waves — from radio waves to gamma rays. The most energy it emits in the area of gamma-rays (so that the pulsar deserves the title of

gamma-ray pulsar); the action of the gamma flux in the x-ray region is less in 5-10 times. In the region of visible light it is still ten times less.

You can check that at any temperature the radiation of the heated body can not have such a distribution of energy along the spectrum.

Except the pulsar of the crab nebula, "millisecond" pulsar in the constellation Chanterelles and a pulsar in the constellation Vela, and all other radio pulsars have been reported only due to the radiation at radio frequencies. It is possible that they emit in other areas of the spectrum, visible light, x-rays and gamma rays, similar to the crab pulsar .nebula (although probably not as intense as he is); but they are farther away from us, and the sensitivity of existing radio telescopes higher sensitivity, x-ray and gamma-ray telescopes.

Interestingly, and only data about the luminosity of pulsars in the radio, without any information about the radiation at shorter wavelengths is sufficient to verify non-thermal, acernotelight the nature of their radiation.

Energy source

The frequency of the pulses of the pulsar is aged with surprising accuracy. This is the most accurate watch in nature. And yet for many .pulsars managed to register and the regular changes in their periods. Of course, it's only small changes, and they occur very slowly, so that the regularity of the pulse is only very weak. The characteristic time of change of the period is, for most pulsars, about a million years; this means that only a million years we can expect the visible — say, by half — change period.

In all known cases, the pulsars increasing, rather than reduce its period. In other words, their rotation slows down with time. Something inhibits the rotation of the neutron star, something to spend her energy of rotation. So does not serve as the rotation source supplying radiation of a pulsar?

To check this, you need to do primarily in the energy assessment. If the pulsar emits is really due to rotation, the kinetic energy of the rotation is to

provide the observed radiation power, its luminosity.

For the pulsar of the crab nebula, a period which is one-thirtieth of a second assessment should be done separately. He and the characteristic time of the increase period, not a million years; it is observed that it is comparable with the age, i.e., close to a thousand years. In this case, the power Train will be a million times more than the ratio (1.5); it exceeds by several orders of magnitude the full luminosity of the pulsar in all wavelength ranges.

You can thus say that the assumption of rotation as the energy source of the pulsar can withstand the first test: the kinetic energy of the rotation of the neutron star is large enough and it can serve as a reservoir from which radiation derives its energy. While the rays spent only a small proportion of the total energy consumption.

Magnetic dipole radiation

How does the rotational energy is converted into energy of electromagnetic waves? According to the idea put forward by the Italian astrophysicist F. Pacini and English theorist Thomas gold, a decisive role in this should belong to the magnetic field of the neutron star. As we have said, a neutron star can have a very significant magnetic field. Most likely, the field has a dipole character, and its axis is inclined to the axis of rotation of the neutron star as an x-ray pulsar System of the magnetic field lines rotates with the angular velocity with which rotates the neutron star itself. Outside the light cylinder the magnetic field of a rotating inclined dipole can not stay the same as inside it. On the light cylinder is the transformation of the dipole magnetic field in electromagnetic waves which spread outward, carrying with it a certain energy. This energy is drawn from the rotational energy of the neutron star. This kind of magnetic-dipole radiation has long been studied in electrodynamics. It is known that the frequency of the radiated waves is equal to the rotation frequency of the magnetic dipole, the wavelength is equal to the radius of the light cylinder. So, rotating neutron star with an oblique magnetic field is able to emit electromagnetic waves. The energy of rotation is converted into radiation energy. But magnetic-dipole wave is not the radiation observed from pulsars: its frequency is too low and the wavelength too large — tens to hundreds of kilometers. Magnetic-dipole waves must

undergo some very significant transformations before it becomes the background radiation of pulsars. These transformations take place, apparently, in the magnetosphere of the pulsar — in the surrounding a neutron star rotating cloud of charged particles.

The magnetosphere

The possibility and even the necessity of existence of such clouds proved American astrophysicists-theorists Goldreich P., and V. Julian. They studied the electromagnetic phenomena occurring not at the light cylinder, where magnetic dipole radiation, and near the surface of the neutron star. Here is a magnetized neutron star is able to "work" like the Dynamo: its rotation causes the appearance of strong electric fields, and with them the currents, i.e. the directed movement of charged particles.

The same estimate for the proton shows that the existing electrical power a billion times more than gravity to a neutron star. This means that gravity is completely irrelevant to the charged particles in comparison with the electrical forces at the surface of the neutron star. Electric power is extremely high and they are able to freely control the movement of electrons and protons: they can tear them from the surface of the neutron star, accelerate them, telling the particles of enormous energy. Electric force field on a particle of charge performs in the way particles work.

It's really a huge energy, many orders of magnitude beyond the rest energy of the electron and proton. The giant energy of the particles corresponds to their speeds approaching the speed of light, and actually matching it. High energy particles detached from the surface of the neutron star and accelerated by the strong electric field, creating a flow, which originates from the neutron star similar to the solar or stellar wind. The magnetic field carries the stream into rotation together about a neutron star. So it occurs around the expanding and rotating magnetosphere. The birth and acceleration of the particles, forming the magnetosphere, requires considerable energy, which is drawn from the kinetic energy of rotation of the neutron star. Theoretical analysis done by P. Goldreich and V.; Julian, shows that it spent approximately the same amount of energy as magnetic dipole radiation. At the same time and very magnetic dipole radiation adds to the energy of the magnetosphere, it hardly goes out and is absorbed by the magnetosphere, transferring their energy to its

particles. There is no doubt that in the magnetosphere of the neutron star and played diverse physical processes that define all the observable manifestations of the pulsar. Complete and comprehensive theory of these processes yet; the theory of radio pulsars is in the process of development, and even the main questions she can't give a complete and convincing answer. We are primarily interested in how the orientation of the radiation of the pulsar, creating this natural beacon. Now it is possible to present only the most preliminary considerations, does not claim strict validity, but containing, nevertheless, a number of important ideas. You probably need to assume that particles of high energy that fills the magnetosphere of the pulsar, are able to emit electromagnetic waves of very high frequency, or, in quantum language, the photon is very high energy. One of the physical mechanisms of radiation associated with the particle motion in strong magnetic fields. Particles follow mainly along magnetic field lines, and since lines of force are curved, the particle motion may not be rectilinear and uniform. Deviation from the rectilinear and uniform motion means acceleration (or deceleration) of particles and, consequently, is accompanied by the emission of electromagnetic waves. According to the calculations of an electromagnetic wave such origin belong to the gamma range. In turn, the gamma photons are able to generate (in the presence of a strong magnetic field) pairs of electrons and positrons. Electrons and positrons also emit electromagnetic waves in its movement in a magnetic field, and these new waves able to generate new pairs of particles, etc. Such cascade processes develops mainly near the magnetic poles of the neutron star, where magnetic lines of force and field are especially great. Here are formed, as can be put to flows coherently moving particles, which — as in the antenna radiate directionally and in concert, creating the beam of the pulsar. The magnetic axis of the star does not coincide with its axis of rotation, and because the beam rotates like a lighthouse beam. But how exactly this happens remains to be seen.

The main part of energy of rotation, lose a neutron star, is converted not in the observed radiation of the pulsar and in the energy of the particles accelerated in the magnetosphere of the neutron star. Radio pulsars are thus a powerful source of high-energy particles. The high energy electrons emitted by the pulsar of the crab nebula, directly manifest themselves in the glow of the nebula. This will be discussed later, but here it is necessary to say a few

words about evolution and the future of radio pulsars. Over time the pulsar loses its rotational energy and magnetic energy, so gradually and rotational speed, and the magnetic field of the neutron star decreases. Because of this reduced electric field at the surface of the star, decreasing the efficiency of separation of the particles and their acceleration. Sooner or later high energy particles will cease to be born, and the radio emission of the pulsar stops. If the pulsar was a couple of along with the regular star, he could then turn into a Buster, the radiation of which feeds the accretion flow, entrained from the surface of the companion star. But (with very few exceptions, as mentioned) radio pulsars are single neutron stars, and not members of close binary systems. Nevertheless, the glow, though rather weak, can still occur. According to the Soviet astrophysicist I. A. Gypsy it can be obliged accretion of neutral interstellar gas, which moves through an extinct radio pulsar. The search for such pulsars the former and current gamma stars — one of the interesting problems of gamma-astronomy.

Pulsars and cosmic rays.

Even in 1934. V. Baade and F. Zwicky pointed to a possible link between supernova explosions, neutron stars and cosmic rays — high-energy particles coming to Earth from outer space.

Cosmic rays were discovered over 60 years ago and since then are subject to a careful examination. The interest in them is primarily associated with the ability to use them to study the interactions of elementary particles at high energies unattainable in the laboratory of accelerator devices. Particles of high energy coming to Earth from interplanetary and interstellar space, the rise in the earth's atmosphere new, secondary particles, also having a considerable energies. But more interesting, obviously the source of the primary particle. They represent mainly the protons; among them there are a small number and the atomic nuclei of elements such as helium, lithium, beryllium, carbon, oxygen, etc., up to uranium.

Electrons in cosmic rays is not more than 1-2 %. The flux of cosmic rays is isotropic — it comes to the Earth uniformly from all sides (except, of course, of the particles emitted by the Sun).

Cosmic rays propagating in the interstellar magnetic fields, capable of creating synchrotron radiation. The total radio emission of the Galaxy has been known since the late 40-ies.

However, Radionet Galaxy much more. A General explanation of radio Galaxies as synchrotron radiation of electrons of cosmic rays by V. L" Ginzburg in the years 1950-1951. the Basic question of cosmic ray physics from the very beginning of its development — the nature of their high energy. It is still not resolved. Discusses a number of interesting possibilities: the acceleration of particles in interstellar magnetic fields (as is assumed in the 40-ies of the E. Fermi), in the shells, is released in the supernova explosions (this idea is developed now by many authors), in the nucleus of the Galaxy or even outside it — in quasars. The discovery of pulsars, the analysis of electrodynamics, the data on high-energy particles in the crab nebula, obtained from analysis of synchrotron radiation,—all this points to pulsars as an efficient source of cosmic rays. An old idea Baade V. and F. Zwicky about the unity of the origin of neutron stars and cosmic rays is currently gaining new grounds.

The rapid development of Astronautics, progress in learning and study near-earth and interplanetary space greatly expanded our understanding of the Sun and the moon, on Mars, Venus and other planets. Very effective was the study of upper atmosphere, ionosphere, magnetosphere. However, revealed a very high efficiency near-earth space and space technology for the benefit of many Earth Sciences.

The use of satellites for communication and television, operational and long-term weather forecasting and hydro-meteorological situation, for navigation on the seaways and aviation routes for high-precision geodesy, the study of the Earth's natural resources and control the environment becomes more familiar. In the short and in the longer term, versatile use of space and space technology in various areas of the economy will increase significantly.

For our epoch characterized by a huge growth of information in all spheres of human activity. In addition to the progressive development of the traditional means of communication—telephony, telegraphy, radio broadcasting, there is a need to create new types of television, exchange of data, in automatic control systems and computer, transfer matrices for the printing of

Newspapers.

The global nature of various economic problems and scientific studies, wide inter-state integration and cooperation in production, trade, . research activities, the expansion of exchange in the field of culture has led to a significant increase of international and Intercontinental communication, including the exchange of television programs.

Traditional means of communication in relation to their types, amount, range, timeliness and reliability of information transmission will be improved continually. However, the further development of their encounters considerable difficulties, both technical and economic nature. Already it is now clear that the requirements for bandwidth, quality, reliability of long-distance communication channels cannot be completely satisfied with ground-based wired and wireless communications.

The construction of the distant land and underwater cable lines takes a lot of time. They are complex and expensive not only in construction but also in operation, and for further development. Conventional cable lines have besides a relatively small bandwidth. The best prospects have a broadband concentric cables, however, they have several drawbacks that limit their use.

Much greater bandwidth, range, possibility of adjustment for different types of communications with a radio. But radio have certain shortcomings, which hinder in many cases, their application.

Sverdlovskoye radio system because of the limited range is usually used only for transportation needs, aviation and special types of communication.

Long-wave radio because of the limited bandwidth and relatively small range actions are primarily used for local radio communication and radio broadcasting.

Shortwave radio have sufficient range and are widely used in many kinds of communication for different purposes.

New ways to overcome the inherent long-range radio flaws has opened the

launches of artificial Earth satellites (AES).

Practice confirmed that the use of satellites for communication, particularly for long-haul international and Intercontinental, television and remote control, when transferring large amounts of data, eliminates many difficulties. That is why satellite communication systems (SCS) in a short time was especially fast, wide and versatile application.

The first attempt to put the issue of the creation of EAS was made in December 1953 in the preparation of the draft resolution of the Council of Ministers on rocket R-7. Was proposed: "to Organize, in NII-88 scientific-research Department with the task of development of problem-solving tasks together with an in flight at altitudes of 500 km and more, as well as development issues associated with the creation of artificial Earth satellite and the study of interplanetary space with the product".

This problem was considered in the Bureau not as a single, and is based on the creation of special directions in the development of rocketry Such a large-scale formulation of the question required extensive prior training, up to the cost estimates of upcoming work on the creation of satellites.

When planning work on the satellite specific reference served as data on U.S. jobs in this area. Priority continued to be the main argument throughout the subsequent period of space development. Therefore, the reports primarily provide a detailed overview of the status of work abroad. Thus expressed, we can say, the fundamental idea that "artificial satellite is an inevitable stage in the development of rocket equipment, after which it will be possible interplanetary messages". Draws attention to the fact that over the last 2-3 years has increased the attention of foreign press to the problem of creating artificial satellite and interplanetary communications.

The most remarkable documents on the subject is the judgments about the prospect of work on the satellite. Development of a simple satellite is only the first stage. The second stage is the establishment of a satellite to ensure the flight of one or two people in orbit. The third stage of the creation of the satellite-station for a long stay of people in orbit. When this project was proposed to collect the satellite-station of the individual parts are delivered

alternately into orbit.

Preparatory work for the first launches of the missile were considerable difficulties and delays in deadlines. However, the designer was confident that with hard work in March 1957 starts launches. Rocket by some alterations can be adapted to trigger the option of an artificial Earth satellite with a small payload in the form of the devices, weighing about 25 pounds... and separating the container actually spherical satellite with a diameter of about 450 mm and a weight of 40-50 kg.

And here in the Soviet Union was created a rocket capable of reaching a speed of 8 km/sec. She was launched on 4 October 1957, Flew up vertically, a candle, a rocket pierced the stratosphere. It was led by automatic devices which operate according to a preset program. The rocket rose to over two hundred kilometers, gradually adopted the horizontal direction and on course. It had to be done very precisely:

error by one degree would spoil everything. But the machines worked perfectly. The missile scored the desired speed and was sent on his way brilliant ball of aluminum alloys— the world's first artificial satellite, made in our country.

8 km per second, 28800 km per hour!

If at any moment the satellite was over Australia, in 20 minutes over Alaska, after another 12 minutes over new York, even after 10 — over Brazil. An hour and a half trip around the world, 15 revolutions per day, and each time on a new track because the plane of the satellite's orbit in space is stationary and the Earth rotates around its axis within this orbit.

The first satellite was small: its diameter — 58 cm, weight 83.6 per kg. He was six-foot mustache — antennas. Inside are two transmitter Passing over all countries of the world, Sputnik was announced that the era of space travel has already begun, and this era was opened by the country of socialism. Behind him went on a journey around the Earth the second and third satellites.

"Baby-moon" — "Moon baby" — called Americans our interplanetary firstborn. Thousands of eyes and radios followed his flight. And every hour of his life has interested scientists. First the earthly body raised to a height of 947 km. for the First time at such heights worked the radio.

Signals it was shown how the radio waves through the upper ionized layers of the atmosphere, allowed a deeper understanding of their structure.

Radio transmission requires energy. The energy in the space there. It is possible to borrow from the Sun. Let it with its rays charges the batteries. But the first companion stood battery charged on the Ground. They dried up after a while, but the silence and the satellite continued to serve science. At high altitudes, where was his own route, there is almost no air... but still "almost there" and not "no". Even at low density air has a resistance, and the speed of the satellite gradually decreases. This allows you to set the density of the atmosphere at different altitudes.

Some peculiarities in the satellite motion point to an uneven pull of the Earth. This allows you to specify the form and structure of our planet, to find hidden underground heavy or light weight.

Theoretically, the body flying over the Earth at a speed of 8 km/sec, will not fall ever. But satellites can't fly forever. Negligible air resistance eventually slowed their flight. They fell and crashed through dense layers of air that burned and crumbled.

Now it was necessary to solve the most important question: can the living entity to move space flight, or it will inevitably die outside the atmosphere? The second Soviet artificial satellite, launched 3 November 1957, was to answer this question. It into space to a height of 1670 km went to the first traveler — the dog Laika. Special devices watched her breathing, pulse, blood pressure. We know that Laika responded well to a rapid start and multi day journey around the Earth. On the third Soviet artificial Earth satellite was installed even whiter a variety of equipment to study properties of the earth's atmosphere, solar radiation, etc. He weighed 1.3 tons, and supplies its electric energy to power devices has increased due to the effects of sunlight on the installed devices. Later, several artificial satellites failed to launch in the

United States.

The third Soviet Sputnik proved the most durable and the most difficult. The Soviet people managed to throw in a space solid construction, the size of a passenger car.

Interestingly, the idea of using artificial satellites for communication was made before the launch of the first satellite. In 1945, the famous Soviet scientist P. V. Shmakov advanced the idea of using satellites for global television broadcasting.

What are the principles on the use of satellites for communication purposes and why satellite systems allow to overcome many difficulties arising in the organization regard the old, traditional methods?

It is known that the sphere reflects electromagnetic waves uniformly in all directions, and its effective reflective surface is proportional to the square of the diameter. Increase the reflective properties of the ball can be achieved by increasing its diameter. Inflating the balloon was carried out after the withdrawal of the satellites on orbit by way of sublimation. It had a protective film and a special metallic coating. The ball was made up of separate meridional segments. Metal ball segments imposed on the scope, provide electric contact between all of the meridional segments.

Despite the obvious simplicity, low cost and certain technical advantages such satellite communication systems, very soon revealed serious flaws. To maintain stable relations it took a lot of power transmission and high sensitivity foster ground devices. But under these conditions, the radio link worked steadily enough, were susceptible to interference. The life of these satellites due to changes in their shape, compression shell and deterioration of the reflective properties, but also because of the rapid loss of height was small.

The satellite, however, is constantly moving in space and may not always be in the area of joint visibility to points in need of. How does the SSS if you want long hours or even round-the-clock, the relationship between the commanded points ?

One possible solution to this task is run on the respective orbits of such satellites to as soon as one of them will come from the area of the joint coverage of items in need of when the other satellites immediately be included in this zone. However, even when a sufficiently large number of satellites, if their position in orbit by accident, it is not excluded that in the area of joint visibility of the two points in need of connection, not have any satellites.

From what depends the number of satellites required to provide continuous communication? Obviously, the higher the orbit, the longer the joint visibility of the satellite by ground stations.

The inclination is the most important condition coverage satellite communication system is a particular area of Land specified service area. In connection with the utmost, we can say decisive, role the orbits of satellites in satellite communication systems it is necessary, at least very briefly, to highlight some of the main types and concepts.

Circular orbit is the orbit at which the distance from the satellite to the center of the Earth is approximately constant. Elliptical orbit — when a satellite moves around the Earth along a curve close to an ellipse. The maximum distance it from the Earth (apogee) and minimum (perigee) may significantly differ from each other. The shape of the ellipse is determined by its eccentricity (the ratio of the difference of the distances from the center of the Earth to the apogee and perigee to the major axis of the ellipse). Orbit with large eccentricity have a high apogee and called HEO.

The choice of the shape of the orbit (circular, elliptical, highly elliptical), inclination (polar, inclined with a predetermined angle of inclination, Equatorial), magnitude, period and nature of the reference orbit around the Earth (synchronous, geostationary) is crucial in the design of a particular system of satellite communication and, in turn, is determined by the objectives of the designed system.

Since the first launches of satellites almost always form a system. Single EAS connection, wide usage are rarely used.

In satellite communication systems use low-orbit spacecraft high-elliptical satellites and geostationary.

A communication system using low-orbit satellites

First for the purpose was applied the low-orbit satellites.

This is due, in particular, the fact that the output of the satellites on the low orbit is more simple and is performed with minimal energy cost. First launch of low-orbit communications satellites showed the possibility and expediency of application of satellites for communications, confirmed the correctness of the technical principles of active relay. However, the first experience of operating satellites in low orbits, it became clear that they can not provide sufficiently effective solutions for satellite communications.

For the expansion areas and increase the duration of SSS was envisaged to go towards increasing the number of satellites in the system. Soon, however, it became clear that the multi-satellite communication system for low earth orbit satellites as a system for General use has many operational inconveniences and unprofitable.

In low-orbit communications satellites can be placed in space relative to each other accidentally PLI orderly. For random location will need a larger number of satellites, however, ordered their location in space will require considerable effort to create and maintain the specified relative location. This requires constant monitoring of the location of satellites and correction of the orbit due to the evolution of them during the flight.

The advantages of SSS are in low orbits, as already mentioned, the comparative cheapness of their launch into orbit and more simple onboard equipment. Disadvantages — the difficulty of maintaining continuous communication complexity of ground equipment through the use of tracking antenna systems, the smaller the lifetime of the SPACECRAFT.

Leo SSS can be effective in cases that do not require continuously operating bilateral relationship (for example, if you need only periodic data transmission).

Communications system with satellites in highly elliptical orbits

To avoid the drawbacks of satellite communications system in low earth orbit, it is necessary to raise the orbit. Two options are possible such orbits, high circular and highly elliptical. The removal of satellites on highly elliptical orbits, in some cases, does have certain advantages.

Due to the height of the orbit, the delay will increase. Moreover, it additionally will increase due to the fact that the time of visibility are close to the apogee of the satellite in a specified area for the period of his treatment at satellites with an elliptical orbit is significantly larger.

According to the laws of celestial mechanics (the second law of Kepler) upon motion of a satellite in an elliptical orbit, its angular velocity is smaller, the farther it is from the center of the Earth. In other words, the satellite is near apogee it moves significantly slower than near perigee. In determining the estimated parameters of the orbits of communication satellites, of course, also takes into account the energy characteristics of the launch vehicle, capabilities of the spaceport and command-measuring complex and other factors contributing to the output of the satellite into orbit and control them in flight.

Satellites with an elliptical orbit include, for example, the American satellite "Telstar" (perigee—about 1 thousand km, apogee—about 11 thousand km).

A good example of satellites with highly elliptical orbit serving Soviet communication satellites "Molniya". For satellites of this class is selected the orbit with the apogee over the Northern hemisphere of about 40 thousand km and a perigee of about 500 km, with inclination of 65° and orbital period of 12 h. With the orbital period of the satellite "Lightning", is equal to 12 h, is provided at the same time radiowidget between Moscow and the Far East for 8—9 h in the same orbit.

Orbital structure of satellite communication systems (the number of satellites, their orbits and vzaimoporozhdeniya in space), subject to requirements of reliability, continuity of transmission range, the minimum allowable elevation angle, wherein the working ground station, and other factors.

System with geostationary satellites

All the more common satellite communication system with geostationary satellites, often called CISS (stationary satellites). They are used for telephone and Telegraph communications, radio and television. Created geostationary spacecraft complex type for meteorological purposes, the study of the Earth's natural resources, control the environment, perform other tasks.

The major advantage of geostationary satellites is the formation of a huge permanent area of visibility for the many items on the Ground coverage of vast territories, a possibility of organization of communication for longer range and with a significant number of correspondents.

A significant advantage of SSS with satellites in geostationary orbits is that their use reduces the requirements for ground-based tracking systems and communications, with simplified or eliminated and device targeting on-Board antennas. three such satellites, positioned relative to each other at angles of 120° , it is possible to create a global communication system, i.e. a system covering almost the entire Earth.

Geostationary communication satellites, which metaphorically can be thought of as the tower raised to a height of 36 thousand km, in principle, allow direct transmission without the help of local telecentres directly to the subscriber's antenna. Currently the power level of the radiated TV signals from geostationary still inadequate for admission to normal, the typical subscriber antenna, so you have to use special antennas small group use. With regard to radio broadcasting, the reception it can be done at a very small outdoor antenna.

Speaking about the undoubted advantages of CISS, we cannot lose sight of the fact that the withdrawal of the device into a stationary orbit is harder than on low or even on the HEO. Shipping 1 kg of payload into geostationary orbit is much more expensive. To hold SISS at a given point "standing" for the desired longitude requires regular adjustment of the orbit with the help of micro-motors and on Board the satellite is necessary for these purposes, the fuel reserves. Maintaining control in flight. Development of space allows, however, to count on quick and successful overcoming all the problems arising from the establishment and operation of satellite communications

systems on geostationary.

Successfully operating Soviet geostationary communications satellites and television broadcast type Raduga, Ekran, Gorizont.

In operation of foreign communications satellites of the type "Intelsat", "Domsat" (USA), "Telesat" (Canada) and others.

Despite its advantages, geostationary, but not in all cases advantageous in technical and economic terms. Under certain conditions, more efficient use of satellites in highly elliptical orbits, such as the type "Lightning".

The bandwidth branching systems, the reliability and efficiency of the SSS is constantly growing. Multiprogram TV gradually incorporated into all new areas, including the most remote corners of Russia. Increased the value of SSS in the management of various sectors of the economy, in systems of mass education, alerts about the different kinds of natural phenomena, medical care. Massive widespread mobile satellite communications, allowing fast and virtually in all parts of the country to communicate with satellites.

Significantly expanded international cooperation in the use of satellite communication systems, develop system "Intersputnik", "Hospital" increased their interaction with the systems "Intel-sat", "Inmarsat" and other SSS around the world.

Millions of people have the ability to direct the use of SSS for individual communication with any subscriber of the world with low power and very compact transmitting and receiving devices (mobile phones). Really use CCC for "email" (Internet). It is also possible the use of PPE for individual definition of the site at any point of the globe. This assumes that users will be small and cheap personal navigation devices like a small transistor.

Every year satellite communication systems will become increasingly essential part of Unified communications, an important element of the global communication system. They now play a significant role in improving relations and understanding between countries and over time, this role will increase.

The beginning of the space age

On 4 October 1957 the USSR launched the world's first artificial Earth satellite. The first Soviet satellite made it possible to measure the density of the upper atmosphere, to obtain data on the propagation of radio signals in the ionosphere, to work out issues launch, thermal regime, etc. the Satellite represented an aluminum sphere with a diameter of 58 cm and weight was 83.6 kg, with four whip antenna length 2.4-2.9 m. In a hermetic enclosure of the satellite housed the equipment and power supplies.

Initial orbital parameters were: perigee altitude of 228 km, apogee altitude of 947 km, inclination of 65.1 degrees. November 3, the Soviet Union announced the launching into orbit of the second Soviet satellite. In a separate hermetically sealed cabin was the dog Laika, and a telemetry system to check its behavior in weightlessness. The satellite was also equipped with scientific instruments to study solar radiation and cosmic rays.

December 6, 1957 in the USA attempted to launch a satellite "vanguard-1", using a booster developed by the Research laboratory of the Navy. After ignition, the rocket went over the starting table, however in a second the engines shut down and the rocket fell on the table, exploding on impact.

January 31, 1958, was launched into orbit satellite "Explorer 1", the American response to the launch of the Soviet satellites. Size and weight he was not a candidate in Champions. As long less than 1 m and a diameter of only ~15.2 cm, he weighed only 4.8 kg. However, its payload was president to the fourth, last stage of the rocket-medium "Juno-1". The satellite with a missile in orbit had a length of 205 cm and weight 14 kg. It was installed sensors of external and internal temperatures, sensors for erosion and impacts to determine the fluxes of micro-meteorites and Geiger-Muller for the registration of the penetrating cosmic rays.

An important scientific result of the flight of Sputnik was the opening surrounding the Earth radiation belts. Geiger-Muller stopped the account when the craft was at apogee at the altitude of 2530 km, the perigee altitude was 360 km.

5 Feb 1958 in the USA was made a second attempt to launch a satellite "vanguard 1", but it also ended in failure as the first attempt. Finally on March 17 the satellite was launched into orbit. In the period from December 1957 to September 1959 it was made eleven attempts to launch "vanguard-1" only three of them were successful. Both satellites have contributed to space science and technology (solar panels, new data on the density of the upper atmosphere, precise mapping of the Islands in the Pacific ocean, etc.) 17 Aug 1958 in the United States was the first attempt to send from Cape Canaveral in the vicinity of the moon probe with scientific equipment. She was unsuccessful. The rocket went up and flew just 16 km First stage of the rocket exploded on flight 77. October 11, 1958, was made a second attempt to launch a lunar probe "pioneer-1", also failed. The next few launches also failed, until March 3, 1959 "pioneer 4", weight 6,1 kg partially completed the task successfully: passed the moon on distance of 60000 km (instead of the planned 24000 km).

As with the launch of Sputnik, the priority in the launch of the first probe belongs, Union, January 2, 1959 launched the first man-made object that was placed on a trajectory passing close enough to the moon, orbit the Sun. Thus the "Moon-1" for the first time reached the second cosmic speed. "Moon-1" had a lot 361,3 kg and flew past the moon at a distance of 5500 km 113000 miles away from Earth with a rocket stage, docked to the "moon-1", was released a cloud of sodium vapor, ogrzewanie artificial comet. Solar radiation caused a bright glow of sodium vapor and of the optical system on the Ground took pictures of the cloud on the background of the constellation Aquarius.

"Luna-2" was launched 12 Sep 1959 made the world's first flight to another celestial body. In 390,2-pound sphere housed the instruments, which showed that the Moon has no magnetic field and radiation belts.

Automatic interplanetary station (AMS) "Luna-3" was launched on 4 October 1959 the station Weight was equal to 435 kg. the Main purpose of the launch was a flight around the moon and photograph its back, invisible from the Land side. Photographing was carried out on 7 October for 40 min with a height of 6200 miles above the Moon.

Man in space.

April 12, 1961 at 9 h 07 min Moscow time, a few dozen kilometers Severnye the village of Tyuratam in Kazakhstan at the Soviet Baikonur cosmodrome hosted launch of an Intercontinental ballistic missile R-7, in the forward compartment which houses manned spacecraft "Vostok" with the air force major Yuri Alexeyevich Gagarin on Board. The launch was successful. The spacecraft was launched into orbit with an inclination of 65 g, a height of perigee of 181 km and an apogee of 327 km and made one revolution around the Earth in 89 min At 108 minutes after launch, he returned to Earth and landed near the village Smelovka, Saratov region. Thus, 4 years after the launch of the first artificial Earth satellite by the Soviet Union for the first time in the world carried out a manned flight into space.

The spacecraft consisted of two compartments. Lander, who is also the cabin the astronaut, was a sphere with a diameter of 2.3 m, is covered with ablative material for thermal protection during reentry. Control of the ship automatically, as well as an astronaut. In flight continuously maintained with the Ground. The atmosphere of the ship — a mixture of oxygen with nitrogen under a pressure of 1 ATM (760 mm Hg. calendar). "Vostok-1" had a weight of 4730 kg, and with the last stage booster 6170 kg. Space ship "Vostok" was displayed in the space 5 times, after which it was announced about its safety for human flight.

Four weeks after Gagarin's flight may 5, 1961, the captain of the 3rd rank Alan Shepard became the first American astronaut. Although he never reached earth orbit, he rose above the Ground to a height of about 186 km, and Shepard launched from Cape Canaveral in KK "mercury-3" with a modified ballistic missiles "Redstone", spent 15 minutes in flight with a 22 before landing in the Atlantic ocean. He proved that a person in conditions of weightlessness may realize the manual control of the spacecraft. KK "mercury" was significantly different from the spacecraft "Vostok". It consisted of only one module, the manned capsule in the form of a truncated cone long 2.9 m and a base diameter of 1.89 m. It sealed the shell of the Nickel alloy were lining titanium to protect it from heating during atmospheric entry. The atmosphere inside the mercury was pure oxygen at a pressure of 0.36 at.

On February 20, 1962, the United States reached low-earth orbit. From Cape Canaveral was launched the ship "mercury-6", piloted by Navy Lieutenant Colonel John Glenn. Glenn remained in orbit for only 4 h 55 min, having 3 coils to a successful landing. The purpose of the flight Glenn was the definition of the ability to work in QA "mercury". The last time the mercury was launched into space on 15 may 1963

March 18, 1965 was put into orbit spacecraft "Voskhod" with two astronauts on Board — the commander Colonel Pavel Ivanovichem Belyaev and co-pilot, Lieutenant Colonel Alexei Arkhipovich Leonov. Immediately after reaching orbit, the crew cleared himself from nitrogen, breathing in pure oxygen. Then was deployed airlock : Leonov entered the airlock, closed the hatch and KK for the first time in the world made out of space. Cosmonaut with Autonomous life support system was outside the cabin KK for 20 minutes, sometimes moving away from the ship to a distance of 5 m. During graduation he was connected with QC only phone and telematicheskikh cables. Thus, it was practically confirmed the possibility of stay and work of an astronaut outside the spacecraft.

June 3, was launched spacecraft "Gemini-4" captain James Mcdivitt and Edward white. During this flight, which lasted 97 hours 56 min white came out of KK and held outside the cab 21 min, checking the ability to maneuver in space using manual jet gun by compressed gas. Unfortunately the space is not without casualties. 27 January 1967 the crew was preparing to make its first manned flight program "Apollo" were killed during a fire inside KK burned for 15 s in an atmosphere of pure oxygen. Virgil Grissom, Edward white and Roger Chaffee become the first American astronauts killed in spacecraft. April 23, from Baikonur launched a new spacecraft "Soyuz-1" piloted by Colonel Vladimir Komarov. The launch was successful. On 18 round, after 26 hours and 45 minutes after starting, the Mosquitoes began orientation for atmospheric entry. All operations were normal, but after atmospheric entry and braking refused the parachute system. The astronaut died instantaneously at the moment of impact of the Union on the Ground with a speed of 644 km\h. In the future, the Space took human life, but these sacrifices were the first.

Voices from outer space.

In television (TV) programs, there is no mention of the fact that the transmission is via satellite. This is another evidence of the huge success in the industrialization of space has become an integral part of our lives. Communication satellites literally span the world by invisible threads. The idea of creation of communications satellites was born shortly after the second world war, when A. Clark issue of the journal "World of radio" (Wireless World) October 1945. presented the concept of relay communication station located at a height of 35880 km above the Earth. Merit Clark was that he had determined the orbit on which the satellite is stationary relative to the Earth. This orbit is called a geostationary or Clarke orbit. When moving in a circular orbit with a height of 35880 km one revolution is completed in 24 hours, i.e. during the period of the daily rotation of the Earth. A satellite moving in such an orbit will always be over a certain point on the surface of the Earth. The first communications satellite "Telstar 1" was launched still in low earth orbit with parameters 950 x 5630 km that happened on 10 July 1962. Almost a year later was followed by the launch of the satellite "Telstar-2".

The first show was shown the American flag in New England on the background of the station in Andover. This image was transferred to the UK, France and on the American station in new Jersey in 15 hours after the launch of Sputnik. Two weeks later millions of Europeans and Americans watched the talks of people on the opposite shores of the Atlantic ocean. They not only spoke but saw each other, communicating via satellite. Historians can consider this day as the date of birth space TV.

The world's largest public satellite communication system created in Russia. It was started in April 1965. launch of series of satellites Molniya displayed on silhouette an elliptical orbit with the apogee over the Northern hemisphere. Each series includes four pairs of satellites circulating in orbit at angular distance from each other 90 degrees. On the basis of the satellite "Molniya", built the first system for deep space network "Orbit". In December 1975. a family of communications satellites has been enriched with satellite "rainbow", operating on the geostationary orbit. Then came the satellite "Screen" with a more powerful transmitter and a more simple ground stations. After the first development of satellites has entered a new period in the development of satellite communication technology when satellites began

to withdraw into geostationary orbit in which they move synchronously with the rotation of the Earth. It is possible to establish persistent communication between ground stations using satellites of the new generation : American "sinkom", "Earle bird" and "Intelsat" Russian Raduga and Gorizont.

A great future is associated with a location in geostationary orbit the antenna complexes.

Space meteorology.

After the launch of the Soviet and American satellites, the question arose about the practical use of the developed technology. The possibilities of the instruments and satellites themselves have attracted the attention of meteorologists from the point of view of obtaining regular information on the ever-changing weather on a global scale.

The first attempt in this direction was taken by the Americans ,who created a family of meteorological satellites of the "tiros". Nine of these satellites was put into orbit in the period 1960-1965. Each satellite was equipped with two small TV cameras and approximately half of the satellites is a scanning infrared radiometer to image the cloud cover of the Earth . In Russia, meteorological spacecraft has become the satellite "meteor". Two or three satellites of this series are in orbit at the same time and gather information about the state of the atmosphere , thermal radiation of the Earth, etc. Payload of the satellite consists of opto-mechanical TV equipment operating in the visible region of the spectrum. In addition, there are infrared scanning apparatus for obtaining data on the moisture content of the atmosphere and the vertical temperature profile. Warning of sudden weather changes on the combined data from weather radar and satellites, transmitted by radio from Moscow, St. Petersburg and other centers, and special service reports this information on vessels and aircraft. Over the last 20 years has significantly increased the quantity, quality and reliability of the review with the help of satellites.

Since 1966, the Earth is regularly photographed at least once a day. Photographs are used in everyday work, as well as placed in the archives. The meteorological information acquired from satellites is steadily becoming

more important. Currently, it is widely used by meteorologists and specialists in the environment all over the world in daily practice and are considered almost mandatory for tests and short-term forecasts. Meteorological information from all of the light enters the National service of environmental control with the aid of satellites, located in Washington, is processed into materials of a wide range and is distributed worldwide. Satellite information has been particularly useful in two areas of study. First, there are large areas of land, of which the meteorological information by conventional means are unavailable. This area of the oceans of the Northern and southern hemispheres, deserts and polar regions. Satellite data fills in these gaps, identifying large-scale features of the formations of the clouds. The latter include storm systems, fronts, the most significant mejdunarodnye troughs and ridges, jet streams, dense fog, stratus clouds, ice conditions, snow cover and partly to the direction and speed of the strongest winds. Secondly, the satellite information was successfully used to track hurricanes, typhoons and tropical storms. Satellite information includes information about the presence and location of atmospheric fronts, storms, and total cloud cover. In the end, currently the satellite has become almost a recognized tool of meteorologists in most countries of the world. Weather maps that in the evening appear on our television screens, clearly indicate the value of observations from satellites for the provision of meteorological systems.

The study of Earth from space.

Man first appreciated the role of satellites to monitor the status of agricultural land, forests and drogenpolitik resources of the Earth only a few years after the onset of the space age. It all started in the 1960's, when using meteorological satellite "tiros" was received like a map of the outlines of the globe lying under clouds. These first black and white TV image gave a very vague idea about human activities and yet this was the first step. Soon developed new technical means, allowing to improve the quality of observations. Information was extracted from multispectral images in the visible and infrared (IR) regions of the spectrum. The first satellites designed to make maximum use of these opportunities was the "Landsat". For example, satellite "Landsat-D", the fourth of the series observed the Earth from a height of over 640 km using the improved sensitivity of instruments, allowing consumers to obtain significantly more detailed and timely

information . One of the first applications of images of the earth's surface, was cartography. In despotiko era maps of many regions, even in developed parts of the world were drawn inaccurately. Images obtained by satellite "Landsat", allowed to adjust and update some of the existing maps of the United States. In the USSR image received from the station "salute" turned out to be essential for the alignment of railway tracks BAM.

In the mid 70-ies of the NASA, the Ministry of agriculture of the USA has decided to demonstrate the capabilities of the satellite system in forecasting the most important agricultural culture of wheat. Satellite observations proved unusually accurate was later extended to other crops. Around the same time in the USSR, monitoring of agricultural crops is conducted with satellites of series "Cosmos", "meteor", "monsoon" and orbital stations "Salyut".

The use of satellite imagery has revealed its advantages in the estimation of the volume of timber in large areas of any country. Became possible to control the process of deforestation and, if necessary, to make recommendations on contouring of the area of deforestation from the point of view of better preservation of the forest. Thanks to images from satellites has been possible to quickly assess the limits of forest fires, especially the "coronopus", harakternyh for the Western regions of North America , as well as areas of Primorye and southern areas of Eastern Siberia in Russia.

Great importance for humanity as a whole has the opportunity to observe almost continuously over the oceans of the World, this "forge" the weather. Over by thick layers of ocean water are the origin of the monstrous strength of hurricanes and typhoons, carrying numerous victims and destruction for the inhabitants of the coast. Early warning of the population is often crucial to save lives of tens of thousands of people. Definition of stocks of fish and other seafood are also of great practical importance . Ocean currents often distorted, changing course and sizes. For example , the El Nino warm current in the South direction off the coast of Ecuador in some years may extend idol the coast of Peru to 12 g. Yu.sh. . When it comes along plankton and fish are dying in huge numbers, causing irreparable damage to fisheries for many countries including Russia. Large concentrations of single-celled marine organisms, increase mortality of fish, perhaps because they contained toxins. Observation from satellites helps to identify the "whims" of such flows and

provide useful information to those who need it. According to some estimates of Russian and American scientists fuel economy combined with the "extra catch" through the use of satellite information obtained in the infrared range, gives an annual profit of \$ 2.44 million. The use of satellites for the purposes of the review has facilitated the task of laying rate ships.

In operation of the Russian nuclear-powered icebreaker "Sibir" was used information from four types of satellites to obtain a safe and economical ways in the Northern seas. Received from navigation satellites "Kosmos-1000" information used in a computer of the vehicle to determine the exact location. Satellites "meteor" were images of the cloud cover prognozy snow and ice conditions, which allowed us to choose the best course. With help of the satellite Molniya maintained communication with the vehicle base. Also with the help of satellites find oil pollution, air pollution, minerals.

The science of space.

Within a short period of time from the beginning of the space age, people not only sent an automatic space station to other planets and set foot on the moon, but also made a revolution in the science of the cosmos, which had no equal in the history of mankind. Along with the great technical achievements caused by the development of cosmonautics, were obtained new knowledge about planet Earth and its neighboring worlds.

One of the first important discoveries made not traditional to the visual and another method of observation was the finding of a sharp increase with height, beginning from some threshold height, the intensity of the previously considered isotropic cosmic rays.

This discovery belongs to the Austrian V. F. Hess, started in 1946, a gas balloon with equipment to great heights. In 1952 and 1953 Dr. James van Allen conducted studies of low energy cosmic rays when the spins near the magnetic North pole of the Earth small rockets to a height of 19 to 24 km and high-altitude balloons-cylinders. After analyzing rezulaty conducted experimentation, van Allen proposed to place on Board the first American artificial satellites is quite simple in design detectors of cosmic rays.

Via satellite "Explorer 1" the inferred U.S. into orbit on 31 January 1958 it was discovered a sharp decrease in the intensity of cosmic radiation at altitudes above 950 km. At the end of 1958 AMC "pioneer-3" preodolevaya the day of the flight distance of over 100,000 km, registered with the available onboard sensors, the second located above the first radiation belt of the Earth, which also surrounds the entire globe.

In August and September 1958 at the height of more than 320 km were produced three atomic explosion, each with a power of 1.5 CT. The purpose of the test, codenamed "Argus" was studying the possibility of loss of radio and radar communication in such tests. The study of the Sun — the most important scientific task, the solution of which is dedicated to a launch of the first satellites and AMC.

American "pioneer 4 — pioneer 9" (1959-1968rr.) with the solar orbit over the radio on the Ground important information about the structure of the Sun. At the same time was launched more than twenty satellites "Intercosmos" to study the Sun and circumsolar space.

Flights AMS to the moon and planets.

In the early 60-ies in the United States and the Soviet Union were designed, manufactured and launched to the moon a number of AMS . The most successful for the Americans was the launch in July 1964. "Ranger-7", which was transmitted to Earth more than 4,300 high-quality TV images of the moon obtained before contact with the surface. The last image captured from a height of 1600 meters ,covers an area of 30×50 m. there were clearly visible craters with a diameter of 1 m.

In the Soviet Union was first created ability to implement a soft landing on the moon with the creation of the new AMC series "the Moon" in 1963. These stations weighing up to 1.8 t were designed for the delivery of the instrument container of mass 100 kg on the lunar surface.

When you run the AMS "Luna-9" in February 1966. was first successfully carried out a soft landing on the moon of an object made by human hands. The second "preludesys" station became "Luna-13". With the help of

mechanical groomer and radiation densitometer provided unique information on the density and composition of the surface of the soil. When you start AMC "Luna-17" was first given the task of movement on the lunar surface. After a successful landing with the landing stage was launched apparatus "Lunokhod-1". During 10 months of "Lunokhod-1", controlled from Earth by radio, was on the lunar surface more than 10.5 km. One of the brightest luminaries of the night sky is covered with clouds, the planet Venus was one of the first goals of flying AMS. For the first time the ability to run AMS emerged in the late 1960., when the Soviet Union was created the first booster And 2. In February 1961. taking advantage of the "window" for launch to Venus, the Soviet Union launched AMC "Venera-1" held at a distance of 100 million miles from Venus and went into orbit .

November 12, 1965 was launched, with the aim of achieving the surface "Venera-3". March 1, 1965, the station reached the surface of Venus by the first flight of AMS to another planet. In 1967, a successful flight station "Venera-4", aimed directly at the planet. At the distance of 45,000 km from Venus from the station separated spherical descent module (SA) with a diameter of 1 m, which is at the entrance to the planet's atmosphere survived the overload up to 300 g. The parachute system further ensured the descent in the atmosphere, which lasted 94 min. Was adopted information that at the height of 25 km the atmospheric temperature is 271 gr. and pressure 17-20 bar. On the planet's surface temperature smooth 475 grams. and a pressure of 15 ATM.

It was found that the atmosphere of Venus is composed almost entirely of carbon dioxide. Was later carried out several runs with the purpose of the immersion in the atmosphere of Venus.

The first space station launched to Mars on 1 November 1962, was Soviet AMC "Mars-1". The United States launched in 1964, the first two of AMC's "Mariner". The launch of the "Mariner-3" was unsuccessful and after three weeks in orbit, was launched "Mariner-4".

July 14, 1965, he flew a distance of 9600 km from Mars, finding neither radiation belts nor a magnetic field around the planet. It has been estimated that the pressure at the surface of the planet is less than 1% of the earth

pressure above the sea level and corresponds to the pressure in the Earth's atmosphere at a height of 30-35 km. On the surface of Mars were discovered craters similar to the moon.

The first Soviet AMC landing on Mars was "Mars-2" weight of 4650 lbs. In the composition of the soil was observed: 15-20 % silicon, 14 % iron, calcium, aluminum, sulfur, titanium, magnesium, cesium and potassium. In the air was observed 95% carbon dioxide 2.7% of nitrogen and signs of the presence of oxygen, argon and water vapor.

To mercury first went AMS "Mariner-10", originally sent to Venus in 1973 March 29, 1973, the spacecraft reached its target, the planet mercury, passing at a distance of 690 km from its shadow surface. During each flight was preceded by studies of the planet's surface. In the atmosphere of mercury have been found traces of argon, neon and helium a trillion times fewer than on Earth. The range of surface temperatures from 510 to -210 gr. the magnetic field strength 1% of earth mass planets 6% of the mass of the Earth.

It can also be sent to Jupiter and Saturn.

Man on the moon.

In accordance with the program "Apollo" in the period from 1969 to 1972 were sent to the moon nine expeditions. Six of them ended with the landing of twelve astronauts on the moon from the Ocean of Storms on the West to the Taurus mountain range to the East. The two first expeditions were limited to flights on selenocentric orbit, and landing astronauts on the moon in one of the expeditions were canceled because of the explosion of an oxygen tank for the fuel cell and life support system that took place two days after launch. Damaged the spacecraft "Apollo 13" flew over the moon and blah blah gopalan returned to Earth. The first landing site was chosen on the basis of basalt, the sea of Tranquility, located to the East of the center region of the lunar plains. Neil Armstrong (commander) and Colonel Edwin Aldrin (lunar module pilot) made a landing here in the lunar cabin (LK) "eagle" July 20, 1969 at 20 h 17 min 43 s Greenwich. The astronauts did a lot of photographs of the lunar landscape, including the rocks and the plains, and collected 22 kg of lunar soil samples for study on Earth. Coming the first of the LK and the last entering in it, Armstrong spent on the moon 2H 31MIN. During the sixth

expedition to the moon in December 1972, the residence time of the crew on the surface was 22 h 5 min travel Length on the moon had also increased by 100 m, which walked the first astronauts spacecraft "Apollo-11", up to 35 km on electric car drove the crew of "Apollo-17".

Expedition spacecraft "Apollo 17" was the last expedition to the moon. During six visits to the moon were collected 384,2 kg of rock samples and soil. In the process of implementation of the programme of studies were made a number of discoveries, but the most important are the following two. First, it was established that the Moon is sterile, it is not discovered any forms of life. Secondly it was established that the Moon, like Earth, has gone through several periods of internal heating.

The study of the moon using a manned SPACECRAFT was completed after the sixth successful landing of astronauts on its surface with the spacecraft "Apollo 17" in December 1972

Space station.

Work on the creation of manned space stations started in the US and the USSR almost simultaneously in the early 60-ies. But as Americans in the future, focused on the prestigious Apollo program, from the extensive program of space research in addition to the "Apollo" they were only orbital station Skylab launched into orbit may 14, 1973, and space transportation reusable spacecraft "Space Shuttle", which is the only manned deistvuyushim KK the United States.

Orbital unit space station (COP) was established on the basis of the missile of the S-4B third stage of the rocket-medium "Saturn-5", to deliver in due time a man on the moon. It (the rocket) hydrogen tank had been converted into a spacious two-storey room for a crew of three people. Full internal volume of the COP Skylab with docked her a modified main unit of the spacecraft "Apollo" — about 330 cubic meters (the volume of a small house with two bedrooms). The astronauts were breathing a mixture of oxygen with nitrogen at a pressure of 0,35 at at temperature of 21 gr. C.

For the period from may 1973 to February 1974 on the COP Skylab has

worked 3 of the crew. The latter, consisting of Gerald Carr, Edward Gibson and William Popa worked on Board for 84 days. July 11, 1979, the station entered the dense layers of the atmosphere and ceased to exist.

In the USSR work on the orbital of the COP program began in the late 60-ies. On 19 April 1971 to orbit rocket-medium "proton" was developed the world's first orbiting COP "salute-1". The station consisted of three main sections — the transition, the worker and the aggregate, represents a cylinder with a diameter of 2.9 m, 4.15 m and 2.2 m respectively. Full long orbital complex "Salyut-1" — "Union" — 21.4 m, weight more than 25 tons.

At COP "Salyut-1" worked one crew of Dobrovolsky, V. Patsayev, and V. Volkov died while returning to Earth. After 175 days after the launch of the team on the Ground worked brake motors KS "Salyut-1" fell into the Pacific ocean. All were operated successfully in orbit for seven stations series "salute". The last of them "Salyut-7" worked until the end of 1985.

In February 1986, the Soviet Union was bred in space orbital station of new generation "the World." Unlike its predecessors, "Fireworks", this station embodies a fundamentally new approach to move in near earth space. If "Fireworks" were both home and place of work, "Peace" was the basic unit, that is, the link, around which are grouped large specialized KA — scientific modules. In these large facilities, rich scientific and other studies. The station "Mir" is not only a link, obyedinyaet different KA in a single unit, but also performs the role of the center, where the crew controls the entire orbital complex. The first module — astrophysical Observatory Kvant docked to the "World" spring 1987 — slightly inferior in size to the station. The whole volume of the station is 40 cubic meters.

We came only in the fourth decade of the cosmic era, and already quite accustomed to such miracles as to cover the entire Earth satellite communications and weather observation, navigation and assistance will terbisil on land and at sea. As something quite ordinary we listen to the message mnogoetajnoe working people in orbit, not surprised at the footprints on the moon taken by "blank" photographs of distant planets, the SPACECRAFT first shown the comet nucleus. In a very short historical period, space exploration has become an integral part of our lives, a faithful

assistant in economic Affairs and knowledge of the world. And there is no doubt that the further development of a terrestrial civilization can not do without the development of the whole near-earth space. Space exploration — the "province of all mankind" — continues rapidly.

AMERICAN-RUSSIAN VENTURE IN SPACE.

American commercial company "SPACEHAB Inkorporeyted", which, by the way, some of the orders and NASA, and producing a pressurized modules for the space Shuttle, entered into an agreement with the Russian company Energia, which produces aerospace equipment and building and installation on the International space station special sealed module is designed to perform exclusively commercial projects. In this module, named the enterprise — "Enterprise" will be carried out experiments, and implemented processes for the orders of industrial firms. It will also serve as a basis for commercial transfers and interactive activities from space, said the official representatives of the company "SPACEHAB". The cost of a commercial module will be about \$ 100 million. 50 million of this amount, said the company's President, David Rossi, will be granted his company in cash, and the remaining funds will come in the form of long-term loans. With regard to the International Space station which is being built by 16 countries — the US, Russia, Japan, Canada, Brazil and 11 members of the European space Agency is at an altitude of 400 kilometers above the Earth, it will cost \$ 60 billion and will weigh 450 tons. The construction will be completed in 2004-m to year, after which the station will be the largest research laboratory in earth orbit. Ultimately, the US and other countries are hoping that the station will become fully or at least partially a commercial unit and will generate revenue that will reimburse spent money on it. New commercial module — the first step taken in this direction. "Our module will initiate a new era in space entrepreneurship", — said the Chairman of "SPACEHAB" Dr. Shelley Harrison is planning the future construction of such modules according to the specifications of commercial customers. The employee research group at the us Congress Marsha Clark, which specializiruetsya on space policy, agreed that the construction of a commercial module is a bold step towards the commercialization of space activities, which was limited to still only good intentions. Head of the international division, NASA Dr. John Schumacher said the countries participating in the construction of the Space station have signed the agreement on the procedure for space extensions on their

electricity supply from a common grid, and so on. The President "SPACEHAB" Harrison explained that a commercial module would be a sealed cylinder of length 11 and a diameter of 3.5 meters, and will weigh from 6.5 to 9 tons. In addition to purely commercial scientific and technical activities, the module will be used for educational purposes in schools and universities around the globe, as it is already practiced with the space shuttles, as well as for television and Internet broadcasts with a paid advertising Supplement.

In the framework adopted by the President of the Russian Federation during the visit of Bill Clinton to Russia of the decision in 1998 will continue bilateral talks, and then work on further arrangement of the joint Center for monitoring missile launches. This was announced by the representative of the Russian defense Ministry. The beginning of the joint control Centre has already been made. It is formed on the basis of the Russian analytical Center for early warning. Until recently, the Centre jointly with the Center for strategic stability "Problems-2000" (Paterson air force base, Colorado springs, USA) performed the functions of collection, processing, analysis and assessment of the emerging missile and space situation in connection with the transition of the computer systems of the military departments of Russia and the USA in 2000-th year. Epic "Problems-2000" was successfully completed. Western analysts' forecasts on the possible failures of computers of the Armed Forces of the Russian Federation were not confirmed. Currently, the main burden of further development of the Center rests on the shoulders of employees of nits, Ministry of defense of the Russian Federation. At the point of collection and processing of information by the special operative communication to receive information from the defense ministries of Russia and the USA. There are preconditions to what is already in the current year for consoles and computers sit analysts of the strategic nuclear forces of both countries.

PEACE TO THE WORLD

TWO DEVELOPMENT PLAN

The fate of the orbital station "Mir" in 2000 remains uncertain. The debate about its preservation in orbit or sinking in the ocean with the participation of

the government of the Russian aerospace Agency (CANCER) and companies of the space industry continues.

There was a 2 plan developments this year. Under the first plan, supported CANCER, the Mir station had to be submerged in the ocean at the end of June. The plan called for sending a "Mir" at the end of April one of the crew who will work for two months. Astronauts prepare the station for mixing with an orbit. Also provided for sending to the station two unmanned cargo ships "Progress" in January and in May 2000, CANCER believes that the station is to sink to send all funds for the implementation of Russian part of International space station project. The second plan was proposed rocket-space Corporation "Energy", which is engaged in the service station "Mir". The plan provides for the preservation of the habitats in orbit for 2000. The astronauts will have to go on a "World" at the end of April, but will remain on the station for six months until the arrival of the next crew in October. In addition, it was envisaged sending in "Peace" four cargo ships "Progress".

Now RSC Energia is engaged in the search for Western investors because the government-allocated funds for the full operation of the station is not enough.

Annual station operation cost of 200 million dollars was not affordable. "A sin to leave "the World", — said the press Secretary of the RSC "Energy" Sergey Gromov. — He's already 14 years in orbit and can run indefinitely, because 80 percent of the equipment when necessary can be replaced. We were trying to find funds for maintaining the station. Created charitable foundations, started my own account." However, according to Gromov, profit is not produced and had to look for Western partners.

For the maintenance of the station until August will need 750 million rubles to be attracted from extrabudgetary sources.

21.01.00 in 8 hours 30 minutes on the orbital complex "Mir" was included on-Board computer. The onboard computer is included for the preparation of the "Peace" cargo ship "Progress", the launch of which was scheduled for 1 February. "Progress" delivered to "the World" oxygen to maintain normal pressure inside the station. When it recovers, the orbiting complex will be ready to receive the 28th main expedition, which will be launched at the end

of March — beginning of April.

The expedition will be financed from extra-budgetary sources. Some American firms "the Golden Apple" signed under the project and allocated \$ 20 million.

7 and 9 February was the inclusion of the onboard engines of the Mir station to adjust its orbit. As a result of these actions, the orbit of the station was raised to a height of 30 km, Now the station is on a given orbit with the following parameters: the minimum distance from the Earth is 352 km, and maximum 369 km. To adjust the height of the orbit of the station was about 320 km above Earth, that is, "the World" dangerously close to the upper layers of the atmosphere, where additional braking its height could be further reduced. Now the onboard computer of the station will be disabled and it will go into a slow uncontrolled spin. 30 March to the station was supposed to leave the crew after a long hiatus. Before his arrival in the compartments of inflated air, brought a cargo spacecraft "Progress M-1".

Russian cosmonauts on the Mir station needs to perform many tasks, including testing equipment to prevent leaks of air from the space station modules. One of the modules has a hairline fracture, through which the leak occurs. Russian cosmonauts should also check out the base station unit is the oldest of the modules, and solar panels of the Kristall module. As reported by CNN, the continuation of the work on the station was made possible due to the fact that international investors are found for 30 million dollars. Company MirCorp (the Netherlands), rent "the World" Russia wants, according to CNN, turn it into a "space hotel". MirCorp hopes to extract from the plant operation profit. She is in talks with several advertising companies and scientists interested in conducting experiments According to MirCorp, the astronauts will stay aboard the station for 45 days. They should investigate its condition and to determine the need for repairs. If MirCorp will not be able to receive financial support sufficient to continue operation of the plant, it will be her last crew.

CAMPING TRIPS TO "THE WORLD"

The fate of the Russian space station Mir has repeatedly hung in the balance.

And that seems to be her anchor of salvation. American financier Walt Anderson set out to transform the Russian space station in the industrial Park and the hotel is in orbit.

According to reports from several sources, the 19th of June, the company MirCorp, which is engaged in the exploitation of the orbital station "Mir", planning to submit the first space tourist who will go to "World". Reportedly, his name is Dennis Tito (Dennis Tito). He is a former engineer for one of the divisions of NASA, and now he is the founder of the investment firm of Los Angeles Wilshire Associates. If all this be true, then Tito will fly to the station "Mir" as a "civilian researchers" in January 2001. in the second or third commercial crew, he's going to stay 7 to 10 days. The cost of "vouchers" to "the World" has not yet been announced, but expect it to be from 10 to 40 million dollars. Last week representatives of MirCorp said that they have one good candidate for space tourists — "a rich lover to risk long been interested in space." Tito, like, fit this definition. He received a bachelor's degree and a postgraduate degree from new York University in Aeronautics and Astronautics in the 60-ies he worked at the jet propulsion Laboratory (JPL). In the 70's, he left the aerospace field and in 1975 he founded the investment firm Wilshire, which is now one of the largest consulting companies in the US. However, previous experience with foreign space tourist was unsuccessful. In 1999, the Russian space Agency has announced that British businessman Peter Llewellyn (Peter Llewellyn) will pay \$ 100 million. for the flight on station "the World". But then it turned out that at home he was once prosecuted for fraud in business. In addition, it turned out that his flight to the Mir he was going to use to raise money for the children's hospital, which he intended to build in Russia, and to pay for the flight he had planned.

THE FLOODING OF THE STATION

The decision about the necessity of flooding the complex was adopted by the Council of chief designers of space-rocket techniques. Soon the appeal will be sent to the Russian aviation and space Agency and the government — there is a solution designers must obtain approval. On the whole operation by flooding the space station in the southern part of the Pacific ocean will require 600 million rubles For this, you will need to build a modernized cargo ship

"Progress M-1". The process of flooding of the Mir station will be completely automated. However, in the case of an emergency situation you will need to run to the station astronauts. In this regard, it was decided to start preparing for such option of manned spacecraft "Soyuz".

The station still does not fall, it is continuing its overflights of the globe. But with each orbit dense layers of the atmosphere near, then nothing can keep the "Peace", he will rush to the Ground. To avoid this, the Council of chief designers made the decision to raise the orbit of the station. To do this, it will fly fully fueled cargo ship "Progress". The launch is scheduled for October 16. Such efficiency is really necessary: until the gathering of the "World" from an orbit according to latest calculations, ballistics have remained between 11 and 15 weeks. A more exact date can not be named because the behavior of a station depends on solar activity: flares on it significantly inhibit the flight of the orbital complex. During periods of active Sun, repeating every eleven years (and now this is the peak), the station is reduced by more than 300 meters per day, and in the quiet years — only 80-100. It is not clear how to behave in the Sun in the coming months. If the activity is high, "Peace" (if not raised orbit) fall to Earth at the end of December 2000. Slightly lower activity of the Sun — the time of the fall is transferred to the end of January 2001.

And yet the Russian government at its meeting approved the allocation of 750 million rubles for the maintenance of the station "Mir". In November of 2000. the bill proposes amendments to the Federal budget for next year was submitted to the Duma. Previously it was assumed that if additional Federal funds will not be sought to support the station in orbit, the station will be sunk in the Pacific ocean in February next year. Now before the lower house of Parliament is a very important and responsible task. It will have to resolve the dispute with the orbital station, which, according to some, must be destroyed as long ago worn out, but, as others, can be retained to support the level of space industry in Russia at the appropriate level. Meanwhile, from Star city to the Baikonur cosmodrome, the crew flies first long-duration expedition to the International space station. This American William shepherd and two Russian — Yuri Gidzenko and Sergei Krikalev. The launch from Baikonur is scheduled for October 31. The three astronauts will be working on the ISS for 117 days.

The flight of the Russian space station "Mir" provide a total of about 80 thousand people. It is possible that flooding of the complex, scheduled for February 2001, some of them will be unemployed, but most will lead to other projects, — have informed in the mission control Center. Work on "the World" by specialists of the Mission control centre, rocket and space Corporation Energia, TSNII of machinebuilding and several dozens of design bureaus and enterprises throughout Russia. In the suburban MCC control of the flight station are a few hundred people. But none of them will be unemployed after flooding "the World". All the specialists will go to work with the international space station.

Mars Polar Lander

In 2003 the European space Agency (ESA) plans to send to Mars cheap spacecraft Mars Express with the descent camera that will search for water on Mars and signs of life. As reported, during the preparation of this expedition guide ESA intends to consider the mistakes made by NASA during the last two unsuccessful Mars missions. However, the risk of an accident can not be absolutely ruled out.

Mars Express, as reported, will also be built faster and cheaper than any other comparable spacecraft ESA. The launch of Mars Express is scheduled for June 2003, will bring the Ship into space a Russian carrier rocket "Soyuz" with the upper stage "Fregat". Arrival at Mars is scheduled for December 2003 the aim of the expedition will be to find groundwater to be maintained and the Orbiter, and the lander on the Martian surface. The space ship will be equipped with 7 scientific instruments that will perform a series of experiments on remote sensing of the atmosphere and soil of the planet. The lander is called Beagle 2 after the ship on which Charles Darwin conducted research on the terrestrial fauna in 1831

The spacecraft Mars Polar Lander, a trail which was lost near Mars on December 3 last year, according to scientists, is in a gigantic crater with a depth of about a kilometer on the West part of the surface of the planet. The walls of the crater located at an angle of 20 degrees, and the design of the Rover allowed him to land on slopes no more than 10 degrees. The cause of the accident in case of confirmation of this theory may be human error —

delayed transfer to the center of the flight planning critical information about the presence of the canyon in the proposed area of landing of the Rover.

Programmed to the first communication session with a receiver antenna that is installed in the California desert Mojave, after the first half hour after the alleged landing on the South pole of Mars, Mars Polar Lander did not respond. Fails and subsequent attempts the next two days and all this reduces the probability of success of the entire mission, although the leaders of the project planned the use of several natural “Windows”, when the signal from the South pole of Mars has been available to earthlings. The extreme of them — December 7, 12-20 a.m. Pacific time via another Mars probe is working successfully for 2 years of the Mars Global Surveyor. And before the expected landing on the evening of 3 December, all went according to plan, the morning of 30 November NASA made sure that he finished fourth, on account the prescribed manoeuvre and reduce the speed to the required 60 inches per second and at the same time the operator of the flight Dr. Sam Thurman said that the camera on the right path to the goal. Launched on 3 January this year, the Mars Polar Lander is under close attention of scientists not only due to set before him a scientific task, but in connection with the September misunderstanding when the group start lost of the Mars Climate Orbiter suddenly found that the software developed by them with no adjustments for differences in the system response. After all, who made this machine Lockheed-Martin works in the International system of units, i.e. uses the value as the meter, kilogram, etc., while NASA operate miles and pounds. Silence is expected at the South pole of Mars companion explained from the very beginning or deviation of the antenna, either its breakdown or a failure of the onboard computer, though small — semisodium, but of the ship. The associated press cites another version of the Lander could have burned in the explosion, separating it from the Deep Space 2 probes, which carried him to Mars, by the way, the most favorable for the life of the planet (after Earth). Scientists are interested in Martian groundwater and climate in General, launched 11 months ago, the Lander is equipped with a microphone to record all the sounds of the Martian nature. A relatively bright picture of the Martian landscape was obtained through a successful expedition 97-th year. And later in our Technology-youth appeared an article by candidate of physico-mathematical Sciences Muscovite Alexander Rabinovich, Mars is sparse ring, a collision with which particles are led astray by landers.

January 6 in the Denver Post published an article, which stated that the research probe Mars Polar Lander (MPL) during the Mars landing crashed on the steep canyon walls near the South pole of this planet. The company Lockheed Martin Astronautics at the time, built the probe MPL, and an unnamed source from the company cited the words of the leaders of the project. Moreover, the existence of this canyon was unknown until mid-December, when we received very detailed topographic map of the landing area, created based on the data of laser altimeter Mars Orbiter Laser Altimeter (MOLA) defined on the space probe Mars Global Surveyor. On this map see the canyon, located just where it is now expected and crashed Mars probe. The depth of this canyon 1-1,3 km, and If the probe was in him, he, without any doubt, crashed. However, silence is not only MPL, but also the micro probes that were supposed to be separated from him shortly before entering the atmosphere, says that the accident occurred before the fall. Apparently, for some reason, the micro probes are not separated after the reset cap of the spacecraft, if the reset actually happened. Official comment on this issue either from Lockheed Martin or from the project Manager at the jet propulsion Laboratory was not. While trying to catch any signal from the MPL probe is continuing, although all know they're useless. Orbiter Mars Global Surveyor continues to survey the intended landing area, but sent him the photos do not show any signs of either of the probe or of its braking parachute.

The leaders of the Martian project recognized the loss of the Mars Polar Lander probe. For two weeks there were repeated attempts to catch the signal of the probe, but in vain. Currently the project is entering a new stage. You need to find out why have not been in contact probe MPL and two micro probe Deep Space Two. Since no information from the probe since the entry in the upper atmosphere of Mars has not been received, to determine what happened pretty hard. Guess you can build a variety of. Located on the Martian orbit, the Mars Global Surveyor probe (MGS) began shooting the alleged landing site Mars Polar Lander. From 16 to 24 December, the probe made several series of photographs of the Martian surface. Unfortunately, the resolution of the MGS camera does not allow to distinguish in the picture the probe itself, but may be able to see 20-foot diameter parachute used for braking in the atmosphere. Currently, processing of photos, after which a decision will be made regarding further prospecting.

NASA launched a new attempt to contact AMC "Mars polar lander". According to NASA, the decision to try was made after the participants of the Mars project managed to find comes from this planet, a very weak radio signal, which may have belonged to the missing station. The last time the Earth was heard "Mars polar lander" December 3, just before the device was supposed to enter Martian atmosphere. According to existing plans, the station for 90 days was to study the climate of Mars and search for water beneath the surface of the planet. But instead, "Mars polar lander" became the second interplanetary apparatus, the victim in just 3 months fail on this planet. Attempts to contact him were formally terminated on January 17. However, re-analysis of previously recorded data showed that on 18 December and 4 January, the radio antenna at Stanford University, might have heard the "call sign" of the device at a cost of 165 million dollars. But the signal was so weak that then he was not noticed and only now, having spent several weeks of painstaking work, the team was able to find something that resembled the spacecraft's signal. In the end, January 25, on the "Mars lander" was sent to communicate with the antenna at Stanford University. But, as experts warn, even if the spacecraft and respond to the Earth, it will take another few days to signal to detect, decode, and perform. In any case, scientific information from the unit to will not succeed, but you may be able to establish the cause of the unsuccessful completion of an interplanetary expedition.

Now put forward several hypotheses, including the assumption that the device exploded at the entrance to the Martian atmosphere or landed on too steep a slope and overturned. A week later, was made another attempt to contact lost Mars Polar Lander probe. It was assumed that if the probe is "alive", it will execute the command on the transfer at midnight of 26 to 27 January signal about its existence. To detect this weak signal of the probe was again involved a radio telescope at Stanford University. In addition, with the assistance of NASA turned to a radio Observatory in England, Italy and the Netherlands, where he listened to the airwaves. For the analysis of the information requires quite a long time, but now experts from the Stanford radio telescope announced that they had failed to detect the probe signal. However, they are going to continue processing the received information in the hope that a more detailed analysis will reveal the signal of the probe.

THE FIRST ORBIT OF THE SPACE PROBE STARDUST

Research probe Stardust was launched on 7 February 1999. It is intended to collect cosmic dust and gas. The main purpose of this expedition is comet Wild 2, the probe needs to fly on 2 January 2004, two years after the meeting with the comet, Stardust should deliver on the ground collected samples of cosmic dust and gas for future research. The capsule with the samples separated from the spacecraft and will descend to earth by parachute. It is anticipated that these studies will help to shed light on the formation of the Solar system 5 billion years ago.

Recently carried out a correction of the trajectory of the Stardust vehicle with the inclusion of onboard engine for 5 minutes. As a result of this maneuver, its speed increased to 11 m/sec. 22 February 2000 and in July 2002 the probe to collect samples of interstellar dust in the Solar system. Comet Wild 2, which Stardust in the surrounding area have to collect cosmic dust and gas samples is considered to be an ideal candidate for research. A large part of its orbit, this comet is very far away from the Sun, so it practically collapses under the effect of its radiation. Therefore, it should be preserved substances, became in time the building blocks of our solar system. The Stardust probe will have to fly at a distance of 160 km from the nucleus of this comet.

In November 2002, the probe needs to fly past the asteroid Annefrank and photograph it. Thus, there will be tests of photographic equipment probe before meeting with the comet.

SPACE SHUTTLE ENDEAVOUR

The heads of NASA have confirmed earlier rumors were circulating about the change of plan for the launch of "Shuttle" in late 2000, Now at NASA considered the possibility of sending to the International space station for more expedition on one of the "shuttles". It is now called the estimated date of start "mapping" mission STS-99 Shuttle Endeavour on 31 January. On the launch of the next expedition STS-101 Shuttle Atlantis while it is only that he will be held not before 16 March. The crew of the Atlantis to go to the International space station to conduct Assembly work. However, the idea is that earlier it was supposed that this expedition will take place after the

launch of the Russian service module "Zvezda", but by 16 March due to problems with the proton booster launched, will not. In result, NASA had to redraw the plans for the ISS. Now consider the question of sending to the ISS for more expedition, probably with the same crew and in the mission

STS-101. That is, the original program works on mission STS-101 will be divided into 2 expedition. First go to the ISS until the launch of "Stars" and conduct the necessary maintenance work on the modules Zarya and Unity, and the second will take place after docking to the ISS Zvezda module. Then both of the expedition will be performed on the Shuttle Orbiter Atlantis with the same crew. But all this is under discussion.

With the first working day of the new year began actively preparing to launch Shuttle Endeavour on mission STS-99. The leadership of NASA has called the alleged time of its launch — 31 Jan 12 hours 47 min local time (20 h 47 min GMT). Earlier this expedition was scheduled for mid-September 1999, however, the runs of all the "Shuttle" was postponed due to a full scan of all electrical cables. In addition, initially, the mission STS-99 on Endeavour had to go into space before Discovery (mission STS-103), but a problem on the Hubble telescope made to change the order.

December 13, Endeavour was installed on the launch pad. This is still in the Assembly housing on it have replaced one of the engines.

The main goal of this 11-day expedition — shooting detailed maps of the globe with the help of a radar system installed in the cargo compartment of the Shuttle. This project is implemented by NASA in cooperation with the National mapping Agency of the USA (National Imagery and Mapping Agency) and the German space Agency DLR.

LAUNCH ROCKET "RUMBLE"

Representatives of Space center. Khrunichev and the Russian-German JV Eurockot announced that the launch rocket "Rumble", damaged during pre-flight tests in December of last year, was moved to March. According to initial plans the first demonstration launch of a rocket "Rokot" with upper stage block "breeze" from the Plesetsk cosmodrome was scheduled for 17 December 1999, Then announced the postponement of the start of the second

half of January 2000, which was explained by the necessity to conduct the most thorough preparation to the first start. However, on 22 December, during integrated tests of the rocket on the launch pad was damaged fairing) was dropped due to unauthorized operation of onboard electrical equipment and was damaged as a result of falling on the ground). The rocket was not fueled, and the satellite RVSN-40 also was not installed on it. Then it was decided to send a rocket Rokot with the upper stage for additional checks and tests. Representatives of the center. Khrunichev and Eurockot, the company announced that the implications of the incident was less serious than it seemed before. Fairing will be replaced and no other damage to the rocket and the launch pad is not detected. Eventually it was decided to postpone the launch of "Rokot" at the end of March. On the launch pad the rocket will be installed in January.

STUDIES OF THE MOONS OF JUPITER

American AMC Galileo successfully completed another stage of the research satellites of Jupiter, the largest planet in the Solar system. At this time, the powerful radiation belts of the giant planet does not affect the operation of onboard systems and onboard computer "Galileo." According to the staff of the jet propulsion Laboratory in Pasadena (California), "Galileo" once flew over the frozen world of Europe, where, as expected, under a thick layer of ice can support life. He then turned his attention to the study of the smaller moons of Jupiter — Amalthea, Thebes and Matidi. Interplanetary spacecraft also managed to perform a series of measurements of various characteristics of the volcanic activity of IO. The next meeting of the IO scheduled for 22 February and 30 may and on 28 December the messenger of the Earth will converge with the Ganymede. In addition, in December, "Galilee", apparently, will have to work in "the spark" with the spacecraft "Cassini", flying to Saturn, but this time will be close to Jupiter.

IN ORBIT SATELLITE "ARSENAL"

9.01.00, Sunday at 13.00 from the Baikonur "cosmodrome" carrier rocket "Cyclone-2" launched into orbit the Earth satellite "Cosmos-2367". A message obtained from the well-known in St. Petersburg design Bureau "Arsenal", which is the developer of this spacecraft made in the shops of

machine-building plant "Arsenal". Flying in an orbit in the New year's eve "Space", has on Board, besides the main instrument for solving problems of defense, created the St. Petersburg Physico-technical Institute named after A. F. Ioffe of the Russian Academy of Sciences instruments for the study of the bursts of cosmic gamma radiation. Thus will continue the experiment "Konus - a" successfully conducted in 1995-1997, with the satellite "Kosmos-2326" (also developed by the design office "Arsenal") in the framework of the joint Russian-American project "Konus - wind" in the field of astrophysics. As stated by the leaders of the design Bureau "Kosmos-2367" for a year or two, which is designed to work installed on the satellite equipment that will transmit to Earth valuable scientific information about some of the processes occurring in outer space. This last in this year's run, carried out in accordance with the Federal space program, is a peculiar result of half a century of activities of the design Bureau "Arsenal". Over the years it created more than 20 types of automated shipboard artillery and rocket launchers, the country's first large rocket engines solid fuel and solid-fuel ballistic missile strategic purpose. In recent years, the KB is mainly engaged in the development of spacecraft and systems for various purposes. Satellite flying in an orbit now 76-th, developed by St. Petersburg designers. In the coming years they plan to create a spacecraft with such devices that will register the processes that are harbingers of earthquakes to explore the Earth radiation belts and other phenomena occurring in space.

THE STABILIZATION OF THE PROBE DEEP SPACE 1

Research probe Deep Space One (DS1) November 11 of last year went into safe flight mode after experiencing a failure in the orientation system of the ship by the stars. This system since the launch in October 1998 repeatedly fails, but before she returned to normal operation within hours. This time it was much more serious, and experts came to the conclusion that to restore its work will not succeed. Therefore developed methods of organization of work of the probe without using the orientation of the stars. On-Board computer was sent to the appropriate DS1, causing its antenna failed to deploy towards the Earth, and the transfer was initiated on the Ground of previously recorded scientific information. When the probe was in a protected mode of flight that the antenna is turned towards the Sun, as the most easily distinguishable goal in this region of space. In this mode, the probe could transmit data to Earth at

a speed of only 79 bps. In 2001 DS1 will span close to two comets, Wilson-Harrington (Wilson-Harrington), and Borrelli (Borrelly), during which the probe will study the clouds of gas around the comet.

START RN "THE MINOTAUR"

The U.S. air force has carried out the evening of 26 January, the launch of new carrier rocket (RN) "the Minotaur" with the objective to launch a number of scientific and military satellites. The launch took place from Vandenberg air force base (California). As reported by the official representative of the air force Lieutenant Collin County, the first satellite was supposed to separate from the rocket 10 minutes after the start, the rest in the next 10 minutes. However, knowing how productive the office and the devices on the scheduled orbits, the staff of the mission control center will be only a few hours, when the satellites begin to transmit the first signals. And yet for the air force the main objective of the launch was not a conclusion of satellites, and the test itself PH "Minotaur". The first two stages taken from the ICBM "Minuteman-2", which fell under the Contract on reduction of strategic offensive arms (SNV-1). And the third and fourth stage of the rocket "Pegasus", which is already used for commercial launches since the early 90-ies. This combination allows almost a third to reduce the cost of payload in space. If it is confirmed that during his first run "the Minotaur" has successfully fulfilled all the tasks, said Lena, you will have a chance to use are now in storage 350 ICBM "Minuteman-2".

After several delays, finally launched on Minotaur rockets. She was launched from the spaceport on a U.S. air force base Vandenberg on January 27 in 3 hours 3 minutes, according to universal time (6 hours 3 min GMT). Reportedly, the launch went without any problems. The Minotaur rocket is a conglomeration of the bottom two rungs taken out of service missile Minuteman 2 and the two upper stages of the rocket Pegasus XL, launched from the aircraft. Minotaur can bring to heliosynchronous orbit with an altitude of 740 km a weight of 340 kg. This time on Board the rocket was a few micro satellites, which were located in a special module, called JAWSAT. The number of micro satellites were experimental satellite FalconSat built in the United States air force Academy; ASUSat 1, the assembled students of the University of Arizona; an inflatable balloon

Optical Calibration Sphere Experiment, the final diameter of which was 3.5 m belonging to the research laboratory of the air force. It will be used as a target for ground lasers; and Sputnik Opal, owned by Stanford University, which in turn consisted of 6 smaller "picosatellites" built by University of Santa Clara, the Aerospace Corporation, and several Amateur radio operators networks.

In addition, the JAWSAT after the withdrawal of the orbits of all these satellites will still have 2 devices: Plasma Experiment Satellite Test (PEST), collected in the center of them. Marshall and NASA designed to study plasma and height control Attitude Control Platform, which will test new low-cost stabilization system in space.

RUSSIAN RESEARCH PROBE will GO TO MARS IN 2005

In 2005, to Mars and its satellite Phobos will go Russian research probe. This was announced by space research Institute at a meeting on Russian space project of the 21st century. Of course, it was added that the expedition will take place if it will be found money. ICA and not counting on assistance from the state, and hopes to participate in the project of foreign space agencies. In July 1988, with a difference of 5 days to Mars and Phobos 2 were sent to the Russian spacecraft. However, due to technical problems the probe Phobos-1 was lost in September 1988, and Phobos-2 — six months after it. The last attempt of the launch of the Russian probe to Mars took place in November 1996, when the rocket "proton" launched into orbit the spacecraft "Mars-8". Due to a malfunction in the upper stage of the launch vehicle from earth orbit to Mars did not take place. Through the day the probe was de-orbited and burned in the dense layers of the atmosphere, and the unburned fragments fell into the Pacific ocean.

PROBE NEAR

Research probe Near-Earth Asteroid Rendezvous (NEAR), heading to the asteroid Eros, is already on the finishing straight to his goal. In the period 2 to 8 February should be made off side of the engine NEAR to correct its trajectory, and February 14, the probe should enter orbit around the asteroid. Now all the ship's systems are operating normally. Recently, the centre for flight control were tested with a simulation of the final 30-hour flight before

meeting with the asteroid.

Project managers hope to avoid last year's problems with the probe when it failed to put into orbit around this asteroid. In late December 1998, during a previous approach of the asteroid occurred emergency engine shut-down, the probe went into safe flight mode, and the communication with him was lost. Then the ship was restored, but time was lost, and NEAR flew past the asteroid. Over the past year, the probe made orbit around the Sun and again approaching the asteroid Eros. The camera probe recently made another series of photos of the asteroid, which is already possible to discern its shape.

Research NEAR the probe is orbiting the asteroid Eros for a little more than a week, but to specialists it became clear that this asteroid cannot be attributed to ordinary space rocks. The probe has already sent a lot of pictures that were a surprise to researchers. Equipment mounted on the probe allows you to receive stereo images that allow you to conduct a geological analysis of the asteroid. The first images obtained from the probe NEAR, and found that the surface of the asteroid Eros has craters, grooves, protrusions, and in General, it has a layered structure. Moreover, these layers are very flat and can be traced throughout the asteroid.

According to experts, the asteroid looks as if he was part of a larger body, perhaps a fragment of some planet. In principle, this pattern fits the hypothesis of the origin of the asteroid belt lying between the orbits of Mars and Jupiter. It is assumed that these asteroids are remnants of a planet that would have formed in this area about 4.6 billion years ago when the Solar system was still young. However, to form this planet were not meant to be, it was prevented by the strong gravitational field of Jupiter. Perhaps the asteroid Eros is a fragment this small of a failed planet, which was broken as a result of collisions with other asteroids.

Already determined the density of the material of the asteroid Eros. It is equal to 2.4 g/CC, i.e., almost the same as the density of the crust. The resulting photographs have already given some information about the age of the asteroid. Because on the surface many craters, the youngest he can not be his age, perhaps, is billions of years old.

Probe NEAR now orbit the asteroid Eros at a speed of slightly more than 3 km/h. This is possible due to the low mass of this asteroid. Some problems for the mission control center of the probe is rough shape of the asteroid. If the asteroid was spherical, it would have been easier. Now, the control center needs to continually monitor the orbit of the probe and from time to time to adjust it.

During the year, the instrument probe will investigate its chemical composition and geological structure. Soon to start working x-ray and gamma-ray spectrometer and laser rangefinder. The spectrometer will measure content in the asteroid main chemical elements (silicon, magnesium, iron, uranium, thorium, and potassium), and a laser range finder I'll scan the surface of Eros to determine its exact shape. Well, after a year, perhaps, will be landing a probe on an asteroid. Question about this now is seen. Much will depend on the fuel reserves on the probe.

SYSTEM TEST OF "SOYUZ-FREGAT".

February 9 at the Baikonur cosmodrome tested system "Soyuz-Fregat". The launch complex was the first phase of the international space programme, with the participation of "TsSKB-Progress" and a number of other Samara enterprises. But all ended in a sudden embarrassment: down to earth, the spacecraft disappeared. Launch rocket "Soyuz" with the upper stage "Fregat" was implemented in the framework of the international program launches of foreign satellites for scientific purposes "Cluster". In addition to the "TsSKB-Progress" took part the Russian space Agency, NPO Lavochkina (the developer RB "Fregat"), and the French company "Starsem". Samara in this project would play a significant role, in particular, the enterprise carried out modernization of the carrier rocket "Union" for the installation it booster. In addition, in the enterprise and on the basis of aerospace University was deployed to the information center for receiving and transmitting information from launch, telemetry data from the rocket at NPO Lavochkin and back to Samara. The upper stage "Fregat", intended for delivery of equipment into orbit according to the project "Cluster-2". Currently available launch vehicles "Union" do not meet the requirements of the European space Agency, in particular, the orbit of the withdrawal of a number of telecommunication and scientific satellites should be in the range from 1500 to 1800 km. But the

current launcher is able to deliver equipment weighing about 7 tons on orbit at an altitude of 200-450 km and more three-stage rocket "Union" is not strong enough. Correct the situation can use the fourth stage, which will become the upper stage "Fregat". After its actuation and branches at a given height RB for multiple inclusions of the engine achieves a new orbit. "Union", adapted to the use of the upper stage "Fregat" will be displayed in the space of a wide range of previously inaccessible equipment and satellites. The first demonstration launch was worked out objectives of the future Martian program (it works on NPO Lavochkin), and as the payload for the booster was installed soft landing system (inflatable braking device with a diameter of 15 meters). According to the Deputy head of research and theoretical Department of the enterprise Igor Smirnov, the upper stage "Fregat" was originally created for the rocket "Soyuz-2" (improved version of the existing "Union"), which was to increase the accuracy of removal of cargo into orbit and its height. However, due to problems with financing the modernization of the "Union" will be delayed until 2001. Therefore, for a "Frigate" was selected the regular launcher, which increased the space beneath the payload fairing from 3.3 to 3.7 metres. Was conducted aerodynamic testing of the carrier rocket, a modified control system and design elements. However, the successful launch of the "Frigate" turned into an embarrassment: during descent, the Frigate and descended with it into orbit a German companion had disappeared. They were looking for a visual way, as located on the "Frigate" beacon showed no signs of life. The loss during the landing caused a mixed reaction from foreign companies involved in this project. Their relationship to future joint projects with the Russian space enterprises will directly depend on how will be the process of landing system. Gennady ANSHAKOV, first Deputy General Director, first Deputy General designer of SE "TsSKB-Progress": — a Few years ago on the instructions of the Russian government customers in the enterprise has started development of the rocket "Soyuz-2" in the framework of development work "Rus". There is a need to improve power, strength characteristics of the carrier rocket "Soyuz". Until recently, RCA used two missiles "Union" and "Lightning". The first to launch satellites into orbit, the second to high ellipticity. Today contain two versions of the missiles is economically unprofitable, so the three-stage Soyuz upgraded to a four-speed. As the fourth selected block and the upper stage "Fregat". For TsSKB it is most promising, as almost all the tasks that previously required the chords of "Lightning" and

"Union", now decides to just "Union". As a result of successful testing of our products showed interest, and has orders from St. Petersburg KB "Arsenal", NPO Reshetnev (developer of telecommunication systems). There are a number of commercial offers along the lines of "Starsem". The launch was attended by the European space Agency, expressed their admiration for the tests. It is hoped that from the experiences we get to specific cases, and the orders start coming in, which generally has a positive impact on such enterprises as "TsSKB-Progress", JSC "Motorostroitel", "Samara metallurgical plant", etc.

At Baikonur successfully tested a new rocket technology Sergei LESKOV, a New reusable upper stage "Fregat" is created in NPO Lavochkin in Khimki near Moscow. This is an important event for the domestic space, which, due to financial diet not long ago introduced a new technique. The first sign of progress in space is the mass delivered to orbit payload. In this regard, "the Frigate" — as the leap from "Oka" to "Lada". "Soyuz" with the upper stage "Icarus" displays on the geostationary orbit 3.3 tons, and with the upper stage Fregat — 4.2 tons, that is by a quarter more. "Frigate" is generic and can be used as an upper stage on almost all types of Russian rockets "Soyuz", "Zenith", "Proton" and created a rocket "Angara". But while all specific plans associated with the "Union" that since the Queen remains the most reliable rocket in the world. [...] "News" 10.02.2000

THE FIRST FLIGHT OF THE BLOCK "THE BREEZE-M"

6 hours 59 minutes Moscow time on June 6, 2000 from the Baikonur cosmodrome launched the Russian heavy carrier rocket "proton", which put into orbit a communication satellite "Horizon". This successful launch would be considered an ordinary event in the region has already become quite a usual activity on the use of near-earth space in the interests of national economy of Russia, if not for one circumstance. Immediately attracted the attention of professionals around the world — in the rocket-space complex consisted of a new upper stage "breeze-M", created by the State space scientific production center (Khrunichev) them. M. V. Khrunichev. The upper stage "breeze-M" has great versatility, but its main task is the removal of heavy (maximum capacity up to 6 tons) payloads to GTO and GSO. Acute need to build new upper stages for the Russian heavy carrier rocket could be felt for a long time. Analysis of the global space market is showing a stable

trend, the growth of masses and dimensions of SPACECRAFT (SC), planned for launch in the period 2000-2015 in addition to commercial tasks, the excretion of CA, planned in the framework of the implementation of national space programs of the Russian Federation also demanded for increasing the energy characteristics and flexibility of the use of boosters, as well as a significant increase in the size of the area to accommodate the payload under the fairing of the launch vehicle.

DEVELOPED PH "BAIKAL".

In Russia developed the original design of the booster under the name "Baikal" reusable its first stage, RIA "news" the chief designer at the Moscow aerospace NPO "Molniya" Alexander Pankevich. According to him, "is the time when you run the "exhaust" stage rockets literally fell from the sky on the head of humans. The specialists of "Lightning" and Khrunichev Khrunichev developed the first stage rocket, which, after "output rocket into space, testing their resources and separation from her payload is landing on an airfield as an unmanned aerial vehicle for its new use." Baikal solves environmental problems and reduces the startup process — this stage can be used up to 100 times. The invention is patented in Russia and is patented abroad, said Pankevich.

ODYSSEY — THE NEXT MARS EXPEDITION NASA

The leadership of NASA has announced that expedition to Mars, scheduled for 2001 and formerly known as the "Mars Surveyor 2001 Orbiter", now renamed "2001 Mars Odyssey" ("2001 Mars Odyssey"). This is done in order to acquaint you with the famous film Stanley Kubrick's "Space Odyssey 2001" (2001: A Space Odyssey), based on a book of the famous science fiction writer Arthur C. Clarke, and emphasize the novelty used in the next Mars probe technology.

The launch of the spacecraft 2001 Mars Odyssey is scheduled for April 7 2001, It will show in a space rocket Delta 2. The launch will take place at the spaceport at Cape Canaveral. Odyssey will arrive at Mars in six months and will first take a temporary orbit. Only two months later, maneuvering engines and using the technique of aerobraking, he will enter the final Mars orbit.

Odyssey will explore Mars from orbit only, no lander on it.

On the probe 2001 Mars Odyssey is equipped with three main instruments: the infrared camera-spectrometer THEMIS (Thermal Emission Imaging System), is designed to determine the mineral composition and morphology of the Martian surface; gamma-ray spectrometer GRS (Gamma Ray Spectrometer) to study the elemental composition of the surface and under the surface layer of Mars (special attention will be paid to the search of traces of hydrogen, which may be proof of the existence of water on Mars); system and MARIE (Mars Radiation Environment Experiment) to study the orbit of background radiation on Mars (with an eye on future manned expeditions).

Recall that this will be the first NASA mission to Mars after the failure of two expeditions in a row: last year, the accident suffered two probes — the Mars Polar Lander and Mars Climate Orbiter. The accident forced NASA to rethink its entire program of Mars exploration, but the mission Odyssey was planned even before these incidents, and therefore this project decided to complete in accordance with the original plans.

In 2003, NASA plans to send to Mars two of the Rover's twin, which will be delivered in different areas of this planet. Around the same time Mars will depart for the first European Mars Express mission. The development of this project deals with the European space Agency. Mars Express will take on the Mars lander Beagle 2, built in the UK.

STUDIES OF JUPITER

In the next two to three months of the study of Jupiter will lead once the two spacecraft NASA — Galileo and Cassini. It is expected that such studies will allow experts to better understand the processes occurring in the vortex atmosphere of this planet, the structure and nature of huge clouds of electrically charged gas that surrounds the planet, and to get maximum information about the many moons of Jupiter. The Galileo probe is in orbit around Jupiter since December 1995, he has twice blocked your original resource of work in this orbit, and had three times greater dose of radiation than that which it was designed. The near a major event in his work will be circled largest satellites of Jupiter — Ganymede, which will be held on 29

December 2000, around the same time — 30 December, the Cassini spacecraft will be located at a minimum distance from Jupiter (about 10 million km). Cassini was launched into space in October 1997 in General, he's headed to Saturn in 2004. should reset the micro probe Huygens to the surface of its largest satellite Titan. But before reaching Saturn, Cassini will fly close to Jupiter. This probe is now at a distance of about 70 million km from Jupiter, and already sends pictures of the planet taken in different wavelength ranges. During the joint studies of the solar wind in November of this year, the Cassini spacecraft will be situated almost in the place where the solar wind hits the magnetosphere of Jupiter, and the Galileo probe will be inside the magnetosphere. Cassini will monitor fluctuations in the solar wind and Galileo is to observe their effects in the magnetosphere of Jupiter. Such studies will be conducted for the first time.

"UNION TM-31"

October 31 at 10 a.m. 52 min 47 sec Moscow time from Baikonur cosmodrome launched a carrier rocket "Soyuz-U", which after 8 minutes, 50 seconds put into orbit manned transport spacecraft "Soyuz TM-31". It is the first long-term crew of the International space station (ISS), composed of three people: the American astronaut William shepherd (William Sheperd) — the commander of the ISS-1 flight engineer-2 of "Soyuz TM-31" and two Russian cosmonaut Yuri Gidzenko — the commander of the ship "Union TM-31" and Sergei Krikalev — flight engineer. November 2 at 12 hours and 24 minutes Moscow time the spacecraft "Soyuz TM-31" should dock with the ISS, after which work will be initiated for the implementation of the programme the first long-term expedition, with a total duration of 117 days. As reported in the official press release from RSC Energia crew first need to reactivate the system service module "Zvezda" and set it previously delivered equipment. Then throughout the expedition the crew will have to maintain the health of the station and to implement a program of applied research. During his stay on the ISS, the crew will take two cargo ship "Progress", to ensure their docking, unloading and undocking. The first "Progress" must be sent to the ISS on 14 November and the second on 12 December. In addition, during this time, the ISS will arrive three "Shuttle", and the first long-term crew of the station will have to ensure that their dock. The first of them — "Shuttle" Endeavour — should start on 1 December. He will deliver to the

station the solar panels that will be mounted on the farm Z1, photovoltaic module and other equipment. The launch of the second Shuttle — Atlantis — is scheduled for 18 January, 2001, he will deliver to the ISS the U.S. laboratory module Destiny. The third Shuttle — Discovery — will travel to the ISS on 15 February 2001 it the station will arrive multi-purpose logistics module Leonardo and the second long-term crew. Well, the current crew on February 24 will return to Discovery on the Ground. According to the latest plans, landing of Discovery to be held February 26, 2001.

The main stellar characteristics

Luminosity and distance to stars

First of all we must understand that stars, with very few exceptions, are observed as "point" sources of radiation. This means that their angular sizes are very small. Even in the biggest telescopes can't see the stars in the form of "real" disks. I emphasize the word "real", as due to purely instrumental effects, and mainly hectic atmosphere in the focal plane of the telescopes is obtained by "false" the image of the star disc. The angular size of this disk are rarely less than one second of arc, whereas even for the nearest stars must be smaller than one hundredth of a second of arc.

So, the star even in the largest telescope can't be, say the astronomers, "allowed". This means that we can only measure the fluxes from stars in different spectral regions. The measure of flux is the magnitude.

The luminosity is determined if we know the apparent magnitude and the distance to the star. If the definition of the apparent magnitude astronomy has quite reliable methods, the distance to the stars to determine not so simple. For relatively close stars, distant at a distance not exceeding a few tens of parsecs, the known distance is determined from the beginning of the last century, trigonometric method, which consists in measuring the infinitesimal angular displacement of stars when observed from different points of the earth's orbit, that is, at different times of the year. This method has high accuracy and reliable enough. However, for most other, more remote stars it is not good: too small displacement of the position of the stars to be measured — less than one hundredth of a second of arc! Come to the aid of other methods, less accurate, but nevertheless fairly reliable. In some cases, the

absolute magnitude of stars can be determined and directly, without measuring the distance to them according to some observable characteristics of their radiation.

Spectra of stars and their chemical composition

Extremely rich information allows the study of the spectra of stars. Spectra has long been the vast majority of stars are divided into classes. The sequence of spectral classes is denoted by the letters O, B, A, F, G, K, M. the present system of classification of stellar spectra so accurate that it allows to determine range with an accuracy of one tenth of the class. For example, part of the sequence of stellar spectra between classes B and A, denoted as B0, B1 . . . B9, A0 and so on. Range of stars in a first approximation similar to the spectrum of a radiating black body with a certain temperature T . These temperatures gradually changing from 40-50 thousand degrees for stars of spectral class a to 3000 degrees for stars of spectral class M. In accordance with this, the main part of the radiation of stars of spectral classes O and b occur in the ultraviolet part of the spectrum, unobservable from the earth's surface. However, in recent decades, was launched on specialized artificial satellites of the earth; aboard them were set up telescopes with which help it was possible to explore and ultraviolet radiation.

A characteristic feature of stellar spectra is the presence of a huge number of absorption lines belonging to various elements. Subtle analysis of these lines allowed us to obtain particularly valuable information about the nature of the outer layers of stars.

The chemical composition of the outer layers of the stars where we "directly" comes their radiation is dominated by hydrogen. In second place is helium, and the abundance of other elements is quite small. Approximately ha of every ten thousand atoms of hydrogen have thousands of helium atoms, about 10 atoms of oxygen, a little less carbon and nitrogen and only one atom of iron. The abundance of other elements is quite negligible. It is no exaggeration to say that the outer layers of stars is a giant hydrogen-helium plasma with a small admixture of heavier elements.

A good indicator of the temperature of the outer layers of a star is its color.

Hot stars of spectral classes O and B are blue in color; stars similar to our Sun (spectral class G2) represented by the yellow stars of the same spectral classes K and M red. In astrophysics there is a carefully designed and perfectly objective system colors. It is based on a comparison of the observed magnitudes obtained in strictly talonrakennus through different filters. Quantitatively, the color of the stars is characterized by the difference between the two values obtained using two filters, one of which passes primarily blue light ("B"), and the other has a curve of the spectral sensitivity similar to the human eye("V"). The technique of measuring the color of stars is so high that the measured value of B-V, you can determine the spectrum of a star with a precision of a subclass. For faint stars the analysis of the flowers — the only way their spectral classification.

The temperature and mass of stars

Knowledge of the spectral class or color stars immediately gives the temperature of its surface. As the stars emit approximately as an absolutely black body the appropriate temperature, the power emitted by unit surface is determined from the law of Stefan Boltzmann.

The radiation power of the entire surface of the star. Thus, to determine the radius of a star we must know its luminosity and surface temperature.

We have to define another one, perhaps, the most important characteristic of a star is its mass. I must say that to make it not so easy. And most importantly there aren't too many stars that have reliably determine their masses. The last is easiest to determine if stars form a binary system for which the semimajor axis of the orbit and the orbital period P is known. In this case, the mass determined from the third Kepler law. The equation gives the sum of the component masses of the system. If, moreover, we know the orbital speeds, their mass can be defined separately. Unfortunately, only a relatively small amount of binary systems can therefore to determine the mass of each star.

In fact, astronomy does not have and does not have currently a method of direct and independent determination of the mass (that is, not part of a multiple system) of an isolated star. And this is quite a serious drawback of our science about the Universe. If such a method existed, the progress of our

knowledge would be much faster. In this situation, astronomers tacitly accept that stars with the same luminosity and color have the same mass. The latter are defined only for binary systems. The assertion that a single star with the same luminosity and color has the same weight as her "sister", a member of the binary system, should always be taken with some caution.

Main magnitudes

So, modern astronomy includes methods of determining the basic stellar parameters: luminosity, surface temperature (color), radius, chemical composition and mass. An important question arises: are these characteristics independent? It turns out, no. First of all, there is a functional relation between the radius of the star, its bolometric luminosity and surface temperature. This dependence is represented by a simple formula ($*$) is trivial. Along with this, however, has long been a correlation between the luminosity of stars and their spectral class (or, in fact, one and the same - color). This relationship is empirically established (independently) on a large statistical material in the beginning of this century eminent astronomers Hertzsprung Danish and American Russell.

It took, however, thousands of years of the development of science that mankind has realized a simple, yet magnificent the fact that stars are objects that are more or less similar to the Sun, but only separated from us by much larger distances. Newton was the first who correctly assessed the distance to the stars. Two centuries after the great English scientist almost all tacitly assumed to be monstrously large space where the stars are, there is absolute emptiness. Only a few astronomers from time to time raised the question of the possible absorption of light in the interstellar medium. Only at the beginning of the XX century German astronomer Hartmann proved that the space between stars is not a mythical void. It is filled with gas, however, very small, but well-defined density. This outstanding discovery, as well as many others, was made using the spectral analysis.

Almost half a century interstellar gas was studied mainly through the analysis generated in this absorption line. It was found, for example, that quite often these lines have a complex structure that is composed of several closely spaced to each other component. Each such component occurs during the

absorption of star light in some kind of a cloud of interstellar medium and clouds move relative to each other at a speed close to 10 km/h. This leads due to the Doppler effect to a slight shift of the wavelengths of the absorption lines.

The chemical composition of interstellar gas in the first approximation was quite close to the chemical composition of the Sun and stars. The dominant elements are hydrogen and helium, whereas the other elements we can consider as "impurities".

Interstellar dust

Still, speaking of the interstellar medium, we mean only the interstellar gas. but there is another component. We are talking about interstellar dust. We mentioned above that in the last century debated the question of the transparency of interstellar space. Only around 1930 with certainty it has been proven that mezhzvezdnoi the space is really not very transparent. The light absorbing substance is concentrated in a rather thin layer near the galactic plane. Most strongly absorbed by the blue and violet rays, whereas the absorption of the red rays is relatively small.

What is this substance? Now it seems proved that the light absorption due to interstellar dust, i.e. solid microscopic particles of the substance smaller than a micron. These dust particles have a complex chemical composition. Found that dust particles have quite an elongated shape and to some extent "guided", that is, the direction of their elongation have a tendency to "line up" in the cloud more or less in parallel. For this reason, passing through a thin environment, stellar light becomes partially polarized.

A variety of physical conditions

A characteristic feature of the interstellar medium is the variety of existing physical conditions. There are, first, areas, the kinetic temperature varies by two orders of magnitude. There are relatively dense clouds with the concentration of gas particles in excess of several thousand per cubic centimeter, and extremely rarefied medium between the clouds, where the concentration does not exceed 0.1 particles per cubic centimeter. there is, finally, a huge region, where the spread of the shock wave from the

explosions of stars.

Along with private clouds, as the ionized and non-ionized gas in the Galaxy are observed considerably large in size, mass and density units of cold interstellar matter, called "gas-and-dust complexes." For us most significant is that in such gas-dust complexes occurs the most important process of condensation of stars from diffuse interstellar medium.

Why should be born of a new star?

The value of gas-and-dust complexes in modern astrophysics is very large. The fact that for a long time astronomers, largely intuitively linked the formation of condensation in the interstellar medium with important the process of star formation from "diffuse" relatively depleted of gas and dust environment. What grounds are there for assumptions about the relationship between gas-dust complexes and process zvezdoobrazovaniya? First, it should be stressed that, at least since the forties of our century, astronomers clear that the stars in the Galaxy must continuously (meaning literally "our eyes") to be formed from a qualitatively different substance. The fact is that by 1939 it was established that the source of stellar energy is occurring in the depths of the stars fusion. Roughly speaking, the vast majority of stars emit because their bowels four protons are connected via a number of intermediate stages into a single alpha particle. Since the mass of one proton (in atomic units) is equal to 1,0081, and the mass of a helium nucleus (alpha particle) is equal to 4,0039, the excess of mass equal to 0,007 atomic units the proton should be allocated as energy. Thereby determines the supply of nuclear energy, which is constantly spent on radiation. In the most favorable case of a pure hydrogen star reserves nuclear energy is not enough for more than 100 million years, while in real terms the evolution of the lifetime of a star is less than this is clearly an overestimation. But tens of millions of years is an insignificant time for the evolution of our Galaxy, whose age is not less than 10 billion years. The age of massive stars is comparable to the age of humanity on Earth! So the stars (or at least, massive high luminosity) can not be in the Galaxy "initially", i.e. from the moment of its formation. It turns out that every year in the Galaxy "dies" at least one star. So, in order for "star tribe" not "degenerated", it is necessary that the same number of stars in average were formed in our Galaxy every year. In order to for a long time

(billions of years) the Galaxy would have preserved unchanged their main characteristics (e.g. the distribution of stars in classes, or, what is practically the same, spectral classes), it is necessary to automatically maintain a dynamic equilibrium between births and "dying" stars. In this respect the Galaxy is similar to a primeval forest composed of trees of various types and ages, and the age of trees is much less than the age of the forest. There is, however, one important difference between a Galaxy and a forest. In the Galaxy the life time of stars with mass less than the sun exceeds her age. Therefore, we should expect a gradual increase in stars with relatively small mass, as they are still "not yet" to die, to be born and continue. But for more massive stars the above mentioned dynamic equilibrium must inevitably occur.

Gas-dust complexes, the cradle of the stars

Why are there in our Galaxy young and "sverhdorogie" stars? For a long time, according to the established tradition, ascending to the hypothesis of Kant and Laplace of the origin of the Solar system, astronomers assumed that the stars formed from the scattered diffuse gas and dust environment. There was only one strict theoretical basis of such beliefs is the gravitational instability of initially homogeneous diffuse environment. The fact is that in this environment of the inevitable small perturbations of the density, that is, deviations from strict uniformity. in the future, however, if the masses of these condensate exceed a certain limit, under the influence of forces of gravitation are small perturbations will grow and the original homogeneous environment are broken into several condensate. Under the force of gravity, this condensation will continue to shrink and, as you can assume, eventually will turn into stars.

The characteristic time of compression of the cloud to the size of the protostar can be estimated by a simple formula mechanics, describing a free falling body under the influence of some acceleration. So, for example, a cloud with a mass equal to the sun, will shrink in a million years.

In the process just described, the first stage condensing gas-dust cloud into a star, which is called the "stage of free fall", is released a certain amount of gravitational energy. Half of the released compression of the clouds has to

leave the cloud in the form of infrared radiation, and the other half go on heating the substance.

As soon as the Contracting cloud will be opaque to your infrared radiation, the luminosity it will fall sharply. It will continue to shrink, but not according to the law of free fall, but much slower. The temperature of its inner regions , since the process of dissociation of molecular hydrogen will end, will certainly rise, as half of the released compression of the gravitational energy will go into heating the cloud. However, such an object is called a cloud anymore. This is a real protostar.

Thus, simple laws of physics, we should expect that may be the only and logical process of evolution of the gas-dust complexes in the first protostar, and later in stars. However, the possibility is not reality. The primary objective of observational astronomy is, first, to explore the real clouds of the interstellar medium and to examine whether they can compress under its own gravity. For this we need to know their size, density, and temperature. Secondly, it is very important to obtain additional arguments in favor of "genetic proximity of clouds and stars (e.g. fine details of their chemical and even isotopic composition, the genetic relation between stars and clouds, etc.). Thirdly, it is very important to obtain from observations irrefutable evidence of the existence of the earliest stages of protostars (e.g., flash infrared radiation in the end stages of free fall). In addition, there can be observed, and, apparently, observed an unexpected phenomenon. Finally, we need to examine the protostar. But to do this, first we must be able to distinguish them from "normal" stars.

Stellar associations

Empirical confirmation of the process of star formation from the clouds of the interstellar medium is a long-known fact that massive stars of classes O and B are distributed in the Galaxy is not homogeneous, and are grouped in a separate large clumps, which later became known as the "Association". But these stars must be young objects. Thus, the very practice of astronomical observations, suggests that stars are born not alone, and like a nest, which is qualitatively consistent with the theory of gravitational instability. Young Association of stars (consisting not only of some hot massive giants, but also

from other notable known young objects) are closely related to large gas-dust complexes in the interstellar medium. It is natural to assume that such a relationship must be genetic, that is, these stars are formed by the condensation of clouds of gas and dust environment.

The process of birth of stars, usually not visible because it is hidden from us by a veil of light-absorbing cosmic dust. Only radioastronomia how can now safely be considered to have made a radical change in the problem of studying the birth of stars. First, interstellar dust does not absorb radio waves. Second, radio astronomy has opened a totally unexpected phenomenon in gas-dust complexes Interstar environment that have a direct relationship to the star formation process.

Briefly about the whole process of birth

We are quite in detail considered the question of condensation to protostar dense cold molecular clouds, which because of gravitational instability breaks down the gas-dust complex interstellar medium. Here it is important to emphasize that this process is natural, that is inevitable. In fact, the thermal instability of the interstellar medium will inevitably lead to its fragmentation, i.e. the division into separate, relatively dense clouds and bezoblachnoe environment. However, self-gravity cannot compress clouds — for that they are not dense and are great. But then "comes into play" the interstellar magnetic field. In the system of lines of force of this field is inevitably formed a fairly deep "hole", where the "flock" clouds of the interstellar medium. This leads to the formation of a huge gas-dust complexes. In such complexes, a layer of cold gas as the ionizing interstellar carbon ultraviolet star radiation is strongly absorbed in a dense set of cosmic dust, neutral carbon atoms are strongly cooled interstellar gas and "thermostatic" it at a very low temperature — about 5-10 degrees Kelvin. As the cold layer of the gas pressure equal to the external pressure of the surrounding hotter gas, the density in this layer is much higher and reaches several thousand atoms per cubic centimeter. Under the influence of its own gravity cold layer, after it reaches a thickness of about one parsec away, will "slice" into separate, more dense clumps that under the influence of its own gravity will continue to shrink. So quite naturally in the interstellar medium an Association of protostars. Each protostar evolyutsioniruet at a speed depending on its mass.

When a substantial part of the mass of gas to turn into stars, interstellar magnetic field, which by its pressure supported gas-dust complex, of course, will not affect the young star and a protostar. Under the influence of the gravitational attraction of the Galaxy they will start falling towards the galactic plane. Thus, young stellar associations should always approach the galactic plane.

If you look at the night sky on a clear night, you can see about a thousand stars of our Galaxy. Each of those stars, like our Sun, shines for millions or billions of years, and the light that we see has travelled in interstellar space from four years to two thousand years before it reached our eyes.

The theme "are we Alone in the Universe?", I chose maybe because many people touch on the subject, and it is not open. To this question there is much talk by yourself or even with someone else's evidence.

To explore the world, including the Universe, man began with the fact that he was able to observe directly. Possessing the organ of vision, sensitive to light rays as physicists say — to optical range of electromagnetic waves, he saw in the sky the Sun, stars, planets. Based on these observations, he made the first ideas about the universe.

In the future, for many centuries, including when the researchers of the Universe armed with telescopes and photographic equipment, greatly expand the capabilities of the human eye, astronomy continued to be an optical science, but light is the only messenger of the cosmic worlds, carrying information about the processes occurring in the depths of the Universe.

Until the beginning of this century no one doubted that the universe was stationary, in its main features it does not change over time, the vast majority of the heavenly bodies develops gradually, passing from one stationary state to another. A similar view was shared by such an outstanding physicist of our age, like Einstein.

But in the twenties opened the expansion of the Universe. And with each new astrophysical discovery unfolds before us a world of "increasingly bizarre", the world is all the more strange, unusual processes.

So, the inexhaustibility of the Universe, the inevitability of unexpected, unforeseen discoveries, the world is increasingly strange phenomena — these are the characteristic features of modern astronomy and physics.

And as a result, certain qualities should have a modern Explorer of the Universe: deep knowledge, constant willingness to take on the unexpected, the ability to understand the unusual ability to the original findings...

Modern researchers have to solve increasingly complex problems. Venturing into the wilds of an increasingly strange world, science is very close to such boundaries to overcome, which may need special efforts, including the efforts of the intellectual...

Now we are sufficiently prepared to cross the threshold of the "weirder world", which gives us a modern science about the Universe.

All of our Earth — ship in a vast cosmic ocean. We all live in the Solar system, being exposed to all radiations that are sent to the Earth from all directions of the Universe.

In the past, the universe looked very different than today: there was no stars, no planets, no galaxies, and the substance from which the planets were formed, was in a state of enormous density. Gigantic stellar Islands — the galaxies with enormous speeds scatter in different directions. We live in an expanding Universe.

Evolution and structure of galaxies.

The poet asked: "Listen! If stars are lit it means there's someone who needs it?". We know that the stars need to Shine, and our Sun provides the necessary for our existence energy. And why do we need galaxies? Is and galaxy needed, and not only the Sun provides us with energy. Astronomical observations show that the nuclei of galaxies there is a continuous outflow of hydrogen. Thus, the nuclei of galaxies are factories for the production of basic building material of the Universe — hydrogen.

The hydrogen atom consists of one proton in the nucleus and one electron in

its orbit, is the simplest "building block" from which in the bowels of stars formed during the nuclear reactions of more complex atoms. And it turns out that the stars are not by chance have a different value. The more massive the star, the more complex atoms are synthesized in the nucleus.

Our Sun as an ordinary star, only produces helium from hydrogen (which gives the nuclei of galaxies), very massive stars produce carbon — the main building block of living matter. That galaxies and stars. What is an Earth? It produces all the substances necessary for existence of human life. And why man exists? This question cannot be answered by science, but it can force us to think about him.

If the "ignition" stars someone needs, then maybe people need someone? Scientific data helps us formulate an idea about our destiny, about the meaning of our lives. To address when answering these questions to the evolution of the Universe, therefore, is to think cosmically. Science teaches to think cosmically, at the same time, not looking up from reality of our existence.

The question of the formation and structure of galaxies, the next important question of the origin of the Universe. It examines not only cosmology as the science about the Universe is a unified whole, but also cosmogony (gr. "Goneja" means birth) is the science which studies the origin and evolution of cosmic bodies and their systems (distinguish between planetary, stellar, galactic cosmology).

Galaxy is a gigantic cluster of stars and their systems, with your center (core) and different, not only spherical, but often spiral, elliptical, flattened or even an irregular shape. Galaxies — billions and billions of stars.

Our galaxy is called the milky Way consists of 150 billion stars. It consists of a nucleus and a few spiral branches. Its size is 100 thousand light years. The majority of stars in our galaxy concentrated in a giant "disk" with a thickness of about 1500 light years. At a distance of about 30 thousand light years from the galactic center is the Sun.

The nearest to our galaxy (to which the light beam runs 2 million years) —

"Andromeda". It is so named because it is in the Andromeda constellation in 1917, was the first extragalactic object. It belongs to another galaxy was proven in 1923 by E. Hubble, found by spectral analysis of this object stars. It was later discovered the stars and other nebulae.

And in 1963 were discovered quasars (quasi-star radio) — the most powerful radio sources in the Universe with luminosities hundreds of times larger luminosity of galaxies and the size ten times smaller them. It was suggested that quasars are the cores of new galaxies and, therefore, the formation of galaxies continues to this day.

And at the end of the introduction in my essay I aim to find out what Universe we are not alone. I want to know about distant cosmic worlds, of the Universe. In my opinion, the most important thing in astronomy to find out how the world works, whether there is life on other planets, are we alone in the vast Universe or there is life like ours? Maybe on other planets that are so far removed from us that we are not even able to observe them? And if they life? These and many other questions that scientists thought in the XV century, is not permitted until now. A few decades ago we discussed the question: "is There life on Mars?" There were a lot of hypotheses, arguments that we are unique in the entire Universe. Especially great hopes are pinned exactly on Mars by observing the planet through a telescope noticed that it is covered with the right network of "channels". For a long time even believed that these "channels" — not that other, as "the handiwork of a Martian". But, alas, the first images received from the American automatic interplanetary station "Mariner 4" which is on 14 July 1965 flew on a distance of 9600 km from Mars, dispelled this myth. Artificial channels were not available.

For the evolution of living organisms from the simplest forms (viruses, bacteria) to sentient beings requires a lot of time intervals as the driving force for this selection are mutations and natural selection processes occasional. Through a large number of random processes a natural progression from lower life forms to higher. For example, our planet Earth, we know that this interval of time, apparently, surpasses a billion years. Therefore, only on planets orbiting a fairly old stars, we can expect the presence of highly organized living creatures. In the present state of astronomy we can only talk about arguments in favor of the hypothesis of the multiplicity of planetary systems and the possibility of life on them. A strict proof of these important

statements astronomy does not yet have. In order to talk about life, we must at least consider that old enough stars have planetary systems. For the development of life on the planet, you need to satisfy a number of conditions of a General nature. And it is clear that not every planet can be life.

We can imagine each star having a planetary system, the zone where temperature conditions do not exclude the possibility of the development of life. Hardly it is possible on planets like mercury, the temperature of sunlit part of which above the melting point of lead, or like Neptune, the surface temperature of which is 2000 C. it is Impossible, however, to underestimate the huge adaptability of living organisms to adverse environmental conditions. It should also be noted that for the life of living organisms is much dangerous very high temperatures than low, as the simplest types of viruses and bacteria can, as you know, is in suspended animation at a temperature close to absolute zero.

In addition, it is necessary that the radiation of the stars for many hundred of millions and even billions of years remained approximately constant. For example, a large class of variable stars, the luminosity of which vary greatly with time (often periodically), should be excluded from consideration. However, most of the stars radiates with amazing regularity. For example, according to geological data, the luminosity of our Sun over the past few billion years, remained continuously with a precision of up to several tens of percent.

2. The emergence of life on Earth.

If the world could get a life, its weight must not be too small. On the other hand, too much weight is also a disadvantage, the planets small the probability of formation of a hard surface, they usually are balls of gas with a rapidly growing toward the center density (e.g. Jupiter and Saturn). Anyway, the masses of planets suitable for the development of life, must be limited both from above and from below. Apparently, the lower limit of the possibilities of mass this planet is close to several hundredth of the mass of the Earth, and the top tens of times greater than earth's. Very important is the chemical composition of the surface and atmosphere. As can be seen, the range and characteristics of planets suitable for life, is quite broad.

To study life we must first of all define the concept of "living matter". This question is far from simple. Many scientists, for example, define living matter as a complex protein body having an ordered metabolism. This view is adhered to, in particular, academician A. I. Oparin, a lot of dealing with the problem of the origin of life on Earth. Of course, metabolism is a very important attribute of life, however, the question is, is it possible to reduce the essence of life, especially metabolism, is controversial. Because in the world of the nonliving, for example, in some solutions, there is metabolism in its simplest forms. The question of the definition of "life" is very serious when we are discussing the possibility of life on other planetary systems.

At present life is determined not through the inner structure and substance, which it is inherent, and through its functions: "management system" that includes the mechanism of transmission of genetic information to ensure the safety of future generations. Thus, due to the unavoidable interference in the transmission of such information to our molecular complex (organism) is capable of mutations, and therefore evolution.

The emergence of living matter on Earth (and, as you can judge by analogy, on other planets) was preceded by a rather long and complex evolution of the chemical composition of the atmosphere, ultimately leading to the formation of several organic molecules. These molecules subsequently serve as "building blocks" for the formation of living matter.

According to current data, planets are formed from the primary gas-dust clouds, chemical composition of which is similar to the chemical composition of the Sun and stars, their original atmosphere consisted mainly of the simplest compounds of hydrogen the most abundant element in the cosmos. Most of the hydrogen molecules, ammonia, water and methane. In addition, the primary atmosphere had to be rich in inert gases, especially helium and neon. Currently, noble gases on Earth, as they were disciplinal (evaporated) into interplanetary space, like a hydrogen-containing compound.

However, apparently, a crucial role in establishing the composition of earth's atmosphere has played a plant photosynthesis, which releases oxygen. It is not excluded that some, and maybe even a substantial amount of organic

matter has been brought to the Ground by the fall of meteorites, and possibly even comets. Some meteorites are quite rich in organic compounds. It is estimated that over 2 billion years old meteorites could bring to Earth from 10⁸ to 10¹² tons of such substances. Such organic compounds can in small amounts be the result of volcanic activity, meteorite impact, lightning, radioactive decay of some elements.

Reasonably good geological data indicate that the already 3.5 billion years ago earth's atmosphere was rich in oxygen. On the other hand the age of the crust estimated by geologists to be 4.5 billion years old. Life had to arise on Earth before the atmosphere became rich in oxygen, as the latter is largely a product of plants. According to a recent estimate by American expert on planetary astronomy, Sagan, life on Earth originated 4.0 — 4.4 billion years ago.

The mechanism of complication of the structure of organic substances and appearance of their properties inherent in the living substance, is at present still poorly understood, although recently there has been great progress in this field of biology. But it is already clear that these processes last for billions of years.

Any arbitrarily complex combination of amino acids and other organic compounds is not a living organism. You can certainly assume, that under some exceptional circumstances where on Earth there is some "prank", which was the beginning of all living things. It is unlikely, however, so, if a hypothetical "prank" was quite similar to the modern one. The fact that modern DNA by itself is utterly helpless. It can function only in the presence of protein enzymes. To think that purely by chance, by "shaking up" of individual proteins polyatomic molecules, there could be such a complicated machine as "prank" and necessary for its functioning complex of proteins-enzymes — it means to believe in miracles. However, we can assume that the molecules of DNA and RNA evolved from more primitive molecules.

For generated on the planet's first primitive living organisms high doses of radiation can present a deadly danger, because mutations will occur so rapidly that natural selection is not keeping up with them.

Noteworthy another question: why life on Earth does not arise from inanimate matter in our time? It can only be explained by the fact that previously occurred will not give life an opportunity for the new generation of life. Bacteria and viruses will eat the first sprouts of a new life. It is impossible to completely rule out the possibility that life on Earth arose by chance.

There is another circumstance, it may be wise to pay attention. It is well known that all "live" proteins consist of 22 amino acids, however, only amino acids known to be over 100. It is not clear what these acids differ from the rest of their "brothers". If there is any deep connection between the origin of life and this amazing phenomenon?

If life on Earth arose by chance, then life in the Universe rare (although, of course, in any case not individual) phenomenon. For this planet (like our Earth) the emergence of a special form of highly organized matter, which we call "life" is an accident. But in the vast expanse of the Universe arising so life must be a natural phenomenon.

Again it should be noted that the Central problem of the origin of life on Earth is the explanation of the qualitative leap from "inanimate" to "living" — is still far from clear. No wonder one of the founders of modern molecular biology Professor Creek Byurakan Symposium on the problem of extraterrestrial civilizations in September 1971, said, "We don't see the way from primordial soup to natural selection. It can be concluded that the origin of life is a miracle, but it only shows our ignorance"

3. Life on other planets.

A question about life on other planets occupied the minds of astronomers for centuries. The possibility of the existence of planetary systems around other stars are only now becoming the subject of scientific research. Previously, the question of life on other planets was the realm of pure speculation. Meanwhile, Mars, Venus and other planets of the Solar system has long been known as niesamowita solid celestial bodies surrounded by atmospheres. Long ago it became clear that in General they resemble the Earth, and if so, why would they not be life, even highly organized, and who knows reasonable?

It is natural to assume that the physical conditions that prevailed on the newly formed from gas-dust environment of the terrestrial planets (mercury, Venus, Earth, Mars), were very similar, particularly their original atmosphere was the same.

The main atoms forming part of those molecular complexes, which were formed from living matter are hydrogen, oxygen, nitrogen, and carbon. The role of the latter is particularly important. Carbon — tetravalent element. Therefore, only carbon compounds lead to the formation of long molecular chains with rich and changeable side branches. It is to this type belong to different protein molecules. Often used as a substitute of carbon called silicon. Silicon is quite abundant in space. In the atmospheres of stars, its content is only 5-6 times less than carbon, that is sufficiently large. It is unlikely, however, silicon can play the role of "cornerstone" of life. For some reason, his connections cannot provide such a wide variety of lateral branches in complex molecular chains, as carbon compounds. Meanwhile, the richness and complexity of such side branches it provides a huge variety of properties of protein compounds, as well as the exclusive "informative" DNA, which is essential for the emergence and development of life.

The most important condition for the emergence of life on the planet is presence on its surface of a sufficiently large quantity of a liquid medium. In such an environment are dissolved organic compounds and can create favorable conditions for synthesis on their basis of complex molecular systems. Furthermore, the liquid environment is necessary only that the living organisms to protect against the damaging effects of ultraviolet radiation, which at the initial stage of evolution of the planet can freely penetrate to its surface.

It can be expected that such liquid coating may be only water and liquid ammonia, a compound which, by the way, its structure is similar to organic compounds, so being considered the possibility of life on the ammonia basis. The formation of liquid ammonia require relatively low surface temperature of the planet. In General, the value of the initial temperature of the planet for the emergence of life on it is very large. If the temperature is large enough, such as 1000C, and the pressure of the atmosphere is not large, its surface may form a water shell, not to mention ammonia. In such circumstances, to

talk about the possibility of life on the planet is not necessary. Based on the foregoing, we can expect that the conditions for the emergence in the distant past of life on Mars and Venus could be, generally speaking, favorable. Molten shell could only be water, not the ammonia that follows from the analysis of the physical conditions on these planets in the epoch of their formation. Currently these planets are well understood and there is nothing to indicate the presence of even the simplest life forms on any planet in the Solar system, not to mention intelligent life. However, to obtain clear evidence for the presence of life on some planet by astronomical observations very difficult, especially if we are talking about a planet in another star system. Even the most powerful telescopes under the most favorable conditions of observation the size of the details visible on the surface of Mars equal to 100 km.

Until now we have identified the most General conditions under which the Universe can (not necessarily should) be life. Such a complex form of matter, like life, depends on a large number of completely unrelated phenomena. But all these arguments apply only to the simplest forms of life. When we turn to the possibility of certain manifestations of intelligent life in the Universe, we are faced with very great difficulties.

4. The problem of extraterrestrial civilizations.

One of the most interesting topics of astronomy is the possibility of the existence of extraterrestrial civilizations. This topic is constantly ongoing debate, and consensus does not exist. But most modern astronomers and philosophers believe that life is widespread in the Universe there are many worlds inhabited by civilization.

The level of development of some extraterrestrial civilizations may be far above the level of the development of human civilization. With such civilizations earthlings especially interested to make contact.

The development of views about the many civilizations influenced by several arguments.

First, in the Metagalaxy there are a huge number of stars similar to our Sun,

and therefore planetary systems can exist not only in the Sun. And what's more, studies have shown that some of the stars of certain spectral classes revolve slowly around its axis, which may be caused by the presence around these stars planetary systems.

Second, under the right conditions, life could arise on planets of other stars according to the type of evolutionary development of life on Earth. Molecular compounds necessary for the initial stage of the evolution of inanimate nature are quite common in the Universe and are open even in the interstellar medium.

Thirdly, the possible existence of non-protein life forms, fundamentally different from those common on Earth. However, nothing specific about them is not known to science.

Not all scientists are so optimistic concerning the problem of extraterrestrial civilizations. Proponents of the opposite point of view believe that life, especially intelligent life are extremely rare, and maybe unique phenomenon in the Universe. On the development of their opinions were influenced by the following arguments:

First, the probability that in the evolution of inanimate matter creates life, and especially intelligence, is very small, as in the course of this evolution there is a huge number of obstacles to the formation and subsequent complications cells.

Secondly, in the Solar system is highly organized forms of life is only on Earth. On the moon and possibly on Mars, contrary to expectations, was not even microorganisms having a high adaptability to environmental conditions.

Thirdly, there is no irrefutable evidence that the Earth ever visited the envoys of other worlds. Mere rumors.

Fourth, radiovoice signals of extraterrestrial civilizations have not yet been successful. Not detected any signs of the activity of extraterrestrial civilizations, that seems strange, assuming that these civilizations could achieve higher levels of development, in comparison with the Earth.

So, extraterrestrial civilizations still are among the hypothetical object, which is of great interest. There is ongoing debate about the reality of extraterrestrial civilizations, but only further observation and experimentation will determine whether there are somewhere inhabited worlds or are we alone, at least within our Galaxy.

5. The emergence of the mind.

Life on any planet should do a lot of evolution before becoming reasonable. The driving force of this evolution is the ability of organisms to mutations and natural selection. In the process of this evolution organisms more and more complicated, and parts of them spetsializiruyutsya. The complication comes in both qualitative and quantitative direction. For example, the worm has only about 1,000 nerve cells, and in humans about ten billion. The development of the nervous system significantly increases the ability of organisms to adaptation, their plasticity. These properties are highly developed organisms are necessary but certainly not sufficient for the emergence of mind. The latter can be defined as the adaptation of organisms to their complex social behaviour. The emergence of the mind must be closely associated with radically improving ways of sharing information between individuals. Therefore, the history of intelligent life on Earth the emergence of language was crucial. Can we, however, this process is considered to be universal for the evolution of life in all corners of the Universe? Most likely — no! In principle, under entirely different conditions by means of exchange of information between individuals could be not longitudinal oscillations of the atmosphere (or hydrosphere), which live in these individuals, but something completely different. Why not imagine a way to share information, not based on acoustic effects, and, say, optical or magnetic? And in General — is it really necessary to life on some planet in the course of its evolution became reasonable?

Meanwhile, this theme since time immemorial have troubled mankind. Speaking about life in the Universe, always, meant intelligent life. Are we alone in the infinite vastness of space? Philosophers and scientists since ancient times have always been convinced that there are many worlds where there exists intelligent life. No science-based arguments in favor of this statement is not cited. Reasoning, essentially, was conducted according to the following scheme: if on Earth one of the planets of the Solar system there is

life, then why not on other planets? This method of reasoning, if logically developed, not so bad. In General it is terrible to imagine that out of 10²⁰ — 10²² of the planetary systems in the Universe, in a region with a radius of ten billion light years, the mind only exists on our tiny planet... But maybe intelligent life is extremely rare. May be, for example, that our planet as an abode of intelligent life in the Galaxy only, and not in all the Galaxies there is intelligent life. Can we assume work on intelligent life in the Universe scientific? Perhaps, after all, at the modern level of technological development can and must tackle this problem now, the more it can suddenly be extremely important for the development of civilization...

The detection of any life, especially intelligent could imagine, and make a huge difference. So for a long time, attempts to find and establish contact with other civilizations. In 1974, the U.S. was running an automatic interplanetary station "pioneer 10". A few years later, she left the confines of the Solar system, performing various scientific tasks. If a negligible probability that someday, after many millions of years, unknown to us highly civilized alien beings will find "pioneer 10" and will meet him as the messenger of another, unknown world. In this case inside the station laid a steel plate with the engraved pattern and the characters that give the minimum information about our earth civilization. This image is made in such a way that rational creatures, who found him, was able to determine the position of the Solar system in our Galaxy would have guessed about our appearance and, perhaps, intentions. But of course the alien civilization is much more likely to be detected by us on Earth than to find the "pioneer 10".

6. Communication with other worlds.

The question of the possibility of communication with other worlds was first analyzed Kokkónion and Morris in 1959. They came to the conclusion that the most natural and viable channel of communication between any civilizations separated by interstellar distances, can be installed with the help of electromagnetic waves. The obvious advantage of this type of communication — the distribution of the signal with the highest possible in nature speed and concentration of energy within a relatively small solid angles without any significant scattering. The main disadvantages of this method are the small power of the received signal and strong interference

arising due to vast distances and cosmic radiation. Nature itself tells us that the transmission should go at a wavelength of 21 cm (wavelength of emission free hydrogen), the energy loss of the signal will be minimal, and the probability of receiving the signal of an extraterrestrial civilization much more than a randomly taken wavelength. Most likely, what to expect signals from space, we should expect the same wave.

But let's say that we found a strange signal. Now we have to go to the next, quite an important issue. How to recognize the artificial nature of the signal? Most likely, it needs to be modulated, that is, its power over time must be changed regularly. At first it needs seem to be simple enough. After the signal will be accepted (unless, of course it will happen), between civilizations will be established two way radio communication, and then we can start exchanging more complex information. Of course, we should not forget that the answers can be obtained not earlier than after several tens or even hundreds of years. However, the importance and value of such negotiations, of course, have to compensate their slowness.

Radio observations of several closest stars was held for several times in a large project "OSA" in 1960, and by means of a telescope of the National radio astronomy laboratory, USA in 1971. Developed a large number of expensive projects to establish contacts with other civilizations, but they are not funded, and the actual observations is carried out is very small.

Despite the obvious benefits of space radio communication, we must not lose sight of other types of communication, as it is impossible to tell in advance what signals we can deal with. First is optical communication, the main drawback of which is very weak signal strength, because, despite the fact that the divergence angle of the light beam could be reduced to 10^{-8} rad., its width at a distance of several light years will be huge. Also communication can be done by automatic probes. For obvious reasons this kind of communication earthlings are not yet available, and will not be available even with the controlled thermonuclear reactions. If you run such probe we would be faced with a huge number of problems, even if you count the time his flight to the target is acceptable. Besides, less than 100 light-years from the Solar system already has more than 50,000 stars. On which to send a probe?

Thus, the establishment of direct contact with an alien civilization from our side is impossible. But maybe we should just wait? Here it is impossible not to mention the very topical issue of UFOs on Earth. UFO's are a reality on 5% fiction and 90%. The existence of the problem of unscientific phenomena understood by the fact that our world is incomparably more difficult than that which to us is science. They lead us to the conclusion that our world is not alone, that there is some sort of parallel world, which exists independently of us and is not subject to our laws. Very well the problem of unscientific phenomena covered in the TV series "Secret materials" on the basis of data of the CIA and the FBI. The material is very good for the layman, but not for a scientist. Because science completely rejects this issue. It is a science completely unknown. Various cases of "monitoring" of aliens and their activity has already seen so much, that in no event it is impossible to refute these data. We can only say that many of them, as it turned out over time was a fiction or a mistake. But that's a topic of other studies.

If somewhere in space is detected some form of life or civilization, we're not even close, can't imagine how will look her representatives and how they will react to contact with us. And suddenly this reaction will be, from our point of view, negative. Well then if the level of development of extraterrestrial beings lower than ours. But it can be immeasurably higher. Such contact, it is normal to us the attitude of other civilizations, is of the greatest interest. But about the level of development of the aliens can only guess, and their structure are not to say anything at all.

Many scientists are of the opinion that civilization can not progress beyond a certain limit, and then she dies or never develops. For example, the German astronomer von Horner called six reasons, in his opinion, is able to limit the duration of the existence of a technically advanced civilization:

the complete destruction of all life on the planet;

the destruction of the only highly organized beings;

physical or spiritual degeneration and extinction;

loss of interest in science and technology;

lack of energy for the development of a highly developed civilization;

life time is infinitely large;

The last opportunity the von Horner believes absolutely incredible. Further, he believes that in the second and third cases, the same planet can develop another civilization on the basis of (or fragments) of the old, and such "renewal" is relatively small.

7. SPACE MESSAGES.

Over the past 40 years the people became convinced that near the Earth there are civilizations that transmit messages by radio. The humans decided to send a message to the unknown space brothers. In the 70-ies to the stars was sent dispatches and automatic probes with parcels on Board. What was their content?

First of all, he had to solve the question, in what form to send a message: in the form of text or pictures, i.e. are concepts or images. Use linkos not yet decided. All messages sent into space on the radio and on Board spacecraft contain images — pictures, slides, sounds, speech, music. The short text consists of several numbers needed to specify the "return address" — position of our planet in the Galaxy.

On 16 November 1974 from the Arecibo Observatory sent a message in the direction of the globular cluster M 13 in the constellation Hercules. It's about a million stars, like our Sun, so it is likely that the message will someone taken. However the signal will get there only after 25 thousand years. The message sent on the wave length of 12.6 cm and contains 1679 characters. As I hope the earthlings, their alien colleagues will think that the message is a frame 23x73.

While earthlings unknown quick ways of interstellar travel; flight even to the nearest star would take tens of thousand years. For a person the way to the stars is closed. But the machines have already rushed into interstellar space: four probes left the Solar system is a "pioneer-10, -11", launched in 1972-1973 and "Voyager-1, -2" running 1977 Flying past the outer planets, they

have overcome the attraction of the Sun and are now removed into the depths of the Galaxy. So why not send them news in other worlds? There is a chance that they will ever fall into the hands of intelligent beings. Therefore, each of the probes carries a special message.

Inside the "Pioneers" founded a small metal plate on which is engraved "calling card" of earthlings. It depicts the people on the background of the silhouette of the spacecraft (to show scale). Welcome man raised his hand. Below shows a diagram of the Solar system; a line extending from the third planet the little silhouette of the "Pioneer" shows the flight path. Top left shows the double-hydrogen atom. The circle represents the orbit of the electron, and stick with the point — direction of the spin (axis of spin) of an electron and proton. In the right image the spins of the particles coincide and they are opposite on the left. Every physicist (including, probably, unearthly) knows that when you rotate the spins of the hydrogen atom emits a radar pulse with a frequency of 1420 MHz, i.e. with a wavelength of 21 cm These length and frequency (measure of time) are the units of all other distances and times specified on the drawing.

The most important message is encoded in the "star" left of center. This is our "return address" in the middle of the Sun, and stretching from the rays show the direction and distance to a "beacon" of the Galaxy — pulsars. A neutron star, a rapidly rotating and emitting radio pulses with a certain period. Each pulsar period, which in a binary code recorded along the beam. All developed civilizations of these pulsars must be known. And knowing their coordinates in the Galaxy, it is easy to find and the position of the Sun. The long horizontal beam indicates the direction and distance to the galactic center — the "capital" of our "star of the Empire".

"Voyager" is sent for the whole package: to Board each of them attached round aluminum box, put there a gold-plated disc. Instruction for its reproduction is depicted on the lid of the box.

On the disk 115 images (slides), which collected important scientific data, the types of the Earth, its continents, different landscapes, scenes from the life of animals and humans, their anatomical structure and biochemical structure, including DNA molecule.

III. Conclusion

We live in the era of scientific technological revolution. The rapid development of physics and astrophysics introduces us to a range of increasingly unusual and strange phenomena. Systematic discovery becomes the norm of modern science. All with greater clarity the picture appears "invisible" Universe.

Currently, scientists working in the field of physics and astrophysics, the vast majority accept the idea of "weirder world". Debates and discussions are deployed mainly not about that, there is this "world" or not, around the question of "the limits of applicability of the" ideas "weirder world" in each case, that is, around the question of whether to include these or other new and unusual facts in the system of existing values or judgement are required beyond the usual fundamental concepts, the discovery of new laws of nature and the development of fundamentally new scientific theories.

And what new discoveries we expect of astronomy and astrophysics in the near future?

Unfortunately, to answer this question with any sufficient certainty is almost impossible. As rightly noted academician G. I. Naal, open therefore are the discoveries that they are usually unexpected and therefore unpredictable. And it was unexpected discoveries and change the face of science, introduce us to new, unexplored regions of the "weirder world". Not accidentally one of the greatest physicists of our time academician P. L. Kapitsa likes to point out that the most important and interesting discoveries are those that cannot be foreseen. And repeats the words of hamlet: "There are more things in heaven and earth, Horatio, than are dreamed of our sages".

In the physical sense, the Earth, compared to stars and Galaxies, a grain of sand, and we feel it is better than someone else. But the view from the other side. After all, the man who lives on this insignificant grain of sand, capable of thinking, and his thought has reached distant Galaxies... So, man is great because his works are great. Assessing the spiritual power of man, especially of his tremendous ability, to know the surrounding nature, we see how powerful it is.

From this summary it can be concluded that until now, scientists around the world are not proved, "are we alone in the Universe?" and whether there is intelligent life on other planets. We often ask very General questions concerning the existence and properties of the Universe as a whole. But if the question posed, it does not mean that it can be answered. Whether it is legitimate to raise the question of why the world in which we live is so, and not some other? To get to this question, a comprehensive answer, we would need to go beyond the observable Universe and embrace the world in all its infinite variety. And this, alas, is impossible both fundamentally and for reasons purely practical. Of course, everything in the world is in principle knowable. In the sense that all phenomena have natural causes and are subject to natural laws. But practically we can learn not all. First of all, because the process of cognition is endless, the Universe is infinite in time and at any level of development of science in the world will always be for us something unknown. Second, because not all the global processes we can obtain the necessary information.

From all I have written a specific answer to the question "are we Alone in the Universe?" does not exist.

So let's hope that in the near future will get the answer to this question.

Mars, the Fourth in order from the Sun largest planet in the Solar system, distant and mysterious from time immemorial, has now become close. This is made possible today thanks to the progress of Astronautics. And yesterday, another interesting and purposeful humanity was satisfied with the "blue dream" of flying on the "red planet."

From time immemorial Mars has attracted the interest and imagination of earthlings. The possibility of life on other planets of the Solar system excited the best minds of humanity. In the literature, the theme of Mars is also very popular: Such works as "Aelita" by Alexei Tolstoy's "the Martian Chronicles" by ray Bradbury and "war of the Worlds" by Hg wells known to almost everyone, and to list all authors who wrote about Mars at all.

The romantic pathos of 60 years when the cinemas went enthusiastic the question "...is there life on Mars?", changed work routine flights to Mars automatic interplanetary stations (AWS) initiated its first flight to the "red

planet" Soviet "Mars-1", launched November 1, 1962 Mars was "a tough nut". Since 1959 in the USSR and Russia, we developed eight types of "Martian" stations that have survived to the flight tests. The way to our last, unfortunately unsuccessful, expedition was thorny: from 1962 to 1996. made 17 starts the AMC to Mars. Of these, only four missions were considered partially successful. Last start station "Mars-8" (project "Mars-96"), held on 16 November 1996, were unsuccessful. The apparatus with the upper stage went into orbit. However, the launch to Mars orbit with this already took place. The failure most likely occurred due to the failure of the upper stage. On 17 November, the station "Mars-8" burned in the Earth's atmosphere over the Pacific ocean. The failure of missions to Mars has befallen not only us but also the United States. But despite that, not all of the expedition was a failure, so people have accumulated a lot of information about the atmosphere of Mars, its climate, surface composition and geological processes occurring on it. But learning is still very, very much.

In the wildest dreams of scientists want to change the climate of Mars to make it habitable and populated by people, but if some believe that it is near the reality, others say that further conversations business does not go down, but if Mars and destined to shelter the people, it will happen very, very soon.

Raises a legitimate question: "Why?" Why Mars, why is it tied so much attention to how ordinary people and scientists? Probably because Mars is the only planet in the Solar System, where you can nuzzle people. The moon is lifeless, atmosphereless world with jumps of temperature from $+130^{\circ}\text{C}$ to -170°C . mercury is considered inauspicious for any form of life imaginable, as is a tiny, seething ball; Venus is the second planet from the Sun, where the poisonous clouds of the twenty-four hours a day pouring concentrated sulfuric acid. Gas giants are too far, extremely cold and they don't even have a solid surface, to them it was possible to live. Neptune is very far, little studied and is a small ice ball. So Mars is the only suitable planet. He is undoubtedly the most "earth-like" planet in the Solar system. Its axis is inclined at an angle of 24.935 degrees in the orbital plane of its rotation around the Sun (the tilt of the Earth's axis is 23.5 degrees). The period of rotation of Mars on its axis is 24 hours 39 minutes 36 seconds (Earth is 23 hours 56 minutes 5 seconds). Like Earth, it is not a perfect sphere, but somewhat flattened with poles and a few swells at the equator. Like Earth it

has four seasons, though their duration is almost twice more: because of the elliptical orbit, the seasons in the Northern and southern hemispheres have different duration: the summer in the Northern hemisphere continues 177 Martian days, and in the South it is 21 days shorter and warmer by 20 degrees than summer in the Northern hemisphere. Finally, like Earth, it has icy polar caps, mountains, deserts, and dust storms. Although Mars is now gives the impression of a lifeless desert, there is evidence that in ancient times it was making the oceans and rivers, and its climate was very similar to earth.

The Red Planet.

The first striking feature of Mars is its red color. This feature was so important that it determined the name of the planet. Ancient not be tormented by the question why Mars is coloured red. They were sure that it was blood. Because during the so-called great struggles[1] Mars approaches Earth at the closest distance, and then between people somehow break out of the most brutal war. Really, what's better than blood could symbolize the coming horrors? The Babylonians identified the planet — the harbinger of misery the God of battles Nangalam, Greeks and Romans — with the God of war Ares or Mars. The name "Mars" was fixed and is fully justified itself throughout the history of mankind. That's the last Great opposition, when Mars once again came close to the Earth, coincided with the beginning of the second world war and the German attack on the Soviet Union.

Why is Mars red? The color of Mars received due to the minerals that contain excessive amounts of iron oxide, has a reddish color. So the ancients were not so far from the truth — the Martian sand doing the same red oxide of iron, which owes its color to the hemoglobin of human blood.

Of the moon.

The satellites of Mars were discovered 11 and 17 August 1877, during the great confrontation by American astronomer Asaph Hall. Names such satellites are received again from Greek mythology: Phobos and Deimos are sons of Ares (Mars) and Aphrodite (Venus), accompanied his father. In Greek “Phobos” means “fear” and Deimos “terror”.

Phobos is the closest moon to its planet in the Solar system. Distance from Phobos to Mars is 9400 kilometers and rotates the satellite around Mars with a period of 7 hours. 39 min. Thus, the Phobos makes circulation around the planet three times faster than Mars rotates on its axis. During the day, Phobos manages to make three full turns and pass an arc of 78° . To a Martian observer Phobos rises in the West and sets in the East.

The small sizes of Phobos-28x20x18 km away. the Latest data received from the lander "Mars global Surveyor", showed that the surface of Phobos, which is a rib relative to the planet, covered in craters from meteorite constant collision.

In 1945, the American astronomer B. Sharples discovered the secular acceleration in motion of Phobos in orbit. This meant that Phobos, strictly speaking, is moving in a very shallow spiral, gradually approaching the surface of Mars. If things continue like this, in 15 million years-a period from a space point of view is very small, Phobos falls on Mars. Interestingly, there is a program designed to "help" Fobos fall on Mars to raise the temperature of the planet due to the collision with the satellite, but how it actually-will show time.

Deimos is the smallest known moon in the Solar system. The satellite has a spherical shape, its dimensions are 11x15 km Distance to Mars of the order of 23.5 thousand kilometers. The period of rotation of the satellite around Mars in 30 hours 21 minutes. The orbital period of Deimos is slightly larger than the period of rotation of Mars, so even though Deimos and "normal" rises in the East and sets in the West, but moves across the sky of Mars is extremely slow.

Small craters dotted the surface of the satellites about as well as the Moon. At the General similarity, the abundance of finely fragmented rocks that cover the surface of the satellites Phobos looks more "ragged", and Deimos has a smoother, dust-covered surface. On Phobos discovered the mysterious furrows that cross almost the entire satellite. The furrows have a width of 100-200 m, and extend for tens of kilometers. Their depth is from 20 to 90 meters. There are several hypotheses to explain the origin of these furrows, but not yet enough convincing explanation, however, and explaining the

origin of the satellites themselves. This is most likely captured asteroids.

The atmosphere on Mars is very sparse, because Mars is not able long to keep himself near the gas molecules. In the distant future, the atmosphere is apparently completely dissolved in space. And at the moment the pressure at the surface at best accounts for only one percent of the normal terrestrial atmospheric pressure. However, three times smaller gravity on Mars allows even this thin air to raise the millions of tons of dust. Dust storms on the red planet — are not uncommon. Astronomers seeking something from the Earth to see Mars, already struggling with two atmospheres. Dust storms in the Martian atmosphere can sometimes rage for months. After a certain time in the storm accumulates too much dust and it starts to disintegrate. Storms are strongest in the spring and summer in the southern hemisphere when the planet is closest to the Sun and winds are strongest. Is the Martian atmosphere is 95.3 per cent of carbon dioxide, 2.7 percent molecular nitrogen and 1.6% argon. There is in the atmosphere a small amount of water vapor.

The low temperatures of Mars bound carbon dioxide, which reflects the energy received by the planet from the Sun. Almost absent atmosphere helps Mars with increasing temperature. On the shady and Sunny sides of a temperature much strife.

When the first pictures from the surface of Mars, made a “Viking” were transferred to the Earth, scientists were very surprised to see that the Martian sky is not black as it was supposed to be a pink. It turned out that the dust hanging in the air, absorbs 40% of incoming sunlight, creating a color effect.

The key issue of Mars not even its low temperature and very strong rarefaction of the air. Scientists have long dreamed of sending an expedition to the volcano mount Olympus, but on top of it the air is thin so that the lander can't even slow down for a successful landing. Again, because of the low atmospheric pressure on Mars can not exist in liquid water, necessary for all life. With the combination of low pressure and low temperature liquid water would be frozen instantly. Despite the fact that the amount of water in the atmosphere is very small, it is close to the saturation is due to low pressure.

The results of the research of the American lander the Pathfinder showed that if people stood on Mars, the difference of temperature between his feet and the breast would have amounted to approximately 15 degrees.

However, the isotopic composition of the atmosphere and the presence of inert gases indicate that in the past the atmosphere was very different from the one that now shows a meter of the spacecraft.

The temperature regime of the planet.

First measure the temperature of Mars with a thermometer placed in the focus of the reflecting telescope, was carried out in the early 20-ies. Measurement V. Lampland in 1922. given the average temperature of the surface of Mars -28°C , and E. Pettit and S. Nicholson received in 1924. -13°C . the lower value obtained in 1960. W. and J. Sinton. Strong: -43°C .

Later, in the 50s and 60s were accumulated and summarized a number of measurements of temperatures in different points on the surface of Mars, in different seasons and times of day. From these measurements it followed that a day at the equator the temperature can reach $+27^{\circ}\text{C}$, but by the evening it drops to zero, and in the morning to -50°C . At the poles the temperature can range from $+10^{\circ}\text{C}$ in the polar day period to extremely low temperatures during polar night.

In 1956 the measurement of temperature was used a new method – radio astronomy. Mars, like every heated body emits not only infrared radiation but also the longer-wavelength lying in the radio. It is called thermal radiation, in contrast to the nonthermal associated with the various electromagnetic and plasma processes. Measuring the amount of thermal radiation, it is possible to determine the temperature of the planet.

The first such measurements were performed by K. Mayer, T. Mackellar and R. Slonaker in 1956, They received the average surface temperature of Mars is -55°C , i.e. significantly lower for infrared radiation. Measurements taken in recent years from the spacecraft showed that Mars can be observed and even lower temperatures, reaching up to -133°C — below the freezing point of carbon dioxide.

The difference in temperature between day and night, polar and tropical regions, winter and summer leads to winds, sometimes with speeds of 40-50 km/h. The air circulation on Mars, now being studied by various methods by many researchers.

Among the formations found on the surface of Mars, the spotlight attract rakobraznye ducts, or meander valley. Their appearance, the presence of "tributaries" can hardly be explained otherwise than suggesting that it is rivers.

However, on Mars at the present time, the river flow can not, there cannot be liquid water. The reason for this is that at the low pressures that prevail on Mars, water boils at very low temperatures. No other liquid could not form the observed channels: lava quickly solidifies, and the liquid carbon dioxide, even under terrestrial conditions cannot exist.

So, the only possible explanation of the meanders on Mars – is the formation of streams, rivers. It currently has no necessary conditions—so they were in the past. For this you need to assume that in an earlier era, the atmospheric pressure on Mars was significantly higher than at present.

The Topography Of Mars

The geological features.

Mars is unusual in that it has a strong asymmetry relative to the equator, which divides Mars into two hemispheres, differing sharply from each other.

The southern hemisphere is situated at altitude 1-3 km of the Martian sea level, the entire surface much isserlin meteorites and contains many kilometres of deep channels. The Northern hemisphere is below sea level and is covered with volcanic flows, and contain few craters, but mostly it's plains or mesas.

The surface of Mars is frozen to a depth of over a kilometer, and is stable at the poles the ice is so strong that plays a significant role in the growth of volcanoes.

Craters.

The study of craters is important, because no rock samples delivered to Earth was not at the craters, we can estimate the age of the surface of Mars. The process of Dating the surface is only for visual observation is called stratigraphy and all the tools for analysis available to us, only the photos taken of unmanned vehicles.

Small craters (about 5 km in diameter) resemble a ball with a flat bottom and sharp slopes. Large craters (50 to 70 km in diameter) resemble a small plain, surrounded by hills covered with fuzzy, eroded slopes.

According to the analysis of substances ejected from the surface of Mars by a meteorite, it is possible to determine whether Mars is covered with water or ice, when the crater was formed.

A large part of the southern hemisphere and the Northern part has a surface heavily covered with craters. Maybe the Northern hemisphere has much more smooth surface due to the fact that the craters were filled with lava. It is not necessarily visible volcanoes, the lava could fall through the cracks on the crater floor.

Judging by the fact that the southern hemisphere is much stronger covered with craters, we can assume that the surface over the surface of the Northern hemisphere. According to another theory, all the irregularities of the Northern hemisphere was wiped out due to falling of a huge meteorite.

Large craters were formed about 3.8 billion years ago.

Plain

The most heavily cratered plains were formed about 3.5 billion years ago, a little cratered plains formed after the bombing of Mars decreased it occurred less than 500 million years ago.

Plains at the equator is greater than any seen in the Land of plains and was the result of volcanic activity: they consist of ash and lava. Other plains

probably formed as a result of volcanic activity, winds and ice.

Volcanoes

There are two types of eruptions taking place on Mars: those that come from one crater constantly and thus building around itself a volcanic mountain, and the eruption coming from cracks in the bark, through which formed the great plains. Because of little tectonic activity on Mars is a volcano, usually growing not spreading as long as enough magma.

Volcanoes are mainly located on the Elysium uplifts and Tharsis near the equator. Only on the North-West of the uplift of Tharsis is a volcano Olympus is the highest volcano not only on earth but in the Solar system. Geologists klassificeret it as a “shield volcano”, which consists of a round lump of lava is 700 km in diameter, rising to the top in the form of a Caldera with a diameter of 80 km from the Outer edge of the build-up of lava is restricted to steep cliffs rising to 6 km above the surrounding plains. This volcano is similar to terrestrial volcanoes, such as on a famous volcano in Hawaii, the main difference is his huge size. The reason for such size, apparently a combination of two factors: low tectonic activity of Mars and the deep source of magma. Magma is moving under very strong pressure, because in order to reach the surface of Olympus, she needs 150-200 km (the distance from the Hawaiian volcano 60 km). Large volcanoes have the smooth gentle slopes of the order of 6 degrees or less, respectively, of a small volcanic slopes steeper.

Raising.

Southwest of Olympus is raising the Elysium — a huge hill crowned by three volcanoes. The highest of them — mount Elysium rises 9 km above the surrounding plains.

To the South-East of mount Olympus at a distance of 1600 km away from the even more gigantic hill known as the Tharsis uplift. It rises 10 km above notional sea level and stretches more than 4 thousand km from North to South and 3 thousand km from East to West, i.e. equal in size to Africa South of the Congo river. In turn, it is topped with a solid three giant volcanoes — Arsia, Peacock and Astraslim, known under the common title “the Mountain

of Tharsis”. Located on the broad shoulders of the Tharsis uplift they uplift their peaks to a height of 20 km above sea level and remain visible for the spacecraft, even during the strongest dust storms.

Channels.

At the Eastern edge of the uplift of Tharsis Mars seems to split some catastrophic forces. Among the fancy weave of interconnected canyons and valleys known as the Labyrinth of Night, the surface of the planet blows up a monstrous sinuous furrow, which stretches over a distance of 4500 km to the East almost parallel to the equator, between the fifth and twentieth Parallels of South latitude.

This is the valley of Marinerio, named in honor of the “Mariner-9”-the first spacecraft that photographed it. In depth it reaches 7 km with a maximum width of 200 odd km For comparison will indicate that it is 4 times deeper, up to 6 times wider and more than 10 times longer than the Grand Canyon in the United States.

The Eastern extremity of the Valles Marineris turns North to the equator and flows into the so-called “chaotic terrain” — tortured and mangled landscape of massive remains of the valleys and fractures.

From the Northern part of this chaotic zones appear deeply embedded, very wide and long channels — Simud, Tiu and Ares (the last July 4, 1997 landing of the lander of NASA's “global Surveyor”). These channels intersect the bottom of a huge depression known as the plain of Chryse, where they are joined by other channels, including Casey, who comes from the Northern part of the Central section of the canyons of Marinerio and stretches for 3 thousand km.

In the unanimous opinion of geologists, the striking thing about these channels is that they could be laid only by the flow of huge quantities of water. These streams flowed from the southern hemisphere of Mars in the North at very high speed because it flowed downhill. In support of this theory there is another fact — in some parts of the canyons have layered sediments. They could be formed under water, although these deposits could be formed

and as a result of seasonal changes.

The polar caps

Freezing carbon dioxide and water vapor to form polar caps, the size of which with the movement of Mars in its orbit changes. On Mars there is a change of seasons for the same reasons as on Earth. Winter in the Northern hemisphere polar cap is increasing, and in the South almost disappears: the summer. Six months later, the hemispheres are reversed. However, the southern cap in winter, grows to half the distance of the pole and the equator, and the North only to one third. Why is it so unequal roles? As the Mars's orbit is highly elongated, the same season in different hemispheres of Mars occurs in different ways. In the southern hemisphere winter is colder and summer is warmer. In the summer of the southern hemisphere of Mars is nearest to the Sun site its orbit, and in winter — the remote. With the Earth, by the way, the same thing happens.

Measuring “reflection spectra of” caps, scientists have discovered what they are. The southern cap is much colder than the North — is composed entirely of solid carbon dioxide. The Northern cap contains variable amounts of solid carbon dioxide and maintains a constant rest — about 1000 km wide — pure water ice. He is considered “the largest reservoir of water on the planet.”

The Arctic ice is surrounded by and go under it — as they are called by geologists “extensive layered deposits”. It is believed that they were brought here by the winds. They cut a narrow twisting valley and surrounds, the largest in the Solar system sea of sand dunes.

Life on Mars.

The search for life.

Before people there was always the question about the existence of life on Mars, and now, in 1976, American scientists attempted to solve it by conducting an elaborate series of experiments on the surface of Mars using landers "Viking".

The program "Viking" was prepared for several years. Two spacecraft were launched August 20 and September 9, 1975

"Viking 1" on June 19, 1976., after 10 months, came to areocentric orbit, and one month later – July 20 planting unit made the descent and landing in the field Chrise. Appliances "Viking-1" immediately started the transmission of panoramic images of the planet's surface. The landing area has a fairly flat topography and is a sandy desert with lots of rocks, half covered with a thin layer of dust.

Conditions at the landing site of the block was quite harsh. X-ray fluorescence spectrometer gave preliminary information about the composition of the Martian soil: 12 to 16% iron, 13-15% silicon, 3-8 percent calcium 2-7 percent aluminum, 0.5-2% titanium.

In the place of the descent of the landing unit "Viking-2" in the bright region Utopia — the picture was almost the same as in the field Chrise. The same stones and rocks among the sandy desert, some of them speckled by holes, and resemble pumice.

But all were primarily interested in the results of experiments on sampling and analysis of soil samples for the presence of microorganisms. July 31 American scientists got very excited. Analyzer gas exchange showed a 15-fold increase in the oxygen content compared to normal after two hours of incubation. After another 24 hours, the oxygen concentration is increased by 30%, and then began to fall, and a week later fell to zero.

In the second experiment, a part of sample was loaded into the reservoir with a nutrient broth in which there were radioactive atoms. The analyzer has detected gases is recovered and found the increase in carbon dioxide almost the same as in the analysis of biologically active samples of the earth's soil. But soon in this device the level of reporting fell to almost zero.

The third experiment, which recorded absorption of the isotope of carbon C14 alleged organic compounds of Martian soil on August 6 showed increased activity.

"Viking-2" oxygen of the samples was much slower than on the "Viking-1", however, the American scientists believe that these results cannot be explained only by chemical reactions.

So, the first experiments "Viking" were encouraging in relation to the hypothesis of the existence on Mars of organic life. Of course, this is not proof of its existence. More research is needed.

Sidonia

On 25 July 1976 by the American interplanetary station "Viking-1" photographed on the surface of Mars is an amazing education length of 1.5 kilometers, resembling a female face. It was a sensation — the rounds of all the periodicals of the world and repeatedly appeared on television screens.

Of course, the Orthodox astronomers declared the image an "accidental natural". However, "the face was oriented along the Meridian of Mars, but admitted it "random". In short, what was needed was expertise amazing picture, and it did not take long to wait.

Specialist of the company "the Analyst of the Sciences" in Boston (United States) mark Carlotto built in computer technique three-dimensional image of said structure and really saw it as a "head"! Then, enhancing the contrast right, shaded by her hand, found the second "eye" is approximately one hundred meters below the "nose" and even something resembling "teeth"! In his article in the scientific journal "Applied optics", Carlotta wrote: "the results Obtained suggest that all this cannot have a natural origin."

Moreover, a specialist in space Vincent di Pietro and cyberneticist Gregory Molenaar discovered in the archive of the Martian SECOND image of the same "person"! This picture was taken 35 days after the first with different lightning. Computer processing not only confirmed the details of the first photos, but also reveal additional details. Now there were visible "eyeballs" "eyeballs," again "teeth" and the sunlit "cheek"... stone "tear"! Di Pietro and Molenaar concluded: "If the striking detail of this stone the "head" arose in a natural way, that nature needs to be highly developed creature!"

And now, after two decades, came the "hour of truth". 25 June 1995, the leadership of NASA (the American National office for the exploration and study of outer space) under public pressure included in the program of flight interplanetary station "Mars global Surveyor" control shooting "faces". April 5, 1998 mission control Center received the long-awaited photos. Interplanetary station took a picture of the coveted "face" with a height of 440 kilometers (in 1976 the survey was conducted from a height of 1,870 kilometers). To the severe disappointment of people who believe in the artificial origin of this formation, at the check photos on the spot "faces" are only visible irregularities of the relief, to see in which "death mask", depicting the tragedy of a Martian civilization, is possible only with unlimited imagination.

Whatever happened to "person" since at the time very rigorous examination? The simplest explanation lies on the surface — the traditional slyness of officials from the American space science, long earned a reputation of "hush" space photos with non-traditional subjects. For example, it would cost them nothing to make the completely different places. Another explanation for more serious. History of the study of Mars is replete with registration on the surface of the mysterious processes. Will have to remember about the infamous "channels", for which many eminent astronomers had long and unsuccessfully hunting. They have found, for example, that "channel" Nefes-Thoth, seemed in 1939, barely noticeable, in 1941, was split in two, and in 1958 turned into broad band. These changes are confirmed by photos. In reports, the famous discoverer of the "canals" of Schiaparelli mentioned "channel", Erinnyes, then long disappeared from the Martian cards. And in 1941 he appeared again...

However, nobody has managed to explain the periodic change of color in some areas of the red planet, sudden dust storms, a string of unexplained incidents with spacecraft EN route to Mars, and finally, the mysterious "flash", which only in 1894 during the next approach of Mars to Earth has reached four hundred! 8 December 1951 the Japanese astronomer by Tsuneo Saeki spotted a bright spot in the Martian Lake TITANUS shining shimmering light 5 minutes. In 1954, the Japanese watched two of these "outbreaks", and in 1958 four...

If we understand the processes these natural disasters, nothing can prevent

speculation about the possible destruction of "death mask" blind Martian element...

I myself don't believe in the artificial origin of Cydonia, and as proof I want to mention one incident that occurred in the suburbs: in 1925, in the career of a brick factory near was discovered petrified human brain perfectly preserved all the details. Plaster casting with amazing finds were shown at many international congresses and conferences with the same success. Many enthusiasts developed based on the findings exciting hypothesis: some said that we have before us the remains of a stranger, who died during an expedition that visited Earth during the Carboniferous period; others thought before us evidence that civilization on Earth now makes at least the second round — people with such a developed brain once on our planet already existed... But right at the end of the third — those who believed before us only a unique testimony to the nature of the game. Indeed, after decades geologists and paleontologists still proved natural origin of silicon nodule, repeats the form and structure of the human brain. If it is possible on our planet are so unlikely coincidence, what can we say about the possible similarity in the form of huge blocks of stone with a human face, which we can only judge by the photos are quite low quality.

The meteorite ALH84001.

Although separated by tens of millions of kilometers of empty space, Mars and the Earth are in mysterious communication.

Between the two planets have repeatedly taken place, the exchange of materials — in the most recent of them involved space ships from Earth, mounted, on Mars since the early 70-ies. Today we also know that thrown from the surface fragments of rock periodically hit the Earth. By 1997 more than a dozen meteorites by their chemical composition was established Martian origin. Their combined work, the term “SNC-meteorites” (the names given to the first three meteorites found “Shergotty”, “couple of times” and “Cassini”). Scientists looking for meteorites around the world. According to the calculations of Dr. Colin Pillinger from the English Institute of planetary research, “the Land falls annually one hundred tons of Martian material.”

One of these meteorites-ALH84001, dwell on it in detail.

August 7, 1996 at the headquarters of NASA in Washington, was held a historic press conference. Several scientists from NASA and Stendforsky University made a stunning statement, they confirmed that found evidence of ancient microscopic life in a Martian meteorite, known as ALH84001 (Allen hills, 1984, room 001). The meteorite was ejected from Mars as a result of collision of a comet or asteroid with the planet about 15 million years ago and traveling in space all the time, and 13 thousand years ago entered the atmosphere of the Earth and fell in Antarctica. The meteorite lay there until 1984, when the team from the Space Center. Johnson from NASA accidentally found it. Originally the meteorite was classified as a moon, but in 1993 was correctly identified as a Martian meteorite. It's one of only 12 "SNC" meteorites, which meet the unique signature of Mars.

American scientists are based on four facts, "...on the basis of which the existence of life on Mars — the logical conclusion" — as the inscription on one of the American sites on the Internet, dedicated to research in this area. First, the presence of small droplets, the size of a typographical point on this page, usually walls of fractures in a Martian meteorite ALH 84001. This so-called carbon outlet. The centre of this "point" consists of manganese compounds, surrounded by a layer of carbonate of iron, followed by a sylph ring of iron. Some earth bacteria living in the ponds that can leave such traces, "digesting" present in water of compounds of iron and manganese. But, as suggested by the biologist K. Nielson, such deposition may occur in the course of purely chemical processes.

In the meteorite were also found polycyclic aromatic hydrocarbons — a relatively complex chemical compounds, often part of organisms or their products of decomposition. Chemist R. SAR claimed it decomposed remains of once living organic matter. However, his colleague from the University of Oregon, B. Simonet, by contrast, indicates that at high temperatures these compounds can arise spontaneously from water and carbon. Moreover, in some meteorites falling on the planet from a meteor belt that exists between the orbits of Mars and Jupiter, researchers discover even amino acids and hundreds of other complex organic compounds used by living organisms, however no one argues that the asteroid belt is a hotbed of life.

The third argument of the enthusiasts detect under an electron microscope of tiny droplets consisting of magnetite and iron sulfide. Some researchers, such as John. Kirshvink, a renowned expert on minerals, saying that the droplet is the result of the activity of bacteria. However, others, like the geologist E. Shock, I believe that such forms can occur as a result of other processes.

The sharp debate was the fourth proof, presented to a group of NASA. In the carbonate part of the meteorite under an electron microscope they found elongated and egg-shaped structures with a length of several tens of nanometers. Supporters of Dr. Mac-Kay (the head of group of researchers NASA) believe that found fossils of Martian organisms sverhekonomichny. But their volume a thousand times smaller than the smallest terrestrial bacteria. "So it is unlikely the rest of his life — believe the naysayers. Rather, before us is a ultra-small crystals of minerals, the unusual shape which due to their miniature size".

For my work I used as a work of American scientists, and the work of Russian scientists and scientists of other countries. In this regard, I faced many uncertainties, contentious issues, etc. it is No secret that the message about sensational discovery was made just at a time when the U.S. Congress was going to cut allocations for Mars, and a constant race between the two surrenderable also plays an important role.

There are many more arguments, debate, speculation and them alone enough for a whole essay, I just highlighted this issue, and the debate can continue indefinitely.

“Irrigation channels”

On the surface of Mars a network of channels. Most likely they were once rinsed with water. With these channels, due to many misconceptions that greatly fueled interest in Mars; in the late 19th century and early 20th centuries observations from Earth with telescopes brought the first sensation on “life on Mars”-the assertion that this planet is riddled with cells of the giant network of irrigation canals delivering water to parched Equatorial regions. This statement was made by the famous American astronomer Lowell Percivale and left an indelible imprint on the collective psyche of the

American people. Many scholars ridiculed the idea of Lowell, and in 70-e years of running NASA “Mariner-9” and “the Vikings”-1 and -2 did with the orbit of this planet photos, finally proved that there are no channels that would have been built by intelligent beings. It is now acknowledged that Lowell and others claimed to have seen channels become victims of low-quality telescopic images, and optical illusions, which prompts the brain to connect disparate and unrelated dash in straight lines, so I hope for the existence of intelligent Martians who were trying to save the dying and drying up the planet, did not materialize.

The value of Martian life.

While traces of life, which told scientists that were allegedly found in the Martian meteorite ALH84001, only microscopic, for the people it plays a very big difference, because if life on Mars ever existed is proof that the origin of life — not just a unique Fluke, or some divine influence, and the result emanating from specific data. Moreover, if all that is necessary for the origin of life is a liquid environment, which could dissolve substances (such is the theory of the origin of life, which at the moment scientists adhere to), for example liquid water, we can say that the universe is just teeming with life! Suspected liquid water oceans on some of the updated the Jupiter moons (Europa and Callisto) could be filled with life, and that life may still exist beneath the surface of Mars, assuming that there is liquid water and the necessary heat energy.

Conclusion

In my work I tried to cover all the main aspects relating to Mars. Material about the red planet a lot and all of it interesting. If you try to talk about all ideas, theories, interesting points about Mars, will be released not just one or two books.

Mars has always harbored and still harbors many secrets, and this veil people just lifted. Unfortunately, Mars does not pay us back and I think he's starting to take over in April this year, the head of the program for the study of the planets in the framework of NASA's Dr. Carl Pilcher at the annual

Conference for the exploration of the moon and the planets of the solar system, held in Houston, Texas, said that sending the Mars robot, scheduled for next year, to be replaced by another low-budget project, but the orbital research will be continued. This decision was taken after the failure of two multi-million projects: station Mars Polar Lander cost \$ 165 million in December last year and have not made contact after landing near the pole, and interplanetary station Mars Climate Orbiter cost \$ 125 million burned up in the atmosphere of Mars because of an error of programmers in October 1999. The research program of the surface will be frozen as long as mankind does not come up as trouble-free to carry out the landing on Mars, said Dr Carl Pilcher.

If Americans have no extra money and they will not risk to waste them, not knowing exactly what will happen, what to say about our research.

From 1960 to Mars fly properly. As in other space directions, there was intense rivalry between the two giants. Ours was less fortunate: in 1971 due to operator error, the spacecraft flew past Mars, followed by two less successful flight. The leaders of our science thought that now we are doomed to catch up with the Americans, and decided to Excel in the study of Venus. Spent 10 years and a lot of effort, and the pleasure received is scanty. As a scientific object Venus was of little interest. By 1987, when we came around, the Americans have gone far ahead. We were not able to land on the surface of Mars research station, and they had one "Viking" passed out information for four years, another six years.

Mission to Mars... I Want to believe that in 20 years of the next century the whole world will applaud this triumph of the human mind and progress of the civilized world. The best evidence of this can be the words spoken by the first man to walk on the moon, astronaut Neil Armstrong: "I think we're going to the moon because people have always challenged everything and everyone. So arranged human nature".

"ANCIENT" MOON

The moon is Earth's natural satellite and the closest to the Earth celestial body and therefore the best known, but a few years ago with some amazement watched primitive man in the moon! Brooding and mysterious light, the dim

night sun, lonely wandering in the silent celestial sky ball is the Moon in all times and among all peoples especially attracted human interest and imagination. The moon was exposed to the vicissitudes of human opinion. Jules Verne, Cyrano de Bergerac, and other writers, visionaries imagined, and some claimed that the Moon is inhabited by living beings of rich and fruitful life. Before the invention of the telescope, philosophers, quite naturally, were inclined to see in the moon, the earth, similar to the one that we live in. When Galileo first pointing the telescope at the ball, found there the mountains and valleys, similar to the various forms of surface relief of our planet, and vast grey plains that could easily be mistaken for the sea – the similarity between these worlds and ours seemed obvious, and it immediately populated not only by human beings but various animals. It was first drawn up maps, and large dark stains, it was agreed to christen the name "sea" which they are now.

Astronomers, thinkers were convinced that the increasing number of telescopes, followed by a rapid success, and in the reign of Louis XIV was even suggested to build a "pipe length of 100 thousand feet for examining existing animals on the moon". But it is not trying optics, their success is far couldn't keep pace with the imagination. When it became clear to distinguish the surface of the lunar seas, she was not liquid and not smooth, sandy and uneven. This luminary was unable to open any of this morph, not a lake, not the slightest trace of the presence of water in any form: in the form of clouds, snow or ice. Not less than attentive observation of the stars and planets at the time of the coating passing in front of us the Moon showed above and beyond what the light of these luminaries, when they come in contact with lunar edge, not in the least diminished, or refracted, and that the ball is not surrounded by any visible atmosphere. The gradual lunar life dissipated like smoke, and little by little became a habit to put in astronomical books the phrase: "the Moon is a lifeless light." Today it is proven both theoretically and practically. The moon is devoid of atmosphere and water, which without a dense atmosphere in liquid form can not exist. Without the atmosphere of the existence of any organic life impossible.

PHYSICAL CONDITIONS ON THE MOON

As has been said: the Moon is the closest to the earth celestial body and therefore the best known. Coming to us the planets are about 100 times further. The moon is less than Earth's diameter is four times its radius is 1738 km, or 0.272 radius of the Earth. Its weight is less of the Earth is 81 times and 0,0123 equal to the mass of the Earth. The mass of the moon is reliably determined by the movement of artificial satellites repeatedly displayed on selenocentric orbit, i.e. the orbit around the moon (from the Greek. Selena – Moon). Its average density is equal to $3.55 \cdot 10^3 \text{ kg/m}^3$ or 0.6 of the density of the Earth, and the acceleration of free fall on its surface $g=1.63 \text{ m/s}^2$, i.e. 6 times smaller than the earth, so any object on the moon's surface weighs times less than on Earth. As already noted, the moon has no atmosphere, softening the scorching sun rays and protect from cosmic rays and streams of meteorites. There was no clouds, no water, no fog, no rainbow, no dawns with the dawn. Due to the lack of air and gaseous sheath on the moon there is a very curious phenomenon. Here there is no twilight, night becomes day and day becomes night instantly, like a lamp, which instantaneously extinguishes and lights up in the dark. There is no gradual transition from warm to cold. The temperature on the moon from falling from the boiling point to a temperature of interplanetary space. Huge temperature swings of the lunar surface from day to night due not only to the lack of atmosphere, but the duration of the lunar day and lunar night, which corresponds to two weeks. The temperature in sunflower point of the moon is equal to $+120^\circ\text{C}$, while the opposite point in the night hemisphere -170°C . so the temperature changes during one lunar day! For the same reason meteors without inhibition and with great speed hit the lunar surface, causing strong shaking of the soil and forming a funnel.

Due to the lack of atmosphere in the lunar sky no colors. Throughout the night, which lasts two earth weeks and a long day in the scorching Sun over the Moon, the black sky dotted with numerous stars, distinct and absolutely flicker-free. The stars in the lunar sky visible by day as well as night.

Several millennia ago, people with amazement watched as the Moon grew and subsided like a living creature, waxed fat, and dried. Vanished completely, and has been steadily revived in the starry black of the sky. In this striking change has been the steady pattern, which was evident from the beginning of the century, which will remain unchanged until the end of the

years. And when people finally realized that the two new moons are the four quarters, they took a fundamental step from a short measure of time of the day to longer — month. Periodic changing of the moon phases in the flesh and blood of human ideas about the world. Not by chance the Moon in Sanskrit is called "wt", i.e. the meter is no accident the Latin "macules" — a month — is in close connection with the word "makoura" — measure. It is the Moon, not the Sun became the first object of worship. The peoples of Central America had long existed the lunar year is the time used for establishing the religious holidays. The lunar calendar used by the peoples of Mesopotamia. In determining religious holidays are governed by lunar calendar the Jews, the Christians, who identify it offensive Easter. The coincidence of the phases of the moon with a variety of manifestations of animate and inanimate nature: tides in the seas, lowering temperatures and heavy dew that usually falls on a clear moonlit night, increased the growth of some plants and lunar periodicity of the vital functions of the human body — all this has long been worried about people. Subsequently, the phases of the moon associated with the concept of death and resurrection. With the stay of the month the new moon is associated not only grain growth but also the welfare of the herds and children's health. So Central African tribe when a new month mothers carried their babies and showed them the rebirth of the moon. When the Moon entered the last quarter the impact of its contrary, it is considered unfavorable. New cases it was better not to start. Around the globe among the farmers there is a belief that we must sow when it on damages. In a certain period of Kul, the moon occupied an important place in many religions. Now science, medicine point to a possible link of certain disorders of the human psyche with the phases of the moon. The moon can influence the human body, which is more than 80% consists of water, similar to how it affects the seas and oceans.

A huge moon was shining the sky, the Earth, the moon has the same phase as for the Moon, but in reverse order. During the new moon the Sun illuminates the hemisphere of the Earth turned to our companion, and then there is "the Earth is full". During the full moon, on the contrary, the dark hemisphere is turned towards our satellite, and then there is "new Earth". When the moon shows us first quarter, the Earth is the last, etc. Regardless of these phases our ball is the moon revolving around its axis 24 hours and 48 min. because The moon returns to earth each Meridian not before as after this period of time.

Recall that the period of rotation of moon around its axes is equal 27,32 g (earth days) and so she turned to the earth one hemisphere. The full moon also repeated in of 29.53 g, this means that a solar day on the moon lasts of 29.53 g, i.e. about 14,8 g lasts a day and the same night.

THE TERRAIN OF THE MOON

Since the time of Galileo began mapping the moon. The first detailed maps of the lunar surface made outstanding Polish astronomer J. Haveli (1611-1687) in 1647 in the book "Selenography or Description of the moon." In 1651 the Italian astronomer J. Riccioli (1598-1671) published a map of the moon, compiled them together with the Italian physicist F. Grimaldi. (1618-1663). It is on this map for the first time rounded lowland called the seas, which has maintained its name till the present day: the Sea of Tranquility, Sea Clear, Sea Dangers, the Sea of Rains, Sea of Clouds etc. They go from 200 to 1100 km in diameter. "Sea" – plain, in which not a drop of water. The bottom of their dark and relatively smooth. The surface of the seas is folded and covered with dark matter, including solidified lava that once erupted from the lunar interior. The largest lowland, stretching 2000 km is called the Ocean of Storms. The surface of the seas has folds and hills and a small pointed and rounded hills that represent the peaks of the low mountains, filled with solidified lava subsequently. Distinctive in its shape to the boundary area of the seas are called bays, and a small isolated dark valley – the lakes. Seas and lakes occupy about 40% of the entire visible earth, the surface of the moon, and the vast majority of them are located in the Northern hemisphere. The rest (60%) part of the lunar hemisphere is a continent covered as individual mountains and mountain ranges and ridges. Most mountain ranges stretches along the margin of the seas and the earth is the name proposed by J. Evelien. So, the Sea of Rains is restricted to the North-East Alps, in the East – the Caucasus, South-East by the Apennines and the South Carpathians. Some mountain ranges are named after scientists: the mountains d'alembert, Leibnitz mountains, etc. the height of the mountains different, separate mountain peaks – peaks – rise up to 9 km Mountain slopes are cut by many canyons and cracks, between the mountains and long stretch of valley. Form the mountains of the moon is mostly circular mountain with a hollow in the middle. But depression is not always empty, it is not always the newest crater in the middle of it sometimes rises even a mountain and again with a cavity, a crater is newer, but rarely, rarely applicable with a reddish inside, on the

bottom of it, lava. A lot on the moon and plateaus with steep slopes, wide and narrow cracks in the bark extending to several tens or even hundreds of kilometers. Lunar terrain it is better to learn it at an oblique sunlight light, particularly near the terminator that separates the day hemisphere of the moon from the night, i.e. near him the shade, even from the low mountains is very long and easily noticeable. Very interesting in the next hour to follow in a telescope how close to the terminator on the night side glows bright dots are the tops of the shafts of the lunar craters. Gradually out of darkness comes light horseshoe – part of the crater wall, but the bottom of the crater still immersed in complete darkness, finally sketched out the whole crater. Thus it is clearly seen that, the smaller the craters, the more of them. They are often located chains and even sit on each other. Later craters, as has been said, was formed at the baths of older craters. In the center of the craters visible in the slide, in reality it is a group of mountains. The crater walls are broken with terraces and cool inside. The bottom of the crater is below the surrounding terrain. The mountainous areas of the lunar surface is almost completely cratered, and in smaller number they are in the seas. The dimensions of craters from 1 m to 250 km. Large and medium size craters, known since the first telescopic observations of the moon are named after scientists: Aristotle, Copernicus, Tycho, Herodotus, Timocharis, Hipparchus, Kepler, etc.

In the Sea of Rains clearly shows the large craters Archimedes ($d=73$ km), Aristotle ($d=51$ km), Autolycus ($d=36$ km), and in mountainous areas, in the middle of the lunar disk drives — the entire chain of large craters, including Ptolemy ($d=146$ km), Alphonse ($d=124$ km) and Arzachel ($d=32$ km). Many medium and large-sized craters, surrounded by the gentle shafts (ring off) and have a smooth bottom. Others have the form of craters, which are formed in the explosions. Small craters, in General, cover the entire lunar surface and the bottom and shafts in larger craters. Many small craters (diameter up to 10-15 km) are formed by explosions of material bodies, collide with the Moon. Larger craters, in particular with the Central slides are of volcanic origin, as evidenced by the photo of the crater Copernicus, obtained from a height of 25 km one of the artificial satellites of the moon, the bottom of which bears clear signs of volcanism. Let us consider in more detail the origin of the craters.

A large part of the crater owes its origin to impacts of small meteoritic. The meteorite upon impact on the moon meets a counteraction of the atmosphere.

Without changing speed, he hits the ground and explodes. If the impact velocity 16 km/s, then the average speed during penetration into the ground 8 km/s. Even a one-mile asteroid will slow down less than half a second. Naturally, there is an explosion of extraordinary strength and there is a crater. The crater is formed partly under the influence of gas encountered in the vaporization of the meteorite and ground rocks, and partly under the influence resulting in a ground shock wave. The shock wave caused when energy is suddenly liberated propagates in the medium at supersonic speed. The resulting force throw some of the soil located above the point of explosion far from the site of impact, but mostly the crater formed at the instant the displacement of rocks in all directions from the explosion point. The energy is so great that it far exceeds the energy of chemical bonds in rocks and in the distribution of the shock wave rocks become plastic. They crumple, bend and squeezed upward and outward, forming cavities and a large part of the shaft. For example, the Sea of Rains was formed in this way.

In may 1972 with the Moon faced a large meteoritic body. According to the seismologist G. Latham (Lamont Geological Observatory, USA), a drop was registered and transferred via telemetry to the Ground by four seismometers delivered to the moon by astronauts. Released in the fall energy is very large: it is equivalent to the explosion of about 1 thousand tons of TNT. Formed in the fall of the crater as large as a football field. The place of the meteorite fall is the area of the crater Fra Mauro, inside the place of landing of "Apollo-14". The rain clouds formed by the ejected rocks. Lasted about a minute. So there was the fall of a giant meteorite on the moon.

Meteorites apparently owe their origin to the long bright rays, which radically diverge from some large craters (e.g., craters Tycho, Copernicus, Kepler) under consideration in several hundred and even thousand kilometers. They represent a chain of small craters covered with fine substance. Strongly scattering sunlight.

3 February 1966 for the first time in the history of mankind on the lunar surface in the Ocean of Storms gently down automatic station "Luna-9". Launched from earth on 31 January 1966. This station on February 4 and 5 gave the Ground an image of the lunar landscape. A soft landing of the automatic station "Luna-9" on the moon — a remarkable scientific and

technical achievement. For the first time it became possible to investigate the microstructure of the lunar surface. Near the station inside a small crater, no visible layer of dust. The ground is firm enough to withstand the weight of the station. On the surface of the individual stones is not only recorded by the dust, but how would "grow" from the ground surface as a result of its gradual destruction. The landing site is a fairly smooth surface with a distinct topography, with hills, visible lines on the whole line of the visible horizon. The most typical form mesorelief are holes and craters, i.e. a fall — pits of very different sizes. Another common element of the landscape is stone-like and homeopathic objects. Their size is different. June 21, 1969 on the moon in the Sea of Tranquility fell for the first time landing cabin "Eagle" ("Orel") is an American spacecraft "Apollo-II" and the first humans stepped on the lunar surface; they were N. Armstrong and E. Aldrin. They found on the moon several scientific instruments, including seismographs, took samples of lunar rocks, returned to the ship, where they were expected astronaut M. Collins, and on July 24 returned to Earth. In the subsequent 2 years 5 American expeditions went to the moon, safely returned to Earth. They went, and even went on a special all-terrain vehicle on the lunar surface, established a different apparatus, in particular the seismographs for the registration of "moonquakes". Chemical analysis of samples of lunar material showed that the rocks of the moon are not as diverse as the earth and similar in composition to the basalts.

Soviet scientists are studying the moon automatic machines. 20 Sep 1970 in a Sea of Plenty landing automatic station "Luna-16", in subsequent years, "Luna-20" and "Luna-24" landed on the moon and brought to Earth samples of lunar soil. In General, the mineral composition of the lunar rocks of similar composition to earth's basalts, but reflects the characteristics of the chemical composition. In particular, low oxygen fugacity during crystallization of lunar rocks leads to the formation of metallic iron and the practical absence of iron oxide — a phenomenon that is extremely rare for the Earth. In consequence of this we find here such exotic minerals as troilite, pyroxferroite and armalcolite, the last mineral was named in honor of the three astronauts "Apollo-11" — N. Armstrong, E. Aldrin and M. Collins. The average soil density close to 1.5 g/cm³, low density due to its large porosity (up to 50%). The ages of lunar rocks is estimated to be between 3.1 to 4.2 billion years, which allows to consider the age of the moon close to 4.6

billion years old, i.e. the age of the Earth.

Rained down on the moon and built an automatic self-propelled laboratory — Rovers. November 17, 1970 "Luna-17" delivered "Lunokhod-1", and January 16, 1973 "Lunokhod-2" was delivered by "Luna-21". Almost 10 months of "Lunokhod-1" surf the Sea of Rains, passed on panoramas, performed chemical analyses of soil. This experiment has greatly enriched our knowledge about the natural satellite of the Earth and showed the promise of further exploration of the moon and the planets self-propelled vehicles. Received the "Lunokhod-1" panoramas appear the craters of several types. Selenology placed craters in a series of severity – from the most recent comprehensive and clearly expressed to strongly altered, deprived of the shaft and stones. Such morphological number reflects the stages of evolution are the processes of destruction of the lunar surface due to micrometeorite erosion. Morphological analysis confirmed the concept of predominantly shock-the explosive origin of the investigated craters. The material collected on the distribution of craters and rocks allowed us to know the age and sequence of their formations.

"Lunokhod-2" sat on the surface of the Sea of Clarity. It weighs 840 lbs. Between them and "Lunokhod-1" there are no fundamental differences. But the truth is the new car weighs more and its equipment is more advanced. One TV camera removed from the common housing, so that when driving the Rover track can be seen better. Not a single self-propelled unit have not committed such a difficult route. He several times crossed the 15-meter craters with internal slopes up to 20°-25°. In individual sessions, self-propelled laboratory took up to 2 km. Studies of "Lunokhod-2" was significantly supplemented and clarified our understanding of lunar topography and the processes that form it. Lunokhod was on the moon a few tens of km. in areas of the lunar surface, which from the Earth looks flat, the soil is replete with craters and strewn with rocks of various sizes. The Rover, controlled from Earth by radio, "step by step" moved, given the nature of the terrain, which was transmitted on television. This is the greatest achievement of science is important as an example of a direct study of the physical conditions on another heavenly body, which is from the Earth at a great distance.

SIDE OF THE MOON

Despite the fact that the study of the surface visible from the Earth side of the moon did not stop, throughout the history of this examination, the interest of scientists to the other side, hidden from human eyes didn't lessen.

It turned out that side of the moon has some differences from the visible hemisphere. Pictures of the back side of the moon showed that it has almost no seas, which on the visible side is 40% of the area. Several small seas occupy about 7% of the area. One of them called sea of Moscow, three times — a Sea of Dreams, the third, the Eastern sea, a small part of which can be traced on the very edge of the visible hemisphere. Among the many craters of different sizes clearly shows the almost straight chain of craters stretching for hundreds of kilometers. Largest crater has the names of outstanding scientists, including domestic — M. V. Lomonosov, Tsiolkovsky, Sergei Korolev, Igor Kurchatov, and many others. Not forgotten and astronauts. Two craters are named after Yuri Gagarin and Vladimir Komarov.

In the present time, there are detailed maps of both hemispheres of the moon.

The thickness of lunar crust appears to be, does not exceed 50-60 km below a depth of about 1000 km, the mantle, and the core diameter until 1500 km is difficult to judge, but obviously it is silicate and almost solid, because of the small size and the average density of the moon pressure-no more 6×10^4 MPa and a temperature above 1000°C . the obtained results of direct measurements indicate that the moon may be hot and melted inside, but rather is a relatively cold body.

THE MAGNETISM OF THE MOON

Very interesting information available on the subject: the magnetic field of the moon's magnetism. The magnetometers installed on the moon will find 2 types of lunar magnetic fields: constant fields generated by the "fossil" magnetism of lunar substance, and the variable fields caused by electric currents excited in the interior of the moon. These magnetic measurements

give us unique information about the history and present state of the moon. The source of "fossil" magnetism is unknown and indicates the existence of some extraordinary era in the history of the moon. Variable fields are excited in the moon magnetic field changes associated with the "solar wind" streams of charged particles emitted by the sun. Although the tension constant fields measured on the moon is less than 1% of the magnetic field of the Earth, the moon field was much stronger than expected on the basis of measurements conducted previously by Soviet and American spacecraft.

Instruments delivered to the surface of the moon "Apollo", testified that the permanent fields on the moon vary from point to point but do not fit into the picture of the global dipole field similar to the earth. This suggests that the detected field caused by local sources. Moreover, the strong field indicates that the sources of acquired magnetization in external fields is much stronger than the moon not existing currently. Sometime in the past either the moon itself has a strong magnetic field or was in the region of strong fields. We are confronted here with a whole series of mysteries of the moon history: did the Moon field similar to the earth? If she was much closer to the Earth where the earth's magnetic field was strong enough? Purchased whether it is the magnetization in some other area of the solar system and was later captured by the Earth? The answers to these questions can be encoded in n fossil" magnetism of lunar substance.

Variable fields generated by electric currents flowing in the bowels of the moon, associated with the whole Moon and not any of its individual areas. These fields are growing rapidly and decrease in accordance with changes in the solar wind. The properties of the induced lunar fields depend on the conductivity of the lunar subsurface fields, and the latter, in turn, is closely related to the temperature of the substance. Therefore, the magnetometer can be used as indirect "resistance thermometer" to determine the internal temperature of the moon.

MAN ON THE MOON

June 21, 1969 on the moon was first stepped on.

Freak Borman, the commander of the spacecraft "Apollo-8" said: "the us

Flight is made possible thanks to the work of thousands of people. And not only in the United States. Without the first artificial Earth satellite and Yuri Gagarin's flight, without research scientists from many countries flying to the moon would take place... the earth is really a very small planet. We are personally convinced, and the earth, its inhabitants, should unite to face the world of space. Space exploration is the task of all mankind and not just individual countries."

The day of the landing lasted a very long time, and all this time the astronauts was not a moment's peace. They were always absorbed in computer work and therefore could not pay adequate attention to orientation "in the area". And only when they wanted to go down below 3 thousand feet, was the first to look outwards. The horizon on the moon is very close, so from this height don't see much.

The only landmark that they noticed was a large and very impressive crater known as the West, though at this moment they did not recognize him. In the last seconds of the descent engine the "eagle" has raised significant amounts of dust, which is a very high speed scattered radially, almost parallel to the surface of the moon. On Earth dust usually weighs in the air and settles very slowly. As on the moon not that of the atmosphere, moon dust and lies on a flat low trajectory, leaving behind a clean space. The astronauts needed some more time to get out of the "eagle" than expected. Neil Armstrong, the commander of the "Apollon-11" before you set foot on the moon pondered what to say at this point. He thought about this even before the flight but only after landing said, "one small step for man, one giant leap for mankind."

While on the lunar surface the astronauts nor felt any smell, nor suits, nor in the mask. And back in the cockpit and taking off hats, I felt some smell. The smell of lunar soil, the pungent, as the smell of gunpowder. In the cabin they have brought a lot of lunar dust on spacesuits, boots. The smell was felt immediately. The lunar surface at the time of landing was brightly lit. On the black sky no stars, no planets, except for Earth, was not visible.

The lunar module stood in a vertical operational position. The balance was easy. To get to his feet after an accidental fall, too, was not difficult. General feeling of gravity on the moon is better than earth, and even better the state of

weightlessness, as he wrote N. Armstrong.

The sun during the stay of the ship on the moon rose above the horizon. The average lighting level was very high (as on a cloudless day on Earth). Shadows were thick, but not black. Sunlight is reflected from the slopes of lunar craters, and had good visibility.

The peculiar photometric properties of the moon have long been known. There was a fear that at some point the eyes of the astronauts blinded by the Sun, can't see why the descent trajectory of the lunar module was designed so that at the point of landing the sun's rays do not interfere with the astronauts. The color is hardly visible or not detected at all. With the minimal height of the Sun above the horizon almost to distinguish colors is impossible. When the sun rises over the horizons to 10° , begin to appear brown and shades of brown. And when you exit the cabin, the astronauts unexpectedly found that the debris and partly of the lunar soil has a dark gray or charcoal gray.

During the flight, "Apollo 11" the earth was approximately at 30° from Zenith. She seemed convex and very bright. Dominated by 2 colors: blue oceans and white clouds. However, it was easy to distinguish and gray-brown continents. The angular diameter of the Earth when observing the moon and 4 times bigger than the moon observed from Earth. Although the Earth PI seemed small, yet it was a very colorful spectacle, according to astronauts.

It should be noted that clothing and protective equipment, the equipment of the astronauts has interesting features. The main items of clothing astronauts protect the body from the vacuum, thermal impacts and from micrometeorites. The backpack system consists of communication equipment, and ventilation equipment to regulate temperature and pressure. This system falls 100% oxygen. Temperature protection ensures the normal functioning at outdoor temperatures up to 121° .

The suit is equipped with a hermetic helmet. Gloves, protective coatings and various sensors.

Put it through a vertical slit in back and zip it up. The sleeves are mounted on spherical joints, allowing to rotate by hand. Hermetic helmet — transparent bubble with a complex system. Protective shell includes 2 pairs of detachable

filters for protection against ultraviolet and infrared radiation. On the helmet 3 fortified bubble that protects from the sun's rays. Multilayer coatings provide hermetic sealing. Protection from temperature and from damage by micrometeorites. Multi-layered lining the top and a thick sole made of special rubber. Directly to the body adjacent clothing with liquid cooling that serves as heat buffer between the body of the astronaut and the cooling medium. In the knapsack (portable life support system) is a means of communication. The sensors and device, falling oxygen. Carbon dioxide is absorbed by lithium hydroxide, the water — to-water separator, odors — activated carbon, debris filter and thermal heat sink.

Astronaut dressed in a space suit and is equipped with a jetpack. The center of gravity moves up and a little back. In order not to lose balance, he leans forward. On the corners of his movement is also noticeably slower than on Earth. To move faster, you need to make 3 or 4 steps with a small acceleration or badly to lean forward and vigorously repelled by typing the desired speed with the first step. Both methods are satisfactory, but usually the astronauts used the first. Speed of walking did not exceed 0.5 m/s. At higher speeds, the astronaut, making a step as if soared. While running he was skipping with both feet simultaneously repelled from the surface. The latter method was the most effective when traveling long distances, as was achieved at the rate of 1-1,5 m/s, and in some areas up to 2 m/s. a lot of time was spent to choose the best way on an uneven surface. Jump similar to skipping a run, but they are on the moon, unlike running, feet moving slowly. The feeling of slow running. Running as we know it on Earth, on the moon cannot be reproduced. To stop while walking from impossible. Steps in strontium hampered by limited mobility of the suit. In General, the movement on the moon requires more calculation and attention than on Earth. Of course, in terms of the lunar gravity wants to jump up. Free jumping with maintaining control over the movement is possible up to 1 m. Jumping to great heights often end up falling. Maximum height of jumps was 2 m. the Fall had unpleasant consequences. Usually when the balance drop can be prevented by turning and step to the other side, fall. If an astronaut falls face down, it's easy to climb without assistance. If you fall on your back needs to exert more effort to stand up for himself. The trace of the walk deep into the lunar soil 1 cm, the particles stick to shoes. The spacesuit. American astronauts believe. The improvement of the suit will help to improve the

efficiency of activities on the moon.

Asteroids (minor planets). These cosmic bodies are different from planets, especially for its size. So, the largest of the small planets Ceres has a diameter of 995 km; next (size): Palada is 560 km Hygeia — 380 km, Psyche — 240 km, etc. For comparison, the smallest of the major planets mercury has a diameter of 4878 km, i.e. 5 times greater than the diameter of Ceres, and the masses vary them many hundreds of times.

The total number of minor planets, observable with modern telescopes, is defined in 40 thousand, but the total mass is 1 thousand times less than the mass of the Earth.

The movement of small planets around the Sun is in elliptical orbits, but more elongated (average eccentricity of the orbits they 0,51) than large planets, and inclination of orbital planes to ekleptica they have more than major planets (the average angle of 9.54). The bulk of the planets revolve around the Sun between the orbits of Mars and Jupiter, forming the so-called asteroid belt. But there are small planets whose orbits lie closer to the Sun than the orbit of mercury. The most distant are for Jupiter and Saturn.

The space researchers have expressed different views on the reason for the large concentration of asteroids in a relatively narrow space of the interplanetary medium between the orbits of Mars and Jupiter. One of the most common hypotheses for the origin of bodies of the asteroid belt is the representation of the destruction of the mythical planet Phaeton. The idea of the planet's existence is supported by many scientists, and even if backed up by mathematical calculations. However, unexplained is the cause of the destruction of the planet. There are different assumptions. Some researchers believe that the destruction of Phaeton occurred as a result of its collision with some large body. For others, the reasons for the collapse of the planet was explosive processes in its interior. Currently, the problem of the origin of bodies of the asteroid belt is an integral element in an extensive program of space research on the international and national levels.

Minor planet stands out among the original group of bodies whose orbits intersect with Earth's orbit, and therefore there is the potential of collision with her. Planet this group became known Apollo object, or just Apollo

(Wetherill, 1979). For the first time about the existence of Apollo became known from 30 years of this century. In 1932 he discovered the asteroid. It was called

Apollo 1932 HA. But he's not excited much interest, although his name has become a byword for all asteroids that cross earth's orbit.

In 1937, a cosmic body with a diameter of about 1 km passed 800 thousand km from the Earth and double the distance from the moon. Subsequently, he was named Hermes. Currently there are 31 such a body, and each of them got its own name. The size of their diameters range from 1 to 8 km, and the inclination of orbital planes to the Ecliptic to be in the range from 1 to 68. Five of them revolve in orbits between Earth and Mars, and the rest 26 between Mars and Jupiter (Wetherill, 1979). I believe that out of 40 thousand Small planets of the asteroid belt with a diameter of over 1 km may be several hundred Apollo. Therefore, the collision of such heavenly bodies on Earth is likely, but after very long intervals of time.

It can be assumed that once in a century one of these cosmic bodies can pass near Earth at a distance less than from us to the moon, and every 250 thousand years can it be a collision with our planet. The impact of such a body emits energy equal to 10 thousand Hydrogen bombs, each with a capacity of 10 MT. And there should be formed a crater with a diameter of about 20 km, But such cases are rare and for human history is unknown. Hermes refers to the asteroids III class, and in fact many such bodies and larger size — classes I and II. The blow in a collision with the soil will naturally be even more significant.

When in 1781 was opened Uranium heliocentric his average distance was appropriate rule of Titius — Bode, then in 1789 began the search for planets that, according to this rule, was supposed to be between the orbits of Mars and Jupiter, at an average distance $a=2.8 \cdot a_{Earth}$ from the sun. But the disparate reviews of the sky did not bring success, and therefore 21 Sep 1800, several German astronomers, headed by K. Tzsch decided to organize a collective search. They divided the entire search of the zodiacal constellations on the 24 and distributed among themselves for thorough research. But they did not have time to do a systematic search, as of the 1st January 1801. Italian

astronomer Giuseppe Piazzi (1746-1826) discovered through a telescope like object, seventh magnitude, slowly moving over the constellation of Taurus. Calculated by K. Gauss (1777-1855) the orbit of the object was a planet, the corresponding rule of Titius-Bode: the semimajor axis $a=2.77$ a.e. and eccentricity $e=0.080$. The newly discovered planet of Piazzi called Ceres.

28 Mar 1802, German physician and astronomer W. Olbers (1758-1840) discovered near Ceres another planet (8m), called Pallas ($a=2.77$ a.e. $e=0.235$). 2nd Sep 1804 was opened on the third planet, Juno ($a=2.67$ a.e.) the and on 29 March 1807 - 4, Vesta ($a=2.36$ in.e.). All the newly discovered planets had star-shaped, without drives, attesting to their small geometrical dimensions. Therefore, these heavenly bodies called planets or small, at the suggestion of W. Herschel, asteroids (from Greek "Aster" — star and "Eidos" - view).

By 1891 the visual methods was found about 320 asteroids. At the end of 1891 German astronomer M. Wolf (1863-1932) proposed a photographic method of searching: when 2-3 - hour exposure image of stars on a photographic plate obtained point, and the trace of a moving asteroid as a small dash. Photographic methods have led to a sharp increase in discoveries of asteroids. Particularly intensive studies of minor planets are now in the Institute of theoretical astronomy (St. Petersburg) and in the Crimean Astrophysical Observatory of the Russian Academy of Sciences.

The asteroid orbits are reliably determined, assign a name and a sequence number. Such asteroids are now known to be over 3,500, but the Solar system is much greater.

Of a specified number of asteroids known to astronomers of the Crimean Astrophysical Observatory was opened near 550, perpetuate in their names the names of famous people.

The vast majority (98%) of known asteroids moving between the orbits of Mars and Jupiter at average distances from the Sun of 2.06 to 4.30.e. (period from 2.96 to 8.92 years). However, there are asteroids with orbits unique, and assigns them male names, usually from Greek mythology.

The first three of these minor planets are moving out of the asteroid belt, and at perihelion Icarus approaches the Sun closer than Mercury, and Hermes and Adonis — Venus is closer. They can be found with Earth at a distance from 6 million to 23 million km, and Hermes in 1937 was near the Earth even at a distance of 580 thousand km, i.e. just one and a half times further away than the moon. Hidalgo is at aphelion out beyond the orbit of Saturn. But Hidalgo is no exception. In recent years, there are about 10 asteroids, the perihelion of which are located in close proximity to the orbits of the terrestrial planets, aphelion near the orbit of Jupiter. Such orbits are characteristic of comets of the Jupiter family and indicate a possible common origin of asteroids and comets.

In 1977, discovered a unique asteroid that orbits the Sun in an orbit with the semimajor axis $a=13.70$ a.u. and eccentricity $e=0.38$, so that at perihelion ($q=8.49$ a.u.) it comes just inside the orbit of Saturn and at aphelion ($Q=18.91$ a.u.) approaching the orbit of Uranus. He called Chiron. Apparently, there are other similar distant asteroids, the search for which continues.

The brilliance of most of the known asteroids in the background from 7m to 16m, but there are more faint objects. The most striking (up to 6m) is Vesta.

The diameters of asteroids are evaluated for their brilliance and reflectivity in the visual and the infrared. It turned out that the largest asteroids not so much. The largest is Ceres (diameter 1000 km), Pallas (610 km), Vesta (540 km) and Gygis (450 km). Only 14 asteroid diameters over 250 km, and the rest less up to 0.7 km. From the bodies of such small size cannot be spheroidal in shape, and all the asteroids (except, perhaps, the largest) are shapeless lumps.

The masses of the asteroids are very various: the greatest close to $1.5 \cdot 10^{21}$ kg (ie, 4 thousand times smaller than the mass of the earth), has Ceres. The total mass of all the asteroids does not exceed 0.001 of the mass of the Earth. Of course, all these heavenly bodies devoid of atmospheres. Many of the asteroids for the regular change in their brightness detected axial rotation.

In particular, the rotation period of Ceres 9.1 h, and Pallas — 7.9 h

Faster all revolves Icarus, 2H 16m.

The study of the reflectivity of many asteroids are allowed to combine them into three main groups: dark, light and metallic. The surface of dark asteroids reflect only 5% of the incident sunlight and comprises of substances similar to black basalt and carbonaceous rocks. These asteroids are often called carbon. Asteroids reflect light from 10% to 25% of the sunlight that unites the surface with silicon compounds is rocky asteroids. Metal asteroids (an absolute minority) too bright, but its reflective properties, their surface is similar to iron-Nickel alloys. Such a division of the asteroid is confirmed by the chemical composition of the drop-down to Earth meteorites. A small number of asteroids studied does not belong to any of the three main groups.

It is significant that in the spectra of carbonaceous asteroids discovered the absorption band of water ($\lambda = 3\mu\text{m}$). In particular, the surface of the asteroid Ceres is made up of minerals similar to earth clay and containing about 10% water.

At small sizes and masses of the asteroids, the pressure in the subsoil is small: even the largest asteroids do not exceed $7 \cdot 10^5$

$8 \cdot 10^5$ HPa (700 — 800 ATM) and can not cause warming up their cold hard subsoil. Only the surface of asteroids are very poorly heated far from their Sun, but this negligible energy is radiated into interplanetary space. Calculated according to the laws of physics the surface temperature of the vast majority of asteroids was close to 150 — 170 K (-120...-100°C).

And only a few asteroids that pass near the Sun, the surface in these times is very hot . So, the surface temperature of the car rises to almost 1000 K (+730°C), and removing from the Sun again is dramatically reduced.

The orbits of the remaining asteroids are subject to considerable perturbations from the gravitational effects of major planets, mainly Jupiter. A particularly strong perturbation experienced smaller asteroids, which leads to collisions of these bodies and their fragmentation into fragments of various sizes from hundreds of meters in diameter to dust.

Currently, the physical nature of asteroids is studied because it is possible to

trace the evolution (development) of the substance from which our Solar system was formed.

Everyone probably knows that the Sun can not be seen with the naked eye, and even more through a telescope without a special, very dark filters or other devices that reduce the light. Ignoring this advice, the observer risks to severe burns of the eye. The easiest way to look at the Sun to project its image on a white screen. With even a small Amateur telescope to obtain a magnified image of the solar disk. What we can see in this picture?

First of all draws attention to itself sharpness. The sun is a ball of gas, not having clear boundaries, and its density decreases gradually. Why, in this case, we see it sharply defined? The thing is that almost all visible radiation from the Sun comes from a very thin layer, which has a special name – photosphere (from the Greek – "sphere of light"). Its thickness does not exceed 300 kilometers. It is this thin layer and gives the observer the illusion that the Sun has "surface"

HISTORY

History of telescopic observations of the Sun from observations made by G. Galileo Galilei in 1611; was opened sunspots, determined the rotation period of the Sun around its axis. In 1843, a German astronomer, Schwabe discovered the cyclical nature of solar activity. The development of methods of spectral analysis enabled to study the physical conditions in the Sun. In 1814, Th. Fraunhofer discovered the dark absorption lines in the spectrum of the Sun — this was the beginning of the study of the chemical composition of the Sun. From 1836 to regularly conduct observations of the eclipses of the Sun, which led to the discovery of the corona and chromosphere of the Sun and solar prominences. In 1913 the American astronomer George. Hale watched Semenovskoe splitting of Fraunhofer's lines of the spectrum of sunspots and this proved the existence in the Sun's magnetic fields. By 1942, the Swedish astronomer B. edlen and others have identified several lines of the spectrum of the solar corona with lines vysokotarifitsirovannyh elements, proving that the high temperature in the solar corona. In 1931 B. Lyot invented the solar coronagraph, which allowed us to observe the chromosphere and corona outside eclipses. In the early 40-ies of XX century, was discovered radio emission of the Sun. A significant impetus for the

development of solar physics in the second half of the twentieth century was the development of magnetic hydrodynamics and plasma physics. After the beginning of the space age study of ultraviolet and x-ray radiation from the Sun is held by the methods of extra-atmospheric astronomy with the help of rockets, automatic orbiting observatories on satellites, space laboratories with people on Board.

GENERAL CHARACTERISTICS

The sun, Central body of the solar system, is a glowing plasma ball, the Sun is the closest star to Earth. The mass of the Sun $1,990 \cdot 10^{30}$ kg (332958 times the mass of the Earth). In the Sun is concentrated 99,866% of the mass of the Solar system. The solar parallax is equal to $8,794''$ ($4,263 \cdot 10^{-5}$ radian). The distance from the Earth to the Sun varies from $1,4710 \cdot 10^{11}$ m (in January) to of $1,5210 \cdot 10^{11}$ (July), averaging $1,4960 \cdot 10^{11}$ m. This distance is considered to be one astronomical unit. The average angular diameter of the Sun is $1919,26''$ ($9,305 \cdot 10^{-3}$ rad), which corresponds to a linear diameter of the Sun equal to $1,392 \cdot 10^9$ m (109 times the diameter of the equator of the Earth). The average density of the Sun $1,41 \cdot 10^3$ kg/m. Acceleration of free fall on the surface of the Sun is 273,98 m/sec. The escape velocity on the surface of the Sun is equal $6,18 \cdot 10^5$ m/h. The effective surface temperature of the Sun determined under the law of radiation Stefan-Boltzmann, the full radiation of the Sun is 5770 K.

The Sun's rotation around the axis going in the same direction as the rotation of the Earth, in a plane that is tilted $7^{\circ}15'$ to the plane of Earth's orbit (the Ecliptic). The speed of rotation is determined by the apparent motion of various parts in the solar atmosphere and shift of spectral lines in the spectrum of the edge of the solar disk due to the Doppler effect. Thus it was found that the rotation period of the Sun varies at different latitudes. The position of the different parts on the surface of the Sun is determined by using geograficheskikh coordinate counted off the solar equator (geograficheskaya latitude) and from the Central Meridian of the visible disk of the Sun or from some Meridian selected as primary (the so-called Meridian Carrington). At the same time believe that the Sun rotates as a solid body. One revolution relative to the Earth point with geograficheskoi latitude 17° 27,275 commit for days (the synodic period). The turnaround time at the

same latitude of the Sun relative to stars (sidereal period) is 25.38 days. The angular velocity of rotation ω sidereal rotation varies with latitude φ by law: $\omega = 14,33^\circ - 3^\circ \sin 2\varphi$ per day. The linear velocity of rotation at the equator of the Sun is about 2000 m/sec.

The sun as a typical star is a yellow dwarf and is located in the middle part of the main sequence stars on the diagram of Hertzsprung-Russell. The apparent photovisual magnitude of the Sun is equal $-26,74$, the absolute visual magnitude M is equal to $4,83$. Color index of the Sun is for the case of blue (b) and visual (V) spectral range $M_b - M_V = 0,65$. The spectral class of G2V Sun. The speed of motion relative to the aggregate of the nearest stars is $19,7 \cdot 10^3$ m/s. The sun is located inside one of the spiral branches of our Galaxy at a distance of about 10 KPS from the centre. The period of revolution of the Sun around the center of the Galaxy about 200 million years. The age of the Sun — about $5 \cdot 10^9$ years.

THE INTERNAL STRUCTURE

The internal structure of the Sun is determined on the assumption that it is spherically symmetric body and is in equilibrium. The energy equation, law of conservation of energy, equation of state of an ideal gas, Stefan-Boltzmann law and hydrostatic conditions, the radiative and convective equilibrium together with the determined from observations, the values of the total luminosity, total mass and radius of the Sun and its chemical composition provide the opportunity to build a model of the internal structure of the Sun. I believe that the hydrogen content of the Sun, by mass, about 70%, and helium about 27%, the content of all other elements around 2.5%. Based on these assumptions, calculated that the temperature in the center of the Sun is $10-15 \cdot 10^6$ K, a density of about $1,5 \cdot 10^5$ kg/m³, pressure of $3,4 \cdot 10^{16}$ n/m² (about $3 \cdot 10^{11}$ atmospheres). It is believed that the source of energy entering the radiation loss and supports the high temperature of the Sun are nuclear reactions occurring in the solar interior. The average amount of energy produced inside the Sun is 1.92 erg/g/sec. The release of energy is determined by nuclear reactions in which hydrogen is converted into helium. In the Sun there are two groups of thermonuclear reactions known as the proton-proton (hydrogen) cycle and the carbon cycle (Bethe cycle). It is most likely that the Sun dominates the proton-proton cycle, consists of three

reactions, the first of which is from the hydrogen nuclei are formed the nucleus of deuterium (heavy hydrogen isotope, atomic mass; in the second of the hydrogen nuclei are formed the nucleus of the isotope of helium with atomic mass 3 and, finally, in the third of them formed the nucleus stable isotope of helium with atomic mass 4.

The transfer of energy from the inner layers of the Sun occurs mainly through absorption of electromagnetic radiation coming from below and the subsequent reradiation. Following the decrease of temperature with distance from the Sun gradually increased, the wavelength of the radiation carrying most of the energy in the upper layers. The transfer of energy by movement of hot matter from the inner layers, and the cooled inside (convection) plays a significant role in relatively high layers forming the convective zone of the Sun, which begins at a depth of about 0.2 solar radius and has a thickness of about 10^5 m. the Velocity of the convective motions increases with the distance from the center of the Sun and in the outer part of the convection zone reaches $(2-2,5) \times 10^3$ m/sec. In even higher layers (in the solar atmosphere) the transfer of energy again by radiation. In the upper layers of the solar atmosphere (chromosphere and corona) of the energy delivered mechanical and magnetohydrodynamic waves generated in the convection zone, but are absorbed only in these layers. The density in the upper atmosphere is very small, and the necessary removal of energy by radiation and conduction is only possible if the kinetic energy of these layers is large enough. Finally, in the upper part of the solar corona most of the energy carry flows of matter, moving from the Sun, called the solar wind. The temperature in each layer is set at such a level that the system energy balance: the amount brought energy due to the absorption of all types of radiation, heat conduction or the motion of matter is equal to the sum of all energy losses of the layer.

The spectral composition of light emitted by the Sun, that is, the distribution of energy in the center of the Sun (when the effect of absorption in the earth's atmosphere and the influence of Fraunhofer's lines), roughly corresponds to the distribution of energy in blackbody radiation with a temperature of about 6000 K. However, in certain parts of the spectrum, there are noticeable deviations. The maximum energy in the spectrum of the Sun corresponds to the wavelength of 4600 Å. the Spectrum of the Sun is a continuous spectrum, which is superimposed on no more than 20 thousand absorption lines (Fraunhofer's lines). Over 60% of them identified with the spectral lines of

known chemical elements by comparing the wavelengths and relative intensities of the absorption lines in the solar spectrum with laboratory spectra. The study of Fraunhofer's lines gives information not only about the chemical composition of the solar atmosphere, but also on the physical conditions in those layers in which the formation of certain acquisitions. The predominant element in the Sun is hydrogen. The number of helium atoms is 4-5 times less than hydrogen. The number of atoms of all other elements put together, at least 1000 times less than the number of hydrogen atoms. Among them the most abundant oxygen, carbon, nitrogen, magnesium, iron and others. In the spectrum of the Sun can also identify the lines belonging to certain molecules and free radicals: OH, NH, CH, CO, and others.

Magnetic fields on the Sun are measured mainly by Zeeman splitting of the absorption lines in the spectrum of the Sun. There are several types of magnetic fields on the Sun. Total magnetic field of the Sun is small and achieves the tension in this 1 or the other polarity, and changes with time. This field is closely related to the interplanetary magnetic field and its sectoral structure. Magnetic fields associated with solar activity, can reach the Sunny spots of tension in a few thousand. The structure of magnetic fields in active regions is very complicated, alternating magnetic poles of different polarity. There are also local magnetic field with a field strength in the hundreds outside of sunspots. Magnetic fields penetrate into the chromosphere and solar corona.

Important role the Sun played magnetogasdynamic and plasma processes. At a temperature of 5000 — 10000 K gas is sufficiently ionized, its conductivity is large and due to the huge scale of solar phenomena, the significance of Electromechanical and magneto-mechanical interactions is very large.

THE ATMOSPHERE OF THE SUN

The atmosphere of the Sun form the external available observations layers. Almost all of the Sun's radiation comes from the lower part of its atmosphere called the photosphere. On the basis of the equations of radiant energy transfer, the radiative and local thermodynamic equilibrium and the observed radiation flux is theoretically possible to build a model of the distribution of temperature and density with depth in the photosphere. The thickness of the

photosphere of about three hundred miles, its average density $3 \cdot 10^{-5}$ kg/m. The temperature in the photosphere decreases as we move to more outer layers, its average value of the order 6000 K on the border of the photosphere of about 4200 K. the Pressure changes from $2 \cdot 10^5$ to 10^4 n/m. the Existence of convection in podvoloshino zone of the Sun is evident in the uneven brightness of the photosphere, the visible grain of its so — called granulation structure. Granules are bright spots more or less round shape. The grain size is 150 — 1000 km, life time 5 — 10 minutes, individual granules can be observed within 20 minutes. Sometimes the granules form clusters of size up to 30 thousand kilometers. Granules brighter the interstitial spaces 20 — 30%, which corresponds to the difference in the average temperature of 300 K. unlike other formations on the Sun's surface granulation geograficheskikh the same at all latitudes and does not depend on solar activity. The speed of the random motions (turbulent velocity) in the photosphere are different definitions 1-3 km/sec. In the photosphere discovered quasi-periodic oscillation in the radial direction. They occur on sites with size 2-3 thousand miles with a period of about five minutes and the amplitude of the velocity about 500 m/sec. After several periods of oscillations in this place fade, then it might occur again. Observations have also shown the existence of cells in which motion occurs in a horizontal direction from the cell center to its borders. The speed of such movements of about 500 m/sec. Cell size — supergranules make 30 — 40 thousand kilometers. On supergranule coincide with the mesh cells chromospheres. At the boundaries of supergranules magnetic field is strengthened. Assume that supergranule reflect on the depth of a few thousand kilometers under the surface of the convective cells of the same size. Initially it was assumed that the photosphere only gives continuous radiation and absorption lines are formed in turn from the layer. It was later established that are formed in the photosphere and spectral lines and continuous spectrum. However, to simplify mathematical calculations when calculating the spectral lines of the concept of the converting layer is sometimes used.

Often observed in the photosphere sun spots and flares.

Sun spots

Sunspots — a dark education, consisting generally of a darker nucleus

(shadow) and the penumbra. The diameters of the spots reach two hundred thousand miles. Sometimes the spot is surrounded by a bright rim. Does scarlet spots are called pores. The lifetime of spots from several hours to several months. In the spectrum of the spots even more lines and absorption bands than the spectrum of the photosphere, it resembles the spectrum of a star of spectral class KO. The offset lines in the spectrum of the spots is due to the Doppler effect indicates that the motion of matter in spots — leakage at lower levels and inrush at a higher speed reaches 3 thousand km/h. From comparisons of the intensities of the lines and the continuous spectrum of the spots and the photosphere, it follows that spots are cooler than the photosphere at 1-2 thousand degrees (4500 K and below). As a result, on the background of the photosphere spots seem dark, the brightness of the core is 0.2 to 0.5 of the brightness of the photosphere, penumbra brightness for about 80% of the photospheric. All sunspots have a strong magnetic field, reaching for the large patches of tension 5 thousand asterdam. Spots usually form groups, which in terms of the magnetic field may be unipolar, bipolar or multipolar, containing a lot of spots of different polarity, often United by a common penumbra. Band patches are always surrounded by torches and flocculi, prominences, around them, sometimes there are solar flares and in the solar corona above them there are formations in the form of rays hats, fans — all this together forms an active region on the Sun. The average annual number of observed spots and active regions, and the average area occupied by them, varies with a period of about 11 years. It is an average value, the duration of individual cycles of solar activity ranges from 7.5 to 16 years. The greatest number of spots appear on the Sun's surface, varies for different cycles by more than two times. Basically spots are found in the so-called Royal zones, stretching from 5 to 30° geograficheskoi latitude on either side of the solar equator. At the beginning of the solar cycle the latitude of the location of the spots above, and at the end of the cycle and at higher latitudes, appear spots of a new cycle. Often observed a bipolar group of spots, consisting of two large spots — the head and later having opposite magnetic polarity, and several smaller ones. Head spots have the same polarity throughout the solar cycle, the polarity of the opposite in the Northern and southern hemispheres of the Sun. Apparently, the spots are depressions in the photosphere, and the density of matter in them is less than the density of matter in the photosphere at the same level.

Torches

In active regions of the Sun observed the torches of bright photospheric emission, visible in white light primarily near the edge of the solar disk. Usually the torches appear before the stains and there are some time after their disappearance. Square flare sites is several times the area of the corresponding group of spots. The number of flares on the solar disk depends on the phase of the solar cycle. Maximum contrast (18%) have the torches close to the edge of the solar disk, but not on the edge. In the center of the disk of the Sun flares are not visible, their contrast is very low. The torches have a complex fibrous structure, the contrast depends on wavelength, where surveys were conducted. The temperature of the torches several hundred degrees higher than the temperature of the photosphere, the total radiation per square centimeter exceeds the photospheric 3 — 5%. Apparently, the torches few rise above the photosphere. The average duration of their existence - 15 days, but can reach almost three months.

CHROMOSPHERE

Above the photosphere is a layer of Sun's atmosphere called the chromosphere. Without special telescopes, the chromosphere is visible only during total solar eclipses as a pink ring surrounding the dark disk in those moments when the Moon completely covers the photosphere. Then it is possible to observe the spectrum of the chromosphere. On the edge of the solar disk, the chromosphere appears to the observer as rough strip from which are the individual cloves - chromosphere spicules. The diameter of the spicules 200-2000 kilometers, the altitude of about 10,000 kilometers, the rate of rise of plasma in the spicules of up to 30 km/h. Simultaneously there is a Sun up to 250 thousand spicules. When observed in monochromatic light on the solar disk visible bright chromosphere mesh consisting of separate nodules small with diameter up to 1,000 km and a major diameter of from 2000 to 8000 km. Large nodules are clusters of small. The size of the grid cells 30 — 40 thousand kilometers. I believe that the spicules are formed at the cell boundary chromospheres mesh. The density in the chromosphere decreases with increasing distance from the center of the Sun. The number of atoms in one cubic centimeter varies from 10515 0вблизи photosphere to 1059 at the top of the chromosphere. Study of the spectra of the

chromosphere led to the conclusion that in the layer where the transition occurs from the photosphere to the chromosphere, the temperature goes through a minimum and increasing the height above the base of the chromosphere becomes equal to 8 to 10 thousand Kelvins, and at an altitude of several thousand kilometers and reaches 15 — 20 thousand Kelvin.

Found that in the chromosphere takes place, the chaotic motion of gas masses at speeds up to $15 \cdot 10^3$ m/s. In the chromosphere flares in active regions visible as the light of eruption, usually called flocculi. In the red line spectrum hydrogen visible dark units called fibers. On the edge of the solar disk fiber in favor of the disk observed in the sky as bright prominences. Most often fiber and prominences occur in four symmetrically arranged relative to the solar equator zones: polar zones North of $+40^\circ$ degrees and South of -40° geographical latitude and low-latitude areas near $\sqrt{(30^\circ)}$ at the beginning of the solar cycle and $\sqrt{(17^\circ)}$ at the end of the cycle. Fiber and low-latitude prominence zones show a pronounced 11-year cycle, their maximum coincides with the maximum of spots. At high-latitude prominences dependence on phases of the solar cycle is less pronounced high occurs within two years after the high spots. Fiber, which is quiet prominences, can reach lengths of solar radius and exist within a few turns of the Sun. The average height of the protuberances above the surface of the Sun is 30 — 50 thousand kilometers, the average length is 200 thousand kilometers, width – 5 thousand kilometers. According to research by A. B. Severny, all the prominences on the nature of the movement can be divided into 3 groups: electromagnetic, in which the movements are ordered curved lines — the magnetic field lines; chaotic, dominated by disordered turbulent motion (velocity about 10 km/h); the eruptive, in which the substance of the initial relaxed flare with chaotic movements suddenly thrown with increasing speed (reaching 700 km/sec) away from the Sun. The temperature in the prominences (the fibers) 5 — 10 thousand Kelvin, the density is close to the average density of the chromosphere. Fiber, which represents the active, rapidly changing prominences, usually change much in a few hours or even minutes. Form and character of motions in prominences are closely associated with the magnetic field in the chromosphere and the solar corona.

The solar corona

The solar corona – the outermost and most sparse part of the solar atmosphere extending to several (more than 10) solar radii. Until 1931, the corona could be observed only during total solar eclipses in the form of a silvery pearl glow around the Moon closed the Sun disk. In the crown of well separated parts of its structure: hats, mufflers, coronal rays and polar brushes. After the invention of the coronagraph on the solar corona observed outside eclipses. The General form of the corona changes with the phase of solar activity cycle: in years of low corona is strongly elongated along the equator in the years of high it is almost spherical. In white light the surface brightness of the solar corona is a million times smaller than the brightness of the center of the solar disk. Her glow is formed mainly due to scattering of photospheric radiation by free electrons. Almost all the atoms in the corona is ionized. The concentration of ions and free electrons at the base of the crown is 10^{19} of particles in the 1 see the Heating of the corona is similar to the heating of the chromosphere. The greatest release of energy occurs in the lower part of the crown, but due to the high thermal conductivity of the crown almost isothermically temperature decreases outward very slowly. The flow of energy in the corona occurs in several ways.

In the lower part of the corona plays a major role in the transfer of energy downward by heat conduction. Loss of energy leaving the crown of the fastest particles. In the outer parts of the corona most of the energy takes the solar wind – the flow of coronal gas, the speed of which increases with distance from the Sun from a few km/sec at the surface to 450 km/sec at the distance of the Earth. The temperature in the corona exceeds 10⁶ K. In the active layers of the crown temperature is higher — up to 10⁷ K. Over the active regions can be formed so-called coronal condensation in which the particle concentration increases tenfold. Part of the radiation inside the crown is a line radiation of multiply ionized atoms of iron, calcium, magnesium, carbon, oxygen, sulfur and other chemical elements. They are observed in the visible spectrum and in the ultraviolet region. In the solar corona generated radio emission of the Sun at meter wavelengths and x-ray radiation, increasing many times in active areas. As shown by calculations, the solar corona is not in equilibrium with the interplanetary environment. From the corona into interplanetary space are subject to the flow of particles forming the solar wind. Between the chromosphere and the corona has a relatively thin transition layer in which there is a sharp increase in temperature to the

values characteristic of the corona. The conditions in it are defined by energy flow from the crown as a result of heat conduction. The transition layer is the source of much of ultraviolet imaging radiation from the Sun. The chromosphere, transition layer and corona give all the observed radio emission of the Sun. In active regions the structure of the chromosphere, corona and the transition layer changes. This change, however, is poorly understood.

In active regions of the chromosphere sudden and relatively brief increase in brightness, visible in many spectral lines. These bright formations exist from several minutes to several hours. They are called solar flares (formerly known as solar flares). Flares are best seen in the light of the hydrogen line, but the most striking visible sometimes in white light. In the spectrum of solar flares, there are several hundred emission lines of various elements, neutral and ionized. The temperature of those layers of the solar atmosphere that give glow in chromospheric lines $(1-2) \times 10^4$ K, in the higher layers up to 10^5 K. the particle Density in the flash reaches $10^{13} - 10^{14}$ one cubic centimeter. Square solar flares can reach 10^{15} m. Usually solar flares occur near rapidly-developing groups of sunspots with complex magnetic field configurations. They are accompanied by the activation of filaments and floccules and emissions of the substance. In a flash a large amount of energy (up to $10^{21} - 10^{25}$ joules). It is assumed that the solar flare energy initially stored in the magnetic field, and then released quickly, which leads to local heating and acceleration of protons and electrons that cause further heating of the gas, its glow in different parts of the spectrum of electromagnetic radiation, formation of shock waves. Solar flares provide a significant increase in ultraviolet imaging radiation of the Sun, accompanied by bursts of x-rays (sometimes very powerful), the radio burst, burst of high energy corpuscle until 10^{10} eV. Sometimes there are bursts of x-ray radiation and without increasing the glow of the chromosphere. Some flash units (called proton) is accompanied by particularly strong fluxes of energetic particles — cosmic rays of solar origin. Proton flares pose a risk to in-flight astronauts, as energetic particles colliding with atoms of the shell of the ship generate x-rays and gamma rays, sometimes in dangerous doses.

The level of solar activity (number of active regions and sunspots, the number and capacity of solar flares, etc.) varies with a period of about 11 years. There are also weak oscillations of the magnitude of the maxima of the

11-year cycle with a period of about 90 years. On Earth, the 11-year cycle can be traced in a number of the phenomena of organic and inorganic nature (perturbations of the magnetic field, the auroras, disturbance of the ionosphere, changing the speed of growth of trees with a period of about 11 years old, installed by alternating the thickness of the annual rings, etc.). On terrestrial processes is also affected by a separate active region on the Sun and what happens in them is intermittent, but sometimes very powerful flash. The existence of individual magnetic areas on the Sun can reach one year. Called this area of disturbance in the magnetosphere and the upper atmosphere of the Earth repeated every 27 days (as seen from Earth the rotation period of the Sun). The most powerful manifestations of solar activity — solar (chromosphere) outbreaks occur sporadically (often in close proximity to periods of peak activity), the duration is 5-40 minutes, rarely a few hours. Energy solar flares can reach 10^{25} joules, released when the flash energy is only 1-10% are electromagnetic radiation in the optical range. Compared to the full radiation of the Sun in the optical range the energy of the flare is not large, but short-wave radiation flashes and flares generated by the electrons, and sometimes solar cosmic rays can give a noticeable contribution to x-ray and corpuscular radiation of the Sun. In periods of increasing solar activity x-ray emission increases in the range of 30 nm -10 two times, in the range of 10 -1 nm 3-5 times, in the range 1-0,2 nm more than a hundred times. With decreasing wavelength of the radiation contribution of active regions in the full radiation of the Sun increases and in the latter of these bands almost all the radiation is due to the active regions. Hard x-rays with a wavelength of less than 0.2 nm appears in the spectrum of the Sun only for a short time after the flashes.

In the ultraviolet range (wavelength of 180-350 nm) radiation of the Sun over the 11-year cycle is changed by only 1-10% and in the range 290-2400 nm remains almost constant at $3.6 \cdot 10^{26}$ watts.

The constancy of the energy received by the Earth from the Sun, ensures the stationarity of the heat balance of the Earth. Solar activity does not significantly effect the energy of the Earth as a planet, but individual components of the radiation of solar flares can have a significant impact on many physical, biophysical and biochemical processes on Earth.

Active regions are a powerful source of corpuscular radiation. Particles with energies of about 1 Kev (mainly protons) propagating along the field lines of the interplanetary magnetic field from active regions increase the solar wind. These gain (impulses) of the solar wind are repeated every 27 days and are called recurrent. Same flows, but the greater energy and density occur during outbreaks. They cause the so-called sporadic disturbances of the solar wind and reach Earth over the time interval from 8 hours to two days. Protons of high energy (100 MeV to 1 GeV) from the very powerful "proton" flares and electrons with energies of 10-500 Kev, is included in the composition of the solar cosmic rays come to Earth in tens of minutes after the outbreaks; later come those of them who fell into the "trap" of the interplanetary magnetic field and moving along with the solar wind. Short-wave radiation and solar cosmic rays (at high latitudes) ionize the earth's atmosphere, which leads to fluctuations in its transparency in the ultraviolet and infrared ranges, as well as to change the conditions of propagation of short radio waves (in some cases, disturbances of short-wave radio).

The increase in solar wind caused by the flash, causes compression of the Earth's magnetosphere on the Sunny side, strengthening currents on its external border, a partial penetration of solar wind particles into the magnetosphere, the replenishment of high-energy particles of the radiation belts of the Earth, etc. These processes are accompanied by fluctuations of intensity of the geomagnetic field (magnetic storm), auroras and other geophysical phenomena that reflect the General indignation of the Earth's magnetic field. The impact of active processes on the Sun (solar storms) on geophysical phenomena is carried out as short-wave radiation, and through the magnetic field of the Earth. Apparently, these factors are key for physico-chemical and biological processes. To trace the entire chain of connections, leading to an 11-year periodicity of many processes on the Earth is not yet possible, but accumulated vast factual material leaves no doubt as to the existence of such links. So, was the correlation between 11-year solar cycle and earthquakes, crop yields, number of cardiovascular diseases, etc. These data indicate a constant effect of solar-terrestrial relations.

Observations of the Sun are conducted using refractors small or medium-sized and large reflecting telescopes, whose large optics part stationary, and the sun's rays are directed onto a horizontal or tower the installation of the

telescope by means of one or two moving mirrors. Created a special type of solar telescope — coronagraph. Inside the coronagraph is the darkening of the Sun a special opaque screen. In the coronagraph many times decreases the amount of ambient light, so you can watch out Eclipse the outer layers of the solar atmosphere. Solar telescopes are often supplied with narrowband filters that allow observation at the light of a single spectral line. Created neutral filter with variable transparency along the radius, allowing to observe the solar corona at a distance of several radii of the Sun. Usually large solar telescopes are equipped with powerful spectrographs with photographic or photoelectric fixation of the spectra. The spectrograph can also have magnetograph — apparatus for the study of Zeeman splitting and polarization of spectral lines and determine the magnitude and direction of the magnetic field on the Sun. The need to eliminate the action of the earth's atmosphere, and studies of solar radiation in the ultraviolet, infrared and some other regions of the spectrum that are absorbed in the Earth's atmosphere, has led to the development of orbiting observatories outside the atmosphere, allowing to obtain spectra of the Sun and of the individual formations on its surface outside the earth's atmosphere.

THE PATH OF THE SUN AMONG THE STARS

The daily path of the Sun

Every day, rising over the horizon in the Eastern sky, the Sun passes across the sky and hides again in the West. For residents of the Northern hemisphere, this motion from left to right, South, right to left. At noon, the Sun reaches its greatest height, or, as astronomers say, culminates. Noon is upper culmination, and is still, and lower at midnight. In our middle latitudes of the lower culmination of the Sun is not visible because it occurs beneath the horizon. But in the Arctic circle, where in summer the Sun sometimes never sets, it is possible to observe both the upper and lower culmination.

The geographical pole, the daily path of the Sun almost parallel to the horizon. Appearing in the vernal equinox, the Sun is a quarter of the year, rising higher and higher circles above the horizon. At the summer solstice it reaches its maximum height (23.5°). Next quarter of the year, before the autumnal equinox, the Sun goes down. It is polar day. Then six months polar

night sets in.

In the middle latitudes throughout the year, the apparent daily path of the Sun that decreases, then increases. Least he is in the winter solstice, is higher in the summer solstice. During the equinoxes the Sun is on the celestial equator. At the same time it rises in the East point and sets the point of the West.

In the period from spring equinox to summer solstice location of sunrise is slightly shifted from the point of sunrise to the left, to the North. And the place of sunset is deleted from points West to the right, but also to the North. At the summer solstice the Sun appears in the North-East, and at noon it culminates at a maximum for the year height. The Sun sets in the Northwest.

Then the place of sunrise and sunset shifted back to the South. In the winter solstice the Sun rises in the South-East, crosses the celestial Meridian at a minimum height and sets in the southwest.

Note that due to refraction (i.e. the refraction of light rays in the earth's atmosphere) the visible height of the luminaries is always more true. Therefore, the sunrise occurs earlier and sunset is later than it would be in the absence of the atmosphere.

So the daily path of the Sun is a small circle of the celestial sphere parallel to the celestial equator. At the same time during the year, the Sun moves relative to the celestial equator to the North, to the South. Day and night part of its path varies. They are equal only during the equinoxes, when the Sun is on the celestial equator.

Annual path of the Sun

The expression "the path of the Sun among the stars" seem strange. After all, the day stars are not visible. Therefore, it is hard to notice that the Sun slowly, about 1 per day, moves among the stars from right to left. But you can see how during the year changes view of the starry sky. All this is the result of the revolution of the Earth around the Sun.

The path of the visible annual movement of the Sun against the background stars is called the Ecliptic (from the Greek "eklipis" – "Eclipse"), and the

period of turnover on the Ecliptic – star year. It is equal to 265 days 6 hours 9 minutes 10 seconds, or 365, 2564 mean solar days.

The Ecliptic and the celestial equator intersect at an angle of 23°26' at the points of vernal and autumnal equinoxes. In the first of these points the Sun is usually on March 21, when it moves from the southern hemisphere of the sky in the North. In the second – on 23 September, when their Northern to the southern hemisphere. In the farthest North point of the Ecliptic, the Sun is on 22 June (summer solstice), and to the South – December 22 (winter solstice). In a leap year, these dates are shifted by one day.

Of the four main points of the Ecliptic is the vernal equinox point. It is counted one of the celestial coordinates of right ascension. It also serves to count the stellar time and the tropical year – the interval of time between two successive passages of the centre of the Sun through the vernal equinox. The tropical year determines the seasons on our planet.

Since the vernal equinox point moves slowly among the stars due to precession of earth's axis, the length of the tropical year less than the duration of star. It is 365,2422 average solar day.

About 2 thousand years ago, when Hipparchus made a star catalogue (the first extant as a whole), the vernal equinox was in the constellation Aries. To our time it has moved almost 30, in the constellation of Pisces, and the point of the autumnal equinox from the constellation of Libra into the constellation Virgo. But traditionally the point of the equinoxes are indicated by the same signs the old "Ravnodenstvie" constellations – Aries and Libra. The same happened with the points of solstices: summer in the constellation Taurus marks the sign of Cancer, and winter in the constellation of Sagittarius – the sign of Capricorn.

And one last thing, which is associated with a visible annual movement of the Sun. Half of the Ecliptic from spring equinox to autumn (21 March and 23 September) the Sun passes for 186 days. The second half, from the autumn equinox to the spring Yes, for 179 days (180 in a leap year). But half of the Ecliptic are equal to each 180. Therefore, the Sun moves along the Ecliptic uneven. This irregularity is due to a change of speed of the Earth in an

elliptical orbit around the Sun.

The uneven motion of the Sun along the Ecliptic causes a different duration times of the year. For residents of the Northern hemisphere, for example, spring and summer for six days longer than autumn and winter. Land 2-4 June are from the Sun by 5 million kilometers longer than 2-3 January, and moves in its orbit more slowly in accordance with the second law of Kepler. In the summer the Earth receives from the Sun less heat, but the summer in the Northern hemisphere longer winter. Therefore, in the Northern hemisphere is warmer than in the South.

SOLAR ECLIPSE

At the time of the lunar new moon can occur a solar Eclipse because new moon the Moon passes between the Sun and Earth. Astronomers know when and where will occur a solar Eclipse, and this information is in astronomical calendars.

The land was given to a single satellite, but what! The moon is 400 times smaller than the Sun and just 400 times closer to the Earth, so in heaven the Sun and Moon seem to be disks of equal size. So when a total solar Eclipse the Moon completely obscures the bright surface of the Sun, while leaving open the entire solar atmosphere.

Exactly at the appointed hour and moment through the dark glass, it can be seen as the bright disk of the Sun creeps from the right edge of something black appears black hole. It gradually grows, until finally the sun will not take the form of a narrow sickle. In this fast-waning daylight. The Sun was completely hidden behind a dark door, which goes out the last day-beam, and the darkness, seeming deeper than it vnezapnoe, is spread around, flinging the man and the whole of nature in silent surprise.

On the solar Eclipse of 8 July 1842, in the city of Pavia (Italy) says the English astronomer Francis Bailey: "When it was full Eclipse and the sun light was instantly extinguished, around the dark body of the moon suddenly appeared a bright glow, like a corona or halo around the head of the Saint. Any reports about past eclipses was not written about something similar, and

I didn't expect to see the magnificence that was now in front of me. The width of the crown, measured from the circumference of the disk of the Moon, was equal to about half a lunar diameter. She seemed made up of bright rays. Her light was denser around the edge of the moon, and the farther the rays of the crown was becoming weaker and thinner. The weakening of light went absolutely smoothly with increasing distance. The crown was presented in the form of direct beams of weak beams; their outer ends are diverged like a fan; the beams were of unequal length. The crown was not reddish, not pearl, she was completely white. Its rays shimmered or flickered like a gas flame. Not brilliant as it was this phenomenon, whatever enthusiasm it aroused the audience, but in this strange and wonderful sight it was definitely something sinister, and I completely understand how he could be shocked and horrified people in the times when these phenomena occurred quite unexpectedly.

The most striking detail of the whole picture was the appearance of three large protuberances (protuberances) that towered over the edge of the moon, but was obviously part of the crown. They were like mountains of enormous height, snow peaks of the Alps, when they are illuminated by the red rays of the setting Sun. Their red color into lilac or purple; perhaps it would be best here would be a shade of peach flowers. Light projections, in contrast to other parts of the crown, was absolutely quiet, "the mountain" didn't sparkle and didn't sparkle. All three projections, somewhat different in size, were visible until the last moment of the total phase of the Eclipse. But once broke the first ray of the Sun, the prominences, together with the crown disappeared without a trace, and immediately restored the bright light of day." This phenomenon is so subtly and vividly described Bailey lasted just over two minutes.

Remember Turgenev boys Baginska meadow? Pavel talked about how the Sun was not seen, about a man with a jug on her head, who took over the Antichrist Tresco. So it was a story about the Eclipse on 8 July 1842!

But it was not in Russia eclipses moreover, about which narrate "the Word about Igor's regiment" and the ancient Chronicles. In the spring of 1185 Novgorod-Seversky Prince Igor with his brother Vsevolod, filled with the martial spirit, went at Polovtsy to acquire glory to himself and the squad

production. 1 may, towards evening, as soon as I entered the shelf "Dazhd-God's grandchildren" (descendants of the Sun) to a foreign land, zatemnil early, the birds were silent, the horses whinnying ine went, the shadow riders were vague and strange, steppe breathed cold. Igor looked around and saw that accompanies them, "the sun, standing like a month." And Igor said to his boyars and the team: "See? What does the radiance of this??" They looked, and saw, and hung his head. And told the men, "our Prince! Does not promise us good glow!" Igor answered: "Brethren and warriors! The mystery of God is unknown to anyone. What God gives us – for the benefit of us or on the mountain – we'll see." On the tenth day of may, the squad were killed Igor in the Polovtsian steppe, and the wounded Prince was taken prisoner.

In the "Word" real Eclipse turns into a poetic image. Acting "darkness" against the Russians, the Sun warns them against hasty trip to the steppe.

Igor and his warriors were caught in the desert private zatmenie when not shone all day, and about $\frac{3}{4}$ of its drive were closed by the Moon. A total Eclipse at that time passed through Novgorod and Suzdal.

Look at the Earth and the moon from the side to understand where and AS5 runs a solar Eclipse. Passing between the Sun and Earth, little Moon cannot fully obscure the Ground. Short Moonshadow potemneet only a small circle. Only here in this moment it is possible to observe a total solar Eclipse. But the Moon revolves in its orbit, and Earth rotates under the shadow. So the shadow like traces on the Ground a strip of total Eclipse with a width of about 100 kilometers. If the shadow track will pass us at a distance of 3-4 thousand miles, then we will not see any Eclipse. And if we are close to a strip of a total Eclipse, penumbra, only part of the Sun will be eclipsed by the Moon, will experience a partial Eclipse.

Some new moon the edge of the moon's shadow passes by the earth, and fall to the Ground and only partial shade. Then the calendars announce a partial Eclipse of the Sun.

If the day of the Eclipse, the Moon moves in its eccentric orbit, will be at a considerable distance from Land, then the visible disk will be small and will not completely cover the Sun. So in the middle of the Eclipse the edge of the

Sun will peek out from behind the moon, making it difficult to see and capture the crown. This is an annular Eclipse.

Ancient astronomers predicted a solar Eclipse as well as lunar – Saros. According to their theory, for 18 years 11 days and 8 hours there is also another lunar 28 and 43 of the solar Eclipse, 15 of them private, 15 annular and 13 full. But to predict a solar Eclipse was a lot harder than the lunar. After all, the band of the Eclipse covers only a small part of the surface of the earth, and the Saros is not a whole number of days. Pass 6585 days, it seems that the Eclipse will happen again, but the planet wrong way for another third of a turn so that the shadow track will run in very different regions of the Earth. Then the sages invented the triple Saros – $3 \times 6585,3$ days. But here, the ancient astronomers were mistakes in the predictions. It sometimes had unfortunate consequences. In the fall of 2137 BC was executed by Chinese court astronomers he and Ho, in failing to warn the Emperor about the upcoming Eclipse. The decree stipulated that the perpetrators miscalculated the Eclipse "indulging in drinking", but, perhaps, unfortunate stargazers before each successive Eclipse with fear thinking, to convey or not to convey, not knowing exactly pass it through China or not.

In our time of eclipses with great accuracy the computed thousands of years ago and hundreds of years. Eclipse, designed for the distant past, allow historians to exactly date the events of the day and year of the Eclipse.

Although in General on Earth, Solar eclipses occur more frequently than lunar, in some areas total Eclipse of the Sun occur rarely: about once in 300 years. For example, in the history of Moscow, its "visited" four total solar eclipses: in 1140, 1450, 1476 and 1887. The next total Eclipse of the Muscovites will see 16 October 2126. Astronomical calendars, publish cards of the strip of total Eclipse and the surrounding areas of the partial Eclipse. So that experts and Amateur astronomers can not "wait for the mercy from nature", and pre-select a convenient location for the expedition.

Total Eclipse to study the solar atmosphere: a silver crown and a lower layer – red chromosphere, above which rise the fiery fountains of the prominences. However, astronomers manage to see all this and on a typical Sunny day, making the flap the solar disk right in the tube of the telescope.

For photographing a solar Eclipse it is useful to have two cameras. One for shooting the private phase of the Eclipse, when it is necessary to capture the dazzling sickle. And the other for internal and external crowns of the Sun.

ULTRAVIOLET RADIATION OF THE SUN

The radiation of the Sun must be quite a lot of UV rays, significantly more than that observed from Earth, because they absorb the earth's atmosphere. Launches unmanned balloons raised to a height of 30 kilometers or more measuring devices and transmitters, showed that higher 25 – 28 miles, the air temperature grows, reaching the maximum at 30 – 35 miles. Even higher temperature again decreases, and the intensity of UV rays increases.

Scientists have concluded that at the height of 30 – 35 kilometers, there is an intensive absorption of solar UV radiation with the formation of ozone, a substance the molecule of which consists of three (not two, as usual) oxygen atoms. Ozone very strongly absorbs the rays with wavelengths shorter than $0.3\ \mu\text{m}$, saving us from their damaging effects on the skin and the organs of vision. That's why worrying is the existence of ozone holes through these gaps in the ozone layer, solar UV radiation reaching the earth's surface. One of the reasons for the destruction of the ozone "shield" are the emissions of fluorocarbon compounds that are widely used in refrigerators.

But not only to ozone formation energy of solar UV rays.

Radio waves, like all electromagnetic waves must propagate in a straight line. So, since the Earth is a sphere, telecommunication between Europe and America is impossible? Italian radio engineer Guglielmo Marconi realized in 1901 a direct radio link between England and the United States, once and for all proving that radio waves can circumnavigate the globe. For this they need to bounce off a "mirror" hanging above the earth's surface at an altitude of 150 – 300 kilometers. This "mirror" is the ionized layers of the atmosphere, and the source of ionization is ultraviolet radiation of the Sun. In short, UV rays are imperiously interfere in earthly Affairs.

Now it was little: to directly measure the intensity of the UV radiation from the Sun. The ballistic missile allowed the researchers to take the instrument outside the earth's atmosphere, to an altitude of over 100 kilometers. And the

first launches were successful: the UV radiation of the Sun was detected and measured. Radiation with wavelengths shorter than $0.15\ \mu\text{m}$ no longer associated with the visible surface of the Sun, but with a higher and hot atmospheric layers.

With the development of satellite astronomy, the study ultraviolet radiation from the Sun has become a required component. The reason is clear: UV-radiation monitors the state of the ionized layers of the atmosphere, and hence the conditions of radio communication on Earth, especially in the polar regions. This unpleasant dependence on the whims of the Sun began to weaken only in the last decade, with the development of satellite communications.

THE SUN'S POSITION IN THE GALAXY

In the vicinity of the Sun it is possible to consider the fate of two spiral branches, distant from us about 3 thousand light years. The constellations that are experiencing these sites, they are called sleeve sleeve Sagittarius and Perseus. The sun is almost in the middle between the spiral branches. However, relatively close (in galactic terms) from us in the constellation of Orion, is another, not as a distinct branch, which is considered an offshoot of one of the major spiral arms of the Galaxy.

The distance from the Sun to the center of the Galaxy is 23 – 28 thousand light years, which is about 7 – 9 thousand parsecs. This suggests that the Sun is located between the center and edge of the disk of the Galaxy.

Together with all the family of stars the Sun revolves around the galactic centre with a speed of 200 – 220 kilometers per second, making one revolution in about 200 million years. So, for all time of its existence, the Earth orbited around the galactic centre is not more than 30 times.

The speed of rotation of the Sun around the galactic center almost coincides with the speed with which this district moving wave seal, forming a spiral sleeve. This situation in General extraordinary for the Galaxy: the spiral arms rotate with a constant angular velocity, like the spokes of a wheel, and the movement of the stars obeys completely different laws. Therefore, almost all

of the stellar population of the disk that is inside the spiral branches, out of them. The only place where the speeds of the stars and sleeves are the same, is the so – called corotational circumference. It is located in close proximity to her and the Sun.

For the Earth this circumstance is extremely positive. After all, in the spiral branches of the turbulent processes occur, generating a powerful radiation, harmful to all living things. And no atmosphere would not be able to protect. But our planet exists in a relatively calm place in the Galaxy for hundreds of millions and billions of years have not experienced the catastrophic influence of cosmic cataclysms. Maybe that's why on Earth there could be life.

For a long time the position of the Sun among the stars was considered the most mediocre. Today we know that it is not so: in a sense, it is privileged. And this should be considered in discussing the possible existence of life in other parts of our Galaxy.

Cycles of solar activity

The number of sunspots is not constant, it changes as the day to day and over longer periods of time. German Amateur astronomer Heinrich Schwabe, who for 17 years led a systematic observation of sunspots, noticed that their number decreases from maximum to minimum, and then increases to a maximum value over a period of about 10 children. In the maximum on the solar disk can be observed 100 or more spots, while the low – only a few, and sometimes for whole weeks not observed any. The message about his discovery Schwabe published in 1843.

Swiss astronomer Rudolf wolf said that the average period of change in the number of spots is 10, and 11. He suggested for the quantitative assessment of solar activity to use a conditional value called since the wolf number. It is defined as the sum of the total number of sunspots (f), and redoubled the number of sunspot groups (g), and one isolated spot is also considered as a group: $W = f + 10g$.

The cycle of solar activity, called the 11-year-old in all the textbooks and popular books on astronomy. However, the Sun likes to do on his own. So,

for the last 50 years, the interval between peaks averaged 10.4 years. Generally, during regular observations of the Sun the period varied from 7 to 17 years. And that's not all. After analyzing the observations of the spots since the beginning of telescopic studies, English astronomer Walter Maunder in 1893 came to the conclusion that from 1645 to 1715, the Sun had no spots! This conclusion was confirmed in later works; moreover, it was found that this "vacation" the Sun and took in the more distant past. By the way, it is "murderously low" was the period of the coldest winters in Europe over the last Millennium.

But the surprises of solar cycles do not end. The leading spot in the group (the first in the direction of movement of the Sun) usually has the same polarity (e.g. North), and closing the opposite (southern), and this rule holds for all groups of spots in one hemisphere of the Sun. In the other hemisphere, the picture is reversed: the leading spot in the groups will have a South polarity, and the trailing – Northern. But, it turns out that the appearance of spots of new generation(next cycle), the polarity of the leading spots is reversed! Only after one cycle the leading spots have former polarity. So the "true" solar cycle with the return of the old magnetic polarity of the leading spots in fact covers not 11 and 22 years (average, of course).

HOW THE SUN AFFECTS THE EARTH

The sun lights and warms our planet, without this would have been possible life on it is not only man, but even microorganisms. The sun is the main (though not the only) engine of what is happening on Earth processes. But not only heat and light the Earth receives from the Sun. Different types of solar radiation and the streams of particles constantly influence the life of our planet.

The sun sends to the Earth electromagnetic waves of all spectrum, from long radio waves to gamma rays. The surroundings of the Earth also reaches the charged particles of different energies as high (solar cosmic rays) and low to medium (solar wind streams, emissions from flares). Finally, the Sun emits a powerful stream of elementary particles – neutrinos. However, the influence of the latter on terrestrial processes is negligible: for these particles, the globe is transparent, and they freely pass through it.

Only a very small portion of charged particles from the interplanetary space enters the Earth's atmosphere – the rest of the rejects go delay the geomagnetic field. But their energy is enough to cause aurorae and perturbations of the magnetic field of our planet.

The energy of sunlight

Electromagnetic radiation is subjected to a strict selection in the earth's atmosphere. It is transparent only to visible light and near ultraviolet and infrared radiation, and radio waves in a relatively narrow range (from centimeter to meter). The rest of the radiation is either reflected or absorbed by the atmosphere, heating and ionizing the upper layers.

The absorption of x-rays and hard ultraviolet rays starts at altitudes of 300 – 350 km; at these altitudes reflects the longest radio waves coming from space. When strong bursts of solar x-ray radiation from solar flares x-ray quanta penetrate to altitudes of 80-100 kilometers, ionize the atmosphere and cause a disruption in the communication on short waves.

Soft (long-wavelength) UV radiation is able to penetrate deeper, it is absorbed at a height of 30 – 35 kilometers. Here, ultraviolet rays are broken down into atoms (dissociate) oxygen molecules (O_2) with subsequent formation of ozone (O_3). Thus, it is not transparent to UV radiation "ozone screen" that protects life on Earth for the disastrous rays. Not absorbed part of most long-wave ultraviolet radiation reaches the earth's surface. It is these rays and cause people to sunburn and even skin burns with prolonged exposure to the sun.

Radiation in the visible range is absorbed poorly. However, it is scattered by the atmosphere even in the absence of clouds, and part of it returns into interplanetary space. Clouds made of water droplets and solid particles, greatly increase the reflection of solar radiation. As a result, until the surface of the planet comes to an average of about half falling on the border of the earth's atmosphere the light.

The amount of solar energy falling on a surface area of 1 m^2 , deployed perpendicular to the sun rays on the border of the earth's atmosphere, called

solar constant. Measure it from the Ground very difficult, and therefore the values found for the early space research was very rough. Small oscillations (if they really existed) is obviously "drowned" in incorrect measurements. Only special space program to determine the solar constant is allowed to find its reliable value. According to the latest data, it is 1370 W/m^2 , accurate to 0.5%. Fluctuations greater than 0.2% during the measurements was not detected.

On Earth radiation is absorbed by land and ocean. Heated Earth surface in turn radiates in the far infrared region. For such radiation the nitrogen and oxygen of the atmosphere is transparent. But it is greedily absorbed by water vapor and carbon dioxide. Thanks to this small component envelope of air keeps heat out. This is the greenhouse effect of the atmosphere. Between the arrival of solar energy on the Earth and its loss on the planet in General, there is a balance: how comes so much and is spent. Otherwise, the temperature of the earth's surface with the atmosphere or would have increased or fell.

Solar wind and interplanetary magnetic field

In the late 50-ies of XX century, American astrophysicist Eugene Parker concluded that, because the gas in the solar corona has a high temperature, which is maintained with distance from the Sun, it needs to continuously expand, filling the Solar system. The results obtained with the help of Soviet and American spacecrafts have confirmed the correctness of the theory of Parker.

In the interplanetary space do sent hurtling from the Sun the flow of matter, called the solar wind. It is a continuation of the expanding solar corona; it is mainly hydrogen nuclei (protons) and helium (alpha particles) and electrons. The solar wind particles are flying with speeds, components of several hundred kilometers per second, away from the Sun for many tens of astronomical units where the interplanetary medium of the Solar system moves in the rarefied interstellar gas. And with the wind in interplanetary space are transferred and the solar magnetic field.

Total magnetic field of the Sun in the form of lines of magnetic induction is a bit like earth. But the lines of force of the earth's field near the equator are

closed and do not let towards the Earth charged particles. The lines of force of the solar field, on the contrary, in the Equatorial region are open and stretch out into interplanetary space, being bent like a spiral. Explain that the lines of force remain associated with the Sun, which rotates around its axis. Solar wind with frozen-in magnetic field forms a gas tails of comets, sending them out to the sides from the Sun. Encountering on its way the Earth, the solar wind greatly distorts its magnetosphere, resulting in our planet's long magnetic "tail", also directed from the Sun. The Earth's magnetic field sensitively responds to blowing it flows of solar material.

The bombardment of energetic particles

In addition to continuously "blowing" the solar wind our star is a source of energetic charged particles (mostly protons, helium nuclei and electrons) with energies of $10^6 - 10^9$ electron volts (eV). They are called solar cosmic rays. Distance from the sun to the Earth – 150 million kilometers – the most energetic of these particles cover only 10 – 15 minutes. The main source of solar cosmic rays are solar flares.

According to modern concepts, flash is the sudden release of energy stored in the magnetic field of the core. At a certain height above the surface of the Sun a region where the magnetic field a small extent changes dramatically in magnitude and direction. At some point the field lines suddenly "prisoedinyaetsya", the configuration it changes dramatically, which is accompanied by acceleration of charged particles to high energy, heating a substance and the appearance of hard electromagnetic radiation. When this occurs, the emission of high-energy particles in interplanetary space and there is a powerful radiation at radio frequencies.

Although the "principle" of the outbreak, scientists seem to have got right, a detailed theory of the flares yet.

Flash – the most powerful explosive processes observed on the Sun, or rather in its chromosphere. They can last for a few minutes, but during this time the energy is released, which sometimes reaches 10^{25} joules. About the same amount of heat passes from the Sun to the entire surface of our planet for an entire year.

Streams of rigid x-ray radiation and the solar space beams, born at flashes, render strong influence on physical processes in the Earth's upper atmosphere and near-earth space. If you do not take special measures are easily damaged complex space devices and solar panels. There is even a serious danger of radiation exposure of astronauts in orbit. Therefore, in different countries work on the scientific prediction of solar flares based on the measurement of solar magnetic fields.

As x-ray radiation, solar space beams do not reach the Earth's surface, but can insulate the upper layers of its atmosphere, which affects the stability of radio communications between distant points. But the action of the particles is not limited. Fast particles cause strong currents in the earth's currents in the earth's atmosphere, result in indignation of the magnetic field of our planet, and even affect the air circulation in the atmosphere.

The most striking and impressive display of bombardment of the atmosphere by solar particles is the Aurora. This glow in the upper atmosphere, have either blurred (diffuse) form or the form of crowns or curtains (drapery), consisting of many separate beams. The lights are usually red or green: exactly lit the main components of the atmosphere – oxygen and nitrogen – under their irradiation with energetic particles. The spectacle silently emerging red and green stripes and rays, silent play of colors, slow or almost instantaneous extinction of the oscillating "curtains" leave a lasting impression. Such phenomena are best seen along the auroral oval, situated between 10° and 20° of latitude from the magnetic poles. In the period of solar maxima in the Northern hemisphere oval is shifted to the South, and the glow can be observed in lower latitudes.

The frequency and intensity of the Aurora quite clearly follow the solar cycle: the maximum solar activity, a rare day goes without lights, and at least they can be absent for months. The presence or absence of auroras, thus, serves as a good indicator of solar activity. And it allows us to observe the solar cycles in the past, beyond the historical period, when carried out systematic observations of sunspots.

Solar activity and human health

Alexander Leonidovich Chizhevsky made a great contribution to the study of

the influence of the Sun on the occurrence of epidemic diseases. The results of these studies are of particular value: after all, he worked with the material in those epochs, when the medicine is not yet able to deal with any plague, nor cholera, nor typhus. The spontaneous nature of the emergence and spread of epidemics gave hope to identify their relationship with solar activity "in the clear" In the vast material scientist showed that the strongest and most deadly epidemic coincided with the highs in solar activity. The same pattern was discovered for diphtheria, meningitis, polio, dysentery and scarlet fever.

And in the early 60-ies there was a scientific publication about the relationship of cardiovascular diseases with solar activity. They have shown that are exposed to the sun people who have already suffered one heart attack. It turned out that their body does not respond to the absolute value of the level of activity and the speed of its change.

In a number of diverse manifestations of solar activity the special place is occupied by solar flares. These powerful explosive processes can significantly affect the magnetosphere, atmosphere and biosphere of the Earth. The Earth's magnetic field begins to vary randomly, and this is the cause of magnetic storms.

In the 30-ies of XX century in the city of nice (France) by chance it was noticed that the number of myocardial infarctions and strokes in the elderly increases dramatically in the days when local telephone exchanges were observed strong violations of context until its termination. As it turned out later, the disconnections were caused by magnetic storms.

Data on influence of magnetic field on the human body existed in ancient times. The therapeutic properties of the magnet described by Aristotle and Pliny, Paracelsus and William Gilbert. It is now established that the magnetic field primarily affects the regulatory systems of the body (nervous, endocrine and circulatory). It inhibits the effects of conditional and unconditional reflexes, changes in blood composition. Such a reaction on the magnetic field is primarily due to changes in the properties of aqueous solutions in the human body.

In 1934, the British scientists John Bernal and Ralph Fowler conjectured that

water may exhibit properties of solid crystals. Subsequently, this hypothesis was experimentally proven, and nowadays liquid crystals are widely spread in everyday life: they are used in electronic watches, calculators pagers and other devices (have recently appeared on LCD monitors). Under normal conditions, the crystalline structure of water is extremely unstable and weakly manifests itself. But if the water flow through a constant magnetic field, this structure becomes visible, and the water acquires a number of unusual properties. Thus, the "magnetized" water gives a much smaller scale, changing its dielectric constant, otherwise it absorbs the light, and the germination of seeds and growth of plants treated with the water, is much faster.

In any living organism more than 70% water, which is an integral part of cells and tissues. If we assume that for the "magnetization" of water inside the body, it is sufficient even a relatively weak field of the Earth, the periods of magnetic storms should expect drastic changes in life processes. Because these processes occur at the cellular level, a magnetic storm will cause changes in the behavior of all living things, beginning with man and ending with the microbe. That's why in the years of the active radiation of the Sun can take such disparate events as the massacre of St. Bartholomew or the ravages of locusts.

All the weighty body mutually experience the gravity, this force causes the motion of the planets around the sun and satellites around planets. Theory of gravity — a theory created by Newton, stood at the cradle of modern science. Another theory of gravitation developed by Einstein, is the greatest achievement of theoretical physics of the 20th century. During the centuries of development, mankind observed the phenomenon of mutual attraction of bodies was measured and its value; they tried to put this phenomenon to the service, to surpass its influence, and finally, the most recent count it with extreme precision during the first steps into the Universe.

The vast complexity of the surrounding bodies is primarily due to this multistage structure, the finite elements which are elementary particles — have a relatively small number of interactions. But these kinds of interaction differ sharply on its strength. The particles that make up the atomic nucleus, are bound together by the most powerful of all known forces; to separate these particles from each other, it is necessary to expend enormous amounts

of energy. The electrons in the atom are connected with the nucleus by electromagnetic forces; just provide them with the very modest energy (generally enough energy in a chemical reaction) as the electrons separate from the nucleus. If we talk about elementary particles and atoms, the weak interaction is the gravitational interaction.

In comparison with the interaction of elementary particles the gravitational force is so weak that it is hard to imagine. However, they and only they have full control over the motion of celestial bodies. This is because the attraction combines two features, because of which its action is enhanced when we turn to large bodies. In contrast to the nuclear interaction, the force of gravitational attraction is palpable and at large distances from the creating of their bodies. Besides the gravitational forces are always forces of attraction, that is, bodies always attract each other.

The development of the theory of gravity had occurred at the beginning of the emergence of modern science on the interaction of celestial bodies. their work was simplified by the fact that heavenly bodies move in the vacuum world without side effect of other forces. Brilliant astronomers Galileo and Kepler had produced his works the stage for further discoveries in this area. In the future, the great Newton was able to come up with a coherent theory and give it a mathematical form.

2. Newton and his predecessors

Among all the forces that exist in nature, the force of gravity is different primarily because it manifests itself everywhere. All bodies possess mass, which is defined as the ratio of the force applied to the body, to the acceleration, which acquires under the action of this force the body. The force of attraction acting between any two bodies depends on the masses of both bodies; it is proportional to product of masses of the considered bodies. in addition, the gravity is characterized by the fact that it obeys the law of inverse proportionality to the square of the distance. Other forces may depend on the distance differently; there are many such forces.

One aspect of gravity — amazing dual role played by the mass — became the cornerstone for building the General theory of relativity. According to

Newton's second law mass is a characteristic of every body that shows how you will behave in the body when it is applied force, regardless of whether it is gravity or some other force. Since all bodies, according to Newton, in response to an external force accelerate (change its velocity) , body mass determines how much acceleration a body experiences when it applied to the specified strength. If the same force is applied to the bike and the car, each of them will reach a certain speed at different times.

But in relation to gravity mass plays a different role, not what she was playing as the ratio of force to acceleration: the mass is the source of the mutual attraction of bodies; if you take two bodies and see how they act on a third body located at the same distance first from one and then from another body, we find that the ratio of these forces is equal to the ratio of the first two masses. In fact, it turns out that this force is proportional to the mass of the source. Similarly, under the third Newton's law, force of attraction, experiencing two different bodies under the action of the same magnet (at the same distance from it), proportional to the ratio of the masses of the bodies. In engineering Sciences and daily life about the force with which a body is attracted to earth, talking about how body weight.

Now, mass is included in the link that exists between force and acceleration; on the other hand, the mass determines the magnitude of the force of gravity. This dual role of the mass causes the acceleration of different bodies in the same gravitational field is the same. Indeed, take two distinct bodies with masses m and M respectively. May they both freely fall to the Ground. The ratio of the gravitational forces experienced by these bodies is equal to the ratio of the masses of the bodies m/M . However, the acceleration acquired by them is the same. Thus, the acceleration acquired by the bodies in the gravitational field, is for all bodies in the same gravitational field is the same and does not depend on specific properties of falling bodies. This acceleration depends only on mass of the bodies creating the gravitational field, and the location of these bodies in space. The dual role of the masses and deriving from it the equality of acceleration of all bodies in the same gravitational field is known as the equivalence principle. This name has a historical background, highlighting the fact that the effects of gravity and inertia to a certain extent equivalent.

On the Earth's surface the acceleration of gravity, roughly speaking, equal to 10 m/s^2 . The speed of a freely falling body, if we ignore air resistance when falling, increases by 10 m/sec . Every second. For example, if the body starts to fall freely from rest by the end of the third second its speed will be equal to 30 m/sec . Usually the acceleration of gravity is denoted by g . Due to the fact that the shape of the Earth do not strictly coincide with the ball, the value of g on Earth is not same everywhere; it is more at the poles than at the equator, and less at the tops of big mountains than in the valleys. If the value of g is determined with sufficient accuracy, it even affects the geological structure. This explains the fact that in the geological methods of prospecting for oil and other minerals is also accurate determination of g .

What this place is all bodies experience the same acceleration — a characteristic feature of gravity; such properties no other forces do not possess. Although Newton did not have anything best how to describe this fact, he understood the universality and the unity of the acceleration of gravity. The share of German theoretical physicist Albert Einstein (1870 — 1955) had the honor to find out the principle on which it was possible to explain this property of gravitation, the equivalence principle. Einstein also belong to the foundations of modern understanding of the nature of space and time.

3. The special theory of relativity

Since the time of Newton it was believed that all systems of reference are a set of rigid bars or any other items that can set the position of bodies in space. Of course, in every system of reference such bodies have chosen differently. However, it was assumed that all observers of one and the same time. This assumption seemed intuitively so obvious that is not specifically stipulated. In everyday practice on the Ground, this assumption is confirmed by all our experience.

But Einstein was able to show that the comparison of the clock readings, taking into account their relative motion, does not require special attention only in the case when the relative clock speed is much less than the speed of light in vacuum. So, the first result of Einstein's analysis was the establishment of the relativity of simultaneity: two events, occurring at sufficient distance from each other, may be for one observer are

simultaneous, while for an observer moving relative to him, occurring at different points in time. Therefore, the assumption of a single time may not be justified: it is impossible to specify a particular procedure that allows any observer to establish this universal time irrespective of the movement in which he participates. The reference system must be present and the clock moving with the observer and synchronized with the clock of the observer.

The next step taken by Einstein was to establish a new relationship of measurement results of distances and time in two different inertial frames of reference. The special theory of relativity is “absolute length” and “absolute time” has brought to light a different “absolute magnitude”, which is called the invariant space — time interval. For two specified events occurring at some distance from each other, the spatial distance between them is not absolute (i.e. independent of the reference system) is not even in the Newtonian scheme, if between the occurrence of these events has a certain amount of time. Indeed, if two events occur simultaneously, the observer moving with a certain reference frame in one direction and found themselves at the point where there is a first event, for the period of time separating these two events, to be in the place where the second event occurs; for this observer, both events will take place in the same place of space, though for an observer moving in the opposite direction, they may seem to have occurred at a considerable distance from each other.

4. The theory of relativity and gravity

What deeper research into the ultimate building blocks of matter and the less the number of particles and forces acting between them become the more demands a comprehensive understanding of the operation and structure of each component of matter. For this reason, when Einstein and other physicists were convinced that the special theory of relativity has replaced Newtonian physics, they took up again the fundamental properties of particles and force fields. The most important object that needs to be revised, was gravity.

But why the discrepancy between the relativity of time and the law of gravitation of Newton does not allow, just as in electrodynamics? You would have to enter the concept of the gravitational field that would extend about

the same as electric and magnetic fields, and which would mediate the gravitational interaction of bodies, in accord with the theory of relativity. It is the gravitational interaction would be reduced to the Newtonian law of gravitation, when the relative velocity of the bodies would have been small compared with the speed of light. Einstein tried to build a relativistic theory of gravitation on this basis, but for one circumstance did not allow him to carry out this intention: no one knew anything about the propagation of gravitational interaction, there was only some information regarding effects associated with high velocities of motion of gravitational field sources — masses.

The effect of high speeds on the masses unlike the effect of high speeds on the charges. If the electric charge of the body remains the same for all observers, the mass of bodies depend on their velocity relative to the observer. The higher the speed, the greater the observed mass. For a given body least weight will be determined by an observer relative to which the body is at rest. This value of mass is called the rest mass of the body. For all other observers, the mass will be greater than rest mass by an amount equal to the kinetic energy of the body divided by c . The value of the mass would be infinite in the reference frame in which the speed of the object would equal the speed of light. About this reference system it is possible to speak only conditionally. Since the magnitude of the source of gravity so much depends on the system of reference in which it determined the value generated by the weight field must be more complex than the electromagnetic field. Einstein concluded therefore, that the gravitational field, apparently, is a so-called tensor field described a large number of components than the electromagnetic field.

As following the original principle Einstein postulated that the laws of the gravitational field is supposed to be based on a mathematical procedure similar to the procedure leading to the laws of the electromagnetic theory; the laws of the gravitational field obtained in this way must obviously be similar in form with the laws of electromagnetism. But even taking into account all these considerations, Einstein found that he could construct several different theories that equally satisfy all requirements. What was needed was a different point of view to clearly come to the relativistic theory of gravitation. Einstein found such a new point of view in the principle of equivalence,

according to which the acceleration acquired by the body in the force field of gravity, does not depend on characteristics of that body.

5. The relativity of free fall

In the special theory of relativity, as in Newtonian physics, postulated the existence of inertial reference systems, i.e. systems for which the bodies move without acceleration when they do not act external forces. The experimental finding of such a system depends on whether we will be able to put the test body in such conditions when they are not subject to any external forces, and should be experimental confirmation of the absence of such forces. But if, for example, an electric (or any other force) field can be detected from the difference in the effect that these fields have on a variety of test particles and all test particles are placed in the same gravitational field, acquire the same acceleration.

However, even in the presence of a gravitational field there is a certain class of reference systems that can be dedicated purely local experiments. Since all of the gravitational acceleration at a given point (small area) all the bodies are identical as in magnitude and direction, they will be equal to zero relative to the reference system that is accelerated along with other physical objects that are only under the influence of gravity. This system of reference is called a freely falling frame of reference. Such a system cannot continue indefinitely in all space and at all points in time. It can be determined uniquely only in the neighborhood of a world point in a bounded region of space and for a limited period of time. In this sense, a freely falling frame of reference can be called a local reference systems. Relative to a freely falling reference system of the material body on which no forces act except gravity forces are not experiencing acceleration.

A freely falling reference system in the absence of gravitational fields is identical with the inertial frames of reference; in this case, they are unlimited prodolzhim. But such an unlimited the distribution systems becomes impossible, when the gravitational field. The fact that a freely falling system all exist even if only as a local reference system, is a direct consequence of the equivalence principle, which is subject to gravitational effects. But the same principle responsible for the fact that no local procedures it is

impossible to build the inertial reference system in the presence of gravitational fields.

Einstein regarded the equivalence principle as the most fundamental property of gravitation. He realized that the about unlimited prodoljenii inertial reference systems should be abandoned favor of the local freely falling frames of reference; and only by doing so, you can accept the principle of equivalence as a fundamental part of the Foundation of physics. This approach has enabled the physicists to look deeper into the nature of gravity. The presence of a gravitational field is equivalent to the impossibility of distribution in space and time of the local freely falling frame of reference; thus, when studying gravitational fields should focus not so much on the local magnitude of the field, how much for gravitational fields. The value of this approach, which ultimately denies the universality of the existence of inertial reference systems, is that it clearly shows the following: there is no reason to accept without thinking the possibility of constructing inertial frames of reference, despite the fact that such systems have been used for several centuries.

6. Gravitation in time and space

In the theory of gravitation of Newton the acceleration of gravity caused by the large mass given in proportion to the mass and inversely proportional to the square of the distance from that mass. The same law can be formulated a little differently, but we can get the relativistic law of gravitation. This different wording is based on the concept of the gravitational field as something that is imprinted near a large gravitating mass. The field can be completely described by specifying at each point of the space vector, magnitude and direction of which correspond to gravitational acceleration. Which acquires any test body placed at this point. It is possible to describe the gravitational field graphically, spending in this curve, the tangent to which at each point in space coincides with the direction of the local gravitational field (acceleration); these curves are carried out with the density (a certain number of curves per unit area of the cross section, Fig. 2) equal to the value of the local field. If you are considering one large mass, such curves are called lines of force — are straight lines; these lines are pointed directly to the body creating the gravitational field.

Inversely proportional dependence on the square of the distance expressed graphically as follows: all of the power lines start at infinity and end on the big weights. If the density of force lines is equal to the magnitude of the acceleration, the number of lines passing through a spherical surface whose centre is situated on a large mass, is exactly equal to the density of lines of force multiplied by the area of a spherical surface of radius r ; the area of the spherical surface is proportional to the square of its radius. In the General case, Newton's law inverse square of the distance can be given in a form which is equally suitable for the source of gravity in the form of one large mass and random distribution of masses: all the lines of force of the gravitational field starts at infinity and ends with the masses. The total number of lines of force ending in a region containing mass, in proportion to the total mass enclosed in this region. In addition, the gravitational field is conservative field: lines of force can take the form of closed curves, and the movement of a test body along a closed curve may not lead neither to win nor to loss of energy.

In the relativistic theory of gravitation the role of sources is given to combinations of mass and momentum (momentum is a link between the condition of one and the same object in different or four dimensional, Lorentz, reference systems). The inhomogeneity of the relativistic gravitational field described by the curvature tensor. A tensor is a mathematical object obtained by the generalization of the notions of vectors. In the variety described by coordinates, the tensors can be mapped to components that fully define the tensor. Relativistic theory relates the curvature tensor with the tensor describing the behavior of sources of gravitation. These tensors are proportional to each other. The coefficient of proportionality is determined from the requirement: the law of gravity in tensor form should be reduced to the Newtonian law of gravity for weak gravitational fields and small velocities of bodies; the proportionality coefficient with an accuracy of world constants is equal to the constant of gravitation of Newton. With this step, Einstein completed the theory of gravity, called General relativity.

7. Conclusion

General relativity gave an opportunity to look differently at the issues related

to gravitational interactions. It included the entire classical Newton's mechanics only as a special case at small velocities of motion. has opened the widest field for the study of the Universe, where gravity plays a crucial role.

The beginning of the space age

On 4 October 1957 the USSR launched the world's first artificial Earth satellite. The first Soviet satellite made it possible to measure the density of the upper atmosphere, to obtain data on the propagation of radio signals in the ionosphere, to work out issues launch, thermal regime, etc. the Satellite represented an aluminum sphere with a diameter of 58 cm and weight was 83.6 kg, with four whip antennas length 2.4-2.9 m. In a hermetic enclosure of the satellite housed the equipment and power supplies.

Initial orbital parameters were: perigee altitude of 228 km, apogee altitude of 947 km, inclination of 65.1 degrees.

November 3, the Soviet Union announced the launching into orbit of the second Soviet satellite. In a separate hermetically sealed cabin was the dog Laika, and a telemetry system to check its behavior in weightlessness. The satellite was also equipped with scientific instruments to study solar radiation and cosmic rays.

December 6, 1957 in the USA attempted to launch a satellite "vanguard-1", using a booster developed by the Research laboratory of the Navy. After ignition, the rocket went over the starting table, however in a second the engines shut down and the rocket fell on the table, exploding on impact.

January 31, 1958, was launched into orbit satellite "Explorer 1", the American response to the launch of the Soviet satellites. Size and weight he was not a candidate in Champions. As long less than 1 m and a diameter of only ~15.2 cm, he weighed only 4.8 kg.

However, its payload was attached to the fourth, the last stage of the carrier rocket "Juno-1". The satellite with a missile in orbit had a length of 205 cm and a weight of 14 kg. it was installed sensors of external and internal temperatures, sensors for erosion and impacts to determine the fluxes of micro-meteorites and Geiger-Muller for the registration of the penetrating

cosmic rays.

An important scientific result of the flight of Sputnik was the opening of the surrounding Earth's radiation belts. Geiger-Muller stopped the account when the craft was at apogee at the altitude of 2530 km, the perigee altitude was 360 km.

5 Feb 1958 in the USA was made a second attempt to launch a satellite "vanguard 1", but it also ended in failure as the first attempt. Finally on March 17 the satellite was launched into orbit. In the period from December 1957 to September 1959 it was made eleven attempts to launch "vanguard-1" only three of them were successful. Both satellites have contributed to space science and technology (solar panels, new data on the density of the upper atmosphere, precise mapping of the Islands in the Pacific ocean, etc.) 17 Aug 1958 in the United States was the first attempt to send from Cape Canaveral in the vicinity of the moon probe with scientific equipment. She was unsuccessful. The rocket went up and flew just 16 km First stage of the rocket exploded on flight 77. October 11, 1958, was made a second attempt to launch a lunar probe "pioneer-1", also failed. The next few launches also failed, until March 3, 1959 "pioneer 4", weight 6,1 kg partially completed the task successfully: passed the moon on distance of 60000 km (instead of the planned 24000 km) .

As with the launch of Sputnik, the priority in the launch of the first probe belongs to the USSR, 2 January 1959, was launched the first man-made object that was placed on a trajectory passing close enough to the moon, orbit the Sun. Thus the "Moon-1" for the first time reached the second cosmic speed. "Moon-1" had a lot 361,3 kg and flew past the moon at a distance of 5500 km 113000 miles away from Earth with a rocket stage, docked to the "moon-1", was released a cloud of sodium vapor that formed an artificial comet. Solar radiation caused a bright glow of sodium vapor and of the optical system on the Ground took pictures of the cloud on the background of the constellation Aquarius.

"Luna-2" was launched 12 Sep 1959 made the world's first flight to another celestial body. In 390,2-pound sphere housed the instruments, which showed that the Moon has no magnetic La and the radiation belts.

Automatic interplanetary station (AMS) “Luna-3” was launched on 4 October 1959 the station Weight was equal to 435 kg. the Main purpose of the launch was a flight around the moon and photograph its back, not visible from the Land side. Photographing was carried out on 7 October for 40 min with a height of 6200 miles above the Moon.

Man in space

April 12, 1961 at 9 h 07 min Moscow time, a few dozen kilometers North of the village of Tyuratam in Kazakhstan at the Soviet Baikonur cosmodrome hosted launch of an Intercontinental ballistic missile R-7, in the forward compartment which houses manned spacecraft “Vostok” with the air force major Yuri Alexeyevich Gagarin on Board. About the launch was successful. The spacecraft was launched into orbit with an inclination of 65 g, a height of perigee of 181 km and an apogee of 327 km and made one revolution around the Earth in 89 min At 108 minutes after launch, he returned to Earth and landed near the village Smelovka, Saratov region. Thus, 4 years after the launch of the first artificial Earth satellite by the Soviet Union for the first time in the world carried out a manned flight into space.

The spacecraft consisted of two compartments. Lander, who is also the cabin the astronaut, was a sphere with a diameter of 2.3 m, is covered with ablative material for thermal protection during reentry. Control of the ship automatically, as well as an astronaut. In flight continuously maintained with the Ground. The atmosphere of the ship — a mixture of oxygen with nitrogen under a pressure of 1 ATM (760 mm Hg. calendar) . “Vostok 1” had a weight of 4730 kg, and with the last stage booster 6170 kg. Space ship “Vostok” was displayed in the space 5 times, after which it was announced about its safety for human flight.

Four weeks after Gagarin's flight may 5, 1961, the captain of the 3rd rank Alan Shepard became the first American astronaut.

Although he never reached earth orbit, he rose above the Ground to a height of about 186 km. Shepard, launched from Cape Canaveral in KK “mercury-3” with a modified ballistic missiles “Redstone” , spent 15 minutes in flight with a 22 before landing in the Atlantic ocean. He proved that a person in

conditions of weightlessness can realize the manual control of the spacecraft. KK “mercury” was significantly different from the spacecraft “Vostok”.

It consisted of only one module, the manned capsule in the form of a truncated cone long 2.9 m and a base diameter of 1.89 m. the hermetic shell of Nickel alloy had about shivku of titanium for protection from heat when entering the atmosphere.

The atmosphere inside the mercury was pure oxygen at a pressure of 0.36 at.

On February 20, 1962, the United States reached low-earth orbit. From Cape Canaveral was launched the ship “mercury-6” , piloted by Navy Lieutenant Colonel John Glenn. Glenn remained in orbit for only 4 h 55 min, having 3 coils to a successful landing. The purpose of the flight Glenn was the definition of the ability to work in a human spacecraft “mercury” . The last time the mercury was launched into space on 15 may 1963

March 18, 1965 was put into orbit spacecraft “Voskhod” with two astronauts on Board — the commander Colonel Pavel Ivanovichem Belyaev and co-pilot, Lieutenant Colonel Alexei Arkhipovich Leonov. Immediately after reaching orbit, the crew cleared himself from nitrogen, breathing in pure oxygen. Then was deployed airlock: Leonov entered the airlock, the hatch to the wing CC and the first in the world made out of space. Astronaut with Autonomous life support system was outside the cabin KK for 20 minutes, sometimes moving away from the ship to a distance of 5 m. During graduation he was connected with QC only telephone and telemetry cables. Thus, it was practically confirmed the possibility of stay and work of an astronaut outside the spacecraft.

June 3, was launched spacecraft “Gemini-4” captain James Mcdivitt and Edward white. During this flight, which lasted 97 hours 56 min white came out of KK and held outside the cab 21 min, checking the ability to maneuver in space using manual jet gun by compressed gas.

Unfortunately space exploration is not without Gers TV. 27 January 1967 the crew was preparing to make its first manned flight program “Apollo” were killed during a fire inside KK burned for 15 s in an atmosphere of pure

oxygen. Virgil Grissom, Edward white and Roger Chaffee become the first American astronauts killed in spacecraft. April 23, from Baikonur launched a new spacecraft "Soyuz-1" piloted by Colonel Vladimir Komarov. The launch was successful.

On 18 round, after 26 hours and 45 minutes after starting, the Mosquitoes began orientation for atmospheric entry. All operations were normal but, after atmospheric entry and braking refused the parachute system. Cosmonaut died instantly at the moment of impact of the Union on the Ground with a speed of 644 km\h. In the future, the Space took human life, but these sacrifices were the first.

Voices from outer space

In television (TV) programs, there is no mention of the fact that the transmission is via satellite. This is another evidence of the huge success in the industrialization of space has become an integral part of our lives. Communication satellites literally span the world by invisible threads. The idea of creation of communications satellites was born shortly after the second world war, when A. Clark issue of the journal "World of radio" (Wireless World) October 1945. presented the concept of relay communication station located at a height of 35880 km above the Earth.

Merit Clark was that he had determined the orbit on which the satellite is stationary relative to the Earth. This orbit is called a geostationary or Clarke orbit. When moving in a circular orbit with a height of 35880 km one revolution is completed in 24 hours, i.e. during the period of the daily rotation of the Earth. A satellite moving in such an orbit will always be over a certain point on the surface of the Earth.

The first communications satellite "Telstar 1" was launched still in low earth orbit with parameters 950 x 5630 km is HAPPEL July 10, 1962. Almost a year later was followed by the launch of the satellite "Telstar-2" .

The first show was shown the American flag in New England on the background of the station in Andover. This image was transferred to the UK, France and on the American station in new Jersey in 15 hours after the launch of Sputnik.

Two weeks later millions of Europeans and Americans watched the talks of people on the opposite shores of the Atlantic ocean. They not only talked, but seen each other, communicating via satellite. Historians can consider this day as the date of birth space TV.

The world's largest public satellite communication system created in Russia. It was started in April 1965. launch of series of satellites Molniya displayed on a highly elongated elliptical orbit with an apogee over the Northern hemisphere. Each series includes four pairs of satellites circulating in orbit at angular distance from each other 90 degrees.

On the basis of the satellite “Molniya”, built the first system for deep space network “Orbit”. In December 1975. a family of communications satellites has been enriched with satellite “rainbow” , operating on the geostationary orbit. Then came the satellite “Screen” with a more powerful transmitter and a more simple ground stations. After the first development of satellites has come the new period in the development of satellite communication technology when satellites began to withdraw into geostationary orbit in which they move synchronously with the rotation of the Earth. It is possible to establish persistent communication between ground stations using satellites of the new generation: American “sinkom”, “er whether bird” and “Intelsat” Russian Raduga and Gorizont.

A great future is associated with a location in geostationary orbit the antenna complexes.

Space meteorology

After the launch of the Soviet and American satellites, the question arose about the practical use of the developed technology. The possibilities of the instruments and satellites themselves have attracted the attention of meteorologists from the point of view of obtaining regular information on the ever-changing weather on a global scale.

The first attempt in this direction was taken by the Americans, who created a family of meteorological satellites of the “tiros” . Nine of these satellites was put into orbit in the period 1960-1965. Each satellite was equipped with two

small TV cameras and approximately half of the satellites scanning infrared radiometer to image the cloud cover of the Earth. In Russia, meteorological spacecraft has become the satellite “meteor” . Two or three satellites of this series are in orbit at the same time and gather information about the state of the atmosphere, thermal radiation of the Earth, etc. Payload of the satellite consists of opto-mechanical TV equipment operating in the visible region of the spectrum. In addition, there are infrared scanning apparatus for obtaining data on the moisture content of the atmosphere and the vertical profile of temperature. Warning of sudden weather changes on the combined data from weather radar and satellites, transmitted by radio from Moscow, St. Petersburg and other centers, and special service reports this information on vessels and aircraft. Over the past 20 years has significantly increased the quantity, quality and reliability of the review with the help of satellites.

Since 1966, the Earth is regularly photographed at least once a day. Photographs are used in everyday work, as well as placed in the archives. The meteorological information acquired from satellites is steadily becoming more important. Currently, it is widely used by meteorologists and specialists in the environment all over the world in daily practice and are considered almost mandatory for tests and short-term forecasts. Meteorological information from all light comes to the National environment monitoring by satellites, located in Washington, is processed into materials of a wide range and is distributed worldwide. Satellite information has been particularly useful in two areas of study. First, there are large areas of land, of which the meteorological information by conventional means are unavailable. This area of the oceans of the Northern and southern hemispheres, deserts and polar regions. Satellite data fills in these gaps, identifying large-scale features of the formations of the clouds. The latter include storm systems, fronts, the most significant mejdunarodnye troughs and ridges, jet streams, dense fog, stratus clouds, ice conditions, snow cover and partly to the direction and speed of the strongest winds. Second, the satellite information was successfully used to follow the development for hurricanes, typhoons and tropical storms. Satellite information includes information about the presence and location of atmospheric fronts, storms, and total cloud cover. In the end, currently the satellite has become almost a recognized tool of meteorologists in most countries of the world. Weather maps that in the evening appear on our television screens, clearly indicate the value of observations from satellites

for the provision of meteorological systems.

The study of Earth from space

Man first appreciated the role of satellites to monitor the status of agricultural land, forests and other natural resources of the Earth only a few years after the onset of the space age. It all started in the 1960's, when using meteorological satellite "tiros" was received like a map of the outlines of the globe lying under clouds. These first black and white TV image gave a very vague idea about human activities and yet this was the first step. Soon developed new technical means, allowing to improve the quality of observations. Information was extracted from multispectral images in the visible and infrared (IR) regions of the spectrum. The first satellites designed to make maximum use of these opportunities was the "Landsat". For example, satellite "Landsat-D", the fourth of the series observed the Earth from a height of over 640 km with the help of advanced sensing devices that allowed consumers to obtain significantly more detailed and timely information. One of the first applications of images of the earth's surface, was cartography. In despotiko era maps of many regions, even in developed parts of the world were drawn inaccurately. Images obtained by satellite "Landsat", allowed to adjust and update some of the existing maps of the United States. In the USSR image received from the station "salute" turned out to be essential for the alignment of railway tracks BAM.

In the mid 70-ies of the NASA, the Ministry of agriculture of the USA has decided to demonstrate the capabilities of satellite systems in predicting major crops of wheat. Satellite observations turned out to be extremely accurate in the future was extended to other crops. Around the same time in the USSR, monitoring of agricultural crops is conducted with satellites of series "Cosmos", "meteor", "monsoon" and orbital stations "Salyut".

The use of satellite imagery has revealed its advantages in the estimation of the volume of timber in large areas of any country. Became possible to control the process of deforestation and, if necessary, to make recommendations on contouring of the area of deforestation from the point of view of better preservation of the forest. Thanks to images from satellites has been possible to quickly assess the limits of forest fires, especially the

“coronopus”, characteristic for the Western regions of North America, as well as areas of Primorye and southern areas of Eastern Siberia in Russia.

Great importance for humanity as a whole has the opportunity to observe almost continuously over the oceans of the World, this “forge” the weather. Over by thick layers of ocean water originate monstrous force hurricanes and typhoons, carrying numerous victims and destruction for the inhabitants of the coast. Early warning of the population is often crucial to save lives of tens of thousands of people. Definition of stocks of fish and other seafood are also of great practical importance. Ocean currents often distorted, changing course and sizes. For example, the El Nino warm current in the South direction off the coast of Ecuador in some years may be distributed along the coast of Peru to 12 g. Yu. W.. When this happens the plankton and fish are dying in huge numbers, causing irreparable damage to fisheries for many countries including Russia. Large concentrations of single-celled marine organisms, increase mortality of fish, perhaps because they contained toxins. Observation from satellites helps to identify the “whims” of such flows and provide useful information to those who need it. According to some estimates of Russian and American scientists fuel economy combined with the “extra catch” through the use of satellite information obtained in the infrared range, gives an annual profit of \$ 2.44 million. The use of satellites for the purposes of the review has facilitated the task of laying rate ships.

In operation of the Russian nuclear-powered icebreaker “Sibir” was used information from four types of satellites to obtain a safe and economical ways in the Northern seas. The floor Cheema with navigation satellite “Kosmos-1000” information used in a computer of the vehicle to determine the exact location. Satellites “meteor” were images of the cloud cover and forecasts of snow and ice, allowing you to choose the best course. Via satellite Molniya maintained communication with the vehicle base. Also with the help of satellites find oil pollution, air pollution, minerals.

The science of space

Within a short period of time from the beginning of the space age, people not only sent an automatic space station to other planets and set foot on the moon, but also made a revolution in the science of the cosmos, which had no equal in the history of mankind. Along with the great technological advances

caused by the development of cosmonautics, were obtained new knowledge about planet Earth and its neighboring worlds.

One of the first important discoveries made not traditional to the visual and another method of observation was the finding of a sharp increase with height, beginning from some threshold height, the intensity of the previously considered isotropic cosmic rays.

This discovery belongs to Austrian V. F. Hess, started in 1946, a gas balloon with equipment to great heights.

In 1952 and 1953 Dr. James van Allen conducted research on NCDs to the energy of cosmic rays at near the magnetic North pole of the Earth small rockets to a height of 19 to 24 km and shells of cylinders. After analyzing the results of the experiments, van Allen proposed to place on Board the first American artificial satellites is quite simple in design detectors of cosmic rays.

Via satellite “Explorer 1” the inferred U.S. into orbit on 31 January 1958 it was discovered a sharp decrease in the intensity of cosmic radiation at altitudes above 950 km.

At the end of 1958 AMC “pioneer-3” break during the day, flight distance of over 100,000 km, registered with the available onboard sensors, the second located above the first radiation belt of the Earth, which also surrounds the entire globe.

In August and September 1958 at the height of more than 320 km were produced three atomic explosion, each with a capacity of 1.5 CT. The purpose of the test, codenamed “Argus” was studying the possibility of loss of radio and radar communication in such tests. The study of the Sun — the most important scientific task, the solution of which is dedicated to a launch of the first satellites and AMC.

American “pioneer 4 — pioneer 9” (1959-1968rr.) with the solar orbit over the radio on the Ground important information about the structure of the Sun. At the same time was launched more than twenty satellites “Intercosmos” to

study the Sun and circumsolar space.

Flights AMS to the moon and planets

In the early 60-ies in the United States and the Soviet Union were designed, manufactured and launched to the moon a number of AMS. The most successful for the Americans was the launch in July 1964. “Ranger-7” , which was transmitted to Earth more than 4,300 high-quality TV images of the moon obtained before contact with the surface. The last image captured from a height of 1600 meters, covers an area of 30×50 m. there were clearly visible craters with a diameter of 1 m.

In the Soviet Union was first created ability to implement a soft landing on the moon with the creation of the new AMC series “the Moon” in 1963. These stations weighing up to 1.8 t were designed for the delivery of the instrument container of mass 100 kg on the lunar surface.

When you run the AMS “Luna-9” in February 1966. was first successfully carried out a soft landing on the moon of an object made by human hands. The second “preludesys” station became “Luna-13” .

With the help of mechanical groomer and radiation densitometer provided unique information on the density and composition of the surface of the soil. When you start AMC “Luna-17” was first given the task of movement on the lunar surface. After a successful landing with the landing stage was launched apparatus “Lunokhod-1” for 10 months. the work of the “Lunokhod-1” , controlled from Earth by radio, was on the lunar surface more than 10.5 km.

One of the brightest luminaries of the night sky is covered with clouds, the planet Venus was one of the first goals of flying AMS. For the first time the ability to run AMS emerged in the late 1960., when the Soviet Union was created the first booster And 2. In February 1961. taking advantage of the “window” for launch to Venus, the Soviet Union launched AMC “Venera-1” held at a distance of 100 million miles from Venus and went into orbit.

November 12, 1965 was launched, with the aim of achieving the surface “Venera-3” . March 1, 1965, the station reached the surface of Venus by the

first flight of AMS to another planet. In 1967, a successful flight was made by the station "Venera-4", aimed directly at the planet. At a distance of 45,000 km from Venus from the station separated spherical descent module (SA) with a diameter of 1 m, which is at the entrance to the planet's atmosphere survived the overload up to 300 g. The parachute system further ensured the descent in the atmosphere, which lasted 94 min. Was adopted information that at the height of 25 km the atmospheric temperature is 271 gr. and pressure 17-20 bar. On the planet's surface temperature smooth 475 grams. and a pressure of 15 ATM.

It was found that the atmosphere of Venus is composed almost entirely of carbon dioxide. Was later carried out several runs with the purpose of the immersion in the atmosphere of Venus.

The first space station launched to Mars on 1 November 1962, was Soviet AMC "Mars-1". The United States launched in 1964, the first two of AMC's "Mariner". The launch of the "Mariner-3" was unsuccessful and after three weeks in orbit, was launched "Mariner-4".

July 14, 1965, he flew a distance of 9600 km from Mars, and have found no radiation belts or magnetic field around you. It was established that the pressure at the surface of the planet is less than 1% of the earth pressure above the sea level and corresponds to the pressure in the Earth's atmosphere at a height of 30-35 km On the surface of Mars was discovered craters similar to the moon.

The first Soviet AMC landing on Mars was "Mars 2" weight 4650 kg. In the composition of the soil was discovered: 15-20 % silicon, 14 % iron, calcium, aluminum, sulfur, titanium, magnesium, cesium and potassium. The composition of air was discovered 95% carbon dioxide 2.7% of nitrogen and signs of the presence of oxygen, argon and water vapor.

To mercury first went AMS "Mariner-10", originally sent to Venus in 1973 March 29, 1973, the spacecraft reached its target, the planet mercury, passing at a distance of 690 km from its shadow surface. During each flight conducted the study of the planet's surface. In the atmosphere of the action of the Curia were found traces of argon, neon and helium a trillion times fewer

than on Earth. The range of surface temperatures from 510 to -210 gr. the magnetic field strength 1% of earth mass planets 6% of the mass of the Earth.

It can also be sent to Jupiter and Saturn.

Man on the moon

In accordance with the program “Apollo” in the period from 1969 to 1972 were sent to the moon nine expeditions. Six of them ended in landing twelve astronauts on the moon from the Ocean of Storms on the West to the Taurus mountain range to the East. The two first expeditions were limited to flights on selenocentric orbit, and landing astronauts on the moon in one of the expeditions were canceled because of the explosion of an oxygen tank for the fuel cell and life support system that took place two days after launch. Damaged spacecraft “Apollo-13” circled the moon and returned safely to Earth.

The first landing site was chosen on the basis of basalt, the sea of Tranquility, located to the East of the center region of the lunar plains. Neil Armstrong (commander) and Colonel Edwin Aldrin (lunar module pilot) made a landing here in the lunar cabin (LK) “eagle” July 20, 1969 at 20 h 17 min 43 s Greenwich.

The astronauts did a lot of photographs of the lunar landscape, including the rocks and the plains, and collected 22 kg of lunar soil samples for study on Earth. Coming the first of the LK and the last entering in it, Armstrong spent on the moon 2h 31min. During the sixth expedition to the moon in December 1972, the residence time of the crew on the surface was 22 h 5 min travel Length on the moon had also increased by 100 m, which walked the first astronauts spacecraft “Apollo-11” , up to 35 km on electric car Pro went the crew of “Apollo-17” .

Expedition spacecraft “Apollo 17” was the last expedition to the moon. During six visits to the moon were collected 384,2 kg of rock samples and soil. In the process of implementation of the programme of studies were made a number of discoveries, but the most important are the following two. First, it was established that the Moon is sterile, it is not discovered any forms of life. Secondly it was established that the Moon, like Earth, has gone

through several periods of internal heating.

The study of the moon using a manned SPACECRAFT was completed after the sixth successful landing of astronauts on its surface with the spacecraft “Apollo 17” in December 1972

Space station

Work on the creation of manned space stations started in the US and the USSR almost simultaneously in the early 60-ies.

But as Americans in the future, the main attention is paid Lily prestigious Apollo program, from the extensive programs we for space studies in addition to the “Apollo” they were only orbital station Skylab launched into orbit may 14, 1973, and space transportation reusable spacecraft “Space Shuttle”, which today is the only functioning manned KK the United States.

Orbital unit space station (COP) was established on the BA ze missiles S-4B third stage of the carrier rocket “Saturn-5” , to deliver in due time a man on the moon. It (the rocket) hydrogen tion tank was converted into a spacious two-storey room for a crew of three people. Full internal volume of the COP Skylab with docked her a modified main unit of the spacecraft “Apollo” — about 330 cubic meters (volume not great home with two bedrooms). The astronauts were breathing a mixture of oxygen with nitrogen at a pressure of 0,35 at at temperature of 21 gr. C.

For the period from may 1973 to February 1974 on the COP Skylab has worked 3 of the crew. The latter, consisting of Gerald Carr, Edward Gibson and William Popa worked on Board for 84 days.

July 11, 1979, the station entered the dense layers of the atmosphere and ceased to exist.

In the USSR work on the orbital of the COP program began in the late 60-ies. 19 APR 1971 in orbit by the carrier rocket “proton” was developed the world's first orbiting COP “salute-1” . The station consisted of three main sections — the transition, the worker and the aggregate, represents a cylinder

with a diameter of 2.9 m, 4.15 m and 2.2 m respectively. Full long orbital complex “Salyut-1” — “Union” — 21.4 m, weight more than 25 tons.

At COP “Salyut-1” worked one crew of Dobrovolsky, V. Patsayev, and V. Volkov died while returning to Earth. After 175 days after the launch of the team on the Ground worked brake motors KS “Salyut-1” fell into the Pacific ocean. All were operated successfully in orbit for seven stations series “salute”. The last of them “Salyut-7” worked until the end of 1985.

In February 1986, the Soviet Union was bred in space orbital station of new generation “the World.” Unlike its predecessors, “Fireworks”, this station embodies a fundamentally new approach to move in near earth space. If “Fireworks” were both home and place of work, “Peace” was the basic unit, that is, the link, around which are grouped large specialized KA — scientific modules. In these large facilities, rich scientific and other studies. The station “Mir” is not only build bridges between various SPACECRAFT in a single unit, but also performs the role of the center, where the crew controls the entire orbital complex. The first module — astrophysical Observatory Kvant docked to the “World” spring 1987 — slightly inferior in size to the station. The whole volume of the station is 40 cubic meters.

We came only in the fourth decade of the cosmic era, and already quite accustomed to such miracles as to cover the entire Earth satellite communications and weather observation, navigation, and assistance in distress on land and at sea. As something quite ordinary we listen to the message on the months-long work of people in orbit, not surprised at the footprints on the moon taken by “blank” photographs of distant planets, the SPACECRAFT first shown the comet nucleus. In a very short historical period, space exploration has become an integral part of our lives, a faithful assistant in economic Affairs and knowledge of the world. And there is no doubt that the further development of a terrestrial civilization can not do without the development of the whole near-earth space. Space exploration — the “province of all mankind” — continues rapidly.

THE CALENDAR DEFINITION. THE UNIT OF TIME CHANGES

Calendar called certain system of account long periods of time with units of them in separate shorter periods (years, months, weeks, days) . The very

word calendar comes from the Latin words "caleo" — to proclaim and the "calendarium" — debt book. The first recalls that in ancient Rome the beginning of each month was proclaimed particularly, the second that the first day of the month it was decided to pay the interest on the debt.

That time flows, we are convinced, watching the movement, the development of the surrounding us material bodies. Measure the same time intervals was made possible by matching them with phenomena that are repeated periodically. Such periodic phenomena in the world around us is several. It is primarily the change of day and night, which gave people a natural unit of time — day, then the phases of the moon that occurs over the so-called synodic month (from Greek "synodos" — convergence; meant monthly convergence of the moon and the Sun in the sky, sometimes Moon finds the Sun in the sky — a solar Eclipse occurs) and, finally, the change of seasons and the corresponding unit of account — a tropical year (from the Greek "tropos" — a turn of the tropical year — the period of time after which the height of the Sun above the horizon at noon, reaching a maximum value, decreases again).

The difficulties encountered in the development of the calendar, due to the fact that the duration of the day, the synodic month and tropical year are incommensurable among themselves. It is not surprising, therefore, that in some places, people believed the time units that are close to the length of the synodic month, taking in a certain year (e.g., twelve) number of months and ignoring the change of seasons. So there were lunar calendars. Others measured time in the same months, but the duration of the year sought to reconcile with the changes of seasons (a lunisolar calendar). Finally, some based on accounts of the day accepted the change of seasons and the changing phases of the moon do not take into account (solar calendar) .

HISTORY OF OUR CALENDAR

The seven-day week the Origin of the seven day week. Artificial time unit, consisting of several (three, five, seven, etc.) days, meet many peoples of antiquity. In particular, the ancient Romans were of the days "womenevery" trading weeks in which the days were marked by letters from A to N; seven days a week were workers, the eighth — Bazaar.

But now, the famous Jewish historian Flavius Josephus (37 — CA. 100 C. E.) reads: "No city, Greek or barbarian, nor a single nation, to which would spread our custom to refrain from work on the seventh day." Where does the "went there" this the seven-day week?

The custom to measure the time of the seven-day week came to us from Ancient Babylon and apparently associated with changes in the phases of the moon. In fact, the duration of the synodic month is 29.53 days, and people saw the moon in the sky at about 28 days: seven days, continued increase in the phases of the moon from a narrow Crescent to the first quarter, about the same from the first quarter to the full moon, etc.

But observing the starry sky gave another confirmation of the "exclusivity" of the number seven. At the time of the ancient Babylonian astronomers discovered that, in addition to the fixed stars, the heavens and the seven "wandering" bodies, which were later called planets (from the Greek word "planetes", which means "wandering") . It was assumed that these luminaries revolve around the Earth and that their distance from it increases in this order: Moon, mercury, Venus, Sun, Mars, Jupiter and Saturn. In Ancient Babylon originated astrology is the belief that the planets influence the fate of individual people and entire Nations. Comparing certain events in the lives of people with position of the planets in the night sky, astrologers believed that the same event will occur again if the location of the stars again. The number seven — the number of planets was sacred to the Babylonians and many other ancient peoples.

The name of the days of the week. Dividing the day into 24 hours, the ancient Babylonian astrologers made up the idea that every hour of the day is under the patronage of a certain planet, which, as it "manages" them. It was started on Saturday: the first hour was ruled by Saturn, the second Jupiter, the third Mars, the fourth the Sun, the fifth to Venus, the sixth to mercury and the seventh to the Moon. After that, the cycle is again repeated, so that the 8th, 15th and 22nd hours "ruled" by Saturn, 9th, 16th, 23rd — Jupiter, etc. The result was that the first hour of the next day, Sunday, "ran" the Sun, the first hour of the third day of the moon, the fourth Mars, the fifth mercury, the sixth Jupiter, the seventh to Venus. Accordingly, and got its name days of the week.

The names of the days of the week names of the gods have migrated to the Romans, and then, in the calendars of many peoples of Western Europe. In Latin, Russian and English languages, they are: Russian Latin Latin English Monday Dies Lunae day of the moon Monday Tuesday Dies Martis the day of Mars Tuesday Wednesday Dies Mercurii day of mercury Wednesday Thursday Jovis Dies day of Jupiter Thursday Friday Dies Veneris day of Venus Friday Saturday Dies Saturni the day of Saturn is Saturday and Sunday Dies Solis day of the Sun Sunday Today almost all peoples of the world use a solar calendar, which was practically inherited from the ancient Romans. But if in its current form, the calendar almost perfectly matches the annual movement of the Earth around the Sun, then its the original version you can only say "worse than nowhere". And all likely because, as noted by the Roman poet Ovid (43 BC — 17 ad), the Romans knew better weapon than the stars...

Ancient Roman calendar the Agricultural calendar. Like their neighbors the Greeks, the Romans marked the start of their work at sunrise and sunset the individual stars and groups, i.e. they were linking your calendar with the year changing starry sky. Perhaps the most important "guideline" in this case was sunrise and sunset (morning and evening) the Pleiades star cluster, which in Rome was called Vergiliae. Many start field work here connected favonian warm Western wind that begins to blow in February (3 — 4 February in the modern calendar). According to Pliny, Rome, "it begins with spring." Here are a few examples held by the ancient Romans "anchor" field work to changing the look of the sky: "Between favonius and spring equinox prune trees, dig the vines... Between the spring equinox and sunrise Virgil (morning rising of the Pleiades occurs in mid-may) weed the fields..., cut willow, meadow, garden, should be planted in olives".

"I believe that you should not begin your sowing before (autumn) equinox, because if you start bad weather, the seeds will rot... favonia until the rising of Arcturus (3-16 February) to dig new ditches, to produce a crop in the vineyards "*).

However, it should be borne in mind that this calendar was Packed with the most incredible superstition. So, meadows should fertilize in early spring not only as the new moon when the new moon is still not visible ("then the grass

will grow in the same way as new moon"), and the field is weeds. Eggs under the hen were encouraged to plant only in the first quarter of the moon phase. According to Pliny, "any cutting, tearing, shearing will bring less harm if they do it when the Moon is on the wane". Therefore, the one who decided to get a haircut when the "Moon comes", risked to lose your hair. But if at the specified time, cut off the leaves on the tree, it will soon lose all the leaves. Felled at this time, the tree was threatened with the rot...

Months and intercalary days. We focus on the General structure of the ancient Roman calendar, established in the middle of I century BC

At the specified time of the year in the Roman calendar has a total length of 355 days consisted of 12 months with such a distribution of days in them:

Martius — 31

Quintilis — 31

, November — 29

Aprilis — 29

Sextilis — 29

December — 29

Maius — 31

September — 29

Ianuarius — 29

Yunius — 29

Oktober-31

Februarius-28

*) Varro. Agriculture. — Ed. An SSSR, 1963.

About additional month Macedonia will be discussed below.

As can be seen, with the exception of one, all the months of the Roman calendar had an odd number of days. This is due to the superstitious beliefs of the ancient Romans, like odd numbers are lucky, while the even bring misfortune. The year began with the first day of March. This month was named Martius after Mars, which originally was worshipped as God of agriculture and cattle raising, and later as the God of war designed to protect the peaceful labor. The second month is called Aprilis from the Latin aperire — to open, as this month reveals the buds on the trees or the word apricus "warm Sun". It was dedicated to the goddess of beauty Venus. The third month of Maius was dedicated to the earth goddess Maia, the fourth Yunius — the sky goddess Juno, patroness of women, wife of Jupiter. The names of six further months were associated with their position in the calendar: Quintilis fifth, Sextilis — sixth, September seventh, October the eighth, November the ninth, December tenth.

Name Ianuaria — the penultimate month of the Roman calendar is believed, from the word janua is "login", "door". The month was dedicated to the God Janus, who, according to one version, was the God of the firmament, who kept the gate of the Sun early in the day and closed them at the end. In Rome he was dedicated to the 12 altars — the number of months in a year. He was also the God of entrance, all sorts of endeavors. The Romans depicted him with two faces: one facing forward, if God sees the future, the second, turned back, contemplating the past. And finally, the 12th month was dedicated to the God of the underworld to Februus. Subsequently, its name derives, apparently, from februare "to purify," but, perhaps from the word feralia. So the Romans called was in February memorial week. After it, at the end of the year, they performed a cleansing rite (lustratio populi) "for the reconciliation of the gods with the people." Perhaps because of this they could not do the insert extra days at the end of the year, and it produced, as we shall see, between 23 and 24 February.

The duration of the year of 355 days was 10,242 days shorter than the tropical. But in the economic life of the Romans played an important role in

the agricultural work — sowing, harvesting, etc. and to keep the beginning of the year close of the same season, they did insert the additional days. Thus the Romans, from some superstitious motives did not put a month separately, and in every second year between the 23rd and 24th of February "break" alternately 22 or 23 days. In the end, the number of days in the Roman calendar alternated in this order: 355 days, 377 (355 + 22) days, 355 days, 378 (355 + 23) days.

The intercalary days (dies intercalares) got the name of the month Macedonia, although ancient writers called him intercalated month is intercalaries (inter-calaris) . The word "mercedonius" comes as if from "merces edis" "price of labour": it was like a month, which made the calculations of the tenants with property owners.

As you can see, the result of such insertions average length of the year in the Roman calendar was equal 366,25 days — one day more true. So from time to time these days from the calendar had to be thrown away.

Julian calendar Reform of the calendar held in 46 BC, the Roman high priest, military leader and writer Gaius Julius Caesar (100 — 44 BCE) . Before Caesar visited Egypt, met with Egyptian solar calendar and even made a few not extant treatises on astronomy. The development of the new calendar made a team of the Alexandrian astronomers, led by Sosigenes.

The basis of the calendar, later called Julian, based on the solar year, the duration of which was estimated to be equal to exactly 365.25 days. But in the calendar year can only be an integer number of days. So were instructed to count three out of every four years of 365 days, the fourth of 366 days.

As before a month Mercedonius and now this one day I decided to "hide" between 24 and 25 February. Augmented a year later was called annus bissextus, whence came our word leap.

Julius Caesar has also streamlined the number of days in months on this principle: an odd month has 31 days, even — 30. February in ordinary year and 29 in a leap year — 30 days. In addition, he decided to start counting the days in the new year with a new moon, which fell on the first of January.

In gratitude for the reform, and also because of the outstanding military achievements of Julius Caesar (who was assassinated two years after the reform), the Roman Senate renamed the month of Quintilis (this month Caesar was born) to Julius.

Soon, however, the Roman priests have confused the calendar declaring every third leap year of the calendar. This error is corrected by Emperor Augustus. Thus, the Julian calendar began to function normally from 1 March 4 BC. In this regard, the Senate, considering the great military victory and in gratitude for the revision of the calendar, renamed the month of Sextilis in the month of Augustus. But the length of this month was established by Julius Caesar in 30 days, but now added another day, subtracting it from Februarius. And three months — Julius, Augustus and September — not had a contract for 31 day from September one day was moved to October, and from November — one day at December. Thus was broken the Caesar, the correct alternation of long and short months, and the first half of the year was four days shorter than the second. And after August, some emperors tried to perpetuate his name in the calendar. But these desires of the lords had been rejected by the time...

To 324g. the Roman Emperor Constantine (C. 285 — 337) was proclaimed Christianity the state religion. A year later, in 325, he convened in the city of Nicaea the Church Council, which has been discussed and the question of the date of the celebration of Easter. And since the IV century. BC

the Christian Church has bound our annual cycle of holidays with the Julian calendar. But as a result of varying the length of the tropical year and the Julian calendar every 128 years, the accumulated error in the whole day. And all holidays moving forward: spring to summer, summer to autumn. Therefore, the Church and initiated the subsequent reform of the calendar.

The introduction of "new style" Causes the calendar reform. At the end of the III century ad the vernal equinox fell on March 21. Apparently, the "fathers" attending the Council of Nicaea, believed that it will be so. But as a result of this error, as the date of the vernal equinox and the date of the Paschal new moons, taken as the basis for calculating Easter, don't correspond to real astronomical phenomena.

Therefore, the problem of calendar reform was discussed by the Catholic Church in Basel (1437), the Lateran (1512-1517), Trent (1545-1563) and the Vatican Councils.

The Gregorian reform. The reform of the calendar carried out by Pope Gregory XIII on the basis of the project of the Italian physician and mathematician Luigi Lilio.

The spring equinox was moved on 21 March, "in my place". And that error was not accumulated, it was decided that out of every 400 years to throw for three days. Considered simple the centuries, the number of hundreds of which is not evenly divisible by 4.

This system is called the Gregorian or "new style". In contrast to her behind the Julian calendar was strengthened called "old style" Introduction of the Gregorian calendar in Russia. The question of the reform of the calendar in Russia was raised repeatedly. In particular, this proposal was made by the Russian Academy of Sciences in 1830, However, the then Minister of education, Prince K. A. Lieven presented in his report to Tsar Nicholas I reform as a matter of "ill-timed, improper, could produce unwanted disturbances and confusions of minds". He also reported that the benefits from the change of the calendar is unimportant, almost negligible, and the inconvenience and difficulties are inevitable and great." The Tsar wrote on the report: "the Comments of Prince Lieven absolutely fair" — and the matter was buried.

The question of the reform of the calendar in Russia was solved immediately after the great October socialist revolution. On 16 November 1917 he was put on discussion of the CPC RFSFR, which on 24 January adopted the "Decree on the introduction of the Russian Republic of the Western European calendar". The decree stated: "In order to establish in Russia the same with almost all cultural peoples of computation time, the Council of people's Commissars decides to enter after the month of January this year in civil use the new calendar." For this: "the First day after 31 January of this year not be considered on February 1 and February 14, the second day — 15, etc."

The sword of Damocles reform Today our calendar with the astronomical

point of view is quite accurate and, in fact, does not require any changes. and yet on the reform saying it for decades. Thus the mean does not change the type of calendar, not the introduction of new techniques account leap years. No, we are talking exclusively about the regrouping of days in a year, in order to equalize the length of monthly, quarterly, half-year, to introduce such a procedure for counting days in the year in which the new year had to be on the same day of the week, e.g. Sunday.

In fact, our calendar months have duration of 28,29,30 and 31 days, the length of the quarter varies from 90 to 92 days, and the first half of the year for three to four days shorter than the second. As a result, the complicated work of planning and financial bodies. Awkward is the fact that the week starts in one month or quarter and ends in another. Since the year contains 365 days, it will end the same day it started, and every new year starts with another day.

Therefore, each state annually spends large sums on printing new calendars.

For the past 160 years, there have been various projects for the reform of the calendar. In 1923 when the League of Nations established a special Committee on calendar reform. After the second world war this issue was handed over to the Economic and Social Council of the United Nations.

What are the draft calendar?

Projects calendars. Although projects there are many have to choose from only two: 13 — month calendar or 12 — month. The first of these was proposed in 1849 by French philosopher Auguste Comte (1798 1857) . In this calendar every month begins on Sunday and ends on Saturday. One day in the year has no name and is inserted after the Saturday last, thirteenth month, before the New year as an extra day of rest. In leap year the same day of rest is inserted after VI Saturday of the month.

However, 13 — month calendar would have a number of disadvantages though, because when dividing the year in quarters I would have to share and months. Therefore, the focus is on another version of the calendar, proposed in 1888 French astronomer Gustave Armelina. According to the draft

calendar year consists of 12 months and is divided into 4 quarters for 91 days in each. The first month of the quarter has 31 days, the other two — 30. The first number of the year and the quarter falls on Sunday, each quarter ends on a Saturday and is 13 weeks. In each month of 26 working days. In a simple year one day as the international holiday of peace and friendship of peoples, is inserted after the 30 Dec in a leap year holiday leap year day is inserted even after June 30.

Enter the calendar Armelina is convenient to introduce from the year in which January 1 falls on a Sunday.

The draft calendar was approved by the Soviet Union, India, France, Yugoslavia and several other countries. However, the UN General Assembly postponed its final review and approval. Currently this activity is under the auspices of the UN in General stopped.

The position of the Church. With the introduction of the new calendar will not be a continuous shift days of the week from one year to another. The Church has no objection only against such perpetual calendars, "which preserve and protect the seven-day week with Sunday, without having any days in addition to weeks, so that the sequence of weeks is not broken, don't just suddenly appear very fundamental reasons, which the Apostolic see will have to have a proposition."

There is nothing more exciting than finding life and intelligence in the Universe. The uniqueness of the terrestrial biosphere and the human intellect challenges our faith in the unity of nature. The man will not rest until you solve the mystery of their origin. In this way it is necessary to pass three important stages: learn the secret of the birth of the Universe, to solve the problem of the origin of life and to understand the nature of the mind.

The study of the Universe, its origin and evolution are engaged astronomers and physicists. The study of living things and the mind occupied biologists and psychologists. And the origin of life is of concern to everyone: astronomers, physicists, biologists, chemists. Unfortunately we only know one form of life — protein and only one place in the Universe where the life exists — Earth. A unique phenomenon, as it is known, are difficult to scientific research. Now, if it were possible to detect other inhabited planets,

then the mystery of life would be solved much faster. And if on these planets there would be a rational being... it captures the Spirit, one has only to imagine the first dialogue with the brothers on reason.

But what are the real prospects for such a meeting? Where in the cosmos you can find a suitable place to live? Can life originate in interstellar space, or does it require a planetary surface? How to communicate with other intelligent beings? A lot of questions...

The moon is the only celestial body, where they could visit the earth, and the soil which is thoroughly investigated in the laboratory. No traces of organic life on the moon not found.

The fact that the Moon has not, and never had of the atmosphere: its weak gravitational field cannot retain the gas near the surface. For the same reason the moon has no oceans — they would have evaporated. Not covered by the surface of the moon in the afternoon is heated to 130 °C, and at night cools to -170 °C. in addition, on the lunar surface freely penetrate fatal for life UV and x-rays of the Sun from which the Earth protects the atmosphere. In General, the surface of the moon for the life conditions there. However, under the top layer of soil, at a depth of 1 m, the temperature fluctuations are almost not felt: there is always about -40 °C. But still in such conditions life is not likely to emerge.

Nearest to the Sun the small planet MERCURY have not visited neither the astronauts nor the automatic station. But people do know something about it through research from the Ground and flying near mercury American spacecraft “Mariner-10” (1974 and 1975) . The conditions there even worse than on the moon. Is no atmosphere and surface temperature changes from -170 to 450 °C. Under the soil temperature averages around 80 °C, and with depth it is, of course, increases.

VENUS in the recent past, astronomers believed almost an exact replica of the young Earth. Built guess what's hiding under its cloud layer: warm the oceans, ferns, dinosaurs? Alas, because of the proximity to the Sun Venus is not like Earth: atmospheric pressure at the surface of this planet is 90 times greater than earth's and the temperature both day and night around 460 °C.

when Venus fell several automatic probes find life they are not engaged: it's hard to imagine life in such conditions. Above the surface of Venus is not so hot: at an altitude of 55 km the pressure and temperature are the same as on Earth. But Venus ' atmosphere consists of carbon dioxide, in the floating clouds of sulfuric acid. In short, is not the best place to live.

MARS is not without reason were considered as habitable planet. Although the climate there is very harsh (on a summer day the temperature is around 0 °C overnight -80 °C and in winter comes down to -120 °C) , but it is not hopelessly bad for life: it exists in Antarctica and the peaks of the Himalayas. However, on Mars there is another problem — the extremely rarefied atmosphere 100 times less dense than on Earth. It does not save the surface of Mars from harmful ultraviolet rays of the Sun and does not allow water to remain in liquid state. On Mars water can only exist as vapor and ice. And it really is there, at least in the polar caps of the planet. So eagerly had been waiting for the results of the search for Martian life, taken immediately after the first successful landing on Mars in 1976 automatic stations “Viking–1 and -2” . But they all disappointed: life has not been discovered. But it was only the first experiment. The search continues.

THE GIANT PLANETS.

The climate of Jupiter, Saturn, Uranus and Neptune does not correspond to our ideas of comfort: very cold, terrible gas composition (methane, ammonia, hydrogen , etc.), almost no solid surface, only a dense atmosphere and oceans of liquid gases. All this is very unlike the Earth. However, in the era of the origin of life and the Earth was not as it is now. Its atmosphere was more like Venus and Jupiter, except that was warmer. So in the near future will certainly be made to search for organic compounds in the atmosphere of giant planets.

SATELLITES OF THE PLANETS AND COMETS.

“Family” of satellites, asteroids and comet nuclei is very diverse in its composition. In it, on the one hand, a huge part of Saturn's moon Titan dense nitrogen atmosphere, and the other — small blocks of ice cometary nuclei, most of the time conducting on the far periphery of the Solar system. Serious

hope to find life on these bodies has never been, although research on organic compounds as precursors of life is of particular interest. Recently, the attention of ectobiology (experts on extraterrestrial life) attracts Jupiter's satellite Europa. Under the icy crust of this moon must be the ocean of liquid water. And where is water there is life.

To have fallen to the ground meteorites sometimes find complex organic molecules. At first it was a suspicion that they fall into the meteorites from the earth's soil, but now their extraterrestrial origin is quite reliably proven. For example, fell in Australia in 1972, the Murchison meteorite was picked up the next morning. In its substance found 16 amino acids, the basic building blocks of animal and vegetable proteins, and only 5 of them are present in terrestrial organisms, and the remaining 11 on the Ground are rare. Moreover, among the amino acids of the Murchison meteorite equally present the left and right of the molecule (mirror symmetrical to each other) , whereas in terrestrial organisms — mostly left-wing. In addition to the molecules of the meteorite isotopes of carbon ^{12}C and ^{13}C are represented in different proportions than on Earth. This, undoubtedly, proves that amino acids, as well as guanine and adenine, a component of DNA molecules and RNA can be formed in space.

So, while in the Solar system anywhere other than Earth, life is not discovered. Scientists don't have high hopes; most likely, Earth is the only living planet. For example, the climate of Mars in the past was milder than now. Life could emerge and advance to a certain degree. There is a suspicion that among those on Earth some meteorites are ancient pieces of Mars; one of them discovered strange footprints, possibly belonging to the bacteria. It is still preliminary results, but even they are of interest to Mars.

CONDITIONS FOR LIFE IN SPACE

In space we find a wide range of physical conditions: temperature of a substance changes from $3\text{--}5$ To $10^7\text{--}10^8\text{ K}$ and a density of from 10 to 22 10 to 18 kg/cm^3 . Among such a large variety often able to detect places (e.g. interstellar clouds) where one of the physical parameters from the point of view of the earth's biology favors the development of life. But only on planets can match up all the parameters necessary for life.

PLANETS NEAR STARS.

The planet needs to be not less than of Mars, to keep its surface from the air and water vapor, but not as huge as Jupiter and Saturn, an extended atmosphere which does not transmit sunlight to the surface. In short, planets like Earth, Venus, and perhaps Neptune and Uranus under favorable circumstances, can become a cradle of life. And these circumstances are rather obvious: the steady emission of a star; a certain distance from the planet to light, providing a comfortable temperature; the circular shape of the orbit of the planet, possible only in the vicinity of a solitary star (i.e., single or component of a very wide binary system) . This is important. Often in space meets the totality of these conditions?

Single stars quite a lot — about half of the stars in the Galaxy. Of these, about 10% similar to the Sun in temperature and luminosity. However, not all of them are calm, as our star, but about every tenth is like the Sun in this respect. Recent observations have shown that planetary systems probably formed a significant part of stars of moderate mass. Thus, the Sun with its planetary system have to remind about 1% of stars in the Galaxy that is not so small — billions of stars.

THE ORIGIN OF LIFE ON PLANETS.

In the late 50-ies of XX century American Biophysics Stanley Miller, Juan Oro, Leslie Orgel in the laboratory simulated primary atmospheres (hydrogen, methane, ammonia, hydrogen sulfide, water) . Flasks with a gas mixture they were illuminated with ultraviolet rays was initiated spark discharges (young planets of active volcanic activity accompanied by heavy thunderstorms) . As a result of simple substances very quickly formed a curious compound, for example, 12 of the 20 amino acids that form all proteins of terrestrial organisms, and 4 of the 5 bases that form RNA molecules and DNA. Of course, this is only the basic “building blocks” of which are very complex rules built terrestrial organisms. It is still unclear how these rules have been developed and enshrined by nature in the molecules DNA and RNA.

THE AREAS OF LIFE.

Biologists don't see any other basis for life, in addition to organic molecules, biopolymers. If for some of them, such as DNA molecules, the most important is the sequence of units-monomers, for most other molecules — proteins and in particular enzymes — the most important is their spatial form, which is very sensitive to ambient temperature. Should increase the temperature as the protein denaturiruet — loses its spatial configuration, and with it biological properties. In terrestrial organisms, this occurs at a temperature of about 60 °C. At 100-120 °C destroyed almost all terrestrial life forms. Besides the universal solvent — water under these conditions is converted in the atmosphere into steam, and at temperatures below 0 °C in ice. Therefore, we can assume that favorable for the occurrence of the temperature range is 0-100 °C.

The surface temperature of the planet depends mainly on the luminosity of the parent star and distance from it. At the end of the 50s, the American astrophysicist, Chinese by birth, su-Shu Huang researched this issue in detail: he calculated. At what distance from stars of different types can be inhabited planets, if the average temperature on the surface is in the range of 0-100 °C. it is Clear that around any star there is a region — life area, which borders the orbits of planets should not go. The dwarf stars it is close to the star and narrow. In case of accidental formation of planets, the probability that some of them will get in this area is small. The stars of high luminosity area of life that is far from the star and is very extensive. This is good, but their life expectancy is so small that it is difficult to expect the appearance of their planets sensible substances (earth biosphere it took more than 2 billion years) .

Thus, according to su-Shu Huang, for habitable planets most fit stars of the main sequence spectral classes from F5 to K5. Not good for any of them, but only the stars of the second generation, rich in those chemical elements that are essential for biosynthesis, carbon, oxygen, nitrogen, sulfur, and phosphorus. The sun is such a star, as our Earth moves in the middle of his zone of life. Venus and Mars are near the edges of this zone. In the result of life on them.

So, it is hoped that every sun-like star possessing a planetary system, there is at least one planet with conditions suitable for the development of life on it.

Unfortunately, there are few chances to detect the active biosphere in the Solar system and it is unclear how to look for it in other planetary systems. However, life has reached a reasonable form and created a technical civilization, like the earth, we can try to engage her in contact; created for people technology this is a real challenge.

THE SEARCH FOR EXTRATERRESTRIAL CIVILIZATIONS

How to find brothers on reason? The search strategy depends on how people imagine the possibilities and desire of these brothers. You can split these perceptions into four different types: They are near us. So I think those who believe UFOs are alien spaceships, aliens, and believes the technical capability of interstellar travel, the regular appearance of aliens on Earth. Unfortunately, the scientific basis for such ideas yet.

Here they had once been. Some fans of the stories and archaeologists believe that the monuments literary sources and legends survived indicate visits to Earth by aliens. They do not rule out that we are their descendants. This last statement is from the point of view of biology is very naive: the genetic code and the molecular composition of a person is completely identical to the other beings living on Earth. Of ancient monuments and legends clear opinion yet, but in principle, people jealousy could create any of these creations.

They master space. Here everything is quite simple. The earth people are already mastering the space and can imagine the prospects of this class. The main thing is that humanity consumes more energy, and more dissipates it into the surrounding space in a modified form. For example, for over 100 years, the Earth leaving the radio waves of artificial origin. The last 50 years this is a very powerful signal of our television transmitters and radars, which easily you can register with the neighboring stars. The same applies to powerful laser pulses are sent into space, In the future people will start to build large space settlements, which are sources of infrared (heat) radiation with a characteristic temperature of about 300 K.

Such signs you can try to find civilization, like the earth, even in that case, even if it does not seek to tell about its existence. If the technical level of civilization so high that she learned to use all the energy of its star, for

example, by surrounding her with an opaque sheath (so-called Dyson sphere), instead of the stars we see infrared source. Special search is really possible to find such sources, but so far they have all been formed stars surrounded by dust shells. However, the capacity of the existing infrared telescopes are still quite limited.

They want to talk. Much easier it would be to find brothers in mind, if they wanted to. A powerful radio beacon or laser “spotlight” can be seen from greater distances. Such searches are undertaken. The question is, which way of communication they choose.

COMMUNICATION WITH EXTRATERRESTRIAL CIVILIZATIONS

For wireless communication on earth mainly use the radio. Therefore, the main efforts are now focused on the search of signals of extraterrestrial civilizations (EC) in the radio. But they are in other ranges of radiation. Over the last 20 years there have been several experiments to search for laser signals in the optical range. The advantage of laser communication at short distances is obvious: she has a very high throughput, allowing to transmit huge amount of information in a short time. At large distances the laser beam scatters and is absorbed in the atmosphere, and it has to pass over fiber optic cable. But the space is quite transparent for optical communication. The second feature laser high beam directionality — rather a drawback to wanting to intercept the alien space message.

When observed from the Earth laser signal will give a narrow line in the spectrum of the star, which is located near the laser transmitter VTS. Consequently, the task boils down to finding the “stars lasers”, having swaroski radiation lines. Program to search for such stars is held in the Special astrophysical Observatory of the Russian Academy of Sciences in the Northern Caucasus using a 6-meter BTA reflector. There was developed a special set of instruments MANIA to detect ultra-fast, up to 10^{-7} s, the variation of the luminous flux and the very slim, to 10^{-6} And , the emission line. It is important that the search for signals VC is carried out simultaneously with the solution of astrophysical problems, for example with the study of neutron stars and the search for black holes, i.e. does not distract from the telescopes scientific purposes.

Recently, this work involved the Argentine astronomers, searching for optical signals with a telescope diameter of 2 m in the province of San Juan in close proximity to the Argentinian Andes. It is important that the telescope available to the stars of the southern hemisphere sky. Another program of the search for laser signals in the infrared range is being conducted by the University of California at Berkeley. She used one of the mirrors with a diameter of 1.7 m stellar interferometer, installed in the Observatory mount Wilson. This program includes a study of 300 close to the Land of stars and calculated for several years.

Yet, radio waves are considered the most promising form of communication. Sensitive terrestrial radio antenna could detect the powerful television transmitters type Ostankino on the planets of neighboring stars. Modern technology allows us to communicate with brothers in mind in every corner of the Galaxy, if you know where they are and in what wavelength range are going to negotiate. And maybe these negotiations are already underway, and it remains only to configure the receivers to hear?

So to search for signals of VC in addition to technical and financial problems had to be solved 2 principle: at what point of the sky to point the antenna, and what frequency to set the receiver.

The first problem was solved easily: the antenna aimed at the nearest star similar to the Sun, in the hope that a number of them have planets similar to Earth. The second problem was more difficult. When a person catches an unknown radio home receiver, it just “wanders” throughout the wavelength range. If a station is powerful, it is easy to find, and if the signal is weak, then you need to slowly move from wave to wave, carefully listening to the rustle of interference — it takes a lot of time. Expected from space a signal is so weak that just turning the knob on the receiver, it is not found. In the first years of the search signal VTS scientists have tried to guess at what frequency to expect transmission from space. So I decided: this frequency should be aware of any radio in the Galaxy, so it must be a line of radiation of some cosmic matter, best most common, i.e. hydrogen. Indeed, it is weakly emits at a wave length of 21 cm On the wave and decided to tune in.

OZMA AND SERENDIP

Observations began in 1960, when sir Francis Drake tried using the antenna with a diameter of 26 meters receive signals from the star ϵ of the whale, and Eridanus. His work was called “project OZMA”. Artificial signals were found, but Drake opened the era of the search signals of search CC. First, this activity has received the General name of GETI (Communication with ExtraTerrestrial Intelligents — “Communication with extraterrestrial civilizations”). Later it became known as more cautious SETI (Search for ExtraTerrestrial Intelligents — “the Search for extraterrestrial intelligence”), having in mind that before you will be able to establish the connection, you need to find at least some traces of intelligent beings in space. Over the years, in different countries, mainly in the US and the USSR conducted more than 60 experiments to search for signals of VTS, studied thousands of stars at different frequencies. But until now, signals of intelligent beings was not detected.

Search strategy during this time much has changed. First job was just repeating the idea of Drake in expanded form. Then explored the other stars and on other frequencies, but soon realized that to hope for success only if we manage to listen the whole sky at all frequencies. In the computer age it was possible.

In 1992, the National aeronautic and space USA (NASA) started project SERENDIP (SERENDIP Search for Extraterrestrial Radio Emission from nearby Developed Intelligent Populations — “Search for extraterrestrial radio emissions from nearby developed civilizations”). The project is designed for 10 years. It involves several observatories in different countries. With the help of a parabolic antenna with a diameter of 34 m Goldstone (California) is a continuous view of the sky — stripe for stripe. Upon detection of a suspicious signal their detailed study engaged in larger telescopes, such as antenna with a diameter of 64 m Parkes (Australia) or 300-meter bowl in Arecibo on the island of Puerto Rico.

The work is conducted in parallel to normal science observations. In other words, wherever the telescope received signals, SERENDIP constantly reviewing them for “reasonableness”: a sudden along the way, something interesting find, just like in the famous tale.

Applied new search strategy. First radio telescope of medium size, quickly scans a strip of sky, repeatedly scanning her up and down. “Sight” of the antenna moves fast, and the computer sorts the obtained data, selecting among the detected sources, some of the most interesting. Then use the same antenna they are studied in more detail. The telescope captures the “look” on each of them, thereby increasing their sensitivity. Of course most sources are false: interference from radar, own noises of receiver, etc. But some sources are confirmed and entered into the catalog for detailed study with the largest antennas.

The amazing ability of the project SERENDIP — it multi-channel receivers: the space is bugged not on one frequency, but multiple millions of frequencies, covering a wide range of radio waves. In previous years the signal search was conducted on one fixed frequency, pre-selected by researchers. This strategy resembled the hunt for the fish with a fork in the muddy water. Hunter tries to guess where should be the fish at the moment, and stabs the spear there. Does he have a lot of chance of success? Radios project SERENDIP in this sense, similar to chicken wire network that widely captures and does not miss one fish, and the size of this “Seine” is constantly increasing: on the antenna in Arecibo receiver operates on 4 million channels! Creating these superpriemy, radio astronomers once again have put their antenna on the next stars: thousands of stars in the solar neighborhood listen now on millions of different frequencies.

It should be noted that scientific work does not have immediate practical applications are funded in any country is not very generous, and even more so fantastic, as search CC. Project SERENDIP in 1994 was halted: we need to continue to work \$ 12 million. The us Senate didn't allocate, motivate soya refusal by the fact that the “brothers on reason are unable to solve our financial problems.” But there were enthusiasts, created to support the unique project, the society “Friends of SERENDIP” which was headed by the famous science fiction writer Arthur C. Clarke (the way he for many years lived on the island of Sri Lanka, i.e. in the same fabulous Serendipi). Now space the search continues; already seen hundreds of unusual signals that will be studied in more detail.

THE LANGUAGE OF THE BROTHERS ON REASON

Attempts to establish radio contact with brothers in mind, have been going on for about 40 years. Long ago it became clear that the main problem in this case is not a technique of transmission and receptions of signals, and the language and content of the messages. It is obvious that the choice of language depends on the prior information about the source: the less we know about him, the more universal the language. His choice depends on the shape of the contact. As shown by the experience of the different civilizations of the Earth (e.g., Europeans and Indians) , even here, contacts are very difficult. In the XIX century Russian ethnographer N. N. Maclay, trying to compile a dictionary of the language of the Papuans, are faced with serious difficulties. Wanting to know the name of the sheet, he showed it to several natives, and to my surprise, all heard different names. Gradually, he found out that one of them said “green” and “dirt” and “unfit” , as the sheet was lifted from the ground, the third called the plant, which belonged to the sheet, etc. Even in this simplest case, it has proven difficult to achieve clarity. It was even more difficult with abstract concepts. “For a number of concepts — wrote the traveler, — I in no way could get the appropriate designations for this was lack of my imagination, and my facial expressions. How could I, for example, to introduce the concept of “dreams” or “sleep” as I could find the name of the concept “friend” , “friendship” ? Even the verb “to see” I learned the word only after 4 months and for the verb “to hear” and can learn”.

Contacts with other civilizations will probably be associated with great difficulties, and can generally prove fruitless. It still not just today some texts in dead languages of the Earth — a peculiar message from time immemorial. Even greater difficulties can be expected in the case, if we manage to accidentally overhear radio messages from other worlds designed for internal use, for example, fragments of TV or callsigns cosmic lighthouses. But if someone sends into space a special call sign to search for brothers on reason, he needs to take care of the simplicity of the language, i.e. to create a special language understood by any thinking creature. Scientists call this the principle of anticipatory (from GK. anti — “against”; “cryptos” — “secret, hidden” ; “graph” — “write”).

ARTIFICIAL LANGUAGES.

Their story began with attempts to invent a universal language for people.

The result of one such attempt — the language Esperanto is now in Vogue. However, somehow the core of these languages was the living European languages. Hans Freudenthal, Professor of mathematics, University of Utrecht (Netherlands) decided to create a language that is understandable for creatures that do not have with us anything the General, except of the mind. It was in those years when everyone was excited about the launch of the first satellite and the first attempt of Drake to accept signals from extraterrestrial civilizations. Therefore, Freudenthal called the language linkos (from lat. lingua cosmica — “space language”).

Linkos simple and straightforward, it does not contain any exceptions to the rules, synonyms etc. in addition, this language is totally free of phonetic sounds. The words of this language and never anyone in the Universe you won't hear. They can be encoded in any system, for example in the binary, and pass into space by radio or other means.

Freudenthal has developed lessons linkos, which should start the first message. The first lesson contains simple concepts of mathematics and logic. It starts next to the natural numbers, which are passed to a sequence of pulses. Then enter characters and numbers, and the concept of “equals”. Each sign is transmitted by a pulse of a special shape. Then it shows the arithmetic operation. Thus, the unknown correspondent is a course in mathematics and owns the concept of “more”, “less” , “true” , “false” , “increasing” , “decreasing”, etc.

SPACE MESSAGES.

Over the past 40 years the people became convinced that near the Earth there are civilizations that transmit messages by radio. The humans decided to send a message to the unknown space brothers. In the 70-ies to the stars was sent dispatches and automatic probes with parcels on Board. What was their content?

First of all, he had to solve the question, in what form to send a message: in the form of text or pictures, i.e. are concepts or images. Use linkos not yet decided. All messages sent into space on the radio and on Board spacecraft contain images — pictures, slides, sounds, speech, music. The short text

consists of several numbers needed to specify the “return address” — position of our planet in the Galaxy.

On 16 November 1974 from the Arecibo Observatory sent a message in the direction of the globular cluster M 13 in the constellation Hercules. It's about a million stars, like our Sun, so it is likely that the message will someone taken. However the signal will get there only after 25 thousand years. The message sent on the wave length of 12.6 cm and contains 1679 characters. As I hope the earthlings, their alien colleagues will think that the message is a frame 23x73.

While earthlings unknown quick ways of interstellar travel; flight even to the nearest star would take tens of thousand years. For a person the way to the stars is closed. But the machines have already rushed into interstellar space: four probes left the Solar system is a “pioneer-10, -11” , launched in 1972-1973 and “Voyager-1, -2” running 1977 Flying past the outer planets, they have overcome the attraction of the Sun and are now removed into the depths of the Galaxy. So why not send them news in other worlds? There is a chance that they will ever fall into the hands of intelligent beings. Therefore, each of the probes carries a special message.

Inside the “Pioneers” founded a small metal plate on which is engraved “calling card” of earthlings. It depicts the people on the background of the silhouette of the spacecraft (to show scale) . Welcome man raised his hand. Below shows a diagram of the Solar system; a line extending from the third planet the little silhouette of the “Pioneer” shows the flight path. Top left shows the double-hydrogen atom. The circle represents the orbit of the electron, and stick with the point — direction of the spin (axis of spin) of an electron and proton. In the right image the spins of the particles coincide and they are opposite on the left. Every physicist (including, probably, unearthly) knows that when you rotate the spins of the hydrogen atom emits a radar pulse with a frequency of 1420 MHz, i.e. with a wavelength of 21 cm These length and frequency (measure of time) are the units of all other distances and times specified on the drawing.

The most important message is encoded in the “star” left of center. This is our “return address” in the middle of the Sun, and stretching from the rays

show the direction and distance to a “beacon” of the Galaxy — pulsars. A neutron star, a rapidly rotating and emitting radio pulses with a certain period. Each pulsar period, which in a binary code recorded along the beam. All developed civilizations of these pulsars must be known. And knowing their coordinates in the Galaxy, it is easy to find and the position of the Sun. The long horizontal beam indicates the direction and distance to the galactic center — the “capital” of our “star of the Empire”.

“Voyager” is sent for the whole package: to Board each of them attached round aluminum box, put there a gold-plated disc. Instruction for its reproduction is depicted on the lid of the box.

On the disk 115 images (slides), which collected important scientific data, the types of the Earth, its continents, different landscapes, scenes from the life of animals and humans, their anatomical structure and biochemical structure, including DNA molecule.

In addition to the images on the disc and sounds: whisper of the mother and the baby crying, the voices of birds and animals (e.g., “songs” of whales), the sound of wind and rain, the rumbling of volcanoes and earthquakes, the rustling of sand and ocean surf. There's even a kissing sound, which skillfully reproduced the creators of the DVD.

Human speech is represented on disk, short greetings in 58 languages of the peoples of the world. In Russian it says: “Hello, welcome!” . Special chapters of the letter are the achievements of world musical culture. The disc contains works by Bach, Mozart, Beethoven, jazz Louis Armstrong, Chuck berry and the folk music of many countries.

Will I get this message brother, is now hard to say. This very small piece of land compared to the vast cosmic expanses. But this is only one of the steps that people have started to do in the search for life and intelligence in the cosmos, and now they will not stop until you find them.

Starry sky at all times, occupied the imagination of the people. Why light up the sky? How many of them shining in the night? How far they are from us? Whether the limits of the starry Universe? Since ancient times people thought of these and many other questions, sought to understand and comprehend the

device that big world in which we live.

The earliest knowledge of it was preserved in fairy tales and legends. It's been centuries and millennia before there was and was deep study and development of the science of the Universe, reveal to us the wonderful simplicity, the amazing order of the universe. Not without reason in ancient Greece it was called the Cosmos, and the word originally meant “order” and “beauty.”

The system of the world is the concept of location in space and the motion of the Earth, Sun, moon, planets, stars and other celestial bodies.

II. Picture of the world

In the ancient Indian book called the “rig Veda”, which means “Book of hymns” can you find a description — one of the first in the history of mankind — the Universe as a whole. According to “rig Veda”, it works not too difficult. It is, above all, Land. It seems endless, flat surface — “vast space”. This surface is coated on top of the sky. And the sky is blue, littered with stars “vault”. Between heaven and Earth — “the luminous air” .

From science it was very far away. But it is important here more. Wonderful and Grand itself a daring goal — to embrace the idea of the entire Universe. From here stems the belief that the human mind is able to comprehend, to understand, to unravel its structure, create in your mind a complete picture of the world.

III. The motion of the planets

Observing the annual movement of the Sun among the stars, the ancient people learned to determine in advance the occurrence of a particular time of year. They divided the band of sky along the Ecliptic into 12 constellations, to each of which the Sun is approximately a month. As already noted, these constellations were named the zodiac. They all, with one exception, are animal names.

With the early morning sunrise of a constellation the ancient people tied their

agricultural work, and this is reflected in the names of the constellations. So, the appearance in the sky of the constellation of Aquarius pointed to the expected flood, the appearance of the Fish for the upcoming fish runs for spawning. With the morning appearance of the constellation Virgo began harvest, which was carried out mainly by women. A month later, appeared in the sky nearby constellation Libra, at this time there were just the weighing and counting of the harvest.

Even 2,000 years BC. e. Ancient observers noticed the constellations of the zodiac special five stars, which is constantly changing its position in the sky, moving from one zodiac constellation to another. Later Greek astronomers called these planets the luminaries, i.e., “wandering”. Are mercury, Venus, Mars, Jupiter and Saturn, to preserve in their names the names of ancient Roman gods. To the wandering luminaries were listed as well as the Moon and the Sun.

Probably it took many centuries before the ancient astronomers were able to establish certain regularities in the motions of the planets and, above all, to set the intervals after which the position of the planet in the sky relative to the Sun is repeated. This period of time was later called the synodic period of revolution of the planet. After this was done the next step is to build a common world model, in which each of the planets would be allotted a certain place and taking advantage of which it would be possible to predict the position of the planet for several months or years.

By the nature of its motion on the celestial sphere relative to the Sun of the world (in our understanding) are divided into two groups. Mercury and Venus are named the internal or lower, the other — external or top.

The angular velocity of the Sun is greater than the speed of the direct motion of the upper planets. So the Sun is gradually overtaking the planet. As for the inner planets, at the time when the direction the planet and the Sun is the same, there comes a connection of a planet with the Sun. After the Sun will overtake the planet, it becomes visible before sunrise, in the second half of the night. The moment when the angle between the direction to the Sun and the direction to the planet is 180 degrees is called an opposition of the planet. At this time she is in the middle of the arc of its retrograde motion. Deletion

of the planet from the Sun at 90 degrees to the East is called Eastern quadrature, 90 degrees West — Western quadrature. Everything mentioned here the position of the planets relative to the Sun (from the point of view of the observer) are called configurations.

During excavations of ancient cities and temples of Babylonia discovered tens of thousands of clay tablets with astronomical texts. The breakdown showed that the ancient Babylonian astronomers closely followed the position of the planets in the sky; they were able to determine their synodic periods of rotation and use this data in their calculations.

IV. The first model of the world

Despite the high level of astronomical information of the peoples of the ancient East, their views on the structure of the world was limited to direct visual sensations. So in Babylon formed the view that the Earth is convex Islands surrounded by ocean. Inside the Earth there is “the realm of the dead” . The sky is a solid dome resting on the earth's surface and separating the “lower waters” (the ocean around earth island) from the “top” (rain) water. This dome is attached to the heavenly bodies in the skies as if the gods live. The sun rises in the morning, leaving the East gate, and comes through the West gate, and at night it moves under the Ground.

According to the ideas of the ancient Egyptians, the universe has the appearance of a large valley stretched from North to South, it is Egypt. The sky was like a large iron roof supported on pillars, it is in the form of lamps hanging from the stars.

In Ancient China there existed the notion that the Earth is shaped like a flat rectangle, on which the pillars supported a round domed sky. The enraged dragon as if bent Central pillar, so that the Land bent to the East. Therefore, all the rivers in China flow East. Heaven bent to the West, therefore all heavenly bodies move from East to West.

And only in the Greek colonies on the Western coast of Asia Minor (Ionia), southern Italy and Sicily in the fourth century BC, began the rapid development of science, particularly philosophy, as a doctrine about nature. It

is here in place of simple contemplation of the phenomena of nature and their naive interpretation come the attempts to scientifically explain these phenomena to unravel the true causes of them.

One of the great ancient Greek philosophers was Heraclitus (C. 530-470 BCE). Him belong the words: "World, one of all, not created by any of gods and none of the people, was, is and will be eternally living fire, regularly flammable and natural fading..." Then the Pythagoras of Samos (C. 580-500 BC) expressed the idea that the Earth, like other celestial body is a sphere. The universe seemed to Pythagoras in the form of concentric, nested within other crystal spheres, which though attached to the planet. In the center of the world in this model placed the Earth around it revolved the spheres of the moon, mercury, Venus, Sun, Mars, Jupiter and Saturn. Further all was the sphere of fixed stars.

The first theory of the structure of the world explaining the direct and retrograde motion of the planets, created by the Greek philosopher Eudoxus of Cnidus (C. 408-355 BC). It is suggested that each planet has not one, but several areas are bonded with each other. One of them makes one revolution per day around an axis of the celestial sphere in the direction from East to West. Conversion another (in opposite direction) was assumed equal to the orbital period of the planet. Thus was explained the motion of planets along the Ecliptic. It was assumed that the axis of the second sphere is inclined to the first axis at a certain angle. The combination of these two fields is still allowed to explain retrograde motion relative to the Ecliptic. All features of the motion of the Sun and moon were explained using three spheres. The stars, Eudoxus placed on a sphere that subsumes all the others. Thus, all apparent motion of the heavenly bodies, Eudoxus brought to rotation 27 of the spheres.

It will be recalled that the idea of uniform, circular, absolutely correct movements of the heavenly bodies was expressed by the philosopher Plato. He suggested that the Earth is in the center of the world, what goes around it the moon, the Sun, then the morning star Venus, the star of Hermes, the star of Ares, Zeus and Kronos. In Plato for the first time meet the names of the planets named for the gods, identical with the Babylonian. Plato first formulated mathematicians the task of finding the proper and uniform

circular motion can “save the phenomena presented by the planets”. In other words, Plato's task was to build a geometric model of the world, the center of which, of course, had to be Land.

The improvement of the system of the world of Eudoxus took up Plato's student Aristotle (384-322 BC). As the views of this distinguished philosopher-scientist prevailed in physics and astronomy for almost two thousand years, it will stop on them more in detail.

Aristotle, following the philosopher Empedocle (C. 490-430 BCE), assumed the existence of four “elements”: earth, water, air and fire, from a mixture which supposedly took place all the bodies found on Earth. According to Aristotle, the elements water and earth naturally tend to move toward the center of the world (“down”), while fire and air move “up” to the periphery and the faster, the closer they are to their “natural” place. Therefore, in the center of the world is Earth, above it there is water, air and fire. According to Aristotle, the universe is limited in space, although its movement is eternal, has no end, no beginning. This is possible because, in addition to these four elements there is a fifth, indestructible matter, which Aristotle called ether. From the air though and composed all heavenly bodies for which the eternal circular motion is the natural state. “Area of air” begins around the moon and extends upwards, while below the moon is the world of the four elements.

Here is how his understanding of the universe Aristotle himself: “the Sun and the planets revolve around the Earth, which is motionless in the center of the world. Our fire, about the colour of his own, has no similarity with the sunlight, dazzling white. The sun is composed of fire; it is a huge cluster of air; the heat of the Sun caused by the effect of it on the air during the rotation around the Earth. Comet the essence of the transitory phenomena that are born quickly in the atmosphere and just as quickly disappear. The milky Way is nothing like vapour, ignited by rapid rotation of stars around the Earth... the Movement of the heavenly bodies, generally speaking, are far more correct than notice of motion on Earth; for, as celestial bodies, more perfect than any other bodies, then it behooves the correct movement, and, however, very simple, and such a movement can only be circular because in this case the movement can be however uniform. The heavenly bodies move freely like the gods, to which they are closer than the inhabitants of the Earth; therefore, lights when driving your not in need of rest and the cause of its

movement enclosed in themselves. The highest region of the sky, more sophisticated, containing the fixed stars are, therefore, a most perfect movement — always to the right. As for the part of the sky closest to the Earth, and therefore less than perfect, this part serves as the seat of the much less than perfect bodies, what planet. This last move not only right, but left, and, moreover, in orbits inclined to the orbits of the fixed stars. All heavy bodies tend to the center of the Earth, and every body tends to the centre of the Universe, so the Earth must be motionless in this centre”.

When building his system of the world, Aristotle used the ideas of Eudoxus of concentric spheres on which the planets and orbiting the Earth. According to Aristotle, the cause of this movement is the “engine” — the special rotating sphere, located outside the sphere of “fixed stars”, which sets in motion everything else. In this model, only one sphere to each of the planets rotates from East to West, the other three in the opposite direction. Aristotle believed that these three areas should be compensated by an additional three inner spheres belonging to the same planet. In this case, each subsequent (towards the Earth) the planet has only a daily rotation. Thus, in the system of the world of Aristotle the motion of heavenly bodies was described with 55 a solid crystal of spherical shells.

Later, the system of the world was allocated eight concentric layers (heavens), which transferred its traffic to each other. In each layer, there were seven areas that are driving this planet.

In Aristotle's time there were other views on the structure of the world, in particular, that not the Sun revolves around the earth, and the Earth along with other planets revolves around the Sun. Against this, Aristotle put forward a serious argument: if the Earth was moving in space, then this movement would seem to be regular movement of stars in the sky. As we know, this effect (the annual parallax of the stars) was opened in the 19th century, 2150 years after Aristotle...

On the slope of his age, Aristotle was charged with impiety and fled Athens. In fact, in their understanding of the world he vacillated between materialism and idealism. His idealistic views and, in particular, the idea that the Earth is the center of the universe was designed to protect religion. That's why in the

middle of the second Millennium of our era, the struggle against the views of Aristotle had become essential to the development of science...

V. the First heliocentric system

Contemporaries of Aristotle it was already known that the planet Mars (in opposition), and Venus (in retrograde motion) is much brighter than at other times. According to the theory of spheres, they would have to stay always at the same distance from Earth. So there were other ideas about the structure of the world.

So, Heraclitus of Pontus (388-315 BC) assumed that the Earth moves "... rotation about its axis, like a wheel, from West to East around its own center." He has also argued that the orbits of Venus and mercury are circles, the center of which is the Sun. Together with the Sun these planets are like and revolve around the Earth.

Even bolder views are held by Aristarchus of Samos (C. 310-230 BCE). Outstanding Greek scientist Archimedes (CA. 287-212 BC) in his essay "Psammit" ("Calculus of grit"), referring to the Gelone of Syracuse, wrote about the views of Aristarchus: "You know that according to some astronomers the world is a sphere whose center coincides with the center of the Earth, and the radius equal to the length of the straight line connecting the centers of the Earth and the Sun. But Aristarchus of Samos in his "Proposals," written against the astronomers in rejecting this view, comes to the conclusion that the world is much larger than the one just indicated. He believed that the fixed stars and the Sun do not change their places in space that the Earth moves in a circle around the Sun in its center and that the center of the sphere of the fixed stars coincides with the center of the Sun, and the size of this sphere is such that the circumference described, he suggested that Earth is to the distance of the fixed stars in the same relation in which the center of the ball is to the surface".

VI. The Ptolemaic System

The emergence of astronomy as an exact science began with the work of the outstanding Greek scholar, Hipparchus. He began the first systematic

astronomical observations and a thorough mathematical analysis, laid the foundations of spherical astronomy and trigonometry, he developed the theory of the movement of the Sun and moon, and on its basis — methods of predicting eclipses.

Hipparchos found that the apparent motion of the Sun and moon in the sky is uneven. So he was on the point of view that these lights move uniformly in circular orbits, but the center of the circle is shifted relative to the center of the Earth. Such orbits were called excentric. Hipparchus compiled a spreadsheet on which you can determine the position of the Sun and moon in the sky on any day of the year. As for the planets, then, according to the remark of Ptolemy that he “made no other attempts to explain the planetary motion and were satisfied with the adjustment made to his observations, adding to them a much larger number of its own. He limited himself to stating his contemporaries on the inadequacy of all hypotheses, in which some astronomers thought to explain the motion of heavenly bodies”.

Through the works of Hipparchus, astronomers have refused to imaginary crystal spheres assumed by Eudoxus, and moved on to more complex constructions with epicycles and deferent proposed before Hipparchos Apollonius Pigskin. The classical form of the theory of epicyclic motions gave Ptolemy.

Major works of Ptolemy “Mathematical syntax in 13 books” or, as it was called later the Arabs the “Almagest” (“the Greatest”) was known in medieval Europe only in XII century In 1515 it was printed in Latin in Arabic, and in 1528 in Greek. Three times the “Almagest” was published in Greek, in 1912 he published in German.

“The Almagest” is a real encyclopedia of ancient astronomy. In this book Ptolemy has done what could not be done to any of his predecessors. He developed a method, using which it was possible to calculate the position of a planet on any beforehand given point in time. It was not easy, and in one place he observed: “it is Easier, it seems, to move the planet than understanding their complex movement...” “Setting” Land in the center of the world, Ptolemy introduced a complicated and uneven apparent motion of each planet as a simple sum of several uniform circular motions.

According to Ptolemy, each planet moves uniformly in a small circle — the

epicycle. The center of the epicycle, in turn, uniformly slides along the circumference of a great circle, called deferents. For a better coincidence of the theory with observations we had to assume that the center of deferent offset relative to the center of the Earth. But it was not enough. Ptolemy was obliged to assume that the motion of the center of the epicycle on deferent is uniform (i.e. its angular speed is constant), if we consider this movement is not from the center of deferent and not from the center of the Earth, but with some “leveling points”, named after the company.

By combining observations with the calculations of Ptolemy by successive approximations received that the relationship of the radii of the epicycles to the radii of the deferent for mercury, Venus, Mars, Jupiter and Saturn are respectively 0,376; 0,720; 0,658; 0,192 and the 0.103. Interestingly, to predicate position of the planet in the sky it was not necessary to know the distance from the planet, but only referred to the ratio of the radii of the epicycles and of the deferent.

When building his geometric model of the world Ptolemy took into account the fact that in the process of the movement of the planet a little deviate from the Ecliptic. So for Mars, Jupiter and Saturn, he “tilted” the plane of the deferent to the Ecliptic and the plane of the epicycles to the planes of the deferent. For mercury and Venus, he introduced a fluctuating up and down by small vertical circles. In General for explaining all seen in the time characteristics in the motion of planets, Ptolemy introduced epicycles 40. The world system of Ptolemy, in whose center is the Earth, called geocentric.

In addition to the relationship of the radii of the epicycles and of the deferent for matching theory with observations it is necessary to specify the periods of rotation of these circles. Ptolemy, a complete revolution around the circumference of all the epicycles of the upper planets do in the same period of time, and the Sun on the Ecliptic, i.e., for the year. Therefore, the radii of the epicycles of those planets to the planets are always parallel to the direction from the Earth to the Sun. At the lower planets mercury and Venus, the orbital period of the epicycle is equal to the period of time, and the planet returns to the starting point in the sky. For periods of revolution of the center of the epicycle on the circumference of deferent picture is the opposite. Mercury and Venus they are equal year. Therefore, the centers of their

epicycles always lie on the line connecting the sun and the Earth. For the outer planets, they are defined by the time during which a planet, having described a full circle in the sky, returns to the same stars.

Following Aristotle, Ptolemy attempted to refute the idea of a possible motion of the Earth. He wrote: “There are people who assert that nothing prevents to assume that the sky is stationary and the earth rotates around its axis from West to East, and that it makes a revolution every day. However, speaking of luminaries, there is nothing stopping for simplicity, to prevent this, if we take into account only visible movement. But these people do not realize the extent to which this opinion is ridiculous, if you look at everything what is taking place around us and in the air. If we agree with them — which doesn't exist — that the light of the body is not moving or moving in the same way as bodies are heavy, but, obviously, the air body to move with greater speed than bodies terrestrial; if we agreed with them that the subjects of the most dense and heaviest have their own movement, fast and permanent, whereas in fact they hardly move from reported aftershocks — after all, these people would have to admit that the Earth, owing to its rotation, would have a motion much faster than all those which happen around her, because she would be making such a big circumference in such a small period of time. Thus, the body sustained by the Land, seemingly always moving in the opposite direction with her, and no cloud, nothing flying or thrown, never seemingly heading to the East, for the Earth ahead of any movement in this direction.”

From a modern point of view one can say that he too has overestimated the role of the centrifugal force. He also adhered to the erroneous assertions of Aristotle that the field of gravity, bodies fall with velocities proportional to their masses...

In General, as noted by A. Pannekoek, “Mathematical writing” Ptolemy “was a carnival procession geometry, a celebration of the deepest creation of the human mind in the view of the Universe... the work of Ptolemy appears before us as a great monument to the science of antiquity...”.

After high flourishing antique culture on the European continent entered a period of stagnation and regression. This dark time more than a thousand

years were called the middle ages. It was preceded by the transformation of Christianity the dominant religion in which there was no place for the highly developed science of antiquity. At this time, there was a return to the most primitive notions of a flat Earth.

It is only since the XI century under the influence of increased trade relations, with the stress in the cities a new class — the bourgeoisie. Spiritual life in Europe began to awaken. In the mid-thirteenth century, the Aristotelian philosophy was fitted to Christian theology, cancelled the decisions of Church councils forbidding philosophical ideas of the great ancient Greek philosopher. The views of Aristotle on the structure of the world soon became integral elements of the Christian faith. Now it was impossible to doubt that the Earth is a sphere mounted in the center of the world, and around him are turning all the heavenly bodies. The Ptolemaic system became a Supplement to Aristotle, helping carry out specific calculations of planetary positions.

Basic parameters of its model of the world Ptolemy identified highly skillfully and with high precision. Over time, however, astronomers began to confirm that the true position of the planet in the sky and calculated, there are differences. So, in the early 12th century, the planet Mars was two degrees away from where it was supposed to be on the tables of Ptolemy.

To explain all the features of planetary motion in the sky, have to enter for each of them to ten or more circles with a decreasing radius to the center of a smaller epicycle turned in a circle more. By the 16th century the movement of Sun, moon, and five planets were explained using more than 80 circles! And all the same observations separated by great periods of time find it difficult to “fit” under this scheme. Had to enter new circles to change the radius to shift the centres of the deferent relative to the center of the Earth. In the end, the geocentric system of Ptolemy, overloaded with epicycles and aquantum collapsed under its own weight...

VII. The World Of Copernicus

Copernicus ' book, published in the year of his death, in 1543, bore the modest title: “About rotation of heavenly spheres” . But it was the complete

overthrow of the Aristotelian view of the world. A complex machine of hollow, transparent crystal spheres moved in the past. From this time began a new era in our understanding of the Universe. It continues to this day.

Thanks to Copernicus we learned that the Sun takes its rightful position in the centre of the planetary system. The earth no centre of the world, and one of ordinary planet, orbiting the Sun. So everything fell into place. The structure of the Solar system was finally solved.

Further discoveries of astronomers joined the family of major planets. There are nine: mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. In this order they take their orbit around the Sun. There are many small bodies of the Solar system — asteroids and comets. But it did not change Kopernikovoï new picture of the world. On the contrary, all of these discoveries only confirm and clarify it.

Now we understand that we live on a small planet like a ball. The earth revolves around the Sun in an orbit not too different from a circle. The radius of this circle close to 150 million kilometers.

The distance from the Sun to Saturn, the most distant known in the days of Copernicus the planets about ten times the radius of earth's orbit. This distance rightly identified Copernicus. The size of the Solar system — distance from the Sun to the orbit of the ninth planet, Pluto, nearly four times more, amounting to roughly 6 billion kilometers.

This is the picture of the Universe in our immediate surroundings. This is the world of Copernicus.

But the Solar system is not the whole universe. We can say that this is just our little world. But what about distant stars? About them Copernicus did not venture to Express any definite opinion. He just left them in the same place, not the far field, where they were from Aristotle, and only said, quite correctly, that the distance to stars many times larger than the planetary orbits. Like the ancient scientists, he was the Universe a closed space, limited to this sphere.

VIII. The sun and the Stars

A clear moonless night, when nothing prevents the observation that people with keen eyesight will see in the sky no more than two or three thousand shimmering dots. The list, compiled in the 2nd century BC, the famous Greek astronomer Hipparchos and completed by Ptolemy listed 1022 stars. Haveli, the astronomer, who performed such calculations without the aid of a telescope, brought their number to 1533.

But already in ancient times knew the existence of a large number of stars invisible to the eye. Democritus, the great scientist of antiquity, said that whitish band stretching across the sky that we call the Milky Way, is in reality a compound light invisible separately stars. Disputes about the structure of the milky Way continued for centuries. The decision — in favor of the speculation of Democritus — came in 1610, when Galileo reported the first discoveries made in the sky with a telescope. He wrote with understandable excitement and pride that it is now able to “make available eye stars that had never been visible and the number of which is at least ten times greater than the number of stars known since ancient times”.

But this is a great discovery still left the mysterious world of stars. Do all of them, visible and invisible, are concentrated in a thin spherical shell around the Sun?

Even before the discoveries of Galileo were made completely unexpected, at that time great bold idea. It belongs to Giordano Bruno, whose tragic fate is known to all. Bruno put forward the idea that our Sun is one of the stars of the Universe. Only one of the many, not the center of the Universe. But then another star, too, may have its own planetary system.

If Copernicus had the Earth not in the center of the world, Bruno and the Sun was deprived of this privilege.

Idea Bruno has given rise to many striking effects. From it emerged the rating of the distances to stars. Indeed, the Sun is a star, like the others, but only the closest to us. That's why it's so big and bright. And how far you need to push the Orb to make it look like, like Sirius? The answer to this question was given by the Dutch astronomer Huygens (1629-1695) . He compared the brilliance of these two celestial bodies, and this is what appeared: Sirius is

from us hundreds of times farther than the Sun.

In order to best understand how great the distance to a star, we say that a ray of light passing in one second is 300 thousand kilometers, takes on the journey from Sirius to us for several years. Astronomers say, in this case about a distance of a few light years. Modern to updated data, the distance to Sirius is 8.7 light years. And the distance from us to the sun is only 8 light minutes.

Of course, different stars differ from each other (this is considered in the modern estimate of the distance to Sirius). Therefore, the determination of distances to them and now is often very difficult, and sometimes impossible task for astronomers, although since the time of Huygens invented for this a lot of new ways.

Great idea Bruno, and based on it the calculation of Huygens began a decisive step to mastering the secret of the Universe. Because of this the boundaries of our knowledge of the world greatly opened, they have gone beyond the Solar system and reached the stars.

IX. Galaxy

Since the XVII century the most important goal of astronomers is studying the milky Way — this giant collection of stars that Galileo saw in his telescope. The efforts of many generations of astronomers-observers was intended to find out what the total number of stars in the milky Way, to determine its exact shape and boundaries, to estimate the size. Only in the XIX century failed to understand that it is a single system encompassing all the visible stars. On an equal footing with all involved in this system and our Sun, and with it the Earth and planets. And they are located not in the centre but on its outskirts.

It took many decades of careful observation and deep reflection, before astronomers revealed in its entirety the structure of the Galaxy. So was called the star system which we see, — of course, inside the stripe of the milky Way. (The word “galaxy” is derived from the Greek “Galacticos” , which means “milky” .) It turned out that the Galaxy has a pretty good structure and

shape, despite the ragged milky Way, the randomness with which, we think, scattered stars across the sky. It consists of a disc, a halo and a crown. The disc is like two folded edges of the plates. It is formed of stars that are inside this volume are moving in nearly circular orbits around the galactic center.

The diameter of the disc measured — it is about 100 thousand light years. This means that the light will take a hundred thousand years to cross the disk from one end to the other in diameter. That's how huge the Galaxy! And the number of stars in the disk is approximately a hundred billion.

In the halo comparable with that contains the number of stars. (The word “halo” means “round”). They fill slightly flattened spherical volume and are not moving on circular and highly elongated orbits. The plane of these orbits pass through the center of the Galaxy. In different areas they are distributed more or less evenly.

The disk and the halo surrounding it is immersed in the crown. If the radii of the disk and halo are comparable in magnitude, the radius of the crown in five, maybe ten times more. Why “maybe”? Yes, because it's invisible — it does not come any light. How found out about it then astronomers?

All bodies in nature, create the attraction and experience it. This is evidenced by the Law of gravitation discovered by Newton. Here and on the crown learned not light, and it created gravity. It acts on visible stars, for the light-emitting gas cloud. Watching the movement of these bodies, astronomers have noticed them except for the disk and halo acting something else.

Detailed study of this “something” and allowed, in the end, discover the crown, which creates an additional attraction. It was very massive — several times the mass of all stars belonging to the disk and halo.

Such information, obtained by the Soviet astronomer J. going and his staff in Tartu Observatory.

Of course, to study invisible crown is very difficult. Because of this, and not very accurate while estimates of its size and mass. But the main mystery is that we don't know what it is. We don't know if there's any star, even some

unusual, does not emit light.

Now many assume that its mass is formed not of stars, from the smallest elementary particles — neutrinos. These particles are known to physicists for a long time, but in and of themselves, they also remain largely mysterious. Is known about them, we can say the most important thing: do they have a rest mass that is the mass which a particle possesses when it is not moving and standing still. Most elementary particles have a mass.

This, for example, electron, proton, neutron, which consist of all the atoms. But the photon, quantum of light, it is not. Photons exist only in motion. Neutrinos could be used as material for the crown, but only if they have a rest mass.

It is easy to imagine how impatiently waiting astronomers news from the physical laboratories, which are now special experiments to determine whether neutrinos have rest mass or not. Perhaps physics and solve the mystery of the invisible crown.

X. worlds

The beginning of this century the boundaries of the explored Universe expanded so that it included the Galaxy. Many, if not all, thought that this huge star system is the whole universe in General.

But in 20 years he built a new large telescopes, and astronomers before opened unexpected horizons. It turned out that outside the Galaxy, the world ends. Billions of star systems, galaxies like our own and different from it, scattered here and there around the Universe.

Pictures of galaxies taken with the largest telescopes, striking beauty and a variety of forms: is and powerful vortices of stellar clouds, and the right balls and other star systems do not detect any defined forms, they are ragged and shapeless. All of these types of galaxies — spiral, elliptical, irregular, — named for its appearance in the photos, discovered by American astronomer E. Hubble in the 20-30-ies of our century.

If we could see our Galaxy from afar, it would appear we're not the same as on the schematic drawing on which we became acquainted with its structure. We would not see any disk or halo, nor, of course, the crown that and in fact invisible. From a distance would only see the brightest stars. And they all, as it turned out, gathered in a broad band that arcs out from the Central region of the Galaxy. The brightest stars form the spiral pattern. Only this pattern and would be visible from afar. Our Galaxy is in the picture, taken by astronomer from some of the stellar world, would look very similar to the Andromeda nebula.

Recent studies have shown that many large spiral galaxies possess — as our galaxy — the longest and the massive invisible crowns. This is very important: because if so, that means, and generally almost all the mass of the Universe (or, at least, the overwhelming part of it) is a mysterious, invisible but gravitating “hidden” mass.

Many and maybe almost all galaxies are collected in different groups, called groups, clusters and superclusters, all depends on how much of them there. The group may consist of only three or four galaxies, and the supercluster — up to thousands or even tens of thousands. Our Galaxy, the Andromeda galaxy and even more of the thousands of objects included in the so-called Local supercluster. It has no clearly defined shape.

Approximately the same is arranged and other superclusters, which is far from us, but quite clearly discernible in modern large telescopes.

Until recently, astronomers believed these objects — the biggest formation in the Universe and that some other large systems are not available. But it turned out that it is not.

A few years ago astronomers have made an amazing map of the Universe. It every galaxy is represented by just a point. At first glance, they are scattered randomly on the map. If you look closely, you can find groups, clusters and superclusters that look here chains of points. But what is amazing of all, the map reveals that some of these chains are connected and overlap, forming some sort of reticulated or honeycomb pattern, reminiscent of lace or maybe a honeycomb with cell sizes in the 100-300 million light years.

Cover such “grid” the entire Universe remains to be seen. But a few individual cells, delineated by superclusters, managed to study in detail. Within them galaxies is almost there, they all gathered at “the wall.”

Cell is advanced, the working title for the largest formation in the Universe. Larger systems in nature. It shows a map of the Universe. Astronomy has finally reached the completion of one of the greatest of its tasks: the whole sequence, or, as they say, the hierarchy of astronomical systems is now fully known. And yet...

XI. The universe

More than anything — the universe itself, covering and including all planets, stars, galaxies, clusters, superclusters, and cells. The range of modern telescopes up to several billion light-years.

Planets, stars, galaxies amaze us with the variety of their properties, the complexity of the structure. And how to construct the whole universe, the universe as a whole?

Its main characteristic is the uniformity. This can be said more precisely. Imagine that I have identified in the Universe is very large cubic volume with sides of 500 million light years. Calculate how many galaxies. Will produce the same estimates for other, but equally huge volumes located in different parts of the Universe. If all this is done and compare the results, it appears that in each of them, where they neither take contains the same number of galaxies. The same thing will happen when counting clusters or even cells.

The world appears the same everywhere — solid and homogeneous. Easier device ever. I must say that this people have long suspected. Pointing for reasons of maximum simplicity of the device on the overall homogeneity of the world, a great thinker Pascal (1623-1662) said that the world is a circle whose center is everywhere and circumference nowhere. So with the help of a visual geometric way, he argued, the homogeneity of the world.

In the homogeneous world of all places are equal and any of them can claim that it is the center of the world. And if so, then no center of the world does

not exist.

The Universe has another important property, but it never even guessed. The universe is in motion — it is expanding. The distance between clusters and superclusters is increasing. They seem to scatter from each other. A network of cellular structure is stretched.

At all times people preferred to believe the Universe is eternal and unchanging. This view prevailed until the 20-ies of our century. At that time it was believed that it is limited by the size of our Galaxy. The way can be born and die, the Galaxy is still the same as change in forest where generation after generation are replaced by trees.

The real revolution in the science of the Universe made in 1922-1924 works of Leningrad mathematician and physicist Alexander Friedmann. Relying on just created, then A. Einstein's General theory of relativity, he proved mathematically that the world is not something fixed and unchanging. As a whole he lives his life is dynamic, changes over time, expanding or Contracting of well-defined laws.

Friedman opened the mobility of the starry Universe. It was the theoretical prediction, and the choice between expansion and contraction needs to be done on the basis of astronomical observations. Such observations in 1928-1929 done by the Hubble, the well-known Explorer of galaxies.

He found that distant galaxies, and whole groups move away from us in all directions. But it should look like, in accordance with the predictions of Friedman, the General expansion of the Universe.

Of course, this does not mean that galaxies run away from us. Otherwise we would go back to the old beliefs, to coopernicus picture of the world with the Earth in the center. In reality, the total expansion of the Universe happens so that they all move away from each other, and from any location pattern of this recession looks as we see it from our planet.

If the universe is expanding, it means that in the past clusters were closer to each other. Moreover, from the theory of Friedman implies that fifteen to

twenty billion years ago no stars, no galaxies was not yet all matter was mixed and compressed to enormous density. This substance was then and it's extremely hot. Of such special state and began a General expansion that eventually led to the formation of the Universe, what we see and know it now.

The General idea of the structure of the Universe evolved throughout the history of astronomy. However, only in our century has been able to develop a modern science about the structure and evolution of the Universe — cosmology.

XII. Conclusion

We know the structure of the Universe in a huge amount of space for the intersection whose light requires billions of years. But the inquisitive human thought seeks to penetrate further. What lies beyond the borders of the observed area of the world? If the universe is infinite in volume? And its extension — why did it begin and will it always continue in the future? What is the origin of the “hidden” mass? And finally, how did intelligent life in the Universe?

If she was still somewhere other than our planet? The final and complete answers to these questions are not yet available.

The universe is inexhaustible. Indefatigable thirst for knowledge, forcing people to ask new questions about the world and aggressively seek answers.

History of constellation names

History of the constellations is very interesting. Still a very long time observers of the sky have combined the most vibrant and visible group of stars into constellations and gave them different names. These were the names of different mythical heroes or animals, characters of legends and myths — Hercules, Centaurus, Taurus, Cepheus, Cassiopeia, Andromeda, Pegasus, etc.

The names of the constellations Peacock, Toucan, Indian, South. Cross, Bird of Paradise reflected the era of the Great geographical discoveries.

Constellations very much — 88. But not all of them are bright and noticeable. Most richly bright stars of the winter sky.

At first glance, the names of many constellations seem strange. Often the arrangement of stars is very difficult or even impossible to consider what does the name of the constellation. The big dipper, for example, resembles a bucket, it is difficult to imagine in the sky or a Giraffe Trot. But if you look at old atlases of the sky, these constellations are depicted as animals.

What the ancient Greeks talked about the bears?

On Large and Small Females, there are many legends. Here is one of them. Once in ancient times, the king Lycaon, who ruled the country as an Arcadia, had a daughter named Callisto. Her beauty was so extraordinary that it dared to compete with the Hero — goddess and wife of the Almighty Supreme God Zeus. Jealous Hera eventually avenged Callisto: using his supernatural power, she turned it into an ugly bear. When the son of Kallisto, a young Arcade, one day returning from hunting, saw the door of his house of the wild beast, and he suspecting nothing, almost killed the mother bear. This prevented Zeus — he kept the hand arcade and Callisto took forever to his sky, turning it into a beautiful constellation of the Big Dipper. In a Small Bear at the same time were turned, and a pet dog Callisto. Left on Earth and Arcade games: Zeus and turned into the constellation Bootes, doomed forever to guard in heaven his mother.

The main star of this constellation is called Arcturus, which means “guardian of the bear”. The big and little dipper are the midnight constellations, the most visible in the Northern sky.

There is another legend about the circumpolar constellations. Fearing the evil God Kronos, who devoured the babies, the mother of Zeus, Rhea hid her newborn in a cave, where he was nurtured in addition to Amaltea goats, two bears Melissa and Gelika, subsequently placed it on the sky. Sometimes Melissa called Cynosura, which means “dog's tail”. In the legends of different peoples of the Big Dipper are often called the chariot, a cart, or just seven bulls.

Next to the star Mizar (from the Arabic word “horse”) is the second, or middle, star in the handle of the Big dipper — barely visible star Alcor (in Arabic it means “rider”, “rider”). These stars can check vision; every star should be visible to the naked eye.

HOW PERSEUS SAVED ANDROMEDA

The names of the sky reflected the myth of the hero Perseus. A long time ago, if you believe the ancient Greeks, Ethiopia was ruled by king named Cepheus and a Queen called Cassiopeia. They had only daughter, the beautiful Andromeda. The Queen was very proud of his daughter and once had the imprudence to boast of its beauty and the beauty of his daughter in front of the mythical inhabitant of the sea the Nereids. Those were very angry because they believed that they are the most beautiful in the world. Nereids complained to their father — God of the seas Poseidon, to punish Cassiopeia and Andromeda. And the mighty ruler of the seas was sent to Ethiopia is a huge sea monster — whale. From the mouth of a whale escaped the fire, ears poured black smoke, the tail was covered with sharp spikes. The beast ravaged and burned the country, threatened death to all people. To appease Poseidon, Cepheus and Cassiopeia agreed to give his beloved daughter to be eaten by the monster. The beautiful Andromeda was chained to a coastal rock and waited for his fate. And at this time on the other side of the world one of the most famous legendary heroes — Perseus — made an extraordinary feat. He came to the island where dwelt the Gorgon is a monster in the image of women, where the hair was crawling with snakes. The gaze of the Gorgon was so horrible that anyone who dared to look them in the eye, instantly petrified. But nothing could stop the fearless Perseus. Seizing the moment, when the Gorgon was asleep. Perseus cut off the head of one of them — the biggest, most terrible of all, the Gorgon Medusa. At the same time from a huge body of Medusa flew Pegasus, the winged horse. Perseus was mounted on Pegasus, and rushed home. Flying over Ethiopia, he saw the chained Andromeda to a rock that had to grasp the terrible kit. Brave Perseus battled with the monster. Long this struggle continued. Magic sandals, Perseus lifted him into the air, it stuck in the back of the kit your curved sword. Keith roared and rushed at Perseus. Perseus was sent on a monster deadening gaze of the severed head of Medusa, which was attached to his shield. The monster turned to stone and drowned, becoming the island. Perseus and Andromeda

relaxed and brought her to the Palace of Cepheus. Whereupon the king gave Andromeda the wife of Perseus. In Ethiopia many days went merry feast. And in the sky since then, burning the constellations Cassiopeia, Cepheus, Andromeda, Perseus. On the sky map you will find the constellation Cetus, Pegasus. So the ancient myths of the Earth reflected in the sky.

AS THE WINGED HORSE PEGASUS “FLEW” TO HEAVEN

Near Andromeda is the constellation of Pegasus, which is especially well visible at midnight in mid-October. Three stars of the constellation and the star alpha Andromedae form a shape that received the astronomers called “Big square” . It can be easy to find on the autumn sky. The winged horse Pegasus arose from the Perseus decapitated body of Medusa, but not inherited from her nothing wrong with that. He was a favorite of the nine muses — daughters of Zeus and goddess of memory, Mnemosyne, on the slopes of mount Helicon he struck with his hoof the source of Hippocrene water which brought poets inspiration.

Another legend, which is mentioned Pegasus. The grandson of the king of Sisifa Bellerophon had to kill the fire-breathing monster Chimera (Chimera — in Greek “goat”). Monster had the head of a lion, body of a goat and the tail of the dragon. The Bellerophon managed to slay the Chimera with aid of Pegasus. Once he saw the winged horse, and the desire to possess it covered the young man. In a dream appeared to him the goddess Athena, the favorite daughter of Zeus, wise and warlike, the patroness of many heroes. She gave Bellerophon a wonderful, calming the horses bridle. With its help, Bellerophon caught Pegasus and went to battle with the Chimera. High up in the air, he threw in a monster boom until it gave up the Ghost.

But his good fortune Bellerophon is not satisfied, and wished on a winged horse up into the sky, in the dwelling of the Immortals. Zeus, hearing this, was angry, led the Pegasus into a rage, and he threw his rider to the Ground. Pegasus then ascended to Olympus where were the lightning of Zeus.

The main attraction of the constellation Pegasus — bright globular cluster. In binoculars you can see a round glowing hazy spot, the edges of which sparkle like the city lights, visible from the aircraft. It turns out that this globular

cluster lies about six million suns!

THE MOST BEAUTIFUL CONSTELLATION OF THE SOUTHERN SKY

On the whole sky is no other constellation, which would contain so many interesting and easily accessible for observations of objects like the Orion, near the constellation of Taurus. Orion was the son of Poseidon, God of the sea in Greek mythology (Roman — Neptune) . He was a famous hunter, fought with the bull and boasted that no animal he could not win, for which Hera, the powerful wife of mighty Zeus, sent him the Scorpion. Orion cleared of wild beasts, the island of Chios, and begged the king of this island the hand of his daughter, but he refused. Orion tried to kidnap the girl, and the king blamed him: feeding drunk, he blinded Orion. Helios restored Orion's eyesight, but from the bite sent the Hero of the Scorpion Orion still died. Zeus placed him in heaven so that he can always get away from his pursuer, and, indeed, these two constellations at the same time the sky is not visible never.

WHERE IN THE SKY COMA BERENICES?

The ancient constellation Leo the sky was fairly large territory, and the lion was the owner of the magnificent “brushes” on the tail. But in 243 BC he lost it. There was a funny story, which legend has it.

The Egyptian king Ptolemy Evergete had a beautiful wife, Queen Veronica. Especially gorgeous was her luxurious long hair. When Ptolemy went to war, saddened by his wife swore to the gods that if they will retain her beloved husband, unharmed, to sacrifice their hair. Soon Ptolemy returned home safely, but upon seeing the shorn wife, was upset. The Royal couple somewhat reassured astronomer Conon, stating that the gods offered up the coma Berenices in the sky where they're meant to decorate the spring night.

TAURUS CONSTELLATION

In ancient times the most important was the constellation of Taurus, as the new year begins in the spring. In the zodiac the Taurus is an ancient constellation, because in the life of ancient peoples cattle played a huge role, and bull (Taurus) linked the constellation where the Sun was, like, whipping

the winter and Herald the arrival of spring and summer. Actually, many ancient peoples worshiped this animal, believed it to be sacred. In Ancient Egypt was the sacred bull APIs, who was worshipped during his lifetime and whose mummy was solemnly buried in the magnificent tomb. Every 25 years the APIs were replaced with a new one. In Greece, the bull was also treated with great affection. Crete of the bull called the Minotaur. Heroes of Hellas Hercules, Theseus, Jason pacified bulls. The Aries also was highly revered in ancient times. The Supreme God of the Egypt Amon-RA was depicted with a RAM's head, and the road to his temple was an Avenue of sphinxes with RAM heads. It was believed that the constellation of Aries is named in honor of the RAM with the Golden fleece for which the Argonauts sailed. In the sky, by the way, there are a number of constellations, reflecting the Ship Argo. The alpha star (the brightest) of the constellation called Gamal (Arabic for “adult sheep”). The brightest star in the constellation Taurus called Aldebaran.

WHERE IN THE SKY THE TWINS?

In this constellation of two bright stars located very close to one another. Its name they received in honor of the Argonauts Dioscuri — castor and Pollux the twin sons of Zeus, the mightiest of the Olympian gods, and Leda, frivolous earthly beauty, the brothers of Helen — the hero of the Trojan war.

Castor was famous as a skillful charioteer and Pollux as unsurpassed fist fighter. They participated in the campaign of the Argonauts and kalimanski hunting. But once the pair have not divided the prey with their cousins, the giants IDAs and Linkey. In a battle with them, the brothers were badly wounded. And when castor died, the immortal Pollux did not want to part with his brother and asked Zeus not to separate them. Since then, by the will of Zeus, the brothers spend six months in the gloomy Kingdom of Hades, and six months on Olympus. There are periods when one and the same day the star castor is visible in the background of the dawn, and Pollux — evening. Perhaps this circumstance has given rise to the birth of the legend of the brothers living in the realm of the dead in heaven.

Brothers the Dioscuri were considered in ancient times patrons of sailors caught in a storm. And the appearance on the masts of ships before the storm

“St. Elmo's fire” was considered a visit to the Twins, their sister Elena. St. Elmo's fire — a luminous discharge of atmospheric electricity observed on a pointed object (the top of the mast, lightning rod, etc.). Castor and Pollux were venerated as guardians of the state and patrons of hospitality.

In Ancient Rome, had a circulation silver coin “Dioscuri” with a picture of stars.

AS APPEARED IN THE SKY CANCER

The Cancer constellation is one of the most inconspicuous of the zodiac constellations. Its history is very interesting. There are some rather exotic explanations for the origin of the name of this constellation. So, for example, seriously argued that the Egyptians placed in this region of the sky Cancer as a symbol of destruction and death, because this animal feeds on carrion. Cancer is moving tail first. About two thousand years ago in the constellation of Cancer was the point of the summer solstice (i.e. the longest period of daylight). The sun, reaching this time limit removal to the North began to “back away” back. The day length is gradually decreased.

Classic ancient mythology, a huge sea Cancer attacked Hercules, when he fought the Lernaean Hydra. The hero crushed it, but the goddess Hera, who hated Heracles, placed Cancer at the sky.

The Louvre houses the famous Egyptian zodiac in which the constellation Cancer is above all others.

A TERRIBLE LION IN THE SKY?

About 4.5 thousand years ago in this constellation was the point of the summer solstice, and the Sun was in this constellation during the hottest time of the year. So many people was it that the lion was the symbol of fire.

The Assyrians called this constellation the “great fire” and the Chaldeans connected the ferocious lion with an equally fierce heat, Which was every summer. They believed that the Sun gets more power and warmth of being among the stars of Leo.

In Egypt was also associated this constellation with the summer period: the pack of lions escape the heat, migrated from the desert to the Nile valley, which at that time overflowed. Therefore the Egyptians placed on the blocked sluice gates of irrigation channels directing water to the fields, images in the form of a lion's head with open mouth.

VIRGIN

The constellation of Virgo near Leo, this constellation was sometimes represented by the fabulous Sphinx — mythical creature with a lion's body and woman's head. Often in the early myths of the virgin was identified with Rhea, mother of Zeus, the wife of the God Kronos. Sometimes it saw Themis, goddess of justice, which in its classic form, holds Libra (zodiacal constellation near Virgo). There is evidence that in this constellation the ancient observers saw Astrea, the daughter of Themis and Zeus, the last of the goddesses who left the Earth at the end of the bronze age. Astrea — goddess of justice, a symbol of purity and innocence, left the Earth because of the crimes of the people. We see a virgin in ancient myths.

Virgo is usually depicted with the rod of mercury, and spike. Spicy (in translation from Latin “ear”) named the brightest star of the constellation. The name of the star and the fact that the virgin is depicted with an ear of wheat in hand, indicates the Association of this star with the agricultural activities of man. It is possible that with the advent of it on the sky match the beginning of any agricultural work.

LIBRA IS THE ONLY “NON-LIVING” ZODIACAL CONSTELLATION

Indeed, it seems strange that among animals and “half-animal” in the zodiac is Libra. Over two millennia ago in this constellation was the point of the autumnal equinox. Equality of day and night could be one of the reasons why the zodiacal constellation called “Scales”.

The appearance of the sky the Scales in the middle latitudes indicated that the time of sowing, and the ancient Egyptians at the end of the spring can consider this as a signal to the beginning of the first harvest. Libra the symbol of balance — could just remind the ancient farmers of the need to weigh the

harvest.

The ancient Greeks Astrea — goddess of justice with Scales weighed the fate of people. One myth explains the appearance of the zodiacal constellation Libra as a reminder to people about the need to strictly comply with the laws. The fact that Astraea was the daughter of Almighty Zeus and the goddess of justice Themis. On behalf of Zeus and Themis Astraea regularly “inspected” the Ground (armed with weights and tying the bandage the eye in order to judge everything objectively, to provide Olympus good information and mercilessly punish cheaters, liars and all who dared to accomplish any kind of unfair actions) . So Zeus decided that the Scales of the daughter should be placed in the sky.

DOES THE CONSTELLATION LOOK LIKE A SCORPION?

Not only because of the resemblance of this constellation was assigned the role of poisonous creatures.

Sunshine entered into this region of the sky in late autumn, when all nature is as it were dead to once again rise, like the God Dionysus, in the early spring of the following year. The sun was considered to be “stung” by some poisonous creature (by the way, in this area of the sky there is a constellation of the Snake!), “sick” all winter, while remaining weak and pale.

According to classical Greek mythology, this is the Scorpion, which stung the giant Orion and was hidden by the goddess hero of the diametrically opposite parts of the celestial sphere. It was he, the celestial Scorpion, scared most unfortunate Phaeton, son of the God Helios, who decided to ride across the sky in his fiery chariot, not listening to the warnings of the father.

Other people gave this constellation its name. For example, for the Polynesians it was a fishhook that God Maun pulled from the depths of the Pacific ocean island of New Zealand. Maya is a constellation associated with the name of Algau, which means “Lord of darkness”.

According to many astronomers, the sign of Scorpio, the most ominous symbol of death. He seemed particularly terrible when it turned out to be

disasters planet — Saturn.

Scorpio is a constellation that often break out new stars, in addition, this constellation is rich with bright star clusters.

WHO AIMS A STAR SIGN OF SAGITTARIUS?

In Greek mythology, the wisest of centaurs Chiron, the son of the God Cronus and the goddess Themis, who created the first model of the celestial sphere. Thus one place in the zodiac he took for himself. But it is surpassed insidious centaur Krotos, who took a hoax his place and became the constellation Sagittarius. Chiron and the God Zeus transformed after death into the constellation of the Centaur. And so it was on the air as much as two and a centaur. Evil Archer is afraid of even the Scorpion, in which he aims the bow.

Sometimes you can see an image of Sagittarius as a centaur with two faces: one facing back, the other forward. This he resembles the Roman God Janus. The name of the associated Janus first month of the year — January. And the Sun is in Sagittarius during winter.

Thus, the constellation as it symbolizes the end of old and beginning of the new year, with one face looking to the past and the other in the future.

In the direction of the constellation Sagittarius is the center of our Galaxy. If you look at a map of starry sky, the milky Way passes through the constellation Sagittarius.

Like Scorpio, Sagittarius is very rich in beautiful nebulae. Perhaps this constellation more than any other deserves the title of “heavenly Treasury”. Many star clusters and nebulae are strikingly beautiful.

WHERE GALLOPING GOAT?

Capricorn — a mythical creature with the body of a goat and the tail of a fish. According to the most widespread ancient Greek legend, the goat-footed God pan, son of Hermes, patron of shepherds, scared one hundred head of the giant Typhon and jumped into the water. Since then, he became a water God,

and he grew a fish tail. Transformed by the God Zeus into the constellation, Capricorn became the Lord of the waters and the harbinger of storms. It was thought that he sends to earth an abundant rainfall. According to another legend — the goat Amalthea suckled her milk to Zeus.

The Indians called this constellation Makara, i.e., the magic dragon, also half goat, half fish. Some people portrayed his polychromatism — bird. Similar ideas existed in South America. When the Sun entered the constellation of Capricorn, the Indians celebrated the New year by wearing for ceremonial dance masks depicting a goat's head. But indigenous Australians called the constellation capricornus constellation Kangaroo, followed by chasing celestial hunters to kill it and roast on a big bonfire.

Many ancient peoples of the goat revered as a sacred animal, in honor of the goats committed worship. People were dressed in the sacred garments of goat skins and brought a gift to the gods, sacrificial goat.

With such traditions and with this constellation is connected with the idea of the “scapegoat” to Azazel. Azazel (Kozloduy) — the name of one of masloobraznyj of gods, demons of the desert. The so-called day of Kozloduy selected two goats — one for sacrifice, the other for the scapegoat into the wilderness. From the two goats by the priests chose, which God and which for Azazel. First, they offered a sacrifice to God and then the priest summed up the other goat, on which he laid his hands and thus would be passed to him all the sins of the people. And then the goat was released into the wilderness. The desert was a symbol of the underworld and a natural place for sins. The constellation of Capricorn is located in the lower part of the Ecliptic. Perhaps this caused the idea of the underworld.

In the constellation of Capricorn for about 2 thousand years ago was the point of the winter solstice. The ancient philosopher Macrobi believed that the Sun, having passed the lowest point, begins to climb like a mountain goat, striving for the top.

WHERE POURS WATER AQUARIUS?

This constellation was called Hydrogas the Greeks, the Romans — the

Aquarius, the Arabs — Sakib-al-mA. It all meant the same thing: a man pouring water. With the constellation of Aquarius is associated of the Greek myth about Deucalion and his wife pyrrha, the only people who survived the flood.

The constellation's name does “homeland of the flood” in the valley of the Tigris and Euphrates rivers. In some writings of the ancient people — the Sumerians — the two rivers are shown flowing from the vessel of Aquarius. The eleventh month of the Sumerians called “the month of the water curse.” According to the beliefs of the Sumerians, the constellation of Aquarius was in the center of “heavenly sea”, and so foreshadowed the rainy season. It was identified with the God, warned people about the flood. This legend of the ancient Sumerians similar to the biblical tale of Noah and his family — the only humans who survived the flood in the ark.

In Egypt, the constellation of Aquarius observed in the sky in the days of the highest water level in the river Nile. It was believed that the God of water Knemo Neil throws in a huge bucket. It was also considered that the vessels of God flow rivers White and Blue Nile — tributaries of the Nile.

It is possible that the constellation of Aquarius is a legend about one of the labors of Hercules — cleaning the Augean stables (which the protagonist needed to stem three rivers).

FISH OF THE LOCKING RING OF THE ZODIACAL CONSTELLATIONS

The location of the stars in the sky instills the idea of two fish, tied together with ribbon or rope. The origin of the name of the constellation Pisces is very ancient and, apparently, connected with the Phoenician mythology. In this constellation the Sun fit into the rich fishing. The goddess of fertility was depicted as a woman with a fish tail, which, as legend has it, came to her when she, along with her son, fearing the monster, rushed into the water.

A similar legend existed among the ancient Greeks. They believed that fish became Aphrodite and her son Eros: they walked along the banks of the river, but terrified by the evil Typhon, jumped into the water and escaped,

becoming a fish. Aphrodite turned into a southern Fish, and Eros in the North.

In the center of the Solar system is our daytime star — the Sun. Around him and his companions turn 9 major planets: mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto.

The age of the Solar system have been identified by scientists on the basis of laboratory isotopic analysis of terrestrial rocks and meteors and brought to Earth by spacecraft lunar soil samples. It turned out that the older ones have an age of about 4.5 billion years. It is therefore considered that all the planets formed about the same time — 4.5 — 5 billion years ago.

Venus, the second closest planet to the Sun, almost the same size as Earth, and its mass is more than 80 % of the earth's mass. Closer to the Sun than our planet, Venus receives from it in two times more light and heat than the Earth. However, the shadow side of Venus dominates the frost more than 20 degrees below zero as it does not get sunlight for a very long time. It has very dense, deep and very cloudy atmosphere, not allowing us to see the planet's surface. The atmosphere is a gaseous envelope, on Venus, discovered by M. V. Lomonosov, in 1761, which also showed the similarity of Venus with the Earth.

The average distance from Venus to the Sun 108.2 million km, and it is almost always because the orbit of Venus is closer to the circle than any other planet. Sometimes Venus is to the Earth at a distance less than 40 million km.

The ancient Greeks gave the planet the name of his best of the goddess Aphrodite, the Romans then pereinachili in their own way and named the planet Venus, which, in General, one and the same. However, it happened immediately. One time it was believed that the sky is just two planets. Rather than the stars, one bright, was visible in the morning, another one, the same in the evening. They even called in different ways, yet the Chaldean astronomers, after long observation and more much thought did not come to the conclusion that the star is still one that is a tribute to them as more skilled.

The light of Venus is so bright that if in heaven neither the Sun nor of the moon, it makes objects cast shadows. However, when viewed through a

telescope, Venus is disappointing, and not surprising that until recent years it was considered the “planet of mystery”.

In 1930 about Venus appeared some information. It was found that its atmosphere consists mainly of carbon dioxide, which can act as a kind of blanket, holding the heat of the sun. Was popular two pictures of the planet. One painted surface of Venus is almost completely covered with water, which could develop primitive forms of life, like it did on Earth billions of years ago. Another represented Venus as a hot, dry and dusty desert.

The era of unmanned space probes began in 1962 when the American spacecraft “Mariner — 2” passed near Venus and gave information which confirmed that its surface is very hot. It was also found that the period of rotation of Venus around the axis — long, about 243 earth days — longer than the orbital period around the Sun (224,7 days), therefore on Venus “day” longer than a year, and the calendar quite unusual.

We now know that Venus rotates in the opposite direction — from East to West, not West to East like Earth and most other planets. For an observer on the surface of Venus the Sun rises in the West and sets in the East, although in fact cloudy atmosphere completely covers the sky.

Following the “Mariner — 2” was made a soft landing on the surface of Venus several Soviet unmanned spacecraft descent by parachute through the dense atmosphere. It was the pressure at the surface is almost 100 times greater than the atmospheric pressure at sea level on Earth.

“Mariner — 10” close to Venus in February 1974, and gave the first pictures of the upper layer of clouds. This unit is only once passed near Venus — its primary purpose was the innermost planet — mercury. However, the pictures were high quality and showed a striped structure of clouds. They also confirmed that the period of rotation of the upper layer of clouds only 4 day, so that the structure of the atmosphere of Venus is not like earth.

Meanwhile, American radar research has shown that on the surface of Venus are large in size but small craters. The origin of the craters is unknown, but since in such a dense atmosphere should be a strong erosion of “geological

“standards, they are unlikely to be very old. The cause of the craters may be volcanic, so the hypothesis that Venus occur the volcanic processes could be excluded. Also on Venus are found in the mountainous areas. The largest mountain area — Ishtar — on the area twice Tibet. At its centre to an altitude of 11 km rises a giant volcanic cone. It was discovered that the cloud contains large amounts of sulfuric acid (perhaps even fluoride-sulfuric acid) .

The next important step was taken in October 1975 when two Soviet system — “Venera — 9 and Venera — 10” — made a controlled landing on the surface of the planet and transmitted to Earth pictures. The images were relayed orbital compartment stations remaining on circumplanetary orbit at an altitude of about 1500 km. It was a triumph of Soviet scientists, despite the fact that and “Venera — 9 and Venera — 10” led transmission just less than an hour, has not yet ceased once and for all to act because of too high temperature and pressure.

It turned out that the surface of Venus was covered with smooth rock fragments, composition is similar to terrestrial basalts, many of which were about 1 m in diameter. The surface was well covered: the description of Soviet scientists, light was as much as happens in Moscow in a cloud summer afternoon, so didn't even need the spotlights of the apparatus. Proved besides that the atmosphere does not have excessively high refractive properties, as expected, and all the details of the landscape were clear. The pressure is 90 times the pressure at the surface of the Earth. It was discovered, moreover, that the cloud layer ends at a height of about 30 km. Below is a region of hot caustic mist. At altitudes 50 — 70 km are a powerful cloud layers and blow Gale-force winds. At the surface of Venus the atmosphere is very dense (only 10 times less than the density of water).

Venus is not welcoming the world as it was once intended. With its carbon dioxide atmosphere, clouds of sulfuric acid and the terrible heat it is absolutely not suitable for a person. Under the weight of this information collapsed some hope: after all, less than 20 years ago, many scientists believed Venus more promising target for space exploration than Mars.

Venus has always attracted the views of science fiction writers, poets, scientists. About her and about her wrote a lot and probably even more will

write, and it is even possible that someday some of her secrets will be opened to man.

Modern science has a wealth of material on the physico-chemical basis of life, on ways that you could have a few billion years to lead to primitive organisms.

Chapter 1: the Origin of the Solar system (hypothesis of Schmidt)

The universe is so Grand that it is an honor to play even a modest role.

Harlow Shapley

Part 1: Cosmogony

Cosmogony is the science that studies the origin and development of celestial bodies such as planets and their satellites, the Sun, stars, galaxies.

Astronomers observe cosmic bodies in various stages of development formed recently and in the distant past, fast "aging" or almost "frozen" in their development. Comparing the numerous data of observations with the physical processes that can occur under various conditions in outer space, scientists are trying to explain how fuss cabins of a celestial body. A single, complete theory of star formation, planets or galaxies do not yet exist.

Problems faced by scientists, sometimes difficult to resolve. The question of the origin of the Earth and the Solar system as a whole is greatly hampered by the fact that other similar systems, we do not observe. Our solar system is nothing yet to compare, although the system like it should be quite common and their occurrence should not be random but natural phenomenon.

Currently, when testing a particular hypothesis about the origin of the Solar system is largely based on data on the chemical composition and age of the rocks of the Earth and other bodies in the Solar system. The most accurate method of determining the age of rocks consists in calculating the ratio of radioactive uranium to lead in a given rock. The speed of this process is known exactly, and cannot be changed by any means. The most ancient rocks have an age of several billion years. Earth as a whole, there must have been some time before the earth's crust.

In the middle of the eighteenth century German philosopher Immanuel Kant

proposed his theory of Solar system formation, based on the law of universal gravitation. She had expected the Solar system from a cloud of cold dust particles located in random chaotic motion. In 1796, French scientist P. Laplace described the hypothesis of formation of the Sun and planets of the already rotating gas nebula. Laplace took into account the main features of the Solar system which was supposed to explain any hypothesis about its origins. In this period the most developed is the hypothesis of O. Yu. Schmidt, developed in the middle ages (see parts 2-4) .

Part 2: Nebula

Let's fast forward to the distant past, about 7 billion years ago. Modern science, as scientists say, with a sufficient degree of probability allows us to represent those events. In one word, we "hang" in space and observe the life of one of the gas-and-dust, hydrogen and helium (with an admixture of heavy elements) nebulae. That which in the future will give rise to our Solar system, the Sun, the Earth and us with you. The nebula is dark and opaque like smoke. Sinister invisible slowly she crawls in front of a black abyss, and her ragged, blurred outlines we can only guess at how gradually fade and extinguish for it a distant star. After some time we find that the nebula slowly rotates around its center, barely noticeable turns. We notice that it gradually shrivels, shrinks, obviously, compressed. Operates the attraction, collecting to the center of the particles of the nebula. The rotation of the nebula while accelerating. If you want to understand the mechanics of this phenomenon, recall the simple example of the earth rotating on ice athlete-a figure skater. Making no incremental push, it accelerates its rotation only in that hand, before open to the side, close to her body. Works "the Law of conservation of momentum". There is time. The nebula spins faster. And from this, and there is increased centrifugal force, able to fight gravity. The centrifugal force is familiar to us. It is, for example, works in any bus, when on a steep inversion knocks standing passengers. A struggle between two forces, gravitational, centrifugal, starts in the nebula while accelerating its rotation. Gravity compresses the nebula, the centrifugal force tends to inflate it to break. But the attraction pulls the particles toward the center from all sides equally. And the centrifugal force is absent at the "poles" of the nebula and strongest at its "equator". Therefore, it is on the "equator" she is stronger than gravity and the nebula fanning out to the sides. The nebula, continuing to spin faster,

flattening out, the ball turns into a flat "cake" similar to a sporty drive. There comes a time when on the outer edges of the "disk" centrifugal force balances and then overcomes the attraction. Shreds of the nebula are starting to separate. The Central part of her continues to shrink, everything is speeding up its rotation and from the outer edge continues to move away all the new pieces, separate gas-dust cloud.

Part 3: The Birth Of The Sun

And here's the nebula took on a completely different look. In the middle of the majestically turns a dark, somewhat flattened cloud, and around it at different distances, floating in circular orbits that are located approximately in one plane, detached from it a small "cloud satellite". Follow the Central cloud. It continues to get thicker. But now with the force of gravity begins to fight a new force of the gas pressure. Indeed, in the middle of the cloud accumulates more particles of matter. There is caused "terrible distress" and "incredible crowd" particles. They are torn, stronger hitting each other. In the language of physicists — in the centre of the rising temperature and pressure. It gets warm, then hot. On the outside we do not notice it: the cloud is huge and opaque. Heat does not go out. But something happened inside! The cloud has ceased to shrink. A powerful force increased by heating the gas pressure stopped the work of gravity. Sharply smelled unbearable heat, such as from the mouth of a suddenly opened furnace! Deep black clouds began to weakly Shine through tearing out clubs dull red flame. They're getting closer and brighter. The balloon majestically boiling, stirring to break fire core black fog of its suburbs. Radiant heat causes us to pull back even far back. However, to break out, the hot gas has weakened opposition to gravity. The cloud began to shrink. The temperature in the center of it began to rise again. She has reached hundreds of thousands of degrees! In these circumstances, the substance may not even be gaseous. Atoms apart into their pieces. The substance enters the plasma state. But the plasma — crazy crush atomic nuclei and electrons — can't stand the heat indefinitely. When its temperature rises above ten million degrees, it seems to be "ignited". The impacts of the particles against each other becomes so strong that the nuclei of hydrogen atoms are already not bounce off each other like balls and bump into each other and merge with each other. Begins "nuclear reaction". Out of four nuclei of hydrogen atoms formed one nucleus of helium. This releases

enormous energy. Here is a "nuclear burning" of hydrogen began in our burning bowl. This "fire" is now unstoppable. "Plasma" raged. The gas pressure in the center to work with redoubled strength. The plasma breaks out, like steam from a boiler. With tremendous force it pushes from the inside to the outer layers of the ball and slows their fall to the center.

A balance of the

Plasma can't break the bowl, scattering its fragments to the side. And gravity can't break the plasma pressure and continue the pressing of the ball. Dazzling glowing white-yellow light ball went into a stable stage. He became a star. Became our Sun! Now it is billions of years without changing in size, not cooling and not overheating, Shine equally bright white-yellow light. While inside will not burn out all the hydrogen. And when it all turns into helium, will disappear "backup" inside the Sun, it will shrink. From this, the temperature in the interior to rise again. It is now up to hundreds of millions of degrees. But then "burns" the helium, turning into heavier elements. And compressing again will stop.

Have the stars several more nuclear reactions, which requires for its beginning an increasingly high pressures and temperatures. They are the kernel more complex and heavy elements. In the end, all possible reactions are exhausted. The star will shrink, become tiny "white dwarf". Then it will gradually cool fade. Finally, turn off altogether. Silent invisible will sail in space "black dwarf" cold "firebrand", the rest of the once powerful raging fire. As you can see from the raw material, hydrogen in the interiors of stars, nuclear fusion reactions are the nuclei of atoms of all elements. And I guess you could say that it was there, in the depths of stars, laid the beginning of life. After all, they have the nucleus of the "atom of life" carbon. And behind him, and the nuclei of the atoms of all other necessary for the life of the elements of the periodic table. It is not necessarily valuable "brew" is then buried in the cold "black dwarfs". Many stars formed from larger clusters of nebulae, the nuclear burning takes place too rapidly. The gas pressure is much stronger than gravity. It inflates the star, tearing it to shreds, scattering in all directions. These spectacular explosions in the world are sometimes observed from the Ground and flares are called "supernovas". The explosion scatters the star into interstellar space, enriching it in heavy elements. This is

the main source of that mysterious, vitally important impurities, which we talked about earlier. Now about the identification of this impurity.

Part 4: the Formation of planets

Back to the satellites of our Sun, to the fragments of the nebula, which broke away from the main bunch under the action of centrifugal force and began to whirl around him. Here, the conditions conducive to separation of light and heavy particles of the nebula. There is something similar to our ancient method of gold mining by washing out gold-bearing sand or winnowing grain threshing machines. A jet of air or water, carries light particles, leaving heavy. Clouds-the satellites are at very different distances from the Sun. Far it is barely warm. But in close, his heat evaporates all are able to evaporate. And its dazzling brightest light, working as a kind of "wind" blows all of them evaporated, and all light, leaving only the heavier stuff that "won't budge". Therefore, there is almost no light gases — hydrogen and helium, the main component of the gas-dust nebulae. Little remains and other "volatile" substances. All of this is carried away by hot "wind" into the distance. As a result, over time the chemical composition of clouds of satellites becomes quite different. Far, he has not changed. And Vtech that whirl close to exuding the heat and light of the Sun, leaving only "calcined" and "onduty" material — selected "precious vital admixture of" heavy elements. The material to create habitable planet ready. Starts the process of transforming the "material" in a product particle nebula — in the world.

a) the first stage is the coalescence

In the distant clouds-satellites many molecules of light rare gases and light dust particles gradually gather in huge loose balls low density. In the future, this group of the planet Jupiter. In the clouds-satellites close to the Sun, the heavy dust particles to clump together into a dense stony lumps. They come together in huge massive rocky boulders, a monstrous gray angular masses floating in orbit around its star. Moving in different ways, sometimes intersecting orbits of these asteroids, tens of kilometers in size every face. If a small relative velocity, how would "displace" one another "pile up", "stick" to one another. Merged into larger ones. If at speed, crumple, crumble each other, creating a new "little thing", countless fragments, fragments, which again go a long way associations. Hundreds of millions of years is the

merging process of small particles to the large celestial body. As you increase their size they become more spherical. Increasing the mass increases the force of gravity on their surface. The upper layers put pressure on internal. Protruding parts are a load more heavy and gradually sink into the underlying strata of the masses, pushing them under himself. Those in your hand, fill a basin. Rough "whom" is gradually smoothed out. The result is close to the Sun formed several relatively small in size, but very dense, consisting of very heavy material, terrestrial planets. Among them the Earth. They are all drastically different from the planets of group of Jupiter richness of chemical composition, abundance of heavy elements, high specific gravity. Now look at the Ground. In the starry background, lit from one side bright sunlight, floating in front of us a huge stone charise. It is still not smooth not smooth. Even sticking in some places the ledges slepushin it blocks. Even "read" not fully puffy "seams" between them. While it is still "rough work". But what is interesting. Already have atmosphere. A little unclear, apparently, from the dust, but no clouds. It is extruded from the bowels of the planet, hydrogen and helium, which at the time clung to the rocky particles, and miraculously survived, were not "blown away" by the solar rays. The initial atmosphere of the Earth. It will not last long. "By hook or by crook" the Sun will destroy it. Easy movable molecules of hydrogen and helium under the action of heating by the sun's rays will gradually dissipate into space. This process is called "dissipation".

b) Step two-warming up

Inside the planet, in combination with other are pressed, "locked" radioactive substances. They differ in that they continuously emit heat, a little noticeable heat. But in the thick of the planet, this heat has nowhere to go, no ventilation, no washing moisture. Above them, the powerful "coat" of the overlying layers. Heat builds up. This radioactive heating starts the softening of the entire thickness of the planet. In a softened form of the substance at the time chaotic, haphazard slavivshii it, starting now will be distributed by weight. Heavy gradually descend, sink to the center. Light squeezed them higher up closer to the surface. Gradually the planet gets the structure similar to the current Earth, in the center, balled monstrous weight leaning on top of the layers, the heavy nucleus. It is surrounded by a "mantle" thick layer of substances lighter weight. Finally, outside of the very thin thickness of only a

few tens of kilometers, "bark", consisting of the easiest rocks. Radioactive substances are mainly contained in the light breeds. So now they have accumulated in "the bark", keeping her warm. Most of the heat from the planet's surface out into space from the planet "a little breath of warmth." And at a depth of tens of kilometers heat is retained, warming the rocks.

C) the third Stage of volcanic activity

In some places the bowels of the planet heat up hot. Then even more. The rocks will melt, turning into a hot, glowing orange-white light of a fiery mess "magma". In thicker bark her closely. It is full of compressed gas that was ready to blow, to scatter all this magma in all directions in a fiery spray. But this is not enough. Too strong and heavy around and sitting on top of the crust of the planet. Fire and magma, trying somehow to escape upstairs to the freedom gropes her between the compression blocks weak spots, squeezes into cracks, podplyvaya their walls to their fever. And gradually over the years, the centuries, gathering strength, rises from the depths to the surface of the planet. And that's a victory! "Channel" is critical! Shaking the rocks, with a roar rises from the depths of the flames. Smoke and steam rise to the sky. Fly up stones and ashes. Fiery magma, now called lava, pours out on the planet's surface, spreads out to the sides. There is a volcanic eruption. Such "punched holes from the inside" on the planet a lot. They help young planet "to deal with overheating." Through them she is released from the accumulated fire of magma, breathed arching her hot gases — mostly carbon dioxide and water vapor, and various impurities such as methane, ammonia. Gradually in the atmosphere post has disappeared, hydrogen and helium, and it began to consist mainly of volcanic gases. Oxygen to it yet in sight. For life, this atmosphere is completely unusable. It is very important that volcanoes emit onto the surface a large quantity of water vapor. He's going into the clouds. Of them on the planet's surface the rains pour. Water flows in the lowlands, accumulates. And gradually on the planet, lakes, seas, oceans that can support life.

Here we have to mention. Of the several hypotheses of the origin of life most common, seeming to us the most reasonable, the hypothesis of spontaneous generation proposed by the academician A. I. Oparin (see Chapter 2)

Part 5: Why Earth?

And yet — on the Ground, is prepared to be our cradle. We were lucky. On earth coincided with several favorable living circumstances. Not every star becomes a Sun, surrounded by planets. Cost of nebula slowly rotate, there would be centrifugal force, I would not come off pieces from the main clot, there would be planets. And sailed so lonely "childless" star in a black abyss, fruitlessly wasting its heat and light... not every star that produced the planet, able to create conditions suitable for sustaining life. For the origin and development of life need a lot of time, billions of years. All this time the star has to burn evenly, quietly, in the same way. Then the conditions on the planet will be permanent — and life will be able to adapt to them. But because the stars are not so far, not all are as calm as our Sun. Young stars flare up sometimes. Wave radiant heat falls on the surrounding of the planet, burning, vaporizing everything able to burn and boil. Life on the planet after such a fiery hurricane, of course, will die, and the empty goal the ball will have to start all over again. For the development of life need a quiet star. Our Sun is a calm star. But put our Earth closer to the Sun, for example, in place of mercury or Venus. From the unbearable heat on the Earth will not even be able to form the oceans. The water just boils away. What kind of life. Move the Earth further from the Sun, somewhere in the area of Jupiter. Also life will not arise. Water the basis of life there will be always frozen. We are fortunate that the Earth's orbit is circular but could be elliptical. Now imagine that the Earth is approaching the Sun so close that the water from the surface all evaporates, is removed so far that the water falling from the atmosphere back to Earth freezes through. Using "comfortable" place where the temperature "at the time," she sweeps twice a year with such Celerity, that "nothing to do". For the origin and development of life in just no time. Such heat-cold can be not only on the ellipticity of the orbit. There are "double star". Then, for any orbit of a planet may not always be at equal distance from the heat source. Then one sun close, both far. We were lucky and in terms of the size of our planet. If it is less than, for example, the size of the moon, not to keep her on the atmosphere. And that means that the water tend to evaporate, turning into the atmosphere. How many volcanoes did not plant all new and new portions of gas and water, all of it will quickly evaporate into space. On the moon and therefore no atmosphere, no water, no life. Through the Earth, the size of, say, Jupiter. Uncomfortable due to too strong attraction.

Such a big "Land" will hold a layer of very dense atmosphere with hydrogen and helium, unfavorable to the emergence of life. A thick layer of very dense clouds create on this planet eternal darkness. And without the life-giving solar rays which might be life? In short, when we look at the sky, strewn with stars, we must not forget that, first, it is likely that not all stars have planets, and secondly, not all planets suitable for life. But... stars in our galaxy of about 100 billion, and it is probably enough planets similar to Earth.

Chapter 2: the Origin of life (hypothesis A. I. Oparina)

Long before we make contact with other intelligent beings living elsewhere in the galaxy, we must understand not only the place which we occupy, but we have traversed a long way.

John Bernal

Part 1: The Beginning

So, we have Earth. It has the ocean. Imagine it for myself. Rivers flowing into it, at first flows down mountainsides, along the way crumbling of the rock, and all that I can take out with you to the ocean. The atmosphere above the ocean is saturated with volcanic gases, dust, ashes. Waves, scattering the spray, capture all of that in your depth. As a result, the water in the primeval ocean, of a bitter, muddy. She is a real "broth", so many here just mixed and dissolved. Here you can find almost all the elements of the periodic table. Especially a lot of those are needed to create living beings. Warm water provides molecules and atoms good mobility, mixing, and contacts between them in various combinations. But for chemical reactions it is not enough. For them it is often necessary to "external" force. A push from the outside can help atoms and molecules to connect, can break molecules apart. Chemists to accelerate reactions often apply heat. Similarly, acts and nature. This work not only particles of light — photons, but also "cosmic rays" — fragments of atoms emitted by the distant stars that round-the-clock sweep through the atmosphere and digging into the depths of the ocean. Their attacks are particularly strong and more suitable for breaking of molecules.

Part 2: Flash of lightning

The sky was shrouded in dark clouds. They enter and accumulate electrical charges. They lunged towards each other. A blinding flash of lightning lit up the waves and cliffs. And in the water column sharply darted molecules knocked each other. Some of the strikes collapsed. But others joined. Subsided in the afternoon. Night came. Far from shore at the bottom of the ocean awakened the dormant volcano. Hot gases, escaping from its vents, dissolved in water, saturate it with new portions of carbon dioxide, methane, ammonia, sulfur dioxide. From the bowels of the planet went into a black abyss of fiery lava. Flashed a red glow, began to boil water. Clouds dazzling sparkling bubbles rushed up. Bubbled, lit from within in the darkness of night black waves. Thick clouds of steam engulfed them. "Broth" over the volcano was hotter and thicker. Spend heaps swam a new, fancy "clumps" of atoms — only that large molecules...

Part 3: Natural selection

Ocean waves with no end mix, rearrange the atoms of different combine them. Molecules are created and disintegrate. Again and again in every drop of the ocean of repeated billions of times already been tried and failed combination. Surely in such conditions it is possible at least some evolution? Possible. Themselves, without any plan or system, are different, what happens versions of the molecules. And then tested. Upstairs in the sky, was played in the afternoon. And we see a flash of lightning, sharehouses, falling apart, crumbling all weakly bound molecules. And those that survived this test of strength. At this stage chemical evolution of matter works as a kind of "natural selection". Evolution is in the direction of creating more sophisticated and durable molecules with new properties. And it brings the possibility to find further such forms and properties of the molecules that make the substance being. In chemical evolution of matter main role is played by carbon atoms. this is a special, irreplaceable item. Its atoms have a truly inexhaustible "potential". They are tetravalent (i.e. very high ability to attach the atoms and molecules of chemical elements etc.) that in the nuclear world are rare. Clinging to each other, they can form molecules in the form of rings or chains, while grabbing other atoms or molecules. And then the rings and chains grows "clusters" are grandiose, most complicated molecule in the form of branching trees, has a membership of many thousands of atoms of various elements. Today these molecules in nature countless options. Was not yet created. In a primordial ocean, we are experimenting. Front work wide —

the whole ocean. Atoms — as they want. Time — hundreds of millions of years. And that's a no-no, you get something interesting. Occurs accidentally some new combination of atoms, with progressive properties. And then a tiny step to the emergence of life is made. Making, may be just one such step for thousands of years, nature for a billion years, still a came to the origin of life. Let's try to keep in mind the most important of these steps. Skip a few million years and go back to the primordial ocean. In addition to the original small and primitive molecules, like methane, ammonia and carbon dioxide, with which it all began, in front of us now swimming in the water a lot of completely new, unfamiliar combinations of atoms. There was, for example, polymers — long chains of molecules. Sometimes the same, sometimes different. Appeared catalysts. This molecule helper molecules-mediators that facilitate the restructuring of other molecules. Through many millions of years we see that the simple polymers of steel polypeptides. Swim long, complex, branched filaments, consisting of amino acids. Their thousands of options. But the most striking appeared the copy process is molecular replication. It shaped the evolution. Before the chance combination of atoms, existing in one copy do not affect the course of the chemical evolution in General. Besides, she could at any moment be broken by a stray cosmic particle and the "invention" irretrievably lost. Now, in the replicating molecules, the "experience" is spreading and the death of some instances is not dangerous.

Part 4: Mutation

Replication does not inhibit progress as it may sound, filling the ocean of similar molecules. The fact is that if you copy sometimes fails. The source molecule or its matrix can damage. For example, near a gleaming zip. Will "mutation", and the injury begins to print all the copies, giving rise to a new series of molecules. "Mutants" is not always a marriage. It happens that some of them find valuable finds has advantages over the originals. Therefore, speaking jokingly, external forces don't damage the molecules, and make small changes in them, as if to see what would happen? The results of these natural experiments, nature evaluates practice. Natural selection ruthlessly negates all the millions of "stupid" options, leaving only one "smart". Eventually mutations contribute to increasing the diversity of molecules that help keep chemical evolution of matter.

Part 5: a New level of evolution

Pass millions of years. The nature of "felt" the best sequence of amino acids in the chain polypeptides — there are protein molecules — the future bricks of living organisms. Complicated and has become a perfect replication. The matrix now is not the mechanical form, and conventional, chemical "record" order of amino acids in a protein molecule. The entry in the form of a portable chain specific molecules — nucleotides. The evolution of the substance is raised to a new level. Long, intricately curved thread different protein molecules are clinging to each other and slowly going. First, in small lumps, then in larger clumps, like balls or drops. The molecules are closely adjoined in a lump different properties. Sometimes this leads to a kind of cooperation. For example, catalysts, caught in the midst of the molecules, can contribute to reactions that are useful for the clump as a whole. In other words, the clumps of protein molecules are, in some cases, "systems" capable of some internal activities. But the system is the system of strife. And, of course, begins the long journey of searching for the most successful combinations of molecules in them. Better, for example, those in which outside located rugged molecules. They serve as a mechanical protection for the rest. Better those that have activated molecules, capable of responding to hazardous impurities in the water. They serve as a chemical protection. But the most interesting are those cases in which proved to be good catalysts. Now, however, they need to call enzymes. These lumps starts more or less active "metabolism" with the environment. There is a capture material, splitting molecules, sometimes even with the release of energy, dispose of waste, restoration of damaged molecules. Even replication is the synthesis of protein chains. Metabolism property is very progressive. Such lump is very resistant to destructive external influences, independent, strong, durable. With great complexity, it becomes very tenacious — something to aspire to chemical evolution. The substance in it, in fact, acquired some of the properties of the living! Evolution of protein molecules leads to their specialization. In one example, it's better to go for the reaction energy, others clearly respond to changes in temperature, thirdly, well-established replication. And if we again skip the millions of years, we find in the ocean even more "giant" structures, each containing millions of molecules. Different types of lumps inside them in the form of individual parts. Now biologists call these parts organelles. And the whole structure is generally a

single-celled organism!

Remember history of life. Atoms — molecules — polymers — organelles single-celled creatures. Everything goes in the direction from simple to complex, to a variety of structures, forms, and properties. In living organisms, added a key new — a powerful desire for self-preservation, to longevity. Need better protection, better armament in the struggle for existence. Together, cells of this reach. The struggle for existence, in particular, contributes to the fascination of the variety of forms in the animal world. Sometimes it's far better not to engage in battle with the enemy, but just leave in a different "ecological niche", to change the way of life so that, even while remaining on the same plot of land, never to come into contact with the enemy. To stop competing with him. Not to do with him. To oppose the opponent strength, and a very special quality which gives new opportunities of livelihood. Will take a very long time and the world will be. Will appear, and will change the world in which he lives. He will learn to observe the stars, the planets of the Solar system, to build spacecraft and launch them into space. Many of these devices sit on the planets surface and back.

Chapter 3: Humanity and the search for

Mankind has achieved such success in astronomy, engineering, communications, Cybernetics, which has created a real technical background to establish communication with intelligent life of other worlds.

Academician V. A. Ambartsumian

Part 1: Civilization and its impact on space

The results of his work are already visible from space. This is confirmed by the astronauts, knowing the orbital stations, even roads and Railways, bridges, ships at sea. They see it with the naked eye, and therefore the moon the same can be seen in a telescope a thousand times, what are our observatories. The Martians, if they existed, even armed with technology equivalent to our own, easily found our city, the smoke of industry, spacecraft, testing of atomic bombs. on closer observation, they would have noticed artificial sea and irrigation canals. Well, the work of television

stations can be detected from other planetary systems. People in the world of stars. Civilization. Community of intelligent beings, which grew over billions of years of lumps of mucus, crawling in muddy puddles. Sentient beings, penetrating into the depths of the atom and the given Universe, to know the structure of stars and the mystery of the living cell, who know the laws of its evolution!

Part 2: a New age — a new solution

In every age people in their dreams, solved the problem of dealing with aliens, on the basis of the technology of the time. Until the XVIII century, people believed that for a flight to the stars sufficient energy to muscles, and their Pets. And so, even fantasizing, the only thing they could offer — it's only the crew pulled in... a flock of birds. That air will end as soon as "fly away from home", our ancestors did not know. They did not imagine and the vast distances separating us from the moon and planets, not to mention the distances to stars. Then, by measuring these distances and know that heavenly body parts are almost empty, airless space, began to dream at least about the mutual signaling.

In the nineteenth century, only some hundred years ago all seriously believed in the existence of Martians. And then, quite seriously, scientists speculated about optical communication with them. Mathematician Carl Gauss was asked to hack into the Siberian forests multimeter clearing in the shape of a triangle and to sow it with wheat. The Martians will see in your telescope on a background of dark green forests, bright, neat triangle, and realize that blind nature could not do. So on this world are sentient beings. To many the idea of Gauss is like, but to show the Martians that the earthlings are highly offered on the sides of the triangle to make the squares to fit the pattern of the Pythagorean theorem. This project had significant drawbacks. After all, Siberia is often covered by clouds and snow, and the triangle may long remain unnoticed by the Martians. And most importantly, even in good weather it will be possible to see only during the day. Therefore, a more correct thought of the Viennese astronomer Josef Johann von Liter. He proposed in the Sahara desert, where it is always rosy to dig channels in the form of regular geometric shapes (perhaps the Pythagorean theorem) . The sides of the polygon should be at least thirty kilometers. And at night on top

of the water to pour kerosene and set fire. Fire stripes draw on the night side of the planet, a striking drawing. So the Martians are unable to ignore it. But this project was rejected as too expensive. The Frenchman Charles CROs suggested a much cheaper method of communication. He advised his government to build a huge battery of mirrors to reflect sunlight toward Mars. Bunny, of course, would be blindingly bright. Project Charles CROs had a very big advantage compared to the rest. Mirrors can move, and then when you look from Mars the dazzling bright spot on the Ground winked. And most importantly, the flashing can be sent by the Martians of the message. Naive! And that was recently, in the life of our ancestors. Meanwhile created a number of science fiction devoted to moving between planets. The most famous of them, "From guns to the moon" Jules Verne and the "war of the worlds" by Hg wells.

With the development of rocketry in the postwar years, and most importantly, the launch of the first artificial Earth satellite in 1957 gave a powerful impetus to the old dream of mankind of the interplanetary flights. Gushed a flow of a variety of science fiction. Fly to Venus and Mars, the heroes of books have become easily fly to the stars, furrowing already a huge interstellar ships vast expanses of the Galaxy, fighting with the most different space of evil spirits and villains. But here again, for the umpteenth time, a rigorous analysis of the cooled dreamers. Modern missiles fuelled by chemical fuel, are made of the most durable and lightweight materials, the engine "squeezed" for almost everything, but it does limit our dreams of flying to Mars or Venus. And all the flights within the Solar system is real. But we have no hope to meet here an intelligent being. There are chances to find them in other planetary systems around other stars. But on the flight to the stars on modern missiles is meaningless to say: the flight to the nearest star (besides the Sun) is alpha Centauri will last 80 thousand years at a speed of 17 kilometers per second.

Chapter 4: Solar system: composition and characteristics

We are glad the mystery that is beyond our reach...

Harlow Shapley

The Solar system includes the Sun, 9 large planets along with their satellites

34, more than 100 thousand minor planets (asteroids) , about 10 to 11 degrees of comets, and countless small, so-called meteoroids (diameter from 100 meters to infinitesimal specks) . The Central position in the Solar system is the Sun. Its mass is approximately 750 times greater than the mass of all other bodies included in the system. The gravitational pull of the sun is the main force that determines the motion of all orbiting his Solar system bodies. The average distance from the Sun to the farthest from it of the planet Pluto is 39.5. E., i.e. 6 billion kilometers, which is very small compared with the distances to the nearest stars. Only some of the comet away from the Sun at 100 thousand. E. and are exposed to the attraction of the stars. Moving in the Galaxy, the Solar system from time to time flies through interstellar gas and dust cloud. Due to the extreme sparsity of these substances clouds the immersion of the Solar system to the cloud can appear only in case of small absorption and scattering of sunlight. Manifestations of this effect in the past history of the Earth is not yet established. All the big planets — mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto revolve around the sun in one direction (in the direction of axial rotation of the Sun) , in nearly circular orbits little inclined to each other (and to the solar equator) . The plane of earth's orbit — the Ecliptic is taken as the basic plane of the reference orbit of the planets and other bodies orbiting the Sun. Distances from planets to the Sun form a logical sequence — the intervals between the orbits increases with distance from the Sun. These laws of planetary motion in conjunction with dividing them into two groups on the physical properties indicate that the Solar system is not a random collection of cosmic bodies, and arose in a single process (see Chapter 1) . Thanks to the almost circular form of the planetary orbits and large spaces between them eliminated the possibility that close encounters between planets, with which they could significantly change their movement as a result of mutual attention. This ensures the continued existence of a planetary system. Planets rotate the same about its axis, and almost all of the planets except Venus and Uranus rotating in the same direction as their circulation around the Sun. Extremely slow rotation of Venus takes place in the opposite direction, and Uranus rotates as if lying on its side. Most satellites orbit their planets in the same direction, in which the axial rotation of the planet. The orbits of these satellites are usually circular and lie close to the plane of the equator of the planet, forming a reduced semblance of the planetary system. Such, for example, the system of satellites of Uranus and the system of Galilean satellites of Jupiter. Backward

movements have satellites far from the planet. Saturn, Jupiter and Uranus in addition to individual satellites visible sizes have many small satellites, as it merges into a continuous ring. These satellites move in orbits so close to the planet that its tidal force do not allow them to unite into a single body. The vast majority of the orbits of minor planets now known is located between the orbits of Mars and Jupiter. All the small planets revolve around the Sun in the same direction as the big planets, but their orbits are usually elongated and inclined to the plane of the Ecliptic. Comets move in orbits mainly close to parabolic. Some comets have elongated orbits relatively small — in the tens and hundreds. E. These comets, called periodic, dominated by straight movements, i.e. movement in the direction of rotation of planets. Being a revolving system of bodies, the Solar system has angular momentum (MKD) . The main part of it is related to the orbital motion of planets around the Sun, and the massive Jupiter and Saturn give about 90%. Axial rotation of the Sun encompasses only 2% of the total MKD entire Solar system, although the mass of the Sun constitutes over 99.8% of the total mass. Such a distribution of the MCD between the sun and the planets associated with the slow rotation of the Sun and the huge size of the planetary system — its diameter is several thousand times the diameter of the Sun. MKD planet has acquired in the course of his education: he passed to them from the substances from which they were formed (see Chapter 1) . The planets are divided into two groups, differing in mass, chemical composition (this is manifested in the differences of their density) , speed of rotation and number of satellites. Four planets closest to the Sun, the Terrestrial planets are small, have dense rocky matter and metals. The giant planets — Jupiter, Saturn, Uranus and Neptune is much more massive, are composed mainly of light substances, and therefore, despite the huge pressure in the subsoil, have a low density. Jupiter and Saturn the main proportion of their mass is composed of hydrogen and helium. They contain also up to 20% of rocky substances and light compounds of oxygen, carbon and nitrogen, are able at low temperatures to concentrate in the ice. The subsurface of the planets and some satellites are in hot condition. You have terrestrial planets and satellites due to the low thermal conductivity of the outer layers of the internal heat leaks out very slowly and has no significant impact on surface temperature. The giant planets convection in the subsoil leads to significant heat flow from the depths, transcending the stream it receives from the Sun. Venus, Earth and Mars have atmospheres consisting of gases released from their interiors. The

giant planets atmospheres represent a direct continuation of their resources: these planets do not have solid or liquid surfaces. When you dive inside the atmospheric gases are moving in the condensed state. Ninth planet, Pluto, apparently, cannot be attributed to any of the two groups. By chemical composition it is close to the group of giant planets and the terrestrial to the group. The nuclei of comets by their chemical composition akin to planets-giants: they consist of water ice and ICES of various gases with an admixture of stony substances. Almost all minor planets in its modern composition belong to the rocky planets of terrestrial group. Relatively newly opened Giron, moving mainly between the orbits of Saturn and Uranus, probably similar to the icy nuclei of comets, and small satellites far from the Sun the planets. Fragments of small planets, produced by their collision with each other, occasionally fall on Earth as meteorites. Small planets, owing to their small sizes, depths, fueled by much less than the terrestrial planets, and therefore their substance is often has undergone only minor changes since their formation. Measuring the age of meteorites (the content of radioactive elements and their decay products) have shown that they, and consequently the entire Solar system is about 5 billion years. The age of the Solar system is in agreement with measurements of ancient terrestrial and lunar samples.

Part 1: The Sun

The sun is the Central body of the Solar system — is a glowing plasma ball. Sun — the closest star to Earth. The light from it reaches us in 8.3 minutes the Sun is decisively influenced the formation of all bodies in the Solar system (see Chapter 1) and created the conditions that led to the emergence and development of life on Earth (see Chapter 2) . Its mass is 333 000 times the mass of Earth, and 750 times more massive than all other planets combined. In 5 billion years the Sun about half of the hydrogen in its Central part turned into helium. As a result of this process is allocated the amount of energy that the Sun radiates into space. The power output of the Sun is very large: about $3,8 \cdot 10^{26}$ degree MW. The Earth gets a tiny part of the Solar energy component of about half a billionth. It supports in the gaseous state of the earth's atmosphere, constantly heats the land and water, gives energy to the winds and waterfalls, provides vital functions of animals and plants. Of solar energy stored in the bowels of the Earth in the form of coal, oil and other minerals. Visible from Earth diameter of the Sun varies slightly

due to the ellipticity of the orbit and is an average of 1 392 000 km (109 times the diameter of Earth) . The distance to the Sun is 107 times greater than its diameter. The sun is a spherically symmetric body in equilibrium. Everywhere at equal distances from the center of this ball physical conditions are the same, but they change significantly as you get closer to the center. The density and pressure increase rapidly inland, where the gas is compressed stronger than the pressure of the overlying layers. Consequently, the temperature also increases as it approaches the center. Depending on changes in the physical conditions of the Sun can be divided into several concentric layers, gradually passing into each other.

In the center of the Sun the temperature is 15 million degrees and the pressure exceeds hundreds of billions of atmospheres. Here the gas is compressed to a density of about 150 000 kg/m, Almost all the energy of the Sun is generated in the Central region with a radius of about 1/3 solar. Through the layers surrounding the Central part, this energy is transmitted outwards. During the last third of the radius is the convective zone. The cause of mixing (convection) in the outer layers of the Sun is the same as that in a boiling kettle: the amount of energy supplied from the heater, much more of which is assigned a conductivity. Therefore, the substance is forced in motion and begins to transfer heat. The core and convective zone is not actually observed. Of their existence known either from theoretical calculations or on the basis of circumstantial evidence. Over the convective area is located directly observable layers of the Sun, called its 1 Atmosphere to 0. They are better studied, because their properties can be inferred from the observations.

a) the Solar atmosphere

the same consists of several different layers. The most profound and subtle of them is the photosphere, directly observable in the visible continuous spectrum. The thickness of the photosphere is about 300 km. the deeper layers of the photosphere, so they are hot. In the outer cooler layers of the photosphere in the background of the continuous spectrum are formed Fraunhofer's absorption lines. During the most calm of the earth's atmosphere to observe the characteristic granular structure of the photosphere. Stripping little specks of light granules with a size of about 1000 km, is surrounded by dark intervals, creates the impression of cellular structure — granulation. The appearance of the granulation related to what's happening below the

photosphere by convection. Individual granules at several hundred degrees hotter surrounding gas, and in a few minutes, their distribution over the solar disk changes. Spectral measurements indicate the movement of gas in the granules, similar to the convection in the granules of the gas rises, and in between is omitted. This movement give rise to gases in the solar atmosphere acoustic wave, similar to sound waves in the air. Extending in the upper layers of the atmosphere, waves, arising in the convective zone and the photosphere, convey them a part of the mechanical energy of the convective motions and produce heated gases subsequent layers of the atmosphere — chromosphere and corona. As a result the upper layers of the atmosphere with a temperature of around 4500K are the most "cold" in the Sun. How far inland and up from them the temperature of the gases is growing rapidly. Located above the photosphere is a layer called the chromosphere during total solar eclipses in those moments when the Moon completely covers the photosphere, is visible as a pink ring surrounding the dark disk. On the edge of the chromosphere are observed protruding flame — chromosphere spicules, representing elongated columns of compacted gas. Then you can observe the spectrum of the chromosphere, the so-called flash spectrum. It consists of bright emission lines of hydrogen, helium, ionized calcium and other elements that suddenly breaks out during a full phase of the blackout. Highlighting the Sun's radiation in these lines, you can get a picture of him. The chromosphere differs from the photosphere is much more irregular inhomogeneous structure. Noticeable are two types of heterogeneity — bright and dark. In size they exceed the photospheric granules. In General, the distribution of inhomogeneities forms a so-called chromosphere the grid is especially noticeable in lines of ionized calcium. As granulation, it is a consequence of the movement of gases in podvoloshino the convection zone, only occurring on a larger scale. The temperature in the chromosphere is rapidly growing, reaching in the upper layers of the tens of thousands of degrees. The top and the low part of the solar atmosphere — the corona can be traced from the solar limb to a distance of dozens of solar radii, and having a temperature of about a million degrees. The crown can be seen only during a total solar Eclipse or with a coronagraph. The whole solar atmosphere is constantly fluctuating. It is subject to both vertical and horizontal waves with lengths of several thousand kilometers. Fluctuations are resonant in nature and occur with a period of about 5 min In the occurrence of phenomena occurring on the Sun play a great role of the

magnetic field. Substance everywhere in the Sun is a magnetized plasma. Sometimes in certain areas the magnetic field quickly and greatly increased. This process is accompanied by the appearance of the whole complex phenomena of solar activity in different layers of the solar atmosphere. These include torches and spots in the photosphere, flocculi in the chromosphere, prominences in the corona. The most remarkable phenomenon, encompassing all layers of the solar atmosphere and emerging in the chromosphere, are solar flares (see Solar activity) .

b) radiation from the Sun

The radio emission of the Sun has two components fixed and variable. During a strong solar flare radio emission of the Sun increases into the thousands and even millions of times in comparison with the radio emission of the quiet Sun. X-rays originate mainly from the upper atmosphere and corona. Particularly strong radiation is in the years of maximum solar activity. The sun emits not only light, heat and all other forms of electromagnetic radiation. It is also the source of the permanent flow of particles — corpuscles. Neutrinos, electrons, protons, alpha particles, and heavier atomic nuclei are corpuscular radiation of the Sun. A significant part of this radiation is a more or less continuous outflow of plasma, the solar wind, which is a continuation of the outer layers of the Solar atmosphere — the solar corona. Against this background, the plasma constantly blowing wind separate areas on the Sun are sources of a more directed, enhanced, the so-called corpuscular streams. Most likely they are associated with particular regions of the Solar corona by corona holes, and possibly with long-lived active regions on the Sun (see Solar activity) . Finally, with solar flares the most powerful associated intermittent stream of particles, mainly electrons and protons. The result is the most powerful flares the particles can gain speed, which constitute a considerable fraction of the speed of light. A particle with such large energies are called solar cosmic rays. Solar corpuscular radiation has a strong influence on Land, especially on the upper layers of its atmosphere and magnetic field, causing many interesting geophysical phenomena.

C) Solar activity

Solar activity — a set of phenomena that could occur in the solar atmosphere. Influence of solar activity closely associated with magnetic properties of the solar plasma. The emergence of an active region begins with the gradual increase of magnetic flux in some area of the photosphere. In the appropriate places chromosphere then there is an increase of brightness in the lines of hydrogen and calcium. Such areas are referred to as flocculate.

Approximately the same areas on the Sun's photosphere (i.e., somewhat deeper) in this case also, an increase in brightness in white (visible) light — torches. The increase of energy released in the region of the torch and floccula is a consequence of increased up to several tens extrat magnetic field. Then, in the solar activity observed sunspots occurring 1-2 days after the appearance of flocculi in the form of small black dots since. Many of them will soon disappear, and only a few pores in 2-3 days turn into large dark education. A typical sunspot has a size of several tens of thousand kilometers and consists of a dark Central part — shade and semi-shade fibrous. A crucial feature of the spots is the presence of strong magnetic fields are appeared in the shadow of the highest tension in a few thousand extrat. In General, the spot is a emerging into the photosphere up of the magnetic field lines, completely filling one or more cells chromospheres mesh (see the Solar atmosphere). The upper part of the tube expands and the lines of force it apart, like ears of corn in the sheaf. Therefore, the shadows around the magnetic field lines take the direction close to the horizontal. Full, the total pressure in the spot includes a magnetic field pressure is balanced by the pressure of the surrounding photosphere, therefore the gas pressure in the spot is smaller than in the photosphere Magnetic field as it expands the stain from the inside. In addition, the magnetic field suppresses the convective motion of the gas, transferring energy from the depths up. Consequently, in the region of the spot temperature is less than about 1000K. Blemish chilled and constrained by a magnetic field hole in the solar photosphere. Most of the spots occur in groups, in which, however, there are two large spots. One, the largest, in the West, and the other a little smaller — in the East. Around and among them often many small spots. This group of spots is called bipolar because both large spots are always the opposite polarity of the magnetic field. As if they are connected to the same tube of magnetic field lines, which in the form of a giant loop emerged from under the photosphere, leaving the ends somewhere in the unobservable, deeper layers. The spot, which corresponds to the output of the magnetic field from the photosphere, has a

North polarity, and in which power lines enter back into the photosphere, the South.

The most powerful manifestation of the photosphere — is a flash. They occur in relatively small areas of chromosphere and corona, located above groups of sunspots. Essentially, flash is an explosion caused by the sudden contraction of the solar plasma. Compression occurs under the pressure of the magnetic field and leads to the formation of long plasma string or ribbon. The length of such education in the tens and even hundreds of thousands of kilometers. Flash usually lasts about an hour. Although details of the physical processes leading to the occurrence of outbreaks has not been studied, it is clear that they are of an electromagnetic nature.

The most ambitious formations in the sun's atmosphere prominences are — relatively dense clouds of gases that occur in the solar corona or emitted from the chromosphere. A typical prominence has the appearance of a giant glowing arches, resting on the chromosphere and formed by the jets and flows more thick and cold than the surrounding corona, of the substance. Sometimes this substance is retained caved under its weight to the magnetic field lines, and sometimes slowly flows along magnetic field lines. There are many different types of prominences. Some of them are associated with the explosive emission of matter from the chromosphere to the corona.

The overall activity of the Sun, characterized by the number and power of the manifestations of centers of solar activity changes periodically. There are many different convenient ways to assess the level of solar activity. Usually use the most simple and put before all method — the wolf numbers. The number of wolf proportional to the sum of the total number of spots observed at the moment in the Sun, and redoubled the number of groups that they form. The period of time when a number of the greatest centers of activity called solar maximum and when they do no or almost no minimum. Highs and lows alternate with an average period of 11 years. This is the so-called 11 5-year cycle of solar activity.

d) the Solar corona

- the most external, very rarefied layers of the solar atmosphere. During the total phase of a solar Eclipse around the moon disk, which closes from the

observer the bright photosphere, suddenly as if flashing a pearly radiance. This is several tens of seconds becomes visible solar corona. An important feature of the crown is its radiant structure. Beams come in different lengths, up to ten or more solar radii. The General form of the corona changes with the phase of solar activity cycle: in the years of maximum the corona is almost spherical, in the years of minimum it is strongly elongated along the equator. Corona is a highly rarefied vysokovitaminnye plasma with a temperature of 1-2 million degrees. The reason for such a large heating of the solar corona associated with wave motion occurring in the convective zone of the Sun. The color of the corona is almost identical with light radiation of a Sun. This is because free electrons in the corona and the resulting strong ionization of the gases, dissipate the radiation from the photosphere. Because of the huge temperature particles moving so fast that the collisions of the atoms fly away from the electrons, which begin to move as free particles. As a result, light elements completely lose all their electrons, so that the crown is almost no hydrogen or helium, but only protons and alpha particles. Heaviest elements lose up to 10-15 outer electrons. For this reason, in the solar corona observed unusual spectral lines, which long time could not be identified with known chemical elements. Hot plasma strongly emits and absorbs radio waves. Therefore, the observed solar radio emission at meter and decimeter waves occur in the solar corona. Sometimes in the solar corona observed region of reduced luminescence. They are called coronal holes. Particularly well these holes visible on the pictures in x-rays.

d) the diameter of the Sun

Accurate measurements show that the diameter of the Sun is not constant. About fifteen years ago astronomers discovered that the Sun loses weight and gains weight for a few miles every 2 hours and 40 minutes, and this period is maintained strictly constant. With a period of 2 hours and 40 minutes for a fraction of a percent change and the luminosity of the Sun, i.e. the energy radiated by it. Specify that the diameter of the Sun is experiencing very slow oscillations with significant scale, were obtained through analysis of the results of astronomical observations made many years ago. Accurate measurement of the duration of solar eclipses and the passage of mercury or Venus over the disk of the Sun showed that in the XVII century the diameter of the Sun exceeded the present by about 2000 km, that is 0.1%.

Part 2: the terrestrial Planets

The terrestrial planets — mercury, Venus, Earth and Mars differ from the giant planets smaller dimensions, smaller mass. They move inside belt minor planet. Within the same group of planets similar in such physical characteristics as density, dimensions, chemical composition, but one group differs from another. Each planet has its own unique features.

Mercury is the closest planet to the Sun in the Solar system. Located at a distance of 58 million km from the Sun. A complete revolution in the sky finishes for 88 days. Because of the proximity to the Sun and the small apparent size of mercury has long remained poorly explored planet. Only in 1965 through the use of radar has been measured the period of rotation of mercury around its axis, caught equal 58,65 days ie $\frac{2}{3}$ of its revolution around the Sun. This rotation is dynamically stable. A solar day on mercury is 176 days continue. The rotation axis of mercury is almost perpendicular to the plane of its orbit. As suggested radio observations of the surface temperature of mercury at the point where the Sun is at the Zenith reaches 620 K. the Temperature of the night hemisphere of about 110 K. using the radio observations were able to determine the thermal properties of the outer casual of the planet who were close to the properties tekortkoming Parodi lunar regolith. The reason for this state of rocks, apparently, are continuous blows of meteorites, almost not to weaken the rarefied atmosphere of mercury. Photographing the surface of mercury by the American spacecraft "Mariner-10" in 1974-1975 showed that mind planet resembles the moon. The surface is littered with craters of different sizes, and their distribution on the size of the diameter similar to the distribution of craters of the moon. This suggests that they were formed by intense meteorite bombardment billions of years ago in the early stages of planet evolution. There are craters with bright rays, with a Central slide and without them, with dark and light bottom, with sharp outlines shafts (young) and dilapidated (ancient). Discovered the valley, reminiscent of the famous Valley the Alps are not the moon, smooth round plain, called pools. Most of them Kaloris — has a diameter of 1300 km. the Presence of dark matter in pools and lava-flooded craters suggests that in the initial period of its existence the planet has experienced a strong warming, followed by one or more periods of intensive volcanic activity. The atmosphere of mercury is very weak compared to earth's atmosphere.

According to the data obtained with the "Mariner 10" points, its density does not exceed the density of the earth's atmosphere at an altitude of 620 km. In the composition of the atmosphere discovered a small amount of hydrogen, helium and oxygen are present and some inert gases such as argon and neon. Such gases could be allocated as a result of decay of radioactive substances in the composition of the soil of the planet. Discovered a weak magnetic field, the tension of which is less than that of the Earth, and greater than that of Mars. The interplanetary magnetic field interacting with the nucleus of mercury, can create electric currents. These currents and the movement of charges in the ionosphere, which is mercury weaker compared to the earth, unable to maintain the planet's magnetic field. Interacting with the solar wind (see solar Radiation) , it creates the magnetosphere. The average density of mercury is much higher and the moon almost equal to the average density of the Earth. It is hypothesized that mercury has a powerful silicate shell (500 — 600 km), and the remaining 50% of the volume is a ferrous core. Life on mercury because of the very high daytime temperatures and lack of liquid water cannot exist. Moons mercury has not.

Venus — the second distance between the Sun and the closest planet to Earth in our Solar system. The average distance from the Sun 108 million km orbital Period around it — 225 days. During the bottom of the joints to approach the Ground up to 40 million km, i.e. closer to any other large planets in the Solar system. Synodic period (from one inferior conjunction to the next) is equal to 584 days. Venus — the brightest luminary in the sky after the Sun and moon. Known to people since ancient times. The diameter of Venus is 12 100 km. (95% diameter of Earth) , mass is 81.5% the mass of Earth or 1: 408 400 the mass of the Sun the average density is 5.2 g/cm, the acceleration of gravity on the surface of 8.6 m/s (90% of the earth) . The rotation period of Venus could not install because of the dense atmosphere and cloud layer, enveloping this planet. Only by using the radar determined that it is equal to 243,2 day moreover, Venus rotates backwards compared to Earth and the other planets. The inclination of the rotation axis of Venus to the plane of its orbit is almost equal to 90 0 50. The existence of the atmosphere of Venus was discovered in 1761 M. V. Lomonosov when observed its passage across the solar disk. In the XX century with the help of spectral studies in the atmosphere of Venus was found carbon dioxide, which was the main gas of its atmosphere. According to Soviet space stations series

"Venus", not the proportion of carbon dioxide accounted for 97% of the total composition of the atmosphere of Venus. It includes about 2% nitrogen and inert gases, is not more than 0.1% oxygen, and small amounts of carbon monoxide, bromovalerate and fluoride. In addition, the atmosphere contains about 0.1% water vapor. Carbon dioxide and water vapor created in the atmosphere of Venus the greenhouse effect, leading to a strong warming of the planet. The reason for this is that both balls intensely absorb infrared (heat) rays emitted by the heated surface of Venus. Its temperature reaches about 500 C. the Cloud layer of Venus, hiding from us its surface, as established by the stations of the series "Venus", is located at an altitude 49-68 km above the surface, the density resembles a light mist. But the large extent of the cloud layer makes it completely opaque to the observer. It is assumed that clouds are composed of droplets of hydrogen sulfuric acid solution. The illumination on the surface in the daytime like the earth on a cloudy day. From space the clouds of Venus appear as a system of bands located generally along the equator of the planet, but sometimes they form parts, which was seen from Earth, making it possible to install approximately 4-sutochnye rotation period of the cloud layer. This four day rotation was confirmed by the spacecraft and is due at the cloud level constant winds blowing in the direction of rotation of the planet at a speed of about 100 m/s. atmospheric pressure at the surface of Venus is about 9MPa, and the density is 35 times greater than the density of the earth's atmosphere. The amount of carbon dioxide in the atmosphere of Venus is 400 thousand times greater than earth's atmosphere. The reason for this is likely to be intense volcanic activity, and furthermore, the lack of on the planet the two major sinks of carbon dioxide of the ocean, its plankton, and vegetation. The upper layers of Venus's atmosphere consists entirely of hydrogen. Hydrogen atmosphere extends to an altitude of 5500 km, and Radar made it possible to study invisible because of the clouds of the topography of Venus. In the Equatorial zone is detected for 10 circular structures, like the craters of the moon and mercury, with a diameter from 35 to 150 km, but very smooth and flat. Discovered a crack in the crust of the planet with a length of 1500 km, width of 150 km and a depth of about 2 km, mountain ranges, a volcano with a base diameter of 300-400 km and a height of about 1 km, a huge basin with a length of 1,500 km. from North to South and 1000 km from West to East. Interplanetary station "Venera-9 and Venera-10" allowed us to study the orbits of artificial satellites of Venus, the terrain of the 55 areas of the planet;

when this was discovered hilly terrain with a height difference of 2-3 km, and relatively flat areas. The surface of Venus is relatively smoother than the surface of the moon. Analysis of the nature and surface of Venus can be of great importance to the construction of theory of evolution of all Solar system planets, including our Earth. Venus has no satellites.

The earth is one of planets of the Solar system. Like other planets it moves around the Sun in an elliptical orbit. Distance from Earth to the Sun at different points of the orbit varies. The average distance is about 149,6 million km. during the movement of our planet around the Sun the plane of the earth's equator (inclined to the plane of the orbit at an angle of $23^{\circ}27'$) is moved parallel to itself in such a way that in some parts of the orbit the earth is tilted towards the Sun its Northern hemisphere and the other South. A large part of the Earth's surface (71%) took the World's oceans. The average depth of the oceans — 3900 m. the Existence of sedimentary rocks older than 3.5 billion years, is proof of the existence of the large reservoirs already in that distant time. Modern continents are more common the plains, primarily the lowlands, and the mountains — especially high — is a small part of the surface of the planet, as well as deep-sea trenches on the ocean floor. The shape of the Earth, known to be close to spherical, a more detailed measurement is very difficult, even if you describe to her smooth ocean surface (not distorted by tides, winds, currents) and the conditional continuation of this surface under the continents. Irregularities are supported by the uneven distribution of mass within the Earth. Such a surface is called the geoid. Geoid (with accuracy of the order of hundreds of meters) coincides with the ellipsoid of rotation, an Equatorial radius which is 6378 km and polar radius by 21.38 km less than the Equatorial. The difference between these radii was due to the centrifugal force generated by the Earth's rotation. The daily rotation of the globe occurs with almost constant angular velocity with a period of 23 h 56 min and 4.1 s. i.e. one sidereal day, the number of which in the year for exactly one day more than solar. The axis of rotation of the Earth directed its Northern end approximately to alpha, the Small dipper, which is therefore called the North star. One of the features of the Earth's magnetic field, through which we can use a compass. Magnetic pole, which attracts the North end of the compass needle does not coincide with the geographic North pole. Under the action of the solar wind (see solar Radiation) the Earth's magnetic field gets distorted and becomes "plume" in

the direction from the Sun, which extends to hundreds of thousands of kilometers. Our planet is surrounded by an extensive atmosphere. The main gases within the lower layers of the atmosphere are nitrogen (about 78%) , oxygen (about 21%) and argon (about 1%) . Other gases in the Earth's atmosphere is very small, for example carbon dioxide is about 0.03%. The atmospheric pressure at the level of the ocean surface is under normal conditions approximately 0.1 MPa. I believe that the earth's atmosphere has changed in the process of evolution: enriched with oxygen and become a modern composition as a result of prolonged interaction with rocks and with the participation of the biosphere, i.e. plant and animal organisms. Evidence that such changes actually occurred, are, for example, coal deposits, and thick layers of carbonate sediments in sedimentary rocks. they contain huge amounts of carbon, which previously was part of the earth's atmosphere in the form of carbon dioxide and carbon monoxide. Scientists believe that the ancient atmosphere occurred from the gaseous products of volcanic eruptions; its composition is judged by chemical analysis of a sample of gas, "immured" in the cavities of ancient rocks. In the studied samples, the age of which approx 3.5 billion years, contains about 60% carbon dioxide, and the remaining 40% — sulphur compounds, ammonia, chloride, and hydrogen fluoride. A small amount was found nitrogen and inert gases. All the oxygen was chemically bound. One of the most important tasks of modern Earth science is the study of the evolution of the atmosphere, the surface and outer layers of the Earth, as well as the internal structure of the subsoil. About the internal structure of the Earth is primarily judged by the characteristics passing through the various layers of the Earth the mechanical vibrations that occur during earthquakes or explosions. Valuable information is also given by the measurement of heat flux coming from the bowels, the results of determinations of the total mass, moment of inertia and the polar compression of the planet. The mass of the Earth is found from experimental measurements of the physical constant of gravity and the acceleration of gravity.

Solid shell of the Earth called the lithosphere. It can be compared with the shell covering the entire surface of the Earth. But this "shell" as it cracked into pieces and consists of several large tectonic plates slowly moving relative to one another. Their boundaries concentrates the vast majority of earthquakes. The top layer of the lithosphere is earth's crust, minerals which

consist mainly of oxides of silicon and aluminum, iron oxide and alkaline metals. The crust is of uneven thickness: 35-65 km in the continents and 6-8 km beneath the ocean floor. The top layer of the earth's crust consists of sedimentary rocks of the lower basalts. Between them is a layer of granite, typical for the continental crust. Under the bark is the so-called mantle, has a different chemical composition and higher density. The boundary between crust and mantle is called the mohorovichich's surface. It abruptly increases the velocity of propagation of seismic waves. At depths of 120-250 km beneath the continents and 60-400 km under the oceans there is a layer of mantle called the asthenosphere. Here the substance is close to the melting state, the viscosity greatly lowered it. All lithospheric plates are floating in semi-liquid asthenosphere like ice in water. Thicker areas of the crust, as well as areas composed of less dense rocks rise in relation to other areas of cortex. At the same time the additional load on the area of the cortex, for example, due to the accumulation of a thick layer of continental ice, as is happening in Antarctica, leads to the gradual immersion of the plot. This phenomenon is called isostatic leveling. Below the asthenosphere, starting from a depth of about 410 km. "packing" of atoms in the crystals of minerals are compacted under great pressure. A sharp transition is detected seismic methods at depths of around 2920 km away, where begins the earth's core, or, more precisely, the outer core, because at its center is the inner core, whose radius 1250 km, the Outer core is obviously in the liquid state, because the shear wave is not propagating in the fluid, and through it pass. With the existence of a liquid outer core have attributed the origin of Earth's magnetic field. The inner core appears to be solid. At the lower border of the mantle the pressure reaches 130ГПа, the temperature is not higher than 5000 K. In the center of the Earth temperature may rise above 10 000 K.

The earth has only one natural satellite the moon.

Mars is the fourth in distance from the Sun planet in the Solar system. In the starry sky it looks like my solid red color, which from time to time greatly exceeds the shining stars of the first magnitude. Mars periodically coming to the Earth at a distance of 5 to 7 million km, much closer than any planet except Venus. On the basic physical characteristics of Mars belongs to the planets of terrestrial group. In diameter it is almost half the size of Earth and Venus. Cloaked in a sheath of a gas — atmosphere which has a lower density

than the earth. Even in the deep valleys of Mars, where the atmospheric pressure is greatest, it is about 100 times less than that of the surface of the Earth, and at the level of the Martian mountain peaks in 500-1000 times smaller. However, in the atmosphere of Mars observed the clouds and is constantly present more or less dense haze from small particles of dust and ice crystals. As shown by pictures from American stations "Viking-1 and Viking-2" Martian sky in clear weather is a pinkish color due to the scattering of sunlight by dust and haze orange illuminated the planet's surface. The chemical composition of the Martian atmosphere is different from earth and contains at 95.3% carbon dioxide with an admixture of 2.7% nitrogen, 1.6% argon, 0.07% carbon dioxide, 0.13% oxygen and about 0.03% water vapor, the content of which is changed, as well as impurities neon, krypton, xenon. In the absence of clouds of gas shell Mars is much more transparent than earth's, including for the ultraviolet rays dangerous to living organisms. A solar day on Mars lasts 24h. 39 mins 35S. A significant inclination of equator to orbital plane (25,2 50 0) leads to the fact that in some parts of the orbit are covered and heated by the Sun mainly the Northern latitudes of Mars, on the other the South, i.e., the change of seasons. The Martian year lasts about 686,9 days. The ellipticity of the Martian orbit leads to significant variations of the climate of the Northern and southern hemispheres in the middle latitudes the winter is colder and summer is warmer than in the South, but shorter than in the North. Temperature conditions on Mars are harsh from the point of view of the inhabitant of the Earth. The highest surface temperature 290K is achieved in the so-called sunflower point. Most low surface temperature in the polar regions, where in winter season it is kept at around 150K. Observational data on temperature was the key to explaining the nature of the polar caps, which when observed through the telescope appear as bright, nearly white spot near the poles of the planet. When in the Northern hemisphere of Mars comes summer, the Northern polar cap decreases rapidly, but at this time another near the South pole, where winter comes. In the late XIX — early XX century, believed that the polar caps of Mars is glaciers and snow. According to current data, both the polar caps of Mars — North and South — composed of solid carbon dioxide, i.e. dry ice formed during the freezing of carbon dioxide included in the composition of the Martian atmosphere, and of water ice mixed with mineral dust.

In 1975, on the basis of television coverage of the entire surface of the planet

with spacecraft made a map of parts of the Martian terrain, many of which have received names, and Mars on the map appeared the names of the crater Lomonosov, Queens, Fesenko, etc. marked on maps of Mars in the nineteenth century dark areas mostly retain their shape, but in the scientific literature are examples of local changes in the reflective properties of individual regions of Mars. For many years it was popular hypotheses, which are based on the change in optical properties of certain substances under the influence of changes on Mars, biosphere, i.e. living organisms. The task of finding life on Mars was one of the main programs of the American "Viking". However, to detect any signs of life failed. Not been found in samples of soil and organic compounds. Was conducted for the elemental composition studies of samples of Martian soil. Found a close resemblance of the chemical composition of the samples in two vzaimosoedinenii pick-up locations. In the examined samples found a high content of oxides of silicon and iron. The contents of sulphur (in sulphate form) is ten times greater than in the earth's crust. The pictures of Mars found traces of shock-meteor and volcanic activity, as well as traces of movements, raising and cracking of the Martian crust and contains traces of many of the processes of deterioration and smoothing of the surface topography, displacement, and sediment deposition. The difference in height between the highest peaks and the deepest valleys on Mars is about 20 km from the Martian mountains are characterized by sharp, mostly smooth shape. Furthermore, a typical volcanic cones with craters on top. In the pictures the surface of Mars, spacecraft are clearly visible parts, with a great resemblance to riverbeds on Earth. Because the entire complex of information is against the possibility of the existence there of rivers, we can assume that the Martian riverbed resulted from melting of subsurface water ice in areas of increased heat on the planet. Some additional information about Mars can obtain indirect methods based on studies of its natural satellites — Phobos and Deimos.

Both satellites of Mars are moving almost exactly in the plane of its equator. Using the spacecraft established that Phobos and Deimos are irregular in shape and in its orbital position remains rotated to the planet is always the same side. Dimensions of Phobos be about 27 km, and Deimos is about 15 km from the Surface of the satellites of Mars consists of minerals very dark and covered with numerous craters. One of them on Phobos has a diameter of about 5.3 km away. Craters probably born meteorite bombardment, the origin

of the system of parallel furrows is unknown. The angular velocity of the orbital motion of Phobos is so great that it outpaced the axial rotation of the planet is rising, unlike other luminaries, in the West and sets in the East.

Part 3: the giant Planets

Jupiter, the fifth in distance from the Sun and the largest planet in the Solar system from the Sun is 5.2 times farther than Earth, and spends some turnover in orbit nearly 12 years. The Equatorial diameter of Jupiter is 142 600 km (11 times Earth's diameter). The period of rotation of Jupiter is the shortest of all the planets — 9h. 50 min. 30 sec. at the equator and 9h. 55min. 40C. in the mid-latitudes. Thus, the Jupiter, like the sun rotates as a rigid body — rotation speed varies in different latitudes. Due to the rapid rotation of this planet has strong compression at the poles. The mass of Jupiter is equal to 318 Earth masses. The average density of 1.33 g/cm³, which is close to the density of the Sun. The rotation axis of Jupiter is nearly perpendicular to the plane of its orbit (inclination of 87°). Even in a small telescope shows the polar compression of Jupiter and bands on its surface, parallel to the equator of the planet. The visible surface of Jupiter is an upper level clouds surrounding the planet. This ensures that surface detail of Jupiter is constantly changing its appearance. From sustainable items known Great Red spot, observed for over 300 years. It is a huge oval formation, the size of about 35 000 km in longitude and 14 000 in latitude between the southern tropical and southern temperate bands. Color it reddish, but is subject to change.

Spectral studies of Jupiter have shown that the atmosphere consists of molecular hydrogen and its compounds: methane and ammonia. In small quantities also present are ethane, acetylene, and phosphene water vapor. The clouds of Jupiter are composed of crystals and droplets of ammonia. In December 1973 with the help of the American spacecraft "pioneer 10" points failed to detect the presence of helium in Jupiter's atmosphere and measure its contents. You may assume that Jupiter's atmosphere is 74% hydrogen and 26% helium. The share of methane comprises not more than 0.1% of the composition of the planet's atmosphere (by mass). Atmospheric layer has a thickness of about 1000 km Below the gas layer in the atmosphere is the layer of clouds that we see in the telescope. The layer of liquid molecular

hydrogen has a thickness of 24 000 km. At this depth the pressure is 300 HPa and a temperature of 11 000 K, here the hydrogen goes into a metallic liquid state, i.e., becomes like liquid metal. A layer of liquid metallic hydrogen has a thickness of about 42 000 km. Inside it is a small iron-silicate solid core with a radius of 4 000 km. the core temperature reaches 30 000 K. In 1956 it was discovered radio emission of Jupiter on the wave of 3 cm, corresponding to thermal radiation with a temperature of 145 K. For measurements in the infrared range, the temperature of the outer clouds of Jupiter 130 K. the Flights of American spacecraft "pioneer 10" and "pioneer-11" has helped to clarify the structure of the magnetosphere of Jupiter, and the temperature change of the cloud layer is largely confirmed known from ground-based observations result: the amount of heat that Jupiter emits more than two more than thermal energy that the planet receives from the Sun. It is possible that coming from the bowels of the planet the heat released in the process of slow compression of the giant planets (1mm per year) .

The magnetic field of the planet is complex and consists of two fields: the dipole (as the Earth) that extends to 1.5 million km from Jupiter, and the non-dipole occupying the rest of the magnetosphere. The magnetic field strength at the surface is 20 times bigger than on Earth. In addition to thermal and decimeter radio emission of Jupiter is the source of the radio bursts (sharp strengthenings of the radiation power) in the wave length from 4 to 85 m., lasting from a fraction of a second to several minutes or even hours. However, long term disturbance is not a separate outbursts, and a series of surges — a kind of noise storms and thunderstorms. According to current hypotheses, these bursts are explained by plasma oscillations in the ionosphere of the planet.

Jupiter has 13 moons. The first 4 satellites discovered by Galileo (IO, Europa, Ganymede, Callisto) . They, as well as the inner, closest the satellite Amalthea are moving almost in the plane of the equator of the planet. IO and Europa are almost comparable to the Moon, and Ganymede and Callisto even more mercury, although the weight is significantly inferior to him. Compared to the other Galilean satellites was investigated in more detail. The outer moons revolve around the planet on highly elongated orbits with large angles of inclination to the equator (30°) . It is a small body of 10 to 120 km, apparently irregular shapes. The outer 4 moons of Jupiter revolve around the

planet in the opposite direction. According to the data obtained from the American spacecraft "Voyager", Jupiter is surrounded in the Equatorial region a ring system. The ring is located at a distance of 50 000 km from the planet's surface, its width is about 1 000 km. the Existence of Jupiter's rings was predicted in 1960 by astronomer S. K. Vsekhsvyatsky based on the observations. In 1975 there was discovered an object that, apparently, is the 14th moon of Jupiter. Its orbit is unknown.

Saturn is the second largest among the planets of the Solar system. Its Equatorial diameter is only slightly smaller than Jupiter, but the mass of Jupiter Saturn yields more than three times and has a very low average density of about 0.7 g/cm³. Low density is due to the fact that the giant planets consist mainly of hydrogen and helium. In the depths of Saturn, the pressure reaches such high values, like Jupiter, so the density of matter is lower. Spectroscopic studies have detected in the atmosphere of Saturn some molecules. The surface temperature of the clouds on Saturn are close to the melting point of methane (-184 C) , of solid particles which most likely is the cloud layer of the planet. In a telescope are visible elongated along the equator the dark bands, called belts and bright zones, but these details are less contrasting than on Jupiter, and single spots were observed in them much less frequently. Saturn is surrounded by rings, which are clearly visible in a telescope in the form of "ears" on both sides of the disk of the planet. They were seen by Galileo in 1610. The rings of Saturn is one of the most amazing and interesting formations in the Solar system. Flat system of rings encircles the planet around the equator and never in contact with the surface. In the rings are separated by three major concentric zones, separated by narrow cracks: the outer ring And, In secondary (most bright) , the inner ring With pretty transparent, "Stardust", the inner edge it is not sharp. Closest to the planet slaborazvitym the inner ring are indicated by the symbol D. Discovered the existence of almost transparent on the outermost ring D.

Through all the rings of Saturn are shining stars. The rings revolve around Saturn, the speed of movement of internal parts more than the outer. The rings of Saturn are not solid, but a flat system of an infinite number of small satellites of the planet. The plane of the rings coincides with the Equatorial plane of Saturn and has a constant inclination of the orbital plane, equal to approximately 27. Depending on the provisions of a planet in orbit we see the

ring that with one, on the other hand. A full cycle of change of their form is completed in a period of 29.5 years is the orbital period of Saturn around the Sun. From time to time ring on a short time cease to be visible in telescopes of medium size. This occurs when the plane of the rings passes exactly through the Sun and the lateral surface is devoid of bright light, or when the rings are turned to the observer "edge" and look like an extremely thin strip that is visible only in the largest telescopes. The thickness of the rings, according to recent data, around 3.5 km away. It is very small compared to their diameter, which on the outer edge of the ring And is 275 thousand km, and particle Sizes are not completely defined. Radioastronomical observations indicate the presence of rings in a variety of particle size not less than a few centimeters. There is a possibility of the presence in Saturn's rings is even larger particles, like dust.

Infrared spectra of Saturn's rings resemble the spectra of water frost. However, in other parts of the spectrum were later discovered feature that is not characteristic of pure ice. Besides the rings, Saturn's known satellites 10. This Is Mimas, Enceladus, Tafia, Dione, Rhea, Titan, Hyperion, Yapet, Phoebe, Janus. The last is the closest to Saturn, moving so close to the surface of the planet, which found it was only when eclipses of Saturn's rings, creating together with the planet a bright halo in a field of view of the telescope. The largest moon of Saturn — Titan, one of the biggest satellites in the Solar system in size and mass. Its diameter is approximately the same as the diameter of Ganymede. Titan is surrounded by an atmosphere consisting of methane and hydrogen. In her moving opaque clouds. All the moons of Saturn, except the Phobes, turning in the forward direction. Phoebe orbits with a rather large eccentricity in the reverse direction.

Uranus is seventh in order from the Sun planet in the Solar system. The diameter is almost four times bigger than Earth. Very far from the Sun-lit and relatively weak. Uranium was opened by the English scientist W. Herschel in 1781 any details on the surface of the Uranium fails to distinguish due to the small angular size of the planet in the view of the telescope. This complicates his research, including the study of patterns of rotation. Apparently, Uranium (in contrast to all other planets) rotates around its axis as if lying on its side. This tilt of the equator creates an unusual lighting conditions: at the poles at a certain season the sun's rays fall almost vertically, and the polar day and polar night cover (alternate) the entire surface of the planet, except for a narrow

band along the equator. As Uranus turns on its orbit around the Sun in 84 years, the polar day at the poles lasts 42 years, then is replaced by the polar night of the same duration. Only in the Equatorial belt of Uranus, the Sun regularly rises and sets with regularity uniform axial rotation of the planet. Even in those areas where the Sun is at the Zenith, the temperature on Uranus (more on the visible surface of the cloud) is about -215 C. under these conditions, some gases freeze. In the composition of the atmosphere of Uranus on the spectroscopic observations found hydrogen and a small admixture of methane. In a relatively large number of indirect signs of helium. Like other giant planets, Uranus has such a composition, probably almost to the centre. However, the average Uranium density (1.58 g/cm³) is slightly greater than the density of Saturn and Jupiter, although the substance in the bowels of these giants squeezed much stronger than on Uranus. A density of Uranus can be explained by the assumption that elevated levels of helium or existence in the bowels of the Uranium nuclei of heavy elements.

One unusual feature of Uranus is the open in 1977, a system of surrounding rings. They consist of separate non-transparent and, apparently, very dark particles. Unlike Saturn's rings the rings of Uranus are narrow, like "thread" of education. They are not visible in reflected light and are detected only by the strong weakening of the brilliance of the stars, trapped for the observer behind the rings with orbital motion of the planet. The distance of the rings from the centre of Uranus is from 1.6 to 1.85 radius of the planet.

Moons of Uranus — Miranda, Ariel, Umbriel, Titania and Oberon revolve in orbits, the planes are virtually equal. The whole system is notable for its unusual tilt of its plane almost perpendicular to the middle plane of the planetary orbits.

Neptune — the eighth planet in the Solar system. Neptune opened in an unusual way. It was noticed that Uranus does not move exactly as he's supposed to move under the attraction force of the Sun and known planets. Then suspected the existence of another massive planet and tried to previously the its position in the sky. This extremely complex task independently of each successfully solved by the English astronomer John. Adams and Frenchman U. Le Verrier. The data received Le Verrier, assistant at the Berlin Observatory I. Galle on 23 September 1846 discovered the

planet. The discovery of Neptune was of the greatest importance primarily because it served as a brilliant confirmation of the law of gravity, laid the basis for calculations. The average distance of Neptune from the Sun is 30.1. E. the period of orbit is 164 years and 288 days. Therefore, since Neptune is not even made a full revolution in its orbit. The visible angular diameter of Neptune is about 2". When measuring such small diameter angle measuring devices from the Earth's surface the relative error is very large. To specify the diameter of Neptune managed 7 April 1967, when the planet in its motion against the starry sky obscured one of the distant stars. Based on observations from multiple astronomical observatories in the Equatorial diameter of Neptune is 50 200 km of New data on diameter has helped to clarify the value of the average density of Neptune: it was equal to 2.30 g/cm³. Such characteristics are typical of giant planets, consisting mostly of hydrogen and helium with admixture of compounds from other chemical elements. In the center of Neptune, according to the calculations there is a hard core of silicates, metals and other elements included in the composition of the earth group. The study of the nature of the weakening of the magnitude of the star when it is eclipsed by the atmosphere of Neptune gave a lot more information. In particular, it was found the average molecular weight of nudeblack atmosphere of Neptune. It corresponds to molecular hydrogen with a small admixture of methane. Details on the surface of Neptune is very difficult to distinguish. Therefore, the parameters of the daily rotation — axis position, direction and period of rotation to be determined from ground-based observations very difficult.

Neptune has only two satellites. The first Triton, opened in 1846, two weeks after the opening of the Neptune. Size and weight it is bigger than the moon. Is the opposite direction of the orbital motion. A second satellite Nereid is very small, has a highly eccentric orbit. The distance from the satellite to the planet varies from 1.5 to 9.6 million km. the Direction of the orbital motion is direct.

Part 4: Pluto

Pluto was discovered by Tombaugh Lagoom (USA) in 1930, Of the 9 known major planets of the Solar system, Pluto farthest from the Sun. The average distance of the planet to the Sun is 39.5. E. Pluto looks like a point object 15

5.0 magnitude, i.e., about 4 thousand times weaker than those stars that are at the limit of visibility to the naked eye. Pluto very slowly, over 247.7 year, revolves in an orbit which has an unusually large slope (17.5°) to the Ecliptic plane, and is elongated so that at perihelion Pluto approaches the Sun for a shorter distance than Neptune. Because of the huge distance from the Sun and low-light conditions to study the Pluto is very difficult. Direct measurement of the angular diameter of Pluto at 5-m telescope gave a result of $0.23''$. Astronomers tried to measure the diameter of Pluto more accurate methods — for Eclipse their stars, as was done for Neptune. However, Pluto, passing by stars at a distance of $0.1''$, not overshadowed her, and Eclipse has not happened. From this it was concluded that the angular diameter of Pluto is not less than $0.2''$. Thus, in terms of the unit of length the diameter of Pluto, at least 6 800 km. If the diameter of Pluto to be calculated by its absolute brilliance, it turns out about 3 thousand km of Pluto's Surface, heated by the Sun to minus 220 C, even in the least cold afternoon the area covered, apparently, the snow is frozen methane. The atmosphere of the planet is low and consists of methane gas with possible admixture of inert gases. The Shine of Pluto varies with the rotation period of 6 days. 9h. In 1978 it became clear that this periodicity corresponds to the orbital motion of a satellite of Pluto, discovered by American astronomers. The satellite of Pluto relatively bright, but is close enough to the planet that his picture on the photos merges with the image of Pluto, only slightly protruding from one or the other side. From the orbital period and the distance between the centers calculated the mass of the system "Pluto-satellite". Weight was surprisingly low: 1.7% of the mass of the Earth. Almost all of it concentrated in Pluto, because the diameter of the satellite, according to the gloss, is small compared to the diameter of the planet. In this case, the average density of Pluto is about 0.7 g/cm^3 if to make its diameter equal to 3 thousand miles. This low density means that Pluto consists mainly of volatile chemical elements and compounds, i.e. approximately the same composition as the giant planets and their satellites.

The planet Pluto was also able to detect in 1978 the satellite. This discovery is of great importance, first, because it allows you to more accurately calculate the mass of the planet according to the orbital period of the satellite and, secondly, in connection with the debate about whether Pluto itself "lost" the satellite of Neptune.

Agree, today people, what would be the most remote area of science or the

national economy, he worked, must have an understanding, at least in General, about our Solar system, the stars and modern achievements of astronomy.

A comparative study of the planets and their satellites "moons" is of paramount importance for the knowledge of the nature of the Earth. We are still not clear the conditions that led to the formation of different natural systems, including contributing to the emergence and development of life on Earth. In this essay we will talk about the solar system and its planets.

As sources of information, I chose the max books and computer programs that were available to me, tried to select the most important information. As far as I could – to judge you...

Solar system

Here for two centuries the problem of the origin of the Solar system cares important thinkers of our planet. The issue was handled, from the philosopher Kant and the mathematician Laplace, a galaxy of astronomers and physicists of the XIX and XX centuries.

And yet we are still quite far from solving this problem. But over the last three decades, cleared the question about the ways of evolution of stars. Although the details of the birth of stars from gas and dust of the nebula is still far from clear, we now have a clear vision of what she's been doing for billions of years of further evolution.

Turning to the presentation of the various cosmogonic hypotheses, successive one another over the past two centuries, starting with the hypothesis of the great German philosopher Kant and the theory that a few decades later independently proposed by French mathematician Laplace. Preconditions to creation of these theories has stood the test of time.

The point of view of Kant and Laplace in a number of important issues differed sharply. Kant proceeded from the evolutionary development of the cold dust cloud in the course of which first originated the Central massive body — the future of the Sun, and then planets, while Laplace considered the

original nebula of gas and very hot with high rotation speed. Shrinking under the force of gravity, nebula, due to the law of conservation of angular momentum, spinning faster and faster. Because of the large centrifugal forces from it were successively separated ring. Then they condense, forming the planets.

Thus, according to the hypothesis of Laplace, the planets formed before the Sun. However, despite the differences, the overall important feature is the idea that the Solar system arose as a result of a natural development of the nebula. So called this concept “hypothesis of Kant-Laplace”.

However, this theory faces difficulties. Our Solar system consists of nine planets of different sizes and masses, has a peculiarity: the unusual distribution of angular momentum between the Central body — the sun and the planets.

The moment of momentum is one of the most important characteristics of any isolated from the outside world mechanical system. Exactly how such a system can consider the Sun and its surrounding planets. The angular momentum can be defined as “stock rotation” system. This rotation consists of the orbital motion of the planets and the rotation around the axes of the Sun and planets.

The lion's share of the angular momentum of the Solar system is concentrated in orbital motion of planets-giants Jupiter and Saturn.

From the point of view of the hypothesis of Laplace, it is unclear. In an era when from the initial, rapidly rotating nebula separated ring, the layers of the nebula, which later condensed the Sun, had (per unit mass) about the same time as the substance separated rings (because the angular velocity of ring and the remaining parts were approximately the same) as the mass of the latter was much smaller than the main nebula (“Protosun”), the total angular momentum of the ring should be much less than the “Protosun”. In the hypothesis of Laplace does not have any mechanism for transmission of the torque from the “Protosun” to the ring. Therefore, throughout the further evolution of the angular momentum of the “Protosun”, and then the Sun needs to be a lot more than the rings and the planets formed from them. But

this conclusion contradicts with the actual distribution of momentum between Sun and planets.

For the hypothesis of Laplace, this difficulty was insuperable.

We will focus on the hypothesis of jeans, which became popular in the first third of this century. It is completely opposite to the hypothesis of Kant-Laplace. If the latter draws the formation of planetary systems as the only natural process of evolution from simple to complex, the jeans hypothesis of the formation of such systems is a matter of chance.

Original matter, from which then formed planets were ejected from the Sun (which by that time was already quite “old” and is similar to the current) in case of accidental passing near it some stars. This passage was so close that it can be viewed almost as a collision. Due to tidal forces from the onslaught of the Sun star, from the surface layers of the Sun ejected a jet of gas. This stream will remain in the sphere of attraction of the Sun and after star leaves from the Sun. Then the stream will condense onto and give rise to planets.

If the jeans hypothesis was correct, the number of planetary systems that formed over ten billion years of its evolution, could be counted on the fingers. But planetary systems are actually, hence, this hypothesis is untenable. And nothing implies that ejected from the Sun the stream of hot gas may condense into planets. Thus, the hypothesis of cosmological jeans was untenable.

An outstanding Soviet scientist Otto Schmidt in 1944, proposed his theory of the origin of the Solar system: our planet formed from the material captured from the gas-dust cloud, through which once passed the Sun, already had almost “modern” look. Any difficulties with the rotation time of the planets did not arise, as the original point of the substance of a cloud can be arbitrarily large. Since 1961, this hypothesis was developed English cosmogonist Littleton, who has made a significant improvement. In both hypotheses the “almost modern” the Sun is facing more or less “loose” space object capturing part of its substance. Thus, the formation of planets associated with the star formation process.

General characteristics of the planets and solar system bodies

MERCURY

Mercury is the fourth planet seen: high gloss it is almost as bright as Sirius, the brighter it are only Venus, Mars and Jupiter. However, mercury is a very difficult object to observe because of the smallness of its orbit and, therefore, proximity to the Sun; its greatest possible elongation $^{\circ}$ (the apparent angular distance from the Sun) is 28

To the naked eye, mercury is the bright dot, and in a strong telescope he kind of Serpico or incomplete circle. Change the appearance (phase) of the planet over time show that mercury is the ball, with one side lit by the Sun, and on the other completely dark. The diameter of the ball – 4870 km.

Mercury rotates slowly around its axis, being always turned to the Sun on one side. Thus the period of revolution around the Sun (Mercurian year) is about 88 earth days and a rotation period around its axis is 58 days. It turns out that from sunrise to sunset on mercury is a year, that is 88 earth days. The photos of the layman can not distinguish mercury from the moon. Really, the surface of mercury is largely similar to the surface of the moon, although we do not know whether on the surface of mercury has craters and seas. However, the average visual albedo of mercury (0,14), more than double the albedo of the moon. Before the flight of Mariner 10, it was believed that mercury has no atmosphere, but observations of the American station showed that the surface of the planet is concentrated trace amounts of hydrogen (about 70 atoms per 1 cm³) and helium (4 500 atoms per 1 cm³). These gases on mercury is held a weak magnetic field planets of the solar wind. The atmospheric pressure at the surface of mercury at 500 billion times less than the pressure of the earth's atmosphere. Mercury has a relatively high density among the planets of the Solar system, about 5.44 g/cm³. Scientists suggest that this is due to the presence of massive metallic core (presumably from the molten iron density 10 g/cm³, having a temperature of about 2000 K), containing more than 60% of the mass of the planet and is surrounded by a silicate mantle and probably the crust 60 to 100 km thick.

VENUS

Venus observed as an "evening star" and "morning star" Hesperus and Phosphorus, so called it in the ancient world. After the sun and the moon Venus is the brightest heavenly body, and at night lit by it objects can cast shadows. As Venus is the closest planet to Earth. It is even called "sister Earth". And really — the radius of Venus is almost equal to the earth (0,95), it has a total mass of 0.82 of the mass of the Earth. Venus is quite well-studied people to the planet approaching (and some even sat down) the AMS series "Venus" and the American Mariner. Venus revolves around the Sun in 224.7 earth days, but with this figure, in distinction from mercury, nothing connected. A very interesting fact is connected with the rotation period of the planet around its axis is 243 earth days (opposite direction) and a rotation period of powerful Venusian atmosphere, which makes a complete revolution around the planet in... 4 days! This corresponds to a wind speed at the surface of Venus at 100 m/s or 360 km/h! It has atmosphere, originally the M. V. Lomonosov in 1761 during the passage of the planet across the solar disk. Cloaked in a thick layer of white clouds that hides its surface. The presence in the atmosphere of Venus dense clouds, probably composed of ice crystals, explains high reflectivity of the planet is 60% of the incident sunlight is reflected from it. Modern scientists have found that the Venusian atmosphere is 96% CO₂. Are here also the nitrogen (nearly 4%), oxygen, water vapor, noble gases, etc. (all less than 0.1%). The basis of thick cloud layer located at a height of 50 — 70 km, are small droplets of sulfuric acid H₂SO₄ with a concentration of 75-80% (rest is water, and actively "absorb" droplets of acid).

The relief of Venus is strongly smoothed time due to atmospheric erosion weathered old meteor craters, traces of which are still visible on the surface of the planet; the mountain areas occupy only about 8% of the territory, the General elevation does not exceed 8 km. apparently, on Venus, there are active volcanoes, as it is known that seismic and tectonic activity on Venus has been very active recently. More amazing Venus is formed With a very unusual, crazy wind, dense°according to the earthly standards of conditions: a temperature of more than 400 a layer of bright orange clouds over head and a "rain" of small droplets of concentrated sulfuric acid — here is a picture that maybe will see future astronauts who landed on Venus. The internal structure of this pseudobinary of Land is also similar to the structure of our planet: the average density of Venus — of 5.22 g/cm³, i.e. almost equal to the earth,

which allows to make a conclusion about the presence in the center of Venus to the liquid iron core of radius of about 2900 km, is surrounded by the mantle, as well as our Land. The extreme weakness of the magnetic field of Venus is caused by the low speed of rotation.

EARTH

Our earth seems so big and strong and so important to us that we tend to forget about the modest position which it occupies in the family of planets of the solar system. However Earth still has a pretty thick atmosphere covering a thin non-uniform layer of water, and even winning a satellite with a diameter of about $\frac{1}{4}$ of its diameter. However, these special features of the Land can hardly serve as a sufficient basis for our space "egocentrism". But being a small astronomical body, Earth is the most familiar planet. The radius of the earth $R=6378$ km. The rotation of the globe in the most natural way to explain the change of day and night, sunrise and sunset luminaries. Some Greek scientists knew about the annual motion of the Earth around the Sun. The annual motion of the Earth observer moves and this causes the apparent shift of closer stars relative to more distant. Strictly speaking, the Sun moves around the center of gravity of the system Earth – Moon, the so-called barycenter; around the center of the Earth and Moon describe within one month its orbit.

Radar observations of the last years of Earth's distance from the Sun equal to 149 600 000 km (1 astronomical unit. E.).

Our understanding of the internal structure and physical state of the subsurface of the earth based on various data, among which the essential data of seismology (science of earthquakes and the laws of propagation of elastic waves in the earth). Study of distribution in the globe of elastic waves generated when earthquakes or powerful explosions if allowed to open and study the layered structure of the earth.

Internal structure of the Earth.

The ocean air that surrounds the Earth — its atmosphere — is an arena where the diverse meteorological phenomena.

Basically, the earth's atmosphere consists of nitrogen and oxygen.

The earth's atmosphere is conventionally divided into five layers: the troposphere, stratosphere, mesosphere, ionosphere and exosphere. A great influence on many processes on our planet has a hydrosphere, or oceans, the surface of which is 2.5 times more land area.

The earth has a magnetic field. Beyond the dense layers of the atmosphere he is surrounded by invisible clouds of very rapidly moving particles of high energy. This so-called zone of radiation.

Structure and properties of our planet's surface, its shells and depths, magnetic fields and radiation belts are studied by a complex of geophysical Sciences.

MARS

When in 1965 the American station Mariner-4 small distances first acquired images of Mars, these photos caused a sensation. Astronomers were ready to see anything but a moonscape. One famous astronomer of the Pulkovo Observatory even called the Newspapers to check whether the Newspapers confused the moon with Mars. Alas, the typical lunar landscape belonged to the famous red planet. It is on Mars had pinned great hopes of those who wanted to find life in space. But these expectations are not met — Mars was lifeless. According to current data, the radius of Mars is almost twice smaller than the earth (3390 km), and the mass of Mars is inferior to the Earth ten times. Goes around the Sun this planet for 687 earth days (1,88). A solar day on Mars is almost equal to the earth (°—24 hrs 37 min, and the axis of rotation of the planet is inclined to the plane of the orbit at 25) that allows to make a conclusion similar to the earth's change of seasons°Earth 23. But all the dreams of scientists about the existence of life on the red planet melted after was the composition of the atmosphere of Mars. For a start, it should be noted that the pressure at the surface of the planet is 160 times smaller than the pressure of earth's atmosphere. And it consists of 95% carbon dioxide, contains nearly 3% nitrogen, 1.5% argon, about 1.3% oxygen, 0.1% of water vapor, there is also carbon monoxide, traces of krypton and xenon. Of course, in such a sparse and inhospitable atmosphere, no life can not exist.

Because of the sparseness of the Martian atmosphere, the planet can not retain the sun's heat, resulting in a summer day the temperature reaches 25°C (in the polar regions to -135°C and at night drops to -90°C). Sudden changes in the Average temperature on Mars is about -60°C during the day cause severe dust storms during which the thick clouds of sand and dust rise up to heights of 20 km and the Composition of the Martian soil was finally revealed in studies of the descent of the American spacecraft Viking 1 and Viking-2. Reddish sheen of Mars caused by the abundance of superficial rocks of iron III oxide (ochre). In addition to iron (14%), in the Martian soil were also found in silicon (20%), calcium and magnesium (5%), aluminium (3%) and sulphur (above 3%), which is almost a hundred times more than on Earth. The topography of Mars is very interesting. Here there are dark and light areas, like on the moon, but unlike the moon, Mars, change the color of the surface is not associated with the change of height at the same height can be both light and dark areas. On Mars there are arheografichesky (similar to the term “geography” for Earth; from the Greek name of the God of war Ares, known in Roman mythology Mars) objects on a planetary scale. The famous giant Graben Canyon, with a length of 2500 km, a width of 100-200 km and reaches a depth of 6 km. the Highest mountain of Mars, Olympus Mons, which towers over the surrounding landscape... 24 km! The diameter of the base of this giant volcano is 600 km impact craters on Mars are relatively few, but well visible traces of erosional activity, likely water. That is, when a (presumably about 10 million. years ago) Mars had a more powerful atmosphere, with the pressure at the surface sufficient for the liquefaction of water on Mars, it rained, flowed the river, and there were seas and oceans. Scientists still do not know the nature of the cataclysm that caused the global climate change on Mars that led to the present conditions. One of the most notable and fascinating the minds of astronomers the details of the terrain of the red planet has long remained the polar caps of Mars. These “glaciers” greatly increase in size in the middle of fall and almost completely disappear by early summer. Modern scientists, and they consist °found that the average annual temperature is -70°C caps of two components: seasonal — solid carbon dioxide (“dry ice”) and the age-old ordinary water ice. In summer, the CO_2 sublimates, and in winter, when the decrease again deposited near the pole. °the temperature to -130°C

Assumptions about the internal structure of Mars is similar in many ways

with the ideas in the structure of the Earth: the exterior of the thin film of the lithosphere, covering the solid layer of the mantle, and in the center is a metallic core, about which scientists have not come to the same conclusion — it's liquid or hardened. Around Mars with a high speed fly its two natural satellites — Phobos (22x30 km) and Deimos (15x12 km). They overtake the planet in its rotation around its axis. This small heavenly body, shaped like potatoes, richly dotted with craters, not of great interest to astronomers.

JUPITER

The greatest of the planets in the Solar system — Jupiter can be found at a distance of about 640 million kilometres from us; its mass is over 300 Earth masses, and the volume exceeds the volume of our planet more than 1,000 times. In a telescope Jupiter looks like a gold disk divided by dark and light bands running approximately in parallel. Catch the eye with reddish or brown hues, at the same time you notice irregular cloud-shaped spots, which destroy the homogeneity strips. The disk is slightly elongated in the direction of the strips, the diameter in this direction at 1/15 more than in perpendicular direction. A full rotation around its axis Jupiter makes only 9 hours and 55 minutes. Probably the most attractive object on the surface of Jupiter's monitoring and learning has always been the Great Red Spot (BKP), first noticed in 1878. Scientists believed it is huge (the size of the BCP is 40 000 km in length and 13 000 km wide) island helium hydrogen ice in the ocean, the giant constantly erupting volcano. After repeated encounters with Jupiter American AMC starting in 1973, it was clearly established that CDB — a giant cyclone spinning in the atmosphere of the planet in a counterclockwise direction already, at least 400 years (since its opening) and perform a full rotation every six earth days. Calculations show that in the atmosphere of Jupiter is enormous, such vortices can exist in several millennia! On the surface of Jupiter are observed and others are also semi-permanent education, and they are all to some extent characterized by wandering movements. An interesting feature of Jupiter compared to the already considered planets is its average density: it is only about 1.33 g/cm³. This allows you to make a fairly confident conclusion about the chemical composition of the planet: the vast majority of it consists of hydrogen and helium.

Of the 16 satellites of Jupiter the four largest were discovered by Galileo in

1610. It — IO (the radius of 1820 km), Europe (1530 km), Ganymede (2610) and Callisto (2450). It is easy to notice that Ganymede and Callisto even more mercury. Other IO looks interesting. It is the most seismically active body in the Solar system. During spans of IO by spacecraft since the late 70-ies, there were more than one eruption of volcanoes. Lava is mainly composed of sulfur. IO is surrounded by a distinctive atmosphere: the biggest part of it is atomic hydrogen, but there are also vast cloud of sodium atoms! All the satellites of Jupiter, except the largest five are most likely asteroids, captured by the powerful magnetic field of the planet. Discovered around Jupiter and the ring, but at 105 times less dense than Saturn. Jupiter, the largest planet in the Solar system, by its nature, is a cross between a dwarf star and planets of the earth type.

SATURN

Among the innumerable celestial objects that can be seen through a telescope, the most beautiful is probably the planet Saturn. If you look in the evening, at dusk, when the sky is still bright, Golden-yellow ball of the planet and its fabulously beautiful ring, shimmering in bright blue, seem to be rather a rare work of art than a phenomenon of nature. Slightly visible on the surface of Saturn's bands are much more homogeneous than the bands of Jupiter, parallel to the large ring; only from case to case able to distinguish individual details, which can detect rapid rotation of this giant globe. The brightness gradually decreases from the center to the blurred edge of the disk of the planet, and the outer edge of the rings seem to vanish into the sky. Where the rings cross the disc, it is seen that their inner edge is limited to vague dark band. This is the "crepe ring" is easiest to distinguish by its slight shadows on the disk of the planet. The outer rings also cast shadows on the surface of Saturn, and he, in turn, completely blocking large portions of the rings. The polar region of the planet in the direction perpendicular to the plane of the rings, darker than the other edges of the disk, and when observing them in good atmospheric conditions have a slightly greenish tint. It is easy to find three large parts, which are separated by rings: a bright shining middle ring, the weaker the outer ring and barely glowing Stardust or the inner ring. Rings are composed of separate fragments, each in its own orbit around Saturn according to the law of universal gravitation of Newton. The size of the Saturn yields only to Jupiter, its radius is 9.2 times larger than the earth (he is

almost 60 000 km), and the mass of this planet is more Ground in 95 times. Turns Saturn around the Sun at a distance of 9,58.e. make a complete revolution in about 29.5 earth years, and its axis it makes a full rotation in just 10.5 hours (according to other sources — up to 11 hours), which leads to even larger than Jupiter, the polar flattening is 1/10. In popular books on astronomy sometimes is a funny picture in a giant imaginary pool of water, with the ease of tube, floats Saturn. This fantastic situation reflects a real fact: Saturn is the only body in the Solar system, which is lighter than water. Its average density is only 0.69 g/cm³, which is two times less than the average density of the Sun. This allows a high degree of certainty to say that Saturn consists mostly of hydrogen (80% according to scientists) and helium (18%). Assumptions about the internal structure of Saturn is largely based on the more reliable conclusions about the Jupiter. Overall, the picture is similar: in the upper atmosphere of Saturn, in addition to hydrogen and helium, also found small amounts of methane. Below, as of Jupiter, hydrogen is a global ocean, then a layer of metallic hydrogen. In the center is a silicate-metal core, the estimated weight of which is more than 9 mass of the Earth, and the temperature therein reaches 20 000 K. From the other bodies surrounding the Saturn, it should tell you about the largest of the 17 satellites of the planet — the titanium. The name reflects the essence of Titan, one of the largest satellites in the Solar system, has a diameter of 5150 km. It is remarkable that, surrounded by an atmosphere, which is ten times more massive than earth! Its main component is apparently nitrogen. Great content here of such compounds as methane, ethane and acetylene. Interesting also four major moon of Saturn — yapet, Rhea, dione and Tafia (diameters on the order of 1000 km). The fact that one hemisphere (for yapet — front in the direction of rotation around Saturn, for others — Vice versa) is much darker than the other. Scientists believe that the bright side of these bodies covered with snow, while the other — with some rocks.

URANUS AND NEPTUNE

These two planets like each other as twins, are the giant planets in the farthest regions of the solar system. And they are actually very similar: Uranium is a bit higher (its radius — 26 540 km, Neptune — 24 300 km), but Neptune is more massive — its mass is 17.25 mass of the Earth, whereas Uranium is only 14.6. Due to these minor differences in average densities of the two planets are almost equal: 1,71 g/cm³ for Uranium and 1.72 g/cm³ for

Neptune. To see any details on the surface of Neptune is very difficult, and Uranus can be seen only as a mild belt, these planets, of course, shrouded in atmospheres similar to the atmosphere of Jupiter and Saturn. Planets have high values of albedo, and spectra in the visible absorption bands of methane, similar to the observed Jupiter and Saturn, but more intense. The absorption of the yellow and red light vapors of methane for Uranus and Neptune is so large that planets when directly observed are a greenish color; the greenish color of Neptune, stronger than Uranium. On the spectrograms there is no direct evidence of the presence of ammonia, but hydrogen is present. Do the giant planets are very similar to each other; their differences are mainly external, due to the temperature change in accordance with their position in space. All these planets rotate rapidly, have a huge thick atmosphere consisting of methane and possibly ammonia, and contain in their composition of light gases the helium, hydrogen, and the latter are characterized by a significant concentration towards the center. All of these characteristics of the giant planets differ from the terrestrial planets – mercury, Venus, Earth, Mars and Pluto. These differences are so striking that the Union of these two groups of planets in one system sounds ridiculous. Obviously, these differences are due to some important evolutionary factor. Despite the enormity of size, and maybe it is because of this, the giant planets do not provide any opportunities as the abode for the existence of life in any known forms. Therefore, if we hope to prove the universality of such ephemeral phenomena as life, we need to study the terrestrial planets.

Until the early 80-ies of mankind knew about the existence of Uranus five, and Neptune's two satellites. However, the previously mentioned Voyager 2 discovered ten small celestial bodies orbiting Uranus, but these satellites are of no interest, as they are just rocks, like asteroids, once traveled through the Universe, and now captured by the magnetic field of the planet. It is necessary to focus on the moon of Uranus Miranda (the smallest of the five diameter of about 500 km). It looks so unusual that scientists made the assumption that Miranda had first broken into pieces and again randomly gathered together. The larger of the two moons of Neptune — Triton — part of the largest planetary satellites in the Solar system, its radius is about 2000 km. It moves around Neptune in the direction opposite to the rotation of the planet, which suggests that Triton is an object, captured by Neptune and is not formed together with him. And Uranus and Neptune discovered rings of

the same nature, that of Jupiter and Saturn.

PLUTO

The most distant from the sun of all open still planets quite similar to the other planets in the outer regions of the solar system. A stranger-a dwarf looks like Pluto among the planets.

– not the Orbit of the planet is incredibly much inclined – 17.1° one of the known planet was nothing like this. The tilt axis is 50 moreover, the orbit has an unusual elongation. Because it turns out that Pluto is just 4400000000 km from the sun, then removed from his 7400000000 km. According to most recent its diameter is about 3100 – 3200 km in size, orbit and other characteristics – rather than a planet, and ... companion. Indeed, Pluto is like a defective planet.

In favor of this assumption exist and oddities in the period of rotation of Pluto around its own axis. For a full rotation it takes 6 days 9 hours 17 minutes, which is a lot for such a small body, so the rotation gives him away as an impostor in the family of planets. The speed at which Pluto is moving in its orbit, approximately equal to 16.8 km/h. the Orbit is very long and so one platonovsky year equal 247,7 earth. For example, if you are now 17 years old, on Pluto you would be 0.07.

Acceleration of free fall above the surface of Pluto is equal to 0.49 m/s^2 . If your mass is approximately equal to 70 kg., on this planet you would weigh 4 kg!

In the origin and evolution of the planet. In its depths there was less active processes than on other planets of the Solar system. In the framework of the model the equilibrium condensation of protoplanetary nebula at a temperature of about 40 Kelvin is the body, obviously, was accumulated mainly from methane ice, and composing its substance has not undergone further noticeable differentiation. Another possibility is the formation of hydrates of methane (CH_4 when the condensation temperature of about 70 Kelvin and their subsequent decomposition in the process of internal evolution, degassing of CH_4 and the formation of methane ice on the surface.

His identification in the reflectance spectrum of Pluto favors both of these models, allowing, however, to choose. At the same time for any of them the average density of the planet is not above 1.2 g/cm^3 , and albedo of at least 0.4, respectively, that likely reduces the diameter of Pluto to the size of the moon, and the mass limits of several thousandths of the mass of the Earth. If the density is only 0.7 g/cm^3 , as follows from the analysis of the ratios of the masses of Pluto with the satellite, it is necessary to additionally assume that composing his frozen volatile substances like water and methane ice are in a rather crumbly condition.

Unlike the satellites of the giant planets, Pluto has identified the spectral features of methane in the condensate. The results of narrowband photometry the intensity ratio of the reflectance in two spectral regions, one of which is located the absorption bands of water and ammonia ice and the other strong absorption band of methane ice, was equal to 1.6. If you take pure methane ice and to remove the same spectra in the laboratory, the ratio is only slightly larger, while for satellites of giants with signs of water ice on the surface is the ratio of significantly less than one. That is a pretty strong argument in favor of the presence of methane. The discovery of methane ice on Pluto change existed until recently, ideas about the surface formed by the rock, in the direction of more realistic assumptions about its long covering ice layer.

On Pluto not discovered visible signs of the atmosphere. It is unlikely that the neon can concentrate at least in small quantities, since such a small planet can hold such a light gas.

Above the planet's surface the maximum temperature is about, that is constantly approaching absolute $^{\circ}\text{C}$, and the minimum -273° - 212 equal to zero.

Pluto is a unique and most interesting planet in the Solar system. Remains many mysteries about the exact origin, the chemical composition of Pluto. "Dungeon Lord" have never landed, not a single research facility from Earth, of course photographs of the surface either. Finding the secrets of living organisms is equal to zero, as from the point of view of modern science no single body of Land could not survive in such harsh conditions, and other life forms we have not yet found. There is a small probability of there minerals in

the form of scarce gas, but these chemical elements is more close to the Earth planets.

Small planets

In the middle of the eighteenth century it was noticed that the distance from the Sun to the planets can be linked by a simple relationship:

$$r = a \cdot 0.4 + 0.3 \times 2^n \text{ (and. E.)}$$

So, for mercury , $r=0,4$ (in fact it is equal to 0,387. E.); Venus for $n=0$, $r=0,7$; Earth (real distance — 0,723); Ground $n=1$, $r=1$; for Mars when $n=2$ have $r=1,6$ (the true value 1,523). The next planet is Jupiter. But when $n=3$ we find $r=2,8$, whereas Jupiter corresponds to $n=4$ and $r=5,2$ (should be 5,203), and Saturn is almost perfect $n=5$ and GE (actually — 9,546). It followed that at a distance of approximately 2.8 a. that is from the Sun must exist a planet!

In 1796 was organized a society of astronomers, seeking to discover the unknown planet. But quite independently of him, in 1801, a Sicilian astronomer, Piazzi accidentally discovered a stellar object, the coordinates of which varied from night to night. The calculations showed that this object is moving around the Sun in an elliptical orbit, with major radius, $r=2.77$ a. E. This is the first of the minor planets was named Ceres named after the Greek goddess of fertility, was considered the patroness of Sicily. It was soon discovered three of the asteroid (“star”) — Pallas, Juno and Vesta. To date, more than 3,500 scatalogically asteroids. The largest size is (diameter): Ceres is about 1000 km, Pallas — 608, Vesta — 538, Juno, almost 250 km, the vast majority of the other sizes do not exceed 5 to 10 km More than 97% of the asteroids orbit the Sun between the orbits of Mars and Jupiter, but there are exceptions: highly elongated orbit of Icarus is closer to the Sun than the planet mercury and the asteroid Chiron, opened in 1977, extends far beyond the orbit of Saturn and comes close to the orbit of Uranus. It was only discovered due to its relatively large size — its diameter is about 200 km. Some asteroids in their journey through interplanetary space flew pretty close to the Ground. In 1968, the aforementioned Icarus was at a distance of 7 million km from Earth. And in 1976 opened a new asteroid, named Hathor, who shortly before the opening went from the Land of 1.15 million km, that

is just three times farther away from us than the Moon! But all scientists agree that the probability of Earth collision with an asteroid is negligible. But who would dare to assert this after the famous fall on Jupiter of remnants of comet shoemaker-levy-9 in 1996

Conclusion

So ended the story of the modern state of our planetary system and to a certain limit – its history. Its future, barring anything unexpected, appear to be bright. The probability that some wandering star may disturb the established order of movement of planets, small even within a billion years. Not before we can expect any big changes in solar radiation. Is it possible the recurrence of glacial periods, we can not say. Continents can rise and fall in subsequent periods, as has happened in the past. Random meteors can in some places to scrape the surface of the Earth. However, the order is associated with the very existence of the solar system, will prevail over all these changes.

In 1979-1981 spacecraft "pioneer-11, Voyager-1 and Voyager-2" passed near Saturn. Managed to explore the planet, its rings and moons from distances thousands of times closer than when observed from Earth.

INTRODUCTION

"THE WORLD OF ICE MOONS"

Space geodesy is one of the youngest Sciences. as it is directly connected with space and technology, it gained rapid development. If the first used space methods for the study of the Earth, then eventually have the opportunity to explore other celestial objects.

The first celestial body that was studied by methods of space geodesy, was the Moon. In the study of the moon succeeded both Soviet and American scientists.

That was followed by "storming" of Venus and Mars.

However, the study of the outer planets priority of Americans. One of the

clearest examples of this was the success of the program "pioneer" and "Voyager". The program for these projects was to study the planet Saturn. The flights of AMS has allowed to clarify the main characteristics of the planet and its satellites.

This summary is based on information obtained through these satellites.

THE ATMOSPHERE AND THE CLOUD LAYER

Anyone who observed the planet through a telescope, knows that on the surface of Saturn, that is on the upper border of the cloud cover noticeably little detail and contrast them with the surrounding background is low. This Saturn is different from Jupiter, where there is a lot of contrasting details in dark and light stripes, waves, knots, indicating the significant activity of its atmosphere.

The question arises whether the atmospheric activity of Saturn (e.g. wind speed) lower than that of Jupiter, or the details of its cloud cover just worse visible from Earth because of the larger distance (about 1.5 billion km.) and a more scant coverage of the Sun (almost 3.5 times weaker than the illumination of Jupiter)?

"Voyager" managed to obtain images of the cloud cover of Saturn, which clearly depicts the pattern of atmospheric circulation: dozens of cloud belts, extending along Parallels, as well as the individual vortices. Discovered, in particular, the analogue of the red Heels on Jupiter, although smaller. It is established that the speed of the winds on Saturn are even higher than on Jupiter: at the equator 480 m/s, or 1700 km/h. the Number of cloud belts more than on Jupiter, and they reach higher latitudes. Thus, the images of clouds show the uniqueness of the atmosphere of Saturn, which is even more active than Jupiter.

Meteorological phenomena on Saturn occur at a lower temperature than earth's atmosphere. Since Saturn is 9.5 times further from the Sun than Earth, it receives $9.5^2 = 90$ times less heat.

The temperature of the planet at the level of the upper border of the cloud

cover, where the pressure is 0.1 ATM is only 85 To, or -188 C. Interest but that by heating a single Sun, even this temperature to obtain the impossible. The calculation shows that in the depths of Saturn has its own heat source, the flow from which is 2.5 times more than from the Sun. The sum of these two flows gives the observed temperature of the planet.

The spacecraft studied in detail the chemical composition nadovrazhnoe atmosphere of Saturn. Basically it consists almost 89% of hydrogen. In second place helium (about 11% by weight). Note that in the atmosphere of Jupiter it 19%. The shortage of helium on Saturn explain the gravitational separation of helium and hydrogen in the planet's interior: helium, which is heavier, gradually settles to great depths (which, incidentally, frees up some of the energy that fuels the Saturn) . Other gases in the atmosphere — methane, ammonia, ethane, acetylene, phosphine present in small amounts. Methane at such a low temperature (about -188 C) is located mainly in the drip-liquid state. It forms a cloud cover of Saturn.

As for the small contrast detail visible in the atmosphere of Saturn, as mentioned above, the reasons for this phenomenon are not yet entirely clear. It has been suggested that the atmosphere weighed weaken the contrast of the haze of fine particles. But observations of "Voyager-2" refute this: the dark bands on the surface of the planet remained sharp and clear up to the edge of the disk of Saturn, whereas in the presence of haze they would to the edges samotalis due to the large number of particles in front of them. The question therefore, remains unresolved and requires further investigation.

Data obtained with the "Voyager-1" has helped with great precision to determine the Equatorial radius of Saturn. At the level of the top of the cloud cover Equatorial radius is 60330 km or 9.46 times larger than the earth. Also refined the orbital period of Saturn around the axis: one turn he does during 10 h 39,4 min — 2.25 times faster than the Earth. This rapid rotation has led to the fact that the compression of Saturn much larger than Earth. Equatorial radius of Saturn is 10% more polar (Land — only 0.3%) .

THE MAGNETIC PROPERTIES OF SATURN

Until then, until the first spacecraft reached the Satur on observational data

about its magnetic field does not exist, but from a ground-based radio astronomy observations demonstrated that Jupiter has a powerful magnetic field. This was evidenced by the non-thermal radio emission at decimeter waves, the source of which turned out to be more of the visible disk of the planet, and it stretches along the equator of Jupiter symmetrically to the disk. This geometry and polarization of radiation is evidence of the fact that the observed radiation of the magnetic brake and the source of its electrons captured by the magnetic field of Jupiter and inhabit his radiation belts similar to the radiation belts of the Earth. Flights to Jupiter confirmed these findings.

Because Saturn is very similar to Jupiter in their physical properties, astronomers have suggested that a significant enough magnetic field is and he. The absence of Saturn observed from Earth magnetic braking radio emission was explained by the influence of the rings.

These proposals were confirmed. Even at the approach of "Pioneer-11" to Saturn his instruments have detected around planetary space education, typical for the planet, possessing a strong magnetic field: the head shock wave, the boundary of the magnetosphere (magnetopause) , radiation belt (Earth and the universe, 1980, N2, pp. 22-25 Ed.) . In General, the magnetosphere of Saturn is very similar to earth, but, of course, much larger in size. The outer radius of the magnetosphere of Saturn in sunflower point 23 is the Equatorial radius of the planet, and the distance to the shock wave 26 of the radii. For comparison, we can recall that the external radius of the earth's magnetosphere sunflower in point — about 10 earth radii. So even the relative sizes of the magnetosphere of Saturn exceeds the earth more than twice.

The radiation belts of Saturn are so extensive that they cover not only the ring, but the orbits of some of the inner satellites of the planet.

As expected, in the inner part of radiation belts, which "blocked" the rings of Saturn, the concentration of charged particles is much smaller. The reason for this is easy to understand if we recall that in the radiation belts particles oscillate approximately in the meridional direction, each time crossing the equator. But Saturn in the plane of the equator are rings: they absorb nearly

all particles tending to pass through them. The inner part of radiation belts, which in the absence of the rings would be in the system of Saturn's most intense source of radio emission is weakened. However "Voyager-1" approaching Saturn, discovered non-thermal radio emission of its radiation belts.

Unlike Jupiter, Saturn radiates in the kilometer wavelength range. Noting that the intensity of radiation modulated with a period of 10h. 39,4 min., suggested that this is the period of axial rotation of the radiation belts, or in other words, the period of rotation of the magnetic field of Saturn. But then it is also the period of rotation of Saturn. In fact, Saturn's magnetic field is generated by electric currents in the earth, appears in the layer where under the influence of the tremendous pressures hydrogen is passed into the metallic state. During rotation of the layer with the angular velocity rotates and the magnetic field.

Due to the high viscosity substances of the internal particles of the planet they all revolve with the same period. Thus, the period of rotation of the magnetic field is at the same time, the rotation period the greater part of the mass of Saturn (except for the atmosphere that rotates as a rigid body).

RING

From the Earth to the telescope is clearly visible three rings: outer, middle brightness ring A; secondary, most brilliant ring In the internal, not bright translucent ring, which is sometimes called crepe.

The rings are slightly whiter than the yellowish disc of Saturn. They are located in the plane of the equator of the planet and is extremely thin, with an overall width in the radial direction of about 60 thousand km. they have a thickness of less than 3 km away. Spektroskopicheskie it was found that the rings do not rotate as a rigid body, the distance from Saturn decreases the speed. Moreover, each of the rings has such a speed, which would at this distance, the satellite, freely moving around Saturn in a circular orbit. It is therefore clear: the rings of Saturn essentially represents an enormous accumulation of small solid particles independently orbiting the planet. The size of the particles are so small they cannot be seen not only in terrestrial

telescopes and spacecraft.

A characteristic feature of the structure of the rings, the dark ring gaps (division) where the substance very little. The widest of them (3500 km) separates the ring from the ring and is called the "Cassini division" in honor of the astronomer who first saw it in 1675. Under exceptionally good atmospheric conditions such divisions but over ten. Their nature is apparently resonant. So, the Cassini division is the area of the orbits in which the orbital period of each of the particles around Saturn exactly twice less than that of the nearest large moon of Saturn — Mimas. Because of this coincidence of Mimas to its attraction as if a rocking motion of the particles moving inside the division, and eventually throws them out.

Onboard camera "Voyager" showed that close-UPS of the rings of Saturn like a gramophone record: they would be stratified into thousands of individual narrow ringlets with dark gaps between any mi. Glades are so many to explain their resonances occur about the periods of the satellites of Saturn is impossible.

What explains this fine structure? Likely, a uniform distribution of particles in the plane of the rings are mechanically unstable.

The resulting circular waves density is observed fine structure.

In addition to the rings A, b and C "the Voyagers" found four more: D, E, F and G. they are All very sparse and therefore dim. Rings D and E are barely visible from the Ground under especially favorable conditions; the rings F and G detected for the first time.

The procedure of designation of the rings is due to historical reasons, so it is not the same as alphabetical. If you place the ring on as to remove them from Saturn, we get a number: D, C, B, A, F, G, E.

Of particular interest and much discussion ensued, ring F. sorry, to bring final judgment on this subject is not yet managed, as the observation of two "Voyagers" are not consistent among themselves. Onboard camera "Voyager-1" showed that the F ring consists of several rings with a total width of 60 km, and two of them entwined with each other like lace. Some time

dominated the view that the responsibility for this unusual configuration are two newly discovered small satellites, which move close to the F ring, is one of the inner edge, the other external (a little slower than the first, as it is farther from Saturn). The attraction of these satellites is not extreme gives the particle to go far from the middle, that is, satellites like a "graze" of a particle, for which he received the name "the shepherds".

They are the same, as shown by the calculations, cause the movement of particles at the wavy lines, which creates the observed intertwining of the components of the ring. But "Voyager 2" passed near Saturn nine months later, found the ring F nor weaves, nor any other distortion forms — in particular, in the vicinity of the "shepherds". Thus, the shape of the ring was variable. For judgments about the causes and patterns of this variability of the two observations, of course, is not enough. From the Earth to observe the ring F modern means impossible — the brightness is too low. It is hoped that a more thorough study received "Voyager" images of the ring will shed light on this issue.

The D ring is closest to the planet. Apparently, it extends to the cloud globe of Saturn. The ring E is the outermost. Highly charged times, it at the same time, the broadest of all — around 90 thousand km the Amount of area that it takes from 3.5 to 5 radii the plan you. The density of the material in the E ring increases in the direction of the orbit of Saturn's moon Enceladus. Perhaps Enceladus the source of the substance of this ring.

The particles of Saturn's rings, probably water ice, covered with hoarfrost. It was already known from ground-based observations, and onboard instruments of spacecraft have only confirmed the correctness of this conclusion.

The size of the particles of the main rings was estimated from ground-based observations in the range of centimeters to meters (of course, the particles can not be equal in magnitude: it is not excluded that in different rings of a typical cross-section of particles varies) .

When the "Voyager 1" passed near to Saturn, the spacecraft transmitter is sequentially penetrated by the antenna beam is still 3.6 cm. ring And Cassini

division and a ring S. Then the radio emission was made on the Ground and subjected to analysis. Found out that the particles of the specified zones radio waves scatter mainly forward, although somewhat differently. Thanks to this estimate the average particle size of the rings is 10 μ m, the Cassini division is 8 μ m and ring C is 2 μ m

Strong forward scattering, but this time in visible light, discovered the rings F and E. This means the presence of significant quantities of fine dust (dust particle diameter of about ten thousandths of a millimeter).

In ring have discovered a new structural element radial of structure called "spokes" because of the resemblance with the spokes of the wheel. They also consist of fine dust and located above the plane of the ring. It is not excluded that the needles are retained there by the forces of electrostatic repulsion. It is interesting to note: images of "spokes" was found at some drawings of Saturn made in the last century. But then nobody gave values to them.

Examining the ring, "the Voyagers" found an unexpected effect of numerous short bursts of radio emission coming from the rings. It is not that other, as the signals from electrostatic discharge — a kind of lightning. The source of the electrified particles, apparently, of a collision between them.

In addition, was opened enveloping ring of a gaseous atmosphere made of neutral atomic hydrogen. "Voyager" was observed line Lyman-alpha (1216 Å) in the ultraviolet part of the spectrum. Its intensity was evaluated by the number of hydrogen atoms in a cubic centimeter of the atmosphere. They turned out to be about 600. I must say, some scientists long before the launch of the Saturn spacecraft predicted the possibility of the existence of an atmosphere around Saturn's rings.

"Voyager" was also an attempt was made to measure the mass of the rings.

The difficulty was that the mass of the rings at least a million times smaller than the mass of Saturn. Because of this, the trajectory of the spacecraft near Saturn to a huge extent determined by the powerful gravity of the planet itself and only negligibly perturbed by the weak attraction of the rings. Meanwhile, it is a weak attraction and need to be identified.

The best thing for this purpose was the trajectory of "Pioneer 11". But the analysis of measurements of the trajectory of the device in its radio emission showed that the ring (within measurement accuracy) on the motion of the vehicle is not affected. The precision was 1.7×10^{-6} mass of Saturn. In other words, the mass of the rings is obviously less than 1.7 ppm of the mass of the planet.

SATELLITES

If, before the space missions to Saturn were 10 known satellites of the planet, now we know 17 (Earth and the universe, 1981, No. 2, pp. 40-45, Ed.). New seven satellites is very small, but nevertheless some of them have a major impact on the dynamics of the Saturn system. Such, for example, a small satellite moving near the outer edge of the ring A; it prevents the particles of the ring to go beyond this region. This Satin. (In Greek mythology, the many-eyed giant who guarded on the orders of the goddess Hera Zeus's lover IO. In the sense of transfer — vigilant guardian).

Titan is second largest moon in the Solar System. Its radius is 2575 km. Its mass is $1,346 \times 10^{22}$ Grumm (0,022 mass of the Earth) , and the average density 1,881 g/cm³ Is the only moon with a significant atmosphere, and its atmosphere is denser than any of the terrestrial planets, except Venus. Titan like Venus because it has a global haze, and even a small greenhouse heating at the surface. In the atmosphere, there are probably methane clouds, but it is not firmly established. Although the infrared spectrum is dominated by methane and other hydrocarbons, the main component of the atmosphere is nitrogen, which is evident in the strong UV emissions. The upper atmosphere is very close to the isothermal condition all the way from the stratosphere to ecosphere, and the surface temperature to within a few degrees the same throughout the sphere and equal to 94 K. the Radii a dark orange or brown particles of stratospheric aerosol do not exceed 0.1 micron, and at greater depths may exist larger particles.

It is assumed that aerosols are the end product of photochemical reactions of methane and that they accumulate on the surface (or dissolved in liquid methane or ethane). The observed hydrocarbons and organic molecules may occur under natural photo chemical processes.

A remarkable property of the upper atmosphere is that UV-emission is confined to the day side, but too bright to be able to initiate incoming solar energy. Hydrogen quickly dissipated, adding to the observed torus, together with some amount of nitrogen, knocks N_2 dissociation by electron impact. Based on the observed splitting of the temperature it is possible to construct a global system of winds.

The global structure of Titan, apparently, determined by a set of condensed substances, which are formed in a dense gas disk around proto-Saturn. There are three possible scenarios of origin: the cold accretion (meaning that the temperature rise in the course of evolution is negligible), hot accretion in the absence of a dense gas phase and hot accretion in the presence of a dense gas phase.

Probably hot digidratirovannogo silicate core as well as the molten layer NH_3 - H_2O , however, a detailed location of the ice layers is currently not known. Convection the pre has, except for the outer shell.

Yapet. Perhaps the most mysterious of Saturn's moons, yapet, is the only interval on the albedo of its surface from 0.5 (typical value for icy bodies) to 0.05 in the Central parts of its host in the course of treatment hemisphere. "Voyager 1 spacecraft" were obtained images with a maximum resolution of 50 km/steam lines showing mainly the hemisphere facing Saturn and the boundary between the leading (dark) and trailing (bright) sides. It was a huge dark Equatorial ring with a diameter of about 300 km with the longitude of the center about 300. Voyagemonkey observations obtained with the highest resolution, show that the bright side (and especially the region of the North pole) strongly katerinovka: the surface density is 205 ± 16 craters ($D > 30$ km) 10 km.

Extrapolation to diameters of 10 km leads to a density of more than 2000 craters ($D > 10$ km) by 10 km, Such a density is comparable to densities for other strongly criteriaand bodies, such as mercury and Callisto, or the density of craters on the lunar continents. A characteristic feature of the border between light and dark areas on the yapet is the existence of numerous craters with dark bottom to light a scrap of the matter and the absence of dark matter craters with a bright bottom or craters with halos (or other white spots). The

density of yapet, is 1.16 ± 0.09 g/cm characteristic of the icy Satellites of Saturn and is consistent with models in which water ice is the main component. Bell believes that dark matter is a major component of the original condensate, from which was formed of yapet.

Ray. Almost double of yapet in size, but without his dark matter, ray can be a relatively simple prototype of the icy satellites of the outer regions of the Solar system. Rhea diameter of 1530 km, and a density of 1.24 ± 0.05 g/cm. Its geometric albedo is 0.6 and is similar to the albedo of the poles and the slave hemisphere of yapet.

THE MOONS OF SATURN

This made an important step in the study of the nature of satellites. Knowing the diameter of the satellite, it is easy to calculate its volume. Dividing the mass of the satellite on the volume, we obtain the average density — characteristics that help to determine which substances is the celestial body. It was found that the density of the inner satellites of Saturn from Mimas to Rhea and yapet — close to water density: 1.0 to 1.4 g/cm, There is reason to believe that these satellites mostly consist of water (not liquid as their temperature is about -180 C). Tafia whose density is 1 g/cm, particularly like piece of pure ice. Other satellites also needs to have greater or lesser admixture of stony substances.

"The voyagers" came to the moons of Saturn so close that managed not only to determine the diameters of the satellites, and transmit to Earth images of the surface. Already made the first maps of the satellites.

The most common formation on their surface — ring craters like the moon. The origin of impact craters: flying in the interplanetary space meteor body collides with the satellite, its orbital velocity almost instantly drops to zero, the kinetic energy is converted into heat. An explosion occurs with the formation of a circular crater.

Some of the craters need to be specially mentioned. For example, the large crater on Mimas is small. The diameter of the crater is about 130 km, or one third of the diameter of the satellite. Probably the impact crater on Mimas can

not be. With a slightly larger kinetic energy of the cosmic body striking Mimas would be shattered to pieces.

Many of the craters that we now see in pictures of Saturn's moons, is a chronicle of their history that goes back at least hundreds of millions of years. The marks produced by the celestial stones, indicate that in the remote epoch of the formation of planetary systems the solar space (at least to the orbit of Saturn) was full of a multitude of individual solids from which gradually evolved the planets and satellites. And even after the formation of planets and satellites has basically ended, the residue of these solids for a long time continued to move in space.

These are, basically, our current data on Saturn. It is only necessary to mention that in the first place it was about the actual data. More profound conclusions that can be made of them, and probably will be made, will require long-term work of scientists. She is still ahead.

CONCLUSION

In my work I tried to summarize the results obtained with Pioneer and Voyager, Saturn and its satellites. This data was built planetocentric coordinate system and the refined theory of Saturn's rings.

In this regard, there are new prospects of space geodesy. By 1995, the planned U.S. launch of the project "Cassini", which will test hypotheses about the origin and evolution of the Saturn system, in particular of Titanium. Cassini will clarify the data obtained by previous missions, and also explores the small icy satellites of Saturn.

World, Earth, Cosmos, Universe...

Thousands of years inquisitive mankind turned their views on the world, sought to understand it, to break out of the microcosm in the macrocosm.

The majestic picture of the heavenly dome, studded with myriads of stars, since stars are worried about the mind and the imagination of scientists, poets, all living on the Earth, and enchanted admiring the solemn and wonderful picture, in the words of Lermontov.

What is the earth, the Moon, the Sun, the stars? Where the beginning and the end of the Universe, how long it exists, what it consists of and where its boundaries of knowledge?

In his essay I outlined all of what is known to date, the science of the structure and evolution of the Universe.

The study of the Universe, even if only known to us part is a huge task. To obtain those data available to modern scientists, it took the labor of many generations.

The universe is infinite in time and space. Every particle of the universe has a beginning and an end, both in time and in space, but the whole universe is infinite and eternal as it is eternally self-moving matter.

The universe is everything that exists. The smallest particles and atoms to large clusters in the Islands of the starry worlds and star systems. So it is not wrong to say that any science anyway studies the Universe, or rather, the fact or otherwise of her. Chemistry studies the world of molecules, physics – the world of atoms and elementary particles, in biology, phenomena of nature. But there is a scientific discipline, the object of the study which is the universe itself or "the universe as a whole". This special branch of astronomy so-called cosmology. Cosmology – the study of the Universe as a whole, including the theory all covered by astronomical observations of the region, as part of the Universe, by the way, you should not confuse the concept of the Universe as a whole and observed (visible) Universe. In Le we are talking it is only to that limited region of space that is available to modern methods of scientific research. With the development of Cybernetics in various areas of scientific research have become increasingly popular methods of modeling. The essence of this method is that instead of one or the other of the real object studied his model, more or less just repeating the original or its most important and essential features. The model is not necessarily a real copy of the object. The construction of approximate models of various phenomena helps us all a deeper understanding of the world around us. For example, for a long time astronomers have been studying homogeneous and isochronous (imagined) Universe in which all physical phenomena occur in the same way, and all the laws remain the same for all regions and in all directions. Studied

as models in which these two conditions were added to the third, the immutable picture of the world. This means that in whatever era we contemplated the world, he should always look in General the same. These largely conditional and schematic model helped to highlight some important aspects of the world around us. But! As difficult as it is one or the other theoretical model, which would be diverse facts it may consider any model is not the phenomenon itself, but only more or less exact copy, so to speak, the image of the real world. Therefore, all the results obtained with models of the Universe, it is necessary to check by comparison with reality. It is impossible to identify the phenomenon with the model. It is impossible without a thorough scan, to ascribe to nature those properties possessed by the model. None of the models can claim to the role of accurate "snapshot" of the Universe. This suggests the need for in-depth development of models of heterogeneous and nastroenny Universe.

The stars in the Universe combined into giant Star systems called galaxies. Star system. Which, as an ordinary star, our Sun is called a Galaxy.

The number of stars in the galaxy is about 10^{12} (trillion). The milky way, the bright silver band of stars encircles the whole sky, forming the main part of our Galaxy. The milky way most bright in the constellation Sagittarius, where the most powerful clouds of stars. The least bright in the opposite part of the sky. From this it is easy to deduce the conclusion that the solar system is not at the center of the Galaxy, which is visible from us in the direction of the constellation Sagittarius. The farther away from the plane of the milky Way, the less there faint stars and the less far in these areas stretches star system. In General, our Galaxy is a space, resembling a lens or lentil, if you look at it from the side. The size of the Galaxy was scheduled and the stars that are visible at great distances. It zeidy and hot giants. The diameter of the Galaxy is approximately equal to 3000 PC (Parsec (PC) is the distance with which the semimajor axis of earth's orbit, perpendicular to the line of sight, visible angle $1''$. $1 \text{ Parsec} = 3.26 \text{ light years} = 206265 \cdot e. = 3 \cdot 10^{13} \text{ km}$) or 100,000 light years (light year – distance traveled by light in one year), but clear boundaries she is not, because the star density gradually eroding.

In the center of the galaxy is located - with a diameter of 1000-2000 PC – giant compacted cluster of stars. It is from us at a distance of almost 10000

PCs (30000 light years) in the direction of the constellation Sagittarius, but almost entirely hidden by a dense veil of clouds, which prevents ordinary visual and photographic observations of this interesting object, of the Galaxy. In the kernel includes a lot of red giants and short-period cefid.

Stars top of the main sequence and supergiants and classical Zeidi is more than young people. It is located further from the center and forms a relatively thin layer or disc. Among the stars of this disc is dust matter and clouds of gas. Substarlike and giants form around the nucleus and disk of the Galaxy spherical system.

The mass of our galaxy is now estimated in different ways, equal to $2 \cdot 10^{11}$ solar masses (mass of Sun is $2 \cdot 10^{30}$ kg) and $1 / 1000$ th is enclosed in interstellar gas and dust. The mass of a Galaxy in Andromeda is almost the same as the mass of a Galaxy in the Triangle is estimated at 20 times menshe. The diameter of our galaxy is 100,000 light-years. Due to the hard work of the Moscow astronomer V. V. Kukarin in 1944 found the instructions on the spiral structure of the galaxy, and it turned out that we live between two spiral branches, the poor stars.

In some places in the sky through a telescope, and some where even the naked eye can distinguish close groups of stars that are associated by mutual gravitation, or star clusters.

There are two types of star clusters: globular and scattered.

Scattered clusters usually consist of tens or hundreds of main sequence stars and supergiants with a weak concentration to the center.

Ball the same clusters usually consist of tens or hundreds of main sequence stars and red giants. Sometimes they contain short-period Cepheids. The size of open clusters – a few parsecs. An example of their accumulation Famines and the Pleiades in the constellation Taurus. The size of globular clusters with a strong concentration of stars towards the center to tens of parsecs. There are more than 100 ball and hundreds of open clusters, but in the Galaxy must be tens of thousands.

In addition to stars in the galaxy, composition further includes a scattered matter, extremely diffuse substance composed of interstellar gas and dust. It forms a nebula. Nebulae are diffuse (patchy form) and planetary. Light from them, that their light of nearby stars. Example: gas-dust nebula in the constellation Orion and the dark dust nebula Horse head.

The distance to the nebula in the constellation Orion is 500 PC, the diameter of the Central part of the nebula – 6 PC, a mass of about 100 times the mass of the Sun.

In the Universe there is nothing unique in the sense that there is no such body, the phenomenon of basic and General properties of which would not be repeated in the other body, other phenomena.

The appearance of galaxies is extremely diverse, and some of them are very picturesque. Edwin Powell Hubble (1889-1953), an American astronomer observer, chose the simplest method of classifying galaxies by their appearance, and I must say that though other prominent researchers have made reasonable assumptions according to the classification of the original system derived by Hubble, still remains the basis for the classification of galaxies.

Hubble suggested to divide all galaxies into 3 types:

1. Elliptic is denoted by E (elliptical);
2. Helical (Spiral);
3. Wrong – abbreviated (irregular).

Elliptical galaxies outwardly expressionless. They have the appearance of smooth ellipses or circles with a circular gradual decrease in brightness from the center to the periphery. Any additional parts they have, because Elliptical galaxies are composed of second type stellar population. They are constructed from stars of red and yellow giants, red dwarfs and yellow and some white stars not very high lordship. No blue-white supergiants and giants of groups can be observed in the form of bright clumps that give structure to a system, no dust matter which, in those galaxies where it is available, creates

dark bands shading in the form of a star system .

Externally elliptical galaxies differ from each other mainly on one feature – more or less compression (NGC 636, NGC 4406, NGC 3115, etc.)

With more monotonous in contrast to elliptical galaxies spiral galaxies are maybe even the most spectacular objects in the Universe. The appearance says about the static, steady-state. Spiral galaxies exemplify the dynamics of form. Their beautiful branches emerging from a Central core and, as if losing shape outside of the galaxy, points to a powerful swift motion. Also striking is the diversity of forms and patterns of branches. As a rule, the galaxy has two spiral arms originating at opposite points of the core, developing a similar symmetrical way and losing in opposite areas of the periphery of the galaxy. However, the known examples more than two number of spiral branches of the galaxy. In other cases, spiral two, but they are unequal, one much more developed than the second. Examples of spiral galaxies: M31, NGC 3898, NGC 1302, NGC 6384, NGC 1232 etc.

I have listed so far, the types of galaxies were characterized by forms of symmetry in a certain style. But there are a large number of galaxies of irregular shape. Without any regularity in the structure. Hubble gave them the designation from the English word irregular is wrong.

The irregular shape of the galaxy may be the result of the fact that she didn't have time to make the right shape due to the low density of matter or due to young age. There is another possibility: the galaxy may be incorrect the result of the distortion as a result of interaction with another galaxy. Apparently both cases occur among irregular galaxies and can be related to the separation of irregular galaxies 2 subtype.

Subtype characterized by relatively high surface brightness and complexity of irregular structures (NGC 2574, NGC 5204). French astronomer Vaucouleurs in some galaxies of this subtype, for example Magellanic clouds, found indications of a spiral structure is destroyed.

Wrong galaxy another subtype denoted by III, are of very low surface brightness. This trait makes them stand out from among the other galaxies of

all types. At the same time, it prevents the detection of these galaxies, as a result was able to identify only a few galaxies subtype Are relatively close (galaxy in constellation Leo.).

Only 3 galaxies visible to the naked eye, a Large Magellano cloud, Small Magellano cloud and the Andromeda galaxy. In the table the data about the ten brightest galaxies in the sky. (BMO, MMO Magellano Large cloud and Small cloud Magelanova.).

Non-rotating star system after a certain period should take the form of a ball. This conclusion follows from the theoretical studies. It is confirmed by the example of globular clusters, which are rotating and have spherical shape.

If the stellar system is flattened, it means that it is rotating. Therefore, have to be rotated and elliptical galaxies, except those of them which are spherical, have no compression. The rotation occurs around axis that is perpendicular to the main plane of symmetry. Galaxy is compressed along the axis of its rotation. For the first time the rotation of galaxies was discovered in 1914, the American astronomer Slayfer.

Of particular interest are galaxies with dramatically increased luminosity. They are called radio galaxies. The most prominent galaxy Lebed. This is a faint double galaxy with extremely closely spaced to each other components, which is a powerful discrete source. Objects like galaxy Lebed certainly very rare in the Metagalaxy, but Lebed not the only such object in the Universe. They should be at enormous distance from each other (more 200Mпс).

The flux of radio emission from them in view of the large distances is weaker than from the source Lebed.

Several bright galaxies included in the catalogue NGC, also classified as radio galaxies because of their strong radio emission similar although it is much less light energy. Of these galaxies NGC1273, NGC5128, NGC4782 and NGC6186 are double. Single NGC2623 and NGC4486.

When the English and Australian astronomers, using the interference method in 1963, has defined with great precision the situation of the large number of

discrete radio sources, they also identified other angular sizes of the radio sources. The diameters of most of them was estimated in minutes or dozens of seconds of arc, but 5 sources, namely from 3C48, 3C147, 3C196, 3C273 and 3C286, the size was less than one second of arc.

But the stream of their radio emission is not inferior patki radio other firms of discrete sources, superior the radiation area of tens of thousands of times. These starlike sources of radio emission were called quadras. Now, more than 1000. Shine Quadra-power generation does not remain constant. Mass blocks reach one million solar masses. Isocnet energy blocks is still not clear. There are suggestions that the Quadra is extremely active nuclei of very distant galaxies.

Theoretical modeling is essential to determine past and future of the observable Universe. In 1922, A. Friedman engaged in the development of an original theoretical model of the Universe. He suggested that the average density is not a constant, but varies over time. Friedman concluded that any sufficiently large part of the Universe, uniformly filled, the matter is not in equilibrium: it must either expand or shrink. In 1917, V. M. Slider discovered the "red shift" of spectral lines in the spectra of distant galaxies. A similar shift is observed when the light source is removed from the observer. In 1929 E. Hubble explained this phenomenon in a mutual divergence of these star systems. The phenomenon of "red shift" observed in the spectra of almost all galaxies except the nearest (few). And the farther from us a galaxy is, the greater the shift of lines in its spectrum, i.e. all the stellar system is receding from us with enormous speeds in the hundreds, thousands, tens of thousands of kilometers per second, more distant galaxies have greater speeds. And after the effect of "red shift" was discovered in the radio band, then left, no doubt in the fact that the observed universe is expanding. Currently the known galaxy, receding from us with speeds of up to 0.46 the speed of light. And sverdsvette and Quadra – 0.85 times the speed of light. But why they are increasing? On galaxy are constantly acting some force. In the distant past, matter in our region of the Universe was in surplanted condition. Then came the "explosion", which started the expansion. To find out the fate of the Metagalaxy, it is necessary to estimate the average density of interstellar gas. If it is above 10 protons per 1m^3 , the total gravitational field of the Metagalaxy is large enough to gradually stop the expansion. And it shifts the

grip.

There were two opinions about the state of the Metagalaxy to the start of the expansion. According to one of the original substance of the Metagalaxy consisted of a "cold" mixture of protons, i.e. nuclei of hydrogen atoms, electrons, and neutrons. According to the second, the temperature was very high, and the density of radiation exceeded density of matter. But after the discovery in 1965 of the microwave background radiation A. Tecnom and R. Wilson there was a preference for the second theory. After was presented the attempt to present the course of events in the first stages of expansion of the Metagalaxy: 1s after the beginning of the superdense initial plasma density is decreased to 500 kg/cm^3 , and $t=10^{13}$. Over the next 10^6 density decreased to 50 g/cm^3 , the temperature dropped. Teamed up protons and neutrons \Rightarrow helium nucleus. At $t=40000$, it lasted several hundred thousand years. Then, after the formed hydrogen atoms, a gradual formation of hot hydrogen clouds which formed galaxies and stars. However, the enlargement process could be saved blobs to ultra-dense stellar matter and in the process of decay formed stars and galaxies. It is not excluded that he had acted both mechanisms. The concept of the Metagalaxy is not entirely clear. It was formed based on the analogy with stars. Observations show that galaxies, like stars, scattered and grouped in globular clusters, also in groups and clusters of different sizes. All covered by modern methods of astronomical observations of the Universe called Metagalaxy (or our Universe). In the Metagalaxy space between galaxies is filled with extremely rarefied intergalactic gas, is penetrated by cosmic rays, it has magnetic and gravitational fields, and possibly the invisible mass of the substances.

From the most remote metagalactic objects light goes before us many millions of years. But still there is no evidence to suggest that the Metagalaxy is the entire universe. Perhaps there are others, not yet izvetsiya us Metagalaxy.

In 1929 Hubble discovered a wonderful pattern which was named the "Hubble law" or "law of the red shift": the lines of galaxies are shifted toward the red end, and the offset is greater the farther the galaxy.

Explaining the red shifts of the Doppler effect. Scientists came to the conclusion that the distance between our and other galaxies is continuously

increasing. Although the galaxies do not fly in all directions from our galaxy, which does not occupy any special position in the Metagalaxy, and there is a mutual destruction of all the galaxies. Therefore, the Metagalaxy is not stationary.

The opening of the expansion of the Metagalaxy shows that in the past, the Metagalaxy was not like now and the other will be in the future, i.e. Metagalaxy evolves.

From the redshift determined by the speed of removal of galaxies. In many galaxies they are very large, comparable to the speed of light. The high speeds (more than 250 000 km/s) have some quadrants, which are the most remote from us the objects of the Metagalaxy.

We live in an expanding Metagalaxy; the expansion of the Metagalaxy is manifested only at the level of clusters and superclusters of galaxies. The Metagalaxy has one feature: there was no centre from which the scatter of the galaxy. Managed to calculate the time interval from the beginning of the expansion of the Metagalaxy.

Gap extension is equal to 20-13 billion years. The expansion of the Metagalaxy is most notable at the present time the phenomena of nature. This discovery has produced a fundamental change in the views of philosophers and scientists. Indeed some philosophers have put an equal sign between the Metagalaxy and the universe, and tried to prove that the expansion of the Metagalaxy confirms the religious idea of the divine origin of the universe. But the Universe of known natural processes, in all probability it bursts. There is speculation that the expansion of the Metagalaxy also began with the appearance reminiscent. The tremendous explosion of matter, of enormous temperature and density.

Calculations done by astrophysicists indicate that after the beginning of the substance of the Metagalaxy had a high temperature and consisted of elementary particles (nucleons) and their antiparticles. As expansion has changed not only the temperature and density of the substance, but the composition part of the particle, i.e. a particle-antiparticle manipulated, giving rise to electromagnetic rays, radiation which, in the modern

Metagalaxy was more than the atoms that make up stars, planets, diffuse matter.

This theory is called the theory of "hot Universe" to superdense matter and turned into a substance with a density close to the density of water. After several hours, the density almost equal to the density of our air, and now, after billions of years, the estimation of the average density of matter in the Metagalaxy leads to a value of the order of 10^{-28} kg/m³.

But all these data could only be obtained through a unique complex of equipment allowing to expand the boundaries of the Universe. Until now, mankind perfects it, inventing more ingenious devices, but at the dawn of civilization, when the inquisitive human mind appealed to dizzying heights, the great philosophers thought in their view of the Universe as something infinite. The ancient Greek philosopher Anaximander (Vic. BC) introduced the concept of a common obscurity, did not have any of the usual observations, the qualities, the fundamental principle of all – the Apeiron.

The elements were conceived first as a semimaterial, semi-divine, spiritual substance. View customarily the basis of everything in ancient Greek basis, reached its peak in the doctrine of atomictom of Leucippus and Democritus (V-IV century.in. BC) on Vselennoi consisting of unqualified atoms and the void.

Ancient Greek philosophers owns a number of brilliant insights about the Universe. Anaximander expressed the idea of the isolation of Earth in space. Alali first described the Pythagorean system of the world, where the Earth as the Sun revolved around a "giant of fire." Arrowbreeze Land claimed another pitagoras Parmenides (VI-VC century BC) and Heraclides of Pontus (V-IV century BC) claimed its rotation around its axis and brought to the Greeks more ancient idea of Egyptians that the sun itself can serve as a center of rotation of some planets (Venus, mercury).

The French philosopher and scientist, physicist, mathematician, physiologist Rene Descartes (1596-1650) created the evolutionary theory of the vortex model of the Universe based on heliocentrism. In his model he considered the heavenly bodies and their systems in their development. For The XVII

Century.in. his idea was extraordinarily brave. According to Descartes, all heavenly bodies were formed as a result of vortex motion occurring in a uniform at the beginning, the world of matter. Exactly the same material particles being in constant movement and interaction, change their shape and size, which led us to observe the rich diversity of nature.

The solar system according to Descartes, is one of such vortexes of the world of matter. Planets do not have their own motion – they move, dragged by global vortex. Descartes made a new idea for the explanation of gravity: it is believed that the vortices generated around the planets, the particles press against each other and cause the phenomenon of gravity (e.g. on Earth). Thus Descartes was the first to consider the severity, not as innate, but as a derived quality tel.

The great German scientist, philosopher Immanuel Kant (1724-1804) created the first universal concept of an evolving Universe, enriching the picture of its smooth structure and represented the Universe is infinite in a special way. He explained the opportunities and the significant probability of the occurrence of such a Universe solely under the action of mechanical forces of attraction and repulsion and tried to find out the fate of this Universe at all scales – from planetary system to the world of nebula.

Einstein made a radical scientific revolution, introducing his theory of relativity. It is relatively simple, as all ingenious. He didn't have to pre-open a new phenomena, to establish quantitative laws. He just gave a fundamentally new explanation.

Einstein revealed the deeper meaning of installed dependencies, and effects are already related to some physico-mathematical system (in the form of postulates of Poincare). Replacing in this case the theory of absolute space and time of ideas, their relativity "Poincare", which is now not linked with the idea of absolute space, absolute reference system. Such a revolution removed the basic contradiction that created the crisis in the theoretical comprehension of the action. Moreover opened the way for further insight into the properties and laws of the world, so much so that Einstein himself did not immediately realize the extent of his revolutionary ideas.

In the article from 30.06.1905 G., laid the foundations of the special theory of relativity Einstein, summarizing the principles of relativity of Galileo, proclaimed the equality of all inertial reference systems, not only mechanical, but also electromagnetic phenomena.

Special or special theory of relativity was the result of a generalization of Galilean mechanics and Maxwell's electrodynamics Lorentz. It describes the laws of all physical processes at speeds close to the speed of light.

First fundamentally new kosmologicheskies a consequence of the General theory of relativity revealed an outstanding Soviet mathematician and theoretical physicist Alexander Friedman (1888-1925.). Speaking in 1922-24. he criticised the findings of Einstein that the universe is finite and has the form of a four-dimensional cylinder. Einstein made a conclusion based on the assumption of stationarity of the Universe, but Friedman showed the invalidity of his original postulate.

Friedman brought two models of the Universe. Soon, these models found a remarkably accurate confirmation of direct observations of the movements of distant galaxies to the effect of "red shift" in their spectra.

This Friedman proved that the substance in the Universe may not be alone. Their findings Friedman theoretically contributed to the discovery of the need for a global evolution of the Universe.

There are several theories of evolution: the Theory of pulsating Universe says that our world was the result of a giant explosion. But the expansion of the universe will not last forever, because it will stop gravity.

According to this theory our universe is expanding for 18 billion years from the time of the explosion. In the future, the extension will completely slow down and will stop, and then it will begin to shrink until the matter is again compressed and there will be another explosion.

The theory of a stationary explosion: according to it the universe has no beginning, no end. She arrives in the same condition. Constantly is the formation of a new vortex to replace the substance of receding galaxies. That's the reason the universe is always the same, but if the universe started

by the explosion will expand indefinitely, it will gradually cool down and fade away completely.

But so far none of these theories has not been proved, because at the moment there is no accurate evidence of at least one of them.

The discovery of diverse evolutionary processes in various systems and bodies that compose the Universe, has allowed to study the regularities of cosmic evolution based on observational data and theoretical calculations.

As one of the major challenges deals with the age determination of space objects and their systems. Because in most cases it is difficult to decide what should be considered and understood under the "birth" of a body or system, that setting the age characteristics mean two assessments:

1. The time during which the system is already in the monitored state.
2. Full life time of the system from the moment of its appearance. Obviously the second feature can be obtained only on the basis of theoretical calculations.

Usually the first of the expressed value is called the age, and the second is a life time.

The fact of mutual removal of galaxies that make up the Metagalaxy suggests that some time ago she was in a qualitatively different state and was more dense.

The most probable value of the Hubble constant (the proportionality factor relating the rate of removal of extragalactic objects and distances of 60 km/sec – MPC), which yields the value of the expansion of the Metagalaxy to the current 17 billion years.

Of all the above and the evidence that was not included in my summary because of its bulkiness and mathematical-physical problems it is safe to conclude that the universe evolution is rapid changes have occurred in the past, happen now and will happen in the future.

The problem with living in space is one of the most exciting and popular problems in the science of the Universe, which have long been concerned about not only the scientists but all people. Still John. Bruno and M. Lomonosov was suggested on the plurality of inhabited worlds. The study of life in the Universe – one of the greatest challenges with which ever mankind. We are talking about the phenomenon that the humanity faced. We are talking about the phenomenon that people essentially have not had to face. It is all about life beyond Earth, are purely hypothetical in nature. So deep into the biological patterns and cosmic phenomena does scientific discipline – "actorname".

So of extraterrestrial research, space life forms would help people to understand the essence of life, i.e. what distinguishes living organisms from inorganic nature, and secondly, to find out the path of the emergence and development of life and, thirdly, to determine the place and role of man in the Universe. Now can be considered a firmly established fact that on our own planet life has emerged in the distant past from inanimate, inorganic matter under certain external conditions. Among these conditions, there are three main. First of all, the presence of water, which is part of the living substance, the living cell. Secondly, the presence of the gas atmosphere required for the gas exchange of the organism with the external environment. However, it is possible to imagine any other environment. The third condition is the presence on the surface of the given celestial bodies suitable temperature range. Also require external energy for the synthesis of the molecules of living matter from the source of organic molecules the energy of cosmic rays or UV radiation or energy of the electronic level. The external energy necessary for the subsequent life of living organisms. The conditions necessary for the origin of life, at the time, happened naturally during the evolution of the Earth, but they have no reason to believe that they cannot emerge and the process of development of other celestial bodies. Was put forward many hypotheses about this. Academician A. I. Oparin, said that life was supposed to appear when the surface of our planet was a solid ocean. In the result of joining C_2H_2 and N_2 возникли the simplest organic compounds. Then, in the waters of the primary ocean of the molecules of these compounds, United and strengthened, forming a complex solution of organic substances in the third stage of this environment stood out complexes of molecules that gave rise to the primary living organisms. Oro and

Fesenkov noticed that the original vector if not life itself, at least its initial elements can be comets and meteorites. However, if you do not enter into the area close to the fiction, and stay motivated a fairly firmly established scientific facts, when you look for life on other celestial bodies we must first of all proceed from what we know about the earthly life.

As for our solar system, different planets move at different distances from the Sun and receive different amounts of solar energy. In connection with this. In the solar system can be allocated a heat zone of life, which includes Earth, Mars and Venus, and the Moon at first glance, the physical conditions on the moon does not completely rule out the possibility of the existence of living organisms: on the moon is no atmospheric envelope, there is no water, the temperature changes from -1500°C to $+1300^{\circ}\text{C}$, the lunar surface is exposed to a constant bombardment of meteorites, cosmic rays, ultraviolet radiation from the Sun etc.. And while you can speculate on whether there is in nature highly organized forms of life, able to grow in such conditions. An exception may be only microbes and bacteria, which are known to be able to adapt to the most adverse conditions: deep heating and cooling; ultraviolet and radioactive radiation: the intensity of radiation, etc. currently, a number of scientists believe that the moon has organic matter . They could be formed here in the early days of the moon, or to be covered with meteorites . It has been suggested that over the layer of lunar soil (10m) is a powerful layer of complex organic compounds. As Venus, if the temperature on its surface is high, despite the presence of the atmosphere , the conditions for life on this planet is of little use. Much more promising in this respect Mars.

In our days astronomers primarily interested in the question of the physical conditions on Mars. Living organisms living on a celestial body, continually interact with the environment. For example, on the surface of Mars, there are dark spots "seas". They change color in accordance with the change of seasons. This phenomenon is reminiscent of the seasonal changes in green vegetation. The atmosphere of Mars is much rarefied than earth's. In the air the shell of the seas still have not discovered available oxygen. In this regard, we can assume that Martian plants produce oxygen in the atmosphere and in the soil, or retain it in the roots, or plants so small that they emit a small amount of oxygen to be detected from Earth. Water. It is known that on Mars, no open water surfaces. But researchers believe that the planet's surface is

water: this was evidenced by the reduction in spring-summer periods of white spots, polar caps. Under the physical conditions existing on Mars, water in liquid state is there. It should immediately evaporate and freeze settling in a thin layer of frost. The soil is a layer of ice or permafrost. Liquid water can exist at a considerable depth. It was noted that Martian plants have no chlorophyll, it replaces carotenoid, pigment red. Of special interest are the Martian channels. American astronomer Lovell believes that this irrigation system of intelligent inhabitants of Mars. They look like dark veins of irregular shape and combinations of individual spots. For decades, however, there was a number of hypotheses:

1. Zone of vegetation
2. Evidence of tectonic nature
3. Cracks in the permafrost
4. The results of the meteorite impact.

But only on the basis of hypotheses to make conclusions prematurely. But there is no doubt that quite curious, which leads to the theory of graphs: a thorough statistical analysis of the formation of different types of networks encountered in terrestrial conditions, has led scientists to the conclusion that artificial networks differ from natural sites. Artificial origin is dominated by nodes with four converging lines, and a network of canals of Mars has mostly nodes 4-th order, the network also has considerable percentage of these nodes; doing to determine the nature of the mysterious Martian transformation even more fascinating problem.

Qualitative characteristics of stars

Luminosity

The luminosity of the star L is often expressed in units of solar luminosity, which equals $4 \cdot 10^{33}$ erg/s. luminosity of its stars are very different. There are white stars and blue supergiants (they are, however, relatively little), the luminosity over the luminosity of the Sun in the tens and even hundreds of thousands of times. But most of the stars are dwarfs, the luminosity of which

is much less than the solar, often thousands of times. The characteristic luminosity is the so-called "absolute magnitude" of a star. The apparent magnitude depends, on the one hand, from its luminosity and colour, on the other — from a distance before her. The stars of high luminosity have a negative absolute values, such as -4, -6. Stars of low luminosity are characterized by large positive values, such as +8, +10.

Temperature

The temperature determines the color of the star and its spectrum. For example, if the temperature of the surface layers of stars 3-4 thousand K., the color reddish, 6-7 thousand K. — yellowish. Very hot stars with temperatures above 10-12 thousand K. have a white or bluish color. In astronomy there are quite objective methods of measuring the color of stars. The latter is determined by the so-called "color index" equal to the difference between photographic and visual, and visual magnitude. Each value of the color index corresponds to a certain type of spectrum.

The cold red stars spectra are characterized by absorption lines of neutral metal atoms and strips some of the simplest compounds (for example, CN, SP, H₂O, etc.). As you increase the temperature of the surface in the spectra of stars disappear molecular bands, a weak line of neutral atoms and neutral helium. The shape of the spectrum changes radically. For example, hot stars with temperatures of the surface layers exceeding 20 thousand To occur mainly lines of neutral and ionized helium, and a very intense continuous spectrum in the ultraviolet part. In stars with temperatures of the surface layers is about 10 thousand To the most intense line of hydrogen, while stars with a temperature of about 6 K. thousand lines of ionized calcium, is located on the border of the visible and ultraviolet part of the spectrum. Note that this species I has a spectrum of our Sun.

Spectra of stars

Extremely rich information allows the study of the spectra of stars. Spectra has long been the vast majority of stars are divided into classes. The sequence of spectral classes is denoted by the letters O, B, A, F, G, K, M. the present system of classification of stellar spectra so accurate that it allows to

determine range with an accuracy of one tenth of the class. For example, part of the sequence of stellar spectra between classes B and A, denoted as B0, B1... B9, A0 and so on. Range of stars in a first approximation similar to the spectrum of a radiating black body with a certain temperature T . These temperatures gradually changing from 40-50 thousand degrees for stars of spectral class O to 3000 degrees for stars of spectral class M. In accordance with this, the main part of the radiation of stars of spectral classes O and B occur in the ultraviolet part of the spectrum, unobservable from the earth's surface.

A characteristic feature of stellar spectra is the presence of a huge number of absorption lines belonging to various elements. Subtle analysis of these lines allowed us to obtain particularly valuable information about the nature of the outer layers of stars.

The chemical composition of stars

The chemical composition of the outer layers of the stars where we "directly" comes their radiation is dominated by hydrogen. In second place is helium, and the abundance of other elements is quite small. Approximately every ten thousand atoms of hydrogen have thousands of helium atoms, about 10 atoms of oxygen, a little less carbon and nitrogen and only one atom of iron. The abundance of other elements is quite negligible. It is no exaggeration to say that the outer layers of stars is a giant hydrogen-helium plasma with a small admixture of heavier elements.

Although the number of atoms of the so-called "heavy metals" (i.e. elements with atomic mass greater than helium) in the Universe occupy a very modest place, their role is very large. First of all, they determine the nature of stellar evolution, since stellar opacity of the bowels to radiation significantly depends on its opacity.

The presence in the Universe (particularly the star) of heavy elements is important. Obviously, a living substance can only be built in the presence of heavy elements and their compounds. The well-known role of carbon in the structure of living matter. No less important are other elements such as iron, phosphorus. Kingdom living is a complex clutch of heavy elements. We can,

therefore, clearly to formulate the following provision: if it were not for the heavy metals, there would be no life. Therefore, the problem of chemical composition of cosmic objects (stars, nebulae, planets) is of paramount importance for analysing the conditions of emergence of life in different layers of the Universe.

Radius of stars

The energy emitted by the element surface of unit area per unit time is determined by the Stefan-Boltzmann law. The surface of the star is equal to $4\pi R^2$. Hence the luminosity is equal to: Thus, if we know the temperature and luminosity of the star, we can calculate its radius.

The mass of stars

In fact, astronomy does not have and does not have currently a method of direct and independent determination of the mass (that is, not part of a multiple system) of an isolated star. And this is quite a serious drawback of our science about the Universe. If such a method existed, the progress of our knowledge would be much faster. Masses of stars vary in relatively narrow limits. Very few stars, the mass of which is more or less solar in 10 times. In this situation, astronomers tacitly accept that stars with the same luminosity and color have the same mass. They are defined only for binary systems. The assertion that a single star with the same luminosity and color has the same weight as her "sister", a member of the binary system, should always be taken with some caution.

It is believed that the objects with masses less $0.02 M$ are not stars. They lack internal energy sources and their luminosity is close to zero. Typically, these objects belong to planets. The largest directly measured mass does not exceed $60 M$.

Diagram Hertzsprung Russell

For understanding the nature of stars, it is important to identify dependencies between their individual characteristics. Such relations are found by matching the corresponding values. So, in the beginning of XX century the Danish

astronomer E. Hertzsprung and American astrophysicist G. Russell installed one of these relationships, and presented it in the form of a diagram that bears their names.

On the horizontal axis of the diagram of Hertzsprung Russell (figures G — P) postpone the temperature of the star and the vertical — the luminosity in arbitrary units (relative to the luminosity of the Sun). Each star on the graph corresponds a well-defined point. It is usually said that the place on the graph is a star, and not the corresponding point, and when discussing the evolution of stars write: “the star is moving on the graph”, implying that in the process of the evolution of stars because of changes in the temperature and luminosity of the star, and the corresponding point on the graph G. — R. change its position.

From this diagram it follows that the luminosity of the star and its spectral class is linked to a specific, although not unique addition. Most stars are located along the line going from hot and bright to cold and weak (dim) stars. This is known as main sequence, and belong to her stars of the main sequence. This sequence belongs to the vast majority of stars, including our Sun (spectral class G2) . The main sequence in the location marked with a vertical bar is divided into upper and lower parts. Stars bottom of the main sequence are called yellow or red dwarfs (depending on temperature). The sun — a typical yellow dwarf.

Above the main sequence in the region of temperatures below 6000 K are the stars that make up the group of red giants (luminosity of the order of 10^2 - 10^3 and a radius of about 10-60 R) and a group of red supergiants (10^4 L, 10^2 R, 200-300 R) . Stars are hot (10^4 - 10^5 K) and bright (10^4 - 10^6 L, 10^2 - 10^3 R) are white supergiants. Note that cold and faint stars is much more than hot and bright.

In the lower left corner of the diagram are white dwarfs (10^4 - 10^5 K, 10^{-4} - 10^{-2} L, 10^{-2} - 10^{-1} R) .

So we see that the luminosity of the star and the spectral class are interrelated. One of the first tasks of theory is to explain this dependence, to find the physical phenomena behind it. How did modern astrophysics, we

will see later. Here only note that immediately after the construction of this chart she attributed an evolutionary significance: it was assumed that evolutionary stars along the main sequence, from hot and bright to cold and weak. It turned out that the evolution of stars has a more complicated character, and still stars the images of which are located in the upper left of the chart called "early" and the other end of the main sequence — "late".

Stars are nuclear reactors

In most fusion reactions the energy released in the fusion of four protons into one helium nucleus. This coupling of protons in a helium nucleus can go different ways, but the end result will be the same.

Let us describe the proton-proton reaction.

This reaction begins with such collisions between protons, which produces a nucleus of heavy hydrogen — deuterium. Even in the face of the star depths it occurs very rarely. As a rule, collisions between protons are elastic: after the collision the particles simply scatter in different directions. To the collision of two protons are merged into one nucleus of deuterium, it is necessary that such a collision was performed by two independent conditions. First, it is necessary that one of colliding protons kinetic energy is twenty times superior to the average energy of thermal motions at a temperature of the star's interior. As mentioned above, only one one hundred millionth part of protons has a relatively high energy needed to overcome the "Coulomb barrier". Secondly, it is necessary that during the collision one of the two protons would be able to turn into a neutron, emitting a positron and a neutrino. Because only the proton and neutron can form the nucleus of the deuterium! Note that the duration of a collision is only about 10^{-21} seconds (it is of order the classical radius of the proton divided by its speed). If all this into account, it turns out that each proton has a real chance of becoming this way in the deuterium only once in several tens of billions of years. But as the protons in the interiors of stars quite a lot, such reactions, and, moreover, in the right quantity, will take place.

Different is the fate of the newly formed deuterium nuclei. They are "greedy", just a few seconds, "swallow" something close to a proton, turning into an isotope of helium-3 is Not. Then there are three possible paths

(branches) nuclear reactions. Most often the isotope of helium will interact with the similar core, resulting in a - "ordinary" helium, and two protons. As the concentration of the isotope is Not extremely small, it will happen in a few million years. Now let's create the sequence of these reactions and are released by them energy.

Here, the letter ν is a neutrino and gamma quantum. Not all freed from this chain of reactions the energy is transferred to the star, as part of the energy is carried away neutrinos. With this in mind, the energy released in the formation of one helium nucleus, equal to 26.2 MeV or $4.2 \cdot 10^{-5}$ erg.

The second branch of the proton-proton reaction begins with the coupling kernel is Not with - "ordinary" helium 4 is Not, and then formed the nucleus of beryllium 7 Be. The nucleus of the beryllium in turn can capture a proton, after which formed the nucleus of boron 8 In, or capture an electron and become a lithium nucleus. In the first case, the resulting radioactive isotope 8 undergoes beta decay: note that neutrinos formed in this reaction, discovered with the help of unique, expensive installation. Radioactive beryllium Be^7 is very unstable and quickly decays into two alpha particles. Finally, the third branch of the proton-proton reaction includes the following sections: Be^7 after the capture of the electron is transformed into Li^7 , which after capturing a proton, is transformed into the unstable isotope Be^8 decaying, like the second circuit, into two alpha particles.

We note again that the vast majority of reactions goes on the first chain, but the role of side chains is not all that small.

We now turn to the consideration of carbon-nitrogen cycle. This cycle consists of six reactions.

Explain the contents of this table. Proton colliding with the nucleus of carbon, is transformed into a radioactive isotope of 13 nitrogen, N. In this reaction is emitted is the quantum. The ^{13}N isotope undergoing decay by emitting a positron and a neutrino, is converted into an isotope of carbon 13 C. the Latter, when faced with a proton is transformed into a nitrogen nucleus ^{14}N . In this reaction are also emitted is the quantum. Further, the nitrogen nucleus collides with a proton, whereupon a radioactive isotope of oxygen is

^{15}O and the quantum. Then this isotope by decay is converted into an isotope of nitrogen, ^{15}N . Finally, the last Annex during the collision, the proton decays into ordinary carbon and helium. The whole chain of reactions is a consistent weighting of the carbon nuclei by the addition of protons with the subsequent β -decays. The last link in the chain is the recovery of the initial nucleus of carbon and the formation of new helium nuclei by four protons, which at different times one after the other joined in With 12 and formed from it the isotopes. As can be seen, any change in the number of cores 12 in the matter in which this reaction does not occur. Carbon is the catalyst of the reaction.

The second column lists the energy released at each stage of the carbon-nitrogen reaction. Part of this energy is released in form of neutrinos produced in the decay of radioactive isotopes ^{13}N and ^{15}O . Neutrinos freely leave the star out of the depths, therefore their energy goes into heating the substances of the stars. For example, in the decay of ^{15}O energy Of the resulting neutrinos is on average around 1 MeV. Finally in the formation of a single helium nucleus by a carbon-nitrogen reaction released (excluding neutrinos) 25 MeV energy, neutrinos carry approximately 5% of this value.

In the third column of table II shows the values of the velocities of the various links of the carbon-nitrogen reaction. For processes that just half-life. Much harder to determine the reaction rate when the weighting kernel by addition of the proton. In this case, it is necessary to know the probability of penetration of a proton through the Coulomb barrier and the probability of the relevant nuclear interactions, as the mere penetration of a proton into the nucleus are not of interest to us nuclear transformation. Probability of nuclear reactions are obtained from laboratory experiments or calculated theoretically. For reliable analysis took years of hard work of nuclear physicists, both theoreticians and experimentalists. The numbers in the third column are given the "life time" of the various cores for the Central regions of a star with a temperature of 13 million degrees Kelvin and a density of hydrogen of 100 g/cm^3 . For example, in order under such conditions - 12 by capturing a proton, turned into a radioactive isotope of carbon, to "wait" 13 million years! Consequently, each "active" (i.e. participating in the cycle) nucleus reactions proceed extremely slowly, but the fact that the cores enough.

The main source of energy the Sun, the temperature of the Central regions which is close to 14 million Kelvins, is the proton - proton reaction. For more massive, and therefore hotter stars essential carbon-nitrogen reaction, which dependence on temperature is much stronger.

Continuously running in the Central regions of stars nuclear reactions “slowly but surely” change the chemical composition of the star's interior. The main trend of this chemical evolution—the transformation of hydrogen into helium. In addition, the process of carbon-nitrogen cycle changes the relative concentrations of different isotopes of carbon and nitrogen until then, until a certain equilibrium. In this equilibrium the number of reactions per unit time, leading to the formation of some of the isotope, equal to the number of reactions that it would destroy. However, the time of the establishment of such an equilibrium can be very large. But until equilibrium is established, the relative concentrations of various isotopes may vary within a wide range.

Nuclear processes play, as we have seen in this paragraph, a fundamental role in the long, quiet evolution of stars, located on the main sequence. But, in addition, their role is decisive in rapidly occurring transient processes of explosive character, which is rotatable stages in the evolution of stars. Finally, even seemingly to be highly trivial and very "quiet" stars, like our Sun, nuclear reactions open the possibility to explain phenomena, which seem very far from nuclear physics.

The birth of stars

Modern astronomy has a large number of arguments in favor of the claim that stars are formed by the condensation of clouds of gas and dust the interstellar medium. The process of star formation from that environment continues at the present time. The elucidation of this fact is one of the greatest achievements of modern astronomy. Even relatively recently it was thought that all stars were formed almost at the same time many billions of years ago. The collapse of these metaphysical views is primarily, the progress of observational astronomy, and the development of the theory of structure and evolution of stars. In the result, it became clear that many of the observed stars are relatively young objects, and some of them appeared when on Earth was a man.

An important argument in favor of the conclusion that stars are formed from interstellar gas and dust environment is the arrangement of groups of obviously young stars (so-called “associations”) in the spiral branches of the Galaxy. The fact that according to radio astronomical observations of the interstellar gas is concentrated mainly in the spiral arms of galaxies. In particular, this takes place in our Galaxy. Moreover, from a detailed “radio image” of some close to us galaxies, it follows that the highest density of interstellar gas is observed on the inner (towards the center of the galaxy) the edges of the coil, which finds a natural explanation, the details of which we here are not going to stop. But in these parts of spirals are observed by methods of optical astronomy “zone N of N”, i.e. clouds of ionized interstellar gas. The reason for the ionization of these clouds can only be the ultraviolet radiation from massive hot stars objects obviously young.

Central to the issue of evolution of stars is the question about the sources of their energy. In the last century and early this century have proposed various hypotheses about the nature of the energy sources of the Sun and stars. Some scientists, for example, believed that the source of solar energy is a continuous deposition on the surface of meteors, others were looking for a source of continuous compression of the Sun. Liberated in this process the potential energy could, under certain conditions” to the radiation. As we will see below, this source at an early stage of the evolution of stars can be quite effective, but it can not provide the Sun's radiation for a desired time.

The successes of the nuclear physicists have solved the problem of the sources of stellar energy in the late thirties of our century. This source is thermonuclear fusion reactions occurring in the bowels of stars when the dominant there is a very high temperature (of the order of ten million degrees) .

As a result of these reactions, the rate of which depends strongly on temperature, the protons turn into a helium nucleus and energy is released slowly "seeps" through the interior of stars and in the end, much transformed, is emitted in world space. This is an extremely powerful source. If we assume that initially the Sun consisted only of hydrogen, which as a result of thermonuclear reactions is entirely transformed into helium, the released amount of energy will be approximately 10^{52} erg. Thus, to maintain the

radiation at the observed level for billions of years enough to the Sun "spent" not more than 10% of its initial stock of hydrogen.

We can now present a picture of evolution of some stars in the following way. For some reason (you can specify several) start to condense a cloud of interstellar gas and dust environment. Pretty soon (of course, on an astronomical scale!) under the influence of forces of gravity of the cloud formed a relatively dense opaque ball of gas. Strictly speaking, this ball cannot be called a star, as in its Central regions the temperature is not sufficient enough to start thermonuclear reactions. The pressure of the gas inside the balloon was not able to balance the force of attraction of its individual parts, so it will continuously shrink. Some astronomers used to think that such a protostar observed in individual nebulae in the form of a very dark compact formations, the so-called globules. The success of radio astronomy, however, forced to abandon this rather naive point of view. Usually at the same time not one formed protostar and a more or less numerous group of them. In the future, these groups become stellar associations and clusters, are well known to astronomers. Very likely (at this very early stage of the evolution of stars around it formed clumps of smaller mass which are then gradually transformed into planets.

Compression protostar its temperature increases and a significant portion of the released potential energy is radiated into the surrounding space. Since the size of the compressible gas ball very high, then the radiation per unit of its surface will be negligible. As soon as the radiation flux per unit surface is proportional to the fourth power of temperature (Stefan — Boltzmann law), the temperature of the surface layers of the star are relatively low, whereas its luminosity is almost the same as that of normal stars with the same mass. So in the diagram "spectrum — luminosity", the star will be located to the right of the main sequence, i.e. fall in region of the red giants or red dwarfs, depending on their initial masses.

In the future, the protostar continues to shrink. Its size becomes smaller, and the surface temperature increases resulting spectrum is becoming more early. Thus, moving down the diagram "spectrum — luminosity", the protostar very quickly "sit" on the main sequence. In this period the temperature of the star depths is already sufficient for that, so there began a fusion reaction. The

pressure of the gas in the future of the star balances the gravity and the gas balloon stops shrinking. The protostar becomes a star.

Evolution of stars

To pass the early stage of its evolution, protostars have relatively little time. If, for example, the mass of the protostar more solar, you need only a few million years, if less than several hundred million years. As the time evolution of the protostars is relatively small, this very early phase of star development can be difficult to detect. All the stars in a stage, apparently, observed. We have in mind is a very interesting stars like the T Tauri, usually shipped in a dark nebula.

B 5966 G. unexpectedly revealed the opportunity to observe the protostar in the early stages of their evolution. Great was the surprise of the radio when the view of the sky on the wave of 18 cm corresponding to the radio HE was discovered bright, extremely compact (i.e. having small angular dimensions) sources. It was so unexpected that at first refused even to believe that such a bright radio may belong to the molecule hydroxyl. The hypothesis was expressed that these lines belong to some unknown substance, which immediately gave a "suitable" name "Mysterium". However, the "Mysterium" very soon shared the fate of their optical "brothers" — "nebulium" and "corona". The fact that for many decades the bright lines of the nebulae and the solar corona was incapable of identification with any known spectral lines. Therefore, they were attributed to some unknown on the earth, hypothetical elements "nebulium" and "coronia". In 1939-1941 it was convincingly shown that the mysterious line "Caronia" belong multiply ionized atoms of iron, Nickel and calcium.

If "debunking" the "nebulium" and "Caronia" it took decades, then a few weeks after opening, it became clear that the line "Mysterium" belong to ordinary animals, but only in extraordinary circumstances.

So, sources of "Mysterium" — a giant, natural cosmic masers operating in the Wake of the hydroxyl lines, the length of which 18 see in the masers (and at optical and infrared frequencies — in lasers) achieved a huge brightness in the line, and the spectral width is small. As is known, the gain of the radiation

in the lines due to this effect is possible when the environment in which the radiation propagates, in some way "activated". This means that some "outside" source of energy (the so-called "pumping") makes the concentration of atoms or molecules in the initial (upper) level abnormally high. Without a permanent "pump" the maser or laser is impossible. The question of the nature of the mechanism of "pumping" cosmic masers, while the food is not completely solved. However, most likely "pumped" is powerful enough infrared radiation. Another possible mechanism of "pumping" may be some chemical reaction.

The mechanism of "pumping" of these masers is not yet entirely clear, it is still possible to obtain a rough idea about the physical conditions in the clouds emitting maser mechanism line 18 see First of all, it turns out that these clouds are quite dense: a cubic centimeter there are at least 10^8 - 10^9 particles, with a significant (and maybe large) part of their molecule. Temperature is unlikely to exceed two thousand degrees, it's probably about 1000 degrees. These properties contrast with the properties of even the most dense clouds of interstellar gas. Given the still relatively small size of the clouds, we unwittingly come to the conclusion that they are more like long, rather cold atmosphere of the stars — the supergiants. It seems that these clouds are nothing like the early stage of the development of protostars immediately following their condensation out of the interstellar medium. In favor of this assertion (which the author of this book made in 1966) and others say the facts. In the nebulae, where the observed cosmic masers, visible young hot stars. Consequently, there has recently ended and, most likely, continues at the present time, the process of star formation. Perhaps the most curious is that, as shown by radio-astronomical observations, cosmic masers of this type as if "immersed" in a small, very dense cloud of ionized hydrogen. In these clouds there are a lot of cosmic dust, which makes them unobservable in the optical range. These "cocoons" insults young, hot star within them. In the study of star formation processes proved extremely useful in infrared astronomy. Because infrared rays the interstellar absorption of light is not significant.

We can now present the following picture: the clouds of the interstellar medium, by its condensation, the formation of several clusters of different masses, evolving into a protostar. The rate of evolution is different: for the more massive clusters it will be more. Therefore, sooner of all will become a

hot star is the most massive cluster, whereas the rest will be more or less long stay in the stage of protostar. They are something we see as sources of maser emission in the vicinity of "newborn" hot star insula not skondensirovalas in clumps hydrogen of the cocoon. Of course, this rough diagram will be further refined, and, of course, it will be substantially amended. But the fact remains that suddenly, some time (likely relatively short) newborn protostar, figuratively speaking, a "shout" about their appearance in the world, using the latest methods of quantum Radiophysics (i.e. masers) .

Once on the main sequence and ceasing to burn, the star radiates long almost without changing his position on the diagram "spectrum — luminosity". Its radiation is supported by thermonuclear reactions occurring in the Central regions. Thus, the main sequence represents the locus of points on the diagram "spectrum — luminosity", where the star (depending on its mass) can long and steadily radiate through thermonuclear reactions. Place the stars on the main sequence determined by its mass. It should be noted that there is another parameter that determines the position of equilibrium of the radiating stars in the diagram "spectrum - luminosity". This parameter is the initial chemical composition of stars. If the relative content of heavy elements decreases, the star of "lie" in the diagram below. This explains the sequence of subcortical. As mentioned above, the relative content of heavy elements in these stars are dozens of times less than that of main sequence stars.

Stay stars on the main sequence determined by its initial mass. If the mass is large, the radiation of the stars has a huge power and she quickly spends stocks of the hydrogen "fuel". For example, the stars of the main sequence with a mass in excess of solar a few dozen times (this is the hot blue giants of spectral class O), can steadily emit, in this sequence only a few million years, while stars with a mass close to the sun, are main sequence 10-15 billion years.

"Burning out" of hydrogen (i.e., turning it into helium in thermonuclear reactions) occurs only in the Central regions of stars. This is because stellar matter mixed only in the Central regions of stars, where nuclear reactions, while the outer elephant retain the relative hydrogen content unchanged. Since the amount of hydrogen in the Central regions of stars is limited, sooner or later (depending on the mass of the star) he was there almost the

entire "burn out". Calculations show that the mass and radius of the Central region that is going through a nuclear reaction, is gradually reduced, thus the star moves slowly in the diagram "spectrum — luminosity" to the right. This process occurs much faster in relatively massive stars.

What happens to a star when all (or nearly all) the hydrogen in its core, "burn out"? Since the energy release in the Central regions of the star stops, the temperature and pressure cannot be maintained there at a level needed to counter the force of gravity compressing the star. The core of the star starts to shrink and its temperature will rise. Is formed very hot, dense region, consisting of helium (which become hydrogen) with a small admixture of heavier elements. Gas in this state is called "degenerate". He has a number of interesting properties. In this hot dense nuclear reactions do not occur, but they are pretty intense leaking to the periphery of the nucleus, in a relatively thin layer. Star would "swell" and will "go" with the main sequence, becoming red giants region. Further, it appears that the stars are giants with a lower content of heavy elements will have the same dimensions higher luminosity.

The end of the star

What happens to stars when the reaction of the "helium — carbon" in the Central regions are exhausted, as well as the hydrogen reaction in a thin layer surrounding the hot dense core? What stage of evolution comes after the red giant stage?

White dwarfs

The combination of these observations and some theoretical considerations suggests that at this stage of the evolution of stars whose mass is less than 1.2 solar masses, a substantial part of its mass that forms their outer shell, "reset". This process we are witnessing, apparently, as the formation of so-called "planetary nebulae". After the stars are separated with a relatively small speed of the outer shell, "naked" of her inner, very hot layers. At the same time separated the shell will expand further and further departing from the stars.

Powerful ultraviolet radiation from the star — kernel of planetary nebulae will insulate atoms in the shell, arousing their glow. Few tens of thousands of years the shell will dissipate and will only have a very small hot dense star. Gradually, slowly cooling down, it will turn into a white dwarf.

Thus white dwarfs like "Mature" inside red giant stars and "see the light" after the separation of the outer layers of giant stars. In other cases, the shedding of the outer layers may not occur through the formation of planetary nebulae, and by the gradual expiry of the atoms. Anyway white dwarfs, in which all the hydrogen is "burned" and the nuclear reaction stopped, apparently, represents the final stage of evolution of most stars. The logical conclusion is the recognition of the genetic link between the late stages of stellar evolution and white dwarfs.

Black dwarfs

Gradually cooling down, they emit less and less, turning into invisible "black" dwarfs. This is a dead, cold stars of very high density, millions of times denser than water. Their sizes are less than the size of the globe, although mass comparable to the sun. The cooling process of white dwarfs goes back many hundreds of millions of years. So ends its existence most of the stars. However, the ending of the life of a relatively massive stars can be much more dramatic.

Neutron stars

If the mass of the collapsing star exceeds the mass of the Sun is more than 1.4 times, such star, reaching the stage of a white dwarf, that will not stop. The gravitational forces in this case are very high that the electrons into the atomic nuclei inside. As a result, the isotopes become neutron is able to fly to each other without any gaps. The density of neutron stars is even greater than the density of white dwarfs; but if the mass of the material does not exceed 3 solar masses, neutrons, and electrons, are able to prevent further compression. A typical neutron star has a diameter only about 10 to 15 km, and one cubic centimetre of its matter weighs about a billion tons. In addition to the unheard of huge density, neutron stars have two special properties that allow them to detect, despite the small sizes: it's rapid rotation and strong magnetic field. In General, revolve all the stars but when a star shrinks, the

speed of its rotation increases, just as the skater on the ice spinning much faster when holding a hand. Neutron star makes several revolutions per second. Along with this extremely fast rotation of the neutron star have a magnetic field millions of times stronger than Earth.

Pulsars

The first pulsars were discovered in 1968 when radio astronomers discovered the regular signals coming to us from the four points of the Galaxy. Scientists were struck by the fact that some natural objects can radiate radio pulses in a right and fast rhythm. In the beginning though, for a while astronomers have suspected the involvement of some intelligent beings living in the depths of the Galaxy. But it was soon found a natural explanation. In a strong magnetic field of the neutron star moving in a spiral the electrons generate radio waves that are radiated by a narrow beam, like a ray of light. The star spins and the radio beam crosses the line of our observations, like a lighthouse. Some pulsars emit not only radio waves but also light, x-rays and gamma rays. The period of the slowest pulsars for about four seconds, and the fastest — thousandths of a second. The rotation of these neutron stars was for some reason even more accelerated; they may enter the dual system.

Supernova

The stars, the mass of which does not reach 1.4 solar, die quietly and peacefully. And what happens to more massive stars? As there are neutron stars and black holes? The catastrophic explosion that ends the life of a massive star is a truly impressive event. This is the most powerful of natural phenomena occurring in stars. In a moment released more energy than it radiates our Sun for 10 billion years. Luminous flux sent from one dying star, the equivalent of an entire galaxy, but visible light is only a small fraction of the total energy. The remains of exploded stars fly away with velocities of 20 000 km per second.

Such enormous stellar explosions called supernovae. A supernova is a rare phenomenon. Every year and other galaxies find 20 to 30 supernovae, mainly as a result of systematic search. Per century in each galaxy there may be from one to four. However, in our own Galaxy, not the supernova observed since

1604, Maybe they were, but remained invisible due to the large amounts of dust in the milky Way.

Black holes

FROM stars having mass greater than three solar, and a radius greater than the 8.85 kilometre, the light will not be able to leave her in space. The outgoing from the surface the beam is bent in a gravity field so much that comes back to the surface. Quanta of light — photons — emitted by the body back, as thrown up rocks on earth. No radiation erupts to the outside world to convey the message about the sad fate of the star.

Turned into a black hole, the celestial body does not disappear from the Universe. It makes itself known to the outside world due to its gravity. The black hole absorbs the rays of light coming from it at a greater distance. The black hole may enter into the gravitational interaction with other bodies: it can hold around a planet or to form with another star in a binary system.

We have repeatedly stressed that the speed of evolution of stars is determined by their initial mass. As in a number of ways since the formation of our solar system, the Galaxy, took about 15-20 billion years, for it is the finite (albeit enormous) time, the described evolutionary path were only the stars, the mass of which exceeds some value. Apparently, this "critical" mass of only 10-20% greater than the mass of the Sun. On the other hand, as already stressed, the process of star formation from interstellar gas-dust environment occurred in our Galaxy continuously. It is happening now. That is why we are seeing hot massive stars in the upper left of the main sequence. But even the stars formed in the beginning of the formation of the Galaxy, if their weight is less than 1.2 solar, have not had time to go out of the main sequence. Note, incidentally, that the rate of star formation are currently much lower than many billions of years ago. The sun formed about 5 billion years ago, when the Galaxy has already formed and in its main features was similar to "modern". Now, at least 4.5 billion. years, it "sits" on the main sequence, steadily radiating through nuclear reactions convert hydrogen into helium occurring in its Central regions. How long will it last? Calculations show that our Sun will become a red giant after 8 billion years. In this case its luminosity will increase by hundreds of times, the radius is in the tens. This

stage of evolution of our sun will take a few hundred million years. Finally, one way or another swollen Sun will shed its shell and become a white dwarf. Generally speaking, we are not indifferent to the fate of the Sun, as it is closely linked with the development of life on Earth.

As with any scheme that claims to explain data on the spectrum of cosmic microwave radiation, the chemical composition, substances and hierarchy of cosmic structures, the standard model of the Universe evolution is based on a number of assumptions (about the properties of matter, space and time) playing the role of a kind of "initial conditions expansion of the world. As one of the working hypotheses of this model is the assumption of homogeneity and isotropy properties of the Universe throughout all the stages of its evolution.

In addition, based on data on the spectrum of microwave radiation, it is natural to assume that the Universe in the past existed a state of thermodynamic equilibrium between the plasma and the radiation, the temperature of which was high. Finally, extrapolating into the past the laws of increasing densities of matter and radiation energy, we have to assume that when the temperature of the plasma close to 10^{10} K it, there were protons and neutrons, which were responsible for the formation of chemical composition of cosmic matter.

It is obvious that such complex initial conditions" cannot be formally extrapolated into the very early stages of expansion of the Universe, when the plasma temperature exceeds 10^{12} K. Because in these circumstances, there would be qualitative changes in the composition of matter, associated in particular with the quark structure of nucleons. The period preceding stage to a temperature of about 10^{12} K naturally attributed to over the early stages of the expansion of the Universe, which, unfortunately, at present we know very little.

The fact is that as you go deeper into the past of the Universe we are inevitably faced with the need to describe the processes of interconversion of elementary particles more and more energy in the tens or even thousands of times above the threshold energies, the available research on the most powerful modern accelerators. In such a situation, obviously, raises a set of problems related, first, with our ignorance of new types of particles generated

under conditions of high plasma densities, and secondly, the lack of "reliable" theory, would allow to predict the main characteristics of the cosmological substratum during this period.

However, even without knowing in detail the specific properties of the superdense plasma at high temperatures, it can be assumed that, starting from a temperature slightly less 10^{12} K characteristics satisfy the conditions Listed in the beginning of this section. In other words, at a temperature of about 10^{12} K matter in the Universe was represented by electron-positron pairs (e^- , e^+); muons and antimuonium (μ^- , μ^+); neutrinos and antineutrinos, as the electronic (ν_e , $\bar{\nu}_e$) and muon (ν_μ , $\bar{\nu}_\mu$) and Tau neutrino (ν_τ , $\bar{\nu}_\tau$); nucleons (protons and neutrons) and electromagnetic radiation.

The interaction of all these particles provided in the plasma state of thermodynamic equilibrium, which, however, has changed with the expansion of the Universe for different types of particles. At temperatures less than 10^{12} K to the first it "felt" muon-antimuon pair, the rest energy of approximately 106 MeV . Then at a temperature of about 5.109 To the annihilation of electron-positron pairs began to prevail over the processes of their birth by the interaction of photons, which ultimately led to qualitative changes in the composition of the plasma.

Since temperatures $T < 10^9 \text{ K}$, the main role in the dynamics of expansion of the Universe began to play the electron, muon and Tau neutrinos as well as electromagnetic radiation. How redistributed energy that was "stored" at the lepton stage in massive particles?

It turns out that she went into "heat" radiation, along with the particles at temperatures of more 5.109 in equilibrium with the radiation. Indeed, a small increase in the photon density caused by the annihilation of muons and antimuons, automatically leads to an increase in the concentration of electron-positron pairs, which interact with photons in the reaction $\gamma + \gamma \rightarrow e^- + e^+$. In turn, electrons and positrons can give rise to pairs of neutrinos and antineutrinos.

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Science\Boom.files\image001.gifТаким way, all the excess energy of muons

after their annihilation will be redistributed between the various components of the plasma. Such "pumping" energy of massive particles to more light had to be carried out only until, yet did not annihilate the lightest charged leptons — electrons and positrons, which in recent times "warmed up" radiation at a temperature of about 5.109 K . After this moment the dominant role in the expansion of the Universe played electromagnetic radiation and lepton era the "temperature" of the history of the cosmic plasma was replaced by the era of the dominance of radiation.

In fact, it was during this period when temperature plasma of about 5.109 K To the formation of the equilibrium spectrum of electromagnetic radiation reaching us in the form of a cosmic microwave background. It was during the annihilation of electron-positron pairs of almost all the energy stored in this component were transferred to the electromagnetic radiation, the energy density of which is increased. Remaining from the epoch of annihilation of the electrons colliding with quanta of the radiation, participated in the exchange of energy between the subsystems of the plasma. In addition, collisions of electrons with protons was accompanied by the flashing rays, resulting in a spectrum of electromagnetic radiation were to become characteristic of the equilibrium distribution.

At the end of the era of radiation domination at temperatures close to 10^4 K , the interaction of free electrons with protons was accompanied by the formation of hydrogen atoms and a decrease in the share of free carriers of electric charge. The scattering of photons on electrons became less effective and finally, starting with the period, characterized by decreasing temperature below 3000 K , the distribution of photons was carried out almost freely. The temperature of the electromagnetic radiation after its separation from the plasma decreased only as a result of expansion of the Universe, which shifted spectrum in the millimeter and centimeter ranges.

This microwave background is, thus, a kind of imprint of early high-temperature stages of evolution of the Universe — the relic, proving that in the past, this subsystem has identified the main characteristics of the cosmological plasma. However, in addition to the background microwave radiation, we would need to get another "echo" radiation dominirovanie era of expansion of the Universe. We are talking about nuclei and the isotopes of

light chemical elements, the formation of which in the framework of the model of the Big Bang had to happen in about a million years before the era of the separation of matter from radiation.

The story of the origin of the chemical elements goes back to the pioneering work of the founder of the theory of "hot Universe" G. A. Gamow. The task, pursued by G. A. Gamow and his collaborators in the late 40-ies of our century, with hindsight, seems unsolvable. The authors hoped with the help of the processes of fusion of protons and neutrons in the nucleus of chemical elements to explain the origin of almost all elements of the periodic table in the early stages of expansion of the Universe. In the years when nuclear physics was literally doing the first steps, was not yet known that in nature there are no stable nuclei with atomic weights $A=5$ and $A=8$, and a chain of serial connections of protons and neutrons with the formation of deuterium, helium-3, tritium and helium-4 is open is just the next step.

G. A. Gamow was inspired by another, as is now clear, wrong premise. In those years the Hubble constant was considered in 5 — 10 times greater than find now. Отсюда followed that the age of the Metagalaxy was supposed to be only a few billion years, i.e. as much as, according to geological data, the "living" Earth. So it seemed that all the chemical elements "from small to great" should be formed in a single process of cosmological nucleosynthesis, if, of course, to suggest that the universe in the past was hot. G. A. Gamow predicted and modern temperature of the background radiation on the order of 5 K, as you can see, the value is very close to reality.

In fact, due to the fact that the age of the Metagalaxy order of magnitude greater than that offered by G. A. Gamov, the thermonuclear cauldron of the hot Universe had "cooked" only the very lightest elements (up to helium and, possibly, to lithium inclusive). Then the temperature dropped as a result of expansion so that further synthesis of elements were to stay. Heavier elements, as we now assume, were formed in the thermonuclear reactions in the interiors of stars, and in Supernova explosions.

As often happened in the history of science, despite the wrong premise, and G. A. Gamow "guessed" hot past of the Universe, triumphantly confirmed by the discovery of the cosmic radiophone. How, way in the high-temperature

plasma formed legalactions the isotopic composition of a substance?

It turns out that one of the main roles in this process played the reactions of the weak interaction of electron neutrinos and antineutrinos with protons and neutrons. Another lepton era of the Universe expansion at temperatures above 10^{10} K the neutrino collision $\nu_e, \bar{\nu}_e$ with protons p and neutrons n effective stirred, these particles in the reactions.

Starting from a temperature of 10^{10} K, the characteristic time of these reactions are close to the age of the Metagalaxy, and they are suspended. Calculations show that the neutron concentration was less than the concentration of protons due to small differences in their energies of peace.

This contrast is "frozen" almost as long as the temperature was reduced to 10^9 K. After this, the entire sequence of the interconversion of nucleons in nuclei 4He , 3He , 2H , 3H was carried out in two stages. On the ground at the plasma temperatures of order 10^9 K was the fusion of protons and neutrons in the nucleus of deuterium, $n+p \rightarrow 2\text{H}+\gamma$. the Calculations show that up until almost all of the protons and neutrons are not contacted within nuclei deuterium, helium-3 ($2\text{H}+p \rightarrow 3\text{He}+\gamma$) and tritium ($2\text{H}+n \rightarrow 3\text{H}+\gamma$), the synthesis of 4He was extremely inefficient. After that, take effect the collision of deuterium nuclei among themselves and with the nuclei 3H and 3He , leading to the appearance of nuclei of helium-4, and the duration of the synthesis stage, 4He is extremely small.

In Fig. 3 to illustrate the dynamics of cosmological nucleosynthesis shows the dependence of the mass concentrations of light chemical elements from the plasma temperature. As can be seen, already at a temperature $5.107 \cdot 10^9$ K have formed virtually all of the primary chemical composition of: about 23 — 26% contacted nucleons in 4He ; 74 — 77% by mass is hydrogen and only 0,01 — 0,0001% -deuterium, helium-3 and tritium. Deserves attention the fact that the prevalence of deuterium in the Universe is very sensitive to the matter density. When changing $\rho(0)$ $1.4 \cdot 10^{-31}$ to $7.1030 \cdot 10^{-31}$ g/cm³ relative concentration of the $(2\text{H}/\text{H})$ decreases to almost seven orders of magnitude. At least from the modern value of the density of baryons depends on the weight content of 4He , however, and it increases about 2 times.

This feature can be use to predict the present density of matter in the

Universe, if known, the observed prevalence of space helium-4 and deuterium. However, a significant obstacle to the implementation of this program is the distortion of the primary chemical composition of the substances under the existence of galaxies and stars. For example, in the Solar system measurements give approximately 20 — 26% variation of the mass concentration of 4He relative to hydrogen. In the solar wind, this value varies even more — from 15% to 30% .

Spectroscopic measurements of absorption lines and emission of helium in the atmosphere closest to the Sun stars also indicate the presence of variations in mass concentrations from 10 to 40 %. Presence detect 4He in the oldest objects of our Galaxy — globular clusters, where its prevalence ranges from 26% to 28%. All this, of course, reduces the benefits of using data about the galactic contents of 4He to determine the value of modern density compatible with the Big Bang model.

In this aspect, more informative data are obtained from mapping the cosmological production of deuterium and its contemporary prevalence in the Galaxy. Unlike the 4He isotope is only fade in the course of star formation, and hence today we can talk only about defining the lower bound of its mass density. Observations of absorption lines of atomic deuterium in the interstellar medium and radiation molecules HD , DCN показывают that the content of this isotope in the Galaxy is approximately in the range from 0.001 to 0.00001% by weight of hydrogen. This corresponds to the modern density of matter $\rho(0)=1,4 \cdot 10^{-31} \text{g/cm}^3$.

Interestingly, in addition to explaining the chemical composition of the early Metagalaxy, the theory of cosmological nucleosynthesis allows to obtain unique information about the spatial density of the observed hard particles that have reached the era of the dominance of leptons from the early stages of cosmological expansion. In particular, based on this theory, you can limit the number of possible neutrino types, which have recently become the object of attention of cosmologists.

Still some 6 — 7 years ago this question was like if on the second plan in the model of "hot Universe". It was believed that a decisive role in the formation of the chemical composition of the substance legalactions played electronic

neutrinos and antineutrinos, and to a lesser extent, the muon neutrino ν_μ , $\bar{\nu}_\mu$. The experiment did not give grounds to assume that in nature there are additional types of weakly interacting neutral leptons and cosmologists preferred to be guided by the principle of "Okama razor": *entia non sunt multiplicanda praeter necessitatem* ("entities must not be multiplied beyond necessity").

The situation radically changed after the discovery in 1975 of heavy charged Tau-lepton, which was to fit a new type of neutrino, ν_τ . Now, we have no doubt that the neutrino family has a new member, the rest energy of which does not exceed 250 MeV. Arose a curious situation -the modern accelerators of elementary particles closer only to energies of the order of 10⁵ MeV and have a new type of neutrino. What lies behind this threshold energy? Are we going to see in the future a catastrophic increase in the number of members of the family of leptons as penetration into the depths of the microcosm?

It turns out that on this question the model of "hot Universe" gives the definite answer. If in nature, in addition to ν_e , ν_μ , ν_τ existed new types of neutrinos, the energy of the rest of which did not exceed 30 — 50 eV, their role during the cosmological nucleosynthesis would be reduced to increase the cooling rate of the plasma and, consequently, would change the conditions of the formation of the chemical elements. For the first time such a role of weakly interacting particles in the dynamics of the cosmological synthesis of the light chemical elements were marked in 1969, the Soviet astrophysicist VF Shvartsman, and over the last decade, it was specified only the quantitative side of the issue.

Calculations show that if the upper bound of the prevalence of ⁴He make it a mass concentration of 25%, it inevitably leads to the conclusion that all possible types of neutrinos in nature are already open. With some caution related to the insufficient accuracy of observational data on the prevalence of cosmic ⁴He and ²H, we can assume that, in addition to ν_e , ν_μ , ν_τ exist no more than two types of new neutrinos. This fact plays a significant role in the analysis of the problem of the hidden mass of the Universe.

So, in General we met the two most important eras "temperature" history of

the cosmological plasma, during which occurred the formation of primary chemical composition and spectrum of cosmic microwave background radiation. However, the above scheme requires significant addition, since it is not found even reflect the existence of large-scale structure of Universe — clusters and superclusters of galaxies.

Indeed, after the annihilation of electron-positron pairs in the Universe ($T=5.109$) the most common high temperature component of the cosmological plasma was electromagnetic radiation which, after recombination of hydrogen ceased to interact with matter. The equilibrium nature of this radiation spectrum is due to the existence of a long phase of expansion, when between photons and electrons, there was intense interaction. After recombination of hydrogen and helium universe must be filled of uniformly distributed matter and radiation. And now should not be any structure — no stars, no galaxies, no us. Quite depressing picture.

These predictions are obviously very far from the observed diversity of structural forms of matter in the Universe. This suggests that the observed structure in the early stages of expansion of the Universe must exist fluctuations, although small, but finite deviations of the matter density from the homogeneous and isotropic distribution in space.

II. Big problems Big Bang.

After a careful consideration of the cosmological theory of the origin and structure of the universe begins to crumble.

Take a look at the star-studded night sky. How did all these innumerable stars and planets? Most modern scholars, is likely to answer this question, citing one of the versions of the theory the "big Bang". In accordance with this theory, beginning the entire matter of the Universe was concentrated at one point and heated to very high temperatures. At some point in time occurred a fearful explosion. In the expanding cloud of superheated subatomic particles began to form atoms, stars, galaxies, planets, and finally life began. Currently this script has acquired the status of indisputable truth.

No doubt, the big Bang theory captures the imagination and leaves few

people indifferent. And because it is as if based on factual and backed up by mathematics, and most people it seems to be more acceptable than religious explanations of the Universe. However, the cosmological theory of the big Bang is only the latest of a number of attempts to explain the origin of the Universe from the standpoint of a mechanistic worldview, according to which the world (and people) is a product of matter, operating in strict accordance with the laws of physics.

Scientists attempt to create a purely physical model of the origin of the Universe is based on three pillars:

- 1) all natural phenomena can be exhaustively explained by physical laws expressed in mathematical form;
- 2) these laws of physics are universal and do not depend on time and place;
- 3) all the basic laws of nature are simple.

Many people take these things for granted, but really no one could never prove their truth, moreover, to prove their validity is far from straightforward. In fact, they are merely an integral part of one of the approaches to the description of reality. Considering the most complex phenomenon faced by anyone studying the Universe, scientists have chosen a reductionist approach. "Come on," they say, "let's measure the parameters of physical phenomena and try to describe them with a simple and universal physical laws." Strictly speaking, however, we have no logical reason to reject in advance alternative approaches to understanding the Universe. It is possible that in the Universe are fundamentally different laws that defy simple mathematical expression. And yet many scientists, confusing their understanding of the Universe with its true nature in advance to reject alternative approaches. They insist that all phenomena in the Universe can be described using simple mathematical laws. "We hope to put all the universe in a simple and short formula, which can be printed on t-shirts," — says L. Lederman, Director of the National laboratory of nuclear physics. Fermi in Batavia, Illinois.

There are several psychological reasons that lead scientists to cling to the reductionist approach. If the structure of the Universe can be described by simple quantitative laws, then the scientists, despite the limitations of the

human mind, there is hope sooner or later to understand the structure (and thus get the key to the management of the Universe). Therefore, they believe that such a description is possible, and create thousands of different theories. But if our universe is infinitely complex, then we, with our limited mind and senses, it will be very difficult to learn.

Let me show you an example. Suppose we have a set containing a million digits, and the challenge before us is to describe the structure of this set by a single equation. Practically, this is possible if the structure of the set is quite simple. However, if its structure is very complex, then we are unlikely even to determine the formula that describes it. Similarly, scientists attempt will be equally unsuccessful when they collide with the properties of the Universe that are in principle not amenable to mathematical description. It is not surprising that most of the scientists so stubbornly clings to its current strategy, not wanting to recognize any of the other approaches. In this they are like the man who lost on the road car keys and looks for them under a street lamp, simply because there is more light.

In fact, however, the view of scientists that the physical laws discovered by them in laboratory experiments here on Earth are valid throughout the Universe and at all stages of its evolution, to put it mildly, unfounded. For example, we have no evidence to suggest that once the electric field behave in a certain way in the laboratory, they showed the same properties millions of years ago at a distance of many tens of light-years from Earth. However, without such assumptions it can not do any one attempt to explain the origin of the Universe. After all, we can't go back billions of years ago, at the time of formation of the Universe, or to obtain direct information about what happens outside the Solar system.

Some scientists recognize the risk of the transfer of our very limited knowledge of the universe as a whole. In 1980, K. balding in his address to the American Association for the advancement of science said: "Cosmology... is represented to us by science without a solid Foundation though, because she is exploring a vast Universe on the example of a small part of the study which may not give an objective picture of reality. We watched it for a very short period of time and have a relatively complete view only of a negligible part of its volume." However, not only the conclusions of

cosmologists do not have a solid Foundation, it seems that the attempt to create a simple mathematical model of the Universe is not quite correct, and is associated with fundamental difficulties.

Problematic singularity

As stated in the big Bang theory, the universe originated from a point with zero volume and infinitely high density and temperature. This condition, called singularity, is not amenable to mathematical description.

Trying to explain the origin of the Universe, proponents of the big Bang theory faced with a serious problem, because the original state of the Universe in models developed by them is not amenable to mathematical description. According to all existing theories of the big Bang, beginning the universe was represented as a point in space infinitely small volume, having infinitely high density and temperature. This initial state can not in principle be described mathematically. About this state, nothing can be said. All calculations come to a standstill. It's still what to do by dividing a number by zero — what happens? 1? 5? 5 trillion?.. The answer to this question does not exist. In the language of science this phenomenon is called "singularity."

Professor of radio astronomy University of Manchester B. Lowell wrote about the singularities of the following: "In an attempt to physically describe the initial state of the Universe, we stumble upon an obstacle. The question is whether this obstacle can be overcome. Maybe all our attempts to scientifically describe the initial state of the Universe are doomed to failure? This question, as well as conceptual difficulties related to the description of singular points in the initial moment of time, are one of the main problems of modern scientific thought". While that is an obstacle unable to overcome even the most prominent scientists developing the theory of the big Bang.

The Nobel laureate S. Weinberg noted: "unfortunately, I cannot start the film [color documentary about the big Bang] with the zero reference point when time did not exist, and the temperature was infinite". Thus, the big Bang theory actually does not describe the origin of the Universe, because the initial singularity is, by definition, defies description.

So, the big Bang theory is faced with insurmountable problems literally from the beginning. In a popular scientific presentation of the theory of the big Bang difficulties associated with the initial singularity, either ignored or mentioned in passing, but in special articles, scientists are making attempts to bring mathematical basis for this theory, recognize their main obstacle. Math Professor S. Hawking from Cambridge, and G. Ellis from Cape town noted in his monograph "the large scale structure of space-time": "In our view, it is justified to consider the physical theory that predicts a singularity, failed". And further: "the results of our observations confirm the hypothesis that the universe originated in a point in time. However, the beginning of creation, the singularity, is not subject to any known laws of physics."

It is clear that any hypothesis about the origin of the Universe, which postulates that the initial state of the Universe defies physical description, looks pretty suspicious. But it's not so bad. Next question: where did the singularity itself? And the scientists are forced to declare a mathematically indescribable point of infinite density and infinitesimal size, existing outside of space and time and eternal cause of all causes.

Attempts to solve the singularity

Not wanting to put up with this prospect, theorists have developed several variants of the big Bang theory, which tries to circumvent the problem of singularity. One possible approach is to postulate that the singularity at the origin of the Universe was not perfect. B. Lowell argues that the singularity in the big Bang theory "was often presented as a mathematical problem arising from the postulate of the uniformity of the Universe." All the classic models of the Universe resulting from the big Bang, have perfect mathematical symmetry, and some physicists have considered it a reason for the appearance of singular roots of equations describing the initial state of the Universe. To correct for this, theorists began to introduce in their model the asymmetry, similar to that which you can see in the observable Universe. Thus, they hoped to make in the original state of the Universe enough disorder, the necessary to ensure that it is not reduced to a point. But all their hopes were destroyed by Hawking and Ellis, who argue that, according to their calculations a big Bang model with an asymmetric distribution of matter in either case must have a singularity at the origin."

Where the universe came from?

The problem of singularity is only part of a more General problem, the problem of the origin of the Universe (no matter what was its initial state). If any model of the Universe postulates the singularity is, of course, creates great theoretical difficulties. But even if the singularity can be avoided, then the main question remains unanswered: how, exactly, did the universe?

Hoping to evade the answer to this question, some scholars have proposed the theory of so-called "endlessly pulsating Universe". In accordance with this theory, the universe is expanding, and then shrinking to a singularity, then re-expands, and shrinks again. It has neither beginning nor end. It removes the question about the origin of the Universe — it is conserved, and there forever.

But this model is not without serious shortcomings. First of all, so far no one has been able to satisfactorily explain the mechanism of pulsation. Further, in his "First three minutes" - S. Weinberg argues that each cycle of expansion and contraction should lead to certain progressive changes in the Universe, and this means that the Universe must have a beginning, otherwise the whole history of the Universe will regress, stretching for eternity. Thus, before us again raises the question of the origin of the Universe.

Another attempt to evade the question of the origin of the Universe was proposed by English astrophysicist P. Davis model "pulsating Universe with the appeal of the course of time." According to this theory, the universe first expands and then shrinks to a singularity, and in the beginning of the next cycle of expansion-contraction. time turns back, leading, eventually, to the singularity which began the previous cycle. According to this model, the past becomes the future and future — past, so the concept of "beginning of the Universe" is meaningless. This scenario gives some idea of what tricks are forced to embark on scientists-cosmologists, to explain the origin of the Universe.

Inflationary Universe

Apart from the question of the origin of the Universe, modern cosmologists are faced with a number of other problems. To standard big Bang theory can predict the distribution of matter that we observe, its initial state must be

characterized by a very high degree of organization. Immediately the question arises: how such a structure could be formed? Physicist A. Guth of the Massachusetts Institute of Technology offered his version of the big Bang theory, which explains the spontaneous emergence of this organization, eliminating the need to artificially enter the exact parameters in the equations describing the initial state of the Universe. His model was called the "inflationary Universe." The gist of it is that within a rapidly expanding, Universe feature a small region of space cools and begins to grow stronger, just as supercooled water freezes rapidly expanding. This phase of rapid expansion allows to eliminate some of the problems inherent in the standard theories of the big Bang.

However, the model Guth is also not devoid of disadvantages. To Guth equations correctly described the inflationary Universe, he had very accurately to specify source parameters for their equations. Thus, he faced the same problem as the creators of other theories. He was hoping to get rid of the need to specify the exact parameters of the conditions of the big Bang, but to do this he had to introduce its own parameterization, remaining unexplained. Guth and his co-author P. Steinhardt recognize that in their model "calculations lead to reasonable predictions only if the specified initial parameters of the equations vary in a very narrow range. Most theorists (including ourselves) consider such initial conditions is unlikely." Next the authors talk about their hopes for what will someday be developed a new mathematical theory that will allow them to make your model more believable.

This dependence on as yet undiscovered theories — another drawback of the model Guth. The theory of the unified field, which is based on the inflationary model of the Universe, completely hypothetical and "poorly amenable to experimental verification, because most of its predictions, it is impossible to quantitatively verify in the lab". (Theory of the unified field — it is quite a dubious attempt of scientists to tie together some of the basic forces of the Universe.)

Another disadvantage of the theory Guth is that it says nothing about the origin of the superheated expanding matter. Guth check compatibility of their inflation theory with the three hypotheses of the origin of the Universe.

First, he reviewed the standard big Bang theory. In this case, according to Guth, the inflationary episode was supposed to happen at an early stage of evolution of the Universe. However, this model poses an insoluble problem of singularity. The second hypothesis postulates that the universe emerged from chaos. Some parts were hot, others cold, some expanded, others shrank. In this case, inflation was supposed to start in the superheated area expanding and the Universe. However, Gut recognizes that this model cannot explain the origin of primordial chaos.

A third possibility, which Gut preference, is that the superheated expanding clot of matter occurs quantum mechanically from the void. The article, which appeared in the magazine "scientific American" in 1984, Guth and Shtayngart say: "the Inflationary model of the Universe gives us insight into a possible mechanism by which the observed universe could have come from an infinitely small area of space. Knowing this, it is difficult to resist the temptation to take another step and come to the conclusion that the universe was created literally out of nothing."

However, no matter how appealing this idea is for scientists, ready to take up arms at any mention of the possibility of the existence of the Supreme consciousness who created the Universe, upon closer examination, it is not tenable. "Nothing", which tells the Gut, is a hypothetical quantum-mechanical vacuum described have not yet developed a unified field theory which would combine the equations of quantum mechanics and General relativity. In other words, the moment this vacuum cannot be described, even theoretically.

It should be noted that physicists have described a more simple type of quantum-mechanical vacuum is a sea of so-called "virtual particles", fragments of atoms that are "almost there". From time to time, some of these subatomic particles pass from the vacuum into the world of material reality. This phenomenon is called vacuum fluctuations. Vacuum fluctuations cannot be observed directly, but theories postulating their existence have been confirmed experimentally. According to this theory, particles and antiparticles without any reason arise from the vacuum and disappear almost immediately annihilate each other. Guth and his colleagues admitted that at some point, instead of tiny particles from the vacuum was a whole universe,

and instead of disappearing, this universe, somehow existed billions of years. The authors of this model solved the problem of singularity, postulirovana that the state where the universe comes from the vacuum, is somewhat different from the condition of singularity.

However, this scenario has two main disadvantages. First, one can only wonder at the courage of imagination of scientists, the extension of the limited experience with the subatomic particles in the entire Universe. S. Hawking and G. Ellis wisely warned his overly enthusiastic colleagues: "the Assumption that the laws of physics, discovered and studied in the laboratory, to be fair to other points of the space-time continuum, of course, a very bold extrapolation". Second, strictly speaking, quantum-mechanical vacuum cannot be called "nothing". Description of quantum-mechanical vacuum, even the most simple of the existing theories is the number of pages in highly abstract mathematical calculations. Such a system is certainly a "something", and immediately arises the same stubborn question: "How did such complicated organized by the "vacuum"?"

Back to the original problem, which Guth created the inflationary model: the problem of the precise parameterization of the initial state of the Universe. Without such a parameterization is impossible to obtain the observed distribution of matter in the Universe. As we have seen, to solve this problem Guth failed. Moreover, it seems doubtful the very possibility that some version of the big Bang theory, including the version Guth, can predict the observed distribution of matter in the Universe. Highly organized initial state in the model Guth, according to him, in the end, turns into "the Universe" 10 cm in diameter, filled with homogeneous superdense, superheated gas. It will expand and cool, but there is no reason to suppose that it will ever become something more than a uniform cloud of gas. In fact, this result all the big Bang theory. If the Guth had to go on for many tricks and make dubious assumptions in order in the end to the Universe in the form of a cloud of homogeneous gas, it is possible to imagine, what should be the mathematical apparatus of the theory, leading to the Universe, as we know it! A good scientific theory enables to predict many complex natural phenomena, on the basis of a simple theoretical scheme. But in theory Guth (and any other version of the big Bang theory) is the opposite: as a result of complex mathematical calculations we get the uniform expanding bubble of gas. Despite this, science magazines published enthusiastic articles about the

inflationary theory, accompanied by many colorful illustrations that ought to give the reader the impression that Gut finally reached the cherished goal — found the explanation of the origin of the Universe. We would not rush with such statements. It would be more honest just to open a regular column in scientific journals, to publish the theory of the origin of the Universe, fashion this month.

It's hard to imagine the complexity of the initial state and the conditions necessary for the emergence of our Universe with all the diversity of its structures and organisms. In the case of our Universe, the degree of complexity is such that it can hardly be explained with the help of some physical laws.

Theorists resort to the so-called "anthropic principle."

According to their hypothesis, the quantum mechanical vacuum is producing universes by the millions. But most of them do not have the conditions necessary for the origin of life, so no one can explore these worlds. At the same time, in other universes, including our own, have developed suitable conditions for the emergence of researchers, so there is nothing surprising in the fact that in these universes there is such an unlikely order. In other words, the proponents of the anthropic principle take the very existence of the person for an explanation of the orderly structures of the Universe that created the conditions for the emergence of man. However, such logical evasions do not explain anything.

Another form of pseudo-scientific casuistry is the assertion that the universe came by the will of blind chance. These words also nothing to explain. To say that something that appeared once, there was a chance — so just say it appeared. Such statements cannot be regarded as a scientific explanation, as they do not contain any new information. In other words, these "explanations" not a step closer to a solution to the problem of the origin of the Universe.

Forgive us theorists, but we dare to assume that the methods they use are inadequate to the task. Two main intellectual tool used by cosmologists to describe the Universe is General relativity and quantum mechanics. However,

in addition to all the difficulties already described, both these theories themselves are not without flaws. No doubt, these theories describe some physical phenomena, however, this does not prove that they are perfect in all respects.

General relativity describes curved space-time and is an integral part of any modern theory of the origin of the Universe. Therefore, if the General theory of relativity needs revision, then any cosmological theory based on it also needs to be amended.

The application of the General theory of relativity, as well as earlier theories of Einstein, the special theory of relativity, fraught with one difficulty: both the concept of time reconsidered. In Newtonian physics time is treated as a variable independent of space. Because of this, we can describe the trajectory of an object in space and time: in this time the object is in a certain point in space, and over time its position changes. But the theory of relativity combines space and time into a four dimensional continuum, so what about the object is not to say that at some point in time it occupies a certain position in space. Relativistic description of an object indicates its position in space and time as a whole, from the beginning to the end of the existence of the object. For example, a person from the point of view of the theory of relativity represents the spatial-temporal unity, from the embryo in the womb to the corpse (the so-called "space-time worm"). This "worm" can't say, "Now I'm an adult, and was formerly a child." Time does not exist. All human life is a unified whole. This view of human devalues our personal perception of the past, present and future, forcing us to question the very reality of this perception.

In his letter to M. Besso Einstein wrote: "You have to accept that subjective time with its emphasis on the real has no objective meaning." After the death Besso, Einstein expressed his condolences to his widow as follows: "Michael is a little ahead of me, leaving this strange world. However, it doesn't matter. For us convinced physicists the distinction between past, present, future — and even Intrusive, but just an illusion". "In fact, these views deny the consciousness which underlines the reality of the experienced moment. Our present body we experience as real, whereas our children's body is preserved only in memory. For us there is no doubt that we occupy a certain place in

space at a given time. The theory of relativity makes a series of events in a single space-time structure, but we perceive them as a sequence of certain stages in time. Consequently, any model of the origin of the Universe based on relativity cannot explain our perception of time, and because all of these models in their present form is imperfect and unacceptable.

Quantum physics and reality

All modern cosmological theories based on quantum mechanics, which describes the behavior of atomic and subatomic particles. Quantum physics fundamentally different from classical, Newtonian physics. Classical physics deals with the description of the behavior of material objects, while quantum physics is concentrated only in the mathematical description of the processes of observation and measurement. Physical material reality disappears from her field of view. Nobel prize winner Heisenberg said, "was that we were no longer able to separate the behavior of the particles from the process of observation. As a result, we have to put up with the fact that the laws of nature, which formulates quantum mechanics in mathematical form, are related not to the behavior of elementary particles as such, but only to our knowledge about these particles." In quantum mechanics along with the research object and research tools analyzed picture element is the observer.

However, the application of quantum mechanics to describe the Universe involves serious difficulties. By definition, all observers are part of the Universe. In the case of the Universe we lack the ability to imagine an outside observer. In an attempt to formulate a version of quantum mechanics, which needs no outside observer, the famous physicist Dzh. Wheeler proposed a model, according to which the universe constantly splits into an infinite number of copies. Each parallel universe has its observers that see a given set of quantum alternatives, and all these Universes are real.

V. Vit writes about his reaction to this theory in the magazine "Physics today": "I still remember the shock that is experienced, for the first time acquainted with the theory of multiplicity of worlds. The idea that every moment of I get 10 in 100-degree slightly different from each other twins, and that each of them continues incessantly to share, yet will not change beyond recognition, does not fit into common sense. This is truly the picture of infinitely progressing schizophrenia". This is just one example of fantastic

hypotheses, which you have to press scientists to agree on the big Bang theory with quantum mechanics.

However, troubles scientists, who follow the path of materialistic reductionism, don't stop there. Moreover, the theory of relativity and quantum mechanics by themselves in application to cosmology lead to the absurd and fantastic models. To truly appreciate the precariousness of hope scientists ever find a clue to the origin of the Universe, you need to know that they impose them primarily for not yet created the theory of the unified field (TEP), which would combine relativity and quantum mechanics. They hope that this theory will describe all the forces acting in the Universe, with one compact mathematical expressions. The theory of relativity necessary to describe the General structure of space-time and quantum mechanics to explain the behavior of subatomic particles. Unfortunately, both theories clearly contradict each other.

The first step towards a mathematical integration of both theories is the theory of quantum fields. This theory attempts to describe the behavior of electrons, combining quantum mechanics and special relativity of Einstein. This Association of ideas was quite successful, but at the same time, English physicist, Nobel prize laureate P. Dirac, the author of quantum field theory, confessed: "it Seems that to put this theory on a solid mathematical basis is almost impossible." The second and much more difficult step should be the integration of General relativity and quantum mechanics, but so far no one has any idea on how to do it. Even such a recognized authority as a Nobel laureate S. Weinberg, recognize that the only to create the mathematical apparatus of the new theory will need a century or two.

Since Newton and Galileo physics aim to give a mathematical description of the phenomenon. This mathematical description must be confirmed by the observations and then verified experimentally. We have already seen that the big Bang theory does not meet these requirements. One of the basic requirements of physical theories was easy, but as we can see, the big Bang theory do not meet this criterion. With each new formulation they are becoming more and more bizarre. These theories represent just something that is so distasteful to Newton and Galileo — idle fancies, designed to fill the gaping hole in our knowledge.

Thus, the big Bang theory can't claim the role of a scientific explanation of the origin of the Universe. However, in popular science magazines, television programs and in textbooks scientists deliberately trying to create the impression that they were able to explain the origin of the Universe. As they say, do not deceive — will not sell. It's hard to imagine anything further from the truth.

What about the Galaxies?

We have already seen that all attempts of cosmologists to cram the Universe into the narrow framework of his materialist ideas nor to no avail. Moreover, their theories do not even match their own ideas about the structure of the Universe. For example, the big Bang theory cannot explain the existence of galaxies. Imagine a brilliant scientist who knows all modern cosmological theory, but has no clue about astronomy. Will he be able to predict the existence of galaxies? No. Modern versions of the cosmological theories predict only the emergence of a homogeneous cloud of gas. The density of this cloud to the present time should be not more than one atom per cubic meter — much better than a vacuum. To get more you need to adjust the initial state of the Universe, which is very difficult to prove scientifically. Traditionally, a physical theory is acceptable only if it has predictive power. Value theory, which takes a long time to adjust to squeeze from it some predictions, is very questionable.

S. Weinberg in his book "First three minutes" writes: "the theory of the origin of the galaxies represents one of the most difficult problems of astrophysics, the problems are still very far from resolution." "But then he immediately makes a reservation: "But that's another story". Why not another? This is precisely the story! If the big Bang theory cannot explain the origin of not only the Universe, but one of the main components of the Universe — galaxies, what did she even explain? Apparently, not too much.

The missing mass

One of the unsolved mysteries of the Universe: scientists believe that galaxies can be surrounded by a halo of invisible matter, whose mass is nine times greater than their own.

The theory of "big Bang" should, in theory, explain the structure of the Universe, but the trouble is that many of the characteristics of the Universe have not been studied, so that they can explain. One of the intriguing mysteries is the problem of "missing mass". "Measuring the light energy emitted by the Milky Way, you can roughly determine the mass of our galaxy. It is equal to the mass of a hundred billion Suns. However, studying the communication patterns of the same milky Way with the nearby Andromeda galaxy, we find that our galaxy is attracted to her as if it weighs ten times more," says David Schramm, Professor, University of Chicago. Thus, the difference in mass determined by the two methods is 90%. To explain this, the researchers decided to write off the lack of mass of ghostly subatomic particles called "neutrinos". Originally, the neutrino was considered to be weightless, but when needed, they attributed the mass to "find" the missing mass of the galaxy. Very convenient.

Even if we postpone the question of the origin of the Universe and refer to its structure, we see that here not all is well. Scientists confidently say that the universe extends over X light years and its age At billions of years. They claim to know the nature of all major space objects: stars, galaxies, nebulae, quasars, etc. At the same time, we do not have a clear notion of the milky Way galaxy to which we belong.

For example, in the magazine "scientific American" the famous astronomer BJ. Bock writes: "I remember the mid-seventies, when I and my colleagues, researchers of the milky Way, were absolutely confident... At that time no one could come to a head that very soon we will have to revise his ideas about the size of the milky Way, increasing its diameter tripled, and the mass of ten times". Even if such options were so radically changed after decades of observation and research, what can you expect from the future?! Will we have even more to radically change their views?

Even our own Solar system remains a mystery to us. The traditional explanation of the origin of the planets, according to which the planets were formed in the condensation process of clouds of cosmic dust and gas, and has a rather shaky Foundation, as the equations describing the interaction of the gas in these clouds has still not been resolved. V. Mak-Rei, Professor, University of Sussex, former President of the Royal Astronomical society,

writes: "the problem of the origin of the Solar system remains perhaps the most significant of all the unsolved problems of astronomy".

Hope the above is enough to convince any unbiased reader of the groundlessness of the claims of cosmologists that the strategy of materialistic reductionism has helped them to successfully explain the origin and nature of the Universe. We have no evidence to suggest that all the answers to the questions of cosmology must be described by a simple mathematical expression. The quantitative method often cannot be applied even to the phenomena, is much more simple and affordable than this universe. So it is premature to reject alternative approaches — approaches that may be based on other laws and principles than the known laws of physics.

A different picture of reality

Logically, we cannot exclude the possibility of participation of non-physical factors in the Universe, as it is impossible to exclude the possibility of the existence of the universe, which did not apply the known physical laws. Physicist D. Bohm admits: "there is Always a possibility that will be discovered are fundamentally different properties, qualities, structures, systems, levels, which obey very different laws of nature."

As we have seen, some models and concepts, such as models endlessly throbbing and infinitely divisible Universe, proposed by cosmologists, is clearly contrary to common sense. You should not consider these concepts amusing curiosities — they are among the most respectable hypotheses of modern cosmology. Consider a few of the more eccentric ideas that are being discussed by scientists-cosmologists. One such theory is the theory of "white holes" — quasar, spewing a fountain of galaxy j. Gribbin, author of "White holes", asks: "is it Possible that a white hole was divided, so that the galaxy could reproduce themselves like amoebas, by parthenogenesis? From the point of view of traditional ideas about the behavior of matter, this assumption seems so implausible that you truly appreciate it just by looking at the standard theory of the origin of galaxies and how hopeless their attempts to explain the development of the real Universe. Theory fissioning white hole looks like a straw that a drowning man grabs, but in the absence of other acceptable alternatives, we have no choice but to grab her."

Another theory that is being seriously considered by cosmologists is space-time tunnels or as they are called, "space hole." For the first time seriously considered physicist John. Wheeler in "reemergence" (1962), this theory has received wide recognition thanks to the sci-Fi series "Star wars." In these films, space ships travel through hyperspace, carrying intergalactic flights, which under normal conditions would have required millions of years moving at the speed of light. In some versions of this theory of space tunnels are considered as transitions, linking the past and the future, or even different universes.

In the early twentieth century, Einstein introduced the concept of the fourth dimension. At present, as detected by a new investigation of the gravitational field equations developed by Einstein, physicists have to introduce a new dimension. Theoretical physicist P. Davies writes: "In nature? addition to the three spatial dimensions and one time that we perceive in everyday life, there are seven more dimensions that hitherto nothing has not been noticed"

We say all this to show that even scientists are forced to propose explanations of nature and the Universe that go far beyond the usual ideas and don't fit in ordinary consciousness. In order to understand them or even just come to terms with them requires a certain "stretching" of the mind.

The process of evolution of the Universe is very slow. Because the universe is many times older than astronomy, and General human culture. The origin and evolution of life on earth is only a tiny link in the evolution of the Universe. Yet research conducted in our century, opened the curtain to hide us from the distant past. Modern astronomical observations indicate that the early Universe around ten billion years ago, there was a giant fireball, the hot and dense. Its composition is very simple. This fireball was so hot that it consisted only of free elementary particles, which move rapidly, colliding with each other.

For ten billion years after the big Bang, the simplest formless substance gradually turned into atoms, molecules, crystals, rocks, planets. Born-star system, consisting of a large number of elementary particles with an extremely simple organization. On some planets there might be life forms.

The Beginning Of The Universe

The universe is constantly expanding. The time with which the universe began to expand, considered to be the beginning. When first started and dramatic era in the history of the universe, it is called the “big Bang” or the English term Big Bang.

Under the expansion of the Universe implies such a process when the same number of elementary particles and of photons is constantly increasing. The average density of the Universe the expansion is gradually reduced. This implies that in the past the Density of the Universe was greater than at present. We can assume that in ancient times (approximately ten billion years ago) the density of the Universe was very large. In addition, the high was supposed to be a temperature so high that the density of radiation exceeded density of matter. In other words, the energy of all the photons contained in 1 CC was greater than the sum of the total energy of particles contained in 1 CC. At a very early stage, in the first moments of the big Bang all matter was very hot and dense mixture of particles and antiparticles of high-energy gamma photons. The particles at collision with the corresponding antiparticles annihilated, but the emerging gamma-ray photons instantly materialized in particles and antiparticles.

A detailed analysis shows that the temperature T is decreased in time in accordance with a simple ratio:

$$T = 10^4 \text{ K} \cdot 10^4$$

$$C \cdot t$$

The dependence of the temperature T from time t allows us to determine that, for example, at a time when the age of the universe, there remained only one ten-thousandth of a second, her temperature was one billion degrees Kelvin.

The temperature of hot dense matter at the initial stage of the Universe eventually decreased and this is reflected in the ratio. This means that decreased, the average kinetic energy of particles, kT . According to the ratio $h\nu = kT$ decreased and the energy of the photons. This is possible only in case, if you reduce their frequency ν . Lowering the energy of the photons during the time taken for appearance of particles and antiparticles by the

materialization of important implications. In order that the photon has become (materialized) into a particle and antiparticle with mass m_0 and the rest energy $m_0 c^2$, it is necessary to have energy $2m_0 c^2$ or greater. This dependence is expressed as follows: $h\nu \geq 2m_0 c^2$. Over time, the energy of the photons is decreased and as it fell below works energy particles and antiparticles ($2m_0 c^2$), the photons were not able to provide the appearance of particles and antiparticles with mass m_0 . For example, a photon with energy smaller than the $2.938 \text{ MeV} = 938 \text{ MeV}$, are not able to materialize into a proton and an antiproton, because the rest energy of the proton is 938 MeV .

In the previous ratio can be used to replace the photon energy $h\nu$ the kinetic energy of particles, kT , $kT \geq 2m_0 c^2$ that is $T \geq 2m_0 c^2 / k$.

k

The inequality sign means the following: the particles and their corresponding antiparticles occurred when materialization in a hot substance as long as the temperature T falls below a value.

$2m_0 c^2$

k

At the initial stage of expansion of the Universe from the photons were born particles and antiparticles. This process is constantly weakened, leading to the extinction of particles and antiparticles. Since annihilation can occur at any temperature, continuously process the particle + antiparticle $\rightarrow 2$ gamma-ray photon under the condition of contact of matter with antimatter. The process of materialization of a gamma photon \rightarrow particle + antiparticle States could occur only at high enough temperature. According to how the materialization of the result of lowering the temperature of the hot substance has stopped. The evolution of the Universe can be divided into four eras: hadron, lepton, photon and stellar.

a) At very high temperatures and densities in the early Universe matter consisted of elementary particles. Substance at a very early stage consisted

primarily of hadrons, and therefore the early era of the Universe's evolution is called a hadron, despite the fact that at that time existed and leptons.

Using one millionth of a second since the birth of the Universe, temperature T dropped to 10 billion Kelvin (10^{13} K). The average kinetic energy of particles and photons kT was about a billion eV (10^3 MeV), which corresponds to the rest energy of the baryons. In the first millionth of a second of the Universe's evolution was the materialization of all baryons is unlimited, the same as annihilation. But after this time, the materialization of baryons stopped, since at temperatures below 10^{13} K photons had not enough energy for its implementation. The process of annihilation of baryons and antibaryons lasted as long as the pressure of the radiation is not separated matter from antimatter. Unstable hyperons (heavy baryons) in the process of spontaneous decay to become the lightest baryons (protons and neutrons). So in the universe disappeared the largest group of baryons — hyperons. Neutrons can decay into protons, which then disintegrated, otherwise it would have violated the law of conservation of baryon charge. The decay of the hyperons was happening on stage from 10^{-6} to 10^{-4} seconds.

By the time the age of the Universe made up of one ten-thousandth of a second (10^{-4} s), its temperature dropped to 10^{12} K, and the energy of particles and photons was represented by only 100 MeV. It is not enough for the emergence of the lightest hadrons — the pions. Pions that existed was falling apart, and the new could not arise. This means that by the time the age of the Universe reached 10^{-4} s, it disappeared all the mesons. Ends hadron era, because pions are not only the lightest mesons, but the lightest hadrons. Ever after that the strong interaction (nuclear force) is not manifested in the Universe in such extent as in the hadron era, which lasted only one ten-thousandth of a second.

b) When the energy of particles and photons fell in the range from 100 MeV to 1 MeV in substance it was a lot of leptons. The temperature was high enough to ensure intense appearance of electrons, positrons and neutrinos. Baryons (protons and neutrons) emerging from the hadron era, steel compared to the leptons and photons to meet much less frequently.

The lepton era begins with the collapse of the last of hadrons — pions — muons and muon neutrinos, and ends a few seconds at a temperature of 10^{10}

K, when the energy of the photons decreased to 1 MeV and materialisation of electrons and positrons stopped. During this phase, begins the independent existence of electron and muon neutrinos, which we call “ relic ” . All of space was filled with a huge number of relic electron and muon neutrinos. Occurs neutrino sea.

in), the lepton era, the era of radiation temperature of the Universe dropped to 10^{10} K , and the energy of gamma photons reached 1 MeV, there was only the annihilation of electrons and positrons. A new electron-positron pair could occur as a result of materialization, because the photons do not have sufficient energy. But the annihilation of electrons and positrons on until the pressure of the radiation is not completely separated matter from antimatter. Since hadronic and leptonic era the universe was filled with photons. By the end of the lepton era, photons was two billion times more than protons and electrons. The major components of the Universe after the lepton era, photons become, not only in quantity but also in energy.

In order to compare the role of particles and photons in the Universe, was introduced the value of the energy density. This amount of energy in 1 cubic cm, or more precisely, the average number (based on the premise that substance in the Universe is distributed evenly) . If you add together the energy $h\nu$ of all photons present in 1 cubic cm, we get the energy density of radiation E_r . The sum of the rest energy of all particles in the 1 CC is the average energy E_m of matter in the Universe.

Due to the expansion of the Universe decreased the energy density of photons and particles. With increasing distances in the Universe doubled, the volume has increased eight-fold. In other words, the density of particles and photons decreased in eight times. But the photons in the process of expanding to behave differently than particles. While the rest energy during the expansion of the Universe is not changing, the energy of the photons during the expansion is reduced. Photons lower their frequency of oscillation, like a “tired” over time. As a consequence, the density of photon energy (E_r) falls faster than the energy density of the particles (E_m) . The prevalence in the universe photonic composite on composite particles (energy density) during the era of radiation was reduced until, until it disappeared completely. By this time both the composite has achieved equilibrium (i.e. $E_r = E_m$). Ends the

era of radiation and with it the period of “big Bang”. So was the universe like at the age of about 300,000 years. The distance in that time was a thousand times shorter than at present.

The “big Bang” lasted a relatively short time, only one thirty thousandth of the current age of the Universe. Despite the shortness of the time, it was the most glorious era of the Universe. Ever after that, the evolution of the Universe was not as rapid as in the very beginning, during the “big Bang” . All events in the Universe during that period concerned the free elementary particles and their transformations, birth, decay, and annihilation. We should not forget that in such a short time (a few seconds) from the rich variety of species of elementary particles have disappeared almost all: some by annihilation (conversion to gamma photons) , the other by decay into the lightest baryons (protons) and the light charged leptons (electrons) .

After the “big Bang” there was a long era of matter, the era of the dominance of particles. We call it the star era. It continues from the time of completion of the “big Bang” (approximately 300 000 years) to the present day. Compared to the period of “big Bang” development seems like too slow. This is due to the low density and temperature. Thus, the evolution of the Universe can be compared with the fireworks that ended. Left burning sparks, ashes and smoke. We stand on the cooled ash, peering into the ageing stars, and remember the beauty and brilliance of the Universe. A supernova explosion or a giant explosion in the galaxy — a tiny phenomenon compared to the big Bang.

The birth of svargaloka and clusters of galaxies

During the era of radiation continued rapid expansion of cosmic matter consisting of photons, among which there are free protons or electrons and very rarely the alpha particles. (We must not forget that the photon was a billion times more than protons and electrons) . In the era of radiation, protons and electrons largely remained unchanged, decreased their speed. With photons, the situation was much more complicated. Although the speed remained the same, during the era of gamma-ray photons are gradually transformed into photons of x-ray, and ultraviolet photons of light. Matter and photons to the end of an era is cooled so that each of the protons could

join one electron. If this was a radiation of one ultraviolet photon (or multiple photons of light) and, thus, any hydrogen atom. It was the first system of particles in the Universe.

With the emergence of hydrogen atoms starts Golden age — era particles, more precisely, the era of protons and electrons.

The universe enters the stellar epoch in the form of hydrogen gas with a huge amount of light and ultraviolet photons. Hydrogen gas was expanded in different parts of the Universe at different speeds. Were also uneven and its density. He formed huge clots, many millions of light years. Plenty of space hydrogen clots were in the hundreds of thousands, if not millions of times greater than the mass of our present Galaxy. The gas expansion inside the clusters was slower than the expansion of rarefied hydrogen between the clumps. Later, from separate sites with their own gravity formed surgelati and clusters of galaxies. Now, the largest structural unit of the Universe — surgelati — are the result of the uneven distribution of hydrogen, which occurred in the early stages of the history of the Universe.

The birth of galaxies

Huge hydrogen condensation — nuclei over the galaxies and clusters of galaxies, slowly rotating. They were formed inside vortices, like the eddies. Their diameter reached about one hundred thousand light-years. We call these systems protogalactical, i.e. the nuclei of galaxies. Despite its incredible size, the vortices of protogalactic was only a tiny part of svargaloka and the size does not exceed one-thousandth of surgelati. The force of gravity formed these vortices systems of stars that we call galaxies. Some of the galaxies still resemble a giant twist.

Astronomical studies show that the speed of rotation of the twist determined the shape of the galaxy, born from this vortex. In scientific language, the velocity of axial revolution also determines a type of the future of the galaxy. Of a slowly rotating vortices arose elliptical galaxies, while born of a rapidly rotating tapered spiral galaxy.

As a result of force of gravity of very slowly rotating vortex shrank into a ball or several spljusnutyj ellipsoid. The dimensions of this right, a giant

hydrogen cloud was from a few dozen to a few hundred thousand light-years. It is easy to determine which hydrogen atoms included in the composition of the created elliptic, more precisely ellipsoidal galaxy, and what remained in outer space outside it. If the binding energy of the forces of gravity of the atom on the periphery higher than its kinetic energy, the atom would become an integral part of the galaxy. This condition is called the jeans criterion. It can be used to determine the extent to which depended on the weight and size of the protogalaxy from the density and temperature of the hydrogen gas.

The protogalaxy, which is generally not revolved, became the progenitor of the ball galaxy. Tapered elliptical galaxies originates from slowly rotating protogalactic. Due to insufficient centrifugal force dominated the force of gravity. Protogalactic compressed and the density of hydrogen in it increased. As soon as the density reached a certain level, they started to allocate and compressed clusters of hydrogen. Born protostar, which later evolved into stars. The birth of all the stars in a ball or slightly flattened galaxy happened almost simultaneously. This process lasted for a relatively short time, approximately a hundred million years. This means that elliptical galaxies are all stars approximately the same age, i.e. very old. Elliptical galaxies all the hydrogen has been exhausted immediately at the beginning, about the first hundredth of the existence of the galaxy. Over the next 99 hundredths of the period the stars could not occur. Thus, in elliptical galaxies the amount of interstellar matter is negligible.

Spiral galaxies, including ours, consist of very old spherical component (in this they are similar to elliptical galaxies) and younger flat component located in the spiral arms. Between these components there are several transient components of different levels of splyusnutist, of different ages and rotation speed. The structure of spiral galaxies, thus, more complicated and diverse than the structure of the elliptical. Spiral galaxy in addition rotate much faster than the elliptical galaxy. It should not be forgotten that they formed from a rapidly spinning vortices of surgelati. Therefore, in creating spiral galaxies involved and the gravitational and centrifugal forces.

If our galaxy in a hundred million years after its occurrence (this is the formation of the spherical component) evaporated whole interstellar hydrogen, of a new star would be unable to be born, and our galaxy would be

elliptical.

But the interstellar gas in those days not evaporated, and thus the gravity and the rotation could continue building our and other spiral galaxies. Every atom of interstellar gas operated two forces, the gravity that pulls him to the center of the galaxy and the centrifugal force that pushes it in the direction from the axis of rotation. In the end, the gas compressed in the direction of the galactic plane. At present, the interstellar gas is concentrated to the galactic plane in a very thin layer. He focuses primarily in the spiral arms and is a flat or an intermediate component called the stellar population of the second type.

At each stage of flattening of interstellar gas in increasingly thinning the CD was born of a star. Therefore, in our galaxy, it is possible to find how old that occurred ten billion years ago, and recently born stars in the spiral arms in the so-called associations and scattered clusters. We can say that the more tapered a system in which the stars were born, the younger they are.

Conclusion

The universe is in our time. In spiral galaxies birth and death of stars. The universe continues to expand.

Nebula is a celestial object that unlike the stars appear as spots. The most prominent of these is visible to the naked eye (the Andromeda nebula and the Orion nebula). In 1774, the French Messier involved, however, the study of comets, which resemble in appearance the nebula, produced the first catalog of nebulae, created only. in order to facilitate the Messier the opening of new objects of his interest. Most nebulae of this kahalaga were discovered by Messier. In the directory were collected in all types and classes of nebulae, but classified they were not. Below is a variant of the modern classification of nebulae.

All nebulae are divided into galactic and extragalactic. Detailed classification of extragalactic nebulae (galaxies) were proposed by B. A. Vorontsov-by Veliaminov. Next, will be classified galactic nebula.

Galactic nebulae represent clouds of interstellar dust and gas illuminated by a bright neighbouring stars. All these nebulae are in our Galaxy.

Galactic humanity are divided into gas and dust. The gas of the nebula is a cloud of interstellar gas, glowing by reflected light or in the excitement of hot stars.

Dust (dark) nebulae are clouds of interstellar dust or dark looking spots on the background of more distant bright nebulae, or closing the light of distant stars. An example corresponding to the first case — the Horse Head nebula, in the constellation of Orion. Example. corresponds to the second case — nebula the Coal Sack, which hides the center of our Galaxy.

Class dust nebulae stand out globule — a very compact and very dense dust of the nebula from which stars are formed.

Gaseous nebulae are divided into diffuse, planetary, hydrogen and dust.

Diffuse nebulae are clouds of rarefied gas is very large in size, are immersed in covering their stars, perhaps in common with their origin. These nebulae got their name because of the similarity with glowing spots, spreading (diffusing) through the surrounding black background. A classic example of a diffuse nebula is the Orion nebula.

Planetary nebulae are the result of the explosion of a Supernova (exploding at the end of his career star) and are reset by the explosion of a shell star. This shell glows under the influence of radiation is weak, but very hot Central star. These nebulae look like planetary disks seen in a telescope, that's why it got its name. But some planetary nebulae have irregular shape. For example — the crab nebula resulting from a Supernova explosion in 1054 recorded, incidentally, in the mass number 1.

Hydrogen nebulae composed of pure hydrogen. Hydrogen emits invisible rays, and therefore, do not/in spite of the huge size, these nebulae were discovered only in 1945, A. Shine.

Gas-dust nebula is similar to hydrogen, but include dust, too, and was opened by G. A. Shine.

In one of his speeches albert Einstein said (in 1929): "to be honest, we not only want to know how,.. but also to achieve the purpose of utopian and bold

in appearance — to understand why nature is such a... this is the Promethean element of the scientific work" of the Galaxy became the subject of cosmological research with the 20-ies of our century, when it was reliably established their true nature and proved that it is not a nebula is a cloud of gas and dust near us and a huge star worlds, lying from us at very large distances from us. Of discovery and research in the field of cosmology have elucidated in the past decade, many of the background galaxies and stars, the physical state of the discharged substance from which they were formed in very early times. The basis of all modern cosmology lies one fundamental idea — Dating back to Newton's idea of gravitational instability. The substance cannot remain uniformly dispersed in space because of mutual attraction of all particles of matter strive to create a thickening of certain magnitude and mass. In the early Universe gravitational instability increased initially very weak irregularity in the distribution and motion of matter and in a certain era led to the emergence of strong inhomogeneities: "pancakes" — protoscoleces. The boundaries of these layers seal served as the shock wave at the front which initially nevrastenia, irrotational motion of matter acquired the vorticity. The collapse of the layers on separate thickening also occurred, apparently due to gravitational instability, and this gave rise to protogalactical.

Many of them were rapidly rotating due to the swirling condition of the substance from which they were formed. Fragmentation protogalactic clouds as a result of their gravitational instability led to the emergence of the first stars, and the clouds turned into star systems of the galaxy. Those who had the rapid rotation, have gained because of this two-component structure, they formed a halo, more or less spherical shape, and a disc in which there were spiral arms where still going on the birth of stars. Protogalaxies, where the rotation was slower, or even absent, become elliptical or irregular galaxy.

In parallel with this process was the formation of large-scale structure of the Universe — there were superclusters of galaxies, connecting their edges, formed a sort of honeycomb or cells; they failed to recognize in recent years.

In 20-30-s of XX century, Hubble has developed the basis of the structural classification of galaxies — huge stellar systems, according to which distinguish the three classes of galaxies:

I. Spiral galaxies — characterized by two relatively bright branches arranged in a spiral. The branches come either from the bright nucleus (such galaxies are designated S) , or of all light jumpers, crossing the nucleus (indicated with SB) .

Representative galaxy M82 in the constellation URSA B., has no clear outlines, and consist mainly of hot blue stars and hot gas clouds with them. M82 is from us on distance of 6.5 million light years. Perhaps about a million years ago in the Central part of it was a powerful explosion, in which it acquired the current form.

Spiral galaxy M51 in the constellation Canes venatici is one of the most amazing spiral star systems. The distance to them is about 8 million light years. Thickening at the end of the spiral arms is an independent wrong galaxy. Some bright stars are in our galaxy.

II. Elliptical galaxies (denoted by E) having the shape of ellipsoids.

Representative — the ring nebula in Lyra is at a distance of 2100 light years away and consists of glowing gas surrounding the Central star. This shell was formed when an old star dumped the gas veils, and they rushed into the space. The star shrank and moved to the state of a white dwarf with the mass comparable to our sun, and the size of the Earth.

III. Irregular (irregular) galaxies (denoted I) having irregular shapes.

Representatives of the Large Magellanic Cloud is at a distance 165000 light years and thus is the closest galaxy to us is relatively small. Next to it is a smaller galaxy called the Small Magellanic Cloud. Both are satellites of our galaxy.

According to the degree of clockability branches of the spiral galaxies are divided into subtypes a, b, C. the first of them — the branches are amorphous, the second — a few ragged, the third is very ragged, and the always-dimly and small. In the second half of the 40-ies of XX century U. Baade (USA) found that the ragged spiral of the branches and the blue grow with increasing content of hot blue stars, their clusters and diffuse nebulae.

The Central part of spiral galaxies are yellower than the branches and contains old stars (population of the second type, Baade or the population of the spherical component), while the flat spiral arms consist of young stars (population of the first type or the population of the flat component) .

The density of stars in space increases with the approach to the Equatorial plane of spiral galaxies. This plane is the plane of symmetry of the system, and most of the stars during its rotation around the galactic center remains near it; the period is 10^7 — 10^9 years. The internal parts rotate as a rigid body, and on the periphery of the angular and linear velocity decreases with distance from the center. However, in some cases, inside the nucleus even smaller nucleolus ("core") is spinning the fastest. Similarly, rotating and irregular galaxies, which are also flat space.

Elliptical galaxies are composed of stars of the second type of the population. The rotation is only found in the most compressed of them. Cosmic dust in them, as a rule, no, how are they different from wrong, and especially spiral galaxies, in which dust absorbs light substance available in large quantities.

In spiral galaxies dust absorbs light substance available in large quantities. It ranges from a few thousandths to a hundredth of their total mass. Due to the concentration of dust matter to the Equatorial plane, it forms a dark strip of galaxies, we turned to edge and having the shape of a spindle.

Radio astronomy observations have allowed to detect in galaxies clusters of neutral hydrogen. Weight it is relatively low in spiral galaxies of type Sa, reaches a few percent of Sb, and up to 10% of the mass of stars in galaxies Sc, and in irregular galaxies.

In General, neutral hydrogen is the main gas component of galaxies is located in a narrow Equatorial layer, but the individual clouds are observed far away from him, where there are very hot stars that are able to ionize it and lead to a state of luminescence.

Subsequent observations have shown that the described classification is insufficient to capture all the diversity of forms and properties of galaxies. So, it was discovered galaxy, who is in some sense intermediate between

spiral and elliptical galaxies (denoted by So) . These galaxies have a huge Central concentration and a surrounding flat disk, but no spiral arms. In the 60-ies of XX century was opened to the numerous finger-shaped and disc-shaped galaxy with all the gradations of the abundance of hot stars and dust. In the 30-ies of XX century were discovered dwarf elliptical galaxy in the constellation of the Furnace and the Sculptor with an extremely low surface brightness, so small that these are some of the closest to us galaxies even in the Central part hardly visible against the sky. On the other hand, in the early 60-ies of XX century there were plenty of distant compact galaxies, of which the most distant in appearance indistinguishable from the stars even in the strongest telescopes. From the stars they differ in the range in which we can see bright lines of light with great red shifts corresponding to such large distances, where even the brightest single stars cannot be seen. Unlike ordinary galaxies, which, because of a combination of true distribution of energy in their spectrum and the red shift appear reddish, the most compact galaxies (also called quasizone galaxies) have a bluish color. As a rule, these objects hundreds of times brighter than usual smargiassi galaxies, but there are weaker. Many of the galaxies detected radio emission non-thermal nature of arising, according to the theory of the Russian astronomer I. S. Shklovsky, when braking in a magnetic field, electrons and heavier charged particles moving with velocities close to the speed of light (called synchrotron radiation). Such velocity of a particle is obtained by grandiose explosions inside the galaxies.

Compact distant galaxies with a powerful nonthermal radio emission are called N-galaxies.

Starlike sources of this radiation, called quasars (radio sources quasizone), and galaxies with powerful radio emission and having a visible angular size of the galaxies.

All these objects are extremely distant from us, making them difficult to study.

Radio galaxies with particularly strong non-thermal radio emission, have a predominantly elliptical shape, meet spiral.

Of great interest are the so-called galaxy Seifert. In the spectra of small

kernels, a lot of very broad bright bands, indicating a powerful emission of gas from the center with velocities of up to several thousand km/sec. Some galaxies Seifert discovered very faint non-thermal radio emission. It is possible that optical emission of such nuclei, as in quasars, are caused not by stars, and also has a nonthermal nature. It is possible that a powerful nonthermal radio emission is a temporary stage in the development of irregular galaxies.

Close to us radio galaxies are studied more fully, in particular by means of optical astronomy. Some of them discovered as yet not explained until the end of the features. So, in an elliptical galaxy Centaurus and discovered the extremely powerful dark stripe along its diameter. Another radio galaxy consists of two elliptical galaxies close to each other and connected by a bridge consisting of stars.

In the study of the irregular galaxy M82 in the constellation Ursa Major, the American astronomers A. Sandage and C. Lindley, in 1963, came to the conclusion that, at its centre, about 1.5 million years ago there was a huge explosion, which in all directions at a speed of about 1000 km/h was thrown out of a jet of hot hydrogen. The resistance of the interstellar medium prevented the diffusion of jets of gas in the Equatorial plane, and they began to flow mainly in two opposite directions along the axis of rotation of the galaxy. The explosion apparently created a lot of electrons with velocities close to the speed of light, which was the reason for the nonthermal radio emission.

Long before the discovery of the explosion in M82 for the explanation of many other facts, the Soviet astronomer V. A. Ambartsumian put forward the hypothesis about the possibility of explosions in the nuclei of galaxies. In his opinion, the substance at the center of some galaxies, and it can be divided into parts in the explosions, which are accompanied by strong radio emission.

Thus, radio galaxies are galaxies whose nuclei are in the process of decay. Thrown a dense part, continue to split up, perhaps, form a new galaxy — sisters, or companions of galaxies of smaller mass. In this case the speed of spread of the fragments can reach enormous values. Studies have shown that

many groups and even clusters of galaxies apart: their members are infinitely removed from each other as if they were all created in the explosion.

Also still not explained the reasons for the formation of the so-called interacting galaxies, discovered in 1957-58 by a Soviet astronomer B. A. Vorontsov — by Veliaminov. It pairs or tight groups of galaxies in which one or more members have an obvious distortion in shape, appendages; sometimes they are shipped in General, glowing mist.

There are subtle links connecting a pair of galaxies, and tails directed away from neighbouring galaxies, as if repelled by it. Jumpers are sometimes double that suggests that the distortion of the shapes of interacting galaxies cannot be attributed to tidal phenomena. Often large galaxy one of its branches, sometimes deformed, is connected with the satellite. All these details, like the very galaxies are composed of stars and diffuse matter sometimes.

Often galaxy found in space in pairs and larger groups, sometimes in clusters containing hundreds of galaxies.

Our galaxy with the Magellanic Clouds and other galaxies, the closest are probably also some local cluster of galaxies. The Magellanic clouds and our galaxy is apparently immersed in a common hydrogen cloud. Groups and clusters of various types of member galaxies. Sometimes they contain only spiral and irregular, sometimes only elliptical galaxies, sometimes — and those and others. Closest to us are discharged cloud of galaxies in the Big dipper and wrong clusters in the constellation Virgo. Both contain galaxies of all types. Very rich and compact cluster of galaxies E and So located in the constellation coma Berenices, with thousands of members. The brightness and sizes of galaxies are very diverse.

Galactic supergiants have luminosity of 10 times the luminosity of the Sun, quasars, on average, 100 times brighter; the weakest of the known galaxies — dwarfs is comparable to normal globular clusters in our galaxy. Their luminosity is about 10 in luminosity of the sun.

The sizes of the galaxies are very diverse and range from tens of parsecs to

tens of thousands of parsecs.

The space between the galaxies, especially within clusters of galaxies, apparently sometimes contains cosmic dust. Radio telescopes don't find them significant amounts of neutral hydrogen, but the cosmic rays that pervade it through and through in the same way as the electromagnetic radiation.

There are about 1.5 thousand of bright galaxies (up to the 13th magnitude) . In the "Morphological catalogue of galaxies" (which consists of four volumes) , compiled in the USSR (publication completed in 1968) , contains information about 30 thousand galaxies brighter than 15 magnitude. They cover 3/4 of the entire sky. 5 — meter telescope there are several billion galaxies up to the 21st stellar magnitude. These galaxies are different from the weakest stars only a slight blur.

The galaxy consists of many stars of various types, as well as star clusters and associations, gaseous and dust nebulae and individual atoms and particles scattered in space. Most of them occupies a volume of lenticular shape with a diameter of about 30 and a thickness of about 4 kiloparsec (respectively around 100 thousand and 12 thousand light years) . A smaller part fills a nearly spherical volume with a radius of about 15 kiloparsec (about 50 thousand light years) .

All components of the galaxy are connected in a single dynamic system revolving around a minor axis of symmetry. The earth observer inside the galaxy, it is in the form of the milky Way (hence the name — "Galaxy") and the total number of individual stars visible in the sky.

Stars and interstellar gas and dust matter fill volume of the galaxy is uneven, with most concentrated near the plane perpendicular to the axis of rotation of the galaxy and made her plane of symmetry (the so-called galactic plane). Near the line of intersection of this plane with the celestial sphere (galactic equator) and the visible milky Way, the middle line which represents almost a great circle, as the Solar system is located near this plane. The milky Way is a cluster of a huge number of stars, coalescing into a broad whitish band; however, the stars projected on the sky is near, removed from each other in space at great distances, precluding their collision, despite the fact that they

move at high speeds (tens to hundreds km/sec) in the direction of the poles of the galaxy (its North pole is in the constellation of coma Berenices). The total number of stars in the galaxy is estimated at 100 billion.

Interstellar medium are scattered in space and not evenly, concentrating mainly near the galactic plane in the form of globules, private clouds and nebulae (from 5 to 20 to 30 parsecs in diameter), their complexes or amorphous diffuse formations. A particularly powerful, relatively close to us seem dark nebula to the naked eye in dark glades irregular shapes on the background of the milky Way; the shortage of stars in them is the result of absorption of light by these non-luminous dust clouds. Many interstellar clouds lit close to them stars of great luminosity and presented in the form of bright nebulae, as glow or reflected light (if you are from the space dust) or as a result of excitation of the atoms and subsequent emission energy (if the nebula gas).

Our days rightly called the Golden age of astrophysics is a wonderful and often unexpected discoveries in the world of stars now follow one after the other. The solar system was recently the subject of direct experimental and not just observational studies. Flights interplanetary space stations, orbital laboratories, expeditions to the moon brought a lot of new concrete knowledge of the Earth, near-earth space, the planets, the Sun. We live in an era of startling scientific discoveries and great accomplishments. Wildest fantasies suddenly implemented quickly. Since people wanted to unravel the mysteries of Galaxies, scattered in the boundless expanse of the Universe. We can only marvel at how quickly science advances a different hypothesis and then refutes them. However, astronomy is not in place: new methods of observation, moderniziruyutsya old. With the invention of radio telescopes, for example, astronomers can look into the distance, which in the 40-x. years of the twentieth century seemed to be unavailable. However, a clear understanding of the tremendous value of this course and the enormous challenges still to meet on the way to the stars.

Stars are newborn, young, middle age and old. New stars are constantly formed and old ones die all the time.

The young, which are called stars of T Tauri type (one of the stars in the constellation Taurus), like the Sun, but much younger than him. In fact, they

are still in the process of formation and are examples of protostars (primary stars).

These are variable stars, their luminosity changing, as they have not yet reached the stationary mode existence. Around many stars like the T Tauri, there are rotating disks of matter; and such stars come powerful winds. The energy of matter that falls onto the protostar under the force of gravity is converted to heat. As a result, the temperature inside the protostar is also growing. When the Central part becomes so hot that nuclear fusion begins, the protostar turns into a normal star. As soon as nuclear reactions, the star appears a source of energy, is able to maintain its existence for a very long time. How long — it depends on the size of the stars in the beginning of this process, but the stars as large as our Sun has enough fuel PA stable existence for about 10 billion years.

However, it happens that the stars are much more massive than the Sun, there are only a few million years; the reason is that they compress their nuclear fuel at a far greater rate.

Normal stars

All stars are basically similar to our Sun: it is very huge balls of hot glowing gas, in the depth of which is produced by nuclear energy. But not all stars are exactly like the Sun. The most obvious difference is the color. The stars are reddish or bluish, not yellow.

Furthermore, stars vary in brightness, and luster. How bright a star looks in the sky depends not only on its true luminosity, but also on the distance that separates her from us. Given the distances, brightness of stars varies over a wide range from one ten thousandth the brightness of the Sun to brightness more than E million Suns. The vast majority of stars, as it turned out, is closer to dull the edge of this scale. The sun, which in many ways is a typical star, has a much greater luminosity than most other stars. The naked eye can see a very small amount of the weak nature of stars. In the constellations in the night sky the main focus “signal lights” unusual stars, those that have a very large luminosity.

Why the stars are so very different in its brightness? It turns out that it all depends on the mass of the star.

The quantity of a substance contained in a particular star determines its color and glitter and how the glitter changes with time.

Giants and dwarves

The most massive stars and at the same time the hottest and the brightest. They look white or bluish. Despite its huge size, these stars produce a huge amount of energy, which all their reserves of nuclear fuel burn out in several million years.

In contrast, stars having small mass, always pale, and their color is reddish. They can exist for many billions of years.

However, among the very brightest stars in our sky is red and orange. These include Aldebaran — the bull's eye in the constellation Taurus, and Antares in Scorpio. How can these cool stars with weak emitting surfaces to compete with the incandescent stars like Sirius and VEGA?

The answer is that these stars are very much expanded in size far beyond the normal red stars. For this reason they are called giants or even supergiants.

Due to the huge surface area, the giants emit much more energy than a normal star like our Sun, despite the fact that their surface temperatures are much lower. The diameter of a red supergiant, e.g., Betelgeuse in Orion is several hundred times greater than the diameter of the Sun. On the contrary, the size of a normal red star, as a rule, does not exceed one-tenth the size of the Sun. In contrast to the giants they are called “dwarfs”. Giants and dwarfs are stars at different stages of his life, and the giant can eventually turn into a dwarf, reaching “elderly”.

The life cycle of a star

An ordinary star like the Sun emits energy by converting hydrogen into helium in a nuclear furnace in its core. The sun contains huge amount of

hydrogen, however, its reserves are not infinite. Over the last 5 billion years, the Sun has already spent half of hydrogen fuel and will be able to maintain its existence for another 5 billion years before the inventory of hydrogen in its core runs out. And then what?

After the star runs out of hydrogen contained in its Central part, inside the star is undergoing major changes. Hydrogen begins to burn out not in the center, and the shell which increases in size swells. As a result, the size of the star increases dramatically and its surface temperature drops. It is this process that creates the red giants and super-giants. It is part of the sequence of changes, called stellar evolution, which are all the stars. In the end, all the stars grow old and die, but the duration of each individual star is determined by its mass. Massive stars pass through its life cycle, ending with his spectacular explosion.

Stars of more modest size, including the Sun, on the contrary, at the end of life are compressed, turning into white dwarfs. Then they just fade away.

In the process of transformation from a red giant to a white dwarf star can lose its outer layers as a light shell, exposing the kernel. Gas shell glows brightly under the powerful radiation of a star whose temperature at the surface can reach 100 000°K. When such luminous gas bubbles were first discovered, they were named planetary nebulae, since they often appear as circles of the planetary disk, if you use the little telescope. In fact, they are, of course, nothing to do with planets.

Star clusters

Apparently, almost all stars are born in groups and not individually. There is therefore nothing surprising in the fact that a star cluster is a very common. Astronomers love to study star clusters, because they know that all the stars included in the cluster formed at approximately the same time and approximately the same distance from us. Any noticeable differences in gloss between those stars are the true differences. What tremendous changes have not undergone these stars over time, they started all at the same time. It is particularly useful to study star clusters from the point of view of dependence of their properties from the masses — because the age of these stars and their

distances from earth are about the same, so they differ from each other only by their mass.

Star clusters are interesting not only for scientific study — they are exceptionally beautiful as objects, and for observation by Amateur astronomers. There are two types of star clusters: open and globular. These names are associated with their appearance. In an open cluster of each star separately visible, they are distributed in a certain area of the sky more or less evenly. And globular clusters, on the contrary, is like a sphere, so densely filled with stars at the centre of the individual stars are indistinguishable.

Open star clusters

Probably the most famous open star cluster is the Pleiades, or Seven sisters in the constellation Taurus. Despite the name, most people can see with the naked eye, only six stars. The total number of stars in this cluster is somewhere between 300 and 500, and they are all on a plot size of 30 light-years across and a distance of 400 light years from us.

The age of this cluster is only 50 million years, which by astronomical standards quite a bit, and it contains a very massive luminous star, which had not yet become giants. The Pleiades is a typical open star cluster, usually in this cluster ranges from several hundred to several thousand stars.

Among open star clusters are much more young than old, and the oldest hardly number more than 100 million years. It is believed that the rate at which they are formed, does not change over time.

The fact that in older clusters of stars are moving away from each other, yet do not interfere with the main set of stars — those thousands which come before us in the night sky. Although the attraction to a certain extent holds open clusters together, they are still quite fragile, and the gravity of another object, such as a large interstellar clouds can break.

Some star groups are so loosely held together that they are not called clusters, and stellar associations. They are not very long and usually consist of very young stars close to the interstellar clouds from which they arose. The star

Association is 10 to 100 stars scattered in the region of few hundred light years.

The clouds where stars are formed, concentrated in the disk of our Galaxy, and there find open star clusters. When you consider how many clouds are contained in the milky Way and what a huge amount of dust is in interstellar space, it will become apparent that those 1200 open star clusters that we know of, should be only a small part of their total number in the Galaxy. Perhaps their total number reaches 100,000.

A globular cluster

In contrast open and globular clusters represent a sphere tightly filled with stars, of which there are hundreds of thousands and even millions. The stars in these clusters are located so densely that if our Sun belonged to some kind of ball cluster, we could see in the night sky with the naked eye, more than a million individual stars. The typical size of globular clusters from 20 to 400 light years.

In the densely populated centres of these clusters of stars are so close one another that their mutual gravity binds them to each other, forming a compact binary star system.

Sometimes there is even a full merger of the stars; at the close convergence of the outer layers of the star can collapse, exposing live to see the Central core. In globular clusters double stars occur 100 times more often than anywhere else. Some of these twins are x-ray sources.

Around our Galaxy do we know about 200 globular star clusters that are distributed around a huge spherical halo encompassing the Galaxy. All these clusters are very old, and they appeared more or less at the same time as the Galaxy itself: from 10 to 15 billion years ago. It seems that the clusters formed when parts of the clouds, from which was created the Galaxy, divided into smaller fragments. Globular clusters do not diverge, because the stars in them are sitting very closely, and their powerful mutual gravitational forces bind the cluster in a tight single unit.

Globular clusters are observed not only around our Galaxy and around other galaxies in any class. The brightest globular cluster, easily visible to the naked eye, it is the omega of Centaur in the southern constellation Centaurus. It is located at a distance of 16 500 light years from the Sun and is the most extensive of all known clusters: it has a diameter of 620 light years. The most striking ball cluster in the Northern hemisphere is M13 in Hercules, it is difficult, but still possible to distinguish with the naked eye.

In 1596 a Dutch observer of the stars, a lover, named David Fabricius (1564-1617), discovered a rather bright star in the constellation Cetus; this star gradually began to fade and after a few weeks disappeared altogether from sight. Fabricius was the first who described the observation of variable stars.

This star was named the World — wonderful. Over a period of time in the 332 day of the World alters its luster around 2-th magnitude (at the level of the Polar star) up to 10-th magnitude, when it becomes much weaker than that needed for the unaided eye. In our days there are many thousands of variable stars, although most of them changes its luster is not as dramatic as in the World.

There are different reasons why the stars change their Shine. And glitter is sometimes changed to many light values, and sometimes so slightly that the change can be detected only with very sensitive instruments. Some stars change regularly. Others suddenly extinguished or suddenly erupt. Changes can occur cyclically, with a period of several years, and can happen in seconds. To understand why a particular star is variable, it is necessary first to track exactly how it is changing. Graph of the changes in magnitude of variable star is called a light curve. To draw a curve, the measurement of brightness should be carried out regularly. For the accurate measurement of magnitude, professional astronomers use an instrument called a photometer, numerous observations of variable stars made by Amateur astronomers. With the help of specially prepared cards, and after some practice not too difficult to judge the magnitude of the variable star stars directly into the eyes, when compared with constant stars located nearby.

Graphics Shine of variable stars shows that some stars change regular (correct) way plot their graph in the time interval of a certain length (period)

is repeated again and again. Other stars are changing totally unpredictable. To the correct variable stars include pulsating stars and double stars. The amount of light is changing because the stars pulsate or emit clouds of matter. But there is another group of variable stars that are double (binary). When we see a change in the light of binary stars, this means that one of several possible phenomena. Both stars may be on the line of our vision, because, moving in their respective orbits, they can flow directly one to the other. Such systems are called setmana double stars. The most famous example of this kind — the star ALGOL in the constellation Perseus. In a closely located pair of the material can run from one star to another, often causing dramatic consequences.

Pulsating variable stars

Some of the most regular variable stars pulsate, Contracting and growing again — how would vibrate at a certain frequency, something like this happens with the string of a musical instrument. The most famous type stars like the Cepheids, named for the star Delta cephei, which is a typical example. The stars were supergiants, their mass exceeds the mass of the Sun in 3-10 times, and the luminosity of their hundreds or even thousands of times higher than that of the Sun. The period of pulsation of Cepheids is measured in days. In the process of pulsation of Cepheids as a square, and its surface temperature changes, which causes a General change in its luster.

The world of the first described variable stars, and other kindred stars owe their variability to pulsations. This cool red giants in the last stage of their existence, they will fully loose, as the shell, its outer layers and will create a planetary nebula. Most of the red supergiants, like Betelgeuse in Orion vary only within certain limits.

Using special observation techniques, astronomers discovered on the surface of Betelgeuse large dark spots.

Star RR Lyrae represent another important group of pulsating stars. It's an old star about the same mass as the Sun. Many of them are located in globular star clusters. As a rule, they change their glitter one magnitude in about a day. Their properties as properties of the Cepheids, used to calculate astronomical

distances.

Wrong variable stars R the Northern Crown and stars like her who behave in unpredictable ways. Usually this star can be seen with the naked eye. Every few years the lustre drops to about the eighth magnitude, and then gradually increases, returning to the previous level. Apparently, the reason is that this star is a supergiant throws off clouds of carbon condenseries in grains, forming a kind of soot. If one of these thick black cloud passes between us and the star, it blots out the star light, until the cloud dissipates in space.

Stars of this type make a thick dust, which is crucial in areas where stars are formed.

Flare stars

Magnetic phenomena on the Sun cause sunspots and solar flares, but they cannot significantly affect the brightness of the Sun. For some stars — red dwarfs — this is not so: they are such outbreaks reach enormous proportions, and the resulting light emission may be increased by a whole magnitude or more. Nearest to the Sun star, Proxima of the Centaur, is one of these flare stars. These light emissions can not be predicted in advance, and they continue for only a few minutes.

Double star

About half of all stars in our Galaxy belong to double systems, so that double stars revolving in orbits around one another, a very common phenomenon.

Belonging to a binary system greatly affects the whole life of the stars, especially when partners are close to each other. Flows of matter, rushing from one star to another, leading to dramatic outbursts, such as the explosions of novae and supernovae explosions.

Double stars held together by mutual gravity. Both stars of the binary system revolve in elliptical orbits around a point between them called the center of gravity of these stars. It can be thought of as the fulcrum, if you imagine the stars sitting on a seesaw: one end of the Board, put on a log. The farther the

stars are from each other, the longer it lasts their way at any cost. Most binary stars (or simply — double) is too close to each other, so that they can be discerned individually even the most powerful telescopes. If the distance between the partners is sufficiently large, the orbital period can be measured in years, sometimes a century or more. Double stars that can be seen separately, are referred to as visible double.

The discovery of double stars

Often double stars are determined either by unusual movement of the brighter of the two, either at their joint spectrum. If any star in the sky makes regular fluctuations, this means that she has an invisible partner. Then say that it is an astrometric double star, detected by measurements of its position.

Spectroscopic double star detect change and the special characteristics of their spectra. Spectrum of an ordinary star, like the Sun, like a continuous rainbow, crossed the so-called absorption lines. Accurate color, which are these lines change if the star is moving towards us or away from us. This phenomenon is called Doppler effect. When the stars of the binary system move in their orbits, they alternately approach us, it is deleted. In the result, the line spectrums are moved to a plot of the rainbow. Such moving lines of the spectrum suggests that the star is double. If both parties the dual system have approximately the same sheen in the spectrum you can see two sets of lines. If one of the stars is much brighter than the other, its light will dominate, but regular displacement of the spectral lines will still be given its true dual nature.

Measurement of velocities of stars of the binary system and application of law of gravity represent an important method of determining the masses of stars. The study of binary stars is the only direct way of calculating stellar masses. However, in each case not so easy to get an accurate answer.

Neutron stars

If the mass of the collapsing star exceeds the mass of the Sun is more than 1.4 times, such star, reaching the stage of a white dwarf, the atom will not stop. The gravitational force in this case so great that the electrons into the atomic nuclei inside. As a result, the protons turn into neutrons, are able to adhere to each other without any gaps. The density of neutron stars is even greater than

the density of white dwarfs; but if the mass of the material does not exceed 3 solar masses, neutrons, and electrons, are able to prevent further compression. A typical neutron star has a diameter only about 10 to 15 km, and one cubic centimetre of its matter weighs about a billion tons. In addition to the unheard of huge density, neutron stars have two special properties that allow them to detect, despite the small sizes: it's rapid rotation and strong magnetic field. In General, revolve all the stars but when a star shrinks, the speed of its rotation increases, just as the skater on the ice spinning much faster when holding a hand. Neutron star makes several revolutions per second. Along with this extremely fast rotation of the neutron star have a magnetic field millions of times stronger than Earth.

Pulsars

The first pulsars were discovered in 1968 when radio astronomers discovered the regular signals coming to us from the four points of the Galaxy. Scientists were struck by the fact that some natural objects can radiate radio pulses in a right and fast rhythm. Initially (albeit briefly) astronomers even suspected the involvement of some intelligent beings living in the depths of the Galaxy. But it was soon found a natural explanation. In a strong magnetic field of the neutron star moving in a spiral the electrons generate radio waves that are radiated by a narrow beam, like a ray of light. The star spins and the radio beam crosses the line of our observations, like a lighthouse. Some pulsars emit not only radio waves but also light, x-rays and gamma rays. The period of the slowest pulsars for about four seconds, and the fastest — thousandths of a second. The rotation of these neutron stars was for some reason even more accelerated; they may enter the dual system.

X-ray binary stars

The Galaxy was found, at least 100 powerful x-ray sources. X-rays have such high energy that the origin of their source's got to be something out of the ordinary. According to astronomers, the reason x-ray could provide matter falling onto the surface of a small neutron star.

Possible x-ray sources are double stars, one of which is very small but massive; it could be a neutron star, white dwarf or black hole. The companion

star can either be a massive star, whose mass exceeds the sun 10-20 times, or to have a mass greater than the mass of the Sun not more than half.

Intermediate options seem highly unlikely. For such situations results in a complicated history of evolution and exchange of masses in binary systems, the Final result depends on the initial mass and the initial distance between the stars.

In binary systems with small mass around the neutron star is formed in a gas disk. In the case of systems with high mass material moves directly onto the neutron star is its magnetic field sucks it up like a funnel. Such systems are often x-ray pulsars.

Black holes

In one of the x-ray binary systems, called A0620-00, managed to accurately measure the mass of the compact star (for this purpose we used data of different types of observations) . It was equal to 16 solar masses, far exceeding the capabilities of neutron stars. Besides black holes with masses typical of stars, almost certainly there are supermassive black holes located in the centers of galaxies. Only the fall of matter into a black hole can be a source of tremendous energy emanating from the nuclei of active galaxies.

Supernova

Their weight does not reach 1.4 solar, die quietly and peacefully. And what happens to more massive stars? As there are neutron stars and black holes? The catastrophic explosion that ends the life of a massive star is a truly impressive event. This is the most powerful of natural phenomena occurring in stars. In a flash released more energy than it radiates our Sun for 10 billion years. Luminous flux sent from one dying star, the equivalent of an entire galaxy, but visible light is only a small fraction of the total energy. The remains of exploded stars fly away with velocities of 20 000 km per second.

Such enormous stellar explosions called supernovae. A supernova is a rare phenomenon. Every year and other galaxies find 20 to 30 supernovae, mainly as a result of systematic search. Per century in each galaxy there may be from one to four. However, in our own Galaxy, not the supernova observed since

1604, Maybe they were, but remained invisible due to the large amounts of dust in the milky Way. Radio astronomers have discovered a ring of gas left from a supernova in the constellation Cassiopeia, and calculated the date of the explosion — 1658 At that time no one had registered an unusually bright star, though a rather modest star, which subsequently have not already seen, was marked in the same place on the star map 1680

The origin of the elements

Our ordinary world — the rocky Earth with her oceans, atmosphere, plant and animal life consists of about 100 different chemical elements. In the Universe some are much more common than the other. Combined together, elements form countless different substances. But where did the elements themselves, these are the basic building blocks of the universe? Today astronomers are able to give a full picture of how it was formed and how distributed across the various elements of the Universe. The simplest of all elements — hydrogen. The nucleus of the atom of hydrogen consists of one proton and the addition of one electron completes construction of an atom. Nuclei of other elements contain different numbers of protons and neutrons, which are part of all elements except hydrogen. In the course of nuclear reactions of the individual kernels can be merged with elementary particles like neutrons to form new elements. For the occurrence of nuclear reactions need very high temperature. Such temperatures existed in the early stages of development of the Universe, and now they occur inside stars, in supernova explosions, as well as infall of matter in very dense stars like white dwarfs. All the hydrogen in the Universe, and a significant part of helium, was born in the first few minutes after the beginning of the world. The first formed stars consisted almost entirely of hydrogen and helium. But we have already seen how the stars get their energy by nuclear fusion of hydrogen, producing helium, and then helium fusion with heavier elements, when it turns out everything else, including carbon, oxygen, silicon, iron and so on. When the star drops a shell like a supernova, much of the material brought into the space. The thermal energy of the explosion contributes to the creation of a number of elements. Once there was quite a lot of supernova explosions, the interstellar medium already contains a significant amount of substances produced in stars along with hydrogen and helium that was there from the beginning. Stars that dispense with the explosion, also contribute when they

are gradually freed from their outer layers, causing the appearance of stellar winds or planetary nebulae.

When February 24, 1987, was opened 5M 1987A, astronomers were very excited because it was the brightest supernova since 1604, Though this time not a supernova erupted in our Galaxy and in the nearby Large Magellanic cloud, its magnitude at the maximum gloss reached 2.9 that made it easy to observe a supernova in the southern hemisphere with the naked eye.

For the first time development of supernovae become available surveillance with the help of modern equipment. It is a blue supergiant with a mass of approximately 17 solar; according to calculations, his age was about 20 million years. WAI 1987A In fact the explosion occurred about a day before its discovery. This was established by 60lee early photographs, and researchers studying the flow of cosmic neutrinos on 23 February, registered an unexpectedly large number of them. Neutrinos are elementary particles, hardly have weight. They are very difficult to register, But this work is extremely important, as neutrinos carry away a large amount of energy in a number of nuclear reactions. The detection of neutrinos showed that our theory of the origin of the supernova mostly true. However, on the site of the supernova failed to detect the pulsar or a neutron star.

The crab nebula

One of the most famous supernova remnants, the crab nebula, which owes its name to William Parsons, the third Earl of Rosse, who first observed it in 1844 Its impressive name is not exactly this strange object. Now we know that this nebula is a supernova remnant that was observed and described in 1054 Chinese astronomers. Her age was installed in 1928 Edwin Hubble, who have measured the speed of its expansion and to call attention to the coincidence of its position in the sky from ancient Chinese records. It is oval in shape with jagged edges; reddish and greenish filaments of glowing gas visible on the background of dull white spots. Filaments of glowing gas are reminiscent of chain thrown over the hole. White light comes from the electrons rushing through the spirals in a strong magnetic field is over. Nebula is also an intense source of radio waves and x-rays. When astronomers realized that the pulsar is a neutron supernova, it became clear that the search for pulsars it is necessary in such balances, the type of the crab

nebula. In 1969 было discovered that one of the stars near the center of the nebula emits radio pulses periodically, as well as light and x-ray signals every 33 thousandths of a second. This is a very high frequency even for a pulsar, but it gradually decreases. Those pulsars that spin much slower, much older than the pulsar of the crab nebula.

The name supernova

Although modern astronomers witnessed a supernova in our Galaxy, they were able to observe at least the second interest event — a supernova in 1987 in the Large Magellanic cloud, the nearest galaxy visible in the southern hemisphere. The supernova was given the name S 1987A. Supernovae are named by the year of discovery followed by a capital letter in alphabetical order according to the sequence findings, BH is an abbreviation for supernova. (If more than 26, followed by the symbols AA, BB, etc.)

Earth is the third planet from the Sun in the Solar system. It revolves around a star in an elliptical orbit (very close to circular) with an average speed of 29.765 km/s at an average distance of 149.6 million km for a period equal to 365.24 days. The earth has a satellite — the moon orbiting around the Sun at an average distance of 384400 km and the Inclination of the terrestrial axis to the plane of the Ecliptic is $66^{\circ}33'22''$. The period of rotation of planet around its own axis 23 HR 56 min 4.1 sec. Rotation on its axis causes alternation of day and night, and the inclination of the axis and around the Sun — the change of seasons.

The shape of the Earth — geoid, approximately — triaxial ellipsoid, spheroid. The average radius of the Earth is 6371.032 km, Equatorial — 6378.16 km, polar — 6356.777 km Area of the earth's surface 510 million km² and the volume is $1.083 \cdot 10^{12}$ km³, the average density of 5518 kg/m³. The mass of the Earth is $5.976 \cdot 10^{21}$ kg. the Earth has magnetic and closely related electrical fields. Earth's gravitational field causes its spherical shape and the existence of an atmosphere.

According to modern cosmological ideas, the Earth was formed about 4.7 billion years ago from the scattered in the protosolar gas substances. As a result of differentiation of matter, the Earth, under the action of its gravitational field, in terms of the warming of the earth's interior originated

and developed different chemical composition, state of aggregation and physical properties of the shell — Geosphere: the core (center), mantle, crust, hydrosphere, atmosphere, magnetosphere. In the Earth is dominated by iron (34.6%), oxygen (29.5%), silicon (15.2%), magnesium (12.7%). The crust, the mantle and the inner core is solid chat (the outer part of the core is considered a liquid). From the Earth to the center of the increasing the pressure, density and temperature. The pressure in the center of the planet $3.6 \cdot 10^{11}$ PA, density of about $12.5 \cdot 10^3$ kg/m³, the temperature ranges from 50000 to 60000 C. Main types of crust — continental and oceanic, in the transition zone from continent to ocean crust developed intermediate structure.

Most of the Land is occupied by the World ocean (361.1 million km²; 70.8%), drying is 149.1 million km² (29.2%), and forms six continents and Islands. It rises above the level of the world ocean average of 875 m (the highest altitude of 8848 m mount Everest), mountains occupy more than 1/3 of the land surface. Deserts cover about 20% of the land surface, forest — about 30%, glaciers — more than 10%. The average depth of the oceans is about 3800 m (maximum depth 11020 m — Marianas trench (trench) in the Pacific ocean). The volume of water on the planet is 1370 million km³ average salinity of 35 g/L.

The Earth's atmosphere, the total mass of which $5.15 \cdot 10^{15}$ t, consists of air — a mixture of mostly nitrogen (78.08%) and oxygen (20.95%), the rest is water vapor, carbon dioxide, and inert and other gases. The maximum surface temperature of 570-580 With sushi (in the tropical deserts of Africa and North America), a minimum of about -900 C (in the Central regions of Antarctica).

The formation of the Earth and the initial stage of its development are geologicheskoy stories. The absolute age of most ancient rocks of over 3.5 billion years. The geological history of Earth is divided into two unequal stages: Precambrian, which occupies approximately 5/6 of the entire geological era (about 3 billion years), and the Phanerozoic EON covering the last 570 million years. About 3-3.5 billion years ago as a result of natural evolution of matter on Earth arose life, began development of the biosphere. The sum of all living living organisms, the so-called living matter of the

Earth, had a significant influence on the development of atmosphere, hydrosphere and sedimentary shell. A new factor that has a powerful influence on the biosphere — production activity of a man who appeared on Earth at least 3 million years ago.

The high growth rate of the population (275 million persons in the year 1000, 1.6 billion people in 1900 to approximately 6.3 billion people in 1995) and the influence of human society on the natural environment put forward the problems of the rational use of all natural resources and nature conservation.

Astronomy in ancient times

It's hard to say exactly when it originated astronomy: we had but little information specific to prehistoric times. In that distant epoch, when humans were completely powerless in front of nature, arose the belief in powerful forces that supposedly created the world and control it, for many centuries, deified the moon, the Sun, the planets. This we learn from the myths of all peoples of the world.

The first ideas about the universe were very naive, they are closely intertwined with religious beliefs, were all based on the division of the world into two parts — the earthly and the heavenly. If now every schoolboy knows that the Earth itself is a celestial body, the earlier “earth” was opposed to “heaven.” Thought there is a “firmament”, which is attached to the stars, and the Land taken for the immovable centre of the universe.

The geocentric system of the world

Hipparchus, the Alexandrian scholar, who lived in the 2nd century BC, and other astronomers of his time paid much attention to observations of the motion of the planets.

These movements seemed to them extremely confusing. In fact, the direction of motion of the planets how would describe the sky loop. This apparent difficulty in the movement of the planets caused by the motion of the Earth around the Sun — because we observe the planets from Earth, which itself moves. And when the Earth “catches up” another planet, it seems that the

planet as it stops and then moves back. But the ancient astronomers thought that the planets do make such complex movements around the Earth.

In the 2nd century ad the Alexandrian astronomer Ptolemy put forward his “system of the world”. He tried to explain the Universe, given the apparent complexity of the motions of the planets.

Considering the Earth is spherical, and the size of it is negligible compared to the distance to the planets and especially the stars. Ptolemy, however, followed Aristotle argued that the Earth was the stationary center of the Universe. Because Ptolemy thought the Earth was the center of the Universe, his system of the world was called geocentric.

Around the earth in Ptolemy are moving (in order of distance from Earth), Moon, mercury, Venus, Sun, Mars, Jupiter, Saturn, stars. But if the motion of the moon, Sun, stars, circular, the motion of the planets much more difficult. Each of the planets, according to Ptolemy, does not move around the Earth, but around a fixed point. The point of this, in turn, moves in a circle centered on the Earth. The circle described by a planet around a moving point that Ptolemy called the epicycle, a circle on which the point moves about the Earth — deferent.

It is hard to imagine that in nature were such intricate movements, and even about imaginary points. Such artificial construction needed to Ptolemy in order, based on the false notion of the immobility of the Earth, located in the center of the Universe, to explain the apparent complexity of the motions of the planets.

Ptolemy was a brilliant for his time, a mathematician. But he shared the opinion of Aristotle, who believed that the Earth is stationary and only she can be the center of the Universe.

The system of the world Aristotle-Ptolemy seemed plausible to contemporaries. It gave the opportunity to pre-calculate the movement of the planets for the future — it was necessary for orientation in the way during travel and for the calendar. This false system had recognized almost fifteen hundred years.

Also, this system recognized the Christian religion. The basis of his understanding of the world Christianity put the biblical legend of the creation of the world by God in six days. According to this legend, the Earth is “the focus” of the Universe, and the heavenly bodies were created in order to illuminate the Ground and decorate the vault of heaven. Any deviation from these views of Christianity mercilessly persecuted. The system of the world of Aristotle, Ptolemy, placing the Earth in the centre of the universe, how it will respond to the Christian faith.

Table created by Ptolemy, allowed to determine in advance the position of the planets in the sky. But over time astronomers discovered a discrepancy in the observed positions of the planets with prednisolene. For centuries, the thought system of the world Ptolemy's simply not perfect and trying to improve it, was introduced for each planet new combinations of circular motions.

The heliocentric system of the world

His system of the world the great Polish astronomer Nicolaus Copernicus (1473-1543) outlined in the book “About rotation of heavenly spheres” , published in the year of his death. In this book he proved that the universe is arranged not as many centuries claimed religion.

In all countries, almost half a Millennium possessed the minds of the people about the teachings of Ptolemy, who claimed that the Earth rests motionless in the center of the Universe. The followers of Ptolemy in favor of the Church came up with new “explanations” and “evidence” of planetary motion around the Earth, to preserve the “truth” and “Holiness” of his false teachings. But this system of Ptolemy was becoming increasingly contrived and artificial.

Long before Ptolemy a Greek scientist, Aristarchus argued that the Earth moves around the Sun. Later, in the middle of the century, leading scientists were divided the views of Aristarchus on the structure of the world and rejected the false teachings of Ptolemy. Shortly before Copernicus, the great Italian scientists Nicholas of Cusa and Leonardo da Vinci claimed that the Earth moves, that it is not in the center of the Universe and does not take it in exceptional situation.

Why, in spite of this, the Ptolemaic system continued to dominate?

Because it relied on the all-powerful Church authorities who suppressed free thought, hindered the development of science. In addition, scientists who rejected the doctrine of Ptolemy and Express the correct Outlook on the Universe could not yet convincingly justify them.

It was done only by Copernicus. After thirty years of hard work, much reflection, and complex mathematical calculations he showed that the Earth is only one planet and all planets revolve around the Sun.

With his book he challenged Church authority, exposing their ignorance in matters of the Universe.

Copernicus did not live to see the time when his book has spread around the world, revealing people the truth about the Universe. He was dead when friends brought and put into his cold, dead hands the first copy of the book.

Copernicus was born in 1473 in the Polish town of Torun. He lived in difficult times when Poland and her neighbor — Russian state — continued age-old struggle with the invaders, the Teutonic knights and the Tartars who sought to enslave the Slavic peoples.

Copernicus lost his parents early. He was raised by his maternal uncle Lucas, Watzenrode — an outstanding public and political figure of the time. Thirst for knowledge possessed by Copernicus from childhood, he First studied at home. Then continued education in Italian universities, of Course, there were studied astronomy by Ptolemy, but Copernicus studied carefully and all the surviving works of the great mathematicians and astronomy of antiquity. He was already having second thoughts about the rightness of the conjecture of Aristarchus, on the falsity of the system of Ptolemy. But not one engaged in astronomy Copernicus. He studied philosophy, law, medicine, and returned home well educated, for his time, man.

On his return from Italy, Copernicus settled in Warmia — first in the city Lisburne, then in Frombork, his work was extraordinarily varied. He took an active part in the management of the area: was in charge of her financial,

economic and other Affairs. At the same time, Copernicus tirelessly pondered over the true structure of the solar system and came gradually to his great discovery.

What comprises the book of Copernicus “On the revolutions of heavenly spheres” and why it struck such a devastating blow to the Ptolemaic system, which, with all defects held fourteen centuries under the patronage of the Almighty in the era of Church power? In this book, Copernicus argued that the Earth and other planets — satellites of the sun. He showed that the motion of the Earth around the sun and its daily rotation on its axis explains the apparent motion of the Sun, a strange confusion in the movement of the planets and the apparent rotation of the firmament.

Ingeniously simple Copernicus explained that we perceive the motion of distant celestial bodies in the same way as the movement of various objects on Earth, when they themselves are in motion.

We glide in a boat on a quietly flowing river, and it seems to us that the boat we were stationary, and the shores of the “float” in the opposite direction. Similarly, it seems to us that the Sun moves around the Earth. And in fact, the Earth with all that therein is, moves around the Sun, and during the year makes a complete revolution in its orbit.

Similarly, when the Earth in its motion around the Sun, overtakes another planet, it seems to us that the planet is moving backward, describing a loop in the sky. In reality, the planets move around the Sun in orbits correct, although not perfectly circular in shape, without making any loops. Copernicus, like ancient Greek scientists that the orbits in which the planets move, can only be circular.

After three quarters of a century German astronomer Johannes Kepler, a follower of Copernicus, proved that the orbits of all the planets represent a long the circumference of the ellipse.

Stars Copernicus believed fixed. Supporters of Ptolemy insisted on the immobility of the Earth, argued that if the Earth was moving in space, then the observation of the sky at different times we would have to think that the

stars shifted, changing their position in the sky. But such shifts of the stars for many centuries no one noticed the astronomer. In this supporters of the doctrine of Ptolemy wanted to see proof of the immobility of the Earth.

However, Copernicus argued that the stars are unimaginably huge distances. Therefore, negligible bias they could not be seen. Indeed, the distance from us to even the nearest stars was so great that even after three centuries after Copernicus, they succumbed to precise definition. Only in 1837 Russian astronomer Vasily Yakovlevich Struve marked the beginning of accurate determination of distances to stars.

Clearly, a tremendous impression was to produce the book in which Copernicus explained the world, regardless of religion and even rejecting all authority of the Church in matters of science. The leaders of the Church did not realize what a blow to religion causes scientific work of Copernicus, in which he relegated the Earth to the position of one of the planets. Some time the book was freely distributed among scientists. It was not many years, and the revolutionary significance of the great books were fully apparent. Popped other leading scientists — successor of Copernicus. They developed and spread the idea of the infinity of the Universe in which the Earth is like a grain of sand, and the worlds are countless. Since that time, the Church began a fierce persecution of followers of the teachings of Copernicus.

The new teaching about the solar system — heliocentric — it was contended in fierce struggle with religion. The doctrine of Copernicus undermined the very foundations of the religious world and opened a path to a materialistic, truly scientific knowledge of the phenomena of nature.

In the second half of the 16th century the doctrine of Copernicus found his supporters among the foremost scientists of different countries. Advanced and such scientists, who not only advocated the doctrine of Copernicus, but deepened and expanded it.

Copernicus believed that the universe is limited by the sphere of fixed stars, which are located on the unimaginably huge, but still finite distances from us and from the Sun. In the doctrine of Copernicus was alleged hugeness of the Universe and the infinity of it. Copernicus is also the first time in astronomy,

not only gave a correct diagram of the structure of the Solar system, but also determined the relative distances of the planets from the sun and calculated the period of their circulation around it.

The establishment of the heliocentric mirovozzrenie

The doctrine of Copernicus was recognized immediately. We know that the judgment of the Inquisition in 1600, was burned in Rome was an Italian philosopher, a follower of Copernicus, Giordano Bruno (1548-1600) . Bruno, developing the doctrine of Copernicus argued that the Universe is not and cannot be the centre that the Sun is only the center of the Solar system. He has also made an ingenious conjecture that the stars are suns like ours, and around the countless stars, moving planets, many of which there is intelligent life. Neither torture nor the stake did not break the will of Giordano Bruno, forced him to renounce the new doctrine.

In 1609 Galileo Galilei (1564-1642) was first sent to the sky a telescope and made discoveries that clearly indicate the discoveries of Copernicus. On the moon, he saw mountains. Then, the surface of the moon to some extent similar to earth and there is no fundamental distinction between “earthly” and “heavenly”. Galileo discovered four moons of Jupiter. Their motion around Jupiter disproved the misconception that only the Earth can be the center of celestial bodies. Galileo discovered that Venus, like the moon changes its phase. Therefore, Venus is a spherical body, which shines with reflected sunlight. Studying the features of change of form of a Venus, Galileo made the right conclusion that it is not moving around the Earth and around the Sun. The Sun, symbolizing the “celestial purity” , Galileo discovered spots and watching them, and found that the Sun rotates around its axis. So, various celestial bodies, such as the Sun, the inherent axial rotation. Finally, he found that the milky way is the many faint stars, not discernible to the naked eye. Therefore, the universe is much bigger than previously thought, and it is extremely naive to assume that it is for the day makes a complete revolution around little Earth.

The discovery of Galileo has increased the number of supporters of the heliocentric system of the world and at the same time forced the Church to strengthen the prosecution of copernicana. In 1616 Copernicus ' book “On the rotations of the celestial spheres” was included in the list of prohibited books

as set forth therein contrary to the Holy Scripture. Galileo was forbidden to propagate the teachings of Copernicus. However, in 1632, he still managed to publish a book “Dialogue concerning the two chief world systems — Ptolemy and Copernicus”, in which he was able to show convincingly the truth of the heliocentric system, and this has incurred the wrath of the Catholic Church. In 1633 Galileo appeared before the court of the Inquisition. The aged scientist was forced to sign the “renunciation” of his views and the rest of your life, kept under the supervision of the Inquisition. Only in 1992 the Catholic Church finally exonerated Galileo.

The execution of Bruno, the official ban of the teachings of Copernicus, the trial of Galileo was unable to stop the spread of sopernichestva. In Austria, Johannes Kepler (1571-1630) developed the doctrine of Copernicus, opening the laws of planetary motion. In England Isaac Newton (1643-1727) published his famous law of universal gravitation. In Russia the doctrine of Copernicus boldly supported by M. V. Lomonosov (1711-1765) , who discovered the atmosphere of Venus, defended the idea of multiple inhabited worlds.

The most distant planet in the Solar system, Pluto is the least studied of all the planets. It was opened in March 1930, American astronomer K. tombo. Later it was found on earlier photographs of the sky, since 1914.

The remarkable story of the discoveries of Neptune and Pluto in fact begins with the discovery of Uranus, because without observations of Uranus, two more recent discoveries could linger for many years. However, the discovery of Uranus marks the beginning of a new era in the history of astronomy, as Uranus was the first planet that was “discovered”. After all, mercury, Venus, Mars, Jupiter and Saturn has always been visible to the naked eye any man that looked at the sky (if only the eyes of our prehistoric ancestors was not much nezavershennoe our eyes).

Pluto looks like a star of about 15th magnitude. It is easy to calculate that almost the same Shine would be Mars, if it is attributed to the distance of Pluto. This means that Pluto is approximately the same size as Mars. A more accurate assessment of the diameter of the planet was made in 1950, George. The MoE, who have measured using a 5-meter telescope is its angular diameter and found it equal to 0,23. This value corresponds to the diameter of

the planet 5900 km.

In the night from 28 to 29 April 1965 Pluto was to pass near the star of the 15th magnitude, and so close that he could close it, if its diameter was equal to that defined by the MoE. Twelve observatories watched the glitter star, but he is not weakened even for a second. This meant that the diameter of Pluto is not greater than 5,500 km.

It was even more difficult to determine the mass of Pluto. Until 1978 the satellites it was not known that comets near it did not pass. It remained to study the weak disturbances generated by Pluto in motion are closest to the planets of Neptune and Uranus.

When looking at the plan of the Solar system may give the impression that the orbits of Neptune and Pluto intersect. This impression is erroneous, because the orbit of Pluto is tilted at an angle of 17° to the Ecliptic plane and the orbit of Neptune, and the line of nodes (intersection of orbit planes) are arranged so that just in the area apparent “points of intersection” Pluto is on 10. E. North of the Ecliptic. Moreover, due to the commensurability of the periods of revolution of Neptune and Pluto (three periods of Neptune are nearly equal to two periods of Pluto) the distance between the two planets can never be less than 18. E. Now Pluto approaches its perihelion, and it is closer to the Sun than Neptune.

Closer to Pluto, it is not strange, can approach the Uranium — the distance between them can sometimes be reduced to 14. E. But still the distance is too great. American astronomers R. Duncomb, P. Seidelmann, E. Jackson and the Polish astronomer V. Klepczynski did a great job of processing 5426 observation of the provisions of Neptune in 1846 — 1868 years, taking into account the perturbations from all the other planets and got the best agreement of the theory with observations if the mass of Pluto is 0.11 of earth. It is, as we know, the mass of Mars, but Pluto is less than Mars, and if we accept for him the mass and diameter of 5500 km, the average density of Pluto will be equal to 8 g/cm^3 , which is too much. And suddenly the American astronomer George. Christy on plates taken in April-May 1978 at the 155-cm reflector of the us Naval Observatory in Flagstaff, discovered Pluto's satellite with a diameter of about 500 km. the Discovery was

confirmed using the 4-meter reflector of the Observatory of Cerro Tololo. At the request of the satellite around the planet were able to determine the mass of Pluto is $1.1 \cdot 10^{25}$ g, or about 1/500 the mass of Earth! The diameter of Pluto on the definitions Christy is equal to 2600 km in other words, it is Pluto, but not mercury, is the smallest among the major planets of the Solar system. The density of Pluto is equal to 1.4 g/cm^3 this is almost like the moons of Jupiter Callisto. The diameter of the planet and its brilliance is easy to determine the albedo; it is equal to 0.5. Ordinary rock, as the example of the moon and mercury, do not have such a high albedo, then we can assume that a significant portion of the surface of Pluto is covered with ice or frost.

The temperature on Pluto must be about 40°K . This value is lower than the temperature of condensation of methane at very low pressures (50°C). Therefore, on the surface of Pluto may be methane ice. And just recently, in 1977, the American astronomers D. Cruikshank, D. Morrison and K. Pilcher with a 4-meter reflector of the Observatory Kitt Peak found in the infrared spectrum of Pluto two bands, characteristic for methane ice.

On the other hand, canadian astronomer L. manning, looking at Pluto in the visible region, obtained in 1970, George. Fix, John. Neff and L. Kelsey at 60-cm reflector with the spectrophotometer found in it signs of absorption bands of ions of iron and came to the conclusion that the rocks of the planet are rich in iron.

In 1955, American astronomers M. Walker and R. hardy of the PV observations found a period of rotation of Pluto around its axis — 6 days 9 hours of 16.9 minutes. 12 years later the Soviet astronomer R. I. Kiladze confirmed this period for my own observations. It is now clear that this period is, however, a period of rotation of Pluto around the planet.

Penetration into the secrets of the solar system based on the use of the Newtonian law of gravity and precise observations continued in our century. The culmination of these efforts was the discovery of Pluto, and the circumstances were remarkably similar to the circumstances of the discovery of Neptune. As then, virtually, the planet was discovered during one of the earlier searches, but because of the vicissitudes of its identification occurred

much later.

In the beginning of this century Percival Lowell (1855-1916) , who founded at Flagstaff (Arizona) Observatory to observe the planets, especially Mars, is actively interested in the possibility of the existence of a planet more distant than Neptune. He re-examined the orbit of Uranus and concluded that the apparent errors of observations could substantially reduce, if we consider the perturbations of Uranus by an unknown planet. Lowell calculated the orbit and position of the planet has not been published about 1914, although the search for the planet it started from 1905 Through 24 years in 1929 we completed the construction of a new 13-inch refractor, which was installed at Lowell Observatory to accelerate the search of a new planet.

A young assistant, Clyde Tombaugh was tasked to systematically photographing the sky along the Ecliptic. For each area he did two pictures with long exposures, separated in time by 2 — 3 days. Then, in the search for the expected planet he very carefully compared the obtained photographic plates. The comparison was made using the blink comparator apparatus, equipped with a dual microscope that allows the observer to see alternately the same region of the sky on two plates. Any object that during the interval between the two exposures moved across the sky, seems to be Bouncing “back”, while the stars look stationary.

March 12, 1930, i.e., less than a year after the start of the implementation of the new program, Lowell Observatory through the Harvard Bureau telegraphed astronomical observatories with the following message: “Systematically started many years ago searching in the context of research by Lowell of the planet beyond the orbit of Neptune led to the discovery of the object, speed of movement and trajectory in which for seven weeks has consistently conformed to the body beyond the orbit of Neptune to approximately that distance, which he attributed Lowell. Fifteenth magnitude. Position for 3 hours universal time on 12 March was 7 to the West of d Twins, which is consistent with Lowell's predicted longitude.” The astronomical world soon unanimously agreed to this planet the name Pluto, which suits her because she moves in the external illuminated by the Sun regions of the solar system.

In addition, the first two letters of the name correspond to the initials of

Percival Lowell died in 1916, i.e. just two years after he published a detailed prediction of the motion of the new planet.

Subsequent calculations of the orbit is made on the basis of photographs of the new planet, made even before its opening, showed that it moves around the Sun with a period of 246,5 years in an orbit that is tilted 17° to the mid-plane of the other planets.

At perihelion the orbit of Pluto passes inside Neptune's orbit, but due to the large inclination of the orbits of these two bodies collide can't.

Only the unfortunate accident prevented access Pluto in 1919, astronomers of the Observatory of mount Wilson. At this time Milton Humason on behalf of William Pickering (1858 -1938), who have independently carried out calculations of the intended position of the planet, photographed the area around the predicted position of the planet and really got the image of the planet on some of the plates. However, the image of Pluto on one of the two top plates were on the small marriage of the emulsion (at first glance it seemed a part of that marriage), while on another disc image of the planet is partially superimposed on some star! Even in 1930, when the position of the planet in 1919, was pretty well known from the computed orbit, hardly able to identify those images of Pluto, which were obtained 11 years ago.

If only Pluto has a fantastically high density or not is extremely poor reflector of light, its mass is not big enough to cause those deviations in the motion of Neptune, on which was predicted the existence of Pluto. That's why many astronomers now believe that the discovery of Pluto was an accidental. Nevertheless, the discovery, subsequent to the result of the tireless searches of the planet, represents another step towards the progress of science. All the staff of Lowell Observatory worthy of the highest praise for their painstaking work and the results obtained.

Tombo spread started at Lowell Observatory to search the sky, but found that within the range available to observations with 13-inch telescope, the more planets there. If other planets exist, they should be much further or much less. Continuing the search for the much weaker planets with one of the larger telescopes, such as 5-meter, is unjustified from a practical point of view. The

bigger the telescope, the proportionally smaller area of the sky being photographed. Searches all over the sky, covering all objects, whose brightness is the limit for observation with a 5 m telescope, would require its continuous use during moonless nights for many centuries. Therefore, the discovery of planets, perhaps, of existing beyond the orbit of Pluto is very difficult, if not play a role any happy occasion or not will be applied to new methods of observation. For radar telescopes such distances are too great. A large optical telescope launched into space or placed on the moon and working in conjunction with television equipment and automatic equipment designed to search for planets possible and could contribute to success, yet some astronomers even doubt that there will be found some planets of considerable size.

The most distant from the sun of all open still planets quite similar to the other planets in the outer regions of the solar system. A stranger-a dwarf looks like Pluto among the planets. Our knowledge of Pluto is quite limited; in addition to the orbit, and hence distances, are known to us his brilliance and color, but the mass of Pluto is unknown. According to the definition Kuiper the apparent diameter of Pluto is equal to $0''$, $2.0''$, $3''$, which corresponds to approximately 5800 km. If we assume that the mass of Pluto is, at least approximately corresponds to the calculated value (0.8 Earth) , then the average density of the planet is obtained greater than the density of gold! Since metals and other substances the density of which is higher than that of iron, apparently, meet me in the stars, as well as on Earth, in small quantities, it seems absolutely incredible that the density of Pluto were much higher than the density of iron which is 7.8 times higher than the density of water. Obviously, or its mass or diameter is determined with a large error. If we assume that the density of Pluto is close to the density of the Earth, this assumption inevitably entails an increase in its diameter by half, but since this diameter is quite measurable, we have, together with Brauer and Clemens to the conclusion that the mass of Pluto determined yet insecure.

A very different explanation for the same data about Pluto suggested Walter, according to which the diameter of Pluto more his apparent diameter, but due to the fact that the planet has a fairly smooth surface, sunlight is reflected only from its small Central region. For example, a polished spherical or oval surface when illuminated with a point source of light give отблеск with a

concentration of light to the center of the surface. However, the explanation Walter still does not solve the problem of the relatively weak Shine of Pluto. If Pluto had a reflectivity as low as the Moon's albedo is 0.07, and even then he would have to look twice brighter than is actually observed. As a result, we are forced to the unlikely conclusion that the surface of Pluto is quite smooth, but the reflectivity is only 3 to 4%.

As the temperature of Pluto, appears to be below 220 With ie only for some 50 — 60(above the temperature of absolute zero, on its surface, most conventional gas should become liquid or to freeze.

Of course, you can imagine that Pluto is covered with oceans of liquid (or solid) oxygen (if oxygen was not as reactive) or from nitrogen and hydrogen and helium, which could stay on the Pluto gas, so probably no.

Although one can imagine that the reflectivity of the planet's surface due to the presence of ice crystals of ammonia, and other common compounds will be quite high, we in practice must be prepared for the fact that this surface is like the moon, due to deposition on it of meteorite and cometary material in particular in the early stages of the history of the planet quite uneven. Judging by the yellowish-white color, it can be argued that the surface of Pluto is covered with not too pigmented materials. So it is very difficult to agree with the suggestion of Walter on the relatively smooth surface of Pluto combined with the record low value of albedo.

Probably, Pluto is a barren cold with a small ball; its diameter a little less than half the diameter of Earth, and albedo of 0.15, i.e. twice the albedo of the moon. Of course, this planet is inhospitable to stay on her person; deadly cold night there continues 76.5 hours, and after it comes the same long day, but during the day the Sun Shine is 1600 times fainter than on Earth.

It was even suggested that Pluto is not even a real planet, and the moon, the lost Neptune.

However, this issue cannot be resolved until we have more information about the mechanism of occurrence of planets have satellites.

The science that studies the universe as a whole is called cosmology. Most of

the existing cosmological theories is based on the theory of gravitation, elementary particle physics, General relativity and other fundamental physical theories, and of course for astronomical observations. In cosmology, the widely used simulation method, scientists construct theoretical models of the Universe, looking for observational facts which can be used to verify the correctness of theoretical conclusions. The use of computers allows to carry out necessary calculations. The real universe turned out to be well described by models of the expanding Universe.

THE EXPANSION OF THE UNIVERSE

The first successful determination of the radial velocity of the galaxy observation of the Doppler shift of its spectral lines was made in 1912 by Slidewright in of the Lowell Observatory. He found that the galaxy in the constellation Andromeda is approaching Earth with a speed about 200 km/s. This is a surprising result, if we remember that most of the stars are moving at speeds not exceeding 50 km/s. Studying the spectra of other galaxies, Slidewright found that for most of them the characteristic red shift of the lines, i.e., unlike the galaxy in Andromeda, these galaxies will likely be deleted and not approaching. The displacement of spectral lines again gave a great speed. By 1914, Slidewright measured spectra of 13 galaxies, all of them, except two, were removed to a speed of about 300 km/s.

Such speed was by far the greatest speed ever measured in astronomy. However, the most surprising was yet to come. By 1917 was the speed of 600 km/s, but even this record was soon surpassed. Interesting to read a review of the time. Eddington wrote in 1923: "One of the most perplexing problems of cosmology are enormous velocity of spiral nebulae. Their radial velocities average about 600 km/s, and in the vast majority is dominated by the rate of removal from the Solar system. It is generally believed that spiral nebulae — the most exciting of the currently known objects (although this view is disputed by some authorities), so most likely here than anywhere else, we could look for effects due to General properties of the Universe."

Eddington leads then a list of radial velocities of spiral galaxies measured by Slidewright by February 1922., and he continues: "Very strikingly the enormous preponderance of positive velocities (deletion); however,

unfortunately, the lack of observations of nebulae in the southern hemisphere do not permit a final conclusion. Even if the South of the nebula show a prevalence of positive velocities, cosmological difficulties will not disappear... will Need to understand why two of the nebula (including the great Andromeda nebula) is approaching us rather quickly; these speeds are defined exceptionally well”.

This statement of Eddington reminds us that the time was not definitively established that spiral galaxies lie outside the milky Way. The discovery of the Hubble dates back to 1924 further light on the nature liperovsky speeds were spilled from the opening of the 1926-1927 rotation of the milky Way. The velocity of the Sun around the galactic centre is about 250 km/s. Other objects in the milky way is also turning around its center, so their radial velocities relative to the Sun is much less than 250 km/s. Objects outside the milky way, do not participate in its rotation, so that the velocities of galaxies must be corrected for the movement of the Sun to know their speed relative to the milky Way as a whole. When this amendment was introduced, the rapid approach of the two galaxies, which is so confused Eddington, slowed down considerably, but the most interesting that after correcting for the velocity of approach of galaxies in Andromeda was only about 100 km/s. Thus, the first measured Slideroom speed, which seemed at the time a big scary, do not give idea about the surprises that were to follow.

The value of the results of Slifer cleared up in the future thanks to the important discovery of the Hubble, which showed that the speed of removal of galaxies is not random. On the basis of measured them of distances to spiral galaxies, Hubble In 1929 found that up to a distance of 6 million light years the speed of galaxies is proportional to the distances to them. At first glance it might seem that the discovery of Hubble's restored the privileged position of the milky Way. However, as soon became clear, the result of Hubble does not mean that the milky Way is the only center of the recession of galaxies. On the contrary, the expansion law, in which the speed is directly proportional to the distance, means that any galaxy can be taken as the center of expansion, and there will be observed the same rule of recession.

Hubble believed that the constant of proportionality in the law of recession of galaxies is equal to approximately 500 km/(s· IPU). This scale of speed it is

possible to present a more visual way, which explains why the result of the Hubble means that 2 million years ago all the galaxies were very close to each other. This result was striking not only in itself, but also because, as he thought, the age of the Earth and the Sun more than 2 billion years.

Of course, the assumption that the universe is expanding all the time with constant speed, can be erroneous. In this case, the time when galaxies were in the same region of space, could take place more than 2 billion years ago. This question cannot be solved without expansion theory. Meanwhile, many believed that the time of 2 billion years, which is called the Hubble constant is of fundamental importance for the Universe as a whole.

This conclusion may seem hasty, however, subsequent work tended to confirm it. By 1931 Hubble had expanded the scope of fairness of its law from 6 million to 150 million light-years. Finally, thanks to new measurements of the Doppler shift made Humason, Hubble has reached a distance of 240 million light years where the rate of removal was about $1/7$ the speed of light. This was the situation when Hubble published his book "the World of the nebulae" in 1936

Since then it has commissioned a 200-inch telescope at the mount Wilson and improved methods of registering light collected by the telescope. This allowed us to determine redshifts of weaker and distant galaxies. However, the only important change in the results of the Hubble due to the large error in his scale of distances. The Hubble constant is now taken to equal approximately 10 billion years. This value is greater than the alleged ages of the Earth and the Sun, and comparable to the age of the oldest star clusters. Thus, the assumption that the universe was once very dense, does not encounter any more difficulties.

In our Galaxy more than 100 billion stars. Around 1% of them are listed in directories, and others unnamed and not even read. The star caught to the directory that has the individual designation: this is usually a sequence number or a combination of the coordinates of stars. But in different directories, these numbers may vary. There is no official documents regulating the names of the stars, but there is a tradition, which is supported by astronomers in the preparation of maps and atlases of the night sky. (We omit here the subject of the sale of the names of the stars, confident that our

readers clearly understand the immorality of this "business".)

However, all bright stars, and even many weak in addition to scientific symbols have their own name; these names they received in ancient times. Many of the currently used names of stars, such as Aldebaran, ALGOL, Deneb, Rigel, are of Arab origin, others come from the Greco-Roman tradition. Now the astronomer know about three hundred historical names of the stars. This is a navigation star, which has long been used for orienting hikers and hunters. Often it's the names of the parts of those figures, which gave the name to the whole constellation: Betelgeuse (in Orion constellation) – "giant's shoulder" or "armpit of the giant", Denebola (in Leo constellation) – "the lion's tail", Algenib and Markab (in Pegasus) is a "wing" and "saddle", Fomalhaut (southern Fish) – "mouth of the fish" Achernar (in Eridanus) – "the end of the river", etc. in fact, it is the Arabic translation to indicate the location of stars in the star catalogue included by Ptolemy in his "Almagest". Of course, in different people one and the same star is called differently: for example, the "shoulder" of Orion – Betelgeuse – the Bushmen called "Female antelope".

Starting in the late sixteenth century a detailed study of the sky, astronomers are faced with the need to have symbols for all stars visible to the naked eye, and later at the telescope. In a beautifully illustrated "Uranometria" (1603) by Johann Bayer (1572 – 1625), which depicts the constellation and associated with the names of legendary figures, stars were first designated in lower case (small) letters of the Greek alphabet approximately in descending order of their brightness: α is the brightest star of the constellation, β is the second gloss, etc. If the constellation was rich with stars and the 24 letters of the Greek alphabet is not enough, Bayer used the Latin alphabet: all lower case letters, and if they are not enough, and the title, but not beyond the letter Q. the Complete designation of the star in the system Bayer consists of one letter and the Latin name of the constellation. For example, Sirius – the brightest star of Canis major (Canis Major) is referred to as α Canis Major, or abbreviated as α CMa; ALGOL is the second brightest star in Perseus, is denoted as β Persei, β Per or.

Later Flamsteed John (1646 – 1719), the first astronomer Royal of England, engaged in the determination of precise coordinates of stars, introduced a

system of signs that are not associated with the Shine. In each constellation, he outlined the stars with the numbers in the increasing order of their right ascension, i.e., in the order in which they cross the celestial Meridian. So, Arthur, aka α Bootes (α Bootis), are designated on Flamsteed as 16 Bootis. On modern star charts usually marked with ancient proper names of bright stars (Sirius, Canopus, ...) and Greek letters in the Bayer system; Bayer designation in Latin letters are rarely used. The other, less bright stars are designated by numbers according to the system Flamsteed.

Of particular interest in studying the evolution of stars represent variable stars, changing stars, changing with time its Shine. For them to adopt a special notation, a standard which has the "General catalog of variable stars". Variable stars are denoted by Latin capital letters from R to Z, then combinations of each of these characters with each of the following from RR to ZZ, and then used the combinations of all the letters from A to Q with each subsequent, from AA to QZ (out of all combinations of excluded letter J, which is easily confused with the letter I). The number of these letter combinations 334. Therefore, if the constellation open a larger number of variable stars, they are marked with V (variable – variable) and serial number starting with 335. To each added symbol three-letter designation of the constellation, e.g. R CrB, S Car, RT Per, FU Ori, V557 Sgr, etc. Designations in this system it is customary to give only the variable stars in our Galaxy. Bright variables from the number of stars denoted by Greek letters (Bayer), other symbols are not getting.

The tradition to include the name of the star the name of the constellation in which it is located, potentially fraught with some inconvenience. We already know that the stars as a result of its movement cross the borders of the constellations. For example, ρ eagle now to be found in the constellation of the Dolphin. Over time this confusion will only increase.

Moving in space relative to the Sun, the stars not only from time to time cross the border of the constellations, but they change their distance from us, and therefore visible Shine. Patrick Moore, referring to the calculations Jocelyn Tomkin, leads the list of stars who for the past and next few million years have been or will be the brightest luminaries in our sky. Of course, it was assumed that the luminosity of these stars remains unchanged and their

visible luster varies only because of the distance. Furthermore, it is not taken into account the possibility of unexpected and, as a rule, short-term increase in gloss of other stars: the new, supernovae and other variables. Such events happen regularly, and to predict them we don't know how. For example, *Shine the Worlds* of the kit usually does not exceed 2m, but occasionally increases up to 1.7 m, and in 1772 to 1.2 m. Variable γ Cassiopeia in 1936, reached 1.6 m and then did not rise above 2.2 m. But the unpredictable and violent nature shows a very massive star η of the Keel (η Car). It was first brought to the directory of Edmond Halley in 1677 as the star is 4m, but by 1730 it became one of the brightest stars in the constellation of the keel. However, by 1782, it is much faded and became unavailable for observation, but in 1820 her Shine began to rise again. In 1843, she for some time has increased its brilliance to -0.8 m, becoming the second brightest after Sirius, and between 1900 and 1940 its visual brilliance again dropped to 8m, making a star inaccessible to the naked eye. Now the Shine of this restless hypergiant has grown to 6.2 m, probably soon (in the scale of million years) it is possible to expect the explosion of this massive star.

Back to own the names of the stars. Some outstanding (but not the brightest) stars are often named after the astronomers who first described their unique properties. For example, "flying star Barnardi" named after the American astronomer Edward Emerson Barnard, who discovered it in 1916, fastest proper motions on the sky. After her speed of self-movement is "the star of Captain", named after the discoverers of this fact the Dutch astronomer Jacobus Cornelius Captain. Known as "garnet star Herschel" (dark red star μ Cep), "star van by maanen" (the nearest single white dwarf), "star van Bespoke" (shining record low mass), "star Plaskett" (record massive double star), "Babcock's star" (shining with an extremely strong magnetic field) and some more, in total about two dozen great stars. It should be noted that these names anyone not approved: astronomers use them informally, as a sign of respect for the work of their colleagues.

For example, take the "Przybylski's star", the unusual properties of which were discovered in 1960 It is located in the southern sky in the constellation of the Centaur, and from the territory of Russia is not visible. But in the southern latitudes it can be seen by anyone, if he has binoculars: the star is quite bright, 8th magnitude. Its surface is twice as hot than the Sun, and chemical composition are quite unusual – the star astronomers refer to the

spectral class of the Ar. Discovered and explored this amazing star by the Polish astronomer antonín Przybylski (1913-1986), a man with a very interesting fate; scientific work he was doing in Australia at the Observatory mount Stromlo. Over the past half century, astronomers have studied the thousands of other unusual stars (and to find them, has studied hundreds of thousands of "ordinary"), but more awesome lights than the star Przybylski, perhaps was not found.

This star content of elements of iron group ten times lower than usual, typical for the vast majority of other stars. But she has a lot of chemical elements of the lanthanides group is extremely rare on Earth and in space. In the table Mendeleev lanthanides dedicated separate line at the bottom; chemically they are very similar to each other, and for the low natural concentration called "rare earth elements". Among all the lanthanides of the star Przybylski especially a lot of holmium – heavy metal, similar in weight to the tungsten, platinum and gold. Holmium and Earth is so rare that its properties still not been studied in details, no one cosmic body – in addition to the stars Przybylski – he never discovered! The impression is that this star was going to the holmium of our Galaxy. Star Przybylski defies explanation and, apparently, will long remain a mystery.

As writing colleagues, the astronomer antonín Przybylski was an extremely humble man. He would never want to give the star its name. But since they call it the unique shining "star Sibirskogo".

Another little-known example is the star of the Popper. This first star with extremely high helium content was opened by the astronomer Daniel Popper in 1942, but still look like stars discovered only a few dozen. They contain almost no hydrogen, but very rich in helium. The luminosity of such stars is extremely large for their mass. Itself star Popper with a mass of $1M$ (the sun) has a luminosity $10,000$ (the sun) and the radius $13R$ (sun). Only in 2006 was finally found, as forming such stars. Two white dwarf in a close binary system gradually move closer and eventually merge into a single star, the result is that the brow in the conglomerate re-start the fusion reaction.

Since we are discussing the names of the stars, then you need to think about the Sakurai object in the constellation Sagittarius. In 1996 it was opened by a Japanese Amateur astronomer Sakurai: this is probably the second example

after Garnet star Herschel, when the light outside the Solar system are named for the lover of science. The Sakurai object is often called the fastest growing of them all known stars. In 1996 this object was the size of the Earth and had a surface temperature of about 50,000 K (typical of a young white dwarf), and after just six months, he increased hundreds of times and turned into a yellow supergiant with a temperature of about 6,000 K, Shrouding itself in the opaque shell of carbon dust. It seems that this dying star - planetary nebulae – showed last helium flash. Detection of such rare objects is an honor to astronomers-professionals and especially Amateurs.

Of course, no diplomas "the right of ownership" names of the discoverers are not allowed. Over time, this kind the names of the stars tend to be forgotten. Left with only a dry catalogue of their designations, and the names of the old astronomers who are not familiar to the next generation of researchers, no longer be referred to. As you can see, this question astronomers biologists modest, making their official names part of the names of animals and plants.

Comets – the most unusual in appearance of the celestial objects visible to the unaided eye. They attract the attention of man since ancient times. Along with asteroids and meteoric bodies, comets belong to the small bodies of the Solar system. A feature of comets is that when approaching the Sun they have a tail, almost always directed with the direction from the Sun.

The history of cometary astronomy.

Background to the study of comets. Thousands of years ago people realized that the heavenly bodies practically do not change their mutual location (star), and if they move, according to strictly specified ways and with a definite speed ("wandering stars" or planets, including the moon and the Sun). Therefore the sudden appearance in the night sky "night light" has caused people a sense of fear and was considered a harbinger of bad events.

"Comet" in Greek means "hairy star". In Ancient Greece, and later in the Middle ages, a comet was often depicted in the form of a severed head with flowing hair. Since the history of mankind has always been full of tragic events – wars, epidemics, Palace coups, assassinations of nobles, - each appearance of a bright comet necessarily accompanied any of these events.

The court astrologers had only profoundly "linked to" the things of earth and heaven.

Roman historians reported that the death of Julius Caesar in 44 BC to coincide with the appearance in the sky of a bright comet. So in the Middle ages and even later in the Royal courts of Europe it was widely believed that the comet heralds the death of the king or his heir (a very convenient way to "write off" Palace intrigue in the phenomenon of nature).

Here is an example of an emotional description of the comet of 1528, by the famous French surgeon Ambroise pare: "This comet was so horrible and dreadful, and engendered in the people of so great confusion, that some died from fear alone, and others were sick. She was a light enormous length and the color of blood; the top of it was visible squeezed the hand holding a long sword, as if ready to strike. At the end of his blade was visible three stars. On both sides of the rays emerging from the tail of this comet, was seen in many axes, knives, swords dipped in the blood, and among them were seen the terrible human faces with unkempt beards and hair standing on end".

First recorded in the history of the appearance of the comet, refers to 2296 BC, Then it was observed by Chinese astronomers carefully watched the movement of the comet through the constellations. In the view of the ancient Chinese sky was a vast Empire that controlled the Sun and made up of numerous regions and provinces in which the bright planets were rulers. For delivering Imperial edicts, to distant provinces needed couriers. Their role was given the "tailed stars", as they quickly moved through many of the constellations and be able to transmit the Imperial will. Confirmation of this, the Chinese astronomers believed the movement "the will of the Emperor" planet-rulers from one constellation to another after the passage of the comet. Interestingly, such a positive role comets attributed only in China.

Against narrow-minded views, of course, stood some ancient Greek and Roman philosophers, who considered comets as natural phenomena, not related to the destiny of man. Aristotle believed comets with atmospheric phenomena belonging to the changeable "sublunary world", a kind of native terrestrial evaporation, heating or even flammable close to heaven "sphere of fire". He particularly insisted on his hypothesis; he wrote: "Since we are on

the comets don't have opinions based on experience then I should be satisfied with this explanation, which does not contain contradictions with known truths".

The closest to modern scientific truth, perhaps, came the Roman philosopher Seneca, who in correspondence dispute with Aristotle wrote: "I can't agree that the comet is only ignited by fire; it is rather one of the eternal works of nature the Comet has its own place among the celestial bodies... she describes your way and not go out, but only deleted. Do not be surprised that the laws of motion of comets is still not solved; the time will come when hard work will reveal to us the hidden truth now...". This time it's only one and a half millennia.

Tycho Brahe who observed a bright comet of 1577, compared their data with observations in other European astronomers, and came to the conclusion that comets were not visible parallax, and hence it was far beyond the earth's atmosphere and even beyond the moon's orbit, i.e. were independent celestial body.

The theoretical work of Nicolaus Copernicus and practical discoveries made by Galileo's telescope, to have completely undermined the credibility of the geocentric system of the world of Aristotle and Ptolemy, which served as the basis of the scientific worldview for nearly two millennia. Probably this fact more than any other was surprised to Aristotle himself. In contrast to his numerous followers, he was not dogmatic; he wrote: "I'm talking about celestial bodies, but I see them only from afar; I can't see where they are, and most of what is happening in the sky, avoiding our eyes... If someone can give another explanation for these phenomena based on a better and more natural basis, he acquires a legal right to our gratitude."

Correspondence thanks to Aristotle deserve it, those who prepared the ground for the search of General laws of motion of heavenly bodies astronomers of the era of Tycho and Galileo. By themselves, these laws were set in 1609-18. the talented mathematician Johannes Kepler, who used the most precise data on the movements of the planets obtained by Tycho Brahe. Kepler established three laws of planetary motion in elliptical trajectories around the Sun, but the cause of this movement was unclear. And only the law of universal gravitation and laws of mechanics, was finally formulated by Isaac

Newton in 1687, gave a scientific explanation.

The calculations made by Newton at the request of the English astronomer Edmund Halley proved that the bright comet of 1682, moves in an elliptical orbit. Based on my own observations of this comet and analyze reliable historical records on observations of comets over the preceding 300 years, Halley compiled the first catalogues of 24 comets, including calculated the elements of their orbits. By analyzing this data, Halley noticed a close coincidence of the orbital elements of the three comets that appeared in 1531, 1607 and 1682. He suggested that this may be one and the same comet. Its orbital period around the Sun was 75.5 years, so the next appearance was to take place in 1758. Halley's prediction was confirmed: in the beginning of 1759 appeared a bright comet, establishing the credibility of the laws of mechanics on the basis of which calculations were made of cometary trajectories. Unfortunately, Halley did not live to see this day. Open them periodic comet called Halley's comet. Thus began the scientific study of comets.

As the Central body of the system the Sun is the largest education of this group of bodies. Its diameter is 109 times and the volume is 1.3 million times greater than the diameter and volume of the Earth. It is a star like billions of other stars that we see in the sky. Like them, the Sun consists of hot gases. Coming from this gas ball of light and its associated heat are a necessary condition of life on Earth. Any warm and natural or produced artificially energy on our planet are derived ultimately from the Sun. Electricity and gas with which we cook food and heated the room come from coal; but coal is not that other, as the stored energy of the Sun: it was formed from plants that grew with sunlight millions and billions of years ago. The sun controls the water cycle in nature — successive evaporation, moisture rise up and rainfall. Heating the earth's atmosphere, it creates differences in air pressure that cause the appearance of areas with high and low pressure and, as a consequence, the winds, the sun and the moon's gravity cause tides and low tides in it. D. Measurement it was found that in every minute per square meter of the earth's surface enters the amount of heat which can heat one liter of water from 0 to 20°C. Recall that the surface area of the Earth is about 500 million km^2 so that we can get an idea on value, falling to the Ground solar energy. The total energy flux falling within 1 h to the surface equal to the

cross section of the Earth, is 330 million horsepower.

However, radiated by the Sun uniformly in all directions energy the Earth falls and a billionth, and even a beam of light emitted in the direction of the Earth, only partially penetrates through the atmosphere, reaching the earth's surface. How there can be a lot of energy on the surface or inside the Sun?

The sun consists of several layers. Its nucleus is surrounded by a photosphere (the luminous layer that we see) with a thickness of 4000-5000 km, and Above it there is a much thicker layer of the chromosphere (colored layer), which due to its weak radiation is usually not visible (the thickness is about 10,000 km). Only during a solar Eclipse, when the Moon covers almost the entire solar disk, the chromosphere can be seen for a few seconds. Border with the world space is the crown, which is a very beautiful sight; it can also be observed only during a solar Eclipse. In different layers of the Sun gas, of which it consists (mainly hydrogen and helium, with smaller amounts of other substances) has a different temperature. The surface temperature of the Sun is about 6000°K and to the centre of this gas balloon, it increases to about 20 million°K. the values of temperature, as in the case of other stars, not supplied with the sign °C (Celsius). In astronomy using a scale of Kelvin (hence the sign °). Kelvin as zero took not the melting point of ice, as did Celsius, and proceeded from the lowest attainable temperature. Is - 273° on the Celsius scale. Thus, adding 273° to the centigrade temperature, get a temperature on the Kelvin scale. In the Central core of the Sun is continuously in the process of turning hydrogen into helium. When this gas was discovered in the Sun, we were all sure that it is not on Earth. Therefore, "solar gas" was given the name helium (Greek Helios — sun). A little later it turned out that small amounts of helium exists on Earth.

When fusion in the Sun is helium nuclei from hydrogen nuclei mass, as it is converted into energy; in the conversion of 1 g of hydrogen into helium, energy is released 175, 000 kWh. as the Sun is 90% hydrogen, it is clear that for many billions of years it is a constant production of energy. A similar process occurs during the explosion of a hydrogen bomb. Therefore, one can hardly imagine the devastating effect of such weapons! People should fight to make the results of scientific research were used only for peaceful purposes.

If science will be able to turn hydrogen into helium without an explosion, as occurs in the Sun and in the stars, you can forget concern about the constant growth of energy consumption. But the Sun emits not only life-sustaining light and heat.

There are two significantly different types of solar radiation: emission of electromagnetic waves and the emission of particles.

Electromagnetic waves emitted by the Sun, only partially reach the earth's surface, the rest are absorbed (absorbed) by the atmosphere. The latter has two "Windows" of transparency: "optical window" and "radioone". Through the optical window passes radiation with a wavelength from 3000 to 10 000 Angstrom and is approximately the radiation we perceive as visible light ($1 \text{ \AA} = 10^{-7} \text{ mm}$). In addition to the tangible heat rays with a wavelength of 1 cm, the number reaching the earth's surface waves are partially and radio waves with a length from 1 cm to 10 m. The study of radiation at these wavelengths is engaged in a branch of modern astronomy — radio astronomy, about which in detail below. Color sensations arise in the eye in response to the perception of light of different wavelengths. The color of light of the shortest waves (about 400 millionths of a millimeter) - purple; an even shorter waves in an invisible part of the spectrum is called ultraviolet radiation. The sensation of red is called in our eye radiation of a longer wavelength (about 800 millionths of a millimeter). Radiation of even longer wavelengths called infrared or heat; it is also invisible to us. Ultraviolet radiation is almost completely absorbed by the atmosphere. If the atmosphere were transparent to ultraviolet radiation, in the known forms of life on Earth could not exist. Already in those small quantities that we receive ultraviolet radiation, sometimes we feel the "harmful effect: when intense irradiation of sunlight, its ultraviolet component affects our skin, causing sunburn.

The emission of particles (corpuscular radiation) in contrast to electromagnetic radiation, is throwing the smallest particles of matter, fragments of hydrogen atoms, which fly away from the Sun at a speed of from 100 to 2000 km/sec. They reach the upper layers of the terrestrial atmosphere (ionosphere) and cause the appearance at high altitude spectacular polar auroras. In addition to Aurora, there is still another phenomenon. Due to the physical changes in atoms and molecules of the

respective layers occurring under the action of strong ultraviolet radiation of the Sun, these layers become, for a time, transparent to short radio waves, i.e. they no longer reflect short radio waves sent from the Earth, and therefore make it impossible for radio communication on short waves. Corpuscular and ultraviolet radiation, and also causes a violation of the radio are particularly strong when the Sun starts some short-term processes, known as the manifestations of solar activity, called flares (eruptions).

Solar activity is expressed in different phenomena. The most remarkable and well-known sun spots. They can be observed with a simple auxiliary optical means. Spots representing us dark spots or dark areas on the solar surface, is a region with a lower temperature than the surrounding substance of the photosphere. They can be called gas eddies of enormous proportions. They often appear in groups and their total length can reach 200 000 km that is 15 times larger than the diameter of the Earth. Not always spots in groups equal in number and magnitude. There are years with high and low frequency of spots. It is established that the abundance of spots varies with an average period of 11 years. Every 11 years the spots are large and numerous (high spots); between such periods are periods of time with reduced frequency of occurrence of spots (at least). As flash near sunspots give particularly strong ultraviolet and corpuscular radiation, the period of maximum sunspot-forming activity of the Sun, auroras and violation of telecommunication especially amplified. However, erroneous predictions astrologers attributed to high solar activity the increased risk of disease and war; they have no scientific basis.

Torches - area high-brightness (especially visible on darker parts of the solar disk), appear often in the form of light streaks in the vicinity of the spots. It can be overheated areas the higher layers of the solar atmosphere with high radiation.

Flash is a very powerful, short-term phenomena, in most cases, inside or in the vicinity of large sunspot groups. They emit powerful ultraviolet, x-ray and corpuscular radiation, which are responsible for these disturbances of the earth's ionosphere and the Aurora.

Prominences is another expression of solar activity. Here we are dealing with thrown on the high altitude clouds of hot gases. They sometimes erupt far

beyond the chromosphere and can reach heights of several hundred thousand kilometers. The frequency of occurrence of prominences and flares also varies approximately with the 11-year period. They can be observed not only during a total solar Eclipse, but with the help of special instruments.

With the movements of the Sun, as we see them, i.e., with facile movements, we know from experience. The daily movement of the Sun from East to West due to, as already mentioned, the rotation of the Earth around its axis from West to East. Depending on the time of year we see the Sun at noon, then above, then below the horizon. This is a consequence of its annual movement. But this movement is only apparent and reflects the motion of the Earth around the Sun. In this case, the change of the height of the Sun above the horizon at noon during the year is a consequence of the parallelism of the earth's axis to itself in space during turning of the Earth around the Sun.

When in the Northern hemisphere summer, the Northern half of the globe facing the Sun and the altitude of the Sun at noon at this time, approximately 60° . When we have winter, the Sun is facing the southern hemisphere and the Sun reaches an altitude of only 15° . Due to the difference of the angles of incidence of radiation on the Earth's surface in these two cases, and takes place in different heating of the surface and the air, which the surface transfers heat. Thus, the change of seasons is not due to a change in the distance from the earth to the Sun, but on the contrary, in the Northern hemisphere summer when the Earth is at maximum distance from the Sun!

In addition to these apparent motion, the Sun makes the real movement. It rotates around its axis at a speed of one revolution in 27 days. In addition, along with all the bodies in the Solar system it moves among the stars at a speed of 20 km/sec towards the constellation Hercules, and together with all the surrounding stars takes part in the rotation around the center of the milky Way at a speed of 200 km/h.

One of the oldest concepts of modern astronomy, still not disused, is a constellation. The word "constellation" (lat. constellatio) literally means "a collection (or group) of stars". In astronomy, this term evolved and acquired its final value relatively recently – at least a century ago.

But for many thousands of years ago, people started to distinguish in the night sky expressive group of stars – asterisms, which helped to memorize the pattern of the sky and use it to navigate in space and time. It the asterisms were the precursors of the constellations. In everyday life we are usually called constellations only the most vivid, expressive, easy-to-remember group of stars. Quite a long time astronomers thought about the exact boundaries of the constellations, although included in them are not only bright, but also the surrounding faint stars. However, with the invention of the telescope (XVII century) and especially pictures (the nineteenth century) there was a problem: for learning were available to millions of stars, which had to give markings including the names of the constellations, and the exact boundaries of the constellations did not exist. So astronomers decided to divide the whole sky into the ground with precisely defined and easily reproducible boundaries, while trying not to deviate from the historical tradition.

However, each peoples had their traditions of dividing the stars into constellations. Differed significantly even in the traditional constellations: from ancient Europeans there were dozens of them, the Chinese have hundreds. Obviously too large constellations as celestial cues are meaningless, and too small and numerous works for remembering, and brightest stars for all would not be enough. Used by modern astronomers, the constellations are in the majority include the bright stars, and have names that are traditional for European culture.

In the modern sense, a constellation is an area of the celestial sphere with all projected on him from the point of view of the observer of celestial objects. Modern astronomers divide the sky into 88 constellations, in a natural way consistent with the capabilities of the human brain. It may be recalled that large countries typically are divided into 50-100 regions (provinces, States, etc.) that the most popular Board game takes on a field of 64-100 cells, etc. apparently, this is the optimal number of objects for our memory.

The boundaries between the 88 constellations in the form of straight broken lines in the arcs of the heavenly Parallels (these are small circles of the celestial sphere parallel to the celestial equator) and declination circles (small

semi-circles perpendicular to the equator) in the system of Equatorial coordinates for the epoch 1875, the Modern names of the constellations and their boundaries were established by the decision of the International astronomical Union (IAU) in 1922-1935. Continue these borders and names of constellations considered unchanged.

Although to most readers the following observation might seem trivial, however, as experience shows, it must be done. Speaking about the constellation, it should be understood that it is not some region in outer space, but only a certain range of directions from the point of view of the observer. Therefore, it would be wrong to say "Space ship flew to the constellation Pegasus." To be more precise to say that "the spaceship flew in the direction of the constellation Pegasus." The stars forming the pattern of any constellation, located off of us, as a rule, at various distances. In addition to stars in each constellation can be seen from very distant galaxies, and similar objects in the Solar system – all of them at the moment of observation belong to this constellation. But over time, celestial objects can move from one constellation to another. Faster this happens close and fast moving objects: the Moon holds with the same constellation of no more than two or three days, the world – from several days to several years. Even some close stars over the last century crossed the border of the constellations, while others cross them in the near future – on an astronomical scale of time.

The visible area of the constellation is determined by the solid angle it occupies in the sky; usually it is indicated in square degrees. For comparison, the disk of the moon or Sun is in the sky area of about 0.2 square degrees, and the area of the entire celestial sphere – about 41 253 square degrees.

The names of the constellations given in honor of mythological characters (Andromeda, Cassiopeia, Perseus, etc.) or animals (the lion, the Dragon, the Big dipper, and Tr), in honor of the remarkable objects of antiquity or of modern times (Scales, Altar, Compass, Telescope, Microscope, etc.), as well as just by the names of the objects that resemble the shapes formed by the bright stars of the asterism (Triangle, Arrow, southern Cross, etc.). Often one or more brightest stars in the constellation have their own names, such as Sirius in the constellation Canis major, VEGA in the constellation Lyra, Capella in the constellation Auriga, etc. As a rule, the names of the stars associated with the constellation names, for example, indicate the part of the

body of a mythological character or animal.

The constellation is the monuments of ancient culture, its myths, its first interest in the stars. Historians of astronomy and the mythology they help to understand the way of life and thinking of ancient people. Modern astronomers constellations to help navigate the sky, quickly assess the relative position of objects and their observations in this area and at this time.

Astrophysics National Laboratory DOE/Lawrence Livermore working in collaboration with the international group of researchers found that high energy neutrinos - particles that rarely interact with other substance, may be produced in the disks of neutron stars, including binary systems. This amount of neutrinos the scientists will be enough to one could discover the next generation of neutrino telescopes.

Using computer modeling, a team of researchers that includes astrophysicist Diego Torres from DOE/Lawrence Livermore National Laboratory, showed that the flow of gas onto the neutron star may be a significant new source of high energy neutrinos. That neutrinos are thought to be the final result of the chain reactions produced by the protons (hydrogen atoms without electrons), colliding them with a substance that falls on the rapidly rotating disk of the pulsar and accelerated to a giant velocities in the magnetosphere. A neutron star is a compact object, representing one of the possible end stages of massive stars.

They are often in binary star systems. In such systems, the stars ' orbit of the companion passes close to them and part of matter flows onto the neutron star. The transfer of gas onto the neutron star is shining very brightly last. Because very often neutron stars are pulsars. Torres and his colleagues noticed that during the 110-day orbital period, rotation around a normal star neutron A0545+26, be released large bundles of neutrino energy, which may occur for approximately 50 days of the cycle fluxes of x-ray radiation, which are fixed on the Ground.

"This is the first time we have shown that the flows of x-ray radiation may come and neutrinos that can be detected by the telescopes of the next generation," said Torres, in collaboration with scientists from northeastern University, Institute of radio astronomy in Argentina and astrophysics of the

max Planck Institute, who will present the results of their research in the may 20 edition of the Astrophysical Journal. Neutron stars have long been viewed as an important source of response to questions about the nature of matter and energy. Torres and his colleagues believe that astronomers will be able to use IceCube neutrino Observatory, built at a depth of 1 km deep in the Antarctic ice at the South pole, to detect neutrinos from this neutron star.

It is believed that the milky way contains all the components for the formation of the most powerful sources of energy - cosmic radiation. Radiation is a powerful radiation. So powerful that some astronomers believe that she killed the dinosaurs. Earlier believed that the sources of such intense radiation located outside our galaxy. Now, scientists in Russia, England and Poland believe that such a source might be in our galaxy.

Radiation no matter microwave or x-ray radiation consists of particles which move with great speed. Most sources radiocity for the Earth nasadata in our galaxy is the Sun and the stars. But it is believed that in excess of the strong radioactive radiation comes from a fairly rare exotic sources such as decaying dark matter and the more common gamma radiation sources outside our galaxy. A list of radiation sources may soon Polenitsa thanks to computer modeling, and researchers in Gershenson University in England under sir Arnold Wolfendale.

They found that verysilent cosmic radiation comes from sources such as supernovae and pulsars (rotating black holes are explored). In our galaxy such sources are not found, so Chernye sdelali the conclusion that such sources in our corner of the KOMOS was not. If this happened, life on Earth would be very different. Scientists have calculated that an event of this magnitude within our galaxy could destroy life on Earth, to dry up the oceans and burn the atmosphere. "It is very important to detect the sources of such radiation, says sir Arnold. Because every molecule in our body got its start in the crucible of a supernova".

Interstellar gas clouds are being turned into giant telescopes that can probe the properties of distant quasars. This unique feature provided by nature, managed to carry out at the expense of commissioning of new and much more powerful technique, developed by Australian astronomers.

Interstellar gas clouds are used as lenses to 'zoom' distant objects. A new technique applied doctoral Haley Bignall, a former employee of the University of Adelaide and is now working at the joint Institute for VLBI in Europe, Netherlands. Her method and research findings were published in the Astrophysical journal. Her method enabled a closer look at still poorly explored and most remote objects in the Universe - quasars. Assuming that galaxies with powerful black holes at their core. One of primary interest to astronomers questions is how the energy is channelled from these supermassive black holes.

Current telescopes tend to see the quasars as just points of light in the sky. No resolution of even the most powerful telescopes does not allow to distinguish more than that. A new method has improved resolution 10,000 times greater than the Hubble Space telescope and 100 times more clearly than can be seen with any other ground-based telescopes and different techniques dlinnobaznaya of radiointerferometry. This permission is so powerful that it is equivalent to as if we could see a sugar cube, put in the tea, on the moon's surface, where it is not possible to discern objects smaller than 100 meters.

In the Solar system there are many a variety of free heavenly bodies, do not have their own orbits. Such bodies are the asteroids, meteors, comets, and free moon not belonging to the Solar system. The Space is also enough "garbage" - debris destroyed as a result of collision or explosion of the heavenly bodies. Long been known that the Earth, moon and other planets are often meteorites fall etc. of the heavenly bodies. The earth and other planets are well protected from such "bombing" its atmosphere, which burns the majority of small falling objects. But the moon having no atmosphere, is dotted with impact craters. For example, Saturn's moon Mimas on the left photo made by Cassini in 2005, almost all covered with craters from the smallest to the giant. The sun is not only no exception, but, on the contrary, because of their huge gravity, thousands of times more susceptible to such "bombing." But unlike the Loon, where every drop leaves a mark forever, the fire on the surface of the Sun destroys over time all traces of drops (See. photo 1). Saturn's Moon Mimas. Photo Cassini, 2005.

Sunspots result from the fall on various celestial bodies.

Not all falling objects cause stains, most of them with small sizes or made mostly of ice, burn up before reaching the surface, only the largest leave a temporary mark.

Almost all the features of sunspots can be explained by the fall of cosmic bodies.

1. "Spots arise from disturbances of individual sections of the magnetic field of the Sun..." (Wikipedia)*

Dark spots are areas of the solar surface, suppressed by a falling object, and not suppressed by the magnetic field, as it is mistakenly considered now. Magnetic field disturbance in the area spots, it's not the reason for their appearance, but rather a consequence. Repaid the plot gives here free exit magnetic field. The fallen object is, figuratively speaking, a fuel. As a log thrown into the fire, first extinguish it wherever you fall, then the fire erupted with renewed force.

2. "Sunspots - dark areas on the Sun, temperatures of about 1500 K compared to the surrounding areas of the photosphere..." (Wikipedia).

The lack of fire makes these areas relatively "colder" than the rest of the surface of the Sun. The temperature of the falling objects below the temperature of the surface of the Sun, although when approaching the Sun, they quickly warmed up and the surface begins to burn.

3. "First occurs in this region of the torch, and later to the West is a small point called time, the size of a few thousand kilometers..." (Wikipedia).

The photo on the left, a comet on the Sun 5 may 2011. And this is not the only recorded case of the comet to the Sun. Powerful bright flash as the flare, appeared before the fall of the comet on the surface. This image confirms that the torch, preceding the appearance of spots, and the fall of cosmic bodies are interconnected phenomena. Photo 2. SONO/NASA Comet Kreutz.

4. "Stains are usually formed by groups, but sometimes there is a single spot,

living only a few days, or bipolar group: two spots with different magnetic polarity, connected by magnetic field lines..." (Wikipedia).

Single spots can be explained by the fall in the Sun cosmic bodies, consisting entirely of solid stone rocks, which are not destroyed under the action of gravity. Ordinary, group spotting, on the contrary, can be explained by the destructive action of gravity.

The origin of the astronomical knowledge usually attributed to "ancient times". The accumulation of this knowledge, according to the most common scenario was stimulated by the practical needs of companies. Generally refers to two: the need to focus at the migration and regulation of agricultural work. I believe that the origin of astrology as a holistic doctrine, non-separated (until the end of the middle ages) from the practical astronomy, must also be attributed to the same "ancient times". Some believe that astrology originated later separated from the "practical" astronomy under the influence of some social needs (which is unclear). According to another point of view, the real practical astronomical knowledge was accumulated initially within the astrological paradigm. Astronomy separated from astrology in the process of "decay" myths of totality "worship of Heaven". The reasons for this "decay" is usually not discussed and, in General, remain unclear.

All these ideas do not raise any fundamental objections. However, for example, with the aforementioned incentives the emergence of astronomical knowledge, if it is known that in ancient society could be used other than the astronomical orientation system, and a keen interest in astronomical observations seem to have emerged before the development of the productive economy, i.e. the regulation of agricultural work, apparently, was not the main reason for the interest in astronomy? The steady accumulation of quantitative empirical knowledge seems impossible without the development of writing, but exactly this situation has to face in considering the place and significance of ancient astronomical knowledge in the archaic culture. Remain unclear the circumstances of the emergence and development of the astrological doctrine. In developed Autonomous civilizations of the New world astrology might have played an important role — no less important than in the culture of the Eurasian centers of civilization. If so, its occurrence does not reflect any significant patterns of social development of ancient societies? What are these patterns?

These and many other questions are constantly revived interest in the study of the early stages of the development of astronomy. In the last decade added to this special cause. Among them should include some surprising results the study of the ancient calendar systems and the new data of archaeoastronomy. These results, which seemed at one time is highly improbable, push back the start of regular astronomical observations at very remote times. Finally, it is possible that we are interested in the issue has a direct bearing on the question of the influence of cosmic factors on biological phenomena (including the human body). In this area of research some progress has been made.

Inviting the reader to reflect with the authors on obscure questions of the origin of astronomy — astrology, we first briefly discuss some relatively unknown data about ancient calendar systems. It will have to address the question about the environmental value of ancient calendars, because for our distant ancestors, calendars were not merely a means of arithmetization time. This issue should be considered taking into account the latest data biorythmology. The relevant details are provided in the context of considerations that illustrate the fundamental nature of biological rhythms for normal steady functioning of organisms and ecological systems. A wonderful perfection and deep meaning of such systems as 12-year-old "the calendar of animals", it becomes clear, if we consider the data obtained in archaeoastronomical research. It follows that the occurrence of such calendar systems is the result of a very long-term astronomical observations and comparison of these observations with a variety of biological phenomena.

The archaeoastronomy suggests that the ancient community had given to the astronomical observations is very important. Probably this feature of social activity about 7000 years ago were global in nature. In subsequent periods (say, the turn of BC) in many parts of the known World, of astronomical observations, apparently, was not given such importance. The flowering of megalithic astronomy could be understood if the influence of cosmic factors on natural ecosystems would be so great that it would have to be taken into account in the practice of subsistence farming. In this regard, summarizes the necessary information on the issue of "solar activity — biosphere". It is noted that in ancient times the effects of solar activity in the biosphere "monitored" the monitoring of planetary configurations. We can say further that the solar activity influence on natural phenomena in our time — including climate

variation, crop production, epidemics, etc. — substantially, but still not so important to be vital. But it is necessary to assume that in the era of "mass" construction of megalithic observatories the magnitude of this effect was much greater than at present. This assumption is justified, because the degree of influence of solar activity on the climate (weather) and biological phenomena depends, apparently, on the magnitude of the magnetic moment of the Earth — with the decrease of the magnetic moment and the degree of impact of solar activity on the parameters of the habitat and organisms may increase. Verification of this hypothesis — in the future. Interestingly, however, paleogeograficheskie data, indicating that the magnetic moment of the Earth has reached a minimum in the era preceding the construction of a great astronomical observatories (about 6500 years ago).

Finally, it is interesting to imagine what took place the results of astronomical observations in the system of an ancient culture, where such played an important role in magic, myth, and where, it seems, is not interested in finding causal relationships, but attached special importance to the individual and allowed the existence of several parallel existing interpretations of the same observed phenomenon.

From the outset it is useful to realize that the social calendar function for our ancestors were different than now. Today, the calendar is considered perfect if it is satisfactorily an integer number of days commensurate with the duration of the so-called tropical year (time between successive passages of Sun through vernal equinox). Ancient calendars, usually deprived of arithmetical simplicity, and seem unnecessarily complicated. In all the ancient centers of civilization. — Mesopotamia, Egypt, Greece, India, China, Mesoamerica — ancient calendars were lunar or lunar-solar. In the latter case it was required to coordinate the changing of the moon phases (the synodic month, 29.53 days) with the annual movement of the Sun (365,24 days). For such a negotiation it was necessary to find a calendar the cycles in which the integer number of years with sufficient accuracy would be equal to an integral number of lunar months. This was, for example, the period found in the V century BC by the Greek Meton, 19 years. It would seem, why such complexity? Or, say, our calendar week, is not consistent with either the duration of the year nor with the duration of the month — why is it?

All these complications, however, appear justified and appropriate when you consider that the ancient criterion of perfection of calendars was their

consistency not only with seasons but also with many other cycles (rhythms) of the biosphere. Even in well-developed single calendar system to make such coordination very difficult. This task is often achieved by other means — the use of multiple calendars, which operated in parallel. For example, in Ancient China, in addition to the "normal" lunar-solar calendar and seasonal agricultural calendar, was widely used appliances of the 60-year cyclical calendar. For example, this calendar system it is easy to see how it is "mounted" the most important natural rhythms. But first let us look briefly at these rhythms.

Biorhythmology (chronobiology).

It is generally accepted that periodic (cyclic) nature of the operation is a fundamental property of biological systems. Any biological parameters change cyclically, so that the rhythm in a wide range of periods may occur at any level of the organization. Rhythmically flowing all biological reactions (molecular level). Rhythmically work the cell organelles (e.g., nucleus pulses with a period of tens of minutes), cyclically functioning of individual organs (heart, liver, etc.) cyclically change the physiological, psychological and other indicators of the whole body. Rhythm is inherent in communities of organisms. Long known fluctuations of populations of insects, fish and mammals — the so-called waves of life. The human community is subject to the same laws, so that many of the indicators in social systems also vary cyclically. Such, for example, cycles in the emergence of gifted people (one of the most distinct periods of ~55 years), quasiperiodic in the market economy (the already mentioned period of about 55 years known variations of situation as "waves" Kondratyev). The availability of a continuously flowing set of processes and phenomena of culture. For example, quantitative indicators of the structure of poetic texts by Russian poets in this century vary, with periods of 18 and ~27 years. Cyclically changes the yield of many crops. Even in this century, with developed health care systems many epidemic diseases also have a periodic component. With regard to epidemics (epizootics), occurring spontaneously, their occurrence and development have a distinct rhythm (which was in his time is proved by A. L. Chizhevskiy).

The most important feature of any biological rhythm — its synchronization with the periodic variations of the habitat parameters. Changes in biological

indicators (they occur at the "internal" reasons, in organisms there is a special "biological" clock) will certainly happen in time with the changes in the external environment. "Biological clock" all the time "adapt" under external, specifies the periodic signal. The point of this "adjustment" (it is, incidentally, is never quite accurate) is clear: it is one of the ways of adaptation of organisms to the environment.

The synchronizing signals can be very different physical agents. It is important that in the changes of the corresponding parameter of the external environment contained a periodic component. For the daily rhythm of the synchronizer is the mode of illumination. If this factor is for some reason "not working" (e.g. "off" conditions of the experiment), the time sensor can serve some other cause of change, for example, in the level of penetrating low-frequency electromagnetic fields and acoustic (specifically infrasound) noise.

With very few exceptions rhythms with periods less than a day (microrite), periods of changes synchronizing all agents — regardless of their physical nature — the cosmic origin. Daily, one-year periods — examples are trivial and well known. For some other periods of their cosmic nature has long remained unknown. Let us briefly consider the most interesting examples.

Currently, it appears that in the temporal organization of the biosphere is very widespread okolonolya rhythm (in the era of some clearly pronounced period of 13-15 days). This cycle is largely associated with the so-called sector structure of the interplanetary medium and has a solar origin. In certain ranges of longitudes on the Sun lines of force of the solar magnetic field directed either from the Sun or to him. Corpuscular radiation of the Sun (the solar wind), pull the lines of force in the interplanetary medium. Orbiting the Earth the picture of alternation of polarity of the interplanetary magnetic field. Usually either four or two such sectors with different directions. This whole pattern is repeated with the rotation period of the Sun (about 27 days). The earth in its motion along the orbit consistently gets in sectors with different signs of the interplanetary magnetic field. If four sectors, the change of sign of the field occurs once a week, if two sectors — the average interval between sign changes of about two weeks. If you change the sign of the interplanetary magnetic field earth's magnetosphere is experiencing some restructuring that affects (through a chain of cause and effect) on many indicators of habitat. Crossing sectoral boundaries is accompanied by variations in the magnitude of the geoelectric field, the probability of

occurrence of thunderstorms in some regions, the level of intensity of the electromagnetic background. The characteristic time interval of the change in the weather — "SYNOPTIC length" is approximately equal to a week and apparently physically associated with the intersection of the Earth and sectoral boundaries. On large time intervals the sector structure is stable, but from time to time the duration of sector several changes, so colonnella (allodsonline) rhythm of the environment related to the interplanetary magnetic field it cycles, but not exactly fixed periods. Okolonolya cyclicity there is in the variations of solar activity, so if the sector structure of the interplanetary medium would be observed (at some time in special circumstances this is possible), colonella rhythm of the environment does not disappear.

The vast majority of other rhythms, known in chronobiology (about a month, about 260 days, or almost 2 years, etc.), synchronized with the harmonics of the solar activity variations, whose "main" cycle is about 11 years old.

Primitive hunter and gatherer, of course, could not know about the most important biological cycles, accounting in many cases was vital. How could one not notice the circularity in the reproduction of small mammals? Or so-called wave of growth — the rhythms of growth of the animals (~10-12 days)? Or periods of fruiting, the natural affection of crops by insects? The empirical knowledge in biorythmology made it possible to forecast weather and climate change, efficiency of hunting, time of occurrence of extreme events (outbreaks). The quality of these forecasts was likely a condition of survival.

You can take another step and suggest that the formation of industrial and social rhythm of the primitive community took into account the rhythms in the reproduction of humans and animals. For the survival of the tribe that existed in a very harsh environment, it was important to control not only the level of its own reproduction, but also to adjust its quality settings.

Individuals physically weak with an abnormal psyche (e.g., increased aggressiveness) became a burden to the tribe. So it seems quite probable that in primitive societies was taken into consideration and rhythm of a pathology of pregnancy (one of the well-defined periods of about 11 years), and the cyclicity in the appearance of progeny with high viability.

Factors for synchronization of many important biological rhythms

(kolonodale, okaloosae, biennial, etc.), cannot directly be observed. However, fixing and practical given available as a rule, "specifies" (reference) periods. Okolonolya rhythm easily "tracked" by the phases of the moon: in the years of high level solar activity period changes of sign of the interplanetary magnetic field quite accurately coincides with the synodic period of the moon. Therefore, the passage of sector boundaries (corresponding to a particular phase kolonodale cycle) in these ages is associated directly with some of the phases of the moon. As to the rhythm of solar activity, the period of these variations (11) is easily observed by the movement of the bright planet Jupiter relative to the stars (sidereal orbital period of Jupiter is 11.9 years). The details of these issues we will discuss later. Now back to some features of the 60-year Eastern calendar.

Traditionally, the occurrence of a 60-year-old calendar belong to the reign of the legendary Chinese Emperor Huang di (26 century BC). Some researchers believe that this calendar system is even more ancient and its basic elements are borrowed by the Chinese from the nomadic tribes of Central Asia. The device briefly is as follows: each year, within one complete cycle has a double name. These names reflect a complex symbolism of the ancient Oriental philosophy including ideas about five basic elements of the world (fire, earth, metal, water, wood), their dialectical qualities ("Yin", "Yang") and "earthly roots". "Earthly roots" only twelve, which corresponds to the 12-year animal cycle (mouse, cow, tiger, rabbit, dragon, snake, horse, sheep, monkey, chicken, dog, pig). The 60-year interval that includes 5 of these cycles for 12 "lunar" years, and the number of days in a year can be 354-355 or 383-384. If you use animal names for the 12-year cycle, each year of the 60-year interval is further encoded using color symbolism. For example, the year of the sheep, which falls on the 8th, 20th, 32nd, 44th and 56th years of the 60-year cycle called, respectively, so: a white sheep, then black, blue, red, yellow. The calendar has been adjusted, apparently, observations of Jupiter and Saturn (respectively 5 and 2 cycles for 60 years).

In this system, it is easy to see some now famous rhythms of the biosphere. The actual 60-year cycle is long known variations of the thickness of the rings of trees, some regions in productivity, which explains its presence in the consumer prices (referred to "Kondratieff wave"). The indices of solar activity this period not reliably detected but it always appears in the analysis of geomagnetic indices (which, according to some researchers, indicates it

purely geophysical origin). The 12-year cycle is appropriate to associate with one of the major rhythms of the biosphere, paired with the 11-year solar cycle. The difference in ~ 1 year should be attributed, apparently, due to the short (three and a half centuries) v unrepresentative of a series of telescopic observations. Paleogeograficheskie data show that over a long time interval (about ten thousand years) the average of this cycle are grouped mainly around two values: 12.5 years and 11.9 years. As noted by Soviet astronomer V. F. Chistyakov, due to the correlation between cycle duration and its "amplitude" is to be expected that the cycle length was 12-13 years old in the era of long depressions in the level of solar activity (1000 and 3500 years BC). However, using the catalogue of wolf numbers (this is an integral indicator of the level of solar activity known from the beginning of XVIII century), it is easy to verify that for the 12-year animal cycle in our time maxima of solar activity have, as a rule, for quite some years — often in the sheep and monkeys. It follows that now the calendar can perform its predictive function.

Indeed, it turns out that in the last half century, the years of minimum solar activity have on the years of tiger and rabbit. These years fall to the drought in the Central Asian steppes. The most severe disasters pastoralists of Central Asia — the lack of food, when there is a mass loss of cattle, have for years rabbit. In General, consider a calendar system with skillful use it allowed, apparently, to anticipate the occurrence of certain adverse events (epidemic — epizootic diseases, drought, etc.).

Another argument testifying to the deep ecological sense of a 60-year calendar animals — this cycle appears in the recommendations on the use of ancient therapies of Oriental medicine — acupuncture (acupuncture). As you know, acupuncture is also important daily and monthly (lunar) rhythms. And according to the ancient medical Canon, the impact on certain active points with the aim of achieving the greatest possible therapeutic effect must consider the phase of the major calendar cycles. Interestingly, the connection state of the active points with the level of perturbation of the European geophysical science has discovered recently.

The ancient Mayan calendar.

Another example of a calendar system, explicitly taking into account the important biological rhythms — by the time the Maya, the most advanced of

the ancient civilizations of the New world. It is established that the Maya used (and ancient Chinese) multiple calendar systems, connected to each other by means of a set of cycles. Not all these calendars clear, but there is no doubt that the agriculture of the Maya were governed by "ordinary" solar calendar, where the number of days in the year was 365 (the so-called "Haab"). In addition, they used a one-year timeframe of 360 days ("Tun"), consisting of 18 20-day months; used a lunar calendar and a special ritual calendar with a very short year of 260 days ("Tzolkin"). In this calendar featured a 13-day week — as, it would seem, absurd unit of account, like our European week. If you know nothing about kolonodale (alladvantages) biological rhythm, to understand the appearance of these strange periods in calendars absolutely impossible. Twenty-day interval (month) occurring in the calendars, likely due to "finger" the account — it's called "Vinal" (the man with 20 fingers and toes). But "nine-day" — another week at the Maya most likely, also has a biorhythmic origin. Out of biorythmology difficult to understand the origin zolkina close to the period of maturation of the human fetus.

To develop such a complex calendar systems that regulate social and economic activity of the primitive community in harmony with the natural rhythms of the biosphere, required, obviously, very large time intervals. There have been several attempts to estimate the order of magnitude of this time span. Currently, this assessment was made possible due to the wonderful archaeological discoveries that significantly changed our understanding of the man of the Paleolithic. It seems that the initial stage of creating complex calendars of the type just discussed — can be directly observed. And such events should be attributed to the upper Paleolithic — 20 thousand years ago.

B. A. Frolov conducted a detailed study of the ornaments on almost two hundred items of Paleolithic Eurasian continent. It was found that for the elements of the ornament characteristic groupings of 5, 7, 10 and 14. For example, on a bracelet carved from the Tusk of a mammoth (Parking Mezin R. Desna near Chernigov), slotted the simplest of ornament: along the edge of each plate bracelet (5 total) sliced groups of lines at an angle of 45° relative to the edge of the plate. It turns out that every 14 lines, their direction is changed by 90° . Two series change of the slope ($14 + 14$) can be mapped, according to the B. A. Frolov, with the lunar month — the growing disc of

the moon to full moon and then decreasing to a new moon (28-29 days). Bracelet, thus, is like a wrist lunar calendar. Moreover, the total number of cuts in total on all five plates is 560 — twice the number 280 (10 lunar months cycle of pregnancy). Similar patterns were found on a different bracelet from the same Parking lot. In more complex illustration again, you can find a group of elements 7 and 14, find the number 282 and further to find the ratio giving the number of days of the solar year (366 days). It is natural to assume that this calendar could serve to establish the correspondence between the phases of the moon and seasons of the year. Such a complex structure of ornament occurs not always. In many cases, the cuts on the fragments of tusks, bones, stones correspond to the number of days in one or two lunar months (group 7; group of items for 5 and 10 reflect, apparently, the "finger" account).

At the same time, the American A. Marshak found very close to the "calendar explanation" in some specimens of rock art in caves in Spain. In one case (cave Canal de Mama, 7th Millennium BC) there was even just depicts the sequence of lunar phases, from new moon to full moon and then to oppositely directed Crescent moon last quarter.

It seems very plausible assumption that in that distant era, people began to emphasize number 7, who played later, as is well known, an important role in the history of culture (the seven colors of the rainbow, seven deadly sins, seven wonders of the world seven of the characters in myths, etc.). Among the various hypotheses of the origin of the "magic" seven "space" option associated with the division of the lunar month, I think, the most convincing. Detection kolonodale biological rhythm suggests that for primitive hunter with his keen observation of the lunar month is naturally divided into weekly (or fortnightly) intervals. After all, with such frequency flowed so important a phenomenon as, say, changing weather (in temperate latitudes). What we now would call the hygiene of the mother and child would inevitably follow this same rhythm. (In the recent past, the Uzbeks for newborn and mothers considered especially dangerous fifth, seventh and ninth night after birth.) Unfortunately, in modern chronobiology okolonolya recurrence is a poorly known phenomenon. I wonder what message that contains a convincing justification of the reality of a seven-day variations in physiological indices of man, published in our country more than half a century ago. Now, however, we know that complications of myocardial infarction in far apart

cities occur simultaneously with quasiperiod 6 days ± 1 day. What exacerbation of schizophrenia obey the same patterns (periods of about 5, 7 and maybe 9 days). Such cycles are in bacteria, and probably plants. What kolonodale variations can be observed in chemical reactions. And yet, much that almost knew about the weekly rhythm of our ancestors, we don't know yet.

Statistical results about the Paleolithic, the ornaments that contain "seimitsu days," our knowledge of ancient calendars is not exhaustive. In recent years, research in this direction led to the findings of most of these calendars. Their study is far from over, but the first preliminary results are produced, admittedly, a strong impression. Most, in our opinion, a wonderful Achinsk calendar rod of mammoth Tusk. He was found in 1972 on the site of one of the oldest in Siberia Paleolithic settlements near the town of Achinsk. This is the region where most likely originated considered above the 60-year environmental calendar. Age of settlement is estimated at 18 thousand years. The wand is a phallic-shaped rod that is covered with a spiral pattern of tiny holes. At first glance, the pattern does not have any meaning other than a purely "ornamental". However, the calculations are holes leave no doubt that the scepter is a symbolic system. Its analysis by A. I. Arustamian, revealed the following important details:

1. From some set of integers, one can obtain the fractional count of 29.53 (number of days in a synodic month).
2. The numbers contained in the "ornament", I suppose splitting into three groups (cluster). Able to show that these groups belong to three periods, amounting to the number of days draconically, synodic and tropical years.
3. The total number of elements of "ornament" is the number of days in three lunar years.
4. In the arrangement of the numbers clearly visible pattern, which allows to consider the rod as a computing device that operates the most important calendar periods.

Taken in isolation, these results — taking into account the age of the finds — could seem completely fantastic. The fact, however, that this finding is not an isolated phenomenon. For this same region there are other findings as, apparently, a complicated astronomical icons. Another interesting example is

the necklace with pendants of Paleolithic burial, near the village of Malta (80 km from Irkutsk). Burial was opened in 1929 by M. M. Gerasimov (later well-known sculptor-anthropologist). Studied this necklace V. E. Larichev[1] after the counting of ornamental signs on hangers concludes that the calendar nature of applied ornament no doubt. Detailed deciphering of this audit offices should probably be the subject of interdisciplinary research. The most interesting preliminary results can be summarized as follows:

1. The calendar system is encoded in the "pattern" of suspensions, is, apparently, a lunar-solar.
2. In this system, selected calendar "block" duration of 273 days, which is close to the cycle of maturation of the human fetus. The same block of the same duration appears in Achinsk the rod. Is it a coincidence that this number differs from the "short year" of the Maya for exactly one week this calendar ($260 + 13$)?
3. The number of beads on the necklace 120. If each bead is identified with the year, not the total number of calendar cycle of 120 years (twice in 60 years), combining the score time, not only by the moon and the Sun and the planets?

The last two questions remain open. But the fact of human use of the upper Paleolithic in Siberia has developed a calendar system should seem to consider.

So, a holistic (systemic, in modern language) experience of nature by the ancient people allowed him to discover the cosmic rhythm at a very early stage of cultural evolution. Following this rhythm was probably a factor in the survival of primitive communities. Considering the ancient calendar system as 60-year animal calendar and the Mayan calendar, it is possible to find some confirmation of this hypothesis: in the aforementioned calendar systems are the cycles, well known of modern chronobiology. So the ancient calendars have an ecological meaning. From this point of view, they reveal a high perfection. Not surprisingly, these systems are lunar-solar. This feature allows you to regulate social and industrial activities of the community in harmony with the vital rhythms of the biosphere — okaloosae and colonelului. These last, I noticed an immediate observation seen in any registered structures probably initiated the choice of seven as a "Holy number". Calendars such as 60-year calendar of animals contain, apparently,

a huge information. It is clear that its accumulation requires a large time interval. A lead time for the corresponding cultural evolution has, since the lunar-solar calendar had been known upper Paleolithic period (15-20 thousand years ago).

For the development of calendar systems discussed in the previous section was necessary for systematic astronomical observations. By their nature, such observations are measurements, and for measurements need special devices to be installed in a suitable location. Thus, the development of calendars was to be accompanied by the construction of the observatories. The detection of such structures built in the stone age — another major open middle of this century. It is fortunate that this discovery coincided with the identification of numerical semantics in the Paleolithic ornament — these two discoveries complement each other.

The discovery of megalithic observatories connected with the English astronomer George. Hawkins. He, of course, had predecessors — among them often called the name of his compatriot Giuseppe Verdi. N. The lokver (1836-1920). Yet, John. Hawkins has carefully analyzed the structure of Stonehenge — the construction of huge stone blocks, built 4 years ago out on the plain near Salisbury (UK). Hawkins has convincingly proved that the huge stone arches of Stonehenge was used as a vizier to commit the directions of the sunrises and sunsets and the moon at certain points in their movement through the celestial vault. The so-called Aubrey holes — 56 pits around the circumference at equal distances from each other and filled with crushed chalk, could in principle be used for predicting solar and lunar eclipses. Evidence that Stonehenge was an astronomical Observatory and a path that had to be done John. Hawkins to get the evidence, described in detail by him.

Article John. Hawkins made a strong impression. A mysterious ancient structures were studied to determine whether they are unrecognized first astronomical observatories. Very quickly formed a special field of research, known as archaeoastronomy. The stage of formation of archaeoastronomy is a vivid description of the same John. Hawkins. At first, naturally, fascination and, of course, mistakes. The famous disk of mysterious characters from the fest still no calendar (although there is, apparently, too is the ubiquitous number seven)! If equally famous lines, shapes and drawings in the Nazca

desert (Peru), and are associated with astronomical observations, such a linkage continues to remain for us incomprehensible. In recent years archaeoastronomical research has entered a phase of peaceful development, convened symposia, published magazines, produced a monograph. Of course, we are witnessing the very first steps in these studies, the outcome of the review clearly premature, the above on just a cursory overview of accumulated data, sometimes pre. Studies conducted in Europe and Asia, some of their features differ from research undertaken in the New world, so they should be considered separately.

Grand Stonehenge, focusing the attention of researchers at the initial stage of development of archaeoastronomy in Europe, should not blind us to other buildings of the same kind. After all, they are less monumental and conspicuous, are a measure of the development of astronomical knowledge in the region. Their very presence is most important feature of interpretation of purpose (one possible) of Stonehenge.

Pioneering work on the search and study of the megalithic astronomical observatories was undertaken by Professor Alexander Tom (UK). The extent of the work carried out for decades, forces a small family expedition (involved the son and grandson), can not but cause admiration. Studies cover a vast area, including the Islands of England and North of France, surveyed hundreds of monuments that could be suspect for their astronomical purposes. Access to some of them difficult to survey each monument is a laborious work that requires accurate measurements. The outcome of this work is truly amazing. It turned out that in the era of the late Neolithic — early bronze North-West Europe was covered by a network of observatories for observing the Sun and, somewhat surprisingly, observations of the moon. Many of these observatories are modest — it's just standing stones (menhirs), were used as the vizier, or rings of standing stones (cromlechs). Some of these facilities, for its size hardly inferior to Stonehenge. Such, for example, explored by the expedition of A. Tom complex located in the heart of Carnac (Brittany, France). One of the centers of the complex was once a Large Broken Menhir that has fallen and broken into four parts stone with a total length of 22.5 m Before the fall (probably an earthquake), he towered above the earth's surface to 19 m. the Monolith, known to locals as the "Stone Fairy", weighed about 330 so Near the place of granite, which was the monolith, to the point of installation is 80 km away. no doubt He had been

subjected to treatment (the cross section is oval). To implement the observations using a Large Menhir requires a clear line-of-sight in the directions of sunrises and sunsets and the moon, and the length of lines — to ensure accuracy in fractions of a degree — must be kilometers. For some astronomically significant directions associated with the Moon really was able to find remnants of a near sight at the expected distances. One this kind of sight there are two large standing stones (Le Meneka and Germany). Both of these systems have sharp geometric features and, of course, are countable structures. A variant of the interpretation proposed by A. Tom will likely not final. However, in this case it is important to emphasize more. In the interpretation of each individual construction as a device for astronomical observations there is always some danger to astronomically important direction purely by chance. The study of the totality of such structures allows to approach the problem statistically — in fact at a higher methodological level. In subsequent years, through the implementation of a special research program of the objects studied by A. Tom, was examined again. However, his main results were confirmed (controversial is the question of the precision with which he carried out astronomical observations in this era). Thus the most important result of the work by A. Thomas and its employees — evidence of the systematic astronomical observations of the inhabitants of North-Western Europe in the Neolithic period — should be regarded as a reliably established fact. The magnitude of this discovery can be felt, if you remember what I wrote about the menhirs in the beginning of the century, Jacques de Morgan, one of the major archaeologists of the time:

"In France, menhirs are even more numerous than the dolmens (megalithic tombs. — Ed.). A. de Montilla (French archaeologist. — Ed.) has 6192 menhir, considering including the stone alleys and stone circles... Most of them are found in er-Gras (Fairy stone), now overturned and broken... We are lost in the assumptions regarding the original purpose of these monuments... Cromlechs are large circles from 50 to 60 meters in diameter, formed of menhirs. These monuments are very numerous we have in France, the British Isles, Sweden and Denmark. They are also found in southwest Asia. All the explanations about them, are mine".

Archeoastronomical systematic studies so far covered a relatively small area. Maybe a passion for astronomical observations was peculiar only to the inhabitants of North-Western Europe? An affirmative answer to this question

seems unlikely. However, expect him any reasonable answer in the near future is not necessary. Many years of work by A. Thomas helped to identify many of the ancient Observatories for the reason that they were megalithic (well preserved). In addition, they were "similar" was used, apparently, the same algorithms for the measurements. In their features they are now easily recognizable. Constructions of this kind occur, it seems, in different parts of Eurasia (e.g., in Japan). In the travel notes of N. Roerich encountered the following interesting place: "a Special joy gave us discovery in Tibet, Transhimalaya typical menhirs and cromlechs. Can you imagine how wonderful it is to see these long rows of stones, these stone circles, which vividly transport you to Carnac, in Brittany, to the ocean shore. After a long journey the prehistoric druids recalled their distant homeland..."

Techniques and methods of observations used in ancient communities, must have been, I think, be quite varied, depending on latitude, type of landscape, tradition. Astronomical "devices" can be very different to be combined with ritual and funerary structures. An interesting example is the discovery of "astronomical aspects" of the ancient sanctuary in the Republic of Khakassia (valley of the rivers White Iyus). Here V. E. Laricheva managed to find a specially equipped area for astronomical observations, linked to the Meridian. In General, it is not excluded that at the present time, some types of ancient observatories remain unrecognized. As one would guess about the astronomical purpose of the system of basalt columns near the lake. Turkana (Northwest Kenya) if it were not in advance known that the calendar system of the ancient African state of kushi was a lunar-stellar (ignoring the movement of the Sun)?

An important argument in favor of ideas about the global spread of systematic astronomical observations in primitive society were the results archeoastronomical research in Central America.

Very interesting findings were made in the 70-ies in Chaco Canyon — desert areas of new Mexico (USA). At the southern entrance to the canyon is a massive rocky hill with very steep slopes. On one of the terraces near the top of this "hill" at an altitude of over 100 m from the bottom of the canyon there are three slabs of Sandstone. Plates are pretty massive — tons, two each. They stand almost vertically, barely touching the tops of sheer walls. The distance between them horizontally about 10 cm. A ray of sunshine in okolopoludennye time penetrates into these cracks, forming a "Bunny" on the

rock, which is described leaning against the stove. The researchers were amazed to find that "Sunny bunnies" move (in connection with the movement of the Sun)... in a specially-applied scale composed of two spirals (respectively for the two "bunnies"). The device still works, and you can be sure that on the day of the summer solstice (June 21) the Sun slips within 18 minutes so that it crosses the exact center of one of the spirals. Similarly, probably, were conducted observations of the moon. It is not clear if a plate on purpose, or dropped a pass in a natural way, and the spiral was caused then. This device is undoubtedly used local Indian tribes, who were in the period of "manufacture" of the device (X–XI centuries) on the stage of the Neolithic. Their culture by the time of the described findings were extensively studied. They were engaged in irrigation agriculture, they built excellent roads, impressive ceremonial centers. Their homes and roads were strictly oriented to the cardinal points. They apparently enjoyed quite accurate lunar-solar calendar. Thus, the device in Chaco Canyon good "fit" in the famous historical and cultural background. To search for and study of other similar astronomical devices implemented a special multi-year research program. Was not only discovered, many other observatories (could be rather astronomical points, because some of the observatories are modest), but the estimated accuracy of the performed measurements. The most important numbers for us are:

- the points of the equinoxes were located with an error of ± 1 day;
- the Meridian passage of the sun or the Moon were recorded with an error of \pm a few minutes;
- the main directions were accurate to the fractions of a degree.

According to the researchers, some elements of the "astronomy culture" of the Pueblo Indians clearly did not have immediate practical applications and represented the components of some abstract astronomical concepts.

A considerable diversity in techniques and methods of astronomical observations identified in the last decade when archaeoastronomical studies of the Mayan culture. At Equatorial latitudes such reference date, as the summer solstice, it is sometimes easier to determine based on the changes the Zenith distance of the Sun. It is remarkable that the ancient Maya used the Zenith tube. Anyway, that's now interpreted the purpose of its erection, was found in the ruins of Xochicalco (near Mexico city). It is an eight (!) the pipe in the

ground, on the lower end of which has a small coaxial with the round tube in the chamber room. It was accessed through a special entrance. The pipe is nearly vertical (inclination of 0.5° to the North), perfectly straight, carefully built of stone blocks, the cross section is a hexagon. Almost exactly the same device found in the ruins of Monte Alban, it dates from the third century BC. Special measurements it was found that a ray of sunlight penetrated the "monitoring camera" that anti-aircraft pipe at noon for several weeks. Per day minimum Zenith distance of the Sun duration the sun "Bunny" on the floor of the chamber was the highest.

Similar Supervisory reception were probably very common in the American continent. In Machupicchu (Peruvian Andes, 75 km from Cusco), as recently clarified, the window of the structure, considered a temple made in such a way that the sun's rays at sunrise at the winter solstice fall on the marked place of what was put before the altar. (It may be recalled that the purpose of the building in this city not comment on the Spanish chroniclers, the Incas because for some reason, left the city and it became known to Europeans only in this century.) It would be easy to cite numerous other examples illustrating the high level of astronomical knowledge of the civilizations of Central America. This knowledge, of course, accumulated through a long cultural evolution.

Summing up this part of our discussion, we can say that archeoastronomical research (still very incomplete) allow to make very important conclusions. Turns out regular astronomical observations in the Neolithic period was already quite commonplace. They were engaged, apparently, in different areas of the known World, including low latitude. These observations were conducted using already established methods, and it may well be that they were held much earlier. The objects of observations were often the moon and the Sun, it is possible that observed bright planet, although direct evidence has not been received. The accuracy of these observations — in cases when it can be estimated, was quite sufficient to create a lunar-solar calendars already in the Neolithic era (or even much earlier). In light of these data the detection of astronomical calendar sign systems in the Paleolithic seems quite natural, and the high perfection of the extant ancient calendar systems should not be surprising.

What motivated our ancestors in its activities?

No doubt, the ancients gave regular astronomical observations important. Disparate, having no writing tribes of North-Western Europe spent a considerable part of its resources to building construction like Stonehenge or Karnak complex near the Big Obelisk. Why? It is hardly possible to agree with the view that these astronomical observations were carried out with the ritual order. Equally naive (and unfounded) assumption that this meant "scientific purposes." It was a goal, of course, practical. However, the hypothesis indicating the development of agriculture as a probable stimulus for conducting systematic observations, is not convincing in light of the available historical calendar and archaeoastronomical data. Undoubtedly, some knowledge of dates, marking the seasons, like the spring equinox — for tiller is an urgent necessity. Astronomical observations, however, regularly started before the development of the productive economy, where the volume is clearly in excess of his special needs. Not detected clear signs of a connection between the type of farming (lifestyle) and the degree of interest in astronomy. Themselves astronomical observations of the ancients were, it seems, focused more on the moon than on the Sun. In General, the impression that astronomical observations have answered some very important but broader social needs. It seems very probable that such demand could be forecast, foresight.

Similar to how the normal existence of the individual is impossible without "anticipatory reflection of reality" and social life is impossible to imagine without foresight. In the system of culture of modern society has a very sophisticated predictive device, including the many manifestations of public life, long-term planning, futurology, philosophical doctrines, works of art...

American M. Robertson published in 1898 novel "Futility". It tells of a gigantic ship-the ship who went in swimming with the rich and complacent passengers. Cold April night, a huge ship called "Titan", collided with an iceberg and sank with all passengers and crew. After exactly 14 years after publication due to collision with an iceberg sank the famous Titanic, as two drops of water similar to the vehicle described by Robertson. This is one of countless examples of the "ahead" experiences in the literature.

Archaic society, of course, also should be positioned a predictive device. Some of its features you can imagine on the basis of General considerations, based on established historical-ethnographic patterns. Comparing the culture with advanced writing and more ancient oral culture, well-known specialist in

theory of culture Yuri M. Lotman observes that "if a written culture focused on the past, oral culture for the future. So a huge role in her play predictions, divination, and prophecy... a Society built on tradition and collective experience, must inevitably have a powerful culture of forecasting. This need stimulates observation of nature...", for they "natural phenomena are perceived as resembling or tokens". From General considerations it is also clear that such social systems forecast must wear specifically-applied character and to relate to a specific geographic area. Many of the facts suggests that regular astronomical observations as time and served as important means of meeting this forecast demand. On one such fact — the presence of certain biorhythms in the ancient calendar systems is mentioned. Knowledge of cycles and is, obviously, the ability of foresight. Discussing further the idea of the necessity of astronomical observations for the purposes of the forecast (the idea is certainly not new), we consider v other data. To start the discussion with appropriate understanding of the method of prediction.

For companies in transition from appropriating economy to a producing, it was very important to anticipate changes from year to year:

- 1) weather and climatic situation;
- 2) the immediate prospects of the most important fisheries (fish catch, the extraction of the beast, the yield of wild and cultivated crops);
- 3) demographic situation (in their community and the nearest neighbors);
- 4) risk of particularly adverse periods of time (epidemics, local social crises, individual catastrophic events such as floods, etc.).

The basic principle of the forecast can be explained on the example of forecast climatic changes to which the economic activity of our ancestors was a lot more sensitive than ours.

Weather, climate and solar activity.

Should immediately be noted that the forecast of weather changes in those days were probably large set of signs, using a variety of signs of logging, animal behavior, etc. "Space" signs was probably the only part of their full set. The ancients certainly knew about one of the important features of climatic changes in the area trend towards a more or less stable frequency of

occurrence is similar (analogous) situations. The repetition has a rather complicated time structure — there is a set of cycles that are specific to one geographic area. This regularity arises from the influence of the climate (weather) of the solar activity. This strong unconditional judgment is able to warp the reader who has heard something about the discussions on the issue of "solar activity — weather and climate." Indeed, the debate about the reality of correlations between indices of solar activity and climatic parameters of the last century. In the literature on this problem you can find a lot of contradictions and mutually exclusive of each other's judgments. Character of solar-atmospheric relations is quite complex. The main 11-year solar activity cycle is poorly expressed in the series of meteorological observations. These rows are quite short. The effect of solar activity on atmospheric circulation, as it turned out, significantly depends on the season and geographic region. In General, these and some other reasons not allowed yet to reveal the entire set of basic laws, some of which seem to elude narrowly specialized approach, characteristic of our modern science. Most importantly, even what is empirically well established, yet has no theoretical justification. Admittedly, we do not yet understand the mechanisms of influence of solar activity on atmospheric processes. Some experts even believe that such an understanding will be reached soon.

For our presentation the question of the establishment of the theory on such an important. More importantly, the fact of when "solar activity — climate change" now still can be considered securely established. Will just highlight a few examples. Found in Western parts of the US drought since the beginning of the XVIII century to our days appear regular with a cycle of about 22 years. There is no doubt that this rhythm is associated with a known 22-year cycle of solar activity (consisting of two 11-year cycles). This result was obtained from a careful analysis of data on changes in the thickness of the rings of trees (registered structure, read the first time by the Professor of the Odessa University F. N. By Shvedova in the last century). A similar trend in the occurrence of major droughts exists for certain areas of our country that was discovered by the Soviet scholar T. V. Pokrovskaya using meteorological data. Causes now dispute the connection of solar activity with the frequency of thunderstorms. For England, in particular, thunderstorms happen more often in the epoch of maximum solar activity (in these data is clearly visible 11-year cycle).

Perhaps the most convincing results were obtained while studying the reaction of the atmosphere on some manifestations of solar activity. The known Soviet astronomer E. R. Mustel and his collaborators found that during isolated geomagnetic storms the atmospheric pressure at the same time change over huge territories, and for some areas it decreases, and for others, on the contrary, naturally increases. These changes are very small in absolute value, especially pronounced in winter.

We said at the beginning of the brochure that the magnetosphere of the Earth is undergoing restructuring, when our planet moves from one sector of the interplanetary space (where the interplanetary magnetic field is directed, say, from the Sun) to another (where the magnetic field has a different sign). The restructuring is reflected in the lower atmosphere and is accompanied, as it turned out, weather effects. This remarkable discovery was made in 1967, the Soviet geophysicist R. V. Smirnov and now confirmed by other researchers using a variety of indicators. Found, for example, that the total area of land with a large cyclonic vorticity in the hemisphere is noticeably reduced the next day after passing the sector boundary. It is shown that for the middle latitudes after 1-2 days after crossing the border significantly changes the magnitude of the electric field of the Earth and at the same time increases the probability of registration of a thunderstorm. If these effects are real, we can expect for a certain range of latitudes — a certain regularity in weather changes within the synodic lunar month: as already noted, moon phases in a probabilistic sense, involve a crossing of the Land sector boundaries of the interplanetary magnetic field. This correlation should be interpreted as "the moon's influence on weather". Due to the fact that the period of rotation of the sectoral structure is not always equal to the synodic month, this relationship may not be sustainable. This circumstance is probably one of the reasons for conflicting opinions characteristic of the abundant literature on the Association of weather with the phases of the moon.

There are, however, the facts belonging to the category securely installed. For example, for the Northern part of the American continent, according to a half-century of data, the maximum rainy days are in the 3rd — 5th day after the new moon and full moon. On the other side of the equator (South America) distribution is quite similar, but shifted relative to the first 2-3 days. The effect is rather weak ($< 10\%$), which however does not mean that the relationship with the phases of the moon is negligible. Because the

meteorological consequences of crossing sectoral boundaries, as noted, are clearly manifested in certain geographical areas. Therefore, the broad spatial and temporal averaging of the data could reverse the effect, and in any area he may, is significant. In any case, for Europe, the distribution of days with precipitation different than for America.

It is clear that the relationship is quite complicated, and the reasons are many. Your phases of the Moon not only marks the change of sectors and "mark" the changes of short-wave solar radiation with cycles of about one month. Its gravitational effect it causes in the oceanic and atmospheric tides, that in certain situations, impact the bottom "floor" of the atmosphere (tides have, among other things, long-period harmonics: the total amplitude of the ocean tides varies with periods of 8.9 years, 18.6 years, etc.). In General, the Moon, of course, can be used as a predictor of the weather. Appropriate "rules" of the forecast is quite complicated, vary from place to place and we are now unknown. It is likely that the ancient astronomers these "rules" were familiar. In cuneiform texts of ancient. Babylon is a direct reference to it.

But back to the repeatability of the climatic situations associated with cyclic variations of solar activity. For predicting changes of weather — climate on the basis of such laws would seem to predict solar activity. But it can be carried out using another correlation — depending on the level of solar activity from the configurations of the planets. On solar activity according to the mutual position of the planets can be judged more precisely and more reliable than the time of passage of sector boundaries according to the lunar phases. And here we have to say a few words about a controversial and little-known issue of solar physics.

The study of variations in solar activity, which is carried out using strictly scientific methods for over a hundred years, gradually revealed a very complex multi-periodic nature of these variations. It was found, in particular, that among the variations there are sidereal (counted relative to the stars) the periods of rotation of planets around the Sun: mercury, Venus, Earth, Mars and Jupiter. This fact was the basis for the nomination of a hypothesis that solar activity is directly dependent on dynamic influences of the planets to the Sun (especially hot flashes). In the literature discussed various variants of this hypothesis. Now the opinion of most researchers is that these dynamic effects cannot be the cause of all the complex phenomena of solar activity. The latter is due to processes occurring on the Sun. Nevertheless, the

existence of planetary effects of solar activity should be considered proven. With this statement do not all agree, because it has no generally accepted theoretical interpretation. The presence of planetary effects of solar activity, however, can be understood, for example, on the basis of the hypotheses made by the Soviet physicist V. P. Kozlovym[5]. The essence of this hypothesis is based on the notion of a planetary system as a nonlinear oscillatory system consists in the assumption of the involvement of the Sun (of course, also the oscillating system) in General, synchronous oscillatory mode. This view does not consider weak gravitational influence from the planets on the Sun as the cause of its cyclic activity. These effects just maintain the stability of the oscillatory synchronized regime resulting from a long evolution. Cyclicity of solar activity according to the hypothesis determined by the oscillatory structure of the entire Solar system.

While there have been discussions on the possible mechanisms of planetary influences on solar activity, some researchers are developing methods of forecasting this activity, based on purely observational laws. A peculiar method of forecast was developed, for example, Kiev astronomer P. R. Romanchuk. It was found that the error in prediction of occurrence time of maximum and minimum activity, the value of the smoothed index value at the time of the maximum, this technique, at least not more than for traditional methods. Here, of course, it would be inappropriate to Express the technical side of the forecast. I would like to draw the reader's attention to the main idea of leadership, using "rules" like: "the solar Maximum occurs on average two years after the squaring of Jupiter and Saturn" (quadrature — configuration, in which the planets are visible from the Sun at a right angle). It is clear that observers on some Stonehenge or Carnac could access such "rules", but use them for predictions of solar activity and its terrestrial manifestations, epidemics, drought, locust attacks, especially high yields or outstanding luck hunting seasons.

Incidentally, such "direct" mapping — omitting the indices of solar activity — some geophysical phenomena and configurations of the planets were repeatedly carried out in our time. They unfailingly made disconcertingly clear results — much to the surprise and embarrassment of the authors of these studies. So, E. K. Bigg (Australia) found that large magnetic storms during the interval 1874-1954, he almost never checked in, if Venus and mercury were in the bottom joint. There was even a theoretical construct that

describes the "direct" influence of planets on the ionosphere or magnetosphere.

So now it is possible to formulate a scheme which, according to the authors, widely used by ancient astronomers to predict: of the above triad correlation — configuration of the planets — solar activity — earth manifestations of solar activity — they ruled out solar activity (which, of course, nothing was known). Used "condensed" chain of correlations, so that the configuration of the planets was directly correlated with the effects of solar activity in the environment. This approach is inherently no different from modern studies of the effect of solar activity on weather and climate changes or biological processes (the so-called solar biology), just as the solar activity index used for a certain very General indicator of planetary configuration. If to return to long-term weather forecast, we can see, for example, that for Europe one of the most important cycles of the frequency of occurrence of weather situations is about 2.2 years. It is very close to the period of the connection of Jupiter and Mars. Making systematic observations of their mutual arrangement, it was possible to note, what kind of configuration of these planets favourable weather in the area. When this configuration is repeated in the region and expected good weather. To account for the other rhythms of repetition is "their" planetary configuration. So, for accounting cycle 4.2 years well "suitable" period of paired connections of Jupiter, Earth, Mars and Venus.

The oldest of the currently known astronomical texts — Babylonian cuneiform tablets contain abundant information of this kind:

"In a month Abd on the 6th day NIN-Dar-Anna (Venus) appears in the East; in heaven will be rains in the land of emptying..."

"On the 11th day duzu NIN-Dar-Anna appears in the West. There will be military action; the harvest will be rich".

A sign with this text is now stored in the British Museum, was found in the Ashurbanipal library and is a replica of the specially filmed with earlier entry. Babylonian astronomers, who worked in the temples under the control and direction of the priests, possessed, apparently, of a long series of observations could, in principle, to identify predictive rules while keeping the important harmonics of the frequency of occurrence of the weather in their geographic area. The connection of the weather with the movement of the planets does

not seem to them strange or paradoxical, as it seems to us (with information about the nature of planets, we seem to "know" that this "can not be"...). They closely watched the glowing personifications of their deities and compared their movements with earthly Affairs. What was necessary to society, responded to his demands, was understood as the will of Heaven was fixed and strictly in images. In their empirical epistemological system, nothing more was required.

We will now proceed to consider the phenomena which it was desirable (or necessary) to anticipate.

If solar activity affects the climate and weather, it is not surprising that the most important cycles of solar activity, shown in the productivity indicators. This correlation in European science of the new time was first noticed by the famous English astronomer W. Herschel (1738-1822). From a comparison of the very short series of observations of sunspots and the price of commercial grain, he concluded that the Sun somehow affects the weather and climate conditions and thus yield. His colleagues nearly two hundred years later indeed found that global wheat production, in modern scientific language, modulated by solar activity with the already mentioned periods of 11 years and 22 years. The amplitude of this modulation is not trivial: from 10% to 50 %, depending on the technical equipment of agriculture of a given country. This is a pattern: in the Northern hemisphere the highest yield accounts for the years of maximum solar activity in the southern hemisphere — on the contrary, the most abundant crops are harvested, typically in the age minimum. This global pattern is superimposed, as already mentioned, the local features: in some areas indicated the regularity of poorly expressed, unstable, but in others, with some differences due to the diversity of the landscape — it is often manifested for a long time.

The actual harvest (in the bins) depends, of course, and from a number of other factors. Such as mass diseases of agricultural crops or outbreaks of pests. It is important to recall that many of these factors also have rhythms that are synchronized with solar cycles. Synchronization of biological processes such variations in solar activity does not occur due to weather changes, and owes its origin to the impermanence quite a different environmental parameter is electromagnetic background fields. Until very recently, this factor in evolution was not taken into account, and now its importance is underestimated. It is useful therefore to briefly tell you about it.

Always and everywhere the existing background electromagnetic fields in our environment occurs because of the many, while a variety of processes. At low (below 104 Hz) and low (below 102 Hz) frequencies, where the strength of the fields reaches quite high values, electromagnetic radiation is generated in the upper atmosphere — magnetosphere. Spectrum is a noise with a set of discrete "lines". The field strength increases with the increase in latitude, changes from point to point in connection with the change in the electrical characteristics of the underlying surface and is highly variable in time. Most importantly, these variations are unusually varied and very complex — is a fine indicator of the processes occurring in the near space environment of the Earth. And these processes are controlled by phenomena at the Sun, solar activity (since the orbit of the Earth is, strictly speaking, within the outer layers of the solar atmosphere). It turns out that these variations may reflect variations in solar activity. This is in fact the case. Individual parts of the spectrum of electromagnetic fields on the Earth's surface can be indices simultaneously corpuscular and wave tough solar radiation. For example, the micro-pulsations of the geomagnetic field with a frequency of about 0.1 Hz recorded at mid-latitudes in the daytime almost continuously, changing its frequency all the time "watching" for the intensity of the interplanetary magnetic field and its amplitude — speed solar wind. These oscillations are generated, as suggested, on the border of the magnetosphere. Extending to the earth's surface, they penetrate through the ionosphere, so that ionospheric perturbations also "hurt" these fluctuations. But the ionosphere is a "Registrar" of the intensity of solar radiation — from x-ray to radio.

All these details listed here for the reason that laboratory experiments in the last decade, found very high sensitivity of organisms to extremely low-frequency magnetic and electric fields of low tension. Now no doubt that amplitude spectral variations of low-frequency electromagnetic fields lead to biochemical, physiological etc. changes in organisms from bacteria to humans. Such changes are usually small (in the range of changes caused by any of the usual environmental variables). They are, however, enough to mode oscillations in biological systems (more precisely, self-oscillation) became synchronous with the cyclic variations of electromagnetic background, and consequently solar activity. By its physical nature, the phenomenon is in principle no different from the synchronization of oscillations in the Sun dynamic influences from the planets, which has already been described[6].

One of the most widely known oscillatory models in ecology — periodic changes in the number of two species, one of which serves as food for another (the model "predator — victim" Pan — Volterra). Fluctuations of this type are, of course, also must be synchronized through the same electromagnetic fields from solar activity. Indeed, as the statistics of the production of fur-bearing animals in Canada for this century most abundant in the procurement of pelts years, separated by gaps of about 10 years and have on certain phases of the solar cycle. For different types of these phases are different, which, of course, is not an obstacle to the use of this ancient predictive rules. If the number of, say, the hare reached the maximum in years of low activity, a rule could be formulated as follows: "the Most successful year in the production of a rabbit should occur two years before the squaring of Jupiter and Saturn"... the same type forecast rules, of course, could be found for other species of game animal, and to catch fish because of population dynamics of some species of fish known by the same patterns.

In conclusion, this section will focus on the possibility of prediction — using the same algorithm, phenomena directly related to human health. Here should be considered and the processes responsible for maintaining a demographically stable position in the community. For companies that are on the brink of survival, prediction (and hence control over all these processes) was not less important than a food problem.

First of all, think about confinement to solar maxima the largest epidemics, discovered by A. L. Chizhevskiy in the analysis of European mortality statistics of the plague and cholera. The mechanism of occurrence of the periodicity in this case is similar to that discussed above. It is clear that the onset of the epidemics was quite affordable for astronomical prediction. This forecast may have been used in the organization of control over the reproduction of the community. Now known statistics indicating an increase in the number of cases of complications with increasing level of geomagnetic perturbation (the severity of this phenomenon increases with the approach to high latitudes). Here we have, apparently, not with the biological rhythm, and direct modifying and damaging effects of electromagnetic disturbances. From the standpoint of General biological regularities such damaging effects should be expected particularly in those cases where adaptive (adaptive) mechanisms of the biological system is not yet fully formed, i.e. at an early stage of development of the organism. That is why special attention is

deserved by data on the influence of all kinds of disturbances in the external environment on the human organism during its embryonic (fetal) development.

With regard to the electromagnetic background, laboratory experiments provide in this case clear similar results. Perhaps the strongest impression left by these experiments with isolation of the organism from its external electromagnetic environment. It turns out that in all cases where electromagnetic shielding was highly effective, i.e., ensures the damping of the oscillations at very low frequencies, and when the test organisms were within the shielded volume for a long period of time (including the period of embryonic growth), in the development process have repeatedly pointed to a significant anomaly. As an illustration, you can refer to the experiments of V. P. Kaznacheyev and L. P. Mikhailova, conducted monitoring on cell cultures and chicken embryos. In their cells a magnetostatic field does not exceed 0.1% of the geomagnetic. It was found that the cell culture conditions of screening are relatively quickly lost, and the chickens hatched from incubated in the eggs, in 30% of cases were not viable. Developmental abnormalities were observed in experiments where the embryo is operated artificial weak low-frequency field, so that deviations from the usual electromagnetic background in downward and increase the development of body unwanted.

In the 11-year solar activity cycle, the repetition frequency of the natural electromagnetic disturbances and their extent vary greatly in the transition from high activity to a minimum. Does not it, that organisms whose embryonic period of development accounts for the maximum and minimum solar activity, acquire specific features, certain differences? Indeed, over the past two decades data have accumulated indicating the existence of some constitutional differences of the human body depending on the phase of the 11-year cycle, which accounts for the date of his birth. The differences cover a wide range of parameters. For example, some levels of blood pressure in schoolchildren is higher, the higher was the level of solar activity in the year of their birth. Famous Soviet pediatrician R. P. Narcissus and his collaborators found that children in utero development which took place at a higher level of solar activity are on average more susceptible to some diseases, and in the course of certain diseases these children have notable features. It was also found that the risk of schizophrenia statistically significantly correlated with the level of solar activity during fetal

development.

The number of such examples can be easily increased. We will confine ourselves to mentioning the existence of special physiological tests, giving significantly different results in their application depending on, whether the subject was born in the years of high or low solar activity. In General, if these kinds of observations reflect the real situation, we inevitably come to the conclusion that certain typological characteristics of the human body depends on in which phase of the solar 11-year cycle he was born. Since the phase of the solar cycle may be related to certain planetary configurations, then these typological characteristics are associated with the mutual arrangement of planets. It is tempting to assume that such a correlation was noticed in ancient times and served as the ideological basis for the development of the ancient cosmic doctrine, astrology. One of the first who drew attention to the possible epistemological roots of the emergence of astrology were A. L. Chizhevsky. The above-formulated assumption about the origin of astrology is, of course, a number of questions. Some of them will be discussed in the next Chapter. Here it is appropriate to explain some discrepancy, which probably did not escape the attention of thoughtful readers.

Judging by archeoastronomical data, ancient gave correlation relations between planetary configurations (i.e. solar activity) and terrestrial biological processes are very important practical significance. It seems strange, for in our time the cosmic influences on the biosphere are presented in General rather modest. This kind of influence are identified usually when using sensitive methods of mathematical processing of quite large data sets. The reality of detectable effects for this is often a subject of debate (the effects of solar activity on climatic change and now is controversial). Of course, in assessing the scale of the space influences the effect is still the inertia of the existing views — a century ago, the idea of the existence of such influences, many thought it absurd. In addition, in the past half century has shaped itself artificial habitat. The role of cosmic impacts in such a situation it seems unimportant. But the distinction in the assessment of the degree of importance of cosmic influences on the biosphere between us and our ancestors has another explanation.

Cosmic influences on the biosphere 10 thousand years ago.

It would be a naïve simplification to believe that the effects of solar activity

on the biosphere has at all times been like this. First, there are long term variations in solar activity — such as the Murderously Low, when almost half a century the activity was very low (1650-1700.), or the Medieval Maximum (1150-1250.) during which the activity was abnormally high. Secondly, it is known that the magnetosphere the role of the protective shell of our environment from space impacts affected large-scale changes.

Paleogeographic data relating to the age of 10 thousand years BC, does not contain, apparently, indications prolonged increase in solar activity in the mentioned period of time. As for the magnetic moment of the Earth (and the magnetosphere), it is cyclic with quasiperiod 6-7 thousand years.

Paleomagnetic reconstructions show that the time interval we are interested in the maximum magnetic moment is 1.8 times more modern, were in the 7th century BC. From that time to the present day its value decreases (the tense of the module of the geomagnetic field is decreasing at a rate of about 25 NT/yr). The closest minimum of the magnetic moment is about 4500 years BC (at that time its value was about half the modern value). The minimum on the curve of the restored values of the magnetic moment is quite wide — the era of low tension is the interval 5000-3000 BC All this time, the magnetic storms were on average much stronger and more often than in our days. It is highly likely that more tangible and biological consequences associated with these storms, electromagnetic disturbances. Quite rightly assume that more precise and stable rhythmic climatic variations — the same cyclic frequency of weather situations mentioned above.

Since the mechanism of influence of solar activity on tropospheric circulation remains to this day unknown, the last assumption is now hardly possible to justify. But with electromagnetic disturbances, the situation is clear and simple: laboratory experiments with artificial magnetic fields (for example, at frequencies of 0.1 Hz and 8 Hz) show that physiological, biochemical, etc. changes in experimental mammals accumulate (be more explicit) if exposure (usually about three hours) repeatedly. Higher amplitude variations of electromagnetic background in the era of reduced ("collapsed") of the magnetosphere, most likely, will not affect the synchronization of biological rhythms: for synchronization, the amplitude of the driving impact may be known to be very small. But the increase in electromagnetic disturbances is essential for their damaging effects on the body. But from this it follows that the above dependence of the typological characteristics of the human body from the phase of the 11-year cycle, which have a period of embryonic

development, enhanced, emphasized, when the magnetic moment of the Earth reaches a minimum. In such times become significant and other cycles of electromagnetic disturbances, superimposed on the "basic" 11-year cycle, the seasonal, weekly.

Currently, dependence physiological, psychological, etc. personal characteristics of the person from the season of his birth (or rather, the season, which accounts for the critical periods of embryo development) considered by many to be non-existent. It's definitely wrong. Proved, for example, that the risk of schizophrenia is significantly higher for persons born in the interval from January to April. Well-known Soviet psychiatrists N. A. cornet and V. P. Samokhvalov, analyze the data, note that these seasonal peak appears simultaneously in different geographical areas and does not detect dependence of socio-economic factors. These authors assembled their material, found that the date of births of patients with schizophrenia were intervals of increased geomagnetic perturbation and concentrated within the time of passage of the sector of the interplanetary magnetic field of negative polarity.

For the era, separated from us next 10 thousand years, paleomagnetic data do not allow to reliably estimate the magnetic moment. Likely, however, that in the time interval 10 to 30 thousand years ago its value was on average lower than at present, and somewhere in this interval for several millennia, the magnetic moment was generally close to zero: at this time we had the phenomenon of radical changes in the geomagnetic field of the polar inversion. If such a sign change of the geomagnetic field is the magnetic South pole near the North geographic pole North magnetic appears — magnetosphere completely destroyed and disappeared. The solar wind acts directly on the uppermost layers of earth's atmosphere. In such extreme conditions the effects of solar activity on the biological world, the climate and the weather was even more profound and pronounced.

Maybe this is the time an astronomical prediction has become an important factor in survival? And perhaps, far from the truth those authors that connect with this polar inversion of the spread of modern humans and the disappearance of the Neanderthals, whose cultural resources have been insufficient to adapt to the onset of harsh conditions? Reasoned response to these issues will give future research. If to remain within the less bold hypotheses, we can say that centuries of global variations of the geomagnetic

field to significantly modulate the magnitude of the impact of solar activity on the biosphere and climate weather. About 4500 years BC such impact was probably more significant than in our time, which stimulated the development of astronomical prediction. In the end of the 3rd Millennium BC was accumulated for such knowledge, in the North-West of Europe, a large and sophisticated observatories, including Stonehenge (2500 BC) and Karnak (2000 BC).

The most important results presented in this section can be briefly summarized as follows. The probable cause of such deep and abiding interest in the ancient astronomical observations of the moon, Sun and probably the planets there was satisfaction in the prediction and desire to organize socio-economic rhythms of the community in harmony with the essential rhythms of the biosphere. The prediction of weather and climate change in the coming years, the Outlook for major industries, the demographic situation, the prediction of occurrence of particularly adverse or hazardous events were significant factors for survival around 4500 BC in many parts of the World. Method of forecasting in General is clear. Of the currently known chain of correlations: configuration of the planets — solar activity — solar activity manifestations in the biosphere and atmosphere of the ancient astronomers used two links, directly comparing the relative positions of the planets with the manifestations of solar activity in the environment. Currently available data suggest that in this way it was possible in principle to predict the yield, the number of commercial animal, catch of fish, epidemics and epizootics, and also to control the demographic situation within the 11-year cycle and its major harmonics. Probably, the same has been noticed a connection of some essential typological characteristics of the human body with the phase of the 11-year cycle in which he was born, i.e. on the mutual arrangement of planets. These features are obviously also depend on season of birth (i.e. the movement of the Sun relative to the stars) and okolomatocnah (kolonodale) rhythm (the rate of which can serve as lunar phases). This empirical relationship was probably the ideological basis for the origin of astrology, although it is now clear that all these effects are caused by solar activity, whose effects on the body mediated by variations of the electromagnetic environment for low and ultra-low frequencies.

Correlation of configurations of the planets with vital for ancient human developments perceived them as a direct interference of these planets in his

life — good or evil. Should be surprised that the planet was elevated to the rank of deities, and the sky seemed higher force that controls the world?

Discover new calendar of countable structures (such as Achinsk rod), the results of the study archaeoastronomical postpone the beginning of systematic astronomical observations in the Old world to the era, separated from us by at least twenty thousand years ago. Of course, it is not easy to accept and interpret the output. The most important data and considerations that underlie the above hypothesis are as follows: with the beginning of formation of the person as beings biological social selection has practically ceased to have effect. The only way of adaptation was the change of behaviour driven culture. In the system of culture as the instrument of adjustment to the environment must be mechanisms of prediction. The anticipation of the changes in weather and climate, the prospects of the fishery, the demographic situation for the tribe, who were in extremely harsh conditions, was a factor in survival. The underlying assumption is that at a very early stage of cultural evolution was discovered correlation between variations in local weather and climatic factors, biological phenomena, on the one hand, and the movements of the planets. This correlation occurs in connection with influence of solar activity on earth's atmosphere and biosphere, and the statistical dependence between the level of solar activity and planetary configurations. The opening of such a predictive algorithm might be much facilitated, because the influence of solar activity on terrestrial phenomena in the present era, it was more meaningful than in our time, due to the relatively low then the magnitude of the magnetic moment of the Earth. The explanation of the strong interest of ancient human the Paleolithic era to practical astronomy puts, of course, a lot of questions. Some of them the authors are trying to answer. I would like, however, to warn the reader: in the region where we now are entering, there is more guesswork than informed speculation. The authors, for example, in his arguments, accept that the thinking of primitive man was the same type as ours — this provision, however, is still debatable.

The line between different natural phenomena and cosmic cycles or calendar can only be set for a long time, covering the lives of many generations. Clearly, observations must somehow be fixed and stably transmitted. One of the first questions — is it possible for astronomical information? At first glance, without the involvement of writing the transfer of such information

seems impossible. However, apart from literature, there are also other sign systems. At least two such systems have existed long before when there is a need to commit and then broadcast the first the simplest of abstract knowledge. First, it is rituals, recurring with great precision and executed with scrupulous neatness in all the little details. Secondly, it is art, in particular fine (in fact it was probably one of the single semiotic system, dissect us now because of our strong preference for dissection and analysis...).

About the rituals, sophisticated methods of psychotechnics and imprinting, used, probably, by our ancestors, we know very little. But the signs of the fixed information, which will continue to appear in the calendar systems in the form of icons and special structures the oldest ornaments have a wide — geographically — spread and quite numerous (we've talked about this, talking about the work of B. A. Frolov and A. Marshak). Sometimes these "commemorative record" nature "of the photographic image". Such, for example, the image of the Crescent moon and the surrounding stars, was found on a rocky slab in Fern cave (California, USA). The manufacturer of this fragment of the star map dates from the IX century ad (or even earlier), which corresponded to the region from the Neolithic. The Soviet astronomer J. P. Pskov inflicted on the image of the grid and subjected it to thorough analysis. It turned out that the ancient artist was quite accurate — all bright stars near the moon, it was possible to identify by far!

With the increasing amount and complexity of accumulated knowledge for their sustained transmission has gradually become the necessary special social organization. So a caste of priests. Their initial responsibilities was to regulate social and industrial activities of the community, the development and implementation of measures to strengthen its cohesion and stability, care about the timely implementation of hygienic and sanitary fitness activities. For the effective implementation of such functions is a very important authority. In order to strengthen it was developed by special techniques. Perhaps the most effective demonstration of the "omnipotence" of the priests was a special performance, showing that they "dutifully" not even the sky: after a long ritual procedures in a predetermined (secret) day, in front of all the people they "ordered" the sun out... So in the service of social needs (along with the prestige of a caste of professionals!) it was delivered the ability to predict solar and lunar eclipses. It is likely that the astronomical

service (including the construction of the Observatory) were fully in the competence of the priests. In different cultural regions specific social structures arising from the allocation of a caste of priests, had, of course, its own characteristics. So, in ancient Babylon, the priestly office was elected and the priests carried out their duties using the apparatus of highly educated experts and "technical experts".

The emergence of the first rudiments of literature at present is usually associated with satisfaction primarily economic (accounting) needs. But isn't the need to record the calendar-space information further impetus in the development of writing — at least in some pockets of culture? The Soviet historian A. A. Wyman, studied the formation of Sumerian cuneiform, came, in General, to precisely this conclusion. It turns out that proto-Sumerian figures, the first of which was invented in Mesopotamia symbolic notation, the combined total of the four elements: small and large half-ovals, small and large groups. The semi-ovals, according to A. A. Vaiman, denote the Crescent, and the circles symbolize the solar disk.

During the rule of the priestly caste was accumulated, arranged and recorded a large amount of knowledge. For learning the rituals and dogmas of the druids, the priests of Britain and Northern France, likely the descendants of the builders of Stonehenge — was required, as reported by Julius Caesar, about 20 years. These knowledge were elements of a coherent ideological system, the first in the history of the world, designed in every detail. Astronomy knowledge in this system, belonged, apparently, an important role. Hardly doubt that empirical information about the movement of celestial bodies and their synchronous changes in nature already in that distant time formed part of the special concept of ancient astrology.

The basis for this assumption is the well-known regularity of our cognitive mechanism. And our ancestors and we, of course, there is a common desire to make our knowledge complete. Inevitably — whether we realize it or not, the system of our ideas about some phenomena (or the world) is padded to integrity. This is closed, until the whole augmented system always (at any volume and the reliability of our knowledge) is fundamentally not an adequate nature — an infinite, open system. "Man, says our famous writer V. Tendryakov, can not endure inexplicable, for him there is nothing worse than ignorance". And here he builds on known facts a single building. This kind of completion the ancients seem to us at times childish fantasies and naive

speculation. With regard to ancient astronomical knowledge specified pattern has led, apparently, to the next extrapolation — generalization: "some natural phenomena correlated with the movement of the planets" — "everything in nature is determined by the planetary configurations." Concerning man: "constitutional features of the person associated with the time of birth (i.e. with the season and level of solar activity during embryonic development) — configuration of the planets on the day of birth unambiguously determines the fate of the individual".

In archaic society, any empirical knowledge was closely integrated with other socio-cultural phenomena. In particular this applies to magic.

More than four decades have passed since the time when the famous Soviet neurologist S. N. Davidenkov identified the main idea, explaining the nature and origin of magic rituals from the point of view of modern physiology. Considerations put forward by S. N. By Davidenkov, successfully withstood the test of time and attracts nowadays the attention of a wide circle of researchers. Let us briefly recall the main thrust of these considerations.

Observe, following S. N. Davidenkova, the behavior of modern Australian savage, who hurries home, trying to get to his camp before dark. The Sun does not have time to go until he returns, he makes a ridiculous, seemingly magical rite: breaks off a small twig and insert it in the fork of the tree. How to understand in this case the behavior of the person with, undoubtedly, great powers of observation and basing their actions on experience? But the fact that "ritual, although pointless, it achieves the purpose for which it is made," says S. N. Davidenkov. Hurrying home Australian aborigine is in a state of fear and anxiety. This anxiety hurts him and prevents him to focus, to choose the optimum route, etc. Fear, all increasing, acquires the character of a compulsive neurotic state and is a serious obstacle to achieving the goal. And then the person performs some action to create in the cortex of his brain, a new source of irritation. It does not matter what this action, it is important that a new source of irritation was conditionally linked to the main "pererastaet" hearth and he was quite emotionally powerful. Then for the first hearth it will be a source of external inhibition, and be able to lead other areas of the cerebral cortex in a normal functional state. Thus will destroy the feeling of anxiety prevented him, and came in a normal mental state can, of course, it is better to control his actions and will have a better chance to get

home before dark. The ritual reached the goal. Australian, repeating the process the next time, already justifiably should be treated as a person who performs his actions based on observations and logic. Conditional link used the magical procedure (the emergence of a new source of irritation of the cortex) with fear (the first radiating hearth) is established due to the fact that this procedure (ritual) were revealed to the Australian authoritative the source. The authority for it is so high that he believes in this relationship course.

Themselves separate magic tricks was formed quite by chance in some people, especially impressionable. Then they spread within a particular group in accordance with the mechanism of infection. The implementation in routine practice occurred after the approval (of the consecration) of this with the highest authority of this group. That's why a specific type of ritual are so diverse, quirky in different regions and different cultures. "Just receiving help, as it is not in the specific content of the ritual, and in the General principles of stagnation and negative induction..." writes S. N. Davidenkov. In General, our ancestors gradually developed the whole system of social mechanisms to compensate for undesirable effects of strong stimuli, inhibiting the activity causing the fear, uncertainty and doubt (a person can achieve anything if he believes in their strength). Magic was apparently a very important cultural phenomena of the ancient man. There is nothing unusual in the fact that a different sort of anticipatory signals obtained his information in continuous contact with the external environment, caused a dual reaction: on the one hand, a magical ritual, on the other — the practical steps required for adaptation. Not in all cases, these two types of reactions, we can confidently discern. This can be illustrated by analyzing the numerous types of divination, which is an extensive area of magic.

Mere fanciful variety of methods of divination tells us that here we are faced with the same physiological phenomenon. Indeed, taken in its simplest version, guessing easily amenable to interpretation in the spirit of S. N. Davidenkova. The person faced with the need to make responsible decisions in a situation where several possible outcomes are equally probable, it develops stress. People with defined characteristics of the nervous system that mental stress can have serious consequences. The appeal to the Oracle returns to the client psychological comfort ("made" everything possible...). The effect is, of course, only under condition of unconditional trust to the

Oracle from the "user" that is associated with the prestige of the Oracle and dissemination of appropriate attitudes. However, in all cases specified psychophysiological explanation is exhaustive?

Take, for example, divination by the entrails of sacrificial animals, is very widespread in Ancient Rome. Is the condition of the liver and spleen, the rapidity of blood clotting nothing can be said about the environmental situation? People involved in such examinations — in fact, the professionals could predict the onset of epidemics or severe winter. And it is a fair assumption that for many centuries of systematic observations during these autopsies were correlation "condition on the external environment", which we now know almost nothing, but which could be successfully used for real prediction of the occurrence of certain events. You can find the results of empirical observations and some other divination procedures. So, the Kazakhs from time immemorial it has been observed that just before a sharp rain — storm in winter, thunderstorms in summer, horse the young, especially the rapidly Shalit and sports. A similar change of behavior seen in other regions in dogs, some insects, etc. This is a real phenomenon, sometimes referred to as pre-storm excitement. Can therefore confidently say that guessing the behavior of animals lacking rational?

The same patterns occur when the processing in the system of culture of astronomical information. Some "cosmic" signs of the weather changes that were in Vogue in this century, are strikingly reminiscent of the above cited fragments of cuneiform texts. For example, compare the fragment on p. 34 with this sign: "If you fall Venus is visible in the morning — to the soft, and in the evening — to a harsh winter"Is, of course, in a pure form of empirical generalization, associated with the cycles of weather changes. In other cases, the inner essence of astronomical signs remains unclear.

The appearance of the comet in any cultural tradition — a sign of very bad or horrible. For the inhabitants of the Asian steppes, who enjoyed a 60-year calendar, the comet is a harbinger of the so-called jute — mass fall of cattle due to starvation. In Europe is a sign of impending disaster: the devastation of war, pestilence, drought (a real analogue of the "jute"), death the crowned heads... How to understand this surprising unanimity in the evaluation of the appearance of the comet? The word "superstition" here, as in other cases, explains nothing: it's the origin of "superstition" you have to understand, to withdraw as a consequence of some General regularity. You can, of course,

to assume that the reaction to the appearance of unusual cosmic events is just the manifestation of instinctive fear and the exact nature of the consequences of the "signs" attributed to the existence of some underlying physiological pattern of perception unusual phenomenon by any human being... But the fact of the complexity of an example that there is another possible interpretation.

According to statistics, comets often seen with the naked eye at certain phases of the 11-year solar activity cycle shortly before the maximum and before minimum. But if this is indeed the case, the appearance of a comet is predictive of a possible epidemic, and 60-year-old calendar of the comet should really appear more often before the year of the hare, when happen mentioned the lack of food. The specified pattern is discovered in a limited statistics, and its physical nature is still not clear; but, maybe in the probability of penetration of sporadic comets into the Solar system also has a frequency — such as it is revealed, for example, in the frequency of meteorite falls in China for a large interval of time — 11 years, 60 years?

In General, divination and omens, like other magic rituals performed in society, as a rule, an important function is understandable in the light of the ideas of S. N. Davidenkova. But in complicated real life situations all intertwined in the most amazing way. In some types of divination were present and rational predictive element.

The fate of the astrological doctrine.

Should immediately say that the oldest astrological systems have little in common with modern commercial astrology. The latter is a phenomenon of mass culture. It is, of course, nothing predicts and does not predict, but just for some people partly relieves stress tension, easing some of the burden of decision-making. In this capacity, she is completely invulnerable to scientific criticism, as evidenced by the wide spread of computer games, which allows you to "horoscope", or the prosperity of the respective companies (like "Astroflash").

It's hard to say exactly when the empirical generalization concerning the relation between mutual positions of the planets to some natural phenomena that has become a myth of total subjugation to the Sky of all things. It seems likely that the relationship itself "planetary configuration — the climate, weather and biological processes" was opened independently in different

centers of civilization. Surprisingly, the evolution of the mythologizing of this discovery occurred in the same direction. Making astrological doctrine first taken place apparently in Mesopotamia, where late 17th century BC tables have been produced of the phases of Venus, circa 700 BCE there existed a textbook of astronomy, at a surprisingly high level was practical medicine. "The human mind is constructed so that any of the most fruitful idea of followers aspire to continue beyond its applications", — said our great biologist A. A. Lyubischev. And if in the early stages of astrological predictions was used primarily for coordination of production and social rhythm with the cycles of the biosphere, to anticipate crop failures, epidemics, social crises, etc p., then the focus shifted to a detailed, "petty" regulation, with the division of days "favourable" and "unfavourable", with a schedule of all the days in the "Mesyatseslov". In classical Greece there was the famous concept of the "Great Year" — the connection of all the planets in the constellation is preceded by a global catastrophe, the Nature of the disaster depends on the constellation there was a connection. But the wide circulation was received that part of the astrological scheme, where the "prediction" refers to small everyday events in the life of one person. This is already the phenomenon of mass social consciousness, and the fundamental differences with modern commercial astrology is not here to detect. The creators of a completely new worldview — Greek philosophers — for astrology has no place. An important episode in the history of European astrology had its heyday in the XVII century, entirely different ideological conditions. Maybe by this time and reached its peak astrological magic with her funny for us "formulas" — a child born under the sign of Libra will be balanced, and under the sign of Aquarius will sink...

We should say a few words about the role of astronomy in shaping some of the important features of the ancient myths. Standing in the subheading combination of words usually associated in our minds with the question of the origin of the legends of the symbols of the names of the constellations in the Northern sky. This is an interesting and nontrivial question, but we are not talking about the division of the sky into constellations. The latter is a secondary reflection of the mythology that emerged relatively late, mainly in Ancient Greece. In this case it is important to note something else: the existence of signs of a deep "space" of experiences and certain astronomical knowledge in the ancient myths Dating back to the prehistoric past. An

example is the origin of the archetype of "repetition — the Renaissance". This essential feature of archaic public consciousness, probably, was one of the basic structures of ancient human culture: the reality of an object or action depended on the extent to which they repeat or imitate this archetype. But it is based on lies, apparently, an empirical generalization discussed in the previous sections: the cyclic changes in nature associated with space periods, especially during the change of the lunar phases. It seems likely that other elements of the "astronomical code" myths are the underlying basis of those astronomical knowledge that have been obtained of megalithic observatories or options (we are still little known). If the conjecture contains a significant element of truth, it additionally strengthens us in the main assumption: at the very first stages of development of a culture of observational astronomy has played in society prominent role, such that it left a deep imprint on the entire subsequent cultural evolution of mankind.

Our eyes are a significant element of the current worldview. This rapidly progressive process made a brief call the space program of modern science. The reason of "comisario" clear manifestations of this process are very diverse — from the penetration of the ideas of evolution and historicism in modern physics to the spread of the ultra-modern myths "space" painting. This pamphlet is also a sign of "comisario": an increased interest in the ancient cosmism could appear, of course, the new attitudes in connection with the development of interest in "cosmism" ("cosmism" in painting, "cosmism" in the works of A. N. Scriabin, etc.).

The main "space" attitude — commonplace, "common" idea that the Earth is not isolated from outer influences. It is well known that representations of the ancient this idea was taken a very important place, it seemed natural, not to be questioned. Personality, society, earthly nature was part of the cosmos. Experience the space of ideas and images in archaic cultures takes place in different forms, often it is inseparable from religious experience, fixed and remains very unfamiliar ways. Human experience is often summed up in terms of space and astronomical phenomena, on the contrary, recorded as a special code of conduct. All this for a long time impeded a clear understanding of the cosmism of the ancient science has practical roots. Now the situation has changed. Its characteristics in compressed form may be given following the words of a famous modern philosopher and sociologist P. K. Feyerabend[12]: "Thanks to the discoveries of Hawkins, Marshak and

others. we can assume the existence of some international Paleolithic astronomy that gave rise to schools, observatories, scientific traditions, the most interesting theories. These theories are expressed in sociological, not in mathematical terms, have left their traces in sagas, myths, legends, and can be reconstructed in two ways: to move forward to the present, from the material remnants of the stone age, such as marked stones, stone observatories, etc., and you can go back into the past, starting from the literary traces of..."

Paleolithic astronomy arose from the need to reconcile social and industrial rhythms of the primitive community with the natural cycles of the biosphere as an important part of the predictive apparatus of the ancient culture, allows to anticipate the onset of adverse social events. The main arguments in favor of this hypothesis, discussed in the brochure relate to the first of the two possibilities mentioned by P. K. Feyerabend. They can be summarized in the following theses.

— Ancient calendar systems contain cycles, coinciding with the main biological rhythms, such as weekly, 9 and 13 days, 260 days, 11 years, etc. the Compilation of such a perfect from an environmental point of view calendar, like 60-year-old "the calendar of animals" requires very careful observation for a long time.

— Opening numerical semantics in the Paleolithic ornaments, the detection of such a wonderful iconic structures as the Achinsk rod or a Maltese necklace, show that the accumulation of large amounts of relevant observations of evolution have sufficient time: the age of some of these findings not less than 15 thousand years.

The results archeoastronomical studies in General agree well with the above-mentioned archaeological finds. Although archeoastronomical while the observations cover a small part of the known World and some part of the ancient structures with astronomical purpose remains unsolved even for the surveyed territories, it is clear that already in the Neolithic systematic astronomical observations were common. They were carried out, in particular, at low latitudes, an important object of study was the Moon.

— The algorithm of the forecast of changes in the local climatic situation and prospects the most important crafts, as well as risk of occurrence of epidemics in General terms is clear. Major triads of correlations: "the configuration of the planets, the solar activity is a manifestation of solar

activity in the atmosphere and biosphere" the ancient astronomers used two elements of the triad. They directly compared the relative positions of the planets with the solar activity effects in the environment.

— Influence of solar activity on the tropospheric circulation, on biological processes at the present time it seems to many not too significant. It should, however, consider that we live in the era of anomalously large magnetic moment of the Earth, and a powerful magnetosphere now significantly reduces the effects of solar activity on the troposphere — biosphere. At the end of the Paleolithic — Neolithic, this "protection" was less effective. The closest minimum of the magnetic moment, corresponding to the epoch of maximum expression of the impact of solar activity on the environment, it is necessary to 4500 BC. It is not excluded that the effective prediction of changes in ecological situation was in this era of the survival factor. It is possible that the weakening of the influence of solar activity in connection with the increase of the magnetic moment (the maximum was reached about 7 century BC) contributed to the loss of interest in the practical application of this method of prediction.

The ancient naturalists have then probably noticed the connection of some essential typological characteristics of the human body with the phase of the 11-year cycle in which he was born (in their terms — on the mutual arrangement of planets). Mentioned characteristic features also depend on season of birth (i.e. the movement of the Sun relative to the stars) and okolomatocnah rhythm (where the indicator can serve as lunar phases). This empirical relationship was probably the ideological basis for the emergence of astrology.

— How empirical astronomical data was accumulated, handed down from generation to generation, how they interacted with other socio-cultural phenomena (including magic), you can imagine, of course, the lawsuit is still only in very General terms. Paleolithic astronomy had, presumably, a profound influence on the cultural evolution of mankind. That's why archeoastronomical interdisciplinary research are of great interest. Their further development does not indifferent to representatives of biological disciplines, including experiential knowledge of our ancestors on the problem of cosmic influences on the biosphere was probably more extensive and deeper than ours. The modern era demands the synthesis of ancient and modern knowledge, especially in the field of the science of man.

Astronomy is the study of the sky, the science of cosmic objects and events in the Universe. Is the study of nature and the Universe in which we live. Astronomers conduct their research, looking through telescopes, and "listening" (if we are talking about radio telescopes). There is a small telescopes, huge Observatory and the satellites orbiting the Earth and studying the types of radiation (such as ultraviolet, x-rays, gamma rays), which the atmosphere blocks the way to the ground. Telescopes launch rockets to study the upper layers of the atmosphere (the missiles are equipped with devices for carrying out scientific observations at high altitudes) and on unmanned balloons. Some devices also run on Board spacecraft for deep space exploration.

Professional astronomers conduct research Sun and Solar system, milky Way galaxy (where our Solar system) and the Universe outside our galaxy. They teach at universities, designing satellites in laboratories and working in planetariums. They write books, such as the one you now hold in your hands. Most of them have a scientific rank. It should be noted that today, many astronomers are engaged in theoretical physics, working with automated telescopes-robots, and therefore very distant from direct observation of the night sky. They may not even know where to look in the sky a constellation (group of stars that has a name, such as the Big dipper), which for many people becomes a "dedication" to astronomy. (You've probably seen the Big dipper — asterism (asterism) in the constellation URSA major. Asterism is a star configuration, which is assigned a name, which is neither one of the 88 known constellations.) In Fig. 1.1 shows a photograph of the Big dipper in the night sky.

Light gives us information about planets, moons and comets of our Solar system; the stars, star clusters and nebulae in our galaxy; about objects outside of our galaxy.

But this is not the subject of astronomy

Astronomy is not astrology! Astronomer awfully annoying when it naively called "the astrologer". According to astronomers when Jupiter aligns with Mars, it's a great spectacle for observers, and not a good or a bad omen.

Astronomers are not ufologists; they are not engaged in search of unidentified flying objects (UFO or UFO). Usually they can determine what you see. I

must say that astronomers and ufologists look to the sky. And they both see stars and planets. But, oddly enough, only ufologists take seriously stories about direct observations of alien beings or their aircraft.

The SETI program (Search for Extraterrestrial Intelligence — Search for extraterrestrial intelligence) is another matter. Here are research astronomers. They use sensitive radio telescopes, looking for any hints on the signals from space, which can be transferred from the planets of star systems beyond our Solar system. Recently, scientists have begun to look for messages that might come in the form of flashes of light coming from the lasers. The researchers suggest that these lasers can have civilization, much more advanced than ours.

While astronomers have not received any messages from aliens, but they continue to listen and look. All that astronomers have learned about the planets and stars, makes most of us believe that somewhere in the depths of space there are other habitable planets. Many astronomers agree with the statement, so liked to repeat the late Carl Sagan[3]: "We are not alone in the Universe."

In ancient times people did not think about the physics and chemistry of the stars; they were memorized and passed on to the next generations of legends and myths about the Big dipper, the Star Devil, the Moonlight man, the dragon devouring the Sun during a solar Eclipse, etc. These stories were different in different people, but many people have learned to recognize the configuration of the stars. In Polynesia experienced local sailors took place in the open sea in rowing boats hundreds of miles without a compass and any coastal landmarks in sight. They swam, guided by the stars and the Sun and using their knowledge of prevailing winds and currents.

Watching the light coming from the star, even the ancients noted its brightness, position in the sky and color.

The word "planet" comes from the Greek word planetes, literally "wanderer". The ancient Greeks, like almost all other ancient peoples noticed that the five points of light moved against the background of other stars in the sky. And some are constantly moving forward, and the other from time to time make a loop and go back their own way. And no one knew why. These spots usually do not flicker like other stars. And this difference there was also no

reasonable explanation. Each nation had their own names for these five luminous points or planets. And today we call them mercury, Venus, Mars, Jupiter and Saturn. And almost everyone already knows that they do not wander among the stars, and revolve around the Sun is a star located in the heart of our system.

Today we know that planets are objects that are more or less Land, but they are all much smaller than the Sun. They are much closer to the Earth than to the stars (not the Sun), so at least through a telescope, they are seen in the form of discs. This means that the planets have a round shape and distinct size. And the stars are so far away from Earth that even powerful telescope seem to be only luminous points.

From mythology to science

After the middle ages in place of the myths came scientific explanation of celestial phenomena. To replace, for example, ancient Egyptian myth that the earth and the moon carries the sky on its back the goddess nut, it is understood that the Earth revolves around the Sun, and the Moon around the Earth.

Isaac Newton created the theory of gravitation, and people began to understand what holds celestial objects in their orbits and why planets further from the Sun, periods of rotation around it more than the planets closer to him.

Then came the spectrographs and other devices. With these devices, astronomers determine the temperature of stars what substances enter into their composition, how fast they approach the Earth or away from it, as well as other basic physical characteristics. If space bodies have magnetic field can be measured at a distance. It is possible to estimate the force of gravity at the stellar surface, the density of its gas and more. (The word gas refers to a substance in the gaseous state, not a specific gas. For example, iron, the star is also a gas.)

But perhaps the most difficult to obtain information about the distance to stars and other objects beyond our Solar system. Some stars appear bright, but in reality it is a medium-sized stars, which are just a short distance ("near" means a distance of four light years or slightly more, but not hundreds of light years; a light year definition, see "Light year" in this Chapter). But

other stars are so faint that they can be seen only in the Observatory, a powerful telescope, although, in fact, they are very close (some dozen light years, no more).

Today the sky is divided into 88 constellations, which include all the visible stars. The international astronomical Union (International Astronomical Union), the highest governing body in astronomy, defines the boundaries of the constellations, that there was a clear separation of what belongs to the constellation each star. Before the sky was painted different astronomers who did not adhere to uniform standards. But it should not be. When you read that the nebula tarantula (Tarantula) is in the constellation, the Golden Fish (Dorado) (details in Chapter 12), you know that it should be found in the constellation Dorado, located in the southern hemisphere.

The biggest constellation is Hydra (the Hydra), and the smallest — the southern Cross (Crux). In fact, there is the Northern Cross, but you will find it in the list of constellations because it is the asterism in the constellation Cygnus. About constellation names there is a common agreement, but the meaning of each name, there is no agreement. For example, some astronomers called the constellation, the Golden Fish "swordfish," but I have to reject that name. And the constellation of the Snake (Serpens) is divided into two separate parts, located on both sides of the constellation Ophiuchus (Ophiuchus) the serpent's Head (Serpens Caput) and the tail of the Snake (Serpens Cauda).

Individual stars in a constellation usually not linked, just the Ground they seem to be located nearby. Some stars may be comparatively near the Earth and others at much greater distances. But for an observer on Earth, they are formed in a specific pattern.

As a rule, all bright stars in the constellation of the ancient Greeks or the astronomers of later times appropriated some Greek letter. The brightest star in any constellation is usually called "alpha" (the first letter of the Greek alphabet). The second brightest star is called beta (the second letter of the Greek alphabet), etc. to "omega", the twenty-fourth (and last) letters. By the way, all these Greek letters — lowercase, not uppercase, and they are written as: α , β , ..., ω .

So Sirius, the brightest star in the night sky — which is located in the constellation Canis major (Canis Major) is called alpha Canis major (Alpha

Canis Majoris). (Astronomers added to the end to get the Latin genitive. What can you do, scientists always loved Latin.) In table. 1.1 provides a list of the letters of the Greek alphabet in order — the names of letters and their corresponding symbols.

As example is the constellation of Chanterelles (Vulpecula), in which only one star has the Greek letter (alpha).

Astronomers have no special names, such as Sirius, for each star of the constellation Canis major, so they just call them in Greek letters or other symbols. In fact, there are constellations in which there are no named stars. (Not "buy" the ads, which offer to name a star for a certain amount of money. The international astronomical Union does not recognize the "bought" star names.) In other constellations the stars are assigned Greek letters, but it turns out that they have more 24 legkoatletki stars and Greek letters is not enough. So many stars, astronomers have assigned numbers and letters of the Latin alphabet: e.g. 236 Swan (236 Cygni), b Chanterelles (b Vulpeculae), HR 1516, etc. There is even a star called RU Lupi and SX Sex (honestly, it's not invented). But like any other stars, you can identify them not by name but by position on the sky (specified in astronomical tables), luster, color and the other it characteristics.

If you look in a star Atlas, you will see that certain stars in the constellation are marked as α Canis Majoris, β Canis Majoris, etc. Usually the area of the whole constellation is denoted as "Canis Major" and the stars, just like α , β etc. When in any astronomical journal, you read about the starfish, which is offered in the list of objects to observe, so most likely it will not be referred to either as Alpha Canis Majoris, or even as α Canis Majoris. Instead, to save space, it will be denoted as α Cma; "Cma" is an abbreviation Canis Majoris. Abbreviations of the constellations are given in table. 1.2.

Since alpha is not always the brightest star in the constellation, to describe the "high" status of the brightest star, another term is needed. The term Lucida (lucida). Lucida Big Dog — Sirius (α Canis major), but the Lucida of Orion (Orion) Rigel (b Orion) and Lucida Small Lion (Leo Minor) (not very noticeable constellation) — just 46 Small Lion (46 Leo Minoris).

In table. 1.2 lists the 88 constellations, their brightest stars and magnitude of the latter. Magnitude (magnitude) is a measure of the brightness of the stars.

(Magnitudes will be discussed later in the section "the smaller, the brighter: what is magnitude".) If the Lucida of the constellation is the same as its alpha and she has a name, I just quote it. For example, the brightest star in the constellation Auriga is Capella, the she- α Auriga. But if Lucida is not the same as alpha, I point out the corresponding Greek letter or other designation in parentheses. For example, Lucida Cancer is α Tarf (β Cancer).

On the star map, the image of the constellation or in the directory always specified magnitude of each star. Magnitude (magnitude) — it's just a certain level of brightness (or brilliance). The ancient Greek scientist Hipparchus divided them all visible stars into six classes — the bright, less bright, etc. in descending order of brightness. The brightest stars he assigned a magnitude equal to 1 (or first magnitude), followed by the brightness — is equal to 2, etc. up to the dim stars of the sixth magnitude.

Please note that, in contrast to most systems and units of measurement, the brighter the star the smaller its magnitude. But, since there is no perfection in the world, it was not the Greeks — even Hipparchos was the Achilles' heel: his system didn't left the brightest stars.

Therefore, modern science believes that a few stars have zero or even negative magnitudes. For example, the magnitude of Sirius is equal to 1.5. And the brightest planet in the Solar system Venus sometimes has a magnitude equal to -4 (this value changes depending on the distance of Venus to Earth and the position of Venus relative to the Sun).

Another omission: the ancient Greeks had a class of stellar magnitude for the stars, which they have not seen. At that time it was not considered a mistake, because these stars no one knew anything. But today we know that there are millions of stars that are not visible to the naked eye; of course, they also have some magnitude. They has large number: 7-8 for stars that can be seen easily in binoculars and 10-11 for stars that are easily visible in a small but nice telescope. The values of the magnitudes reach 21 for the faint stars that can be seen in the Palomar Observatory, and even 30-31 for the faint objects, and images are obtained with a telescope "Hubble".

Usually called the stars "fixed" to distinguish them from the wandering planets. But in fact, stars are in constant motion — both real and visible. The sky that we see above the head rotates because the Earth rotates. The stars

rising and setting like the Sun and Moon, but their order is unchanged. For example, the stars of the Big dipper cannot be turned over to Small Dog or Aquarius. Different constellations go back at different times and on different days, if you look at them from different points of the Earth.

In fact, the stars of the Big dipper (and any other constellation) moving relatively one to another with great speed — on the order of hundreds of kilometers per second. But they are so distant from us that scientists need to carry out accurate measurements using relatively large time intervals to detect their movement across the sky. So after 20 thousand years the stars of the Big dipper will create a different pattern in the sky. And maybe it will even be like a bear.

Meanwhile, scientists have determined the situation of millions of stars, has brought information about many of them in catalogs and noted on star maps. The position of the star on the celestial sphere is determined using such coordinates, as right ascension (ascension) and declination (declination refers), denoted by RA and Dec. These coordinates are similar to latitude and longitude used to determine the position of an object on Earth.

RA (right ascension) is the position of the star measured in the Western or Eastern direction on the sky (similar to longitude counted from the zero Greenwich Meridian).

Dec (declination) is the position of the star measured in a North or South direction on the sky (the analogue of latitude is counted from the earth equator).

RA is usually counted in hours, minutes and seconds, like time, but sometimes in degrees.

The star with the coordinates RA 2h 00m 00s is 2 hours East of the star with the coordinates RA 0h 00m 00s, regardless of the declination. RA increases from West to East, starting with the value RA 0h00m00s, which corresponds to the heavenly semicircle with center in the center of the Earth extending from the North celestial pole to the South. The first star can take Dec declination of 30° North, and the second — Dec, 15°25'12" South, but they will still be at 2 o'clock on the axis East-West (and at a distance of 45°25'12" along the axis North-South).

The Northern celestial pole (the North Celestial Pole NCP) is the point on the sky, pointed to the Earth's axis, extended in a northerly direction. If you stand at the geographic North pole, the NCP is directly overhead.

South celestial pole (South Celestial Pole SCP) is the point on the sky, pointed to the Earth's axis, extended to the South. If you stand at the geographic South pole, the SCP is directly overhead. Only need to dress warmly, it's in Antarctica!

Imaginary line corresponding to equal values of RA, passing through the NCP and SCP and represent a semicircle, the center of which is located in the center of the Earth. They imagined, but, nevertheless, marked on most star maps, to provide people the task of finding stars with specific values of RA.

Imaginary line corresponding to equal values of the Dec, for example, 30 to the North, are in the sky directly overhead at the corresponding latitude. So if you are in new York, i.e. at 41° North latitude, directly overhead you will have a point with coordinate Dec 41 North, although its RA coordinate is constantly changing as the Earth's rotation. These imaginary lines also marked on star maps, and they are called circles of declination (declination refers to circles).

Astronomy at home

If your yard is a place, which is visible from the sky (where the trees and neighboring houses do not prevent the review) — that is enough. A clear night will set the telescope or take the binoculars and begin to identify stars. If you live in a major city, the lights of which interfere with observation of the night sky, then join the astronomy club. Usually the club members are, where possible without interference to engage in observations. Sometimes it is enough to leave the city.

If you are mainly interested in science discoveries made by the astronomers — can read news from magazines, specifically targeted at Amateur astronomers. And even better to visit free Web sites where you will tell everything you always wanted to know about space and what you didn't even know existed.

Astronomy is the perfect hobby for the whole family. One has only to set the telescope, as everyone around will want to look at him though the corner of his eye. You have no one to leave the children? Dress them warmly and bring

along the "astronomical event." They will even help you to carry the telescope. Grab the blankets and sleeping bags. The best way to think about the world is struggling with sleep, admire the magnificent spectacle of the starry sky.

Suppose you want to find the NCP. Become the face exactly to the North and look for a point located above the horizon at an angle of X degrees, where X is your latitude. (I assume you live in North America, Europe or any other point of the Northern hemisphere. If you live in South America, South Africa, Australia or anywhere in the southern hemisphere, you will not be able to find NCP, because instead you need to look for SCP. This become the face exactly South and look for a point located above the horizon at an angle equal to the value of your latitude.)

But I want to reassure you: if you just want to learn to find in the sky constellations and planets, it is possible to do without RA and Dec (if they scare you). You only have to compare the star map for the appropriate time of year and night (these cards are printed in the astronomical journals and calendars) that you see in the sky. But if you want to figure out how to use star maps and directories and how to find with your telescope distant galaxy, try to deal with these coordinates.

If you have purchased a new, elegant and surprisingly not too expensive telescope with computer control (detailed in Chapter 3), you can enter the coordinates RA and Dec newly discovered comet and the telescope will be aimed at her. (Typically each message about the discovery of a comet is a small table, or ephemeris, which lists the estimated coordinates of the comet's RA and Dec, night after night, for its path across the sky.)

Gravity: what must be considered

Since the time of Isaac Newton in astronomy, everything revolves around gravity. As explained by Newton, is the force that occurs between two objects that depends on mass and distance. The greater the mass, the stronger the force of his attraction. Conversely, the greater the distance, the weaker the force of gravity.

Albert Einstein developed an improved theory of gravity confirmed by experiments, which could not stand the old theory of Newton. Newton's theory is good for describing gravity in normal conditions, for example, as a

force that causes the Apple to fall on his head (unless, of course, not fiction). But Einstein's theory allows you to predict what happens next with objects of very large mass, where the gravity is extremely high. From the point of view of Einstein, in fact, gravity is not a force but a curvature of space and time an object with a large mass such as a star. Speaking about the curvature, I don't mean shape.

Newton's theory explains the following.

Why the Moon revolves around Earth, Earth around Sun, Sun around the center of the milky Way, etc.

Why are stars and planets round.

Why are gas and space dust are attracted and form new stars.

Everything in the Cosmos is continuously moving and turbulent. Space objects can't stand in place. There is always the body that attracts any star, planet, galaxy or space ship. The Universe has no center.

For Example, The Earth:

rotates on its axis, making a complete revolution per day, or 24 hours;

revolves around the Sun, making a complete revolution in one year, or 365 days;

moving to the Solar system on a very long orbit around the center of the milky Way, making a complete revolution in about 226 million years; the duration of this journey is called a galactic year.

moves along with the Milky Way around the center of mass of the Local Group of Galaxies (Local Group of Galaxies), which includes two dozen galaxies in our corner of the Universe;

moves together with the Local Group of Galaxies in the Hubble flow of galaxies in the expanding Universe generated by the Big Bang.

And any inhabitant of the Land involved in all these outer movements, and always when driving, going to work and even when asleep, without thinking about it. So next time you're late for a few minutes, have to take this fact into account.

Remember the movie "ginger and Fred"? They danced together and ginger

did all the same as Fred, only backwards. Just as in the case of ginger and Fred, the Moon repeats all the movements of the Earth (though not in the reverse direction), with the exception of its rotation around its axis. The moon rotates slowly, making a full rotation in about a month. And, turning on its axis, it is at the same time revolves around the Earth (and also makes a full revolution in about a month).

The big Bang is a hypothetical event which gave rise to the Universe and made it expand at breakneck speed. This theory allows to explain many observed phenomena and to predict that it was impossible to predict before. Today it is considered the best theory of the origin of the Universe.

I hope you understand what a cool book. Even the first Chapter is already ending with a Big Bang!

Chapter 2 observation of the sky: find the company

In this Chapter...

Astronomical clubs and other resources

Observatory and planetarium

Astronomy attracts, if not all, very many. Stars have fascinated people of all countries and continents back to prehistoric times. In ancient times, observation of the sky led to the creation of various theories about the Universe, higher power and purpose of the movement of stars, planets and comets. When you look at the sky, thousands, if not millions, of people around the world are doing the same with you. And over time, these observers have established the foundations of modern knowledge about the sky and celestial bodies. So if we talk about the observation of the sky, then you are not alone in your passion. There are a lot of people, books, articles and other resources that will help you gain the primary knowledge to be aware of events and to take part in the great work of Space exploration.

In this Chapter you will become familiar with these resources and can start their acquaintance with astronomy. Everything else depends on you. Join us!

You are not alone!

A large amount of information, many organizations and people will help you to acquire basic knowledge and to be aware of events. For example, the initial

information on astronomy and information on current celestial phenomena can be found on the Web sites. In addition, you can become a member of clubs and associations to attend meetings, lectures and special classes.

Pulkovo Observatory

Main (Pulkovo) astronomical Observatory of Russian Academy of Sciences (GAO RAS), founded in 1839, located in Pulkovo near St. Petersburg (www.gao.spb.ru). This is a research centre of world importance for the implementation of major fundamental and applied scientific projects in astronomy, designing and building major instruments, the organization of the new Supervisory databases and observatories, training of qualified scientific personnel. The breadth of coverage of areas of modern astronomy — astrometry, celestial mechanics, astrophysics, solar physics, radio physics of the Pulkovo Observatory is the most unique institution in Russia.

GAO was organized and equipped with instruments for observation bases in Azerbaijan (Ordubad), Armenia (Ararat expedition), Tajikistan (Pamir expedition), Uzbekistan (Kitab), Chile, Bolivia. The Simeiz Department of Pulkovo Observatory was transformed into the Crimean astrophysical Observatory (CrAO), Nikolaev branch — in the Nikolaev Observatory (now Observatory Committee on science and intellectual property of Ukraine), the expedition GAO in Bolivia became an independent National astronomical Observatory of Bolivia Santa Anna. Founded in 1948 Kislovodsk Mountain station GAO (GAO GUS) is the only solar Observatory in Russia, providing daily integrated surveillance (monitoring) of the Sun, unique in the world in regularity.

The Observatory conducted extensive work on the development and implementation of unique Astro equipment. Only in recent years created a number of ground-based telescopes (MAGIS, 3A-32), developed three draft space astrometric system ("Struve", "Stereoscope" and JOBS) made ground-based astrometric reflector AR-115.

The main directions of celestial mechanics:

the study of motion of Solar system bodies; the use of the theory of motion of artificial Earth satellites in applied problems;

the study of the shape of the Earth and the gravitational potentials of the Earth and planets of the Solar system;

the study of the dynamics and evolution of planetary rings, the galactic disks and similar objects; chaotic dynamics of celestial bodies;
ephemeris support of observations.

Main areas of astrophysics:

cosmomicrophysics (astronomical methods of the search of non-baryonic dark matter in the Universe);

studies of close binary systems, and stars with shells;

studies of star clusters;

the study of stellar atmospheres;

search for and study supernovas.

Observation programs are carried out at major domestic and international telescopes (BTA-6m, ZTSH-2.6 m Ukraine, the instruments of the European southern Observatory, Observatory, South Africa). A comprehensive program for follow-up observations performed with the telescope AZT-24 GAO RAS, newly installed in Campo Imperatore (Italy) and equipped with modern recording equipment the Italian side.

The main directions of the physics of the Sun:

study of the internal magnetic field of the Sun helioseismology methods;

the study of the nature of solar activity;

monitoring of active processes on the Sun and solar cycles;

nonlinear processes in physics of the Sun and stars.

We live in the era of great discoveries in the Solar system... not all the inhabitants of the Earth excited by this fact. Will not them to blame for it. The age of discovery — 500 years ago — also proceeded without much public interest, but, centuries later, its fruits are all.

The second volume of the series "Astronomy and astrophysics" dedicated to the Solar system — the nature of planets, satellites and small bodies.

Although this book is written by astronomers, we understand that studying the Solar system far beyond the classical science of heavenly bodies. From

looking at the distant hazy spots in the telescope what did astronomers of the past, scientists have turned to direct sensing of the moon and the planets, asteroids and comets. The authors of the latest discoveries on other planets are now not only astronomers, but also specialists in space technology, as well as geographers and geologists, which now can rightfully be called a planetary community. And near the time when a new specialty — ekzoplanety, a specialist in planetary systems of other stars.

However, against the background of this "dizzy with success" it is important to understand that the rapid expansion of the geographical boundaries does not mean that our planet — Earth has already been investigated enough. On the contrary, its detailed study is now in full swing. In fact, only recently, thanks to satellites, people have seen the entire surface of the Earth. And what lies beneath it? What lurks in the depths of the oceans? How to look like the continents under the ice domes of Greenland and Antarctica? What happens deep in the bowels of the earth? How does the geomagnetic field? What is the cause of global climate change and biosphere catastrophes? Finally, how has formed our unique planet and what role in this belongs to its giant companion — the moon? The planet Earth is for us still a mystery. The answers to many questions can be vital to our civilization.

Here is the characteristics of planet Earth:

The semimajor axis of the orbit $1 \text{ a.u.} = 1,496 \times 10^{11} \text{ m}$ Sidereal period of revolution 365,2564 days. Tropical orbital period ("year") 365,2422 days. $= 3,1557 \times 10^7 \text{ s}$. the Sidereal period of rotation ("starry night") 0,99727 day. $= 23 \text{ h } 56 \text{ min } 04 \text{ s}$. the mean solar day ("day") for 24 h. the Eccentricity of the orbit 0,0167. The average orbital speed of 29.8 km/s. the Inclination of the orbit to the equator is $23^\circ 26'$. Mass, $M 5,9736 \times 10^{24} \text{ kg}$ Average density of 5.52 g/cm³ Equatorial radius, $R_e 6378,160 \text{ km}$ and Polar radius $R_p 6356,777 \text{ km}$ the Average radius, $R 6371,032 \text{ km}$ Compression $(R_e - R_p)/R_e 1/298$. Acceleration of gravity to the Earth at the equator 9,80665 m/S² the Acceleration of gravity at the equator 9,78033 m/S² escape Speed (2-space) of 11.19 km/s. rotational Speed at the equator 465,11 m/s Dimensionless moment of inertia (in units MR^2) 0,3308 the radius of the outer (liquid) core 3480 km. the Average density of the outer core 10 g/cm³ the radius of the inner (solid) core 1270 km. the Average density of the inner core 13 g/cm³ Spherical albedo (bond) 0,306. The geometric albedo (visual) 0,367. The flow of solar radiation outside the atmosphere 1369 W/m² total absorbed

radiation is 1.2×10^{17} watts. The flow of heat from the bowels of 0.05 W/m^2 . Effective temperature $247 \text{ K} = -26^\circ\text{C}$. the Average temperature at the surface, $287 \text{ K} = 14^\circ\text{C}$. the air Density at the surface of 1.22 kg/m^3 , the Pressure at the surface of 1.014 bar .

The mass of the ocean is $1.4 \times 10^{21} \text{ kg}$.

The mass of atmosphere is $5.2 \times 10^{18} \text{ kg}$.

Atmospheric composition (volume%) N_2 (78), O_2 (21), Ar (0.9), CO_2 (0.03).

The magnetic moment of a geocentric dipole 0.299 GS Re^3 (2005).

The inclination of the axis of the dipole component to the rotation axis of 10.3° (2005).

The number of satellites 1 (the Moon).

In the study of the planets of the XX century brought us the rather sport-technical achievement than science: most of the planets was "achieved", their spectacular images have been downlinked and distributed, which in itself is great, but detailed systematic studies have not been conducted. The data obtained largely raised new questions than answered old ones. But in the last decade, in fact — the twenty-first century, the planet took seriously: Jupiter and Saturn appeared in the long-term Orbiter (Galileo and Cassini), began landing on moons of planets (while this is only Titanium, but only at the start), working machines Venus, fly to mercury and Pluto, and Mars and say nothing — next to it and on its surface is constantly subject to a scientific Armada. From the category of political-ideological interplanetary flights moved into the category of purely scientific. About them have less to write and speak, but they began to yield a much greater scientific harvest.

While space exploration and Earth have always occurred and are now parallel, waiting, and helping each other. I can recall that the twentieth century began with the conquest of the poles of the Earth, only in the middle of the century had achieved the highest and the deepest point of the earth's surface, and that only the end of the century was more or less explored the whole thickness of the atmosphere of our planet. We can say that in the end of XX century the age of discovery turned into the Grand era of interplanetary missions. Let me remind you that the scientific exploration of Antarctica began during the International geophysical year (1955-1958),

when was launched the first artificial Earth satellites.

In Fig.1 we can see the back side of the moon. Many astronomers of the past centuries were willing to give their lives to see this picture. The space age has brought us many beautiful images of distant planets, but this is the first space nearest the heavenly bodies will forever remain the most valuable. And not because he was the first, although that is important. The value of this picture in his indispensability: from all that we would like to see in the Solar system, in principle, impossible to see, not leaving the Ground, only the back side of the moon. The probe photographed the moon the usual (for that era) cameras with long-focus and short-focus lens, showed a film on Board and using totelevision system transmit the obtained images to the Ground. Computers on Board the probe was not at all. And although the technical quality of this picture is low, he had a big opening — side of the moon are quite similar to the visible side. The mystery is not solved until now.

In fact, the romantic era of geographical discoveries were not interrupted. And today each of us has the opportunity to be a "member" of several challenging expeditions. Through the eyes of robots we see all that you can see the scientists who organized the flights to other planets. Stunning Martian landscapes cannot leave us indifferent. We look forward to planting probes on the surface of planetary satellites, asteroids and comet nuclei. In our days people go ahead of the machines; I probably will always have. But the severity of our sensations is not reduced by this.

I wonder how many people would monitor the expeditions of Columbus and Magellan, if at that time their ships were Webcams on-line? In our days everyone has the opportunity to become a virtual pioneer. But how many people regularly visit the websites of NASA to monitor the progress of the Mars and other interplanetary missions? It turns out that such curious considerably less visitors than the porn sites. Fortunately, romance search is still a unique human trait: the desire for new knowledge for thousands of years helps us to evolve faster than any other species and because of this, radically improve the conditions of our lives. And so it will be up until caravels sail to uncharted lands, and the probes are flying to new planets!

As you know, science and technology mutually reinforce each other. This fully holds true for astronomy. Once, thanks to her, greatly accelerated the development of mechanics and optics, and today's technical achievements

give back to science: starting in the second half of XX century technical revolution in astronomy continues. It was hard to foresee 20 years ago, what heights achieved today, the possibility of astronomical observations.

Telescopes-reflectors with primary mirrors with a diameter of 5-6 m. it seemed (and actually was at the time) the limit of the technical capabilities, and today operates several 10-meter telescopes, and designed tools up to 100 meters in diameter! The astronomer-observer, as a scientist, a recluse, a conductive alone at the telescope long night is gone: a modern 1,000-ton telescope is managed by a team of engineers and computers, solving the task set by the astronomer.

Astronomy is the oldest of the Sciences, and always the chief instrument of the astronomer were the eyes. First it was the naked eye, then — armed with a telescope. And even in the era of photography, significantly ucelevshiy capabilities of the telescope, the eye remained in the ranks, becoming a primary receiver secondary light: photographic emulsion on a glass plate, the astronomer, until recently, could only study eye. Now this age is coming to an end. With the help of automatic photometers astronomers will soon complete the scanning and digitization of all ever captured of photographic plates, and millions of them! and then the era of visual astronomy will end. The content of the precious "glass library" of all the observatories around the world will be available to any professional and even Amateur.

However, the effectiveness of electronic eyes have already won their live counterpart. The last 8-10 years automated telescopes became virtually on their own to make discoveries, and with stunning efficiency. To take this relatively routine work, as the search for asteroids. Since the discovery of the first of these (1801) for 90 years, astronomers have visually opened 322 small planet. In 1891, Max wolf of Heidelberg Observatory (Germany) opened the first photographic asteroid (No. 323). After a century, to January 1, 1991, all were found 4655 asteroids. Thus, the "photographic age" compared to the "visual age" has increased the number of asteroids on the order. In the 1990s the photographic plate and the eye began to replace the electronic light receivers, mainly CCDs. As a result, by the end of 2007, there are about 400 thousand asteroids, of which about half is studied in sufficient detail to accurately determine their orbits. Less than 20 years, the number of known asteroids increased by two orders of magnitude! Now they are open about 5,000 every month! The rapidly growing number of known planetary

satellites: in the 1980s there was 45 today — about 170. At that rate, it will soon be finished, a complete inventory of the Solar system.

The opening of a large number of new objects, first of all requires their classification. In recent years, introduced many new classes and removed some old, for example, "minor planet" as a synonym for "asteroid". In 2006, the International astronomical Union adopted a new term "small Solar system body" (small Solar system body SSSB) to represent all Solar system objects that are not classical planets (mercury, Neptune) or planets-dwarf (dwarf planet) and their satellites. Thus, the number of small bodies in the Solar system were all comets; all the traditional asteroids (except Ceres, are related to the planets-dwarf); "the centaurs" (centaur), moving between the orbits of the giant planets; all the Trojans, moving along the orbits of the planets in sync with them, as well as almost all objects beyond the orbit of Neptune (trans-Neptunian object, TNO), except Pluto and Eris, are related to the planets dwarfs. I repeat: the satellites of the planets are not among the small bodies of the Solar system.

It is possible that over time some of the largest of the small bodies of the Solar system will pass into the category of planets dwarf, if it turns out that they have a rounded shape, acquired under the action of its own gravity (i.e. are in a state of hydrostatic equilibrium). Obviously, among the satellites of planets, some are entered once in the number of small bodies in the Solar system and was later captured in circumplanetary orbits; this primarily refers to the irregular outer satellites of the giant planets. As for the lower boundary of the mass of small bodies of the Solar system, formally it is not defined and, therefore, their number can enable even small objects meteoroids with a size of 1-100 m. this is why in the Chapter "Small bodies of the Solar system" described not only the asteroids and comets, but also meteors, and meteorites.

As you can see, the study of the Solar system, in addition to the purely "financial" achievements, in terms of the number of open objects, there has been progress in matters of principle (as it is known, quantitative changes always go into quality). In recent years, populations of small bodies of the Solar system opened several new classes of objects of interest as their physical properties and character of the movement. For example, highlighted several new families: the near-Earth asteroids; Trojans of Neptune and (maybe) Mars; the centaurs moving in orbits between the giant planets; asteroids in horseshoe orbits; asteroids with satellites and double asteroids; as

well as temporary satellites of major planets, the Kuiper belt objects, burning up in the atmosphere of the Sun the comet, tumbling asteroids, and satellites. In addition, the collection of planets divided into two subclasses — large, or classical, the planets and the planet-dwarfs (so far there are three: Pluto, Ceres and Eris). The decision to exclude Pluto from the group of the classical planets has received a huge public outcry and for many was painful ("the Astronomers promised to find the tenth planet, and have reduced the number to eight!"). Passions have not subsided, but, apparently, the new nomenclature will catch on.

All small bodies are now divided into two main groups — moving inside the orbit of Neptune (cis-Neptunian objects) and outside of its orbit (trans-Neptunian objects, TNOs). Between the to-Neptune-Neptune objects also revealed a small body. We are not talking about satellites of Neptune, and about the "conditionally free" bodies — the Trojans of Neptune. In March 2008 they were known 5; all of them in excess of 100 km diameter, and all move more or less in the orbit of Neptune is 60° ahead of him, in the neighborhood of the Lagrange point L4. In order not to complicate the classification, the Trojans of Neptune attributed to the first group.

Given the huge number of newly discovered small bodies, obviously, in the near future will be highlighted and their new group. For example, a proposed new family of "damocloid" (Damocloids), named for the object 5335 Damocles, having vysokoekonomichnogo long-period orbit, like Halley's comet, but it is not showing the coma and tail. Already found dozens of similar objects, probably is degassed nuclei of comets, covered with a thick crust (the surface all is very dark). Damocles among them he highlighted the fact that moves in a retrograde orbit is a characteristic of comets.

As always in science, the accumulation of facts and following this period of classification is over, a deeper understanding of evolution and its mechanisms — "laniewski" period should be "Darwinian". Soon this period will come in the study of the Solar system. Fortunately, we still have a lot to understand in its history. So the most interesting discoveries ahead!

Along with the astrometry celestial mechanics — the oldest branch of astronomy that existed in the third Millennium BC the Main twofold task of celestial mechanics: from antiquity to the present day — the construction of a mathematical model of the motion of celestial bodies and determination of its

parameters from the observations.

In this article I will use the modern term. But to transfer the flavor of the era sometimes useful to bring and old. Loving the stilted style, our predecessors didn't say "model" and "System World". The phrase celestial mechanics appeared and came into use only after the publication in 1798 of the eponymous essay by P. S. Laplace. But as told before? In ancient times all. Astronomy, and all here! Then they started to add adjectives and long identified theoretical astronomy and celestial mechanics. Then the theoretical topics has appeared in other branches of astronomy — especially in astrophysics, and now the term "theoretical astronomy" almost out of use.

History of celestial mechanics is divided into two big periods: before and after book 1686 I. Newton "Mathematical principles of natural philosophy". From that moment, science in the modern sense of the word. The movement brought a clear result of physical causes, whereas the causes were not known and the mathematical model in no way limited but the lack of imagination of scientists or ideological dogmas that prevailed in the society.

Many of my friends-astrophysics (astrophysics as the beginning of modern science occurred during the lifetime of some still alive centenarians) telling me that celestial mechanics as a science started with Newton, and before that it was only pregnancy. I will not argue about the terminology, because basically we present the development of science in the same way. Generously offer the opposite: add astrophysics to the age of several millennia. Because the color and brightness of the moon, Sun, stars, planets say something about their physical properties; flickering lights and colors of stars change the color and brightness of lights depending on the height above the horizon, changing the color and brightness of the moon during a full lunar Eclipse talking about the properties of the atmosphere of the third planet; the unchanged appearance of Bailey's beads and the corona at a total solar Eclipse tells about the topography of the moon and the properties of the solar atmosphere and corona. You can continue: meteors, meteorites, comets, new stars...

A very ancient China, 2137 BC Court. The two are charged with a state crime. The Prosecutor there is no need to invent clever arguments to support the charges. And not because is the thirty-seventh year. The Prosecutor's brief:

"The Imperial astronomers, Hi and Ho did not predict a solar Eclipse! Know this and can confirm all. As a result, the dragon began to devour the Sun in the eyes of the affected people are not prepared to repel aggression terrible, not warned by those who had to do this on duty".

He took a deep breath, stretched his convicting hand in the direction of pale scholars and continued:

"And they indulged in debauchery by night instead of watching the lights, drinking in the afternoon instead of having to calculate and process monitoring. Fortunately, vigilant guardians of the Public Security did not panic, picked up the people and threw him to fight the dragon. Terrible noise from the pans, pots, basins, which beat furiously screaming people, scared of the dragon and get out. Otherwise would disappear and the Sun would have died in the celestial Empire (scary thought!) and all the other barbaric peoples of the Earth (which, however, negligible, and charges are not included). Death state criminals!"

Protection had nothing to oppose — the Eclipse really occurred, but was not predicted. Poor executed... And we are with you by the method of Sherlock Holmes to draw conclusions from this sad story.

The output of the first. Over four thousand years ago, astronomy was already so developed in China that experts almost accurately predicted eclipses of moon and Sun. If they were wrong at least in one case out of ten, China has perechislili all astronomers.

In fact, the Chinese are already well imagined movement of the Sun and moon on the celestial sphere that need to prednisolene eclipses.

The output of the second. Astronomy was in the public service. Science classes was equal to military training. Is it because Ancient China is the only ancient States disappeared from the face of the earth after Sumeria, Babylon, Assyria, Egypt, Carthage, Rome...

The third conclusion. Eclipse predict not per day, not per month, but at least for a year or two ahead. The Emperor better not to talk about it, and then fired. So you can drink straight month (more is not noticed and thrown out), and then to catch up. So Hee and Ho is INNOCENT! Just astronomy was still in its infancy and the prediction of eclipses occasionally faltered. Such was unthinkable in civilized countries, from the II century BC the "Surprise" of

the Eclipse before the battle of Kalka only a Testament to the savagery of most (but not all!) the Russian princes of that time.

What are the scientific truths about the shape and movement of the wandering luminaries were firmly established scientists of antiquity (bounding Greece, Hellenistic Egypt and Rome, where science was not esoteric, secret, and was available curious free citizens). By the way, scientists of that era were very surprised to raise such issue, not linking the form and the motion of the planets. But now we know that both is determined by gravity and therefore put the questions there.

1. The earth is a sphere. Thousands of books you'll read dozens of proofs of it. For example: in the sea the horizon seems to be round, wherever your ship. Indeed, only the ball has this property. We stay on the cucumber, the distance to the horizon would be different in different directions. But the accuracy with which we know the roundness of the horizon? With a very small. Only astronomical observations confirmed the sphericity of the Earth with high accuracy.

For example, if you evenly go exactly to the South, the North star (or rather, the pole of the world) is uniformly lowered to the horizon, disappears at the equator, and you see a uniformly rising South pole of the world. The first definition of the size of the globe fulfilled in the third century BC Alexandrian scholar Eratosthenes.

2. Ancient scholars have argued that the Sun and Moon — balls. As for the moon, then there was a good reason. On the moon the normal naked eye can see a lot of detail, again unchanged. Therefore, it is clear that the Moon facing us on one side. But that's the side of the flat disc or ball, without a telescope not to distinguish. However, the shape of the line terminator convincingly shows that we are facing hemisphere.

But the blinding disk of the Sun (the latter term is used in astronomy until now) does not issue its convex shape.

So ancient in fact did not know the shape of the Sun. Why are they so loved the ball and convinced themselves the sphericity of the stars? First, by analogy with the Earth and the Moon. But the main reason is a religious and philosophical (shorter — ideological) dogmas. The sky completely, the heavenly bodies are perfect, perfect, form the surface that is equivalent to the

Pythagorean concepts of the sphericity. Rare in the science case, when biased, not having any science supports the dogma leads to the correct answer. Now the sphericity of the Earth, and other close celestial bodies does not need proof: just look at the shot from space pictures and movies. Scientific interest represent only small deviations from the spherical shape.

3. The sun relative to the stars for the observer moves along a great circle of the celestial sphere, received the strange name of the Ecliptic, which means the circle of Eclipse. The fact that lunar eclipses occur when the Moon is in full moon falls on the Ecliptic. Solar eclipses also occur on the Ecliptic when the Moon enters the new moon and closes us from the Sun. But this is trivial: the Sun is by definition always located on the Ecliptic. To call the sun's path the Ecliptic is the same as highway call "by accidents".

The movement of the Sun unequally: in the winter it moves faster in summer, slower. The movement of the moon more difficult. To describe it, astronomers have invented the most powerful technique, the mechanics of playing a major role today: the decomposition of complex movements into a set of simple. That is, the Moon describes a large circle inclined to the Ecliptic plane by about 5° . But this plane rotates around the axis of the Ecliptic in a clockwise direction (when viewed from the North), making one full turn in 18.6 years. As the Sun in its circle of the Moon also moves unevenly, in addition the point of its greatest speed (perigee) moves counter-clockwise, making a full rotation in 9.6 years.

Know astronomers and finer detail in the movements of the Sun and moon across the sky, allowing them the surprise of his contemporaries accurately predict solar and lunar eclipses.

4. The paths of the planets across the sky draw such an intricate tangle that is amazing how the ancients were able to solve it and build an unsurpassed fifteen hundred years of a masterpiece — the theory of their motion relative to the observer. And, as usual, ungrateful offspring, scolded, and sometimes scold them until now because this theory is geocentric.

I repeat that the ancient scientists with the highest degree of perfection described the motion of planets on the celestial sphere in the past, the present and the future relative to the star for the observer. To solve, as planets move in fact, they actually left descendants, as well as made only in the XX century

the question of what this planet really is.

In the theory of planetary motion developed by Hipparchus (II century BC) and brought almost to perfection Claudius Ptolemy (II century AD) it is conditionally possible to allocate two directions. One described the movement of a small number of difficult arranged elements, the second — a large number of simply arranged elements. Don't be the failure of the middle ages, the first direction quickly would have led to a Keplerian ellipse, the second to the Fourier series.

We describe only the more understandable the second direction.

How not very difficult to show, for sufficiently large κ and a well-chosen system parameters (radii R_s , angular velocity ω_s , the orientation of the planes of the epicycles, i.e. the longitude of the nodes and inclinations Ω_s is the center of deferent, the initial position of the points P_s) epicyclic model arbitrarily accurately describes the real motion of the planets. Most interesting is that the necessary number of epicycles for each planet is small, if we limit ourselves to accuracy of the ancient observations at 0.2° : for example, two of the epicycle for the Sun and four for Mars. So the myth about the complexity of the system of Ptolemy has only one base. Until Copernicus, inclusive the parameters of the model from observations have identified the ugly bad, and that entailed a lot of unnecessary circles that do not provide however the required accuracy. The model of Ptolemy — the miracle of the human mind, beside which pales the seven wonders of the ancient world combined.

The Greeks began the construction of the heliocentric system of the world that describe in a good approximation of how the planets move "actually", i.e. from the point of view is not earthly, but a remote observer, say, from a star γ of the Dragon. Now, though in a weakened measure, we have the opportunity to look at the Solar system from the outside. From outer space through the eyes of "Pioneers", "Voyager", "Galileo", "Ulysses", "Cassini", we see the inner planets, including the Earth with the Moon, racing around the Sun. The heliocentric model is much economical describes the movement of celestial bodies and allows you to find distances that are not available in the classical geocentric theory. From a purely scientific point of view, it is unclear why it was discarded system of Aristarchus of Samos, who lived long before Ptolemy and Hipparchus, even in the III century BC, began serious

development of the heliocentric system of the world, but was banished from Athens.

In heaven as on tutorial, a simple trajectory around the Sun describe mercury and Venus. To attach him to the Earth, Mars, Jupiter and Saturn, and needed the genius of Aristarchus. But once the idea is expressed, it is already obvious to any intelligent person. Only a curse ideological dogmas can be explained that the system of Aristarchus was declared incorrect and even harmful. She was recognized as conforming to reality only a hundred years after the death of Copernicus, i.e. when the model of Aristarchus is almost nothing left — it was replaced by much more sophisticated model of Kepler.

Kepler's model became the last purely mathematical, i.e., describing the motion without explaining its reasons. At the end of the XVII century, one of the many consequences of the Newtonian revolution in science was the explanation of Kepler's laws unified fundamental law of gravity.

Ancient Egypt. The people crowded in the Temple of the God Ptah. The sun is shining. Landscape, as in "Aida". Comes the high priest:

"The gods are angry with you! You steeped in Vice! Instead of diligence is laziness. Pyramid, counting from the last adjustment, built fifteenth year, and never ends. Your hardworking ancestors that went West, did more in five years. Why, five years they performed in four years! And your greed? Personal interests placed above the public! Just to fill the stomach. And where sacrifices to the gods? Where offerings to the Temple? I could name a bag of small crimes: murder, steal from each other etc., but this is enough. Look at this!"

Theatrical gestures at the Sun. The people looks up and freezes in horror. The flaming disc is reduced. In desperation, all fall down.

"Repent! Pray To Ptah, Hathor, RA! Swear to work according to the dictates of the moral code of the Builder of the Pyramids! Not to pogledati hands from sunrise to sunset! Donate To The Temple! All the best to the gods and their children! Swear louder and Yes you will hear the immortal gods!"

Long unintelligible, alternating with articulate, howling. The disc of the Sun increases, the solar Eclipse ends. The people rejoice — the end of the world postponed. Bowl "on the reconstruction of the temple of RA-Savior" quickly filled.

What conclusions we'll do this the usual story?

The output of the first. Astronomy was well developed in Ancient Egypt. Much the same can be said about ancient Mesopotamia, where there are similar scenes.

The output of the second. Unlike China, astronomy, and all science, in Ancient Egypt was not in the public service, and languished in temples as an important part of the training of priests and only priests.

The third conclusion. Astronomy as a whole (and other science — part) were esoteric, i.e. a mystery. The priests carefully concealed their science classes, giving for the communication with the gods of their observations of the stars, and for recording the will of the gods — their calculation of the moments of eclipses by solving algebraic and trigonometric equations (alas, the gods differential they not opened). If someone of the priests would read a public lecture "Solar and lunar eclipses, their causes and consequences", he would not have lived until the next day. Murder for violation of esotericist was at that time common. It is difficult to keep from telling anyone the secret, which is owned. Now esotericist science was only in its military part. I wish you to live until the time when it will disappear altogether. But if you see or hear about the "doctor of esoteric Sciences", treat it as a harmful and not useful to fossil.

Back to the Newton. Formula (1) was clear to him (and him alone) intuitively, by analogy with light. Illumination from a point source in a medium without absorption is weakened in inverse proportion to the square of the distance. Why should gravity obey a different law? But intuition can fail even genius (in such cases the story knows as much as necessary). The main merit of Newton — proof of the law of gravitation. The scientist chose a method similar to proof by contradiction. That is, it displays check investigation (1) and make sure that they are consistent with the observations within the measurement errors. If you ever come across a striking contradiction, the law of gravity must be buried. If not... a Mathematician will tell you that from the last anything should not be. "Nasty" can only disprove your assumption, but not to prove it. But astronomy, physics, natural science differs from mathematics. The law (1) was tested by thousands of scientists on millions of objects in all parts of the Universe in all sorts of situations and always came out the winner. So the truth of it installed with the

highest degree of reliability.

It's time to make a significant reservation. According to any of the developed philosophies of our knowledge reflect reality not exactly but with some error. The progress of science is, in particular, that this error by the efforts of scientists is reduced, but a zero it is impossible to do. Some deviations in the movements of the stars from the Newtonian rules were discovered that eventually led to the creation of A. Einstein's more sophisticated theory of gravity including the Newtonian limiting case of small (compared to the speed of light) velocities and relatively weak field of gravitation. Model Einstein received a strange name — the General theory of relativity; we'll talk about it later. And yet note that in the vast majority of cases relativistic corrections (from lat. the relative amendments that confusing so that Russian translation is never used; this refers to the amendments introduced by the theory of relativity, General or private) can be neglected and consider the Newtonian theory of absolute truth. Consider which trajectories will then move the heavenly bodies.

1. Complete isolation, of course not. As an example, compare the forces that attract each of us to Land (F_1) and the Moon (F_2). In podlinnoi point (where the Moon is visible at the Zenith) at the time when the Moon is in the perigee of its orbit, the F_2 maximum. But then $F_2/F_1 \approx 4 \times 10^{-6}$. In fact, the moon's influence on the shape of the Earth even less. It causes tides, what else will be discussed. Now it suffices to note that the isolation in the Solar system is designed in a very good approximation.

2. The sun consists of gas giant planets too, with the possible inclusion of liquid and solid phases in the Central layers, which is insignificant. The earth is solid, and only the Central part is present in the liquid phase. But prolonged exposure to the Earth responds as a plastic body, flowing like wax. — And the mountains? — you will ask. Yes, some voltage solid ground can withstand. The mountains are not flattened, the dimples are not filled before our eyes. But the height of the mountains can not exceed values of the order of 10 km, otherwise the pressure exceeds the critical substance of the sole will be plastic, begins to unravel under the weight, and as a result the height of the mountain decreases.

Such plasticity is observed in all large bodies, up to 500 km in diameter. From small bodies less than 200 km in diameter, gravity is negligible, the

assumption of plasticity is not performed. The intermediate case of 200-500 km is difficult to analysis because you need to know the ancient history of the phone If they were subjected to strong heating, the time was flowing and managed to take the form dictated by gravity. Otherwise, they are shapeless lumps.

3. From the terrestrial planets, satellites, minor planets internal sources of energy exist in the form of scattered, mostly in the cortex of radioactive elements. But their energy is extremely low and can cause mixing of the substance with velocities is that in centimeters per year. Jupiter generates heat due to the ongoing compression. This leads to convection of the substance and of the differential rotation (period of rotation around the axis depends on the latitude and depth). The sun and the majority of normal stars quietly releases energy nuclear reactions occurring in the Central part. As a result, we are seeing the convection and differential rotation like the planets of group of Jupiter. It makes minor amendments to the pure gravity of the form of celestial bodies.

We can conclude that all three assumptions are fulfilled for large bodies in the Solar system and for most of the stars. At least one of them incorrectly for close double stars, nebulae and molecular clouds, small (less than 200-300 km in diameter) bodies, violently releasing the energy of stars. These cases are excluded from consideration. What form will the stationary self-gravitating celestial body? Without any calculations it is clear that the shape of a ball, and the density of a substance will depend only on the distance from the center of the ball, decreasing from the center to the edge. Any raise above the surface it must crawl, seizure — filled, anything heavier inclusion must come down, easier — to emerge. And if there is even any unexpected exotic figures of equilibrium of stationary bodies? No, and it was proved by our great compatriot A. M. Lyapunov (1857-1918), the Petersburg academician. As usual, the proof was very difficult. Was it worth all they to do? Was worth, because intuition can fail, as seen on the example of the Jacobi ellipsoids and pear Poincare (see below). That's where the sphericity of the moon, Earth, Sun and many other celestial bodies: reigns gravity, and not the mythical perfection of heaven.

Now switch on the rotation. In our assumptions, the body will rotate around a fixed axis as a whole. This rotation is called the solid body is liquid, but rotates as if it is rigid, so the distance between the particles unchanged.

Indeed, all sorts of internal currents without energy sources must eventually decay due to friction.

Once the rotation is solid, it is natural to consider the position of each particle in the frame of reference, rigidly connected with the heavenly body, rotating together with him. Such a system is natural to everyone except astronauts. Sitting on a chair, we consider ourselves to be stationary, while turning together with the Earth with angular velocity of 1 revolution per day, which corresponds to the linear velocity at the equator 460m/s (in St. Petersburg it is reduced to 230m/s). However, a rotating system, as they say in physics, non-inertial. This means that the correct description of motion in this system is achieved by introducing inertia forces. In the case of uniform rotation around a fixed axis of such two forces: Coriolis and centrifugal. Coriolis only acts on moving in our system, particles and disappears if they are not moved relative to each other. Centrifugal is directed away from the axis of rotation (it would be better to talk about "Osobino" force, but so is not accepted) and its acceleration is equal to $\omega^2 R$, where ω is the angular velocity, R is the distance from the axis. The particle feels only the vector sum of two forces: gravity and centrifugal. This amount is called the force of gravity. The direction of the latter is perceived as "down" the opposite — the "top".

The surface of equilibrium of the figure must be perpendicular to gravity. Then, a small portion of the surface appears horizontal. Otherwise this site will be inclined, and the liquid will flow from the top down. It is clear that the ball can no longer serve as a figure of equilibrium. It needs to be compressed at the poles (Fig.6). To find the surface of the body T , it is necessary to translate the italicized words into equations and to solve them. You know a lot of examples of how a short formula replaces a long and awkward verbal description. Here the situation is the opposite: a short phrase expressing the physical meaning of phenomena leads to complex and cumbersome equations. After all, gravity is described by the triple integral body, the form of which is unknown! The problem about the form of celestial bodies far from the final solution, although the basic results were still the classics: Newton, K. MacLaren, John. Darwin (UK), P. Laplace, C. Roche (France), K. Jacobi, L. Lichtenstein (Germany), P. L. Chebyshev, A. M. Lyapunov (Russian Federation), S. Chandrasekhar (India, USA) and others.

Not too rapidly rotating homogeneous body takes the form of a compressed ellipsoid of rotation (Maclaurin ellipsoid). The parameters the semimajor and

semiminor axes is uniquely determined by mass and angular velocity of rotation (Fig.7). If rotation is faster, appear triaxial ellipsoids (Jacobi ellipsoids). Their discovery — and they appeared as the solution of a system of equations — has plunged the scientific world in amazement. Intuition clearly says that a homogeneous rotating body must be a body of rotation, the pun was seen as a tautology! But no! The rotation of the body is not obliged to give body rotation! Then were opened even more exotic body rotating on the side of the pear and even the body with a wavy surface. It is true that such exoticism exists only on paper (to use an old expression, awkward sounds "electronic media"). The real body is spinning slowly and they are Lyapunov's theorem: the figure of equilibrium of axisymmetric and possesses the equator, i.e. each meridional cross-section of the same, the Northern and southern hemispheres are the same. Even a little dull. But nature is sophisticated and has managed to overcome the limitations of Lyapunov exponents in close binary systems and poluraspredelenia where the broken condition of isolation.

Flights of Sternfeld — and even a means to change the plane of the orbit. If the point A2 is located very far away, the speed boost V2 there is very small. It can be sent in either direction, spending very little additional fuel, and to obtain a desired orbit inclination.

Leave now near-earth space, and rush to other planets. Surprisingly, nothing new to invent is not necessary. It is enough in our reasoning to replace the Earth Sun orbit launch — the Earth's orbit and the orbit of the finish line — the orbit of the target planet's. However, about the planets need to take into account their gravity. But the area where this attraction significantly (the so-called sphere of influence of the planet), is very small compared to interplanetary distances. How to apply the described theory in space? Almost every trajectory of the flight SPACECRAFT in earth orbit or flying to the moon, Venus, Mars represents the reduced ellipse Homan-Zehnder. The word "abridged" means that the radius-vector connecting the Central body and the SPACECRAFT, rotated by the angle somewhat less than 180° . So the trajectory of the SPACECRAFT close to the optimum, but differs from it, and almost always in one direction. The reason is that we considered until now only one factor — fuel consumption. But the flight time also plays a role. Than it is shorter, the better: less need to store energy for operation of the devices, lower the probability of failures of the device. And as for

manned space flight, the role of time needs no explanation. Next, we need to reduce the sensitivity to the inevitable inaccuracies in the orbit. And the ellipse Homan-Zehnder them very sensitive. A bit I do not get the speed — and undershoot. All this leads to reduce the transitional orbit.

And where are the flights of Sternfeld? In interplanetary flights, they are unlikely to apply. They are profitable only double-pulse to reach Uranus, Neptune, Pluto ...the Sun. But the direct flight to the outer planets requires decades. And three-shots of the flights with departure from the Solar system is hundreds and thousands of years. Unacceptably delayed and the flight to the Sun. But do not despair — we will talk about other ways of achieving this goal.

The radius of the lunar orbit contains 60 Earth radii, so that ρ is much higher than the limit of 15.6. Flight to the moon using salonnys region will save about 8% of fuel. While this scheme of flights was not used because in a few months instead of several days direct flight. But it is possible that during the development of the moon for commercial rocket trains will be used, the trajectory of Sternfeld. Today, however, such trajectories often in orbit of 24-hour satellites: this is the best way to obtain a high orbit of zero inclination when launching from the spaceport with latitude greater than 40° . Note another space paradox: it is easier to bring the SPACECRAFT into lunar orbit than on the orbit of 24-hour satellites, 9 times closer.

The sphere of influence of the planet is very small. But the penetration of it can have a significant impact. KA gets there is always hyperbolic speed — because it comes from "infinity", meaning there is already considerable speed. The trajectory relative to the planet's sphere of influence is a small piece of the hyperbola. Alien to the viewer the result is almost instant puncture spheres of influence will be the turning of the velocity vector by the angle α between the asymptotes (Fig.4). But in the Copernican system with the center of the Sun to the velocity relative to the planet need to add more to the heliocentric speed of the planet itself. As a result, the speed of the SPACECRAFT will change in direction and in magnitude. Not only can we deploy KA according to our will, but to also increase (and if necessary, reduce) its speed. The energy here is taken (or given) from the kinetic energy of revolution of the planet around day light. As the mass of SPACECRAFT is much less than the mass of the planet, changing the planet's energy is not

significantly any most accurate instruments.

The closer a base particle to a magnetic center, the smaller the angle α between the asymptotes differs from 180° and the more efficient gravity-assist maneuver. But we can't fly up to the center of the planet closer than its radius (including the atmosphere). And the more massive the planet, the greater its size. So at first glance it is difficult to say which planets are better suited for gravity assist. Because the mass grows in proportion to the cube of the radius, the conclusion is clear: the more massive a planet is, the greater opportunities it provides for maneuvering. Low-mass mercury and Mars are not able to do much to change the orbit of the SPACECRAFT. Venus and Earth are already capable of it. However, for a large orbit changes require a number of encounters with these planets, and convergence can be alternated in any sequence. For example, three times in a row to go to Venus and then two times to the Ground. Powerful Converter orbit — Jupiter: a single passing near it to leave the Solar system or fall into the Sun.

To maneuver, you can use the gravity field of the moon: for transitions within the system Earth-Moon and to exit the system in interplanetary space.

The world's first gravity-assist maneuver was made in 1959 by the probe "Luna-3". In the result of clever use of the gravitational field of the moon (despite its smallness!) "Luna-3", launched from the Northern hemisphere of the Earth, having flown about our natural satellite, was back again in the Northern hemisphere, what then seemed an unheard-of miracle. So the USSR had obtained the first pictures of the far side of the moon.

Now the gravitational maneuvering is commonplace. In this way the American probe "Voyager-2" after the flyby of Jupiter made up of Saturn, and then Uranus and Neptune (Fig.14). The Soviet VEGA-1 and VEGA-2 was found with Halley's comet after a gravitational maneuver in the field of Venus. American "international comet researcher" was found with the comet of Jacobini-Zinner after complicated maneuvers in the system Earth-Moon. Multiple maneuvers in the field of the Earth and Venus made a "Galileo" and "Cassini". International probe "Ulysses", designed to study the polar regions of the Sun, was able to rise high above the Ecliptic plane only at the expense of a gravitational maneuver in the field of Jupiter.

So far we have considered switching flights. Even gravity assist can be considered a pulse. But already being tested and will soon become the

conventional so-called thrusters. Pull them minor, but it could be months and years. The initial part of the trajectory in this scenario represents the unwinding spiral. The thrusters operate on different principles than conventional chemical impulse engines at high thrust. For example, in electrical rocket engines to enormous velocities of accelerated ion beam. So these engines are very economical. To maneuver in orbit, they are irreplaceable. But the KA can't get off the Ground: the jet acceleration is much less than the gravitational acceleration g . So the initial part of the trajectory mentioned above, this initial orbit that the SPACECRAFT appears classic booster.

The thrusters can be attributed to a solar sail. Light pressure under normal conditions is barely or not noticeable. But if in space to deploy a sail made of a very thin film with an area of several thousand square meters, enough to create a small, but long-term traction. Fuel for the ship, and for the space of a sail is not required. Solar sail is only tested: only recently created lightweight, durable and opaque films. Please note: the film must be opaque (better mirror), otherwise the light of her "not notice" and no pressure will not have. Flights under solar sails — the nearest future. Where are they most effective?

The power of solar radiation is weakened in inverse proportion to the square of the distance from the Sun. In the vicinity of Mars it is two times weaker than Earth. In the vicinity of Jupiter is 30 times weaker than that of Neptune is 900 times. Therefore, a solar sail is reasonable to use for maneuvering in earth orbit and for missions to Mars and into the inner region of the Solar system: Venus, mercury, Sun. When flying to the Sun must still ensure that the sail is not burned and not melted.

The same circumstances determine the efficiency of solar cells. Beyond the orbit of Mars, they are uneconomical. To fly to Jupiter and further it is possible only with nuclear sources of electricity on Board.

When driving at altitudes of 200-1000 km, the satellite is slowly but steadily hampered by the resistance of the upper layers of the atmosphere. The satellite moves in the environment with a speed of about 8 km/s. compared to her very own speed atmosphere small. Resistance can be considered to be aimed directly against the velocity vector of the satellite. The orientation of the orbit in this case is maintained. But the size and shape vary significantly. The density of the air decreases with height very quickly. Falls from height

and the speed of the satellite. Therefore, for discovering satellite, the eccentricity of the orbit which is not vanishingly small — at least more than 0.01 — the main brake is in the vicinity of perigee. Because of this, on each turn, significantly reduced the height of the peak, and only slightly — the height of perigee. Orbit getting closer and closer to circular. Further, the braking is evenly distributed along the trajectory and the satellite begins a gradual decline of the spiral. Paradoxically, the speed increasing!

The point here is the following. Braking in the atmosphere leads to a decrease in mechanical energy of the satellite. The latter is the sum of kinetic and potential (gravitational). Coming down, the satellite loses potential energy. Calculations show that despite the loss of mechanical energy, kinetic energy increases. This happens until the entrance to the dense layers of the atmosphere (for the Earth — less than 150 km). There is already air resistance becomes comparable with the gravity. The result — overload, burn and speed drop. Small satellites burn before they reach the ground. Major satellites and the last stage rockets burn, fall apart, and their fragments fall to the Ground with velocities of tens of meters per second. And only the largest reach the planet's surface with a substantially high speeds. These are, for example, the space station Skylab, Salyut, Mir. When you have limited resource of such station, its descent specifically regulate that she fell in uninhabited areas or the ocean. Unfortunately, it is not always possible. "Skylab" and "salute-7" crashed not quite as planned in the control centers. Fortunately, disaster did not happen.

So far we have only considered the atmosphere as the cause of braking of the satellite. Think of the airplane — air can be a source of lifting power. This quality has long been used in space exploration. During the descent of a manned spacecraft thanks to a small lifting force is now relatively long held the upper atmosphere, which reduces overload. Sometimes used the reflection effect from the atmosphere. This phenomenon is reminiscent of a stone skimming on the water when cast hollow flat stone repeatedly reflect off the water.

Atmospheric drag and lift force can be combined with a gravitational maneuver. For example, entering first in the upper atmosphere of Venus for the subsequent achievements of the circumsolar space. Or in order to repay the hyperbolic planetocentric speed and become a satellite of the planet. Such maneuvers were already used for translation of the us probe in Mars orbit

(unfortunately, not always successfully).

Quite regularly every ten years, tabloids publish gloomy forecasts of professional and semi-professional zapugivaniya population about the parade of planets. The last two have sensation in 1978 and 1999 Introduced the term means such a configuration of the planets, when they all are on the same ray emanating from the Sun. Let us consider here two questions: how often there are parades and if they can do; what they bring us. Let's start with the latter.

The press acts on the pattern of Egyptian priests (see above) with small modifications. Is Eclipse — parade of planets. Instead of intimidation during the apparition — his prediction and promises of earthquakes, volcanic eruptions, floods, fires (by this mandatory set-at least add to taste drought, typhoons, locusts, epidemics, war, etc. etc.). Suppose a planetary alignment really took place. How will this affect the Earth?

It would be a wonderful sight! Simple eye you will see the night Mars, Jupiter and Saturn next to each other. In a small telescope will be added to Uranus and Neptune. A day in the telescope you will see that no one has ever observed: the black drop of Venus crawling across the Sun disc, then it overtakes smaller as the black drop of mercury. The word, day and night, the beauty is indescribable (which will save the world, if you believe F. M. Dostoevsky). But our masahista-predictors of unhappiness don't mention! Will there be a noticeable physical effect of planetary configurations on the Ground? That's what it is, no. Let's review the possible mechanisms of influence.

1) gravity tides on Earth. We know that the effect of gravity on phenomena occurring on the surface of the Earth is tidal forces. Take the tidal acceleration of the moon in podlinnoi point when the Moon is at an average distance from the Earth, per unit. Accordingly, the lunar tidal acceleration at the moments of passage of the Moon perigee and apogee will be 1,15 and 0,85. The greatest tidal acceleration from Venus, when the latter is in the bottom joint, equal to 10^{-4} ; from Jupiter, when the latter is in opposition, equal to 10^{-5} . From other planets it's in the tens, hundreds and thousands of times less.

Thus, the influence of the planets is negligible and sinks not only a drop in the ocean lunar and solar tides, but even in its variations from week to week.

But let's forget about the lunar and solar tides, if they were not at all. Even then, the parade of planets will not make practically nothing. After all, it only adds a few percent to the tide from Venus in inferior conjunction, an event that happens more than once in two years!

2) gravity: tides on the Sun. Planets cause tides on the Sun, which in principle can cause unwanted changes to the earthlings. These tides on the Sun as negligible, and on the Ground. Still rush home from Venus, then Jupiter, and other planets will not and percent. Still planets do not cause anything, even if you forget about the smallness of the effect. Tides from Venus and Jupiter will be formed every four months (in the moments when the inhabitants of Venus-Jupiter is in conjunction or opposition), the addition of the parade is almost zero.

3) Electromagnetism. The earth has a strong magnetic field, powerful radiation belts of charged particles. The influence of the planets on the Earth's electromagnetic field is negligible. Even less electromagnetic influence of the planets on the Sun.

Was there a parade of planets? Of course, the parade was never in the entire history of the Solar system and never will be. Because the plane of the planetary orbits not coincide. For the parade requires that there be a moment t_0 , in which all the planes of the planetary orbits would intersect at the same line (the common line of nodes). In addition, the planets themselves should be on this line, even with one hand. The story orbits in the Solar system is traced billions of years forward and backward, and such a moment in it.

But let us weaken the requirements to the parade, allowing planets to gather not only on the beam but inside the cone with vertex in the center of the Sun. And the angle of the solution cone will pick ten degrees. What is the parade at $\alpha=20^\circ$, for example, when the planets are wandering almost the whole constellation?

We tracked the position of the planets for a million years forward and back and found that even this weakened the parade was and never will be. Sorry, it would be very nice! However, the meeting is not all, and three to five planets in one constellation occur is not so rare, and you probably already saw it (the newspaper always report about this event in advance).

If we assume that planets attract the Sun and not have an impact on each other, they describe Keplerian ellipses. Each planet with a certain period T

returns to its original place. The periods of the planets in the different and common to all period do not exist. So the movement of the planetary system is not periodic from the point of view of mathematics. Let me remind you that in mathematics is called T-periodic, if after time T the system returns to its previous state. But in nature only simple processes can be such, for example, the oscillations of the pendulum.

Let's consider a more complex system: changing of the seasons. For example, 1 July in the same location in different years weather is different, and you can only talk about approximate periodicity. But the exact Sciences do not tolerate rough terms. Invented the concept of quasiperiodicity for the phenomenon, unfolding on the amount of periodic (the Creator of the theory of quasiperiodic functions had been the Riga Professor P. G. Pain).

The unperturbed motion of the planets quasiperiodic. The sum of many periodic processes it is decomposed? The question seems trivial — of course, n, if n denote the number of planets. It is, but is it possible to reduce the number of processes to $n_0 < n$? It turns out that sometimes you can. Consider the two processes, with periods T_1 and T_2 . Let $T_1/T_2 = P_1/P_2$, where P_1, P_2 are integers mutually Prime numbers. Then both processes have a common period $T = p_2 T_1 = p_1 T_2$. For example, if two planets have periods of rotation T_1 and T_2 , then after time T the first planet will make P_2 speed, second — speed P_1 and both will be in the same place. In this case we speak of resonance, or more precisely of the resonance $P_1:p_2$ in the movement of planets. If such integers p_1, P_2 does not exist, talking about lack of resonance in the system.

So, in the absence of resonance in a system of n planets, there are n independent periods, in the case of resonance, the number of the last n_0 less than n.

A little explanation. Definition of resonance is fine from a mathematical point of view, but is not suitable in the natural Sciences. We are talking about the rationality or irrationality of the number of $\eta = T_1/T_2$. Only in the modeling task periods are accurately known and the definition makes sense. In reality, T_1, T_2 are measured with some error. No matter how small it may be, to distinguish between the rational and the irrational case is impossible in principle. In practice, it is important, can you imagine the number of η as a ratio of two small integers $P_1:p_2$ plus a small correction, or not. If you can,

then after a small time T , the system almost returns to its previous position. For example, let $\eta = 2/3 + 10^{-4}\pi$. After the time $T = 3T_1$ the first process will return to its original position, and the second phase will shift by just a thousandth of a circle, i.e. a third of a degree. The resonance is obvious. If not, the system returns to the close position very soon. Suppose, for example, $\eta = 1597/987$ (appropriate fraction for "Golden" numbers $(1+\sqrt{5})/2$). The system will return to its original position only through a huge time $987T_1 = 1597T_2$. Resonance no.

It turns out that our Solar system is arranged so that a massive body (the eight major planets from mercury to Neptune) do not resonate with each other. If we translate the vibrations of the planets (and each of its axes, they vary!) in sound, we hear not "the music of the spheres", and that kind of cacophony in the orchestra by the end of the intermission, when every musician regardless of the other tunes his instrument. On the contrary, among the small bodies of many large and resonating with each other. These are the dozens of satellites, thousands of small planets, and even Pluto (remember, its mass is six times smaller than the moon). While it makes two revolutions around the Sun, Neptune manages to run it smoothly three times.

Take now into account the mutual attraction of the heavenly bodies. the Mass of the largest planet, Jupiter, a thousand times less than Solar. About the same time the acceleration of each planet, caused by the gravity of other planets, the less acceleration towards the Sun. The differential equation of motion can be written in the form

$$\ddot{w} = F_0 + \mu F_1 \quad (10)$$

Here index 0 is marked the main acceleration, the index 1 is caused by the attraction of planets to each other perturbing acceleration; small parameter $\mu \sim 0,001$. Equations of the type (10) it is necessary to write a few, the number of planets. Motion when $\mu = 0$ we know. In true small value of μ trajectory slightly deviates from the unperturbed. It is acceptable to assume that the orbit is still an ellipse, but its elements (semimajor axis, eccentricity, etc.) change slowly with time with a rate of μ . This technique we have already discussed on the example of AES.

A fundamental question: whether the perturbations accumulate over time or fluctuates around a mean value? In the first case we are talking about secular perturbations; at time T_0/μ of the orbit would change beyond recognition.

Here t_0 is the characteristic period of 10 years for the Solar system, about a year of Jupiter. A critical time T_0/μ is equal to only ten thousand years, very little in Earth's history. Fortunately, in the absence of resonances, the perturbations of the semimajor axis, eccentricity and inclination do not accumulate these essential for life on Earth elements only fluctuate within narrow limits.

I must say that to this result, mathematicians and astronomers were three centuries. It was all to prove this theorem, because equation (10) is so complex that until now was not found in the analytical form of their General solution, suitable for cosmological times of the order of T_0/μ^3 . Newton believed that the perturbations are accumulated. The image of the time of the Great Watchmaker has created a watch is not absolute perfection, in need of repair once in several tens of thousands of years. Laplace and Lagrange extended the stability of the motion of the planets to millions of years. At the time, it aroused a storm of enthusiasm in the educated circles, the result of the Laplace-Lagrange called theorem about the stability of the Solar system. It's funny that this theorem pleasant and theists (the Watchmaker created a watch of the highest perfection), and atheists (the Watchmaker is not necessary, according to him — and without him, everything was his order). In the second half of the XX century, Soviet mathematicians A. N. Kolmogorov, V. I. Arnold and independently of their American colleague J. Moser extended the time for sustainability to billions of years. The results are being specified now, but the main thing is already done.

It is curious that the fact of stability of at least the earth's orbit has long been known to geologists and paleontologists. From a human point of view, the Earth's climate is very varied with the geological epochs. But anyway oceans never covered by a solid ice and never heated above 40°C. In the first case, the oceans would have never melted, because the blue and white Earth reflects almost all the incident Sun radiation into space. There was no one to read this book, and to write it. In the second case, we'd have seen a Grand extinction of flora and fauna, in comparison with which the death of the dinosaurs would have seemed like a small nuisance. Therefore, the Earth receives from the Sun approximately the same amount of energy in the past, how much she gets now. The last 3 billion years, the Sun has an almost constant luminosity. So, the semimajor axis and the eccentricity of earth's orbit did not change significantly.

You should pay attention to the words about and almost. The eccentricity oscillations amplitude of 0.03—0.04 have place; they, according to well-reasoned hypothesis Yugoslav scientist M. Milankovitch explains glacial periods in the Pleistocene.

So, the orbits of the eight major planets about 4 billion years ago took a modern look and since then remained roughly the same. And Pluto? We remember his resonance with Neptune. It turns out that in the resonant case, the evolution strongly depends on the phase. The orbits of Pluto and Neptune close to the intersection, the distance between them is less than 2 a.e. When approaching Pluto would pass on a significantly different orbit, and after a series of approaches would have landed on Neptune, or the Sun, or would have been thrown out of the Solar system. But the phase "matched" so that the points of convergence of the orbits of the planets are never together, the distance between them is always greater than 18 a.e. It is proven that it lasts many billions of years, the orbit of Pluto is stable and retains resonance with Neptune. Anyone can tie it with the wisdom of a Watchmaker; unwilling — to do with natural selection. Since 1992 opened hundreds of planet diameters of the order of hundreds of kilometers, moving on similar orbits plutonowy. They are resistant, so we can see. Many of the bodies trapped in an unstable orbit, disappeared as described just above.

Often write that the satellite systems of large planets is the planetary system in miniature. This is not entirely true not only from the point of view of physics (the planet does not warm its satellites), but also mechanics. The satellites are small, and major perturbations in their motion caused by the compression of the Central planets and the attraction of the Sun. Besides, the resonance is found there often. For example, the periods of rotation of three of the Galilean moons of Jupiter — IO, Europe and Ganymede — are related by

$$1/T_1 - 3/T_2 + 2/T_3 = 0$$

Further, the satellites are much closer to their planets than the last to the Sun, not only in absolute but also in relative units. Moon is considered to be a distant companion, but it is 60 earth radii, from the earth to the Sun — 210 sun. While only 6 IO radii of Jupiter, to Phobos 3 the radius of Mars. Therefore, the important role played by tidal effects. Without them, the satellite system would be as stable as the planetary. We emphasize that the

stability of orbits is ensured by the smallness of the planetary masses in comparison with sun, a little satellite mass compared to the planetary, the proximity of the satellites to the planet compared to the distance to the Sun, and the smallness of eccentricities and inclinations.

A striking example of the importance of the latter circumstances is given by the Soviet expert on the mechanics of space flight M. L. Letovym. "Run" the moon in such an orbit that it is now, with one exception: let the inclination of its orbit to the Ecliptic plane is close to 90° . It turns out that the orbit will permanently stretch with small changes in size, eventually the Moon will fall to the Ground. And not for the usual in astronomy, the millions and billions of years, and in just five years!

Return the moon on the existing orbit and turn to the tides. On Earth, the lunar tide causes surface oscillations with an amplitude of half a meter. The earth rotates around its axis 30 times faster than the Moon around the Earth (equal to the angular velocity or, equivalently, periods: day and month). Consequently, the tidal wave is rolling from East to West, against the rotation of the Earth and its friction slows it down. The law of conservation of torque in the system Earth-Moon angular momentum of the orbital motion of the moon increases. As a result, the Earth rotates slower and slower; The moon moves away and too slow in its orbit and its angular velocity in force the third law of Kepler. Approximately 15 billion years day will equal the month, their duration will equal 55 present days. The earth and Moon, like dancers in a waltz, will look at each other on one side.

We now move into the past. The farther back centuries, the faster the Earth rotates and the Moon, the shorter the day and the month. And is it always night on the moon was equal to the month i.e. the Moon showed the Earth only his "face"? Of course not! Initially, the Moon was rotating fast. But on the moon tide the earth is 20 times higher than on Earth of the moon. This ratio is unchanged, whereas the amplitude of the tides was a lot more in the past, when bodies were closer. It is clear that the Moon is quickly slowed their rotation and came to a steady state, and the world is yet to come. Not only the Moon, and many satellites in the Solar system look at our planet on one side, but only one pair of Pluto-Charon is already in the final "going places" state. This couple has already completed its tidal evolution and reached a steady state.

So, as a result of the tidal evolution of many satellites now look at your planet on one side and a recede from it; in this, most satellites like the moon. But some satellites under the action of the tides are approaching their planet. First, a satellite with the reverse movement: of Triton by Neptune, Phoebe of Saturn and some of the distant satellites of Jupiter and Uranus. Secondly, it is very close companions with a straight movement, forward rotation of the planet: Metis and Adrastea of Jupiter, 10 inner moons of Uranus, 5 inner satellites of Neptune. The most famous example of this is a pair of Mars-Phobos. Recent moves in closer and faster until in orbit stationary satellites of Mars. Tidal a hump on Mars behind. Phobos Mars spins and reducing our own orbital torque approaches the planet, moving faster and faster. Approximately 30 million years Phobos falls on Mars, if we do not intervene early.

At the conclusion of the paragraph is a bit about changing the views of scientists on the nature. Thousand years, they wondered, where did the movement and who supports the eternal run of planets. After Newton it became clear that the movement is indestructible, and second, the issue was dropped, but over the first suffered another two hundred years. Now he has disappeared and (at least, not to mention causes the Big Bang and work with already existing matter into familiar forms). On the contrary, astronomers are trying to answer the opposite question as to why the satellites, mercury, Venus, the Sun rotate around their axes so slowly. The answer about the satellites we know. Most likely, the same reason, solar tide, slowed the rotation of the inner planets. The slow rotation of the Sun is related to its rotational moment of the orbital time of the planets. The mechanism of transfer are still not clear.

When Newton published his law of universal gravitation, contemporaries immediately asked him a question, but where did the attraction itself? In my opinion, is the height of tactlessness. Newton made infinite. Explained the subtle details of the motion of the moon, planets, their satellites, comets; finally erased the line between earth and heaven, describing a single image the motion of the thrown stone and the moon showed how to launch satellites and to fly to the moon: it is necessary to disperse the device to the calculated first and second cosmic speed. Fortunately for sir Isaac limited his contemporaries did not stick to him with questions of how to achieve such speeds. Newton explained the closeness of the shapes of celestial bodies to

spherical and compression (a compression of the Earth he predicted); explained the drop in pressure and air density with altitude and the absence of atmosphere on the moon; explain the phenomenon of ocean tides and predicted tide in the solid Earth and the air.

I'm talking about related to gravity phenomena. And how much he made in mathematics, mechanics, optics, instrumentation, economy! And then wonder why Newton had not discovered the cause of gravity and not at the same time gave them the elixir of immortality? There can not be one person to do everything, try it yourself!

230 years history repeated itself: A. Einstein discovered the cause of gravity, creating the General theory of relativity. Matter bends space-time and we perceive this as gravity. The first thing asked Einstein — where did the curvature. In 50 years (or before) the curvature reduce to the phenomenon of X. Of Course, the scientist will immediately ask, where did the phenomenon X.

Of philosophical laws means that like any human-made model, General relativity reflects reality only approximately. However, in the twentieth century no deviations from General relativity (in the region where quantum effects are insignificant) experience not detected, despite the almost daily testing of General relativity. This means that the errors of the theory less subject to bias devices. Today General relativity can be considered absolutely accurate. Although, of course, the day will come when we find out the applicability limits of General relativity and build a more complete theory of gravity.

Formulas of General relativity the Newtonian is more complicated, but the phenomenon described is much simpler and clearer. Mass causes the curvature of space-time propagating with finite speed, the speed of light. This eliminates the inherent kutanovski theory is inconceivable property of instantaneous distribution of gravity. In weak gravitational fields slow movements of the equations of relativity transformed into formulas of the Newtonian mechanics.

What speed can be considered small? It turns out that even space. The relative error of Newton's laws — the value of the order of $\mu = v^2/c^2$, where v — speed of the particle, c the speed of light. The speed of the Earth relative to the Sun $v \approx 30 \text{ km/s}$, so $\mu \approx 10^{-8}$. The speed of satellites is even less. For the

fastest planet mercury, $v \approx 50$ km/s, and $\mu \approx 3 \times 10^{-8}$.

And which field can be considered weak? It is sufficient to determine, to what speed can accelerate freely falling particle. Thus, the intensity of the gravitational field it is possible to estimate escape velocity v_{II} . For the Earth at the surface is $v_{II} \approx 11$ km/s and $\mu \approx 10^{-9}$, which indicates the extreme weakness of gravity of the Earth. (Of course, only for the application of General relativity. Fallen down even from the second floor employees are unlikely to consider the force of gravity is weak). The attraction of the Sun, of course, greater. But mercury's orbit parabolic velocity for the separation from the Sun $v_{II} \approx 70$ km/s, $\mu \approx 6 \times 10^{-8}$. Even at the edge of the Sun $v_{II} \approx 600$ km/s, $\mu \approx 4 \times 10^{-6}$.

So, in the Solar system, relativistic effects are extremely small. They take into account when constructing the most accurate theories of motion of planets, satellites, and spacecraft. So, the error of the Newtonian theory of motion of planets of the terrestrial group in 10 years is about 1000 km and the relativistic — about 5 km, But a qualitative description of the motion no amendments are not necessary to enter.

The situation is in the neighborhood of compact massive objects. A typical neutron star, for example, has mass, like the Sun, and the size of Phobos. At the surface $v_{II} \approx 130$ Mm/s, so $\mu \sim 0,2$. Even a light beam strongly curved, passing near the neutron star. In the system of two close to each other the last neutron stars orbit around a common center of mass with sublight speeds. This leads to the emission of gravitational waves and losing energy. In the end, the stars collide, there is an explosion of immense power that exceeds the luminosity of galaxies is many orders of magnitude.

There are many books that have in the title the two words are: "Entertaining astronomy", "Popular astronomy", "Popular astronomy".

The names have changed. Developed astronomy, has increased the level of knowledge, and what yesterday seemed to be amazing, today became not only well known, but taken for granted have changed the very idea of entertaining.

The greatest revolution in science at the turn of XIX and XX centuries, the emergence of fundamentally new physical theories, like relativity and quantum mechanics, not only greatly expanded scientific knowledge of the

world, but also largely changed the style of scientific thinking, approach to the study of natural phenomena.

Increasingly committed unexpected discoveries, especially in physics and astronomy, discoveries that largely are forced to reconsider conventional ideas, open new sides of the phenomena significantly broadens and deepens our understanding of the world.

Of course, this does not mean that near future science will completely refute all of our modern knowledge. To expect anything like that would be ridiculous. Science has achieved great progress in the knowledge of nature, discovered many fundamental laws, which has found many practical applications. This is the gold Fund, which at any "scientific revolutions" will retain its value. Of course, science moves forward, but in this movement it is primarily based on the entire amount of the achieved knowledge. And if even in science there is a revolution and approved a fundamentally new views, still remains the fundamental theory includes as parts and remains valid for a certain range of phenomena and conditions.

Still, the development of modern science largely due to unusual. Unusual ideas contrary to established views, the unusual formulation of the question, an unusual view of usual, unusual approach to solving a particular problem; the mapping of seemingly disparate things; the unusual conclusion of the long known data; finally, the new facts contrary to the established, familiar concepts.

Inconsistency, the paradox...

Look at the "Great Soviet encyclopedia". We find that a paradox is called a phenomenon or a statement contradicting generally accepted ideas or even common sense.

Paradoxes are different. Some of them reflect the real situation, while others only apparent contradictions. But anyway, a paradox is primarily a contradiction.

One of the actors of the famous Comedy by English writer Oscar Wilde's "an Ideal husband", Lord Caversham, in the course of the play repeats many times the same sacramental phrase:

— A paradox? — I hate paradoxes!..

To understand why the paradoxes brought upon themselves such a persistent dislike of the venerable Lord, it is not so difficult. After all, any contradiction inevitably destroys the familiar system of thought, requires it figured out...

Oscar Wilde in the person of the Lord Caversham ridiculed traditionism stubborn and conservative thinking of a certain part of the English nobility, who did not want to trouble himself with thoughts and prefer to dismiss all unclear and strange.

Meanwhile, shy away from paradoxes are not so easy, because they have to meet almost all areas of human activity.

There are, for example, amusing paradoxes — arguments that contradict conventional wisdom and therefore in the first moment of bewildering and amazing. Is it not paradoxical, to say a proverb: "more haste less speed"?

And need some effort to understand what the meaning is revealed in this statement. And he is...

A very interesting logical paradox reasoning is quite strict, but leading to contradictory conclusions about which we cannot say that they are true or false — the so-called sophisms. Sophistry was familiar to the sages of ancient Greek philosophy.

One person said: "Everything I say is a lie!" But this implies that he lied in this case. And this, in turn, means that he was telling the truth. But if you said that man is the truth, then he lied... etc.

Or the well-known parable about how were going to execute a sage. Before depriving the accused of life, the judge asked him to say the last word, promising that, if the convict tell the truth, it will hang, and if you lie, he will be beheaded. Without thinking, the sage exclaimed: "I will cut your head off!" And... the execution was postponed. After all, if now the sage had hung up, it would have come out that he lied and he would need to cut off the head. But if he was beheaded, it would mean that he was telling the truth and it would hang...

And in that and in other case it is the correct logical reasoning, containing no errors, lead to contradictory results, which is neither true nor false.

Incidentally, the irony here is not that we revolve in a vicious circle of conflicting claims, and that under strict and error-free formal logic, which recognizes either "Yes" or "no" are possible situations in which you cannot

say neither "Yes" nor "no".

Apparently, in the original source packages contain some fundamental flaws. Interestingly, the nature of these paradoxes, in fact, not found out until the present time.

Paradoxes play a crucial role in the development of science. A prominent Soviet physicist academician L. I. Mandelshtam said that there are two degrees of understanding of particular issues. The first — when this phenomena has been well studied and seemed to know everything related to it. But if there is a new question from the same area, it may confound.

And second degree understanding — when there is a common pattern, comes a clear understanding of all communications, both internal and external.

So, very often the transition from the first to the second, higher level of understanding is related to the resolution of certain paradoxes and contradictions.

For example, the famous physicist Sadi Carnot believed at the time that in nature there is constant amount of heat and it only flows from one level to another. But soon another scientist, Joule experimentally proved that heat can arise anew due to execution of work. Both statements clearly contradict each other. Attempts to resolve this contradiction ultimately led to the creation of modern thermodynamics — the science of thermal processes.

It is well known that contradictions and paradoxes, proved insoluble within the framework of classical physics, has led to the creation of the theory of relativity, and later quantum mechanics.

Overcoming a very significant paradoxes directly related to the development of the modern picture of the Universe.

With a paradox faced by modern astrophysics. In recent years, in the depths of the Universe was discovered a number of unusual objects and phenomena: cosmic background radiation, which confirmed the theoretical findings that our Metagalaxy formed by the explosive collapse of a superdense BLOB of hot plasma; quasars emit huge amounts of energy; sources of pulsed radiation, pulsars, stranded hypothetical neutron stars; explosive processes in the nuclei of galaxies; x-ray stars, radio emission of cosmic hydroxyl IT and more.

It may well be that these surprises are the Universe — the first signal about the need to "improve" our ideas about matter and the universe, though it is too early to conclude that the new astronomical discoveries must lead to another revolution in physics.

"Most astrophysicists believe — says a prominent Soviet physicist academician V. L. Ginzburg, that the opportunity to explain unusual phenomena in the Universe, without substantially new ideas, is not yet possible... on the other hand, the nuclei of galaxies and quasars as those objects where likely to suspect the existence of deviations from the known physical laws..."

Contradictions and paradoxes can play in science and a more modest role in helping to understand the Kar; hin phenomena, to understand the diversity of the internal relations of a process to form a clear view about the methods of scientific cognition of nature.

So, it is useful to look at some of the phenomena of the surrounding world from an unusual perspective, to try to see it as he sees us through the prism of traditional ideas.

Involuntarily recall the words of the famous American science fiction writer Robert Sheckley:

"...Everything can be twisted and turn into its own opposite. Based on this assumption, it is possible to play many interesting games..."[2].

I should add: not only amusing, but also useful. And not only the astronomer, physicist or chemist, but any expert engaged in his creative work: the writer, the artist, the engineer, and in General to every curious person.

When one famous designer was asked what qualities must, in his opinion, to have a good engineer, he replied almost by shackley: "the Real engineer should not only understand a particular phenomenon, but to be able to turn it inside-out".

Not enough to study a phenomenon by the book, memorize the relevant laws and memorize the math formulas. You should be able to approach the phenomenon from different angles, to be able to imagine what will happen if it will leak a not quite usual way. And most importantly — be prepared for the fact that it may not flow the way we expected.

An outstanding contemporary physicist R. Feynman writes in his book "the Character of physical law":

"...One philosopher said, "To the very existence of science is absolutely necessary that the same conditions always produces a same results." So this does not work. You can accurately reproduce all the conditions and still not be able to predict which hole you will see electron. However, despite this, science alive, although the same conditions do not always get the same results...

Therefore, in fact to the very existence of science is absolutely necessary that the bright minds that do not require from nature to satisfy some pre-specified conditions..."

The objective of this book is to introduce the extraordinary in modern astronomy. On the one hand, it's new facts, unusual from the point of view of the former traditional beliefs, on the other hand, consideration of the known facts from a different angle. Part of the book devoted to the original hypothetical assumptions, and some discussion questions in modern science about the Universe.

Modern science and astronomy in particular, boldly intrudes into the unknown. And just as blurred in our time the line between abstract theoretical constructs and practical applications, and blurred the line between science and fiction. On the one hand, modern science itself with sufficient tolerance and attention to the most stunning of fantastic hypotheses, on the other, science fiction arena, where you can still freer than in "official" science to Express and discuss the most incredible ideas, of course, if they have a grain of truth. And maybe it was this last circumstance draws today in the sphere of science fiction writers, but also many professional scientists.

Finally, science fiction is making a very real ideas and problems more visible and prominent, and therefore more accessible for perception.

Getting acquainted with the most acute problems of modern science about the Universe, we will resort to the help of science fiction...

A world in which introduces this book, is basically astronomical. But his boundaries are located and other Sciences: physics, mathematics, biology, chemistry... Also one of the characteristic features of modern science — an abundance of border issues...

Going to a way, here is another to suit the occasion is an excerpt from the story by R. Sheckley:

"It is possible that in the distorted world with you, absolutely nothing will happen. To expect that is unreasonable, but it is equally unwise not to be prepared for that... Perhaps those comments about the distorted world have nothing to do with a distorted world. But the traveller forewarned".

The book, to read which you embark is not slender and consistent presentation of the modern astronomy, or any of its sections — entertaining option of a systematic course of astronomical science. It addresses only selected issues connected with the study of the Universe and of interest from the point of view of understanding of diversion, referred to above.

The author tried as little as possible to resort to calculations and formulas, since his main task was to not claiming the severity of the presentation, I try to reveal to the reader primarily qualitative side of the phenomena and their study.

It may seem weird at first sight, a good half of scientific discovery begins with denial. The negative and the positive. Mutually exclusive extremes. But is it really? Is born whether, in some cases, positive or negative? And, in particular, is it really a "negative" role "negative" in science? Maybe it's more "positive"?

Behind this apparent play on words is fraught with serious things.

Any scientific theory has its limits, the range of phenomena and conditions that it describes quite well — the limits of its applicability. Every theory is inevitably limited and unable to Reflect all phenomena are infinitely various nature. However, there is a view according to which the diversity of global processes can in principle be described by a finite number of fundamental laws. However, the validity of such allegations raises serious doubts. In any case, it is not yet proven. History of science is rather evidence to the contrary.

So, any theory, even the most common, has its limits of applicability, and sooner or later discovered facts that lie beyond these boundaries, there is a denial of habitual representations. The denial, which begins with the creation of building a new, more General theory.

And we are not to imagine that a new theory completely rejects everything that came before. On turnover, she incorporates what already exists as a

private, a limiting case. In the area where the old theory is confirmed by facts, it fully retains its value. This is the "matching principle" is one of the pillars of modern physical science.

The old theory is not only not eliminated, on the contrary, the credibility increases many times. First, its provisions were now more clearly defined borders, and this increases their reliability. And secondly, its importance is not only supported by their own "merit", but merit of a more General theory, a special case of which it now becomes...

Therefore, with the emergence of new theories not denied prior knowledge, but only the same "error".

For example, in the epoch of classical physics it was believed that the mechanical laws applicable to all natural phenomena. It was a delusion. It is for him, and not on the mechanics of Newton attacked the theory of relativity. As for classical mechanics, it turned out to be a special case of the theory of relativity at speeds considerably smaller speed of light, and not too large masses. Due to this mechanic not only has not lost its value, but, on the contrary, was much more authentic.

Thus, the essential progress of scientific theory starts with denial.

Do not randomly search for new facts especially intensively in such areas where there is reason to hope for obtaining new information.

"...The experimenters hardest of all are searching for there is where you are likely to find a refutation of our theories, — says R. Feynman. In other words, we try as soon as possible to refute themselves, because it is the only way of progress."

And every denial inevitably precedes doubt.

"Doubt is a necessary component of emerging science, says the same Richard Feynman, one of the prerequisites of scientific knowledge: either we leave the door open to our question, or there will be no progress. There is no knowledge without question, there is no question without a doubt..."

So: new facts — doubt — denial of sense — development are more common than ever before, theoretical concepts — such is the high road of scientific progress. And denial on this road — one of the first hubs.

Thus, new facts that contradict existing views that ultimately do not play

destructive, but rather creative role: they lead to the generalization and deepening of these ideas.

Astronomical science of the last decades is especially rich in discoveries of new facts. This is primarily owe to the improvement of telescopes and the emergence of new effective methods of research of the Universe: radio astronomy, infrared, ultraviolet, x-ray and gamma-ray astronomy and the development of space flight and the use of various spacecraft for astronomical observations.

Plays an important role and the fact that space today is a provider of valuable scientific information, the value of which is far beyond the scope of purely astronomical interest.

In the vast expanses of the Universe occur such processes, which on the Ground does not occur and that we therefore don't know yet. Innumerable forms of existence of matter unknown to man sources of energy, unusual physical conditions...

Modern physics has reached a level of development when almost each new advance requires a very complex and delicate experiments, for which we have to create more powerful and grandiose installation. Their construction takes years and is costly. But it's not just that. As a rule, modern experimental physics research or otherwise represent in most cases the testing of certain conclusions of the theory. Possibilities to encounter in the experiment for some unforeseen, completely unexpected phenomenon with each passing year there are fewer. The days of "free" experimental physical search, as it was in the "good" old classic era, almost passed by long ago.

Another thing — search in infinitely diverse Universe of the laboratory, where is always possible to find something unknown. Although, of course, here much depends on the hardware (not all cosmic phenomena we can observe), and from theoretical assumptions (you may see something original and not to pay attention).

Of course, we should not think that the Earth physicists have nothing more to do and have no choice but to focus its efforts on the study of cosmic phenomena. Earth and space physics should complement each other. But in any case, at this stage of development of the natural Sciences the universe in the near future may become a very important supplier of valuable information

that can significantly expand our understanding of the physics of the universe.

But to produce new facts in the laboratory of the Universe is not easy. First of all, because space objects are at great distances from Earth. There are other difficulties.

In Cybernetics is considered such a task. There is some object, internal structure of which is unknown to us. It is called "black box". But this object has "inputs" and "outputs". On the "inputs" are received an external impact, the object responds to certain reactions.

The challenge is to not "opening" the black box, just by the nature of the input and output signals to get an idea about its internal structure.

Imagine that you know neither the design nor the principle of operation of your radio. It is only known that his "entrance" receives electrical signals from the antenna, and the "output", in dynamics, we hear the sound: voice, music, singing. And these "input" and "output" data to get an idea about the design of the black box radio.

In principle there are two ways of solving the problem. You can register coming from the antenna signals and to compare them with what is happening on the output. This is the way of observations. But there is another possibility, more active. By feeding input signals and observe what happens on the output.

Obviously, the second way is more effective; in particular, it opens the possibility of rapid testing of emerging hypotheses and assumptions regarding the "construction" of the black box. After studying the patterns linking input and output signals can, in principle, to construct a model that accurately reflects the device black box. Astrophysicists solve a similar problem. Most space objects — black boxes, whose internal structure, i.e., ongoing physical processes can be studied only by outward manifestations.

However, the situation is complicated by the astronomers, at least, two circumstances. First, they are deprived of the opportunity to experiment, and can only watch. Second, most of the space of the black boxes — the boxes that have no "inputs".

In any case, these "inputs" V. now unknown to us. For example, we are not

aware of such external influences, which could change the course of physical processes on the Sun. There is, however, extravagant hypothesis, owned by E. Browne, the hypothesis that periodic fluctuations in solar activity are connected with the tidal perturbations by the planets. However, while this is just a guess...

However, among the space objects are those for which external influences play a significant role. In particular, interesting phenomena have been discovered in the so-called dual system consisting of two stars orbiting a common center of mass. If one of those stars massive enough and has a powerful gravitational field, then it, according to the findings of modern astrophysics must flow substance of the second, "normal" stars. Such a process can play the role of the input signal, significantly affecting the state of a massive star.

There are certain "inputs" and such celestial bodies like planets and comets. For the planets, for example, the impact of solar activity and comets — heat and light radiation of the Sun, solar wind, and the gravity of the giant planets.

Studying the Sun the modern astronomers practically there is only one real possibility: to register the phenomena that occur in its external layers. This is the output of a solar black box.

Another difficulty faced by adventurers in search of new facts, is typical not only for astronomy but also to Sciences such as, say, physics and mathematics. The issue is the relationship between our visual perceptions and reality.

The entire experience of cognition of nature and, particularly, the history of astronomy convincingly argue that "visibility" is a very unreliable source of advice when tackling science questions. For example, philosophers reasoned. Imagine that the Universe has an edge and man has made of this region. However, it is only to extend her arm and she will be abroad in the Universe. But the material world will move apart for some distance. Then we can get closer to the new border and repeat the same operation again. And so on without end... So the universe is infinite.

"There's no end to either side of the Universe, because otherwise the edges will certainly she would have had," wrote Lucretius Carus in his poem "On the nature of things".

But, unfortunately, such arguments cannot serve as a basis for serious scientific conclusions. We can't imagine, but that in itself proves nothing. The reasoning is the same Lucrezia, although outwardly logical, really just relies on our familiar earth views, tacitly assuming that they are valid everywhere and always.

You can recall about those objections, which caused at the time, the idea world travel nominated by Magellan. His opponents appealed it to clarity. "How, — they shouted, — all the time moving in a straight line in one direction, return to the same point?" The possibility of such a result is contrary to generally accepted worldly views. But as you know, the reality confirmed the assumptions of Magellan.

Similar objections were met by the idea of the antipodes: if the Earth is spherical, how can people live on the other side? — Because they have to walk upside down...

When the astronomical observations of visibility denies at every step. Every day we see, for example, in the daytime Sun and the night Moon and stars move across the sky from East to West. Visually it seems to us that the Earth is stationary and the heavenly bodies rotate around it. So thought the ancient people taking this apparent movement is valid. Today, every schoolboy knew that the apparent daily movement of the heavenly bodies is only a reflection of the own rotation of the Earth.

Very intricate and visible movements of the planets among the stars that occur over long periods of time. The planets are moving from West to East, then suddenly stop and begin motion in the opposite direction — to the West. And then, describing in the sky a kind of loop, re rush to the East.

In fact, loop-shaped motions of the planets — the movement seeming, illusory. It occurs because we observe the planets from Earth, which itself orbits the Sun. Copernicus not only understand the nature of this phenomenon, but also introduced in science the most important methodological principle: the world may not be what we directly observe. And so the task of science is to find out the true nature of phenomena hidden behind their external appearance.

This principle not only formed the basis of the heliocentric system of the world, was developed by Copernicus, but in essence was the Foundation of

all modern science.

Another example illustrating the Copernican principle. The sun appears to us on the sky is relatively small disk, almost the same as the disk of the moon. However, this is just an illusion — the result of the fact that the Sun is 400 times farther from Earth than our Orb of night. If we were watching the Sun from the orbit of Pluto, the most distant planet of the Solar system, it would seem to us a point.

And the stars? We see their points even when observing the most powerful telescopes. And among them there are giants in the millions and billions times greater than the Sun in its volume. All the matter in great distances.

Distances bring about changes in the observable brightness of the stars. Some stars seem brighter, the other less bright. But in itself it says nothing about the amount of light that they do emit. Here is an example. Here are four well-known stars: the Sun is the brightest star, Sirius — the brightest star in the night sky, the star VEGA of the constellation Lyra (4 times weaker than Sirius) and the North star — is the weakest of the four bodies (6 times weaker than the VEGA).

But if we could have these four stars at the same distance from Earth, we'd have to make a complete "reevaluation of values". In the first place would leave North star, VEGA and Sirius would be interchanged, and the Sun would be in the end...

And General appearance of the heavenly bodies can be quite deceptive. That's at least the Moon. Poets have long styled our cosmic companion silver. On a clear night during a full moon, the earth the objects cast in the rays of the moon quite clear shade...

In reality, the lunar surface reflects only about seven percent of the incident sunlight.

In terrestrial conditions of a subject, which reflects less than one-tenth part of the light rays, we call the black or at least dark gray.

Indeed, the lunar surface is dark. This is evidenced by the television pictures transmitted from the moon by Soviet and American automatic stations. This is confirmed by the observation of American astronauts.

However, fairness demands to note that not all lunar rock black. There are

yellow and brown. In addition, the color of the lunar surface depends on the angle of incidence of sunlight. By the way, objectively measured the color of the moon is dark yellow.

Why is the Moon in earth's sky seems bright luminary? Only in contrast with the surrounding black background of the night sky...

Another astronomical illusion. Each, of course, not just watching the sky, the beautiful Venus, the morning or evening "star". Bright shining point of it is visible at sunrise or sunset... But look at Venus through a telescope. Most often we will see serpi, reminiscent of a lunar "month"...

However, otherwise it can not be. After all, at the time of his appearances is Venus in the direction of the line connecting the Earth with our fluorescent light. And so we under no circumstances are not able to see the whole sunlit half of the planet. This is possible only in the case when Venus is on the other side from the Sun. But then she gets lost in his bright rays, and we can't see.

Venus seems to us to be a star only due to the fact that because of their distance our eyes are not able to distinguish real contours of the Venusian Serpico.

An optical illusion can occur when telescopic observations. One of the most striking examples is the famous story of the discovery of the canals of Mars. In 1877 during another convergence of Mars and Earth, the Italian astronomer Schiaparelli, sending to Mars my telescope, found on the surface of this planet a fine network of lines that intersect it in various directions. Thus was born the mystery of the Martian canals that gave rise to the multitude of fantastic hypotheses about a high civilization, if existing on the mysterious red planet.

However, many astronomers argued that there are no channels on Mars that the notorious TV — only an optical illusion that occurs when telescopic observations. In fact, they said, on the surface of the planet there are a large number of disparate parts. But due to the huge distance they merge to our eyes in a continuous line...

Something similar we are seeing, looking at the TV screen. As is known, a television picture consists of several hundred lines, which traces one after another by an electron beam. If you get close to the TV, especially the big screen TV, these lines are clearly visible. But it is necessary to move away

from the screen a sufficient distance, our eye ceases to distinguish separate lines — they merge in a continuous, uninterrupted image.

Trying to prove that the canals of Mars — an optical illusion, some scholars put an interesting experiment. They collected in a large enough audience of people who have not heard anything about Mars, nor about the problem of the Martian canals, and hung before them on the wall with special pictures, which were scattered all sorts of spots and dots. Then those present were asked to redraw these images.

The results of such experiments proved to be very convincing. Subjects sitting in the front row and well have seen the original quite accurately reproduced it without any additions. But those who sat out, portrayed the line, which was not on the original — portrayed because I could not at a great distance, to clearly distinguish the individual parts that seemed to them the solid lines.

Time has shown that the results of such experiments correctly reflects the true state of Affairs. Spacecraft transmitted television pictures of the Martian surface from a close distance, no channels on this planet is not found. And in those places where in ordinary astronomical images of Mars, "channels" was visible on the surface of the planet, chains of small craters and other small details.

Often the uncertainty in astronomical research arise from the fact that it is not always possible to confidently determine the distance to those or other space objects. Objects located in the same place of the celestial sphere, in fact, may be at significantly different distances from Earth, and hence from each other.

A few years ago, us astronomers reported that in Central star system of our Galaxy, they discovered isolated dense condensations of gas. The nature of motion of these condensations can be interpreted as evidence that the center of our Galaxy is the massive compact body. However, subsequent studies conducted at the largest Soviet radio telescope RATAN-600 showed that the thickening in question is most likely not belong to our Galaxy, but only accidentally projected onto the Central part.

Another circumstance that can give rise to uncertainty: different physical processes in space can generate electromagnetic radiation having approximately identical properties.

Probably it would be possible to cite many examples and reasons showing that the adventurers have no right to trust immediate impressions, or to jump to any conclusions. Especially in cases, when we study complex and obscure cosmic processes.

The fact is that between the physical process occurring anywhere in the Universe, and the findings of scientists observing this process from the Land, lies a chain of many links. And the transition from each to the next possible inaccuracies and wrong conclusions. What-either directly, as is done in, say, physics or biology — is not possible.

In addition, the reading of any measuring instrument used in astronomical research, deflection or darkening of the photographic plates is not in itself a scientific fact. Below the reading device has become such a fact, it must be properly interpreted, interpreted. And this interpretation can be carried out only within a particular scientific theory.

"The experiment never has the character of simple fact that you can say, — said the famous physicist Louis de Broglie. — In the statement of this result always contains a certain amount of interpretation, therefore, the fact is always mixed with theoretical ideas".

And if in any field of science are currently competing theoretical concepts, the same observational or experimental data can obtain from the point of view of these conceptions completely different interpretation. In order to make conclusions about the nature of one or another cosmic phenomenon was sufficiently reliable, it is necessary to consider this phenomenon under different angles, to study it with independent methods and the results obtained correlate.

However, all this, of course, applies not only to astronomy but also to all other Sciences. The only difference is that to an astronomer this question, perhaps, is of special importance. After all, for centuries the main tool of the study of the heavens was the eye — the eye of the observer. He was the source of all information, and much depended on, to trust him completely or treat obtained with the help of information sufficiently critical.

To correctly assess the facts and draw the right conclusions, astronomers are hampered not only by the universal credibility of clarity, but sometimes the most basic of mistakes. No science, not even so exact as mathematics,

unfortunately, is not without errors. Unfortunate omissions and undetected typographical errors eventually found in almost every scientific work. Say, one scientist set out to summarize the mistakes made by the authors of several dozen mathematical books. He wrote about this solid work, but as it turned out, and he made it a few hundred errors.

However, errors are different. Sometimes it is the result of carelessness, often the result of limited knowledge, lack of knowledge of an issue. There are unexpected errors that are difficult to foresee and which is not so easy to detect.

However, errors if they are detected early and how to understand the causes, is also instructive...

A few years ago the astronomical world got a curious message: French scientists at the Observatory of Upper Provence, discovered in the spectrum of the dwarf star HD 117042 line radiation of neutral potassium... Until in the spectra of such stars potassium no one was watching. And in subsequent spectrograms of the same stars nothing like this happened again.

However, two years later a mysterious "potassium flash" was observed in one dwarf star HD 88230.

Intrigued astronomers started a systematic search. Alas, to no avail. Perhaps the matter would have ended, if in 1965 was not found potassium is another flash from a third star.

The air smelled of sensation. After all this time it was about the star, whose surface temperature was about 12 thousand degrees. How could such a huge temperature be maintained potassium in the neutral state?

Mysterious it seemed that all three stars potassium flare was observed only once. On spectrograms obtained after only a few hours, no traces of potassium were not mysterious at all. But how can the atmospheric composition of a star change so much in such a short time? Moreover, the line of potassium at the "flash" was very broad and intense.

And suddenly three California astronomers reported that they found an unexpected solution to the problem. Mysterious lines on the spectrograms of potassium, they argued, is not some "ghosts" and "Fotolia" as the photographs of the notorious "flying saucers", a quite respectable line absolutely real potassium. Only was the potassium is not on the distant stars,

but very close — in the premises of the Observatory, through which is passed a beam of light from the star. And he entered not into the composition of stellar atmospheres, and in the most ordinary match. Yes, it was worth watching to light near the telescope a match, as in the spectrogram, there was a potassium. American scientists have tested this multiple studies. So in the history of astronomy there was "match hypothesis"...

However, maybe the California researchers also wrong? Because of the three observers that registered the mysterious "potassium flares", smokers were only two...

Another example. Spectral methods of studying the chemical composition of Saturn's moon Titan — the only Solar system moon with a gas shell, astronomers came to the conclusion that it consists mainly of methane. On this basis, it expressed even the bold assumption of the existence on Titan of organic life.

However, the instruments installed on Board the automatic interplanetary station "Voyager 1", visited in the area of Saturn in November 1980, showed otherwise. It turned out that the atmosphere of Titan on 93 % consists of nitrogen, and the methane content does not exceed 1 %.

How could astronomers so much wrong? A cruel joke with the scientists played the structure of the atmosphere of Titan. Although the diameter of Titan is only about 5 thousand km, i.e. 2 1/2 times less than the diameter of the Earth, the thickness of its atmosphere is about 10 times greater than the thickness of the atmospheric shell of our planet. And methane, as it turned out, mostly concentrated in the upper layers. This "methane mask" and hide the true state of Affairs, creating a misconception about the whole structure of the atmospheric envelope.

While we have talked about clarity in a more simple and direct meaning of this word: "do not trust the eyes", but rather: "check and re-check what you see". But this problem of clarity in science does not end there. She has another side. Visibility is a necessary condition for the validity of a scientific conclusion? In other words: if a particular scientific position is a true reflection of the real world, does this mean that we definitely can visualize everything that is connected with it, and even so these views do not contradict our common sense?

First of all, what is "common sense?" We already talked about the fact that the real world is always much richer and more varied than our scientific understanding of it. However far we may have advanced in their studies, our knowledge will always be some gaps. Any scientific theory, as we have already noted, have certain limits of applicability. But where exactly are these boundaries in advance is usually unknown. It is natural that attempts to apply existing ideas beyond the boundaries of their applicability inevitably lead to incorrect results. However, from time to time, such results will be accepted for the truth. Thus are born of delusion.

This is the "common sense" a given historical period— "knowledge plus error, taken for knowledge."

And, paradoxically, such fallacies are not only inevitable, but necessary. Knowledge, in which there are clear gaps, difficult to use, it does not give a complete picture of the studied phenomena. These gaps to be filled, from time to time errors.

Thus, delusion is a kind of "temporary knowledge" but rather, "ignorance is taken for knowledge."

Of course, we must distinguish between common sense in everyday sense as a generalization of the practical experience of humanity and common sense, which is determined by the level of scientific knowledge.

Of what constitutes, for example, the common sense of an epoch, when there and established the first system in the world — system of Aristotle — Ptolemy? Than were available in those days science? Observations of fixed stars, the daily rotation of the celestial sphere and the annual looping motions of the planets. That was knowledge. But it lacked for explanations of the observed and build a logically complete picture of the world.

The result is visible from the Ground the movements of the heavenly bodies had been illegally circulated and elevated to the rank of universal truths. Thus arose one of the greatest and most sustainable misconceptions in the history of mankind — the idea of the Central position of the Earth in the Universe.

But with this confusion we managed to build a coherent model of the universe, not only to explain from a unified point of view, the nature of the observed movements of the heavenly bodies, but allowed with an accuracy quite sufficient for those times, predicast future positions of the planets

among the stars.

As we now know, the system of the world of Aristotle — Ptolemy and the relationship between knowledge and misconceptions, which she determined was only one of the stages of cognition of nature. But the transition to the next next stage demanded not only a Herculean effort by the advanced minds of humanity, but also to overcome fierce resistance. And the question in this case is not about resistance from the Church, for which the system of Aristotle — Ptolemy was recognized as the only view of the world, and the resistance from the common sense of the era. The common sense, which, raising the usual misconceptions in the rank of knowledge forces us to take new knowledge for misconceptions...

But in the end, new knowledge still prevails. As you know, change the system of Aristotle — Ptolemy to the doctrine of Copernicus. With the previous misconception — geocentrism was gone forever. But the Copernican system, in turn, contained a number of errors. The author believed that all the planets revolve around the Sun strictly on the circle and with constant angular velocities. Copernicus also believed that the universe is limited by the sphere of fixed stars.

The next step in knowledge of the world was the discovery of Kepler's laws of rotation of planets around the Sun. Kepler showed that the planets actually move in ellipses with variable speeds. But in searching for the causes of this motion, Kepler proceeded from the common at the time, the misconceptions that in order to maintain uniform rectilinear motion requires constant force. And he was looking for in the Solar system the force that "pushes" the planet and not giving them to stop.

Soon this misconception was done away: Galileo discovered the principle of inertia and Newton's basic laws of motion and law of universal gravitation. These discoveries not only finally clarified the regularities of the Solar system, but also destroyed the idea of the sphere of fixed stars.

Classical physics has come to the conclusion that all bodies of the Universe exist and move in the infinite and limitless space.

However, in turn the classical physics of Newton brought a new greatest delusion: a firm belief that without exception, all the phenomena of nature are reduced to purely mechanical processes. We're not talking about such

"private" delusions like "absolute space", "absolute time", etc.

All the questions of the universe presented from the point of view of classical physics is quite clear and resolved completely and permanently, as, indeed, almost all other problems. But this time, the achieved clarity was deceptive, and the truth is far more complex than was thought at the time of Newton.

Opened in the beginning of this century Einstein's theory of relativity turned who had already become familiar Newtonian concepts of space and geometric properties of the Universe. One of the main merits of Einstein has been the formation of the deep organic relationship between properties of matter and geometry of space.

The next transformation of the common sense of science was quite accurately reflected in the verse:

The world was shrouded in deep darkness.

Let there be light! And so was Newton.

But Satan didn't wait long revenge:

Einstein came and everything became as before.

Interestingly, the first and second couplets belong to different authors and written at intervals of about 200 years.

Of course, it is true only that from the classical notions of space had to be abandoned. But this does not mean that the theory of relativity has returned science to its pre-Newtonian, Aristotelian times. The new physics was a very important step towards a deeper understanding of the structure of the world around us...

And this process of change common sense continues today and will continue... Because our modern knowledge about the Universe are not the ultimate truth.

So the common sense in science is relative, temporary, corresponding to the level of knowledge of this period. So scientists in their quest for a deeper knowledge of the world have to lead the inevitable battle with the usual representations, the usual common sense.

As for clarity, the further developing science, especially physics and astronomy, the more we give up all that you can visibly imagine. May not

like it, even annoy, but this will not go away.

The strange world of modern physics! It's a new world, which is very much difficult and even impossible to visually imagine a world not only of modern physics, and modern astronomy. Science has entered its winding and steep road.

And watching an amazing new discoveries, which often rebels against our common sense because they do not fit into the usual understanding, we must never forget that all common sense inevitably includes error.

As we have said, the emergence of fundamentally new facts unexplained in the framework of the existing theories leads to the development of the theory more General, which "absorbs" and previous ideas.

As noted Soviet cosmologist A. L. Zelmanov, if in the process of learning is that some group patterns may be derived from more General patterns, it does not mean that the first is entirely confined to the latter. They have their own specifics. In other words, "hatchability" is not yet a simple "reducibility". The ratio between private and public theories is much more complicated.

Let us imagine that we have two physical theories, one of which is private, the other more General. Then the range of applicability of the special theory lies within the field of General applicability. These different theories of the equation. And it's not just that the equations of the General theory rather. If you take the totality of all physical variables included in the equation, it appears that they are not the same. There are some values common to both theories. But there are different in the equations of the General theory alone, in private other equations.

The emergence of new values in a more General theory related to the application of new concepts. In the transition from the special theory to the General, it turns out that the very concepts of the special theory (the concepts, not equations) are approximations that reflect the real world only with a certain degree of accuracy. The new concepts applied in a more General theory, are more accurate.

Thus, the transition from private to General theory of what's going on is breaking concepts. That is why private and General theories are qualitatively different from each other.

How, in this case, one of them may be a special case of the other, to emerge from it? Equations of a more General physical theory the world will have one constant more. Such constants are present, there are three: the constant of gravitation, the so-called quantum of action or Planck's constant and the speed of light (this is typically the reciprocal of the speed of light).

For example, the equations of classical Newtonian mechanics do not contain the global constants, and the equations of quantum mechanics, which is a special case of Newtonian mechanics, contain Planck's constant.

Order from the General theory to obtain private, should be appropriately transform the equation and go to the limit in the pursuit of the "extra" constants to zero. The equations that we get as a result of such passage to the limit, will not be equivalent to the original. Those and others are qualitatively different from each other, they are different sizes, they have different meaning.

So if we had only the equations of the special theory and want to conduct the reverse operation, i.e. for equations of the special theory to recover General equation, we would have been unable to do so because according to the equations of the special theory it is impossible to guess what should be the equations of the General theory. This requires considerations of a higher order, such as philosophical. This statement, of course, should not be understood in the sense that directly from philosophical considerations, you can display the equation or to obtain specific physical results. But the philosophical principles help to define the most perspective ways of development of science, to exercise a choice between different possible variants of new theories.

Historically, the transition from the special theory to the General is a revolution, requiring a fundamentally new and sometimes "crazy" ideas and developing new concepts.

As example is the Newtonian theory of gravity and General relativity. The first operates on the Euclidean space and independent time; the second considers the space-time continuum, with non-Euclidean properties. The transition to these new concepts was a revolutionary shift in the science of gravity.

Thus, the private and more General theories are qualitatively different. And it

would be more accurate to call private theory is not private, as a limit case of the General theory of relativity.

The history of science is replete with problems, the solution of which required centuries of work of advanced minds of mankind, and a long struggle with false ideas. Clarity was achieved at the cost of enormous effort. But in many cases subsequently, exactly the same results was able to get either much more simple or quite elementary consequences of the latest discoveries and achievements.

Among these challenges is the question of the Earth's rotation around its own axis. The fact that people for a long time failed to prove that they live on a rotating planet, is not so trivial as it might seem at first glance.

Generally speaking, in rotating systems it is possible to detect the acceleration associated with the rotation (called the Coriolis acceleration). These accelerations caused, for example, undermining of right banks of rivers in the Northern hemisphere and left in southern.

But, first, the Coriolis acceleration is manifested only in the movement of bodies, and secondly, they provide only an indirect indication of the rotation of our planet.

Much more such phenomena which allow to detect not acceleration, but the fact of the planet's rotation. The undisputed basis of the daily rotation of the Earth could be the apparent daily movement of the Sun across the sky, and change of day and night. But, unfortunately, the same pattern we have seen in the case if the Earth was stationary and the heavenly bodies, including Sun, "bypassed" around her.

On rotation of other celestial bodies to judge on the basis of direct observation. Thus, the rotation of the Sun can be detected, for example, on the movement of sunspots, the rotation of the planet Mars — the offset of the detail visible on its surface. His own planet, the Earth, people could not watch from the sidelines.

Clear and convincing proof of the Earth's rotation was Foucault's experiment with a swinging pendulum.

The pendulum, i.e. the weight hanging from the thread, is one of the most simple and at the same time the most remarkable devices. The physical

essence of the experience with a pendulum consists in the following. The forces acting on a swinging pendulum, gravity and the tension force of the yarn, lie in the same plane — in the plane of its swing. Therefore, given the movement of a freely suspended pendulum will swing in the same plane. Physicists formulate this property of the pendulum: "the Plane of swing of a pendulum retains the unchanged position in space".

The proof of the rotation of the Earth by swinging a pendulum is well known, and we are not going to remind her of him. We note only that this experience has one significant drawback. To reliably detect the rotation of the plane of swing of a pendulum due to the rotation of the Earth, you need quite a long time.

In the early fifties of our century Soviet engineer by Peshekhonova was proposed an original device for the proof of the daily rotation of our planet. Essentially it's the same pendulum, but of a special type, and the proof is based on a completely different principle.

Imagine a vertically disposed frame mounted on the stand and rotatable relative thereto around a vertical axis. In the center of the frame on the horizontal axis fortified freely rotating rod with weights on the ends. That's the whole device.

How does it work? The effect of this kind of pendulum is based on the law of conservation of angular momentum.

The angular momentum is the product of the mass of a body m on its linear velocity V and distance R from the axis of rotation. But the linear velocity is equal to the product of R for angular velocity ω ($V = R\omega$).

So, $N = m\omega R^2$, where m is a constant.

Now suppose that the radius R decreases, i.e., the body approaches the axis of rotation. Since m is constant, then in order to work ωR^2 not changed, respectively, should increase ω .

In other words: with the approach of the rotating masses to the axis of rotation the angular velocity increases.

Usually the example of a rotating figure skater. Throwing his arms to the side or bringing them to his chest, he adjusts the speed of its rotation. The same thing can be done and a skydiver during a skydiving, and an astronaut, freely

floating in weightlessness in the cabin or in the open space.

Let's return to our pendulum. Install it on a stationary platform and force the Central rod to rotate around the horizontal axis. The rod will rotate until then, until it stops due to friction in the bearings. This is on a stationary platform.

And now let stand rotates uniformly around the vertical axis, i.e. the pendulum is in the center of the rotating base. In this case, the picture will change significantly.

At the time when the rod is in the horizontal position, i.e. the loads are located far from the vertical axis, the pendulum rotates with platform. But at a time when the boom comes to vertical position and loads at its ends will be on the axis of rotation of the cradle, the angular velocity of rotation of the frame about a vertical axis will increase. And frame together with the rod must make a "breakthrough" ahead of the rotation of the stand.

Thus, if our pendulum is on a rotating platform, there will be a gradual rotation of the plane of rotation of the rod. It is easy to think that according to this principle, it is possible to judge the rotation of the stand, even without observing it directly.

This means that the pendulum can be used to detect the rotation of the Earth. A noticeable effect of the offset will be achieved much faster than the Foucault pendulum.

A few years ago, the pendulum in question was built and installed in the foyer of the Moscow planetarium. It worked flawlessly in accordance with the considerations given above.

It would seem that the surest way to better study the Land — to visit every corner of it, to penetrate its depths, to take into account all the phenomena occurring on its surface. Scientists do just that.

But in many cases the solution to earthly problems is greatly facilitated if "break away" from our planet and out into space. If you think about it, there is nothing surprising in this. Generally, science has an unwritten law: if we want to study an object, one must consider not only the object itself, but not necessarily a broader scope of phenomena. In particular, spacewalk gives us a very convincing and at the same time, clear evidence of the earth's rotation. We are talking about the movement of satellites.

On an artificial satellite moving in low earth orbit, in fact, operates only the force of gravity, which lies in the plane of this orbit (we will not take into account deviations associated with the fact that the Earth is not a perfect homogeneous sphere and some other subtle effects). Thanks to the orbit plane of the satellite for short periods of time does not change its position relative to the stars. If the globe does not rotate around its axis, then the satellite with each successive turnover been over the same ground points. But due to the fact that the Earth rotates from West to East, the track of the satellite, i.e. the projection of its motion on the surface of the Earth, shifts towards the West.

As you know, an artificial satellite moving at an altitude of 200-300 km, it takes one complete revolution around the Earth in about 90 minutes, i.e. about one and a half hours. It is easy to calculate that during this time the globe is turned by 22.5° . The length of the circumference of the earth at the equator is about 40 thousand. km. Thus, a rotation of 22.5° corresponds to approximately 2500 km. Therefore, during each revolution, the satellite crosses the equator line for the 2,500 km to the West than the previous one. After about a day, completing 16 orbits around the Earth, the satellite will pass over the launch area.

Remember that the implementation of the group flight of the Soviet spacecraft "Soyuz-6, Soyuz-7 and Soyuz-8" in 1969, each following ship was launched approximately a day after the previous one.

Have you ever thought about why in the daytime the sky can see the stars? Because the air and as transparent as night. The thing here is that during the day, the atmosphere scatters sunlight.

Imagine you are in the evening in a well lit room. Through the window bright lights outside, can be seen quite well. But poorly-lit subjects to see almost impossible. However, it is only to turn off the light in the room as the glass ceases to be an obstacle to our vision.

Something similar happens when observing the sky by day the atmosphere above us, brightly lit, and through it to see the Sun, but can not break through weak light of distant stars. But after the Sun sinks below the horizon and the sunlight (and with it the light, diffused air) "turns off" the atmosphere is "transparent" and you can watch the stars.

The situation is different in space. With the rise of the spacecraft at the height

of the dense layers of the atmosphere remain at the bottom and the sky gradually darkens.

At an altitude of about 200-300 km, where there is usually a manned spacecraft, the sky is completely black. Black is always a visible part at the moment is the Sun.

"The sky is absolutely black. The stars in this sky look a little brighter and more clearly visible on the dark background of the sky" — so described his impressions of the first space cosmonaut Yuri Gagarin.

But with the spacecraft on the day side of the sky you will see not all the stars but only the brightest. Eye prevent dazzling light of the Sun and the light of the Earth.

If you look at the sky from Earth, we will see clearly that all stars twinkle. They would then fade, then flare up, shimmering with different colors. And the lower above the horizon a star is, the stronger flicker.

The twinkling of stars is also due to the presence of the atmosphere. Before reaching our eyes, the light from a star passes through the atmosphere. In the atmosphere there are always masses of warmer and cooler air. The air temperature in one area or another depends on its density. Moving from one area to another, the light rays experiencing refraction. The direction of their propagation changes. Due to this, in some places above the earth's surface they are concentrated, others are relatively rare. As a result of continuous movement of air masses, these areas are all the time shifted, and the observer sees the strengthening, the weakening of the brightness of stars. But since the various colored rays are refracted is not the same, then the chances of strengthening and weakening of different colors does not occur at the same time.

In addition, a role in the twinkling of stars can play other more complex optical effects.

The presence of warm and cold layers of air, intensive movement of air masses impact the quality of telescopic images.

Where are the best conditions for astronomical observations in mountainous regions or on the plains, on the coast or inland, in the forest or in the desert? And in General, it is better for astronomers to ten cloudless nights throughout the month or only one clear night, but that when the air is clear and calm?

This is only a small part of the issues that must be addressed when selecting a location for the construction of observatories and the installation of large telescopes. Such problems are dealt with a special field of science — astroclimate.

A few years ago in our country was put into operation the world's largest telescope with a mirror diameter of six meters. Is a meter more than the diameter of the mirror Malomernogo famous telescope in the United States.

That means extra meter for astronomers? The scope of the observable region of the Universe expanded to approximately 1.2 times.

In connection with the construction of a new telescope, scientists Main astronomical Observatory, USSR Academy of Sciences at Pulkovo for several years conducted astroklimaticheskikh research in various areas of the Soviet Union, primarily in the Kuban steppes, the Caucasus, Georgia and Armenia, in the Pamirs and the Tien Shan mountains, lake Issyk-Kul and even in the Ussuri Krai. As a result of these searches was elected one of the areas of the North Caucasus in the Stavropol region. There and erected a new Observatory for a six-meter giant.

However, in our country there are places with even better astroklimaticheskikh conditions in Central Asia and the Pamirs. However, the construction of a large Observatory in those tight spaces would be fraught with enormous technical difficulties and additional costs. In addition, the areas in question, removed from the great scientific centers. Therefore, the preference nevertheless was given to the North Caucasus.

But, of course, the best conditions for astronomical observations — beyond the dense layers of the atmosphere, in outer space. By the way, and the stars are not twinkling and burning cold tranquil light.

Familiar constellations appear in space just as on Earth. The stars are at enormous distances from us, and the distance from the earth's surface for some hundreds of kilometers can not change anything visible in their mutual arrangement. Even when viewed from Pluto the constellations would be exactly the same.

During one revolution of the spacecraft moving in low earth orbit, in principle, you can see all the constellations in earth's sky. The observation of stars from space is of twofold interest: astronomy and navigation. In

particular, it is very important to observe the starry light, not changed by atmosphere.

No less important in space and navigation by the stars. Watching pre-selected reference stars, it is possible not only to Orient the ship, but also to determine its position in space.

For a long time, astronomers dreamed of future observatories on the moon's surface. It seemed a complete lack of the atmosphere must build on the natural satellite of the Earth, ideal conditions for astronomical observations as during the lunar night and lunar day.

To investigate the conditions of astronomical observations on the moon were conducted by special studies. With this purpose the Soviet automatic mobile laboratory "Lunokhod-2" was equipped with a special device — an astronomical photometer, designed and manufactured at the Crimean astrophysical Observatory, USSR Academy of Sciences. The device is found on the "Rover" in such a way that its optical axis was always directed to the Zenith of the lunar sky.

The measurement results were somewhat unexpected. It turned out that the glow of the sky on the moon and in the visible and especially ultraviolet rays is markedly higher than expected. The study of the characteristics of the illumination showed that it can be caused by residing in near-moon space with particles in the lunar dust.

In this regard, it has been suggested that around the moon there is a rarefied swarm of dust particles, resulting from bombardment of the lunar surface by meteorites and micrometeorites. These particles are kept at a certain height above the moon's surface by the action of electrostatic forces. They dissipate not only the sunlight but also the light of the Earth. After all, our planet in the lunar sky is shining about 40 times brighter than the full Moon in the sky of the Earth.

The presence of dust swarm around the moon can affect the efficiency of astronomical observations from the future lunar observatories.

For over half a century, everyone's attention is attracted to a mysterious event that occurred in the summer of 1908 in Siberia. We are talking about the famous Tunguska meteorite.

At dawn on June 30, 1908 age-old tranquility of the Siberian taiga was suddenly broken by the appearance of a blindingly bright body with great speed flying through the sky. For a few seconds, eclipsing the sunlight and leaving behind a thick trail of smoke, it disappeared over the horizon.

Another moment near the Fort of Vanavara located in the area of the river Podkamennaya Tunguska, shot a giant pillar of flame, easily visible from a distance of up to 450 km, formed a huge smoke cloud. The disaster was accompanied by a deafening explosion that was heard within a radius of 100 km. On the vast territory, as in a severe earthquake shook the ground, shook buildings, cracked panes of glass were swaying hanging objects. Tremors have been recorded by many seismic stations of the Earth, and the air wave several times around the planet...

The first expedition to the place of the Tunguska catastrophe was organized only after the October revolution in 1927, the Academy of Sciences of the USSR. In 1928-1930 was carried out two more expeditions, and in 1938 produced the aerial photography of the disaster area, unfortunately, very incomplete.

Then research was interrupted by the Great Patriotic war, and the next Tunguska expedition took place only in 1958, But in recent years, in place of the Tunguska catastrophe visited several well-equipped Amateur expeditions. Worked in the area and the complex expedition of the USSR Academy of Sciences.

During the initial research found a number of mysterious circumstances. In particular, there were no sinkholes, which usually form when hitting the Ground from space, and no fragments. The forest was knocked over a huge area of tens of kilometers, and the direction lying on the ground the trunks of the trees clearly indicated the direction to the center of the explosion. But it is in the centre, where, apparently, the destruction must be the largest trees stood in the Bud. And only their tops and almost all of the branches were broken off so that was the impression that the air wave would hit them from above...

It has been suggested that the explosion of the Tunguska meteorite occurred in the air at a considerable height above the Earth's surface. Apparently, this explosion was of the pinpoint nature, i.e. it occurred instantly, within hundredths of a second — otherwise it would not turn so the correct radial

fall forest. In this regard, a number of hypotheses about the nature of the mysterious body, including the very exotic — even to a purely fantastic hypothesis about the spaceship crash alien civilization, if the victim over the Tungus taiga nuclear disaster.

However, all assumptions — it is, of course, talking about scientific hypotheses — ran into serious difficulties, and none of them could be considered generally accepted.

On the example of the Tunguska meteorite is distinctly observed one curious pattern associated with the study of the mysterious phenomena of nature, which for a long time could not find an exhaustive scientific explanation. Usually in search of such an explanation attempts to attract each new fundamental discovery in the field of natural science.

So, with the discovery of antiparticles and the development of the idea of antimatter in particle physics, it was suggested that the Tunguska meteorite represented a small piece of antimatter, billions of years floating in space and then collided with our planet. As is known, the contact of matter and antimatter leads to their annihilation — matter and antimatter completely converted into electromagnetic radiation, and this releases huge amounts of energy. In this way, the authors of a new hypothesis has tried to explain those violent events that accompanied the Tunguska catastrophe.

However, the assumption about the "antipirate" of the Tunguska body, the popularity is not acquired. In particular, it was difficult to explain how the "splinter" of antimatter could for a long time to remain, moving in outer space. Because while it would have to constantly deal with numerous particles of interstellar and interplanetary environment and, inevitably, very quickly would lead to his annihilation.

Another attempt to explain the Tunguska phenomenon was made the "traces" of other major discoveries in physics of our century — the creation of quantum generators — lasers.

Put forward the idea that all phenomena that occurred in 1908 in the Tunguska taiga was caused by the fact that at this moment a powerful space laser beam of unknown origin "slashed" on the planet... However, this explanation seemed so fantastic, that it in General-that nobody took seriously.

In most recent years, was made another attempt to link the Tunguska

catastrophe with the new physical ideas. This time the starting point was the hypothesis of "black holes" intensively developed by physicists and astrophysicists. A black hole is matter compressed to such an extent, that it is "locked" by own gravity. Such an object can only absorb surrounding matter, but it out can't break away any particle or radiation[6]. On this basis, American physicists from the University of Texas A. and M. Jackson Rian suggested, according to which the Tunguska meteorite was actually... a small black hole, which with great speed into the earth's atmosphere.

However, more accurate calculations carried out by physicists in different countries, showed that the nature of the phenomena that would be observed in the collision of Earth with a black hole, absolutely do not correspond to what really happened in the fall of the Tunguska meteorite.

At the same time was carried out and it is a serious scientific study of the phenomenon of the Siberian 1908

So Soviet scientists at the Institute of physics of the Earth had been very interesting experiments on the simulation of the explosion of the Tunguska meteorite. In a special chamber was installed, the layout of the terrain of the disaster area in appropriate scale on which many wires were painted the trunks of the trees. On this layout at different points and at different heights blew up a small powder charges, bringing them at different speeds at different angles. In each experience was its own picture of the fall forest. In particular, under certain conditions and managed to get this fall, which coincided with the pattern of fallen trees at the crash site.

Analysis of the results showed that the Tunguska body was moving with the speed of 30-50 km/s, and the resulting explosion occurred at a height of 5 to 15 km away. the force was equivalent to the explosion of 20-40 megatons of TNT. As for damage in the area of the fall, all of them, apparently, was caused by shock waves — a wave that came from above from the explosion, and the wave reflected from the earth's surface.

An interesting hypothesis put forward by the famous Soviet astronomer and specialist in the study of meteorites academician V. G. Fesenkov. According to the assumption of the scientist, our Land in the summer of 1908 was faced with the icy core of a comet. As shown by calculations carried out by the Soviet scientist K. P. Stanukovich, fusible cometary ICES after entering the earth's atmosphere at supersonic speed first evaporate relatively slowly. But

then (it was going to happen in the dense lower air layers), when the whole mass of ice is sufficiently warmed up, she instantly had to turn into a gas and evaporate clot. A powerful explosion occurred.

The appropriate calculations showed that such a hypothesis can satisfactorily explain all the phenomena observed at the time of the Tunguska catastrophe and after it. But in order to prefer this hypothesis to all other assumptions, needed more facts, moreover, that in 1908 near the Sun no comets were recorded. Of course, a small comet could remain unnoticed, but still independent confirmation, podkreplyalisj version of the comet, was necessary. And such confirmation has been obtained.

For quite some time astronomers have noticed that even after the flight in the sky bright fireballs, which are associated with the invasion of the atmosphere is quite large cosmic bodies, usually in the area where there is a spectacular celestial phenomenon (flying in the sky, scattering fiery spray, dazzling ball), meteorites falling occurred. This fact was reflected in the result of observations made in recent years, the Czechoslovak and American astronomers who created a special "meteor" network for the systematic photographing cars.

Thus, the conclusion that the majority of cosmic bodies entering the earth's atmosphere, to the surface of the planet reach. Meanwhile, a large enough stone or iron meteorites would have to fall to the ground. This fact alone suggests that the body that caused the Tunguska catastrophe, and the body often creates the phenomenon of fireballs, have the same physical nature.

Recently the Moscow astronomer V. A. Bronshten, comparing the 33 bright fireballs with the data on the Tunguska meteorite, came to the conclusion about the physical likeness of the Tunguska body and the main mass of large meteoroids, which, entering the earth's atmosphere from the interplanetary space cause the phenomenon of fireballs, but do not reach the surface of the planet. In other words, all these bodies have low density and strength and are easily broken when moving in the atmosphere...

In recent years, was put forward another hypothesis, which represents a further development of the idea of an ice core of the comet. Its author is a well-known Soviet scientist academician G. I. Petrov. According to the calculations of the scientist, a mysterious body that caused the Tunguska catastrophe, was a huge snowball — body with a very loose core, composed

of ice crystals with a mass of about 100 thousand tons and a diameter of about 300 m, the average density which was ten times less than the density of water.

Having flown in earth's atmosphere at speeds more than 100 times greater than the speed of sound, a snowball quickly warmed up and began to evaporate rapidly. At a height of several kilometers remains of the snow body and the resulting evaporative gases, flying in front of him, instantly widened, which led to the formation of a very powerful shock wave. It is this wave and caused a radial fall forest square with a diameter of tens of kilometers.

The proposed hypothesis well explains how the physical nature of the air blast Tunguska meteorite and the absence of craters and shrapnel. However, it should be recognized that consensus on the nature of the Tunguska phenomenon from the experts does not exist and is still a disaster of 1908 near the stony Tunguska river largely remains unclear.

But one thing is certain — the Tunguska catastrophe is undoubtedly a unique phenomenon of nature and unflagging interest of scientists to it is justified. And it may well be that as a result of further study of this amazing phenomenon science will discover new, yet unknown space, and geophysical processes.

Can remote sensing studies to yield reliable information about the world?

The question most relevant to astronomy. Because space objects are at great distances from Earth and so the researchers of the Universe, at least until recently, have not been able to study them directly. In recent years, such a possibility has appeared thanks to the rapid development of rocket-space technology and successful exploration of space. Our eyes born space astronomy: space vehicles measuring and delivering television equipment in the areas closest celestial bodies and even on their surface.

There is a real opportunity to compare "knowledge" painstakingly accumulated by generations of astronomers about the Solar system with new space data. And what?

The answer to this question is very imaginative, although somewhat paradoxical form was given by the famous Soviet astronomer, a corresponding member of the USSR Academy of Sciences I. S. Shklovsky in one of his speeches:

— The greatest achievement in the study of the Solar system with spacecraft is that in this area no great discoveries had been made. Turned out that all was not right. The principled scheme of the processes occurring in the planetary family of the Sun, built ground-based astronomy, has received a convincing confirmation...

This conclusion has extremely important significance: despite the remote nature and resulting challenges, astronomical studies give us reliable knowledge about the Universe.

Of course, it would be naive to think that the role of space-based astronomy is limited to evidence. If this were so, then it probably shouldn't be developed. A new method for studying of space objects, in some cases, much more effective than old traditional. And it allows to extract new information, inaccessible to ground-based astronomy, to find out important details of cosmic processes and phenomena, to find the answer to many questions, has long remained unclear.

So, for example, before a flight to the moon spacecraft had a question about the properties of lunar soil. It was believed that through billions of years of meteoritic bombardment of the surface layer of the moon turned into fine dust, a thick layer which is able to suck in landing the spacecraft. A test of this hypothesis took the radio of the Gorky radiophysical Institute.

Began the study of thermal radiation of the lunar surface. The conclusion was that: the thick layer of dust on the moon is that lunar soil is strong enough and the mechanics resembles wet sand. Of course, the surface layer of the moon is not wet, we are talking about the similarity of the mechanical properties...

This conclusion ground-based astronomy has been confirmed by numerous spacecraft have visited the moon, and the Soviet moon Rovers and participants of the American lunar expeditions.

But first try to understand why remote methods of astronomical investigations bear results that match the actual situation?

To answer this question, we need to get acquainted with the principles that underlie them. The main principle is that we study not space objects themselves, and their radiation — electromagnetic and particulate. The properties of these radiations depend on the properties of their sources. In

other words, they contain information about the properties of space objects and different physical processes occurring in the Universe.

Thus, astronomical research, in principle, be reduced to the monitoring and recording of various radiations coming from space, their analysis and extraction of relevant information. But it's either the same techniques that are successfully used physics in terrestrial laboratories or methods that allow comprehensive experimental verification.

In the last century by the French scientist Auguste Comte declared that man will never be able to know the chemical composition of stars. But this gloomy prediction, like many other similar pessimistic assumptions, was not to be fulfilled. Pretty soon it was refuted. There was a reliable and effective method of determining the chemical composition of remote objects developed by physicists and proven in terrestrial laboratories method of spectral analysis of light radiation. Moreover, spectral studies allow not only to study the chemical composition of the sources of cosmic rays and to determine their temperature, physical state, magnetic properties, the speed of movement in space, finding the answer to many questions of interest to scientists.

The same can be said about other methods of astronomical research.

In conclusion, it should be stressed that space-based astronomy could not do without his terrestrial counterpart. The solution of many problems related to the study of cosmic phenomena, requires parallel optical and radio astronomy research, comparing data obtained by different methods. Only under this condition can we understand the physical essence of a number of observations made with the cosmic orbits. Without ground-based astronomical complex harmonic development of the science of the Universe is simply impossible.

The planet Mars has two small moons — Phobos and Deimos. Deimos turns in its orbit, remote from the planet by approximately 23 thousand km, and Phobos moves at a distance of only about 9 million km from Mars. Remember that the Moon is removed from us at 385 thousand km which is 40 times further from the Earth than Phobos from Mars.

The whole history of the study of Phobos and Deimos is full of amazing events and exciting mysteries. Judge for yourself: the first mention of the

presence of two small satellites of Mars did not appear in scientific papers, and on the pages of the famous "Gulliver's Travels" written by Jonathan Swift in the early eighteenth century.

In the course of events, Gulliver finds himself on the flying island of Laputa. And local astronomers tell him that they were able to open two small moons orbiting Mars.

In reality, the Martian moons were discovered by A. Hall only after a century and a half after the release of the novel in the light, during the great opposition of Mars in 1877. And opened under exceptionally favourable atmospheric conditions after a hard day of observations, at the limit of the capabilities of the instrument and the human eye.

Now we can only guess what prompted him to predict the existence of two satellites of Mars. Anyway, not a telescopic observation. Probably Swift has suggested that the number of satellites of the planets should increase as the distance from the Sun. At that time it was known that Venus has no satellites, around the Earth and drawn one satellite, the Moon and around Jupiter four, they were discovered by Galileo in 1610 was "obvious" geometric progression, which in free space corresponds to Mars, it seemed, by itself begged deuce.

However, Swift predicted not only the existence of Phobos and Deimos, but the fact that the radius of the orbit of the nearest satellite of Mars is equal to three diameters of the planet and the outer five. Three across is about 20 thousand kilometers. About the same distance away, the orbit of Deimos. However, not inner satellite, as claimed by Swift and external — but still the coincidence is impressive. Of course, that is a coincidence...

Attention once again to the Martian moons were involved in the second half of this century. Comparing the results of observations carried out in different years, astronomers came to the conclusion that the closest satellite of Mars, Phobos is experiencing a slowdown, due to which gradually approaches the surface of the planet. The phenomenon looked mysterious. In any case, no effects of celestial mechanics, the observed inhibition to explain failed.

One thing remained: to assume that the deceleration of Phobos is associated with the drag of the Martian atmosphere. However, as was shown by calculations, the gas shell of Mars at a height of 6 thousand km is able to

provide the appropriate resistance only under the condition that the average density of Phobos is small. More precisely, incredibly small!

Then it was an original idea: such a small density of Phobos can be explained by the hollowness of his...! But we don't know of natural processes that could lead to the formation of hollow celestial bodies. Suggests the idea that Phobos and possibly Deimos are artificial satellites of Mars, created millions of years ago by intelligent beings or inhabit while Mars, or flown in from somewhere in outer space.

Perhaps now, when the satellites of Mars photographed from close range by spacecraft and their natural origin leaves no doubt that this was not worth to remember. But the episode in question, is very instructive.

There is science and there is fiction. Where in this hypothesis is the border between them? If the motion of Phobos is indeed the case braking, noted observations, it may indicate that the satellite of Mars hollow. This is a full scientific hypothesis. It comes from the astronomical data using appropriate mathematical calculations leads to a certain conclusion. The usual scheme of a scientific hypothesis: "if something is". Everything else relates to the field of science fiction.

The further fate of the hypothesis in question, were clear from the beginning — it was expected by the same fate as any other scientific hypothesis. She had to either get confirmed or to be refuted. It depended on how accurate will be the observation data regarding the braking of the nearest satellite of Mars. And their reliability instilled fear — observations were conducted at the limit of precision astronomical instruments. And these fears were confirmed...

When a Mars researchers a new, more powerful way to study the planets — unmanned space station, everything was in its place. On satellite images it is clearly seen that Phobos and Deimos — huge lumps of irregular shape and, of course, of natural origin.

If we compare the results of astronomical observations that reported the space station, such a pattern emerges. The moons of Mars — a small celestial body. The size of the Phobos is 27 by 21, Deimos is 15 km away. 12 They move in nearly circular orbits in the plane of the equator of the planet, in the direction of its diurnal rotation. Deimos completes one full rotation in 30 h. 18 m., and Phobos is 7 h 39 m. If we consider that the length of the Martian day is

slightly more than 24 1/2 hours, it is easy to think that Phobos is significantly ahead of the daily rotation of the planet. While on the surface of Mars, we would watch as Phobos and Deimos with his big axes always directed towards the center of Mars. (Remember that in the same way addresses the Moon around the Earth — moon always faces toward our planet the same side.)

Flight of the automatic station "Viking-1" for the first time allowed to estimate the mass of Phobos. When orbital compartment this station flew at a distance of 100 kilometers from the satellite of Mars, American scientists were able to determine the perturbation of its trajectory, caused by the attraction of Phobos. With this background, calculate the mass of the perturbing body is already not worth the effort. And knowing its dimensions, it is possible to calculate and average density. For Phobos it was close to 2 g/cm³. It is a normal density, about the same as the number of stone meteorites. And thus, there is no need for the hypothesis of a hollow structure of the satellites of Mars.

It is now clear where the weak link was this hypothesis — in the original astronomical data on the motion of Phobos.

Knowing the mass of Phobos, one can calculate the magnitude of the force of gravity on its surface. It is smaller than the earth 2 thousands of times. It may seem that an astronaut stranded on the surface of Phobos, at the slightest impulse must travel in space. However, it is not so. As calculations show, the escape velocity for Phobos is on average around 11.7 m/s. It's not so little. Such speed on the Earth can only develop the athlete in the high jump by two and a half meters. As well as the muscular effort everywhere are the same, not yet born a man who, pushing feet from Phobos, would irretrievably to leave.

Of great interest are photos of Phobos and Deimos. They were received by space stations at a distance of only several tens of kilometers. On the surface of both moons of Mars are clearly visible the large number of craters similar to the moon. The largest crater on Phobos reaches a diameter of 10 km.

Interestingly, at the time, discussed the problem of the low density of Phobos, it has been suggested that this phenomenon is not due to the hollowness and is the result of processing the surface by meteorites, whereby the substance of Phobos acquired strong porosity. But this, incidentally, was when there was a

dispute about the origin of lunar craters — meteor or volcanic. The history of science knows and similar incidents — when the correct assumptions are expressed on the basis of incorrect data.

In addition to craters, the photographs of Phobos visible almost in parallel grooves with a width of up to several hundred meters stretching for long distances. The mysterious origin of these bands remains unclear. Perhaps it is the result of the powerful impact of a large meteorite, "shook" Phobos and caused the formation of numerous cracks. Maybe the mysterious furrows arose due to tidal influence of Mars. This is supported by the fact that the Deimos located at much greater distance from Mars, such details were not discovered. It is known that gravitational effects weaken proportionally to the square of the distance.

As for the origin of Phobos and Deimos, it is possible that this asteroid bodies, captured by Mars. Maybe they were formed even earlier than the planet itself. In any case, further study is of interest to determine the regularities of formation of the Solar system.

Since then began the telescopic observations of the moon, one of the most distinctive features of our natural satellite was believed the abundance of ring-mountains — craters. These circular formations cover a significant portion of the visible side of the lunar globe, some of which reach across two hundred or even three hundred kilometers.

About the origin of the lunar craters have long fought two points of view — meteor and volcanic. However, in order to answer the question of what actually constitute the ring mountains on the moon — the craters of extinct volcanoes or craters formed by falling cosmic bodies — meteorites available to researchers of the moon does not have enough of the necessary data. Such data have appeared only as a result of studying our natural satellite spacecraft. These data are convincing evidence in favor of the impact origin of the vast majority of lunar craters (though not all).

In particular, it was found that, according to current estimates, the number of meteoric bodies, plied the space of the Solar system at different times, this is just to explain exactly the number of craters that actually exist in different parts of the lunar surface. For example, counting the number of craters showed that the Moon was subjected to the most intense meteoritic bombardment during the first billion years of its existence. In the future, as

the depletion of meteoric material in the Solar system, the number of meteorite strikes on the lunar surface decreased sharply. This explains the fact that the lunar seas, which were formed somewhat later continental areas, the number of craters approximately thirty times less.

It is interesting to note that currently the intensity of meteorite bombardment of the moon is very small. According to available data scientists, the square radius of Ocala two hundred kilometers meteorite with a mass of about one kilogram of falling, on average, approximately once per month.

Relatively little in modern times falls on the lunar surface and micrometeorites. However, the impact micrometeoritic bodies on the surface of our natural satellite across the moon for astronomical periods of time and significantly in the modern era. This is evidenced by microcrater microscopic craters from the impacts of tiny particles of cosmic matter found on the grains of lunar soil samples brought to Earth. The admixture of meteoritic substance found in the surface layer of lunar soil wherever there were taken relevant samples.

A convincing argument in favor of the meteoritic origin of lunar ring mountains gives, oddly enough, the study is already known to us of the Martian satellite Phobos.

It turned out a curious circumstance. As already mentioned, the surface of Phobos is entirely covered with craters. And they obviously strike origin: the satellites of Mars are small in size — only about 27 km in length, and it is clear that no volcanic processes in the subsoil can not be considered. And this, in turn, means that similar craters on the moon, most likely, must also have a meteoric origin, especially as the craters like the moon in recent years were found not only on Phobos, but on other Solar system bodies, in particular, and Mars. As shown by space photography, many portions of the surface of this planet covered with craters reminiscent of the moon.

Most of these craters were formed about the same age as the craters of the lunar continents, that is 3.5–4 billion years ago. Some of them are quite well preserved, some destroyed, and leaving barely visible traces.

Many meteor craters have been using the spacecraft also discovered and closest to the Sun planet Solar system, mercury. They cover almost the whole surface of this heavenly body. The largest of them have a diameter of several

tens of kilometers, the smallest (which could be seen on the television pictures transmitted from space) is about fifty meters. On average, therefore, the craters of mercury have smaller dimensions than the moon.

Many large Mercurian craters you can find small circular formations, apparently of more recent origin. This suggests that at an early stage of the existence of mercury on its surface fell cosmic blocks in different sizes, including very large ones, but over time the meteoric material in space was getting smaller. The validity of this conclusion is confirmed by the fact that later in its origin craters, lunar seas are much smaller than more ancient continental craters. In this case it is worth noting that the surface of mercury is formed approximately in the same era, that of the lunar continents, which is about 4-4,5 billion years ago.

With the help of radar measurements was discovered crater formation on Venus. As is known, the surface of this planet through a telescope you cannot see because of the thick opaque layer of clouds. But radio waves pass through the cloud layer and are reflected from the surface of the planet, bring information on the nature of its relief. As a result of radio observations in one of the sections of the Equatorial region of Venus was was the ring more than a dozen craters with a diameter from 35 to 150 km. there was also found a crater with a diameter of about 300 km and a depth of 1 km. He was given the name of a famous physicist, one of the pioneers of the study of radioactivity, Lisa Meitner.

Unlike lunar craters, and the craters of mercury, the Venusian craters is quite smooth.

In addition, on Venus was discovered a crater-like circular structure is quite regular in shape, surrounded by a heavily damaged double shaft with a diameter of about 2600 km. However, concerning the nature of education there are different points of view.

As you know, Jupiter and Saturn's hydrogen-helium planet. However, their many moons are the bodies of earthly type. And as shown by the space research in recent years, they too, at one time subjected to intense meteorite bombardment. For example, the traces of numerous meteorite impacts visible on the surface of the so-called Galilean moons of Jupiter Ganymede and especially Callisto.

Both of the satellite is covered with thick ice shell, therefore the crater of education they have a much lighter color than the ring structure on the moon. In the picture of Ganymede is visible also a great dark pool with a diameter of over 3,000 km. it is possible that this "trail" clash of Ganymede with a very large body type asteroid.

Distinct meteor craters visible on the surface of some satellites of the planet Saturn.

For example, at Mimas, on the side constantly facing Saturn, great view of the meteor crater, the diameter of which is 130 km is equal to one third of the diameter of Mimas itself. The calculations show that whether the impact that caused the formation of this crater, a little more and Mimas would fall apart. Craters cover the rest of the surface of Mimas, making it look like the moon. They are smaller in size, but fairly deep.

There are large meteor craters on the surface of another moon of Saturn — dione. The diameter of the largest is about 100 km From some of them diverge rays of light, probably resulting from the release of material under impact of large meteoric bodies. it is Not excluded, however, that the rays in question are the frosting on the surface of dione.

The largest craters discovered on Saturn's moon Rhea. They reach 300 km in diameter. Many of them have Central peaks. In General, their appearance is also very reminiscent of ray the moon or mercury.

With the help of automatic interplanetary station "Voyager-2", who was in the area of Saturn in late August 1981, on the planet's satellite Tethys was was a crater with a diameter of about 400-500 km. Experts believe that this crater was likely formed as a result of the Tethys collision with a massive body.

A crater with a diameter of about 100 km discovered on the surface of Saturn's moon Hyperion. It was also found that this moon has an irregular shape, like a potato. According to scientists, such an unusual shape for a Hyperion to acquire as a result of cosmic collisions.

Thus, the formation of craters as a result of the fall of meteoric bodies is a phenomenon, characteristic for the terrestrial planets and satellites of the giant planets. But in this case there is quite natural question: why such ring formations is not on our planet Earth?

However, the ring-shaped funnel that arose on a place of falling of meteorites on Earth, exist. One of these craters is located in USA in Arizona.

Its diameter of about 1200 m and reaches a depth of 174 m. a group of meteorite craters discovered on the island of Saaremaa in Estonia. The largest of them has about 110 meters in diameter and filled with water.

However, all these and similar craters in its size do not go to any comparison with the most similar large ring formations, for example, on the moon. And until recently it was believed that on Earth, craters of such proportions does not exist.

It seemed at least strange, since the Earth was formed in the same era, that of its neighboring celestial bodies. Therefore in the distant past on the surface also had to fall of large meteorites. A possible explanation was that for millions and billions of years of the giant crater that formed in places of their fall, were exposed to a number of natural factors, the totality of which are specific to the Earth: rain, wind, seasonal temperature changes, the different movements of the earth's crust... Besides, Earth is a biosphere, providing a very significant transformative impact on the structure of the surface layers of our planet.

At the same time, the geological structure, the ring like a giant meteor craters, could arise purely worldly ways have no relation to the fall of cosmic bodies. the number of such events that can cause the formation of large circular depressions, are, for example, subsidence of the surface layers in the karst areas of floating ice masses in permafrost areas, and in particular volcanic processes.

Is it possible to distinguish the giant ancient meteor craters — they are called astrobleme — say, volcanic formations? This possibility is, in principle, exist. The fact that volcanic processes are closely connected with the specific nature of the earth's crust in the area, they prepared by all the preceding history of the development of one or the other of her land. The location of the same meteorite craters completely random, since meteorites with equal probabilities could fall at any point of our planet. In other words, the meteor crater located outside of any dependence from the geological structures.

As the fall of a large meteoric bodies are accompanied by the release of significant amounts of energy upon impact on the earth's surface, meteorite

craters, as a rule, it is possible to detect shifts of species in radial directions. In addition, by crushing rocks in the area of large impact craters disturbed typical for the area the location of the magnetic lines of force.

Finally, the impact of a giant meteorite found specific conical formations from a few centimeters to several meters, for the occurrence of which requires extreme pressure. When hitting a large force is also the formation of specific modifications of quartz with unusual physical properties.

To appreciate the grandiose nature of the phenomena occurring during the fall of a giant meteorite, it is sufficient to compare them with such a powerful natural process like volcanoes. During a giant explosion, which was accompanied by what was happening a few years ago, the eruption of Bezymianny volcano on Kamchatka, the pressure in the shock wave was about 3-5 kbar. This is the maximum pressure which might develop in the course of geological processes. And with the fall of a giant meteorite develops pressures up to 250 kbar and more.

Thus, in principle there is the possibility to distinguish the ancient impact structure similar in form geological formations. And this is very important: identification of meteoritic nature of giant ring structures is not only of theoretical but also of great practical interest. If one or the other structure has no volcanic and meteoritic origin, differently will be evaluated the possibility of the existence in the area of minerals.

In 1970 in the North of the Krasnoyarsk territory was opened one of the most interesting in the world of astrobleme — Popigai. Its diameter reaches 100 km and a depth of 200-250 m. the Calculations show that the meteorite that produced this astrobleme had to be several kilometers in diameter. The falling of this space body occurred around 40 million years ago. Interestingly, in the Popigai astrobleme the nature of the vegetation corresponds to the forest-tundra zone, in particular, grows abundantly larch. In the surroundings of astrobleme vegetation is virtually absent, even far to the South stretches the tundra. Perhaps this phenomenon is due to the fact that astroblema forms a basin, lying considerably below the level of the surrounding area. Maybe in astrobleme there is intensive heat flow from the earth's interior. The final answer to this intriguing question can only be given for special studies.

Currently on the territory of the Soviet Union there are several dozen ancient ring structures (about 20 of them — in Kazakh SSR). The meteoric origin of

these objects is still in doubt.

Thus the Earth and other celestial bodies of the planetary type, are part of the Solar system, at a certain stage of its existence, was subjected to intense meteorite bombardment. This is another evidence in favor of the fact that the planets were formed in a single process. Another conclusion that has important value to clarify the regularities of the formation and evolution of the Solar system in its history was the period when the solar space moved a large number of large meteoric bodies.

Further study of meteorite craters will allow a deeper look into the history of Earth and the Solar system.

Among the planets of the Solar system with its unusual appearance of Saturn stands out. It is surrounded by the amazing and incredibly beautiful education — rings, consisting of many small ice particles and ice blocks with size up to several tens of meters, orbiting the main body of the planet.

For a long time the rings of Saturn was considered unique in the family of planets. However, in 1976, with the help of a few ground-based observations of the rings were discovered around the seventh planet of the Solar system Uranus. And after a while the space station "Voyager-1" recorded a weak ring and the planet Jupiter. Its thickness is about 1 km And it is formed particles, the diameter of which is enclosed in the range from micrometer to several meters.

As for the rings of Saturn, on the basis of long-term observations obtained by ground-based observatories, astronomers believed that the four of them. Ring marked in large letters of the Latin alphabet A, b, C and D, starting from the fourth ring, which at the time was considered the most external. So when it was discovered a fifth, more remote from Saturn's ring, was given to him by the index E.

A new era in the Study of rings was opened through research of Saturn aboard the American interplanetary station "pioneer-11, Voyager-1 and Voyager-2" 1979-1981 In particular, "pioneer-11" has found the most distant ring, marked with the letter F, and "Voyager 1" passed to the Earth the image of the rings D and E, the existence of which aroused certain doubts.

Moreover, the analysis of the images produced "the Voyager 1 spacecraft," has led scientists to the conclusion about the possible existence of one —

seventh of the ring.

But the most sensational was different. It turned out that Saturn is not surrounded by six or seven wide rings, and several hundreds of concentric narrow rings, According to estimates of specialists, their number ranges from 500 to 1000! The photographs of "Voyager-2" shows that these narrow rings in turn break up into still finer "rings" or "strands". No less surprising that not all rings are narrow have the correct form. For example, the width of one of them varies from 25 to 80 km.

How to explain such a structure of the rings? The most interesting is the assumption that stratification of the rings on numerous threads is due to the gravitational influence of Saturn's moons, including small, public most recently by using satellites.

Noteworthy and relatively small width of the ring F. most Likely it is also due to the influence of two previously unknown small moons of Saturn with widths of about 200 km. One of them is located at the outer edges of the ring F, the other internal. The calculations show that these satellites their exposure to "drive" the particles inside the ring. In this regard, they figuratively called "shepherds" — as if they guard ring structure.

Another amazing feature of Saturn's rings — the needles, strange formations, stretching across the rings in radial directions to a distance of several thousand kilometers. Like the spokes of a wheel, they revolve around the planet and can be traced for several turns. But if the needles are an integral part of the rings, they would quickly collapse, as the particles of the rings, located at different distances from the planet, move with different angular velocities. Careful analysis of pictures transmitted by space stations showed that the time of complete turnover of the "spokes" corresponds exactly to the period of the axial rotation of Saturn. In this regard, suggested that the "spokes" formed by tiny particles, arranged above the plane of the rings and held in place by electrostatic forces. And their rotation is because they are addicted to the magnetic field of Saturn.

And another mystery: in the F ring was discovered thickening and even the weave of the individual threads. A phenomenon difficult to explain from the point of view of the ordinary laws of mechanics! Most likely it is also related to electromagnetic effects.

The discovery of the rings of Jupiter and Uranus suggests that the existence of such structures is natural for giant planets. Apparently, their education is the result of nezavisimogo process of formation of the satellites of the planet of the particles doplnena clouds at close distance from it. However, there are other assumptions.

Modern astronomy is characterized by wide application "of the principle of comparison." If we want to study the patterns of development and structure of any space object, one highly effective method of solving this problem is to find in the Universe of other similar objects and try to identify their similarities and differences with an object of interest to us. Finding the cause of this similarity and this difference, we will make considerable headway in solving this problem.

The similarity indicates that the common causes, certain factors that influence the evolution of the studied objects, the distinction helps to find the circumstances that determined different paths of their development.

It is natural that in studying even the most abstract scientific problems ultimate goal of the research is the application of new knowledge in human practice. This focus is due to the social nature of science, as one of the forms of human activity. Is no exception and astronomy. Studying cosmic phenomena, astronomers think first of all about the Earth. This applies in particular to studies of other planets in the Solar system to better understand our own cosmic home. One of the important tasks of this kind is the study of volcanism.

Volcanic processes represent one of the characteristic manifestations of the inner life of our planet, the effects of which have a significant impact on many geophysical processes. On the scale of the earth's volcanism is evident by the fact that on Earth there are about 540 active volcanoes, i.e. volcanoes that had erupted in the memory of mankind. Of them, 360 is in the so-called ring of Fire around the Pacific and 68 on the Kamchatka Peninsula and the Kuril Islands.

More volcanoes, as revealed in recent years, is located at the bottom of oceans. Only in the Central Pacific, they are not less than 200 thousand.

During one only of average power of a volcanic eruption releases energy comparable to energy of 400 thousand tons of conditional fuel. If you

compare volcanic energy with the energy contained in coal, when large eruptions of their "carbon equivalent" reaches 5 million tons.

Many of the solid particles ejected from Earth's interior during eruptions. They come into the atmosphere, scattering the sun's rays, have a significant impact on the amount of heat coming to the Earth. In particular, there is evidence that some periods of prolonged cold in the history of our planet was preceded by strong volcanic activity. Modern science has numerous data indicating that the volcanic phenomena occur not only on Earth but on other celestial bodies of the planetary type, similar to Earth in nature and structure.

The nearest celestial body — the Moon and, apparently, the conditions of its formation were close to the conditions of formation of our own planet. Therefore, the comparison with the Moon is especially of great interest.

As is known, the lunar exploration spacecraft revealed that the vast majority of the lunar ring-mountains, craters have impact, meteorite origin. But nevertheless, on the surface of our natural satellite and detected clear signs of volcanic activity. For example, on the moon widespread basalts of volcanic origin, meet-and-outs of lava. There is also reason to assume that the concentration of mass "maskani", discovered by the artificial satellites of the moon under the bottom of some lunar seas, constitute nothing like a solidified lava tube.

Exist on the surface of the moon and such education, which may be associated with volcanic processes even more closely. We are talking about the so-called domes — a kind of round flat blisters, on top of which is sometimes a formation resembling a volcanic Caldera (collapse crater around). It is interesting that such education occur in fairly large numbers and on the Ground. This — laccoliths, raising the earth's crust resulting from activities of the volcanic centers. These include, for example, some of the mountains of the North Caucasus, which most readers probably well know — Mashuk, Beshtau, Snake...

Generally, in forming the lunar relief participated as external — exogenous processes, and internal — endogenous. As an example the joint action of these factors is the formation of round seas. According to available researchers of the moon according to it happened something like this. As a result of the impact of a large meteorite body appeared crater with a depth of several tens of kilometers. Over time elasticity of the lunar crust the bottom

of the funnel is gradually straightened, and after about 500 million years have been a breakthrough lava from a depth of about 200 km. Filling the bottom of the funnel and when cooled, the lava formed smooth surface. In the same way on the formation of lunar craters with a flat bottom, the so-called flooded craters.

To all this we may add that the study of images of the lunar surface obtained on Board of artificial satellites of the moon, showed that in a number of locations on the lunar surface has solidified lava streams and lakes.

According to experts, active volcanism occurred on the moon mainly in the first half billion years after its formation. In favor of this assumption is to say measuring the age of lunar soil samples that contain volcanic rocks. Age this was at least 3 billion years.

Obvious traces of volcanic activity can be found in photographs taken from space, mercury nearest to the Sun planet. The surface of mercury is almost entirely covered by a huge number of craters. And even though these craters, like the lunar — impact of origin on the bottom are well visible traces of the outpouring of lava.

There is also some data that speak in favor of the assumption that on Venus volcanic activity continues to the present time. As is known, the surface temperature of this planet is approaching 500° Celsius. Apparently, such high temperature is primarily due to the effect of the greenhouse effect, whereby in the lower layers of the Venusian atmosphere accumulates heat coming from the Sun. But it is possible that some contribution to this temperature contribute and volcanic processes, in particular, the effusion on the surface of the mass of hot lava. Perhaps volcanic emissions and involves a significant amount of solid particles, which, according to some estimates, are present in the gas shell of Venus.

It should also be noted large amounts of carbon dioxide (97 %) in the atmosphere of this planet. And as you know, the carbon emissions are characteristic of volcanic phenomena.

We don't know what is the nature of the craters on Venus, volcanic or meteoritic. But found three "bright" spots, i.e., the region that better reflects radio waves.

One of them is about 400 kilometers in diameter. According to experts, spots,

in question, is a formation formed by lava flows.

In the area of the mountain range Maxwell, on top of the highest on Venus mountain located 100 km long Caldera most likely of volcanic origin.

And over the area indicated by the Greek letter "Beta", a significant perturbation of the gravitational field — a phenomenon which in terrestrial conditions observed over the areas of the young (although not necessarily active) volcanoes. It is also anticipated that numerous rays radiating in all directions from the Beta, is lava flows. Apparently, the Beta shield volcano with a base diameter of about 800 km and 80-km Caldera at the top.

In favor of the assumption about the volcanic phenomena occurring on Venus at the present time, numerous electrical discharges type lightning, was the Soviet station "Venera-11, 12 and 13" around some Venusian mountains. A similar phenomenon has been noted and during the eruption of terrestrial volcanoes.

Attention and great speed of motion of gas masses in the atmosphere of Venus. At a relatively slow self rotation of the planet (one rotation around the axis for 243 earth days), atmospheric circulation is 4-5 days. But like hurricane speed must be associated with the cost of enormous quantities of energy. It is possible that this energy comes not only from the Sun but also from the bowels of the planet.

Analysis of new data about Mars, obtained mainly with the help of spacecraft, showed that on this planet a very significant role in the formation of the relief played volcanic processes. So, some Martian craters have Central slides with a dark spot on the top. It is possible that it is extinct volcanoes.

There are on Mars and mountains, relatively to the volcanic nature of which no doubt, for example, mount Olympus with a height of about 24 km. For comparison, it is sufficient to recall that the highest peak of the Earth, Everest is less than 9 km When in 1971 on Mars has raged the strongest dust storm, cone of Olympus towered above the dust shroud.

In the same area there are three huge extinct volcano, whose height is only slightly less. According to experts, the eruption of this volcano group occurred tens or hundreds of millions of years ago. They were accompanied by the ejection of huge quantities of fly ash, probably covering at present a flat region of the planet. The presence on Mars of such the high mountains of

volcanic origin testifies to the great power of volcanic processes by which the surface of the planet were drawn to a huge mass of a substance.

Perhaps one of the most interesting discoveries made with the help of spacecraft, was the discovery on Jupiter's moon IO, 8-9 active volcanoes. They throw out dust and hot gases to a height of 200 km.

Volcanic processes on Earth, associated with the warming of the earth primarily by the decay of radioactive elements. As for IO, here the source of heat, apparently, are the tidal perturbations by the nearby Jupiter satellites in its powerful gravitational field.

Of great interest is the fact that although the photograph of IO stations "Voyager-1 and Voyager-2" several months passed, six of discovered active volcanoes continued to erupt. How to explain such a large duration of the eruptions? An interesting hypothesis put forward by Soviet astronomer G. A. Leikin.

If IO has an intrinsic magnetic field, it is possible that the surface is precipitation of particles from radiation belts of Jupiter. It is also possible that in areas of volcanic eruptions, there are magnetic anomalies that contribute to concentrations of such particles in these areas. Under their influence may be the evaporation of the substance surface, conducive to volcanic phenomena.

Volcanic processes can occur on Saturn's moon Titan, which is one of the largest planetary satellites in the Solar system. But only if the eruptions on Titan is not poured out streams of hot lava, and liquid methane and ammonia solutions.

Thus, volcanic processes, apparently, are, despite their diversity, natural stage of evolution of celestial bodies in the earth's planetary type. Therefore, the study of volcanic phenomena on other planets in the Solar system will undoubtedly contribute to a deeper knowledge of the patterns of the inner life of the Earth.

The moon and the elementary particles

Irreplaceable natural laboratory for physicists, studying the structure of matter, serve as cosmic rays. In the streams of cosmic radiation that permeate space, you can find a particle with such energy that we still do not know how to even on the most powerful accelerators.

However, the "laboratory of cosmic rays" is a very significant drawback: if we are talking about finding particles having rare properties, the wait can last many decades. Because we cannot know in advance when we are interested in the particle will be at the point of space where is located the currently registered equipment.

Physicists are trying to get out of the situation, setting in the mountainous regions of special photographic plates with thick emulsions. Penetrating such emulsions, cosmic rays leave their traces — tracks.

But, first, the duration of such observations is still small, and secondly, even the highest mountain tops is not the space. Not all particles can reach here through the thickness of the earth's atmosphere. However, with the development of technology physics had the opportunity to raise their instruments on high-altitude aircraft, balloons and various spacecraft. But the planes and balloons can provide only short-term observations and spacecraft appeared relatively recently.

Yet, the spacecraft can make in the study of cosmic rays a true revolution. They have made available to researchers the laboratory where the registration of cosmic rays has been going on for billions of years. This laboratory is also created by nature. We are talking about the moon.

As we already know, the lunar surface is not protected by the atmosphere is continuously sampled by particles of cosmic rays. And moon rocks retain traces of these attacks. The study of such traces has already begun.

There was a first, extremely interesting posts. Indian scientists D. Lal and N. Bhaduri as a result of special processing of the samples brought from the moon, found in crystals of the lunar substance unusually long tracks of some particles. One of them is 18 micrometers. For comparison, you can specify that the particles formed by the spontaneous fission of uranium atoms, giving the tracks length only to 14 micrometers.

American scientist B. the Price discovered in lunar rock music track fifty times longer.

What particles can belong to such a long trail?

As for the tracks, discovered by Indian scientists, it is not possible that they left fragments of the nuclei of superheavy transuranium elements...

As you know, at long last, ninety-second place in the periodic table Mendeleev took the uranium. Due to the success of nuclear physics, scientists were able to synthesize a whole series of transuranic elements.

The main difficulty of this synthesis is that the transuranic elements are extremely unstable. The heavier the nucleus, the faster it falls apart. So you can expect to get the items with numbers above 103, the second very difficult or even impossible. However, when in Dubna was synthesized 104-th element, called "kurchatovium", it turned out that his life expectancy is about three seconds.

After analyzing this and some other facts, the theorists came to the conclusion that in the world of TRANS-uranium elements must exist a kind of "Islands of stability" — the atoms having the stable electronic shells. It is assumed that these islets are located in the area 106-114 and 124-126 th elements.

But if some transuranic elements do have a high life expectancy, they must exist in nature. Arisen, for example, when any violent cosmic processes, they were able to get to Land. So, it makes sense to look for their tracks.

In recent years, such searches intensively carried out in different environments: in the earth's crust in the Arctic ice in the ancient sediments at the bottom of oceans and even in the vintage glass and mirrors.

But it may well be that the best environment for such research exist of our ancient companion to the moon...

What a monstrous particle could leave in the lunar substance trail length of almost a millimeter? It is possible that this mysterious monopole — a hypothetical particle, predicted in 1931 the English physicist P. Dirac.

As is known, electric charges, positive and negative, can exist independently of each other. In nature, there are electrons and positrons, protons and antiprotons. At the same time, the magnetic charges North and South are inextricably linked. To create, or at least to observe the monopole and antimonopole, ie separated from each other magnetic poles, anyone have never been able.

According to calculations the Dirac magnetic charge of the monopole should be approximately 70 times greater than the electric charge of the electron. Consequently, even in very weak magnetic fields of the monopole can

acquire tremendous energy. Therefore, having a monopoly, we could quite elementary means to create extremely powerful boosters, not to mention the fact that the proof of the existence of a monopole would help to resolve many of the difficulties the theory of the origin of cosmic rays, in particular, to explain the unusually high energy of some cosmic rays.

In addition, Monopoli, according to the calculations Dirac must have significant mass and interact with each other several thousand times more intense than the elementary electric charge. In this regard, the selection of a monopole and antimonopole in its pure form is much harder than ordinary elementary particles. But, on the other hand, is much smaller and the probability of their mutual annihilation. Due to this, the monopoles could be excellent "shells" atomic artillery to bombing of various elementary particles, "shells", which can be accelerated to enormous energies and use many times in a row. It's attracted to search for the monopole of many physicists, the search, which so far have remained inconclusive.

But it is not only enticing practical possibilities, the promises of the receiving monopole. The question of the existence of elementary magnetic particles is of great theoretical interest.

As the discovery of the monopole and the opening act, "prohibiting" its existence would be equally important for the development of physical ideas concerning the structure of the world.

Different planets "own" different number of satellites. This "wealth" is distributed in the Solar system is clearly uneven. The giant Jupiter, their 15, of Saturn according to some — more than 20, and as it approaches the Sun, the number of satellites is dramatically reduced. Mars has only two moons — the famous Phobos and Deimos, mercury, and Venus none at all.

The Earth's only natural satellite, the Moon.

However, it is also necessary to clarify what is called satellite. We are accustomed to the fact that our Moon is a spherical body, but, generally speaking, the satellites of the planets can be different. It is important that they were connected to this planet by the force of gravity.

In what States can ever be in space solid? In a separate shapeless lumps and... dust, dust clouds. As for the individual blocks, it is quite possible that the Earth has few such satellites. But to register them no one has succeeded,

although some indirect evidence of their existence there.

Satellites and dust?

In the XVIII century the famous French mathematician Lagrange, exploring the problem of motion of three interacting bodies, came to the conclusion that under certain conditions these bodies can form in space a very interesting an equilateral triangle.

Needless to say that over time each of the three bodies will move in its orbit relative to a common center of mass. But the thing is that when these moves are all they will remain at the vertices of an equilateral triangle. This triangle continuously changing, shrinking, stretching and turning about the center of mass. But he always remains equilateral. Thus, in the system of three bodies may exist a kind of "equilibrium point".

And if the system contains only two bodies, such as the system "Earth — Moon"? Then it is still there, so to speak, the potential "balance point", forming together with two other bodies in the vertices of an equilateral triangle. And as in the plane in which already there is a movement of two bodies, you can always build a pair of equilateral triangles with two coincident vertices, where these two bodies, it is obvious that in the system of two bodies there should always be two "equilibrium points". Although from time to time, these points may remain Unallocated.

However, if any body will be in the Lagrange point and will instantly lose speed relative to the Earth and the moon, it will appear as if in a gravitational "trap" and will remain there forever, or at least a very long time.

At first, until the trap is empty, it works poorly — particles freely pass through the "zone of equilibrium" and move on. But as you fill the "trap" substance process "capture" will accelerate. Now flying particles can collide with those already caught in the invisible web, and, losing speed, add "catch".

Although this process is extremely slow, it could be expected that many hundreds of millions of years in the Lagrange points of the system "Earth — Moon" had to accumulate a noticeable amount of substance: because the earth is moving a lot of dust and possibly larger bodies.

At the beginning of this century it was discovered the satellites in the Lagrange points of the system "Sun — Jupiter". Near each of these points astronomers have discovered several asteroids.

All of them were named heroes of ancient Greek epic about the Trojan war. A large group became known as the "Greeks", lower — "Trojans".

However, the same satellites, the possible existence of which stemmed from the theory for a long time could not detect. The fact is that to see such a satellite is possible only when the corresponding Lagrange point is located in a region of the sky opposite the Sun and at the same time far enough away from the bright band of the milky Way. And to all this it is necessary that it was a moonless night...

Such favorable combinations are very rare in the nature. Astronomers for many years photographed the Lagrange point, but no trace of the solid substance is not detected. And only a few years ago finally managed to photograph the "invisible" satellites of our planet. They were quite impressive: the diameter of each of them is comparable to the diameter of the Earth.

However, the mass of these dust clouds by cosmic standards is quite small — only about 20 thousand tons. And certainly not great density — one speck of dust per cubic kilometer. It is not surprising that they are so hard to detect.

However, with the clouds of cosmic matter, located near the "points balance", apparently, will have to seriously be considered in the selection of trajectories for spacecraft.

On the other hand, it is tempting to create points in the Lagrangian space orbital station. Their position in space for a long time almost do not have to adjust. But then will probably need some way to get rid of the accumulated in these regions of matter. It can be dangerous to the structures of the station and to interfere with scientific observations.

Is there inertia?

A very important role in understanding the movements of celestial bodies, particularly planets in the Solar system, played the opening of Galileo law of inertia.

In those days, when this law was still unknown, the great Kepler, trying to find the reason for the planet non-stop to go around the Sun, looking for a mysterious force pushing the planet and not giving them to stop.

Now it is well known that circular planetary motion consists of two

movements — straight and of uniform inertial motion and fall on the Sun by the solar attraction.

But somewhat unexpected question: is there a real world inertia?

For life I remember an instructive case. I then went to school, I think, in eighth grade, and we have passed on the lessons of physics the three laws of Newton.

At the last lesson our teacher, a man creative and well-known physicist, came up with a projection lantern and box of slides.

— Now I will show pictures, — he said. — They depict different situations. And you should carefully scrutinize them and say which of the three laws of Newton are shown in them. Let's start...

On the screen appeared the first picture. Running boy tripped over a stone and falling rapidly, thrusting hand.

So, what Newton's law is it?

On the first, we answered friendly chorus.

And we had the grounds for such a response: the fact that a few days before that we caught the eye of the explanatory note to the set of slides "the Three laws of Newton". I do not know by whom it was made, but in the annotation to one — "the falling boy" says:

"An illustration of Newton's first law — the law of inertia. Boy on the run I caught my foot behind a rock, but the upper part of his body continues to move by inertia. As a result, the boy falls..." Or something like that.

"Suppose," said the teacher. And they called me to the Board.

I cheerfully began:

Boy on the run I caught my foot...

— So... the first law?

I nodded.

Okay. In this case, remember how it reads?

— The body is in a state of rest or uniform and rectilinear movement, while and as it is not ponuguese external forces to change this state, without

hesitation I rattled off the Newtonian formulation.

— Right... now translate this into a common physical language. If the body does not apply external force, its acceleration is zero. Is not it?..

— And the rest? — asked someone. — You don't say?

— Peace — a special case of motion when the velocity is zero... so, what is said and what is not said the first law? He speaks only about the case when the forces are equal to zero. And about anything else. But if the forces are not equal to zero, the first law does not "know".

It was something new. Until that day, we just tried to remember the wording of the three laws and learn how to solve problems. Now, Newton's first law as if parted for us and with his other hand. Suddenly we realized that "falling boy" in the picture has nothing to do with the first law absolutely nothing.

In fact, the boy tripped over a rock. But this means that he was overcome by the force of the movement, the boy suffered acceleration. From that moment his movement ceased to be uniform and straightforward... Really, the first law on this case, can say nothing.

But all this implies an important conclusion. About the coasting, can only speak when the body does not operate absolutely no power. Or at least resultant of all forces is equal to zero.

Quite often we hear such statements: "the Engine is turned off, and the rocket continued to move by inertia", "the Driver braked, but the car continued to slide on the icy road surface".

Is it legitimate to use such expressions? Perhaps only in the literary sense. In reality, the rocket after the engine shuts down and the car after the start of braking was moving rapidly. In the first case is the acceleration (positive or negative) of the rocket, said the attraction of the Earth, the second the negative acceleration of the car reported a friction force between the treads of the wheels and the roadway.

If you stand on a completely rigorous point of view, it is unlikely General in nature, it is possible to specify at least one case of motion "inertia" in its purest form, in strict accordance with Newton's first law. After all, any object, no matter where he was, there are always forces of attraction of many celestial bodies.

We can talk only about such cases when permissible idealization is known, i.e. the forces acting on the body, so small that almost does not affect his movement any influence.

But without this essential clause Newton's first law in nature is almost never performed — it is just an extreme, limiting case of accelerated motion.

As we already know, based on the movements of the heavenly bodies are the Kepler's laws and Newtonian law of gravitation. These laws had become so familiar that one might get the impression that the movement of space objects a lot can be predicted without calculations, so to speak, qualitatively, on the basis of the physical content of the above-mentioned laws. Sometimes it really can be a good idea. However, in some cases the calculations lead to results very similar to those that seemed almost obvious...

The spacecraft launched aboard an artificial satellite moving around the planet in an elliptical orbit. At what moment is advantageous to carry out the start — when the satellite is at apogee or perigee?

It would seem that the answer is perfectly clear: of course, the climax: after all, the farther from Earth, the weaker gravity is, the slower the release, and therefore, the less the required flow rate of fuel.

But we should not forget that, according to the second law of Kepler, the satellite moves in its orbit with variable speed. And in the climax, it is the lowest, and in perigee — the most high.

What is more profitable? A smaller speed of release at apogee, but a smaller stock of initial velocity or the larger the stock of initial velocity at perigee but a higher speed of release, which should gain the ship?

No quality considerations do not give an answer to this question requires precise calculations.

You have to calculate for the apogee and perigee of the difference between the speed of motion of an artificial satellite and the speed of release at this point in near-earth space and to compare these differences among themselves. Obviously, preference shall be given to the option of launching an artificial satellite to which this difference will be smaller.

Consider a specific example. Let the launch vehicle is carried on Board the artificial Earth satellite moving along an orbit with an apogee of 330 km and

a perigee height of 180 km.

Speed values for different release heights have long been calculated and summarized in a special table. Looking at this table, we find that the perigee of the orbit of the satellite is 11 040 m/s and the apogee altitude 10 918 m/s.

It is not difficult to calculate the velocity of the satellite at perigee and apogee. It is accordingly 7850 and 7680 m/s.

Now compute the required difference.

For perigee $11\,040 - 7850 = 3190$ m/s, for peak $10\,918 - 7680 = 3238$ m/s.

Thus, a more advantageous point for a STA that is not the climax, as it might seem at first glance, and the perigee.

Interestingly, with increasing ellipticity of the orbit of the advantages pariganaka start increase to an even greater extent and the paradox becomes especially clear. For example, when a highly eccentric orbit with the perigee at a distance of 40 thousand km from Earth and apogee is located in the moon's orbit at a distance of 480 million miles from our planet to achieve escape velocity and break free from the "clutches" of gravity in four (!) times easier from the area of the perigee than from the area of the peak.

It is strange, isn't it?

This fact once again demonstrates the fallacy of many visual representations. However, it should again be emphasized that the paradox in question, are valid only when comparing the profitability of launches of the same satellites moving in this orbit.

Interestingly, when the reduction of artificial satellite of the Earth is a reverse paradox. It would seem advantageous to include a brake motor installation and start braking at the moment when the satellite passes the perigee, i.e., closest to the earth's surface.

But calculations show that in this case the main role is played not the distance from Earth and the velocity of the satellite along the orbit. At the apogee of it below, and therefore from the point of view of fuel consumption to begin the descent would be best with the apogee of the orbit plot. However, in this case we are talking about some idealized task, however, is not taken into account the speed of entry of the satellite into the dense layers of earth's atmosphere.

Let us now consider another kosmonavtiki a paradox, contrary to the usual representations of the earth's mechanics. Our usual understanding suggests that the faster we move, the sooner you will overcome a predetermined distance. The motion of spacecraft in the gravitational fields of celestial bodies, this statement is not always true. For example, it refuses to serve when flying from Earth to the planet Venus.

As you know, the Earth goes in an orbit around the Sun at a speed of about 29.8 km/s. Therefore, the same initial velocity relative to the Sun has and the spacecraft starting from the orbit of an artificial satellite of the Earth. The orbit of Venus is closer to the day-star, and so in order to achieve it, the initial velocity of the apparatus relative to the Sun should not increase, like, say, during the flight to Mars, and to reduce. But it is as yet only the first "half" of the paradox. It turns out that the smaller the rate, the faster the spacecraft will reach the orbit of Venus. The calculations show that when the speed of flight, equal to 27,3 km/s relative to the Sun, the flight will last 146 days, and at a speed of 23.8 km/s is only 70 days.

Thus, our usual terrestrial view is not always applicable to the movement of spacecraft.

Transport spaceship "OMICRON" have made the next flight to Megos, having on Board twelve man crew and 360 passengers. Captain Meng and Navigator Gasconade stared at the scoreboard and both clearly understood that the situation was hopeless... an Error has occurred at the time of exit from hyperspace. Something didn't work in a difficult economy automatic control of the ship. Insignificant deviation from the program, subtle fluctuation, but it was enough that the ship was actually in the five parsecs from the target site... And here it was waiting for a white dwarf — a little star with enormous density and mighty gravity.

Was on full power all the engines. It is only saved by "OMICRON" from falling into the blazing abyss, but it was not enough to break the chains of gravity. Now the ship was moving around the dwarf in closed orbit at an average distance of about 20 thousand kilometers from the center of the star and all the power of its engines was not enough to escape from captivity. Moreover, the estimated time and energy required to maintain the protective field, opposing the radiant heat of the stars, came to an end.

— How much? said sharply Meng, not taking his eyes off the scoreboard, where the little red dot marked out a neat ellipse around the star.

Navigator, long accustomed perfectly to understand their commander, quickly pressed a few keys on the remote computer.

Six and a half hours... Maybe that will send SOS?

The dwarf was too close. Although the spaceship was guarded by a protective field, Meng almost physically felt the hot breath of the stars. While guarding... But six and a half hours of energy runs out and then...

— Is it possible to weaken the protection? asked Meng.

And so the minimum — briefly responded Gascony. — So how about SOS?

Meng did not answer, dropped into his chair and closed his eyes. Now he had to solve a task daunting even to the most perfect computing device...

Of course, in this situation he was obliged to give SOS. This required the "Space Charter". But Meng knew exactly what was in their sector is now no ship that is able to assist the "OMICRON". The nearest station was at Megasa, and the spaceship from it to a distance that an ordinary radiogram overcome only many months. So the distress call came on time, had to send it through hyperspace. This broadcast was demanding too much energy consumption. And the energy needed for protection from the white dwarf: it is given "OMICRON" extra seconds and minutes.

And yet Meng would dare to hyperspace radio transmissions if there were even the slightest hope. In the galactic fleet, there are only three or four ships, able in this situation to get closer to "OMICRON", to replenish his energy or take in tow, and not to get themselves in the gravitational trap. But Meng knew that all of them are now in distant sectors and under no circumstances will not have time to come to him in time...

— We can buy some time, said Gascony. — Thirty minutes...

The captain looked at the Navigator.

If you take off the artificial gravity, explained Gascony.

— No, — firmly said Meng. — Among the passengers are women and children...

Here's another problem that nobody can solve except the commander of the

ship. Passengers!.. Now they are resting peacefully in their cabins, in full confidence that in a few days will arrive safely to your destination. And none of them even suspects that only six and a half hours separated the ship from inevitable disaster... whether he Should inform the passengers about the incident? Or leave them in blissful ignorance until the end?

During his long space service captain Meng got into a critical situation. But it was a situation of which there was a way out. Then all decided the experience and resourcefulness of the commander, is required in a matter of seconds to find the optimal solution. And still Meng always have.

But now there was no way. This inevitably testified simple calculation that would make any student. And from the captain Menga already depended nothing. He could use all sorts of means, but the outcome was still single.

And this meant that they had to accept her fate meekly and wait until the Sizzling breath of the stars will not turn "omikron" in a sparkling flash.

To surrender without a fight?.. Nothing like Menga was not. "But this happens only once," smiled bitterly to himself Meng.

No, you still need to fight. Don't give up under any circumstances. Even if the situation seems hopeless.

— You have calculated all the possibilities? he asked, looking at the Navigator.

Gasconade slowly turned his head. For the first time since that moment as the scoreboard reported the near accident, they look into each other's eyes. Gasconade shrugged.

— You know...

And still need to check all options.

— This is simple! — exploded Gascony. — What are the options?..

Captain Meng understood it not worse than their automobiles. Classic situation, which was investigated along and across, at the dawn of space flight and which for many years nobody was interested. The newest navigation tools saved the astronauts from such threats. At least for the last fifty years in the gravity trap didn't hit any single ship. And only the "Omikron" had no luck...

But, maybe, therein lies their only chance? That theoretically this problem has long since been abandoned. But science does not stand still. And if you again look at the desperate situation in which they found themselves, from positions of modern knowledge, possibly, will be found a variant, not considered a classic navigation.

In any case, must be sought. But how to convince Gascony? Navigator it is great and works correctly. Meng did not remember the case to Gascony though somewhat deviated from the Instructions. But this was his vulnerable spot. Someone who makes mistakes and knows how to fix them, Willy-nilly, to act in unforeseen situations. Gascony same worshipped one is infallible and omnipotent God — the "how to".

"Alas, his brain, — the captain thought — not programmed for the opening of a new..." — sorry thought that was always more fond of the engineering side of things, and the theory of motion of spacecraft paid much less attention. The basics, of course, he knew well enough and could replace Gascony, but now this knowledge was not enough...

— Offer to wait? asked Meng turned away. — Here so to sit and wait until the end?..

— I propose to send SOS, ' said the Navigator. — As required by "regulations".

— No, — cut off Meng. — Report about his death, we still have time. And while we're obliged to do something... Even against all the instructions.

Gasconade offended pursed his lips.

— I'd like to see...

Meng got up and went to the Navigator's chair:

— Think together. What if...

They did not notice that in the control room became Verin, and saw him when he was standing near the main console, looking at the scoreboard.

Actually, to go into the command cabin of passengers was forbidden most strictly. But Verin was not just a passenger. Based on the design of "OMICRON" was created physical theory. Verin owned countless original ideas, which had a marked influence on the development of physics and

astrophysics. At the University of Magosa he was going to read a course of lectures on the theory of hyperspace.

But still on the "Omikron" Verin was flying as a passenger, and Meng anxiously thought that their plight has now ceased to be a secret.

— A curious situation, isn't it?

In the present situation, these words sounded quite strange and they were spoken with some subtle hint of sarcasm, not that, not that strange satisfaction.

Gascony just shrugged.

— Not enough power, right? asked Verin, finally breaking away from the scoreboard.

— As you can see, not too politely muttered Gascony.

And thermal protection runs out after a few hours?

— Six and a half, — mechanically replied Meng.

"So," indefinitely extended theorist. — M-m, so...

In his deep-set eyes flashed sparks of gambling, and in this moment he unwittingly reminded Meng of the hunter, suddenly saw a rare game. It seemed that Verina had absolutely no interest in that game then in this situation was just he, himself... his eyes went out and rushed away, as if Verin through an opaque wall of the spaceship was watching something hidden in the depths of the cosmos and available to him alone.

"No wonder they say, thought of Meng that he lives only by science."

But Verin did not live only by science. Seeing the scoreboard, he first thought of his old mother, the rest of the world. About how hard it will be to survive the death of his son... And after a moment, his inventive mind began to seek a way out. Verin usual willpower rejected all but unusual conditions, the objectives set ridiculous coincidence. Tasks, which according to all existing canons do not have a positive solution. But Verin's whole life was decided the following tasks...

— Can I use your computer? he asked, for a second, coming out of reverie.

— But, still... it Gascony.

Meng silently put a hand on his shoulder.

But Verin seemed to not pay attention to this little incident any attention. Wasting no time, he walked over to the Desk and began one after another fast to press the keys, glancing to the output device.

Meng tried to keep track of his calculations, but very quickly lost the thread. He could only understand the calculations that Verina to their situation is not difficult.

"It's strange we still behave ridiculous thought suddenly Meng. — We remained there six hours, and Gascony cares about the instructions, Verin became interested in some theoretical problem, and I quietly watched them, as if nothing happened... But maybe it was the fact that the value of time is relative, and six hours if six hours to the end, — not so little?"

Theorist suddenly broke away from the console and looking at the Navigator and asked:

— Do you think the problem is unsolvable?

Proud Gascony stared into Verina: is there a catch?..

— Case elementary, — he said finally, looking off to the side. — Two forces: the attraction of a dwarf and our craving... everything is clear. To develop the second space, the thrust is clearly not enough.

— Yeah, — muttered Verin. — The possibility of solving the problem depends on how it is formulated. In your statement, this task, — he nodded on a Board, is really insoluble.

— Alas, not I this task have objected Gascony.

However, Verin would never hear again... He thought, instantly disconnecting from the outside...

And at this moment Meng for the first time moved hope. He's better than anyone else, understood that to save them now can only wonder. And since miracles do not happen, there needs to be some sverhoriginalnogo, unexpected, earth-shattering decision. And if all you'd expect from someone something like that, then it depends Verina.

The captain looked respectfully at theorist. Who would have thought? Small, puny, with a pointed nose is not a Titan. How he manages to see what can not

see others?

— You know the joke about the dog? — suddenly asked Verin.

And since both astronauts were silent, continued:

"Imagine," said one physicist to another, that the dog was tied to the tail of the metal pan. If the dog run, a frying pan will knock on the pavement. What speed should run a dog not to hear the sound?.. And, oddly enough, the other physicist could not find the answer to this question...

— What do you think, what speed should run a dog? — suddenly asked Verin, and, mysteriously smiling, stared at Gasconade.

— I don't know, dull muttered the Navigator, and imploringly looked at Menga. It was noticeable that he barely restrained...

However, meeting the intense gaze of the captain, Gascony all once tightened and, gritting teeth, reluctantly squeezed:

— Apparently, she's supposed to run at supersonic speeds...

Here, here, — laughed Verin. — So assumed, and the physicist... And true—the answer is simple: the speed of the dog must be zero... Elementary... But the thing is that the task was formulated as follows: what should be the speed? Speed... that's the whole focus. Even physicists sometimes forget that the speed zero is also a speed...

Straightforward and unsophisticated Gasconade looked at Verina, wide-eyed. And Meng was somehow not on itself, even though he was well aware that this joke is now needed by the theorist, of course, not for entertainment, but as a kind of respite. Now working the subconscious mind, and consciousness it was necessary to give rest.

"However, thought Meng — must be a reason he came up with this joke... Maybe he did something already found?.."

As though in confirmation of his optimistic assumption, Verin once again buried in the remote and ridiculous, childish pursing his lips, he began to skillfully play the keyboard.

Meng and Gascony waited silently. Finally, Verin pulled away from the button and sighed, not with relief, not disappointment, but his narrowed grey eyes put the sparkle back in a carefree spark.

— Do you play chess? — he inquired everyday voice.

"Yes," said Meng.

— Know what a sketchy solution? The position is completely lost, however there is a move, it would seem, rapidly leading to defeat. But this strange move brings victory...

Now Meng knew that Verin found the same way.

— And what happens? he asked, unable to contain the impatience.

Verin looked at the captain.

— We need to make a sketchy move, ' he said slowly, as if again something weighing.

In the cabin was silence. The captain stood still, clutching the back of his chair.

— You need to include traction, said Verin. He quickly scribbled on the sheet a few numbers and handed the paper Meng.

"But," muttered smetana Gascony, because it still will do nothing. Perhaps that will make the orbit more elongated.

Here, here, said Verin.

But thirst eat all the energy. And, therefore, thermal protection...

"Wait," interrupted Meng. "Does it matter, he thought, six hours or three..."

But in the soul of captain Meng trust Verin. Without hesitation, he held out his hand to the main console and one by one translated into several divisions four red lever.

Gascony turned pale.

I heard the distinctive hum of the engines, clicked relay anti-g protection.

— Maybe now you'll explain? asked Meng.

— If I'm not mistaken, slowly began Verin, "OMICRON" consists of two separate parts?

"Yes," said Meng. — One command center and engines, the other with cabins and barns.

— And these parts can be separated and withdraw from each other at a considerable distance?

— Yes, such a possibility is provided in case of accident or repair power plants. Both parts of divorce and are reduced by using special "pulsator".

— And what is the maximum distance between them?

A hundred and fifty kilometers.

— Quite a hundred and forty — muttered Verin.

— You want to get rid of the passenger compartment? — finally spoke Gascony. But traction is still not enough.

"No," strenuously objected Verin. — It would be too easy. Dwarf us not so easily let go... There is another idea.

— We're wasting time — intervened Meng. — Maybe...

— Oh! We have time enough — calmly said Verin. — So... did you recognize the idea of a pulsating spaceship?

Gascony and Meng puzzled glances.

— Yes, — said Verin. Is a very old and long-forgotten idea...

— Vaguely I remember something, slowly said Meng. — Seen in the old books... If I am not mistaken, the fact that the spacecraft is not a point, and its mass is distributed over a certain volume.

— Now, now — revived Verin, if you were to divide our ship into two parts, the resultant force of gravity applied to them, will be less than the force that acts on the "omikron" now.

He spoke clearly, as if giving a lecture to students.

— This means, ' replied Meng, that stretched the spaceship the force of repulsion?

And if the climax to connect the two parts, and in perigee — to disconnect, that "OMICRON" can get away with Keplerian orbits and begin to move in a cycle.

— M-Yes... — said Meng.

— I also remembered, suddenly spoke Gasconade excitedly. — Wonderful,

excellent, brilliant!.. — He nervously laughed. But as far as I remember, to overcome this way even gravity, that ship needs a few years. And the attraction of a dwarf?..

— That whole thing — calmly said Verin. "It's amazing, thought the captain,' as this fragile little man manages to maintain total calm in such a difficult situation? He must be able to see much farther than others..."

— That whole thing, ' said Verin. — Attraction in this case works for us. The more massive a star or planet, the sooner will be achieved the speed of release. The fact of the paradox.

— How many hours do we need? asked Meng.

I think...an hour and a half at the most.

— You're a genius — the captain smiled and took a seat at the console.

— You only need to choose the best highlights for the separation and convergence, said Verin.

"I understand," said Meng, pressing the calculator. — Operation after six minutes...

It was an unprecedented spectacle. A giant spaceship as if split into two parts. They dispersed, separated from each other, again closer, melding into a unified whole. And in the process of this unprecedented "space dance" a deadly orbit that was moving "OMICRON", gradually began to unwind.

The mighty element of gravity, submitting to the power of the human mind, confidently took the spaceship further and further from the threatening stars.

The authors of science fiction novels are willing to use all sorts of screens that can protect from the action of gravity forces. Alas, in reality, such screens do not yet exist, and in order to overcome the Earth's gravity, the spacecraft should accelerate with the rocket engine. Is it possible to have a for not engine, and... gravity?

It would seem strange: after all, the gravitation of the Earth does not give a space ship to rush to the world... But, paradoxically, at least in one case this is an option. It has been shown the Soviet scientists V. V. Bielecki and M. E. Giversen.

The fact that all the calculations related to the movement of spaceships, they are usually mistaken for a material point. And with good reason: because the size of the ship is negligible in comparison with the size of celestial bodies.

But strictly speaking, the ship is still not the point, but long body with well-defined size and shape. And because the actual force of gravity acting on it from the side of the Earth, is somewhat different from the force that would act on it in that case, if the entire mass of the ship was concentrated in one point. However, for conventional ships and satellites the difference is so small that it's perfectly legal not to pay attention.

But under one condition, this difference can become quite noticeable: if a spacecraft has a significant length.

Consider, for example, a ship consisting of two balls connected by a rod or a cable perpendicular to the continuation of the radius of the Earth. In this case, each of the balls is the force of gravity, is directed at an angle to the connecting rod. The resultant of these forces it is easy to determine according to the rule of parallelogram. A relatively simple calculation shows that the resultant is slightly less of the force of gravity that would act on the center rod, if it was concentrated all the mass of an unusual ship.

In other words, it appears that "stretch" of the spacecraft is equivalent to the occurrence of a certain repulsive radial force. Therefore, its motion around the Earth will be in an orbit somewhat different from the usual, "Keplerian" orbits.

This circumstance you can cleverly use it. Will. Choose a design from our ship to the balls was fast enough to pull up to each other and to re-breed in the distance.

In that moment, when the ship will reach the most remote point of an orbit of apogee, connect balls. Since then, the ship becomes almost a "material point", and its further movement will occur on the "Keplerian" orbit.

Perigee will carry out reverse the operation to dilute the balls at the same distance. Then there will be the aforementioned "repulsive force". Orbit further movement will be somewhat more elongated than the corresponding "Kepler".

As a result, the second round of the apogee distance will be somewhat greater

than in the first.

Repeat the whole operation again and again will increase the apogee distance. Applying the same tactics in the future, we will make our spacecraft move in a cycle until, until it will leave the gravitational field of the Earth.

But the theoretical possibility is not always compatible with the practical. How much time is needed to disperse this kind of method of "ripple"?

According to the calculations of V. V. Beletsky, in the case when a ship with a length of 140 km starts moving at a distance of 2 thousand km from the center of the Earth, to disperse the above-described way will take about two years.

80 years will it take the same vehicle to go from the sphere of attraction of the Sun, at an initial distance of about 700 thousand km from the centre of day light.

But here's another paradox. The greater the mass of a celestial body and the closer to it the space ship, the faster you can "break" the chains of gravity using the method of "ripple".

On the pages of science fiction novels often tragic situation when the spacecraft is in the thrall of some massive stars. Bielecki calculations show that in the case where the vehicle moves around such stars, it can very quickly gain second space speed, if you apply the method of ripples. So, being at a distance of twenty thousand kilometers from the centre of the famous super dense star — a white dwarf of Sirius, the spacecraft could go for a cycle in the space of an hour and a half.

Another thing is to what extent such a project is feasible in practice — is it possible to create a pulsating space ship? But it is the technology of the future. In any case, the fundamental theoretical possibility exists.

There are in the Solar system one curious pattern... We have already mentioned the fact that the Moon always faces the Earth on one side. In about 28 days our natural satellite completes one revolution around the Earth and at the same time makes one revolution around its own axis.

Thanks to the coincidence of the periods of revolution and rotation of the moon we can see always only one face of the lunar globe. But is it a coincidence?

Generally speaking, your nature is not very likes coincidences of this kind, and they occur not so often. And it is clear why: because the probability of a purely random complex coincidences, as a rule, extremely small. And if we meet in nature any amazing combination of events, it is likely that he has some hidden regularity.

The "behavior" of the moon is no exception: we find something similar in other celestial bodies within the Solar system. So, mercury, the closest planet to the Sun, completes one revolution around the Sun 88 earth days, one rotation around its axis in 59 days. It would seem that there is no coincidence. But the fact is that, according to the second law of Kepler, the planets move in elliptical orbits with their variable speeds: the closer to the Sun, the faster. So, if you calculate the angular velocity in the motion of mercury, we find that the angular velocity of its own rotation coincides with the angular velocity of its revolution around the Sun at the moment when a planet passes closest to the day-star plot its orbit.

Even more complex, we find a coincidence in the movement of Venus. Your revolution around the Sun, this planet, as we already know, makes in 225 earth days. Every 584 days Venus is on the line connecting the Sun and the Earth.

And at this point, Venus always faces the Earth the same side.

What is the reason for all these "coincidences"?

Everyone knows the phenomenon of the lunar tides. Lunar gravity forms in a water shell of the Earth two "hump".

Since our planet rotates, these humps moving on the surface — running tidal wave. Tides occur not only in the hydration shell, but also in the solid Earth. So, thanks to the ebb and flow the soil in Moscow twice a day rises and falls by about 40-50 cm.

As the tidal wave moves toward the daily rotation of the Earth, they will inevitably inhibit it, and the speed of the earth's rotation is gradually reduced. Once the earth's day was much shorter than modern.

But if the Earth goes by the lunar tides, in the substance of the moon should happen to earth's tides, and, moreover, much more powerful — after all, the Earth has a mass 81 times greater than the mass of the moon. Because of this

slow spin of the moon was going to happen pretty fast up until until this rotation relative to the Earth has not stopped at all. Now the Moon is doomed "look" to the Ground always from one side.

Apparently, the same reasons led to the equality of angular velocities of rotation and circulation of mercury is nearest to the Sun point of the orbit. Gravitational force weakens rapidly with distance, in proportion to its square, and because of solar tides on Earth are insignificant compared to the moon. However, for mercury, closest to the Sun planet, these tides probably strong enough and able to exert a significant influence on its rotation. The coincidence angular velocities referred to, most likely, there is also the effect of tidal braking.

As for Venus, the reason for its constant orientation relative to the Earth during periods of closest approach remains unclear. Naturally there is a phenomenon here or we still met S. purely a coincidence, is still unknown. Maybe some role plays the fact that in periods of convergence of Venus are much closer to Earth than to the Sun. However, the solution to this puzzle yet to come.

It would seem that the Universe may be designed to be simpler and more reliable than our Solar system? A crucial role is played here by one force — the force of gravity; the motion of each planet around the Sun is subject to clear and unambiguous laws — Kepler's laws; that it is the movement almost in the same that is common to all planets, except Pluto, plane...

In fact it is not so simple. The fact that each of the planets affects not only the power of solar gravity, but the force of attraction of the other planets in the Solar system. This attraction causes perturbations of each of the planets. Planet deviates somewhat from its normal path prescribed by Kepler's laws, however, every time getting back at him. When you consider that the mutual position of the planets changes all the time, it becomes obvious that the overall picture of their movement very difficult.

And there is a legitimate question. If the perturbations of the planetary motions can lead to irreparable disaster? Where is the guarantee that whenever getting off the rails invisible space, the planet will return to its "native" orbit? But if the deviation is too big? And if all this "inside buildup", a kind of vibration, lead to the total collapse of the Solar system?

The answer to this question can give only calculations. It is necessary to calculate the motion of each planet by considering all possible perturbations caused by the influence of other planets, and then all will become clear.

But it is easy to say to calculate. Of course, in principle this problem is solvable, at least with some degree of accuracy. The movements of the heavenly bodies govern the force of gravity acting between them. The magnitude of these forces depends on the masses of celestial bodies and their mutual distances. In addition, further movement of any body is determined and the speed which it possesses. We can say that in the present state of a system of celestial bodies, i.e. their relative positions and speeds, definitely (again with some degree of accuracy) concluded its future. Therefore, the challenge is that knowing the position and velocity of the planets at the moment, calculating their future move. However, mathematically, this problem is very complex. The fact is that in any system moving cosmic bodies there is a constant redistribution of mass, and hence change the magnitude and direction of forces acting on each body. Even for the simplest case of the motion of three interacting bodies is still no complete mathematical solution in General.

The exact solution of this problem is known in celestial mechanics called "problem of three bodies", it is possible to obtain only in certain cases when there is a possibility to enter a known simplification.

The more difficult an exact calculation of the movement of nine interactive, constantly moving planets in the Solar system; it is beyond the power of even modern mathematics, with its powerful computing technology.

But do you need to answer the question completely rigorous and accurate calculation? In the end, what is important is not so much to know all future mutual position of the planets, how to answer a single question: may or may not be planetary perturbations exceed a "critical limit", beyond which begins an irreversible collapse of the Solar system? In other words, we are interested not quantitative, but qualitative solution of the problem.

Between "quantitative" and "qualitative" there is a significant difference. Quantitative decision shows the change of some physical quantity depending on the change of the other. Qualitative solution gives only an idea of in what directions or to what extent change the value for a specific change in other variables.

But in some cases this knowledge is sufficient. This includes many tasks on stability. Is, say, a chemical process. Need to know what deviations from acceptable to exclude the possibility of an explosion.

Or another task: calculate the design of the railway bridge so that no vibrations arising from the movement of transport, did not lead to developments that tend to exceed the margin of safety of the structure. In both cases, there is no need to calculate all the intermediate States of the system, is sufficient to establish only the link between changes in some of the initial and final values.

The problem of planetary perturbations, there is also the problem of stability — stability of the Solar system. And she, too, admits high-quality solution.

The first such task was solved by the great Russian mathematician A. M. Lyapunov, who managed to show that under no conceivable positions of the planets, their mutual perturbations cannot exceed a critical limit. Thus, no internal forces and interaction can't "shake" the Solar system and to bring her to the brink of collapse. The planetary family of the Sun stable.

The sun and neutrinos

We have said that our day star the Sun is a "black box", which astronomers can observe only "exit". All of the information available about the Sun modern astronomy, obtained through the study of various radiations that occur in the upper layers of our day light.

Directly from the Sun's interior any information to us does not arrive. Thus, the theory of the internal structure of the Sun, whereby its energy is supported by the fusion reactions is, strictly speaking, only a theoretical model.

However, the expression "only" in this case is not quite appropriate. Fusion theory reasonably well explains the processes of stellar evolution and is in good agreement with the observed physical characteristics of the Sun and stars. And yet, like any theoretical model of the internal "mechanism" of a "black box", this theory needs not only circumstantial evidence but direct evidence, which requires information obtained directly from the stellar depths.

In recent years, the opportunity principle appeared. We are talking about the

so-called "neutrino astronomy" or, more precisely, the "neutrino astrophysics".

Neutrino — "elusive" particle that takes part in thermonuclear reactions. In particular, neutrinos are produced in the process of thermonuclear reactions of hydrogen into helium, which, according to modern ideas, are sources of enormous energy. The energy of these particles and the magnitude of their flow depend on the temperature and nature of nuclear reactions.

While a photon generated in the solar interior before getting out, experiencing about 10 billion collisions, neutrinos, possessing great penetrating power, pass through the entire thickness of the solar matter virtually unimpeded and reach Earth. If we managed to catch solar neutrinos, we in a sense "see" what was happening in the center of the Sun. But to observe neutrinos only indirectly by forcing them to interact with other particles and recording the results of such interactions.

Suitable nuclear reaction may be the interaction of the neutrino with the nucleus of one isotope of chlorine with atomic weight 37. Catching neutrinos, such a nucleus is transformed into the nucleus of the isotope argon-37. This leaves one electron that can be registered in well known to physicists ways. In addition, argon 37 is radioactive, it means that after a certain period of time, you can measure how much it accumulated.

But you also need to be different from other space radiation, which can also cause a nuclear reaction of transformation of chlorine to argon. To get rid of such interference, all the measurements are carried out deep underground, where the usual cosmic particles to penetrate obviously can't.

The idea of "chlorine detector" for registration of solar neutrinos was proposed by the famous Soviet physicist academician B. Pontecorvo and implemented by the American physicist R. Davis and his staff. "Neutrino telescope" was a huge tank filled with 600 tons of perchloroethylene — quite prosaic liquids used for cleaning clothes. The equipment was installed in an abandoned gold mine in South Dakota near the town of Homestake.

The observations were carried out for a long time in multiple series and yielded a surprising result. The number of registered acts of interaction was much less than predicted by theory.

For explanations were put forward different hypotheses, including rather

extravagant. For example, some scientists have suggested that solar fusion reactor operates in "pulse mode". Due to certain peculiarities of physical processes in the solar interior by thermonuclear reactions from time to time. And then the Sun shines at the expense of the energy reserves accumulated in the previous cycle. Remember that photons of electromagnetic radiation coming to us from the Sun, actually born about a million years ago — they still had to "make it" to the solar surface. Neutrinos give us information about the state of the Sun almost at the moment of observation. There is therefore nothing surprising in the fact that "electromagnetic" and "neutrino" picture may not match the... does the lack of solar neutrinos in the experiments of Davis that in our era of solar fusion reactor just doesn't work?

One thing is clear: the solution to the problem requires further neutrino observations of the Sun. And for this, we are currently establishing the necessary recording equipment.

On the other hand, there is a possibility that the negative result of the observations of Davis due to the properties of the neutrinos. To this question we return in the next Chapter.

On moonless nights the sky is clearly visible hazy band of the milky Way. But it is not a conglomeration of nebulous masses, and many stars our star system Galaxy. In the Galaxy according to current estimates about 200 billion stars. To cross it from end to end a beam of light at a speed of 300 thousand kilometers per second needs to spend about 100 thousand years.

However, despite this enormous size, our Galaxy is only one of many such Islands of stars in the Universe. She has satellites. The largest of them — the Large and Small Magellanic Clouds. Together with our Galaxy, they orbit around a common center of mass. Our Galaxy, the Magellanic Clouds and several star systems, including the famous Andromeda, form the so-called Local Group of galaxies.

Modern telescopes and radio telescopes and also other astronomical tools of research available a huge area of space. Its radius of 10-12 billion light years. In this area there are billions of galaxies. Their combination is called Metagalaxy.

In the process of cognitive activity a person selects, isolates from an infinite variety of the material world certain objects, phenomena, relations,

interaction. It is therefore advisable to distinguish the concept of the astronomical Universe and the entire material world.

"Meanwhile, writes well-known Soviet scientist, academician P. N. Fedoseev, based on the principle of evolution, there is every reason to believe that the universe studied by modern science, is developing in time education, which has arisen from some preceding conditions and forms of matter and change its States and forms.

For the materialist philosophy alien to ideas about the creation of the physical world by consciousness, as an act of creation of the Universe by some Supreme being. If the universe is studied today originated 20 billion years ago, from a philosophical point of view it is important recognition of the objective character of this process as a cosmic stage of self-development of matter. The specific case of science — physically understand and describe this process. It is possible to think and the existence of many Universes with a complex topology. It is therefore advisable to distinguish the term universe of the naturalist, which indicated our knowledge of the Universe accumulated up to this point in time, from the philosophical concepts of the material world. This concept includes implicit all future advances the doctrine of the Universe of the naturalist".

One of the most stunning astronomical theories, which were born in this century, no doubt, can be considered the theory of "expanding Universe" or, more precisely, expanding Metagalaxy.

The main idea of this theory is that the Metagalaxy was about 15-20 billion years ago in a tremendous cosmic explosion of a compact clot of superdense matter.

A few words about how I came up with the theory.

One of the most effective methods of studying the Universe is the construction of different theoretical models, i.e. simplified theoretical schemes of the universe. For a long time in cosmology have been studied so-called homogeneous isotropic model. What does it mean?

Imagine that we split the Universe into many "basic" areas and that each of them contains a large number of galaxies. Then the homogeneity and isotropy means that the properties and behavior of the Universe in every age the same in all sufficiently large areas and in all directions.

The first models of the homogeneous and isotropic Universe proposed by A. Einstein. She described so-called steady state Universe, i.e. a Universe that over time not only does not change in General terms, but which do not have any movements of fairly large scale.

However, in 1922 a talented Leningrad scientist A. A. Friedman showed that Einstein's equations admit many of nonstationary, namely the expanding and shrinking, homogeneous and isotropic models.

Later it turned out that a static model Einstein inevitably becomes non-stationary. But this meant that the homogeneous and isotropic universe must either expand or shrink.

Before that, the American astronomer Slayfer discovered the red shift of spectral lines in the spectra of galaxies. This phenomenon, known in physics called the Doppler effect occurs in the cases when the distance between the light source and the receiver increases.

After the work of Friedman, the American astronomer Hubble proved conclusively that the farther located from our galaxy, the greater the shift of lines in its spectrum not only revealed a direct proportional relationship between the distance and the magnitude of the red shift. From the point of view of the Doppler principle this means that all galaxies move away from each other with the greater speed, the greater the distance between them.

Based on this motion pattern of the galaxies, derived in the explanation of the red shift using the Doppler effect and developed the theory of expanding Metagalaxy.

However, the recognition of this theory was by no means unanimous. At different times made various attempts to explain the phenomenon of red shift is not mutual recession of galaxies, and any other reasons. None of the proposed hypotheses were not successful.

Nevertheless attempts to refute the Doppler nature of red shift in the spectrum of galaxies continues to this day.

Will try to investigate whether we can explain the red shift in spectra of galaxies is not a Doppler effect, and any other cause, and whether there are any serious grounds to doubt the expansion of the Metagalaxy?

The most common objections to the cosmological interpretation of redshift

have suggested "aging" of photons, their gradual "degradation" and reduce their energy (i.e. increase the wavelength) on the long journey through space.

However, the "dispute" between the Doppler effect and the effect of degradation can be clearly resolved using astronomical observations. The fact that these effects are not exactly the same.

The calculations show that during aging of photons the change $\Delta\nu$ of the frequency ν (i.e., the shift of spectral lines) must be the same across the range. In other words, the shift amount does not depend on frequency.

In the case of the Doppler effect the frequency change is proportional to the frequency. Here the constant is not itself a frequency shift $\Delta\nu$, and its relation to the appropriate frequency $\Delta\nu/\nu$. In other words, the shift amount in this case varies for different spectral lines.

What do they say? They show that just the red shift observed in spectra of galaxies is such that different lines of the same spectrum equally, not changing the frequency, namely the ratio of this change to the frequency. And this clearly shows in favor of "Doppler" explanation for the red shift in spectra of galaxies.

Another question, does the "degradation" of the cosmic photons at all. If the shift of spectral lines does not depend on the frequency, then obviously it needs to be noticeable only in the region of relatively low frequencies, i.e. in the radio. It's like being at a "stretched" radio dial even slight changes in frequencies must be immediately "evident". However, no signs of similar phenomena astrophysical observations not detected.

However, fairness demands to note that, in principle, there is another physical phenomenon with the same characteristics as the Doppler effect. When the radiation travels in the gravitational field, its frequency varies in the same way as with the mutual removal of the source and receiver.

But calculations show that in the case of metagalactic red shift, this effect known as "gravitational displacement" or "Einstein's effect", its size may represent only a very small Supplement to the Doppler effect.

Thus, modern physics does not know of other phenomena in addition to the Doppler effect, which could explain the redshift observed in the spectra of galaxies.

But is there any reason to look for some other explanation, not related to the Doppler effect? It would obviously be justified in that case, if the "Doppler" picture led to any serious contradictions. Are there contradictions in reality?

At the time, was put forward objections relating to the age of space objects. The fact that, according to the theory of the expanding Metagalaxy, the expansion epoch duration is estimated at 10-20 billion years. Not does it conflict with existing estimates of the age of stars, star clusters and galaxies?

At one time indeed it seemed that the duration of the era of expansion and the age of space objects are not consistent with each other. Now, however, can be considered generally accepted that the lifetime of all known cosmic entities of the order of 10 billion years.

However, age estimates of individual space objects to 20 or more billion years and now. The question arises: if these estimates actually confirmed whether this will be catastrophic for the expansion theory?

As emphasized by A. L. Zelmanov, the conclusion about the duration of the era of expansion of the Metagalaxy, equal to 10-20 billion years, made in the framework of the theory of homogeneous and isotropic Universe. In a more General theory of this period may be slightly increased.

However, in the theory of homogeneous and isotropic Universe may be some options that the era of expansion of the Metagalaxy could be longer. In most variants of the theory at the beginning of the expansion is dominated by mutual gravitational attraction that slows down, slows down expansion. But with the expansion of the gravitational pull weakens, and cosmic repulsion, the existence of which under certain conditions allow the equations of General relativity, amplified. Possible the case in which gravity is finally balanced by the repulsion, and then behind him, then decelerating expansion must be replaced by accelerating.

Assume that the Metagalaxy behaved that way and we live in an era of accelerated expansion. But this means that in the recent past it has been slower, and, therefore, lasted longer than by constant braking.

On the other hand, "assessment of age may be reduced.

According to the theory of hot expanding Universe, some time after the start of the expansion was to come a phase when all matter was a plasma consisting of electrons, protons and nuclei of light elements. In addition to

substances, there was electromagnetic radiation: radio waves, light and x-rays. In that period matter and radiation were in equilibrium. Particles (mostly electrons) emitted about the same amount of photons, and how much is absorbed.

Later, however, the temperature dropped enough that the electrons began to join with ions to form atoms of hydrogen, helium and other chemical elements. As a consequence, the environment became transparent to radiation. In other words, photons have practically ceased to be emitted and absorbed.

Further, the temperature of this radiation gradually decreased and, according to the calculations arising from the hot model of the expanding Universe, the global space in the modern era should be filled with radiation with a temperature about 3-4 degrees Kelvin.

In 1965, this is a hypothetical radiation was recorded and was called the relic. Detection of the background radiation is direct evidence that the expansion of the Universe has lasted for many billions of years from the state, far more dense than modern.

However, in most recent years, there were some grounds for doubt. Some researchers believed that really was only a General thermal background of the Metagalaxy, has a completely different physical nature.

Also put forward the hypothesis that radiation taken over the relic and actually belonged in the distant past, some separate space objects, and then gradually dissipated in space.

However, held in the summer of 1970 in England next Congress of the International astronomical Union scientists came to a consensus that there are no serious grounds to doubt the relic was the nature of the space radio-emission does not currently exist.

As for the hypothesis of separate sources of the background radiation in those places where they once were located, would have to be some fluctuations (vibrations) radiation.

However, as shown by studies conducted by Soviet radio astronomer Yu. N. Parijskij, it is possible with great accuracy to assert that such fluctuations of nowhere.

But even if it turned out that the relic radiation does not exist at all, and this does not mean that the theory of extension should be abandoned. In the framework of this theory, this option is possible in which the CMB arises.

A very important argument in favor of the theory of expansion of the Universe allows the study of quasars. Relatively close to us regions of the Universe, the spatial density of these objects is quite small. At distances of the order of 7-9 billion light years it increases significantly, then again fall to zero. But this means that in the distant past, the spatial density of quasars was more, and in an earlier era, they have not yet encountered.

Thus, quasars give us independent confirmation that the universe is not stationary. Nevertheless expressed doubts about whether at all at our disposal the necessary standards to measure the redshift. After all, if the wavelengths of electromagnetic radiation increases as well as the metagalactic distances, and the size of atoms is the same as the wavelength, then indeed nothing is impossible to detect.

First of all it is necessary to note that modern physics comes from the fact that during the expansion of the Metagalaxy is only a change of the cosmological scale. As for the microscopic and macroscopic scale, they are in the process of expansion continue. And it's not just one of the possible points of view, and the question is closely related to the fundamental basis of all modern physics.

So, we live in an expanding Metagalaxy and the observed pattern of removal of galaxies surrounding us in all directions. In this regard, may inadvertently give the impression that we are right in the center of the expansion, the fixed point from which in all directions scatter the rest of star island. But this case does not agree with the theory of probability and is a legitimate bewilderment: why us?

Indeed, the impression of our Central position in the Metagalaxy is wrong. We give an explanatory example proposed by A. L. Zelmanov.

Imagine, for example, that from one place at the same time on a completely straight highway leaves a large number of vehicles and starts moving in the same direction with different speeds. After a while, they obviously are relative to each other according to their velocities: the ones that move faster, go ahead more slow will be left behind.

Now every front running car will obviously move with greater speed than the next. Imagine the observer is located in one of the secondary machines, and sees only other cars ahead and behind. Then no matter which of the machines he rides, he'll feel that he is the center of expansion (stretching) of the chain of cars, so as all the other cars, both front and rear, from him will be removed: front to go farther and farther, back is getting stronger to keep up.

Similarly, the metagalactic red shift means only increasing the distance that separates us from one another and from other galaxies, but not about what we are in the center. If we moved to some other galaxy, we would seem that it is Central.

In connection with the expansion of the Metagalaxy there is another question. As is known, the distance to a particular galaxy, we determine from the redshift using the Hubble law: the more the red shift, the farther from us a galaxy. But while the light beam emitted by the galaxy, came to Earth, this galaxy had to retire to a greater distance still. Moreover, at the same time we accept the rays of light from different galaxies, emitted at different epochs. Not if it thoroughly confuses the whole picture of the structure of the Metagalaxy?

Such concerns are completely unfounded for the simple reason that the theory takes into account these circumstances. It is built in such a way that all distances are automatically recalculated and reduced to the same epoch — the epoch of observation.

And another question: why the red shift increases with distance, in other words, why the more distant galaxies were moving away at high speeds? The dependence of redshift on distance is not a consequence of the ejection of galaxies from some initial point with different speeds. The expansion of the Metagalaxy is happening in such a way that the rate of increase of the distance between any two points is proportional to this distance. It was finally established observations in 1929

As you know, for a very long time, astronomy was a purely "optical" science. The man studied the sky what he saw — first with the naked eye and then telescopes. With the development of radio born radio astronomy, greatly expanding our knowledge of the Universe. Finally, in recent years, with the emergence of space exploration tools had the opportunity to study other electromagnetic messengers of the Universe — infrared, ultraviolet, x-ray

and gamma radiation. Astronomy has evolved into an all-wave science.

One of the new methods of space of objects is x-ray astronomy. Despite the fact that this method is relatively young, currently the Universe is impossible to imagine without the data obtained through observations in x-rays.

Perhaps even more promising source of information is the cosmic gamma-radiation. The fact that the energy of gamma rays may be in the hundreds of thousands and millions of times greater than the energy of photons of visible light. For such gamma-ray universe is virtually transparent. They extend almost in a straight line, come to us from very distant objects and can reveal extremely valuable information on many physical processes occurring in space.

Especially important information gamma rays is able to bring about unusual and extreme States of matter in the Universe, and these States are interested in modern astrophysics in the first place. So, for example, gamma radiation arises in the interaction of matter and antimatter, and where is the birth of cosmic rays — streams of high energy particles.

The main difficulty of gamma-ray observations of the Universe lies in the fact that although the energy of cosmic gamma rays and very large, but the number of these quanta in the near-earth space is negligible. Modern gamma-ray telescopes, even the brightest gamma-ray sources are recorded approximately one quantum in a few minutes.

Significant difficulties arise due to the fact that the primary cosmic radiation have to be studied against the background of numerous interference. Under the action of charged particles of cosmic rays coming to the Earth, protons and electrons, start bright "glow" in the gamma range and the earth's atmosphere and the spacecraft, which is installed on Board recording equipment.

How the universe looks in gamma rays? Imagine for a moment that your eyes are not sensitive to visible light, to gamma rays. What picture would appear before us? Looking at the sky, we would see no Sun, no familiar constellations, and the milky Way would look like a narrow luminous strip. Incidentally, this distribution of galactic gamma radiation confirmed the assumption made at the time of the famous Soviet physicist academician V. L. Ginzburg that cosmic rays are mainly galactic, but not of extragalactic

origin.

Currently using a gamma-ray telescopes on spacecraft was several dozen sources of cosmic gamma radiation. Yet it is impossible to say exactly what they are, — is it the stars or other compact objects, or may be extended education. There is reason to believe that gamma radiation occurs during unsteady, explosive events. Such phenomena include, for example, in a supernova of stars. However, when you survey the 88 known supernova remnants were discovered only two sources of gamma radiation.

At the same time was the extragalactic gamma-ray sources associated with active galaxies and quasars, where there are explosive processes in tens of millions of times more powerful than a supernova. There is a possibility that modern astronomy is on the threshold of discovery of a fundamentally new class of objects, the physical nature of which is still unknown to us.

A very interesting gamma-ray source was discovered in the constellation of Ophiuchus. In this place there is a dense dust cloud, which is located inside a group of young hot flare stars. Registered gamma radiation and from the other nebula — the Orion nebula in which young stars and where according to some expanding systems of stars, stellar associations.

According to modern concepts, the supernova is one of the final stages in the life of stars. Are the same phenomena, apparently typical for the early stages of development of these heavenly bodies the impression that the gamma radiation and generating its process of formation cosmic rays are not associated with dying stars, but rather with their birth.

Registration of cosmic gamma radiation is a high energy, in principle, allows to detect objects which are the generators of cosmic rays, i.e. to solve the problem, which has long been one of the most important in astrophysics. The fact that in the interaction of energetic nuclei included in cosmic rays with interstellar medium, surrounding the source particles of gas or dust — must be born special elementary particles, the so-called PI-zero mesons. These short-lived particles and decay into gamma rays which can be registered with gamma-ray telescopes. In this case the gamma the brighter the glow, the greater the density of cosmic radiation. Thus, the observation in the gamma-range can not only determine where the object is located, generating cosmic rays, but also to estimate its intensity.

Sources of gamma rays are neutron stars — pulsars. In particular, the brightest "star" in the gamma range of the pulsar located in the constellation Vela, invisible to optical telescopes. Other "gamma star" identified with the famous pulsar in the crab nebula. However, no direct evidence that pulsars are born energetic core and therefore pulsars are sources of cosmic rays, yet. Most likely the gamma luminosity of the pulsars is generated by fast electrons.

A few years ago with the help of instruments installed on artificial satellites and high-altitude balloons, was discovered a strong flare of cosmic gamma radiation. Smote them enormous power. The energy released during flashing their mysterious sources, about a million times superior to the energy of the light radiation from the Sun.

Although the physical nature of these phenomena is still unclear, there is some reason to believe that they can be associated with the processes occurring in binary systems, composed of neutron stars. It is not excluded that powerful bursts of gamma radiation occur in the fall, substances emitted one of the stars in a binary system to the neutron star.

Further study of cosmic gamma radiation should provide answers to many questions of fundamental importance for understanding the structure of cosmic objects and events in the Universe physical processes. In particular, the fact that gamma rays propagate rectilinearly, opens up the possibility not only to detect very distant gamma-ray sources, but also to determine the direction in which they are located.

And because the mechanism of gamma radiation associated with the impact of "nonthermal" particles with high enough energy, this radiation carries extremely valuable information about the physical processes occurring in such regions of the Universe where there is a high concentration of nonthermal particles.

Even forty years ago, astronomers believed that the space object little change over time. It seemed that stars and galaxies evolve so slowly that in the foreseeable period of time in their physical condition does not occur any significant changes. It is true, was known of the physical variable stars, characterized, for example, frequent changes to Shine; the stars, violently emitting substance, and outbreaks of new and supernovae, accompanied by

the release of huge amounts of energy. Although these phenomena attracted the attention of researchers, but still seemed incidental, not fundamental importance.

However, in 50 years has spread the belief that the phenomena of the instability is a natural stage of evolution of matter in the Universe, playing a crucial role in the development of space objects. Indeed, there was discovered a number of phenomena in the Universe, associated with the release of enormous quantities of energy and even explosive processes.

In particular, it was found that some galaxies are powerful radio sources.

One such radio galaxies, the radio source Cygnus-A, is located in the heart of the constellation Cygnus. This extremely powerful space station: its radio waves taken on the Ground, has the same power as the radio emission of the quiet Sun, although the Sun is only about 8 light minutes away and the galaxy in Cygnus, about 700 million light-years.

The calculations show that the total energy of relativistic electrons that generate the radio emission of radio galaxies, can reach a huge size. So, for the radio source Cygnus-A, this energy is ten times greater than the energy of attraction of all the stars that are included in this radio galaxy, and a hundred times more than the energy of its rotation.

Two questions arise: what is the physical mechanism for radio emission of radio galaxies and where does the energy required to maintain this radio?

In the Northern hemisphere sky in the constellation Taurus is a small gas nebula. For their quirky shape, reminiscent of a giant crab, with its many tentacles, it was called the crab. Comparison of photographs of this nebula, taken in different years, showed that gases, included in its composition, fly with enormous speed around 1000 km/s. Apparently, this is a consequence of the massive explosion that occurred about 900 years ago when all the matter in the crab nebula was concentrated in one place. What happened in this area of the sky at the beginning of the second Millennium of our era?

The answer we find in the annals of those times. They tell that in the spring of 1054 in the constellation Taurus star broke. For 23 days she shone so bright it was clearly visible in the daytime sky when the Sun shines. The comparison of these facts has led scientists to the conclusion that the crab nebula is a remnant of supernova stars.

Observations showed that the crab nebula is an extremely powerful source of radio emission. In General, any space object, whether a galaxy, star, planet or nebula, if its temperature is above absolute zero must emit electromagnetic waves in the radio — the so-called thermal radiation. Amazing was the fact that the radio emission of the crab nebula was many times more powerful than that of thermal radiation, which it would have to possess in accordance with its temperature. Here then was made one of the most remarkable discoveries in modern astrophysics, the discovery that not only explained the nature of the radio emission of the crab nebula, but gave the key to understanding the physical nature of many phenomena occurring in the Universe. However, this is not surprising: indeed, in each separate space object reflected the most General regularities of natural processes.

Efforts mainly Soviet scientists developed the theory of nonthermal electromagnetic radiation of space objects caused by the movement of very fast electrons in magnetic fields. By analogy with some processes occurring in charged particle accelerators, such radiation was called synchrotron.

Later it became clear that the synchrotron radio emission is a characteristic feature of a number of cosmic phenomena. In particular, it is of such a nature has the radio emission of radio galaxies.

As for the energy source, the crab nebula in this source was the supernova explosion. And in the radio galaxies?

Many facts indicate that the source of power their radio emission, apparently, are the active physical processes in the cores of these stellar systems.

As shown by astronomical observations in the Central parts of most known galaxies are compact formation, having a rather strong magnetic field. These formations are called nuclei. Often-concentrated a significant portion of the entire galaxy. Is the core of our Galaxy. As shown by radio observations, it is a continuous outflow of hydrogen. For the year ejected mass of gas equal to one and a half solar masses. A little? But when you consider that our stellar system there are more than 10 billion years, it is easy to calculate that during this time her core was thrown a tremendous amount of substance. While there is good reason to assume that phenomena that are logged in currently, are only weak echoes of the far more rapid processes that occur in the nucleus of our Galaxy when it was younger and richer in energy. This idea to induce a highly energetic phenomena that we observe in the nuclei of some other

galaxies.

For example, in the galaxy M 82 was observed the dispersion of gas jets in all directions from the nucleus with velocities of up to 1500 km/s. Apparently, this phenomenon is associated with the explosion, which occurred several million years ago in the core of this star system. According to some estimates, the energy was overwhelming — it corresponds to the energy of explosion of a thermonuclear charge with a mass equal to the mass of several thousand suns. However, in the relatively recent explosion in M 82 expressed some doubts. However, there are still a number of galaxies, the nuclei of which there are extremely powerful non-stationary phenomena.

In 1963, at very large distances from our Galaxy was discovered striking objects, called quasars. In comparison with the huge star Islands-the galaxies, the quasars are negligible. But each quasar emits hundreds of times more energy than the giant known galaxy, consisting of hundreds of billions of stars.

The discovery of quasars, as well as any similar discovery was unexpected — one of those amazing surprises that from time to time presents we will be present infinitely varied universe. The existence of such objects of physics and astrophysics not only could have imagined in advance, but if before the opening of the quasars they describe their properties, and scientists, according to the famous astrophysicist I. D. Novikov, probably would have said that such objects in nature do not exist.

However, there are quasars and their physical nature requires explanation. However, this generally accepted explanation yet. There were different assumptions, some of them subsequently disappeared, the part still under discussion. But. what physical processes can lead to the release of such enormous amounts of energy, still remains unclear.

At the same time, significant progress has been made in addressing another question: where do quasars in a number of different space objects? Whether they are unique entities, with the peculiar exception to the General rule or a logical step in the development of space systems?

Such a question is characteristic of the whole spirit of modern astrophysics. If even relatively recently, the researchers of the Universe are mainly interested in the study of the physical properties that characterize the current condition

of a space object, it is now at the forefront of advanced research its history, its earlier state, the patterns of its origin and development. This approach resulted from the recognition of the fact that we live in an expanding non-stationary Universe, the past is different from that of its modern state and modern state — from the future.

In light of these ideas of special interest acquires the elucidation of possible family connection between different non-stationary objects. In particular, it was found that according to their structure and optical properties of radio galaxies are nothing exceptional. It turns out that for any radio galaxies can be found like her "normal" galaxy, which differs only in the absence of radio emission. This, apparently, suggests that the ability of the powerful radiation of radio waves occurs only at a certain stage of evolution of galaxies of one type or another. A kind of "age" phenomenon, which occurs at a certain stage of life of star systems, and then disappears...

Such an assumption is the more probable, that of radio galaxies is much smaller than "normal".

But whether in this case the quasars, these heavy duty "factory of energy", too, a certain stage of development of space objects, perhaps, one of the earliest? In any case, the analysis of electromagnetic radiation of quasars shows a clear similarity between them and the nuclei of some types of radio galaxies.

The famous Moscow astronomer B. A. Vorontsov-Velyaminov drew attention to one very interesting fact. Almost all known quasars (and there was already over a thousand) — single objects. On the other hand, close to them the properties of radio galaxies, as a rule, are clusters of galaxies and are the main, Central members are the most active.

In this regard, B. A. Vorontsov-Velyaminov suggested that quasars — not that other, as "protokolunu" galaxies, i.e. objects, as a result of further evolution that arise in the future galaxies and clusters of galaxies.

In favor of this assumption says, for example, the activity of galactic nuclei, very similar to the activity of quasars, although not as violent. A particularly turbulent processes occur in the nucleus of the so-called Seyfert galaxies. These nuclei are very small in size comparable to the size of quasars, and like them have an extremely powerful electromagnetic radiation. They occur in

the gas flow with great speeds, reaching several thousand kilometers per second. Many Seyfert galaxies have emission compact gas clouds with masses tens to hundreds of solar masses. This releases enormous energy. For example, in the core of Seyfert galaxy NGC 1275 (Perseus a radio source-A) about 5 million years ago (at the time of this galaxy) there was a huge explosion, accompanied by emission of gas jets with velocities up to 3000 km/s. Energy of expansion of gas here is two orders of magnitude higher than in the galaxy M 82.

Another class of galaxies with active nuclei, having an abnormally strong ultraviolet radiation, was discovered by the Soviet astronomer B. E. Markarian. Apparently, most of these galaxies is currently experiencing the era following the release, as astronomers say, postexplosive stage.

It is possible that the energy of radiation of quasars and active nuclei of galaxies are generated by similar physical processes.

As we have said, the quasars are very distant objects. And the farther from us is a particular space object, especially in the more distant past we observe. Galaxies, including galaxies with active nuclei, on average, located closer than the quasars. Consequently, these are objects of later generations — they must have been formed later than the quasars. And this is important evidence that quasars may be nuclei of galaxies.

As for the nature of the physical processes by which the energy of quasars, on this account, there is one interesting hypothesis.

In recent years a lot of popularity in astrophysics has gained the hypothesis of the so-called "black holes".

The twentieth century brought a number of amazing discoveries in physics and astronomy. Is a kind of chain reaction: found a strange phenomenon, and further study and understanding leads to the discovery of the phenomena, even more striking. This is the natural way of development of natural science.

One of the most outlandish, though still "theoretical" space objects, which in recent years has attracted attention of physicists and astrophysicists, black holes. One name which is: holes in the Universe, and even black!

According to the General theory of relativity, gravitation is directly connected with the properties of space. Any body not just exist in the space

itself, but determines its geometry. One day, some enterprising newspaper reporter approached Einstein with a request to explain the essence of his theory in one sentence, and in a way that is understandable to the General public. "Until the end — reply to this Einstein, if the Universe disappeared all matter, space and time would be preserved; the theory of relativity States that, together with matter would disappear also space and time“.

Any masses bend surrounding space. In everyday life we this iskriplennoi not feel nearly as we usually have to deal with a relatively small masses. However, in very strong gravitational fields this effect can make a significant difference.

In recent years, in the Universe discovered a number of phenomena which indicate the possibility of concentration of large numbers in a relatively small space.

If a certain mass of substance will be in a small volume, critical for a given mass, under the influence of its own gravity, this substance begins to shrink. There comes a kind of gravitational catastrophe of gravitational collapse.

In the process of collapse of the growing concentration of mass. Grows in accordance with the General theory of relativity and the curvature of space. And in the end there comes a point at which no ray of light, no particle, no physical signal can not "escape" from such education outside. This is a black hole.

To the outside observer, such an object would cease to exist — doesn't no information: after all, any information may not be distributed by itself, it must have a material carrier.

Radius collapse of the body in which it turns into a black hole, is called gravity. For the mass of the Sun's gravitational radius is 3 km, the mass of the Earth — 0,9 see If the Sun shrunk to the size of sphere with a radius of 3 km it would become a black hole.

On the surface, the radius of which for a given mass is equal to gravity, the gravitational force becomes infinitely large. And in order to overcome it, it would be necessary to develop the escape velocity that exceeds the speed of light. That's why a black hole nothing comes out. At the same time, it can involve itself in the surrounding substance, while increasing its size. Thus, the possibility of the existence of black holes can be explained from the point

of view of classical mechanics of Newton. But to describe the entire complex of phenomena associated with black holes, it is necessary to use General relativity.

In particular, according to this theory in a strong gravitational field, time slows down. So to the outside observer, the process of falling of a body into a black hole should be infinitely long time. For this observer, the compression process of the substance is actually stops when approaching the gravitational radius. A different picture would see an imaginary observer falling along with the matter in a black hole. It is for a finite period of time would reach the gravitational radius and continued to fall to the center of a black hole. The same thing happens with collapsium substance: crossing the gravitational radius, it continues to shrink further.

According to the findings of modern theoretical astrophysics, black holes can be the final stages in the life of massive stars. While in the Central part of the star works as a source of energy, high temperature leads to the expansion of the gas which tends to "push" the overlying layers. At the same time, the enormous gravitational force of stars "pulls" these layers to the center. But after "fuel" in the bowels of the star is completely consumed, the temperature in the Central part was gradually reduced. The balance is disturbed and under its own gravity, the star begins to shrink. Its fate depends on the mass. As calculations show, if the star is 3-5 times more massive than the Sun, its compression at the final stage can lead to gravitational collapse and formation of a black hole.

A few years ago, was discovered space object in the Cygnus constellation, which quite possibly is the black hole. It's a dark object with a mass equal to fourteen solar masses. However, the final proof that the object in Swan is really a black hole, is still ahead.

At the same time, increasingly, it has been suggested that in the nuclei of galaxies and in quasars may be supermassive black holes, which are the sources of the activity of these space objects.

Such black holes are capable of drawing in surrounding matter, the energy of motion in a gravitational field which can be recycled into other forms of energy. In particular, it was made an interesting discovery associated with the galaxy M 87 (the radio source Virgo A), for a long time attracts attention. In the pictures of this galaxy is clearly visible ejected from the jet core

consisting of several individual gas clouds with a total mass of about 10 million solar masses and moving at a speed of about 3000 km/s. It speaks of the great force of the explosion, which occurred in the kernel.

Observations showed that if at a certain distance from the nucleus the distribution of matter in M 87 corresponds to the usual distribution of stars in galaxies, near the center in a very small volume of concentrated enormous faint mass, equal to 6 billion solar masses. Maybe it's a giant black hole, stimulating the activity of the nucleus, and may be very dense formation still unknown to us of nature.

We have directly or indirectly noted the close relationship of physics and astrophysics. On the one hand, the universe becomes a laboratory in modern physics. On the other hand, new physical discoveries, in varying degrees, brought to life by the astrophysical research and astronomical problems, in turn have inevitable influence on the further development of astronomical ideas. This is a kind of feedback in the relationship and interpenetration of these Sciences is the dialectic of knowledge!

Among two hundred-odd elementary particles known to modern physics, there is an amazing particle, the neutrino. According to existed for a long time the theory, this particle is devoid of the so-called rest mass — it always moves at a speed exactly equal to the speed of light. However, on the other hand, the theory does not put any restrictions on the possibility of the existence of the neutrino mass different from zero. This circumstance prompted a group of scientists at the Institute of theoretical and experimental physics, USSR Academy of Sciences to conduct a series of experiments to ascertain the actual value of the mass of the so-called electron neutrinos. The result so far, though preliminary, was to some extent sensational, scientists came to the conclusion that the neutrino mass is not zero, and is in energy units from 14 to 16 electron-volts. The mass is not so large — ranging from one thirty thousandth to one ten-thousandth the mass of the electron, but the fact of its existence, if confirmed, would entail very serious consequences for our ideas about the Universe...

One of the urgent problems of modern astronomy is the problem of vnutribolnichnogo and vnutricostna energy. Until recently it was believed that the source of this energy are thermonuclear reactions of synthesis of helium from hydrogen. And this view is so settled that it was considered one

of the greatest ideas of modern astrophysics. And suddenly the question!.. We already talked about the fact that if in the depths of our fluorescent light really flows thermonuclear reaction, there should be born a neutrino. Thanks to the huge penetration possessed by these particles, very weakly interacting with matter, they are free to "break" in the solar space and a certain part of them will reach the Earth. Built a special set for detection of solar neutrinos were observed. However, the result was highly unexpected: neutrino flux was several times smaller than predicted by the theory. As noted above, for explanations of this phenomenon have been proposed a number of hypotheses, down to the assumption that the main energy source of the Sun and stars are not fusion reactions, and some other, maybe yet unknown physical processes. The question still remains open.

But if it is confirmed that neutrinos have finite mass — opens another possibility to explain the negative result of experiments on solar neutrinos. The fact that in nature there are neutrinos of three different types. As suggested by theorists, neutrinos of one type, with a mass different from zero, can spontaneously transform into neutrinos of another type. So one can imagine the following scene: those neutrinos, which are born within the Sun and for the registration of which is modern detectors, all the way to the Ground, unable to move into neutrinos which these detectors are not registered.

The presence of a finite mass of the neutrino will make substantial changes in the existing cosmological ideas. As is known, the geometrical properties of our Universe are very closely related to the average mass density. If this density is more than some critical value, of about 10^{-29} g/cm³, the Universe is closed and finite. In accordance with the pre-present time of real astrophysical data, the average density was estimated below the critical value. Neutrinos can contribute to this very significant amendment. According to available data, for each proton that exists in the Universe (protons it is because hydrogen is the most abundant in nature chemical element), we have about a billion neutrinos. Thus, if neutrinos do possess finite mass, even assuming that this mass is tens of millions times less than the proton mass, the total mass of neutrinos in the Universe is about 30 times greater than the mass of "ordinary" stuff! It may be that all stars, planets, nebulae and galaxies are only a negligible addition to the neutrino background of the Universe. And this, in turn, would mean that the average density of mass far

exceeds the critical value. And thus, our universe is closed and finite and its expansion over time (through many billions of years) should be replaced by compression.

But that's not all. As you know, modern universe is homogeneous only at large enough scales. If we consider a relatively small region of space, then uniformity would not — cosmic matter is concentrated in the star Islands-the galaxies and clusters of galaxies. According to the theory of hot expanding Universe, these space objects were formed at a certain stage of expansion the development of the inhomogeneities of the medium. The process was supposed to take place in the following way. On one of the relatively early stages of the expansion was a phase homogeneity with small fluctuations arising from gravitational instability. In some areas of substances could be slightly more, some slightly less. If the elastic forces exceed gravity, the heterogeneity may disappear. But if the amount covered by the perturbations is sufficiently large, then there is gravitational instability. Thus, fluctuations of sufficiently large scale should increase. The hypothesis for the formation of galaxies from the fragmentation of the environment due to the gravitational instability successfully develops academician Ya. b. Zeldovich and his collaborators.

However, this hypothesis faces difficulties. One of them is connected with the data of radio astronomy observations.

Currently the universe to photons of the CMB are completely transparent — they are almost without absorption. But in the past when the scale was about 1000 times less, for the universe of quanta of electromagnetic radiation was completely opaque — it completely dissipated. If in that era the medium was completely homogeneous, then the CMB should be perfectly isotropic, its intensity in any direction must be the same.

But the modern universe, as has been said above, is not perfectly uniform — it has the star Islands-the galaxies and clusters of galaxies. And if these objects are indeed formed from the "nuclei" that arose under the action of gravitational instability, at the appropriate stage in the evolution of the space environment was not completely homogeneous. In this case, and the CMB is not completely isotropic, it should be observed small-scale fluctuations. To find them, there have been numerous measurements of the intensity of the CMB on large radio telescopes, including the unique Soviet RATAN-600.

However, at a very high level of accuracy is no small-scale fluctuations could not be found, if you calculate the amount of "germs" on the basis of the size of the modern clusters of galaxies. Occurs intractable mystery! Because galaxies and clusters of something had formed. If not from the inhomogeneities of the medium — what? No other plausible possibilities not yet seen.

The existence of a finite mass of the neutrino could remove this difficulty. At a very early stage of expansion of the Universe in neutrino gas that filled the world space, could be a small random heterogeneities. However, in this period the neutrino has a very high energy and moved with *okolosvetovyyh* speeds. Gravity small condensations was insufficient for such neutrinos to keep. And they gradually broke up, "was resolved".

However, as the expansion speed of the neutrino is decreased, and, as shown by calculations, about 300 years after the initial moment of a sufficiently massive thickening already have them "capture". These condensation was to have a mass of about 10^{15} solar masses. They gradually became more massive, involving its powerful attraction of the new neutrino, and after about a million years after the beginning of the ordinary matter is an inert gas. Accumulating in the Central parts of the invisible neutrino inhomogeneities, it was formed into clusters of galaxies that we observe. According to calculations, the mass of the substance at several tens of times less than the total mass of the neutrino condensations.

Thus, the vast majority of the mass of the initial heterogeneities, of which later formed clusters of galaxies, the background radiation is "invisible" and could not lead to violation of isotropy. The masses of ordinary matter, were part of the neutrino inhomogeneities, clearly insufficient to cause such fluctuations intensity of the background radiation which could be detected using modern equipment. Thus, if the neutrino has a finite mass, then the contradiction between the modern theory of the origin of galaxies and observations of the background radiation is completely eliminated.

Finally, there is another very important issue to which the discovery of finite neutrino mass can make a difference clarity.

Astrophysicists over the years concerned about the problem of so-called hidden mass. The fact that the mass of galaxy clusters can be determined in two ways. First, luminosity: the greater the mass of the clusters the higher the

luminosity. And, secondly, the law of gravity, on the basis of observations of the mutual motions of galaxies in clusters. It turned out that the mass of the same clusters, are defined in different ways, are not the same — mass, calculated according to the law of gravitation is much greater than the mass calculated from luminosity. One possible explanation is that the clusters are non-luminous objects that contribute to their total mass, but does not affect the luminosity. It is these "hidden mass" and acceleration of galaxy clusters up to high speeds. Problem: what is the physical nature of the "hidden masses"?

There have been a number of assumptions: gas, dust, faint stars, black holes. However, none of them for one reason or another did not give a satisfactory answer to a question. Position and still remains to some extent uncertain. Certainty can make neutrinos. If these particles have finite mass, their contribution to the total mass of clusters of galaxies is able to cover a mysterious mass deficiency occurring at different ways of its determination.

But all this — if... we now Return again to the question of neutrino mass. The extent to which reliable can be considered the conclusion that this mass is not zero?

As is known, the existence of neutrino was predicted as a result of studying the so-called beta decay — the physical process by which a nucleus of one chemical element emits an electron and turns into a nucleus of another chemical element. It was observed that the energy of the emitted electron in some cases was less than it followed from theoretical calculations. The famous Swiss physicist W. Pauli suggested that the missing energy is carried away with itself still unknown to science neutral particle, weakly interacting with matter and therefore remaining undetected. This particle and proved the neutrinos.

But the process of beta-decay could, in principle, serve as an indirect indicator to determine the question of neutrino mass. In this way and was Soviet physics. For measurements were used the process of beta-decay of tritium, in which the nuclei of atoms of this element, emitting electrons, are transformed into the nuclei of atoms of the isotope of helium. If the neutrino mass is zero, among the electrons emitted from the nuclei of tritium must be present electrons, having the maximum possible for that process energy. In the same case, if neutrinos have finite mass, then the maximum energy of the

emitted electrons will be slightly less, and this difference depends on the neutrino mass.

As a result of such a series of experiments carried out at the Institute of theoretical and experimental physics, and was made a preliminary conclusion about the presence of a neutrino mass different from zero.

In recent years, the problem of neutrino masses was also engaged in American physics. In their measurements they assumed that the presence of finite mass neutrinos of the same "class" can turn into a neutrino of a different "grades", with zero mass, such transformations cannot take place. The scientists who conducted the relevant experiments, reported that the transitions in question, they discovered. However, the magnitude of the neutrino mass they estimated slightly lower than Soviet scientists. Later however, reports emerged that put this result into question...

Thus, the situation remains uncertain and for sure the conclusion will require numerous experiments and observations. But it begs a curious comparison. To the discovery of neutrinos has led to the need to explain the missing energy in beta decay. By its very existence, the neutrino resolve the mystery. Perhaps, the situation to some extent? In modern astrophysics, as we have seen, there are a number of mysteries that would receive its decision in the case of a finite neutrino mass. Once using neutrinos could explain the lack of energy may now be possible to explain the lack of mass. As rightly noted by one famous astrophysicist, if it turns out that the neutrino mass is still equal to zero, you will have to "invent" another particle very weakly interacting with matter, but with finite mass.

Of course, analogies in physics and astronomy do not have probative force. But to stimulate further research in the study of the question of the neutrino mass they can and should.

It is for this reason that the issue of possible astrophysical consequences of the existence of a finite mass of the neutrino deserves a detailed discussion today, although a final conclusion about the presence or absence of such masses to do yet.

In recent years, the problem of life in the Universe and extraterrestrial civilizations, attracted the attention of not only specialists, but also the widest circles of people. Despite the fact that we still failed to detect any

extraterrestrial living organism, modern science has reached a very high level of development that has the opportunity to raise the question of life beyond Earth on other celestial worlds on a sound scientific basis. Currently in this area is ongoing serious research, which involved the participation of representatives of various Sciences.

At first glance it may seem that the data available to scientists, almost clearly indicate the prevalence of intelligent life in the Universe. First, if living organisms arose naturally on the Earth in a natural way in the evolution of our planet, it is logical to assume that they can occur on other celestial bodies of the planetary type. Second, the carbon constituting the chemical basis of living matter, is one of the most common chemical elements in the Universe. Thirdly, the methods of the so-called molecular astronomy established that the clouds of gas and dust that fills interstellar space, the synthesis of complex organic molecules, a kind of "bricks" from which can be constructed of living substance.

However, the reality is much more complicated. Apparently, the formation of planets from dust and gas substances are those organic molecules that formed in outer space should be destroyed. Therefore, for the emergence of living organisms on some planet it is necessary that it formed its prebiotic compounds. Thus, even the very wide prevalence of organic molecules in the interstellar medium does not apparently influence the probability of life on the bodies of the planetary type.

But the most important thing is that modern science, unfortunately, does not know how nature performed an amazing act of self-organization of matter, like inanimate becomes alive. Science, in fact, only just begun to explore this fundamental problem. And the more she studied, the more difficult it looks. And therefore, we do not know what set of conditions necessary and sufficient for the formation of living structures. And therefore cannot estimate the probability of how often such conditions could arise in the process of evolution of the Universe. This is one of the most significant uncertainties among many others facing the problem of extraterrestrial civilizations.

It may also be mentioned that the methods of modern astronomy not give you the ability to confidently detect a planetary system even the closest stars. And none of the other planetary families like the sun, was not registered.

Meanwhile, there is no reason to doubt that among the great variety of different objects that inhabit the Universe, the abode of life and especially of mind can only be a planet.

However, currently developing new, more sophisticated methods of searching planetary systems. But expect them to concrete and practical results can still.

Thus, on a theoretical level to give any reasonable answer to the question about the prevalence of intelligent life in the Universe is not possible. The data available to modern science, it is not enough.

In this regard, special interest is the observation aspect of the research. We are talking about the discovery attempts of the existing transmitters of extraterrestrial civilizations, or any other manifestations of their practice. In the framework of this program over the past decade on several major radio astronomy instruments in different countries, including the Soviet Union, was held radioassay different areas of the sky. However, none of space "radio programs", which could be at least suspected of artificial origin, could not be found.

Was not observed in the Universe and any other phenomena which could be linked with the actions of rational beings — representatives of extraterrestrial civilizations.

Thus, in a modern science there are no facts which would directly or indirectly testify about the existence of extraterrestrial civilizations.

There are different points of view. So, corresponding member of the USSR Academy of Sciences I. S. Shklovskii does not exclude the possibility that civilization on earth represents something unique and is the only one in our Galaxy and maybe in the Metagalaxy. The logic of reasoning about such Shklovsky. If we assume that civilizations in the Universe a lot, because of the natural unevenness of their development, they need to have different scientific, technical and technological capabilities. Must be civilization behind us and ahead of us. In particular, there must be at least a few "super-civilizations" who have mastered the energy resources, comparable with the energy of their star systems-the galaxies. The scope of practical activities such sverzellati should be such that we could not detect. But since we don't find out, so sverzellati no. And since no super-civilizations, and there is no

extraterrestrial civilizations in General. Because if they existed, would have to exist and supercivilization.

Expressed other opinions. Some scientists assume that alien civilizations don't exist not because they are not, and for other reasons. An interesting hypothesis proposed corresponding member of the USSR Academy of Sciences V. S. Troitsky. According to the theory of hot expanding Universe at a very early stage of evolution there were no stars, no planets, no molecules, not even atoms. All these objects were formed much later. Thus, the conditions necessary for the formation of living structures, there is in the Universe only at a certain stage of its evolution. It was then, according to the Trinity, and the origin of life — almost simultaneously in different space worlds. And, therefore, of civilizations, much ahead of us in their development, simply does not exist. For this reason, we do not find.

Other scientists believe that at any level of civilization development of their space activities will be linked to the severe restrictions of energy, caused by the need to maintain certain physical parameters of the environment. For example, the creation of a powerful enough radio transmitter, which could be Omni-directional transmit signals to establish contact with other intelligent inhabitants of the Universe, would require the concentration of such enormous quantities of energy that it would put in jeopardy the very existence of a supercivilization. Furthermore, the implementation of such a project would require such enormous efforts that civilization could go for its implementation only in that case if that was vital for her.

With similar considerations one can agree or disagree, but the question remains open. And the reality is that extraterrestrials have not yet been found and the prospects of their detection in the foreseeable future look very, very problematic.

What's the meaning of the study of the problem of extraterrestrial civilizations on the contemporary level? It is very well expressed by the Academy of Sciences of the Estonian SSR G. I. naan studying the problem of extraterrestrial civilizations, we first of all try to know ourselves.

Humanity has reached a stage of development, when we can no longer ignore the fact that physically the earth is part of the Universe, obeying applicable it laws. Knowledge of these laws is becoming increasingly essential for planning and forecasting our practical activity, in particular the achievements

of global and cosmic proportions. It was found that the present level of development of science one of the most effective ways of solving such problems is the study of the problem of space civilizations in its most General form. We investigate patterns of cosmic existence of civilizations in General, including laws of our own cosmic existence. Thus, we would look at human civilization from a space point of view, studying it in the "space mirror".

In the same aspect, we must first consider the so-called problem contacts, i.e. the possible exchange of information with extraterrestrial civilizations. To examine this question also is very important, and again, regardless of whether such contact is ever to be practical. A study on the ways of information exchange between intelligent beings of different space worlds, perhaps with differing scientific views about the natural environment, also has numerous exits in purely earthly practices, in particular, to solve the most effective "understanding" and interaction between man and various cybernetic devices.

The ship went into a circular orbit and is now moving around the third planet in the system of green-yellow stars with a surface temperature of about 6 thousand degrees. In the wardroom the leaders of the expedition gathered at the emergency meeting.

We made a great discovery, he began discussing the Commander — discovery that will have far-reaching consequences. We found an alien civilization. And now there is no doubt that we are not the only intelligent inhabitants of the Universe. We have Space brothers on reason!

— What's the point, ' muttered the Biologist. — What's the point if any contacts with these, as you say, brothers in mind, it is absolutely impossible.

— Why brand? — said the Physicist, the youngest and the most impatient among the audience. — This conclusion seems to me to be too speculative and therefore premature. I suggest to start experimenting!

Premature? — frowned a Biologist. — Do I have to remind you of the trivial things?

— Well, try, — said cockily Physicist.

— To begin with, continuing to frown, said the Biologist, for contact and understanding requires a well-defined objective conditions. But they are not! First of all, the planet's inhabitants consist mainly of nucleons and electrons and our bodies are built of neutrinos. So for them we are invisible and

imperceptible. Like all our technology. And there is no doubt that any our attempt to join with the inhabitants of this green planet in any communication will inevitably cause them to have severe psychological shock. It can be even deadly. And you say — to begin to experiment...

— Well, — said the Astronomer, I would not be so categorical. After all, we live in the same Universe, where there are uniform physical laws. And since we discovered civilization has reached a very high level and even exercise space flights, their knowledge about the world can be very different from ours. And it is quite sufficient reason for contact: is similar to the scientific picture of the world.

And as the Philosopher says? — asked the Commander.

— I think that the situation is much more complicated... In my opinion, our esteemed Astronomer is showing too much optimism. But this optimism is, alas, absolutely not justified. Yes, we live in the same Universe. And it is the same for us and for them. But because the universe is infinitely diverse! In her countless connections, relationships, interactions, events. Any scientific picture of the world — as long as it was created for a finite period of time — can cover only a finite number of these connections, events and interactions. This means that the picture of the world, built by different civilizations may not only not coincide with each other, but even overlap! Where is the basis for communication?

But can intersect, — said the Physicist.

— Yes you can, but only in principle. Don't forget that science is a social, public phenomenon. It develops not only by itself, by its internal logic, but above all meets the practical needs of society. Excuse me, I need to remind you-so-famous things... in short, the picture of the world of two space civilizations can be the same only if they shared a common social development. But in our case, as you know, is deliberately excluded. So... the Philosopher an expressive shrug.

In the wardroom reigned the dull silence.

— What do you suggest? asked the Physicist. — Removed and without any attempts?

— Sorry... it was correctly stated — contact the necessary Foundation. The Foundation on which to build to... May be quite unexpected. I'm such a

Foundation not see. No idea how one might try to establish contact with this civilization without any risk of causing unwanted, and possibly very serious consequences...

"So," said the Commander, taking a hard look present — I wait for specific proposals.

All were silent.

— Well, — concluded the Commander — it seems to have come to a consensus.

— And yet... — Physicist spoke again. — Do we get out?

— This is a necessity, sternly said the Commander. — Give three hours of additional research on this planet. Then — start.

In the wardroom became the operations officer.

— Commander! Emergency! Disappeared on a pleasure boat.

What do you mean disappeared? The commander looked askance at the officer. — The boat could not disappear by itself.

— That's right. Apparently, it flew your grandson. It's nowhere on the ship.

— Chuck? — asked the Commander. His face was grim. — I told you not to take such an expedition child, ' he murmured.

— And have you seen him? — asked the Commander of the Physicist.

— Quite recently. He, as usual, accosted me, asking to play with him. But I told him today not to play.

— He asked me — said the Physicist.

— And me, — said the Biologist.

And me, said the Philosopher.

— Of course, he flew to this planet, — said the Biologist. — Commander, we must immediately take action! It can do irreparable.

— Yes, — said the Commander. That Ru — he turned to the officer. — We'll have to charge it to you. Take the second boat and rushed in pursuit. But proceed with the greatest caution. And remember — no contact with the natives!

— Yes! — clearly said the officer and promptly left the cabin...

— No, not that!.. — Tim wood with irritation crumpled sheet of paper, on which you just wrote, and tossed it aside.

— Not, not, — he repeated several times, rapidly pacing from corner to corner. — Dry, boring, no highlights. Not an article, and a funeral March....

This afternoon wood, not looking for an apartment, came to my small country house. He did so whenever there was a need to write another article. The silence and loneliness could not be better disposed to work. Over the years, wood developed a sort of reflex: as soon as the car crossed the city limits and the highway leading to his "country residence," as he jokingly called his modest house, deep into the forest, he at once was freed from countless everyday problems, from repetitive strain, leaving the bustle of the big city, the mind brightened and thoughts that there, in a close editorial office, he was compelled by force to cough up, now born by themselves, freely and relaxed... Often, out of the car, Tim has "kept in mind" the finished article. It only remained to sit down at the typewriter and tap out the idea.

But today there is neither a picturesque forest road, fun in the sun, or a country silence, nor solitude didn't help. Ideas were not...

I knew that sooner or later it will happen, gloomily said wood, continuing to pace around the room. He always loved working, wondering out loud — it helped to think. — The reader requires sensationalism. Did modern man something that will surprise? Nevertheless, we all want the extraordinary! They don't want just to read about new scientific discoveries — even the most prominent. They definitely want something out of the ordinary... However, wood in the depths of the soul was well aware that sensations require not so much the readers, as the editor. He has long been accustomed to write primarily for the editor, so I accepted it.

But I can't invent sensationalism without end, damn it! Because they need to be not only stunning, but believable. All... I'm exhausted!.. The end...

Wood stopped his throwing and plopped down in the chair. His eyes went out, was indifferent and absent.

It's unknown how long he remained in this state if his attention was drawn to a strange phenomenon. Right in front of him in a wide pier between two Windows hung three landscapes in wooden frames, donated by Voodoo a

familiar artist. They were suspended on silk laces, attached to a thin metal tube is fixed under the ceiling. Voodoo seemed that all three paintings began to slowly crawl up the wall, as if someone started to turn up, reeling at her shoelaces.

Tim's eyes following the movement of the paintings, climbed on his forehead. Oh, the devil! he muttered and even shook his head to get rid of delusions. — I haven't been drinking today anything good...

Pictures slowly slid down and took his usual position.

— No, so you can go mad, wood rose determinedly from the chair and capturing on the way a blank sheet of paper, sat down at the table. — We have to work.

After a second of thought, he reached for a ballpoint pen that lay on the other end of the table. And then rapidly withdrew his hand like he touched a hot iron: the handle itself rolled to the other side of the table. Wood tried again, but the pen again jumped to the side.

However, a sense of humor, not once rescued wood in the most difficult situations, not change him this time.

It becomes curious, ' said he smiling. — It wouldn't start if my house is haunted? That would've been nice — this is enough for me until the end of life.

He carefully looked around the room, but nothing unusual was found. All subjects were in their rightful places and did not show anything that would be prohibited by the laws of nature.

— Well, well... even with some disappointment handed wood. — So it seemed.

And at the same instant a sheet of paper lying before him, fluttered into the air and hanging before his face a few times gently tickled him on the nose.

— Great! excited cried wood. — This is exactly what I was missing...

He ran to the typewriter, hurriedly put him in a clean sheet and printed the title of the future article: "Ghosts are back!".

Then, abruptly moved the carriage and, for a moment, stood, and began to figure in mind the first sentence. But the machine suddenly came to life and,

like direct-printing device electronic calculating machines, cheerfully attukal itself:

"You're not afraid of me?"

Wood is dumbfounded looked at did such an unusual way phrase. But he began to get involved in this strange game.

"I am pleased to welcome you!" — he printed the answer.

Some time the machine is "silent", then again whirred to life itself:

"Play with me".

— That's a thing! rapturously cried wood and banged his fist on the coffee table with such force that standing on it the machine with a crash jumped. — Blimey, never heard of ghosts played with people in any game.

"I'm not a Ghost — printed car. — I'm from another planet“.

— The hour is not easier! broke the wood. — Where are you?

Machine working again:

"I'm with you. But you can't neither see or feel — I am so arranged. But I hear you... Play with me.“

"Play? — feverishly wood. But the kind of game I can play with the creature, who did not see or hear? Not hide-and-seek in the end? It is enough that we are, though just barely, but we talk. And even managed to go on you"".

— How do you know our language? asked wood.

"We studied it," attukal machine.

Studied?... Then, maybe...

Wood turned the machine on large font and printed on a blank spot first came to mind the letter "C".

— We'll take turns to put the letter on the right and left of any other letters, — he explained. — But, not to get finished words. Someone out — one penalty point. And so up to five penalty points. Who was the first pick — he lost.

The platen of the typewriter began to spin, pushing the sheet and clean place there is the question of the alien:

"And what is this game called?"

— We usually call it the game "Balda" — a little hesitation, said wood. Instead of penalty points, the loser is written first with the letter "b", then "a" — and so until until one of the players does not reach all the word "noodle". But maybe you do not understand its value?

"No, why, — was the answer. — I understand that. Blockhead — it's the "eccentric fool"".

Ha — laughed the wood — very nice!.. Well, if so, then start.

The cushion is spun in the opposite direction, one of the knobs hit the paper near the letter "C" printed wood, on the right side appeared the letter "a".

"So," commented wood — not too complicated, but first, tolerably well.

After thinking a little, he stroke to the left another letter.

— That's trickier — wood was referring to the word "Passat", ending on the alien. — What good I asked you a task?

Instead of answering, the machine immediately threw right to the three existing letters letter "D". Wood stared blankly at the resulting combination:

— That's a thing!..

Mind it was only two words, which included this combination: "seedlings" and "abrasion". But both ended on him. He, however, remembered another one word "hotbed", but it is not saved.

— Deftly! — wood sighed, recognizing defeat. Well, remember — I have a "b". Now you start.

Machine along the sheet on a free place printed soft sign...

At this time, wood lost even faster. And anyway soon it was all over for him with a disheartening 0-for-5.

Revenge? — hesitantly asked wood.

— This game bored me, — said the alien. — Think of something else.

"Okay," agreed wood and suddenly, with a belated regret he realized that he could not lose in the first round of the game "Balda". It occurred to him, another right word: "glide path". It was necessary not to give up, but ascribe

to the combination of "SAD" to the right of the letter "A", and the alien is unlikely to get out of this situation. However, this final result is hardly changed, but still the expense would not be "dry". Would be scored, as they say sports commentators, the goal of prestige...

— That a proposed word — will make words. From the letters contained in any word. Time, say fifteen minutes — who is more...

"Understood," — said the alien. — "Waiting for words".

Wood tucked into the machine a clean sheet and printed in discharge first came to mind the word "jewel." Then put another sheet in front of him on the coffee table, reaching took a large table with a ballpoint pen, which this time did not attempt to escape, and wrote in the upper corner of the same word.

— Thus, the term fifteen minutes... Go!

The machine instantly whirled to life. Not managed wood to write three words, they are alien has grown long column. And the machine continued to work at a frantic pace a good computer... in Exactly 15 minutes the knocking stopped. At this point, Voodoo managed to come up with 63. The et—155! Wood glanced through the first column: value, horns, road, mountain, top, neon, argon, grotto, price, axle, gen, hail, sleep, nose, stone, garden, soda, rod, gums, leg, fire, rent, toga, hell... do not say Anything, the aliens apparently well learned human civilization, words have said that they know the structure of the human body, physics, chemistry, and history, and more.

Wood theatrically raised his hands:

— I give up!.. What do we do next?

"Play" — printed car.

"What could it be? thought wood. It has awakened a passion for sports, play is no longer wanted. — Should I support the honor the earth civilization. Need to come up with a game where our chances would be equal..."

Wood was frantically going over in his mind all the known games. Domino? Too long and boring, especially alone. Besides, here he and Domino was not. Table tennis? But this idea seemed to Voodoo so absurd that he even laughed: how to play table tennis with invisible? Maybe Billiards?.. Well, of course, Billiards! How did he not think of that immediately?.. Wood loved this game and was considered an excellent pool player. Few friends were able

to successfully resist. And, pitching his country house, he was installed in the billiard room.

— Move on to the next room, — springing up, loudly asked wood, as if he feared that the alien will not hear him.

He opened the door to the billiard room, then, tapping himself on the forehead, went back, took the car, moved it and put it on the chair next to the Billiards.

"Let's do it!" — impatiently attukal machine.

Wood took up the cue.

— The game is — he proceeded to explain to chase balls in these holes by the pockets.

Going to play Russian pyramid. On the balls drawn numbers from one to fifteen. Wins who first scores 71 points. You can beat only one bowl — this striped, it is called a "cue." And be forewarned. Let's say... wood looked green cloth field on which randomly placed balls, to twelfth to third in the right corner...

He leaned over the table and, almost without aiming, hit. Twelfth, even without hitting the edges of the pocket, gently slid into the net.

"Got it! — printed machine. — Let's rather play".

— What is the look — think wood, aligning balls wooden triangle.

He set the cue ball on the starting point, and prudently put it in such a way that the ball hitting the back Board, quietly joined the others, without violating the initial construction.

— Your turn, announced wood and only then thought about whether an alien actually play this game? How he would hold the cue? After all, wood had no idea what he looks like. However, even this word "looks" in this case is clearly not fit...

However, doubt wood was resolved immediately: the cue itself sharply spun and destroyed, consisting of balls a triangle. The balls rapidly peals in all directions.

Dashing! thought wood, watching the jam. — I have a good chance!

— Whew!.. — he whistled immediately.

The cue ball slowly, as if reluctantly, retreated to the corner of the table and coming into the pocket, stayed in some millimeters from the edge. With such a position to produce the effective shot was absolutely impossible.

— And he's no slouch! — admired wood. So fast to catch the essence of the game!

After a second of thought, he hit no order, just tried to put the cue ball in an awkward position. After seeing the striped ball eyes, smiled contentedly: now let them try.

Pounding machine. Wood looked at the paper and could not believe my eyes: the "third ball in the thirteenth, the thirteenth from the two sides in the seventh, the seventh to the fifteenth, fifteenth from the third into the right corner."

Incredible! Wood jumped to the table. Just at this moment the cue, getting up from the place, struck on a long Board and flicked the ball with the number "three". "Three" I crashed in "the thirteenth", which, in turn, reflected from two sides, short and long, pushed by a seven. "Seven," gently cut the balloon with the number "fifteen" and he rolled towards the corner pocket, however, is clearly not into it. Wood was contentedly grinned, but at the last moment the way "fifteenth" crossed still continued to roll after hitting the "Troika". Balloons gently touch each other and "the fifteenth" silently fell in the hole...

Wood surprise I went — in all my vast billiard practice he has never seen anything like it. And the alien one after the other ordered more puzzling combination that seemed completely impossible. Nevertheless, balls obediently fell in one and then the other pocket. Wood barely had time to remove them. When the number of points scored by the alien, has passed for 50, wood put aside the cue. And it did: after three strokes it was all over.

"Play again"? quickly typed up typewriter.

Must be a billiard game came alien the taste.

— Not really, drawled wood, unable to hide his disappointment, as he laid on the pool table a lot of hope. — Let's better play some other game...

After three crushing defeats Voodoo became clear that to compete with the alien in these games where everything is decided by the stock of knowledge,

or skill, or a precise calculation is beyond him. Apparently, the brain of this stealth is not inferior to the computing machine of high class and are able to quickly solve extremely complex problems. Apparently, the chances of success may appear only in the case when the result of the game depends on the purely fortuitous circumstances. However, to win a game like this is a small merit, but at least the game itself will be carried out on equal...

Okay, I'll try to play with dice, decided wood and took from the shelf a box with two small cubes, carved from ivory, a gift of one Indian colleagues.

— We'll take turns to throw the dice, explained wood. — Win the one who first scores, say, fifty points. But after the cubes are cast, they cannot be stopped and in General to touch them — prudently he added, remembering the extraordinary possibilities of his partner.

— Begin... — wood put aside the remaining Billiards balls and threw both dice on the green cloth.

Turned over several times, they stopped. On their upper faces were three and four grooves, painted over with black paint.

Seven points, summarized wood. — Now it's your turn.

Cubes immediately jumped in the air and skated across the surface of the table, he stopped. Looking, wood saw two sixes and 12 points. Maybe a coincidence? He again took the dice and threw a second time, however, with a lesser degree of confidence. Dropped six and five.

"Not so bad, thought wood, pulling himself together. — We'll see what happens next..."

The cubes themselves again jumped, rolled and froze. And again two sixes.

Batch of wood was done without any interest. And the alien every time you threw two sixes. Scoring after four attempts 48 points, the last move he threw two ones and thus gained the agreed amount just point to point.

And in this game, wood gave way. And he had no reason to suspect her unseen partner in dishonesty. He probably knew how to calculate the power of the throw that dice have made a certain number of turns and stayed right faces up.

"And the accident did not help, disappointedly thought wood. — However,

what a coincidence, if it is possible to accurately calculate in advance? This for me is an accident, but for him... Need a completely random, unpredictable."

And then wood is thought about one of the fundamental principles of quantum physics — the uncertainty principle. He often had to conduct interviews with physicists working in this field, to write a popular article about the phenomena occurring in the microworld, and he's not bad at all had it figured out.

The uncertainty principle! The Holy of holies of the physics of micro-processes. The principle from which it follows that the behavior of individual particles, for example electrons, may not be exactly predicting in advance — it only obeys the laws of probability theory. And they are applicable only to sufficiently large number of events.

Wood going to the TV, standing in the far corner of the billiard-room, and switched it to the gaming unit.

"As one of the main components of this block is a generator of random variables in which the important role played by electronic processes, — he reasoned, — the data generated by this unit, completely unpredictable."

— Need to call any six numbers from one to fifty, has launched wood for another explanation. — After this button is pressed and the screen displays six numbers randomly selected by a special device, attached to the TV. Who among us can guess more times, for example, out of five attempts, he will be the winner. I start... Say: 3, 8, 17, 21, 46, 48. Now let's see how successful was my choice.

Wood pressed the button on the remote panel and the screen instantly appeared in large numbers: 2, 17, 29, 35, 36, 41.

— One match, commented wood. — One point. Your turn...

"6, 23, 34, 41, 43, 49", — repulsed by the machine.

Wood again pressed the button of the gaming unit, and with interest looked at the screen: 5, 23, 34, 42, 43, 50.

"Yeah, this time only three of the "hit" — it seems that things are looking up" — said to myself wood.

In the second series alien guessed twice. In the third or four times. The fourth

attempt was a wholly — matched all six numbers. Finally, in the fifth series, the result was again more modest — just two correct numbers. Thus, the visitor from outer space in total guessed it 17 times. During this same time, Voodoo was able to correctly predict the number that appeared on the screen only three times. He lost again and again with a big score. But the result of the alien this time also not. was absolute.

"Well, pleased to have thought of wood — this time, my defeat is quite an honor. And the victory of the alien is not so unconditional. Although he apparently has the ability to predict the course of micro-processes is much more accurate than it learned to our earthly physics... what if?.."

Alien quite successfully competed with a block of random variables. Perhaps he did not yield to any most perfect computer. A person?.. After all, what competed with him wood? The amount of memory in the speed of extraction from it the necessary information, the accuracy of the calculation... speed... precision... And in the intellect?

Wood went up to the bookcase, took out the chessboard and placed it on the coffee table next to the typewriter. Despite the constant of journalism, and perhaps because of them, wood was a versatile man. Having a mathematical mind, he played chess in the power of a good master, though not performed in competitions.

— Look, — he muttered, placing the figures...

Ten minutes left for the explanation of the rules. Then, to test how alien they learned that wood asked him a few chess problems — dvuhhodovki and Trenchtown. Guest from outer space took them out instantly. Then wood asked him two fairly complex study. And they were resolved in just a few seconds... you Can start the game.

Wood mounted shapes to their original positions.

— You start, he said. White.

Out of habit he looked at the machine, but at this moment the white pawn on E2 itself has moved to E4.

"Well, of course, figured wood, if it can typing and move pool balls, so why not manage, and chess pieces?"

The Board turned the hot battle. First space alien answered pretty quickly,

and though he was not privy to the subtleties of the opening theory, played unmistakably. But as soon as the situation on the Board becomes complicated answers of an alien had to wait longer and longer and his game became more and more vulnerable. Apparently, he was not yet far enough to calculate all possible options. And then, wood has aggravated the game. The Board position became so complicated that any detailed rendering options became impracticable. In such a situation, bail could only be a chess intuition.

— Well, let's see, ' muttered wood, sacrificing the horse.

He himself could at this point say to what consequences can lead the course. But rich chess instinct told him that white, regardless of whether they offered sacrifice or reject it, will still be placed in a difficult position.

The alien took a horse, and in three moves wood put it in front of a not too pleasant choice: either to lose the rook, or return a slight figure, but get a lost position...

This time the alien for quite a long time not made itself felt.

"Yeah, triumphantly concluded wood — found and you have a vulnerable place. You're not going to win..."

And suddenly, instead of the next movement of the pieces on the Board, pounding a typewriter.

"I can't finish the party — read wood. For me profit..."

And that's all!

Wood feel like it in some way cheated.

Victory was so close, his first and most important victory over the alien. The victory, which was to prove, if not the advantage of human intelligence, then at least a fairly high level, giving the right to space the contacts. And suddenly, this coveted victory sailed from...

But wood immediately straightened himself. It does not matter whether the last point? Much more important is that he still beat the alien, despite all of its computing capabilities. Yes, unless it's important?!

Wood jumped up. Only now he suddenly discovered the significance of what happened. Covered gaming excitement and passion of a professional newspaperman, encounter the shocking sensation, he once did not think about

this aspect of the case, separated the real sensation from all others composed by himself and existed only on paper...

He even thought, maybe not the most important thing is that now the existence of extraterrestrial civilizations has become an irreversible fact, and not that people have grown to the level which opens the possibility of communication with alien intelligent beings, even completely unlike the earthlings, and most importantly that contact with them is possible and feasible. And wood now knew which way...

The officer entered the wardroom. And behind him, cheerfully smiling and apparently does not feel to blame Chuck.

— Commander, I brought him in, ' said the officer.

The commander looked sternly at Chuck. But he continued to smile regardless.

I'm listening to you, — said the Commander, glancing at the officer...

By the end of the report wrinkles on the face of the Commander disappeared, and his eyes sparkled.

It's epic! — exclaimed the Physicist.

Now we know how to act! — joined an Astronomer.

— There is no hurry, — said the Commander. — We need to consider carefully, to weigh, to develop. This will take the next expedition. But I think the key is found!..

In the meantime, on Earth, in a little house, lost in the dense foliage of ancient trees, journalist Tim wood hastily invested in a typewriter, a blank sheet of paper and, striking the keys, printed the name of its new articles, the most important of all that ever was written. This name consisted of two words: "Contact!".

"The game is a vital need for any living being, and above all, reasonable, — he printed, without stopping. And we can assume that this is true not only for living beings that live on Earth, but also for the inhabitants of any other world, whatever they may be. It is common ground that unites the intelligent inhabitants of the Universe..."

By the evening this article was ready. Wood pulled out of the car the last leaf

and came out on the porch. In the summer the black sky was lit up with stars. Peering into its bottomless depths, wood noticed a short bluish flash. Perhaps it was launched to the star the alien ship. Maybe Voodoo it only seemed.

With all the conventions of the story and the plot of the story is "Naughty", it addresses a very real problem that is associated with the search for intelligent life in the Universe, namely the possibility of contacts with cosmic civilizations.

If such civilizations do exist, then the probability of finding such a society of intelligent beings, which is similar to earthly humanity, passed a similar path of social development and had the same scientific knowledge is extremely low. But this means that the scientific picture of the world built by mankind, and the scientific picture of the world created by another civilization is likely to differ significantly from one another. They may not even intersect. After all, the scientific picture of the world is the ultimate cross-section of the infinitely varied objective reality, the nature of which directly depends on the whole prehistory of practical and cognitive activity of the civilization.

Therefore, the establishment of mutual understanding with other civilizations, if they exist, is a task of immense complexity.

Chapter four. WHAT WOULD HAPPEN IF?

At the turn of the 50-ies and 60-ies of the book, which immediately attracted attention. It was the book "the Inevitability of a strange world," wrote her famous Soviet writer D. Danin.

What kind of world it was said and why the world is this strange and inevitable?

It was about the revolution in physical concepts, which brought the twentieth century, the ideas of modern physics, which openly contradicted the usual views, and therefore many seemed preposterous, even insane, but despite this, was well confirmed by experience.

Everyday life takes place in the world of classical physics, and it is not surprising that many of the provisions of modern physics and astrophysics are in conflict with our everyday ideas. Is it easy, say, to assume that the mass of a body depends on its velocity and therefore the mass of any proton or neutron flying at a speed close to the speed of light can, in principle, to

exceed the mass of our entire Galaxy? Or to accept that from the collision of just two particles, according to the views of some physicists, it may generate hundreds of billions of stars? Or imagine a microparticle, which by any means cannot accurately measure speed and position in space — microparticle, which is a sort of blurry clouds? It is not easy to visualize and monstrous density of some space objects.

And this is not a complete list of the weird world of modern physics and astrophysics. But most striking, perhaps, is that this world exists somewhere inside of us, it's not the house across the street that we may one day enter, but can never enter, the world in and around us, we in him and live. Live without encountering so many of its amazing properties, not noticing them. But only from time to time.

If cast trinitrotoluene block in the oven, it will be easy to burn and give heat. But the same tol can explode and blow the stove to pieces. In this case, work properties, which tol has when just burned, but which manifest themselves only under certain conditions...

We have just mentioned that, according to the theory of relativity the mass of any body increases with the speed. Therefore, when we go in the normal car or flying in an airplane, the weight of our body also increases. But the increase is so insignificant that not only plays no practical role, but also modern means can't even be measured. However, this effect is quite real, and, like some other effects, discovered the theory of relativity, we have to consider in the calculation and design of nuclear and atomic physics. And since science will never stop in their knowledge of the world, we will inevitably meet with more and more subtle and unusual effects. V. I. Lenin emphasized that by opening a lot of outlandish in nature, people will discover even more...

The beginning of our century was marked by a fireworks display of outstanding physical discoveries affecting the basic ideas about the world. Since then, our knowledge about the structure of matter has greatly increased and deepened. Was discovered a number of previously unknown phenomena, opened new laws, solved many challenging problems. However, there are new questions and new challenges. It is possible that they will lead to a new substantial revision of the most basic, fundamental concepts of modern physics the concepts of particles, fields, space and time, etc.

Can change our usual views on the relationship between macroscopic and microscopic forms of existence of matter. So whether in fact there is a great divide between micro - and macrocosm?

Experimenters discover new and more heavy particles, so-called resonances, with masses significantly exceeding the mass of the nucleon. Is there a limit of these masses? And if in ultrasmall space-time regions to be born of macroscopic objects?

Of course, this can happen only at very high energies of interactions. Such energy in accelerators has not yet been achieved. Can't help and observation in a traditional "laboratory" physics — cosmic rays. The fact that the cosmic particles arriving in our region of the Universe, will inevitably lose part of its energy by interaction with photons of the CMB, and therefore the energy of these particles is automatically "clipped" at some level and can never exceed it.

In any case, the study of microalloy today leads to problems of the cosmic order, and the decision of the cosmological issues are increasingly encountering fundamental problems in elementary particle physics.

In General astronomy, even more so than particle physics, is now the region's most amazing discoveries that require or may require the most profound and far-reaching revision of our ideas about nature.

Modern astronomy and physics and then present to us the most unexpected surprises, open the "strange" phenomena, lead us deep into "increasingly bizarre".

And because it is sometimes useful to try to look with an unusual, paradoxical point of view to some "normal" phenomenon.

In some cases it helps to clarify the particular problem, to better understand the nature of the processes.

One of the possibilities of creating such paradoxical situations is to put the question: "What would happen if?.." So, small series of thought experiments: what would happen if...

Any major achievement of science in the end somehow changes the life of each of us. So it was with the discovery of electricity and electromagnetic waves, with the invention of flying machines heavier than air, with the

creation of semiconductors... Now in the life of mankind consists of rockets and space ships.

There is no doubt that it will take another few decades and people will use it for Intercontinental rocket transport messages with the same calmness and equanimity with which they now climb aboard a passenger jet airliner. Become commonplace and space communication between Earth and the Moon. People will live and work on space stations, appears profession the space of welders, installers, etc.

But perhaps the first time, thanks to scientific and technological achievements in space exploration, people will be in entirely new conditions where otherwise manifested the usual physical laws. Something like that could happen except only in the development of the deep sea.

Of course, the basic laws of physics and in particular mechanics are the same on Earth, under water and in space. But they manifest themselves differently depending on the conditions. And these conditions on Earth and in space is not the same. On our planet they are characterized by two main circumstances. First, there is no noticeable speed change — acceleration in the movement of the earth's surface points. And secondly, our planet attracts objects and causes them to exert pressure on their supports.

The lack of tangible acceleration is due to the motion of the Earth in the world space. Together with our planet we are engaged in two major movements: daily rotation around its own axis and yearly around the Sun. And while we race along with the Earth around the Sun at a speed of 30 km/s, and together with the Solar system around the galactic center with a monstrous top speed of about 230 km/s, we do not feel, as the human body is quite insensitive to the speed of uniform motion.

However, according to one of the fundamental aspects of mechanics, no internal physical experiments and measurements it is impossible to detect uniform and rectilinear motion.

Well, if some system, for example, a space rocket, it will move with acceleration under the action of motors or testing the resistance of the medium? In this movement there is an overload, i.e. an increase in pressure on the bearing. On the contrary, if the motion occurs with the engine off in the void, pressure support disappears, there comes a state of weightlessness.

In terms of the Earth pressure on the ground due to the action of gravity. But some people think that the pressure force on the bearing is the force with which a body is attracted by the Earth. If it were the case, then, for example, in the spacecraft moving towards the moon, zero gravity would not be, because at any point of the orbit on the ship would act the force of gravity. And indeed in space, it is hardly possible to find a place where the resultant of the gravitational forces would be equal to zero.

Note that the pressure on the bearing can be driven by not only gravity, but also other reasons, for example, acceleration. For a stationary body resting on the earth's surface, the attractive force really coincides with the pressure force on the bearing. But this is only a special case.

Meanwhile, the attractive force applied to the support, and to the body. Thus, pressure support and gravity are completely different forces.

If a space rocket moves with acceleration, the pressure of the support body increases in many times, how many jet rocket acceleration exceeds the acceleration of gravity, equal to 9.81 m/s^2 . In other words, the accelerated phase of motion increases the reaction support. But at the same time, in accordance with the third law of mechanics, at the same time increasing the pressure on the bearing.

The ratio of the actual pressure on the bearing to its bearing pressure under the Earth is called overload. For a person located on the earth's surface, overloading equal, thus, to one. The effect of this constant overload of the human body adapted, and we just don't notice.

The physical essence of the phenomenon of congestion is that not all points of the body are accelerated simultaneously. Acting on the body force, for example, the thrust of the rocket engine, applied in this case to a relatively small part of its surface. The rest of the material points of the body are accelerated with some delay through the deformation. In other words, the body seems to be flattened, pressed to the support.

Numerous experimental studies, which was started after K. E. Tsiolkovsky, showed that the physiological impact of overload greatly depends not only on its duration but also on the position of the body. At vertical position of a person a significant portion of blood is shifted to the lower half of the body, which leads to disruption of the blood supply of the brain. Internal organs as

a result of increasing its weight is also shifted down, causing a strong tension of ligaments.

In order to avoid hazardous overloads on areas of accelerated movement, should be placed in such a way that the effect of the overload was sent from back to chest. Such a provision allows you to transfer approximately three times as large overload.

Incidentally, it is for this reason to relax lying down is better than standing...

If action overloads the inhabitants of the Earth although not often, but still have to meet, with the weightlessness they almost met.

It's amazing the condition comes after the shutdown of a rocket engine, when the pressure on the support and response support completely disappear. Disappear and the usual person the direction of the top and bottom, and loose objects float freely in the air.

Relative weightlessness, there are a number of misconceptions. Some people think that this condition occurs when the spacecraft is in a vacuum, "outside the sphere of gravity". Others believe that the weightlessness in the satellite of the Earth obtained by the action on it "centrifugal force".

All this, however, is completely wrong.

Under what conditions there is a weightlessness and pressure on the ground becomes zero? This phenomenon is due to the fact that during free movement in space and the missile itself, and everything contained in it objects under the action of gravitational forces move at the same acceleration. Support all the time as it goes from under the body, and the body has no time to push her.

However, traffic on the active sites under the action of the rocket engine, and the movement under the action of gravity forces motions are accelerated. They both occur under the action of forces. Why in one case there is an overload and the other with weightlessness?

This apparent paradox. As stated above, that in the event of overload of the acceleration communicated to the various points of the body through deformation. Another thing, when rocket moves in the gravitational field. Within the dimensions of the rocket the gravitational field is almost uniform, and this means that all particles of the rocket simultaneously apply equal forces. Because of gravitational forces belong to the so-called mass forces, ie

forces which are applied simultaneously to all points of the system.

Thanks to all the rockets simultaneously receive the same acceleration, and any interaction between them disappears. No response support no pressure on the bearing. There comes a state of complete weightlessness.

Not really usually must take place in conditions of weightlessness, and some physical processes. Even Einstein long before space flight has put a curious question: will the candle burn in the cabin of the spacecraft?

The great scholar replied in the negative — he believed that due to zero gravity the hot gases will not escape from the zone of the flame. Thus, the access of oxygen to the wick will be barred, and the flame goes out.

However, meticulous modern experimenters decided to test Einstein's assertion on experience. In one of the laboratories was a pretty basic experiment. A burning candle placed in a closed glass jar, dropped from a height of about 70 m. the Falling object in the gravity (disregarding air resistance). However, the candle is not extinguished, only the shape of flame — he became more spherical, and they emitted the light became less bright.

Apparently, it's all about the diffusion, through which oxygen from the environment gets into the flame zone. Because the diffusion process does not depend on the action of gravity forces.

Still, the conditions of combustion in zero gravity other than the Earth. This fact had to consider the Soviet designers, who created unique welding machine for carrying out welding in microgravity.

As you know, this device was tested in 1969 on the Soviet spaceship "Soyuz-8" and worked successfully.

As you know, day and night — a direct consequence of the daily rotation of the Earth. Turning on its axis, our planet in every moment of the framing beams of the Sun only half of its surface...

Because of this of the time people have to spend in the dark, to spend enormous amounts of energy resources on night lighting and streets.

Can't even get rid of the night?

In recent years this account has been promoted a number of original projects. Most of them are still fiction, but in principle after some time they can be

implemented. So what are these projects?

One of them is to set on an artificial Earth satellite "hydrogen Sun", i.e. the controlled thermonuclear reactor, which would occur adjustable reaction of synthesis, i.e. combining the nuclei of hydrogen atoms, similar to the one which occurs in the depths of the Sun. As if such a reaction develops temperatures of millions of degrees, fusion reactor really could serve as an artificial source of light and heat. In this orbit, the satellite could be chosen so that the artificial Sun appeared mainly on the night parts of the earth's surface or the longest time was moving over the polar regions. Then it would be possible to eliminate the long polar night and at the same time to insulate the Arctic and Antarctic.

Technically such a project yet, of course, is not feasible: not yet solved the problem of a controlled thermonuclear reaction. But after it is solved, apparently, it will take time before scientists and engineers will learn to create artificial "hydrogen of the sun", which could be installed on satellites.

There is another ingenious project, which is based on the use of artificial Earth satellites. But these satellites should not be a spacecraft, "stuffed" unique equipment, and... lots of dust particles, delivered in near-earth space with special missiles. As a result of such operations around the planet would appear to be a huge dust ring, somewhat reminiscent of the famous ring of Saturn.

"Capturing" those Sunny rays that are now held by the Earth and lost in space, and scattering them in all directions, dust particles will direct part of the solar light and heat to Earth. Due to this, the night will disappear, and the climate of our planet will become much warmer.

Now it would be possible to count the number of dust particles required to create the desired effect and what should be the size, position and density of the dust rings. But it is, so to speak, the "technical details".

Probably there are other possibilities of partial or complete liquidation of the night. Over time, should be, there will be such projects that can be implemented relatively simple means.

But the question is, can such projects in principle? We are talking about challenges is not technical, and, so to speak, "natural" character.

Elimination night is a radical change in normal heat and light conditions,

climate change of our planet, in particular, a significant increase in the amount of solar energy coming to the Earth. Meanwhile, sustainable natural formations, similar our planet is a complex self-regulating system, which is naturally supported sustainable dynamic equilibrium. Artificial interference can cause undesirable phenomena of a catastrophic nature, to raise the level of seas and oceans, disturbance of the water cycle and atmospheric circulation, unfavorable for humanity of climate change.

In addition, one cannot ignore that the vast majority of living organisms on the Earth for many millions of years have adapted to the existing rhythm of day and night. The sudden sharp violation of this rhythm can cause some very undesirable and even disastrous phenomena in the world of animals and plants.

This does not mean that people will never take the offensive at night and winter cold, but this attack should be preceded by a thorough scientific training.

The famous Roman philosopher Seneca said that if the Earth was only one—the only place from where one could watch the stars, to this place from all sides a continuous flow flocked people would...

Seneca thus wanted to emphasize the extraordinary beauty, the greatness and uniqueness of the painting starry sky. Night pearl shimmering scattering on the background of the bottomless blackness of space — the spectacle is really impressive. But is it only spectacle, whether systematic observation of the sky of any practical importance to mankind, or people absolutely could do without them?

To answer this question, imagine for a moment that the earth, the sky completely overcast completely opaque veil of clouds, absolutely excluding the possibility of observation of the stars.

At first glance this assumption may seem too far-fetched: after all the stars that we see... But it will help us to better appreciate the significance of astronomy for the development of mankind.

In addition, the situation in question, not so fantastic. After all, the cosmic body, of which the sky is covered with clouds, do exist. One of them is our space neighbour planet Venus. Eventually, perhaps, people will have to live and work on such celestial bodies. It is possible that in the Universe there are

lots of intelligent civilizations living on the planets cloud...

So, the Land without stars...

Man enjoys the Sun... People tend to blossom into a smile at the sight of shining blue sky, playing in the water, the sunlight, sparkling in the sunlight of spring foliage.

And now, nothing. No blue sky. No sun glare. There are no stars, no moon. Consistently overcast sky. Eternal gloom of the dull dull days. The monotonous rain that seems to never end...

On Earth there are areas where very few Sunny days. And they say that the inhabitants of these places almost never smile. What would happen to people if they did not know of the Sun?

The man — a child of the environment... For many millennia his body was formed under the influence of the environment, those physical conditions that really exist on Earth. These conditions determined the peculiarities of the structure of the human body and its sensitivity to certain light rays, the structure of the hearing aid, etc. But there is no doubt that they left a definite imprint on the psyche of the people.

Here, we are entering a rather precarious area of the guesswork. However, it seems that if for centuries people from generation to generation saw above their heads the sky a monotonous grey, and one dark day as two drops of water resembled the other, may very well the spiritual potential of humanity, so to speak, would have been different, people would be less viable, less optimistic. But again, this is only more or less probable hypothesis.

But what cannot be doubted: the conception of the surrounding world at the beginning of the development of mankind would have been even more vague and mystical than in the real history of human civilization.

Recall, for example, how people know that they live on a globe.

The most convincing proof was obtained by observing lunar eclipses. After all, with this heavenly phenomenon we see on the moon, as if on a giant screen, the contour of the earth's shadow. It has been observed that this path always, for all the eclipses, is a circle. But the ball is in any position to cast a "round" shadow.

However, there is another proof: the gradual disappearance of the receding

objects in the bulge of the Earth. But on land, this phenomenon is not very convincing: it is always possible to explain the uneven terrain. Remain Maritime surveillance. Eternally cloudy sky could not stop people pay attention to the disappearance of ships over the horizon. But in order for this fact to jump to the conclusion about the sphericity of the Earth, it was necessary to compare the results of similar observations made in various parts of the world, it was necessary to ensure that the Land is "convex everywhere."

And this requires communication between the continents, a sea voyage. But they are in the absence of the stars would be very difficult. How to go to the ocean or open sea, not being able to determine their location, to verify the correctness of the course? After all, earth's explorers have long been used for this purpose, the help of stars.

However, to what extent it would be possible to focus on the location of the morning and evening dawns. As you know, even in cloudy weather, the Eastern sector of the sky is getting lighter earlier in the morning, and West branch in the evening it gets dark later than the rest of the sky. The number of observations would figure it out.

Living in a cloud Land, people would not know that there are phenomena connected with sunrise and sunset, but watching the morning and evening sunsets from generation to generation, people in the end would have noticed that they obey certain laws. We can assume that sooner or later would be made a special table that takes into account the offset zarevich sectors with the change in time of year and even with the movement of the observer on the Earth's surface. But unfortunately, the orientation according to the observations of dawn on a cloudy sky too inaccurate, as a result of scattering of sunlight by clouds is extremely difficult to determine by eye the point of sunrise or sunset (especially at a sufficiently dense and multi-layered clouds).

However, it is well known that "demand creates supply". You can think of that would have to receive special sensitive instruments for measuring the sky brightness and identification of the most vivid footage of the dawn. With these devices the accuracy of orientation would be significantly increased.

It is possible, and the magnetic compass were invented much earlier than it actually happened.

Intelligent beings living on a cloud planet, I had to solve quite complex problems associated with timing.

At the dawn of humanity, when there were invented clocks, people kept time by the Sun, and at night by the stars. Astronomical observations lay at the basis of calendars.

At cloud Earth, such observations would be impossible. But to find a way out of this difficulty would seem to be a lot easier than, say, to solve the problem of orientation. With the help of instruments mentioned, people would be able to determine the time of day watching the movement of the brightest region in the sky. In the same way they could be and calendar.

In this calendar the beginning of winter probably would be considered very short, but the beginning of summer — the longest day of the year.

We can also assume that the difficulties of counting time would be a good incentive for inventions of devices such hours than it did in actual history.

There is a concept, as if combining the main results obtained in various science — "worldview". Outlook is not physics, not chemistry, not astronomy, not biology, not math, is much more General and broad. But, on the other hand, it is difficult to imagine how could be a world without, say, astronomical knowledge. And it is in this situation and turned to the inhabitants of cloud Land.

Of course, the history of science shows that the mere contemplation of the starry sky, the movement of the Sun, moon, and planets also still not enough to make a correct view of the world. At first, the apparent motion of celestial bodies are taken for reality, illusion over reality. So the idea of a "Central Land", which occupies a dominant place in the universe, and moving around her heavenly bodies — the system of Aristotle — Ptolemy.

But, anyway, the civilization living on the cloud planet, at a certain stage of its development must inevitably face the problem of the universe.

Reaching a certain level of development, civilization requires not just the disparate information about the world, and in the "knowledge system." The system of knowledge cannot be complete unless it includes ideas about the structure of the world, of the Earth's place in the Universe.

Of course, for the inhabitants of the world of the cloud the existence of

certain external factors located outside the cloud veil, would not be a secret. After all, there would be done on Earth the life-giving light and heat. Probably at first the inhabitants of the planet cloud is exactly the same deified "light", as our ancestors once worshiped the Sun.

But building any scientific picture of the world it would be very difficult. After all, the thought of a man, even when creating the most abstract hypotheses, always starts from observable reality. Meanwhile, cloud the Earth would be much less food for thought than the picture of the starry night sky.

Copernicus came to the conclusion about the motion of the Earth around the Sun, analyzing the loop-like movement of the planets against the background stars. John. Bruno and M. V. Lomonosov developed the idea of multiple inhabited worlds, drawing a parallel between the distant lights of the stars and our sun — Sun.

Nothing like cloud-based scientists on the planet to do would. They probably tried to build various hypotheses concerning the picture of the world, but their assumptions likely would be much further from the truth than the vague guesses of our ancestors.

Undoubtedly, the negative impact would be the impossibility of observation of the Universe and the development of science in General, knowledge of the basic laws of nature.

For example, Galileo discovered his famous "principle of inertia" is largely thanks to the astronomical observations. Because the earth's daily experience does not indicate that the body on which no force can move uniformly and rectilinearly. Moreover, such an assumption is contrary to the "earthly common sense" — no wonder it was accepted with hostility by his contemporaries of Galileo. But the principle of inertia is the Foundation of all mechanics.

Of the astronomical observations he was born and this is a fundamental law of nature like the law of gravity. Of course, the "apples" would fall and cloud on the planet, but we should not forget that the ingenious conjecture of Newton was preceded by a thorough analysis of the motion of the moon around the Earth.

In any case, to discover the universality of gravitation when prolonged cloud

cover the sky would be extremely difficult. Because the force of attraction between different ground objects is so small that it can be measured only in a special very delicate experiments.

Data astronomy has become the basis for such a revolutionary theory which was the theory of relativity. As you know, one of the main provisions of this theory is a statement about finite speed of propagation of the light rays. But purely earthly experience tells us quite otherwise; any event occurs precisely at the moment when we see it. It is easy to see why this is so: the terrestrial scale is negligible compared to the distance that light runs in one second. Only observations of phenomena occurring on a cosmic scale, could destroy such an illusion.

Space has brought us many other wonderful discoveries. Here was discovered a previously unknown on Earth, States of matter and new energy sources (particularly nuclear energy).

If you carefully follow the development of many Sciences, not only physics, but also chemistry and mathematics, and even biology, we find that in many cases their achievements if not directly, then indirectly were associated with the study of the Universe.

No wonder Einstein said that the intellectual tools without which it would be impossible for the advancement of modern technology, came mainly from observation of the stars. In this sense, scientists cloud planet would be in a much worse position. Not only that, invisible from the Earth, the universe never would have harbored their fruitful ideas. In their attempts to understand what happens behind a veil of cloud, they would have had daily and hourly to conduct a much more acute struggle against the "common sense" than our ancestors.

In General, a civilization living on the cloud planet, in many ways resembled a man blind from birth. In the actual history of the study of the Universe has long played a major role in the study of light emission of the celestial bodies. no Wonder the light was called "the Herald of distant worlds". But for people world of the cloud this Bulletin practically wouldn't exist...

At the same time, we know that people are not only blind, but also deaf from birth do not lose the ability to perceive the world, but can even successfully engage in creative activities. Although audio and visual channels of

information for them are completely closed, it still flows through the other channels.

The same thing would have happened to mankind as a whole. Not being able to extract important information contained in the cosmic light, sooner or later scientists would study other messengers of the Universe and in their first waves.

Of course, to use the space channel people could only reach a certain level in the development of science and technology. It would be necessary not only to open our radio waves, but also to build extremely sensitive radio receivers.

A highly significant stage in the development of "cloud civilization" would be "exit" for a veil of cloud. We can expect that the solution to this problem would focus significant efforts.

From this point on, the development of civilization of the inhabitants of cloud planet probably would not be very different from the development of human civilization era of air and space.

Thus, despite the inability to observe stars, the mankind sooner or later would overcome all difficulties. The more modern the mankind will cope with the astronomical difficulties that arise during the development of the cloud of planets.

Imagine for a moment that the Earth would not be its natural companion. What would have changed? First of all, of course, this would affect the beauty of our earth's landscapes would disappear clear moon night, the silver tracks on the water... But this is only a purely external way. Wouldn't lunar tides, and thus changed the conditions of navigation. However, would be preserved solar tides, but they are because of the huge distance to the Sun is much weaker than the lunar.

On the other hand, the lack of moonlight would greatly facilitate many astronomical observations. It can be assumed that under these conditions, the scientists, in particular, discovering more comets and small planets of the Solar system.

It is very possible that the disappearance of the moon would have some influence on the course of some geophysical processes.

But there is another side of things, maybe not so obvious. It is worth

Recalling that the sphericity of the Earth has been proven by the shape of the earth's shadow on the moon during lunar eclipses.

When telescopic observations of the moon, Galileo found on the surface of the mountain, and thus struck the first real breach in the age-old ideas about the impassable border between the earthly and the heavenly.

That Newton in the study of the movement of the moon around the Earth finally formulated the law of universal gravitation.

The observation of the motion of the moon around the Earth was one of the first impulses that led to the idea of creating artificial satellites of our planet...

It should also be noted that with the disappearance of the moon would stop the solar Eclipse.

However, the role of the moon is not limited to its impact on the development of scientific theory. The last time the Moon as the nearest celestial body, has increasingly become a kind of polygon, which are processed and reconciled a complex operation associated with the study and exploration of outer space.

So, the Moon was the first space "radioserial", which focused on developing methods to astronomical radar. Experiments with reflection of radio waves from the lunar surface has helped to develop equipment capable of aciravati the Sun and many planets in the Solar system.

Very important role is played by the Moon, and in the development of space flight. It's not just about the possibility of creating in the future on the lunar surface the space station, but that area of the moon a practiced motion of spacecraft, which are very, very important when flying to other planets.

Thus, our night light is not only "decoration" in earth's sky. His absence could to some extent hinder the development of science and the human exploration of outer space.

In the absence of the moon will greatly weaken the phenomenon, called precession. As you know, our Earth, with a daily rotation has a slightly flattened shape — it is a polar radius about 21 km shorter than the Equatorial. Thus, due to the rotation of the substance of the Land redistributed — some of it as shifted from the poles to the equator, forming a kind of Equatorial bulge. The effect of lunar gravity on that ledge (as well as the attraction of the Sun and planets) leads to the fact that the axis of rotation of our planet in

approximately 26 thousands of years, describes in space a cone, recesserunt. The vertex angle of the cone is about 47 degrees. Therefore, the current North star was not always polar not and it always will be. For example, after 13 millennia, the path to the North of our descendants will point to the bright star VEGA of the constellation Lyra.

Although the mass of the moon is small compared to the mass of the planets and the Sun, we should not forget that the Moon is closest from the Earth. But the force of gravity weakens very quickly with distance — proportional to its square. If there was no moon, and although precession would be preserved, but the vertex angle of the cone that describes the earth's axis, would be much less.

Causing the precession of the Moon due to some peculiarities of its movement, and makes it certain periodic deviations, known as nutation and has a 19-year period. With the disappearance of the moon completely disappeared and nutation.

I have to say — we are talking about the possibility of time travel, i.e., travel back in time against his normal running and subsequent return to the present.

First, we will not discuss the purely physical side of the issue, and try to imagine what would happen if time travel really were possible, what would happen.

The famous contemporary American writer ray Bradbury is a small, but very instructive and fantastic story. Travel Desk arranges for its clients — lovers of hunting tourism unusual voyage: through time machine it sends them to the distant past. A fantastic opportunity to shoot a live dinosaur!.. However, "travelers in time" are obliged to strictly adhere to the same mandatory conditions. They are allowed to kill only a certain amount of lizard that is exactly specified in advance by the Agency employees. Travelers must not interfere in any events of the ancient world, to change anything in it.

But somehow, one of the hikers has violated the prohibition. Exiting especially with the track, which had to move around the city, he had inadvertently stepped on some butterfly and crushed it. Of course, none of the hunters did not attach a trivial incident of no importance. But when tourists have returned in our time, they saw with amazement that things in the world around them changed.

As you know, everything that happens in nature phenomena is a continuous chain of causes and effects. Going back to the past and interfering in the running of any events, changing them, we inevitably would cause some changes in the subsequent causal chain of events. That's why the staff at the travel Desk in the story, Bradbury makes it clear to hunters for the shooting of a certain dinosaur. They chose the lizard, who after a few minutes, still had to die. Thus, a causal chain of events did not undergo any changes.

Of course, you can argue about the extent to which crushed one of the characters in the story Bradbury butterfly could affect the future of humanity. But if travel into the past through vehicles such as "time machine" were really feasible, it is possible arbitrary action "tourists at the ancient epochs", in principle, could cause very serious violation of a particular causal series.

For example, in some of the XI century travellers in time in a skirmish with the natives killed a young man. And he's in the "normal" course of events would have been children... But after the intervention of aliens from the future these children are already in the light will not appear. Therefore will not appear and all their descendants.

But then the present will have to disappear tens or even hundreds of people for whom the victim was the direct ancestor -- They just disappear, so to speak, will completely dissolve in time, as the chain of causes and effects that led to their birth, will be withdrawn one link...

Exactly the same could disappear not only people, but also works of art, buildings and even entire cities.

Yes, not very cheerful life would come to humanity if there were a time machine and irresponsible adventurers let them gallop in different eras. We would live in a constant state of fear that someone or something can disappear. On the other hand, travelers in time not only would destroy the separate causal series, but also created new, and in our reality could suddenly be absolutely unexpected "objects"...

The famous American scientist and science fiction writer Isaac Asimov is an interesting novel "End of eternity", devoted to discussion of possible consequences of displacement in time. It describes the work a kind of "intertemporal" of owning methods of time travel, were engaged in "correcting" and "improving" reality.

Find any negative events that took place in real human history, the experts carefully studied the root causes and corrected them in such a way that unwanted effects of these causes does not occur. Accordingly changed and the memory of humankind, from which all sorts of memories of the same events completely disappeared.

Although these actions seemed to be aimed to improve people's lives, they, as expected, ended in a complete collapse, because it is impossible to make mankind to live on some designed "scenario", especially by the means of simple intervention in the causal series. History is history, and although certain accidental circumstances play her famous role, yet its progress is mainly determined by objective laws, paving the way through any accident. In order to influence events on a global scale, it would be necessary not only to reshape the entire history of mankind from beginning to end, but to change the laws of social development.

But this is the philosophical side of the issue. Back to the physics. How to apply this science to the possibility of time travel to the past? She simply denies, just as it prohibits the creation of a perpetual motion machine.

Any event occurring in the physical system, according to modern theoretical physics, can influence the evolution of this system only in the future and cannot influence the behavior of the system in the past.

This is the physical version of the universal principle of causality requiring that every phenomenon has a natural cause.

On the other hand, it is possible to imagine, although it is not easy that somewhere in the Universe there are areas where time flows in reverse direction in comparison with our time. And this could be used to travel into the past, at least in recent (and if the rate of flow of time in the areas of more rapid, and far). But to do this would be twice to make the transition from the "Tu" and Vice versa.

Although this question is still not completely studied, it is possible to say in advance that for such transitions the laws of physics, in all likelihood, impose similarly stringent ban, as well as to direct travel into the past.

It is widely believed that the theory of relativity does not allow superluminal velocities. Is it really so? Can do from the point of view of modern theory exist in nature, speed, surpassing the speed of light? Here's how to answer

this interesting question A. L. Zelmanov.

Indeed, from the point of view of the theory of relativity there is a certain fundamental speed C , which is the greatest possible velocity of propagation of any law enforcement interactions. What is its physical meaning?

The fact that the velocity with which one object moves in relation to different reference systems, generally speaking, are not the same. On one system, the object may rest, in relation to another — move with small speed relative to the third big. In Newtonian mechanics there is such a speed, the magnitude of which are identical in all reference systems, but it is infinitely large velocity. This speed is only the limit. Any real object can only move with a finite speed. However, in Newtonian mechanics the speed of the motion of bodies can in principle be arbitrarily large.

In relativity theory, too, there is a case where the value of the velocity does not depend on the choice of the reference system. It happens when the body moves with velocity equal in magnitude to the fundamental.

Thus, the fundamental speed of the theory of relativity — an analogue of the infinitely large speed of Newton's mechanics.

From the point of view of the theory of relativity any movement of mass and energy, any transfer of force interactions can occur only at speeds not exceeding fundamental.

There are objects with rest mass not equal to zero — they move only with velocities less fundamental, and objects whose rest mass is zero (photons and neutrinos), they can only move with the fundamental velocity.

And yet, it may seem strange and paradoxical, there may be speeds that exceed the fundamental. One example of such a velocity may be the velocity of the light rabbit on the wall. It can be made to move with an arbitrarily large speed. But it's just the speed of movement of the illuminated area on the surface of the wall — no movement of matter or transfer of interaction with such speed takes place.

Now try to clarify what is generally the speed of any object. It is always a speed with respect to a particular reference frame. Moreover, with respect to the point of this system, through which the object currently is. Talking about the speed of movement of the object relative to any other point which is at a distance, or in relation to another object that existed in a different era, strictly

speaking, does not make sense.

What in this case represents the speed of a galaxy relative to the earth observer? Obviously, such a thing especially makes no sense since we are separated in space and in time.

What is the speed in this case, it is still possible to speak? Only on the speed of the galaxy relative to any specific reference system covering the region and the epoch in which we exist, and that area and that era, which was the galaxy at the time of exit of the light beam. But such a reference system can be build in different ways. Among the possible options we choose such a system, against which our own speed is zero. Then the velocity of other galaxies will obviously depend on deform if our frame of reference over time, and if deformed, then how. It would be natural to choose "hard", non-deforming frame of reference. But this is impossible, because it would result in mutual removal of galaxies changes the density distribution of the masses, and therefore the geometry of space.

Let's try in this case to choose a reference frame which is not deformed at least in radial directions from the point in which we ourselves are. In the homogeneous and isotropic Universe it is possible. In relation to this frame of reference the velocity of the galaxies is non-zero and the magnitude is always less than the fundamental. And these speeds are clearly, however, the rates of change of the distances between receding galaxies, and the point at which we are.

But in theory it is more convenient to use the deformed reference system associated with the expanding system of galaxies, i.e., such system of reference in which the velocity of all the galaxies is zero (if we neglect the relatively small speeds, erratic movements). In accompanying frame of reference the distance between galaxies do not change as a result of their displacement with respect to this system, and due to the deformation (expansion) of the system of reference.

These rate of change of the distances between galaxies can be, like the speed of the Bunny on the wall, and more fundamental.

But they are not the velocity of any material object.

However, it is as if there is quite a paradoxical situation. It turns out that in the first reference frame the rate of change of distance between the galaxies is

always less than the fundamental and the second system are the same speed may be more fundamental.

But this contradiction is apparent. The fact that the distance between any two objects, and the rate of its change is of magnitude, depending on the reference system.

If four?

It is well known that the world in which we live is three-dimensional. The space around us has three dimensions — length, width and height.

Well, if our world had more than three dimensions? How would the "extra" dimension for various physical processes?

On the pages of modern science fiction quite often you can meet with almost instant overcoming the huge distances of space using the so-called "zero-transfer" or go through "hyperspace" or "subspace" or "neprosteno".

What mean science fiction? It is well known that the maximum speed with which can move any real body, is the velocity of light in vacuum, and that it is almost unattainable. What kind of "races" through millions and hundreds of millions of light-years can be a speech? Of course, this idea is fantastic. However, it is based on a rather interesting physical and mathematical considerations.

To begin with, let us imagine a one dimensional being-the point of living in a one-dimensional space, i.e. in a straight line. In this "small" the world has only one dimension — length and only two possible directions — forward and backward.

From two-dimensional imaginary beings, "the flat plane men", significantly more features. They can move in two dimensions, in their world in addition to length, there is also width. But they just are not able to go into the third dimension, as beings-point can't "jump" outside its direct lineage. One-dimensional and two-dimensional inhabitants, in principle, can come to the theoretical conclusion about the possible existence of a larger number of measurements, but the path to the next dimension closed to them.

On either side of the plane is a three-dimensional space in which we live, three-dimensional creatures, unknown to a two-dimensional inhabitant, a prisoner in your two-dimensional world: after all, even he can only see within

their space. Consequently, the existence of a three-dimensional world and its two-dimensional inhabitants resident could know only in case, if some people, for example, the punctured plane with your finger. But then the two-dimensional being could observe only two-dimensional contact area between the finger and the plane. It is unlikely this would be enough to make any conclusions about "the other side" from the point of view of the resident two-dimensional, three-dimensional space and its "mysterious" inhabitants.

But precisely the same argument can be made for our three-dimensional space if it is placed in some even more extensive, four-dimensional space, just as a two-dimensional surface enclosed within it.

However, find out first what actually is a four-dimensional space. In three-dimensional space there are three mutually perpendicular "core" measurements — "length", "width" and "height" (three mutually perpendicular directions of the coordinate axes). If these three areas could add a fourth, also perpendicular to each of them, the space would have four dimensions, it would be four-dimensional.

From the point of view of mathematical logic reasoning about four-dimensional space absolutely perfectly. But in itself it proves nothing, because logical consistency is no proof of the existence in the physical sense. Such proof can only give experience. But experience shows that in our space through a single point can hold only three mutually perpendicular straight lines.

Refer again to the help of "flat plane men". For these beings of the third dimension (which they can't come out) is like our fourth. However, there is a significant difference between a flat imaginary beings "flat plane men" and us, the inhabitants of three-dimensional space. While the plane is two-dimensional part of a real three-dimensional world, all available scientific data clearly show that the world in which we live, geometrically three-dimensional and is not part of a four-dimensional world. If such a four-dimensional world really exist in our three dimensional world could happen some "strange" phenomena.

Back to the two-dimensional flat world. Although its inhabitants and can't get out of the plane, all the same, thanks to the external three-dimensional world, some phenomena are, in principle, can proceed with access to the third dimension. This circumstance, in some cases, makes possible processes that,

in and of itself in a two-dimensional world could occur.

Imagine, for example, drawn in the plane of the ordinary dial of the clock. Whatever ways we rotated and moved the dial, while remaining in the plane, we'll never be able to change the direction of the arrangement of figures so that they follow each other counterclockwise. This can be accomplished only by "removing" dial out of the plane in three-dimensional space, turning it, and then returning into our plane.

In three-dimensional space, these operations would correspond to, for example, such. Whether the glove is designed for right-hand, by mere movements in space (i.e. not twisting inside) to turn into a glove for the left hand? Everyone can easily verify that this operation is not feasible. However, if you have a four-dimensional space of this could be achieved as simply as in the case of a dial.

We don't know the output in four-dimensional space. But not only that. It probably doesn't know and nature. In any case, any phenomena that can be explained by the existence of four-dimensional world encompassing our three-dimensional, we do not know.

What a pity!..

If four-dimensional space and output it really existed, it would open amazing possibilities.

Imagine "plasmatica", which needs to overcome the distance between two points of the flat world, separated from each other by, say, 50 km. If the "plasmatic" moves with a speed of one meter per day, the journey will take more than a hundred years. But imagine that a two-dimensional surface folded into three-dimensional space in such a way that the start and end points of the route were from each other at a distance of only one meter. Now they are separated from each other a very small distance, which is "plasmatic" could be overcome in just one day. But this meter lies in the third dimension! It would be a "zero-transportation" or "coming through".

A similar situation could arise in a curved three-dimensional world...

As shown by General relativity, our world really has a curvature. This is what we already know. And if there was still a four-dimensional space, in which submerged our three-dimensional world, to overcome some giant cosmic

distances would be enough to "jump over" share their four-dimensional crack. That's what mean science fiction writers.

These are the seductive benefits of the four-dimensional world. But he has "shortcomings". It turns out that with increasing number of measurements decreases the resistance movement. Numerous studies show that in two-dimensional space, in General, no amount of outrage can't upset the balance and remove a body moving along a closed path around another body, to infinity. In space of three dimensions the limits are much weaker, but still here, the trajectory of a moving body does not go to infinity, unless the exciting force is not too large.

But in four-dimensional space all circular trajectories become unstable. In this space, the planets could not revolve around the Sun — they either fell on it or got out into infinity.

Using the equations of quantum mechanics, it is also possible to show that in the space having more than three dimensions could exist as a stable formation, and the hydrogen atom. There would be the inevitable fall of the electron to the nucleus.

Adding a fourth dimension would change and some purely geometric properties of space. One of the important branches of geometry, which is not only of theoretical but also of great practical interest is the so-called theory of change. We are talking about how to change various geometric shapes in the transition from one coordinate system to another. One of these types of geometric transformations is called conformal. So called transformations that preserve angles.

More precisely, the situation is as follows. Imagine a simple geometric figure, say a square or a polygon. Put on arbitrary grid of lines, a kind of "skeleton". Conformal, then we call such a transformation a coordinate system in which our square or polygon will pass to any other figure, so that the angles between the lines "skeleton" will be saved. A good example of conformal transformations can serve as the transfer surface of the globe onto a plane — that it builds the map.

In the last century mathematician Riemann showed that any flat solid (i.e. without holes, or, as mathematicians say, *odnotsvetna*) the shape can be conformally transformed into a circle.

Soon, a contemporary of Riemann, J. Liouville proved another important theorem that not every three-dimensional body can be conformal to convert into a ball.

Thus, in three-dimensional space the possibilities of conformal transformations is not so wide as in the plane. The addition of only one axis of coordinates imposes on the geometric properties of the space very stringent additional constraints.

Is it because the real space three-dimensional, not two-dimensional or, say, *patierno*? Maybe just the fact that the two-dimensional space is also too freely, and the geometry of five-dimensional world, on the contrary, too rigidly "fixed"? But really, why? Why is the space in which we live, three-dimensional, not four-dimensional or *patierno*?

Many scientists tried to answer this question, based on General philosophical considerations. The world must have perfection, argued Aristotle, and only three measurements are able to provide excellence.

However, specific physical problems can't be solved with similar techniques.

The next step was taken by Galileo, who noted he experienced the fact that our world can exist at most three mutually perpendicular directions.

However, investigating such things Galileo did.

To do this, Leibniz tried using purely geometric proof. But this way is ineffective because this evidence was built speculatively, without communication with the outside world.

Meanwhile, a number of dimensions is a physical property of the real space, and it must have definite physical causes, be the result of some deep physical laws.

It is unlikely that these reasons can be derived from any of the provisions of modern physics. After all, the property of three-dimensional space lies at the very Foundation, the very basis of all existing physical theories. Apparently, the solution to this problem will be possible only in the framework of a more General physical theory of the future.

And finally, the last question. In the theory of relativity is talking about the four-dimensional space of the Universe. But it's not exactly the four-dimensional space mentioned above.

Let's start with the fact that four-dimensional space the theory of relativity is not an ordinary space. The fourth dimension here is time. As we have said, the theory of relativity has established a close relationship between space and matter. But not only that. It turned out that directly linked also matter, and time, and consequently, space and time. Due to this dependence, the famous mathematician G. Minkowski, whose work formed the basis of the theory of relativity, said: "Henceforth space itself and time itself must become shadows, and only a special kind of combination will retain independence." Minkowski suggested to use for mathematical expressions based on space and time conditional geometric model, four-dimensional "space — time". In this conditional space in three main axis, as usual, the interval length, the fourth axis — time intervals.

Thus, four-dimensional "space — time" relativity is only a mathematical technique that allows in a convenient form to describe various physical processes. So, to say that we live in four-dimensional space, only in the sense that all events in the world occur not only in space but also in time.

Of course, in all mathematical constructions, even the most abstract, reflected some part of objective reality, any relationship between actually existing objects and phenomena. But it would be a gross mistake to put an equal sign between the auxiliary mathematical apparatus, as well as used in conventional mathematics terminology and objective reality.

In light of these considerations, it is clear that the claim citing the theory of relativity, if our world is four-dimensional, approximately the same as to defend the idea that the dark spots on the moon are filled with water, on the grounds that astronomers call them seas.

So "zero-transportation", at least at the present level of development of science, unfortunately, feasible only in the pages of fantastic novels.

We already talked about the fact that our region of the Universe — Metagalaxy is expanding and the farther one or the other galaxy, the faster it is removed from us.

However, the equations of relativity allow also another opportunity compression.

Does the fact that the Metagalaxy that is expanding, not shrinking, as something of fundamental importance?

Let's try to answer the question: what would happen if the Metagalaxy was compressed? Would change anything in the picture of the world around us?

At first glance it may seem that nothing much would happen. No one would have noticed, only astronomers is the red shift would be observed violet. After all, the galaxy is separated from the Land of huge distances of millions and billions of light years.

However actually all is far not so simple... let's Start with the seemingly simple and even somewhat naive question: why is night dark? In fact, this is a very serious problem, which played a significant role in the development of scientific ideas about the Universe. She entered the history of astronomy called the photometric paradox. It consists of the following.

If everywhere in the Universe of scattered stars, which on average emit approximately the same amount of light regardless of whether they are grouped in the galaxy or not, they would cover their discs the whole celestial sphere. Because the Metagalaxy consists of many billions of stars, and, wherever we directed my eyes, it almost certainly will sooner or later come up against any star.

In other words, each area of the night sky would glow like a part of the disc of the Sun, since in such a situation, the apparent surface brightness is not dependent on distance. From the sky we fell would be dazzling and hot stream of light corresponding to a temperature of about 6 thousand degrees, almost 200 000 times longer than the light of the Sun. Meanwhile, night sky black and cold. What's the matter?

In his time attempts were made to eliminate the photometric paradox with reference to the absorption of light scattered by the interstellar matter. But in 1937, the Soviet astronomer V. G. Fesenkov showed that it does not help the situation. Interstellar matter is not so much absorbs the light of stars, how many scatters it. Thus, the situation is even complicated.

Only in the theory of expansion of the Metagalaxy photometric paradox is eliminated automatically. As galaxies scatter in their spectra, as we already know, red shift of spectral lines. As a result, the frequency, and hence the energy of each photon is reduced. Because the red shift is a shift of electromagnetic radiation towards longer wavelengths. And the larger the wavelength, the less energy it carries with it a radiation, and the farther the

galaxy the greater the red shift, and hence the more weakened the energy of each incoming photon to us.

In addition, the continuous increase of the distance between the Earth and the receding galaxy leads to the fact that each photon is forced to overcome a few bigger way than the previous one. Due to this, the photons enter the receiver less frequently than they are emitted by the source. Therefore, decreasing the number arriving per unit time of photons. This also leads to a decrease in the number of incoming per unit time of energy.

Consequently, the red shift reduces the emission of each galaxy, and the stronger, the further it is from us. Thus, because of the red shift is not only the movement of radiation in the lower frequency area, but also the weakening of its energy. That is why the night sky is black.

Here we come to the answer to the question: what would happen if the Metagalaxy was compressed?

If the compression has already lasted for at least billions of years, instead of the red shift in spectra of galaxies observed would be purple. The shift of the radiation would occur in the direction of higher frequencies, and the brightness of the sky would not be weakened, but rather strengthened.

In such conditions in our region of the Universe life could not exist. So, we do not by chance live in rasshiryaya system of galaxies and see it red shift in their spectra.

As wittily noted by A. L. Zelmanov, we are witnessing processes of a certain type, because the processes of a different type occur without witnesses. In particular, life is impossible in the early stages of expansion and in the later stages of compression.

"You never know..." (science fiction)

Barkalov was driving at top speed, as possible a winding mountain road. Finally, the road curved into the last corner and dived down into the valley, cut straight, like a beam of light, ribbon of the railway. Barkalov pressed on the pedal to failure, and machine, vranovici forward, brought it to a stretch of highway parallel to the embankment. Back guessed rapid breathing naganawa his train.

Suddenly hearing Barkalova heard the roar of a distant avalanche. He slowed

and listened. Subsiding peals rang out somewhere ahead and to the right of the road.

— Odd, he thought Barkalov, this collapse may not cause the railway track no harm — too far away. Maybe this is all nonsense, just a harmless, purely theoretical paradox that has nothing to do with reality? But the collapse, after all, has happened! And at the same time! The probability of a random match is almost insignificant...

After the end of the seminar the academician Matveev found Barkalova in the cupboard:

— Almost lost sight of you, — said Matveev, and Barkalova thought his voice oddly flinch. I know that you are in a hurry, but I beg you, Sergey, go now to my office.

Barkalov was really in a hurry: in his pocket lay a ticket on the southern Express, which was supposed to deliver it at the observation station of the Institute, where the astronomers were going to check out one of the predicted effect. Before departure less than two hours, still had to do something and Barkalov did not want to linger. And he had decided to withdraw, citing a lack of time, but trembling voice and flashed on the face of the academician expression of confusion stopped him. It was strange that academician called him by name and patronymic, usually he didn't do it, it must be time saving. Everything else, academician Matveev was a renowned scholar, a real generator of awesome ideas, and the research considered themselves to be his disciple. And instead of politely decline the research arose from the table, leaving his unfinished Cup of coffee, and followed Matveev.

In the hallway of the second floor academician missed Barkalova forward and led, supporting the elbow, as if afraid to lose. Barkalov was surprised more.

When they reached the office, Matveev breathed a sigh of relief, at least so it seemed Barkalova, and bringing his guest to the chair opposite himself.

— I was recently on your report, Sergey, where you expounded the basics of his mathematical theories, he began without preamble. And I want to say that I think your work is out of the ordinary. You are very talented, Sergey, even more... I anticipate that this theory will not only open completely new possibilities in mathematics, but will have a huge impact on physics.

Barkalov listened, not believing his ears. What I said now Matveev, was amazing. He never praised in the eyes. Abused — often, without diplomacy and compromise. But praise the... — this case the research could not recall.

— And you should definitely bring this work to the end, continued Matveev.

— That's what I do more research, still not understanding.

The academician paused, tilting his head forward, looked askance at Barkalova.

And therefore, my dear Sergei, you have to... to keep yourself.

— Do not understand! — completely mingled, he exclaimed Barkalov.

— Well, you know what they say in the old days: better safe than sorry.

— Sorry, Rostislav Valerjanovich, do the research, you say some mysteries. What do you know about me something what I do not know?

— Here, — vaguely replied the dealer.

— Then tell me, finally, what's the matter? pleaded Barkalov, furtively casting a nervous glance at the clock.

— Here in that and a hitch that just does not work, — said mysteriously Matveev and jerk out of the chair throwing his heavy body, flickered around the room. — You know about the hypothesis of the cyclical time of the Universe?

The idea of eternal return? Schopenhauer and Nietzsche?

— Not only. During the life of Einstein Kurt gödel built a model of the Universe, for which verminophobia geodesic lines are closed. In such a Universe is periodically repeated.

But if I remember correctly — said Barkalov, — Einstein treated this work very critical.

— Eyewitness accounts on this score are contradictory, — said Matveev. But that's not it.

And as far as I remember, ' continued the research, Chandrasekhar subsequently showed that reticent trajectories in Godel's model should be discarded, based on the physical principle of reasonableness.

— Uh... my dear, — said Matveev, — this argument is not worth much. What do you mean physical intelligence? It can be understood and so, and commercials.

— What you want to say? — stiffened barcalow.

— Godlewska model, of course, untenable. Then Chandrasekhar is right. But this does not preclude the existence of cyclical patterns in General.

— Something you managed? — with interest asked Barkalov.

That's it... — somehow without enthusiasm muttered academician. — There is one design.

"Very interesting," said barcalow and looked at his watch again.

Matveev caught his eye.

— In a hurry?.. In vain. Anyway, sooner or later the universe will come back to this very moment.

— Are you serious? I was amazed Barkalov. But one thing is a theoretical model, albeit consistent, and quite another...

— And quite another reality, a reality? It you wanted to say? Come on.

And not looking at Barkalova, Matveev crossed the room and disappeared behind the door behind the Desk. Barkalova had no choice but to follow him. They passed a long, narrow internal corridor, past the thick protective lead doors and found himself in a spacious hall, completely lined with sophisticated equipment.

The academician stopped in front of the console with numerous buttons and control screens, and expressively looked at her guest.

— Impressive! said barcalow. — But please note, I'm a pure mathematician and in all this technique did not make sense. And I should warn you, about me go anecdotes as young Paulie: say that when I appear in the lab, all the instruments themselves fail. So beware, Rostislav Valerjanovich!

— Doesn't matter — strange voice said Matveev. They already worked. And without giving Barkalova to recover, continued in quite a different tone: — Sergey, you are going to go somewhere. I'm asking you to cancel this trip.

— But why? — mechanically asked Barkalov and then trailed off: where

Matveev could know about his trip?

Why? — said the academician. — You can take my word for it?

— Excuse me, Rostislav Valerjanovich, I never believed in divination.

— But are you really going to leave?

— I'm not secret about that. In about an hour.

— By train? In a southerly direction?

— Rostislav Valerjanovich, if it's some kind of joke, but now...

— Please answer my question — he asked the academician.

— Yes, a train... Yes, to the South, — hardly constraining irritation, said the research.

— Now, my dear, — said firmly demand you're not going anywhere.

— What's the joke, Rostislav Valerjanovich? — boiled Barkalov. You catch me at the buffet, not just the power to bring into the office, and start talking about cyclic models of the Universe, and then demonstrate some kind of incomprehensible to me equipment and in the end demand that I abandoned the planned trip. Agree that all this is at least strange.

— M-Yes... — sigh Matveev. — Require explanation? And I just wanted to avoid them.

But, Rostislav Valerjanovich, if it's about me, can I know what's going on?

In other cases, it is better not to know.

— And you say it? I was amazed Barkalov. — Another mystery! Are there too many mysteries?

— You just mentioned about divination and prophecies... So, all that I know, too, if you like, a kind of prophecy. Like, do I look like a prophet? — I portrayed a smile, but his eyes remained serious.

— So, my dear Sergey Nikolaevich, — Matveev has continued, — have you ever heard about self-organizing projections? Some of the predictions come true, precisely because they were made. Remember the legend of Oedipus? And I don't want to have my prediction came true... Well, you and then insist?

"Of course," said the research. — Once you have begun, say to the end.

— Well, — said with a sigh Matveev — then listen to this: if you do not cancel your trip, then you can expect a lot of trouble... one word... death.

The unexpectedness of the research started. On the back ran cold down my spine.

— What nonsense? — he muttered. — How do you know?

Matveev nodded in the direction of the equipment:

— I saw...

Wait — the research turned pale. — You want to say?...

— Yes, this setup allowed us to look at the preceding cycle, in the neighborhood of the corresponding space-time point. We tried to scan all the coordinates, but the instrument is still not perfect and the images turned out unclear and blurry. However, to see something succeed.

And this?..

Why would I otherwise know that you are going to leave, and even train in a southern direction?

And can you show me the video? — quietly asked the research.

— Maybe not worth it? Not so nice to see... Well, you know what I mean.

— No, — said firmly Barkalov, I need to see.

"All right," wearily replied the dealer. — Then look at the screen. — He pressed a button on the remote

The matte surface of the screen was filled with swirling blue-pink mist. Then it was gone and in front of Markelovym opened a window into another world...

The research found out the building of the Institute, a conference hall, which was some kind of meeting, including sitting at a table on the stage were scarcely recognized a familiar face. Then the image started shifting and it became impossible to distinguish anything. When the screen cleared again, it flashed the mountains, then the plains — along the railway track the train moved. These shots again gave way to mountain scenery, but suddenly the screen redraw rapid avalanche collapse. Giant boulders, destroying

everything on the way rolled down, dragging the new wreckage. For some time the glowing surface of the screen is filled with interference, and when they ceased, there was a terrible picture of a train crash, or rather its consequences: warped, perched on each other cars, shattered mound, here and there the bodies. The image was enlarged and became visible to the person lying on the ground people...

Matveev pressed another button and the image froze into immobility. Barkalov almost brings her face closer to the screen. In the center of the frame he saw himself. Double Barkalova lifelessly in his arms, was lying at the edge of the embankment, crushed by fallen down to the side of the wagon.

— When that was? with difficulty, exhaled Barkalov, immediately realizing the irony and absurdity of his question.

However, Matveev calmly answered academic tone:

— About thirty or forty billion years ago.

— So I already existed? asked shocked Barkalov.

And it is possible that even countless times.

Although the research was a pure mathematician, accustomed to operate the most incredible abstractions, now he could not recover. Maybe it is because in this case deliberately abstract suddenly appeared inevitable and harshly real. And because this is the real is most directly concerned him.

To regain ground, he needed to understand the situation from different perspectives, try to link it with the usual ideas:

Still very weird to know that you have many times existed, many times lived on the Earth. But so far none of us have anything like that in any way is not felt.

— Perhaps it and not absolutely so, — said Matveev. — It is possible that some signals from the past to us still came. But we were not able to understand them.

— M-Yes — said the research, still getting used to what I have learned. Therefore, it turns out that I have several times killed in a train accident?

Matveev vaguely shrugged his shoulders and mumbled something

unintelligible. For a while there was silence. Academician anxiously followed Markelovym. But he had control of himself so much that regained the ability to reason:

— In the old days people said, from the fate no escape... there's no escaping. It turns out, the way it is. We only repeat what has repeatedly happened, as actors, playing constantly the same play?

But talked of something else, — said Matveev. — You never know what will happen, many troubles could have been avoided. And therefore appealed to all kinds of oracles and astrologers. But, alas, these people could not know about the future.

"And now," grinned the research, and there was an Oracle, able to read the future in the past. Have you thought about what will our lives be now that we all know?

To know we may be far from everything. We are able to obtain information only about those events that are in nearest neighbor space-time point of the previous cycle, corresponding to the moment of observation. But something we really can know now in advance.

— But to what end?

— You surprise me, Barkalov, dryly replied the academician. Knowing that a trip to the southern Express is threatening you with death, you can go and not go. Very simple!

— I never thought — confessed Barkalov. — Not if I call thus some paradox that, even, God forbid, will lead to the death of the Universe?

— The fact that in the model that we calculated and fairness which, as you can see, confirmed by experiment, the behavior of world-lines is subject to statistical laws. And ruled by probability, as you understand, any significant deviation from the average values.

— So picture of the evolution of the Universe in different cycles are not completely identical?

— Within certain limits.

— And you tried to figure out the nature of these deviations? What causes them to spawn? Fluctuations?

— Random disturbance significant role to play. The calculations show that such perturbations, so to speak, rather quickly "die" over time.

Now Matveev spoke deliberately lectures voice answered questions after any scientific report. He was clearly trying to make the conversation less concrete to smooth it a striking impression, which made Barkalova his message.

— Natural disturbances? — asked with surprise Barkalov. Sorry, I don't understand. And can there be any other?

— As we found out, a steady deviation of world lines occur only in those regions of space-time, where there is a sharp decrease in entropy, it is extremely unlikely under purely natural processes.

— Must be I got stupid for the last hour, then barcalow. — I still don't understand.

— I mean that to create an unlikely condition, accompanied by a sharp decrease of entropy in some area, capable only of a rational being. In this case, we are with you.

— Ah here you about what... in Other words, I was lucky. Thanks to your theory and your installation, I had the opportunity to escape?

— You've already saved, smiled Matveev showing on the clock. Express went twenty-seven minutes ago.

Barkalov jumped:

— Went?... But Rostislav Valerjanovich!.. Because on the train people!

Matveev pale and changed countenance.

— Imagine, on this side, I just wasn't thinking. Did not occur — the thoughts were focused on you.

— You can designate the area of the disaster?

— Up to three hundred kilometers in diameter. See map — center zone in the thirty-seventh patrol.

— We can make it!

— Sergey Nikolaevich, — ordered demand, quickly get a car and to the train station to the main Manager! I will try to use our communication channels...

While the research has reached the chief dispatcher, it was still at least an hour. Along the way he decided that nothing about cyclic models to speak to the Manager will not, because an inexperienced person go to understand something like this is absolutely impossible. So he just said that the Institute received a very strong prediction of a landslide in the area of the passage South of the Express, and asked to avoid disaster to delay for some time, the train, until he reached the dangerous area.

Chief Manager shrugged.

— I was called already for this reason your academic, but I assure you, the anxiety is completely unfounded. The track is located a known safe distance from the mountain ranges. Look at the map.

"In fact, surprised at the thought Barkalov, no collapse is not able to overcome such a distance."

— What did the academician? — he inquired.

Promised to contact higher authorities. But so far, no orders were reported. And even if I did...

Well, what then?

— You see, with the Southern Express we have no telemetry connection. It is a programmed machine — the track is simple. So no teams, we still can not pass.

— But how so?

I assure you that the system is absolutely the case. For twelve years no one even the most minor accident. The possibility of an accident is practically eliminated.

— Theoretically?

Well, except that the heavens open...

— If asunder?

— You know, one hundred percent reliability is not even in my own apartment. Some risk always remains.

"I am wasting time here, thought Barkalov, — we must catch up the Express car. If a big push, I just have time to catch him at the border zone at risk. But

we'll see..."

— Of course, we can send control helicopter, ' continued to explain the main Manager, but he can only observe. External control, as I said, this Express not. But the computer itself is able to assess any situation...

However the research it was not listening. He hastily looked at hanging on the wall of a huge scheme of a railway track, trying to remember how the motorway. Then, swiftly fleeing, up the stairs, he got in the car, and there gave full throttle...

When hearing Barkalova heard the roar of a distant avalanche, he slowed and listened. Subsiding peals rang out somewhere ahead and to the right of the road.

"Strange," thought the research. — This collapse and in fact may not cause the railway track no harm — too far away.

The road swerved, and Barcalova for a moment, opened the arrow of the railway. In the blue of the deepening evening gloom, he had noticed in the distance three of the glowing eye — lights raced after him Express. Express, which was supposed to be he himself, if not all of what happened in the last hours...

The research looked forward — where in the evening mist, a glimpse of the distant contours of the mountains. The area seemed familiar. And by pressing on the pedal, he sped on.

Now the research is moving in such a way that the distance between him and the lights of the Express remained unchanged. If the front suddenly, there will be some danger, he will have left a few tens of seconds, and he will be able to do something. However, even he had no idea how to help in such a case. But anxiety for the people who were in the train cars, and unsuspecting of danger, drove him forward.

Flashed the right sign railway crossing and Barkalow had to reduce speed and then apply the brakes: the path was blocked by a barrier.

The move was carried on through a branch, retreating from the main line to the right and closed position of the gate immediately alerted Barkalova. As soon as the main line approached, Express, the lateral branch should remain free. Under these circumstances blocked the highway barrier looked

unnatural.

Behind arose a growing rumble, and over the head Barkalova, hitting the car with a dense wave of air swept the helicopter.

— Academician Matveev works, he thought. But then Barkalov saw something he had a cold heart and the blood pounding in his temples.

On the side of the way downhill rapidly rolled To move three wagons.

— Here it is! — instantly realized the research. Somewhere in the mountains, the collapse tore a freight train and three tail of the car, gathering speed, raced now to the main path.

A glance at the lights of the approaching Express, Barkalov with ruthless distinctness imagine what will happen after a few tens of seconds. The wagons reached the main path at the very moment when the Express train will pass through the fork. Side impact and... in memory Barkalova have any TV picture — a hotchpotch of mutilated cars, the bodies...

That's just the exceptional case when the control is powerless. If a freight train was a locomotive loaded with electronics, having received the signal that the primary path is busy, he certainly would have stopped. But divorced from the whole, the cars became uncontrollable. And from the point of view of electronic control Express all right: a similar situation in her program certainly not provided...

The helicopter circled, returned and hung over fork: apparently, the pilot is also aware of an emergency situation.

But the helicopter has nothing to do Barkalov remembered the words of the Manager.

Meanwhile, the Express and freight cars has been steadily closer. Now it was clear that a passenger train to rush by in no time. Thoughts Barkalova frantically rushed to find the exit...

The decision came at a time when the dark silhouettes of the wagons quietly rose almost before the relocation; Barkalov gave gas and the car, throwing stripy strap, pulled on the crossing, blocking the path. Pop out the research did not...

The evening silence broke the screech of breaking metal. Crushing machine,

heavy wagons still continued to move. But the speed was lost. And when the cars pushing in front of him the remnants of what was until recently a high-speed car, was rolled out on the main road, the Express has managed to pass. A disaster may be performed before countless times in previous cycles of the Universe, this time was prevented...

— The research is still dead, — said the academician Matveev at the meeting of the Academic Council, but died, not meekly submitting once and for all routine course of events, and failing to intervene in the progress and change him... He did not have time to complete the construction devised a new theory. But the cost of his life he retained for the future life of hundreds of people who are able to create many times more than can be done by one person. And yet... the research proved that the course of phenomena subservient to the people, no matter what events may have occurred in previous cycles, our future depends on us. So let us be optimistic!

And in ancient Greek philosophy and in the philosophical systems of ancient India, China and the Middle East, there was a concept of "eternal return", the "circle time".

Something similar we find in some modern cosmological models. In contrast, time "starts" is considered and the option with the cyclic time, i.e., time closed "on itself".

"When we say that matter and motion are not created and not unichtozheny, — wrote F. Engels, — then we say that the world exists as infinite progress... there is still the question whether this process some — in the form of large cycles is the eternal repetition of the same or the cycles have descending and ascending branches."[8]

In 1949, at Princeton University, where he worked at the time, Albert Einstein, the famous mathematician Kurt Godel has indeed made a report "Time in General relativity", in this report he argued the possibility of closed time of the geodesic lines for a certain class of models of the Universe. Translated into ordinary language this means that under certain conditions the universe can return to its original state in the future to repeat exactly over and over again already completed cycles.

If the cyclic option is actually carried out, it practically would mean that the expansion of our Universe in the future should a change of compression to

infinite density. Then would begin a new extension, which would be the same space objects. At some stage again would be formed and our Earth, and it again would repeat the same events and would be born by the same people that would live just exactly the life that their counterparts in the previous cycle... And so an infinite number of times.

Albert Einstein attended gödel's report, but now we find it difficult to judge his true attitude toward the ideas set out. In this respect the eyewitness accounts actually differ. According to one of the greatest physicists in the debate on the report noted that the results presented here do not like him, according to others — he, on the contrary, reacted to the ideas of gödel with a certain sympathy.

Many years later, the famous physicist S. Chandrasekhar once again reviewed in detail the model proposed by gödel, and came to the conclusion that arising in her closed trajectory devoid of physical meaning. However, Chandrasekhar applied the method of "physically reasonable" choice, and such a method is always associated with random intuitive assumptions.

But, in the end, it's not even, true or false, the model proposed by gödel. Apparently, it is still wrong. Because this model is only a special case. Meanwhile, there are other models that satisfy the equations of the theory of relativity and also contain closed time line.

The fact that the situation with the return to the past, as described by gödel, it is impossible in the proposed model (this is the opinion of Chandrasekhar), does not rule out all such possibilities in the framework of General relativity. Well, of course, to prove for the General case premenopauza the impossibility of closed geodesic lines, but so far we can only say that the particular example given by the gödel was wrong...

In other words, the fact that the cyclical return to the past of the Universe is impossible in the special model, as proposed by gödel, doesn't mean one can't exist a world with closed time lines. But what it really is, you still have to prove...

Of course, a fantastic cosmological situation, constructed in the story, are largely conventional. Even if the universe really is periodically passed through the state from the same initial conditions, it is still exactly the same specific situation could be repeated. Such repetition is possible only from the

point of view of classical physics of the nineteenth century, reduced the infinite variety of the world of phenomena to purely mechanical processes, to "iron" the connection of causes and effects. However, the science of the XX century has convincingly shown that the most important role in the movement of matter play random events. They are not able to change the General orientation of evolution of matter, but due to the specific situations that arise in the course of this evolution can vary considerably even in the case when the original points of development were exactly the same physical condition.

This applies not only to inanimate nature, but also to the activities of sentient beings. By the way, in the story in such a random deviation from a "normal" course of events was the actions of his main character — physics Barkalova, significantly affecting the final result.

The small disk of the Sun sank very low on the horizon and, as always, became reddish-violet. For human eyes are all on this planet look unnatural. But worst of all were these reddish-purple sunsets, bringing the longing...

However, the Adhesive in no way oppressed. For two years their first real space duty he has not had time to lose interest in the unusual.

The glue slowly crossed the path that ran up to the base Lodge. In his hands he carried a small dark Orb, slightly larger than a pool...

The Glue finally reached the porch and heavily climbed the stairs. Panting, as if after hard work, he passed into the inner room, and shut a steel door, and dropped the ball on the floor.

The ball quivered a plaintive cry.

Ferry began to stir in his cot.

Again brought some stuff? — he drawled lazily, without turning his head.

— Oh, look at that!.. — enthusiastically said Adhesive. — So small and weighs pounds twenty five or thirty.

Aren't you tired of digging through this trash, all the same indifferent tone of voice noticed ferry, still lying against the wall.

— Trash?.. — outraged Glue. — Because it left them!

— All of this long ago investigated, in a dull voice drawled ferry. — Without

us...

— Maybe not all?

"Geez," muttered ferry. — What kind of a person.

Grunting, he turned and swung his legs to the floor:

Well...

Glue squatted down and gently held the ball with one hand, as if stroking a kitten.

The ball really looked strange. It was made of some strange material, like no metal, no plastics, and seemed transparent, but at the same time it was impossible to see what's inside. The surface of the strange Orb shimmered and shone, it appeared and disappeared vague patterns.

— See?

— So what? — shrugged, unperturbed ferry. Ball as ball.

— You are weird guy, Ferri, Glue wrinkled his forehead, and his thick dark eyebrows closed over the bridge. It was a sure sign that he gets angry. — You not catch anything, no surprise.

— And unless in the world there is something amazing? — grinned ferry. — Especially here, on this godforsaken planet, where local residents long-winded...

Glue hemmed.

— No, all long since laid out on shelves, sighed ferry. — There are no mysteries. No sensationalism... Anything that could shake the imagination.

Risky philosophy — muttered Glue— you can get into a peak state.

— Frankly, now I'm interested in one thing — cut off the ferry, how many days we have left...

Glue stretched herself luxuriously, spreading his arms to the sides and up:

— I like it...

— I was so, ' agreed ferry. — I'd like to see you after the fifth watch. All ostochertelo...

— No!

Well, well, well — a conciliatory said ferry. — Hide your ball, and it's time for dinner.

The glue was on point and the toe of his boot, pushed the ball to the corner of the room where he had piled up a whole bunch of stuff. But the ball suddenly issued a hissing sound, and, describing the floor with a few unexpected twists, intricate, rapidly dived under the bed. Ferry in two jumps he found himself at the door.

— Idiot, — he lashed out at Glue. — And if it's mine?

— Not like — calmly said Adhesive.

God knows, ' muttered the ferry, glancing warily at the bed that still came the strange hissing and crackling. — Now supposed to do with it?

When I found him first so, too, hissed. But then I calmed down.

The hissing gradually died away.

— Well, — said firmly ferry. — To hell. Excuse me, but I'll take it to the store. So it will be quieter.

He approached the bed, knelt down, carefully reached out and took the ball.

Nothing happened. Then ferry pulled the ball to himself. But he seemed rooted to the floor.

— What the hell!

He doesn't want to the store grinned Glue.

As if in answer to his words, the ball suddenly jumped up, slipped on hand at the ferry, drove up to the legs with Glue several times, as if seizes, rubbed against his boot again and slipped under the bed.

Listen, ferry, — thoughtfully asked the Glue, but what if it's...

What?

What if he's... reasonable?

— Nonsense. The inhabitants of this planet were bipedal and two-armed — human. It is well established.

I think he understands something... Better leave him alone.

— Well, — surrendered to the ferry. — Let it...

He began to collect the dinner from time to time casting anxious glances in the direction of the bed. But the ball's been quiet.

— What do we have today? asked Clay, sitting down to the table.

— First course — dish thirteen fraction three, the — ferry — on the second...

Glue wrinkled in anguish.

Again you pulled on the damn dozen...

— And you're superstitious? asked ferry. — The most exquisite delicacy.

— Fear of God, ferry. After all, we eat this roll through the day as soon as your watch.

— Steaks wanted? But still, what kind of blood?

Glue dreamily rolled her eyes.

— Halfway across the galaxy for a piece of meat...

Something new in ferry began, but choked suddenly, and, without blinking, staring at the table. — What the hell!..

The glue also took a look at the table and jumped with a roar dropping the stool.

Before him on a plate, spreading a tantalizing smell, was a huge piece of meat with a mouth-watering Golden brown.

The glue slowly stretched out his hand with the index finger gently touched the mysterious steak.

— Meat...

— Nonsense. How can there be meat?

— I do not know, — said Glue, but it's meat.

He pulled out a folding knife and, holding the steak with your left hand, carefully sawed off a small slice. The cut ran with pink liquid, Glue picked up a piece cut the tip of a knife and held it to his mouth. Careful bite. Moved language from cheek to cheek and with a concentrated look chewed...

— Meat, damn it! — he yelled. — Real meat!

Ferry, warily watching him, chuckled.

— Meat? Damn planet. All we only hallucinations is not enough.

— What the hell hallucinations, snarled Glue — say — a steak. And great. Yes, unless you yourself are blind... don't you see?

— Well, you see... What? Illusion. Anything else and you can't imagine.

— Oh, fraud? Well, then feel.

The glue held the knife out at the end of the Pinker piece of steak.

Ferry frowned, but still several times carefully poked the meat with two fingers.

— Do you feel it? asked Glue.

— Feel. So what? Where is the guarantee that this is not a hallucination?

— I'll put it in your mouth — angered Clay.

But ferry has himself removed the meat with a knife. He has long chewed, smacking his lips and from time to time for breath.

— Convinced?

Ferri shrugged.

— What? What I actually felt hot on the tongue, the taste of meat, but both is just only my feeling: no no meat, no!

Glue laughed.

— Well, well, old. More for me.

He pulled up a stool to the table and vigorously took up the mysterious steak. Ferry, too, sat down, and, irritably muttering something to himself, not less busily got down to my favorite "thirteenth".

— It was fine, said Adhesive having dealt with the steak.

— On your place I would not forget about the thirteenth.

Why? — surprised the Glue. — I've had enough.

Then, maybe because of the illusion, if edible, that in any case low-calorie.

Adhesive regretfully looked at the ferry:

— Do you still consider this piece of meat is an illusion?

— Of course. What do you else do you want him to be?

— Like you said, illusions cannot serve as food. And I'm full.

— Satiety — the feeling, too. And therefore can be misleading.

But the steak was very real.

— So you believe in God? asked ferry.

— What does God do?

— And what else? It is only that a miracle happened. Arose from nothing a piece of meat. Mystic.

— There is some mystic. You're here, apparently, so wild that I forgot about Einstein.

— What does Einstein?

— Pres-Le-co... And despite the fact that the mass depends on the velocity. Of two particles, if they are a good overclock, you can make a whole galaxy — it's not that steak.

— Suppose, — wearily confirmed ferry. — But where have you heard that the atoms themselves were formed in a well-grilled steak? The probability of this happening ten to some hundred thousand minus degree. Almost — zero.

You're right, of course, unless you consider that the steak appeared exactly the way I imagined.

— Great! So God — you?

— Damn it! laughed Glue. — You made a startling discovery. However, God ought not to mention trait.

Nothing. You have the power to let go of my sins.

And that is true. I don't know how to do miracles.

— And you try to smile ferry.

And I'll try, — said lightly Glue. — What to do? he looked around the room.

— Does it matter — ferry collapsed in the chair that stood in the corner of the

room and threw one leg over the other. As usual after dinner he was struck with good humor. — Someone who can work miracles, no matter what to create... to Create or destroy...

"Wait," picked up the Glue, that's an idea!

He slyly squinted and looked at the ferry:

— Well, try it. Let the chair where you now sit, will cease to exist...

Nothing happened.

— Come on, — laughed ferry, would — be miracle-worker...

He paused for a moment and stirred uneasily, for the chair began to happen something strange. It is implausible that curved like in the animated film, has his legs, like a restive horse, and began to melt...

"Hey," yelled the ferry, but it was too late. The chair finally dissolved and he crashed to the floor.

— Here's the thing though... he said the Glue.

— What kind of stupid joke? — screaming ferry, rubbing his bruised elbow.

The adhesive is recovered.

— Did anything happen?

— He still asks...

— Oh, you fell and hit her... But it's just your feelings...

— You throw me out of it again, but, looking at the place where stood the chair, silent. — God knows what...

— So, ' remarked the Glue and wiped the table.

Ferry only chuckled.

The glue is already entered into the taste. After he destroyed one stool, and then a second bedside table, then re-created the stool.

"Stop," cried ferry. — I've had enough.

— What? asked Glue.

— Are you completely devoid of imagination, that's the... Destroyed —

created, created — destroyed... like a child. It's finally getting boring.

— In each of us lives a child, ' said Clay.

And all you could come up with something more interesting.

— All my life I dreamed of a magic wand — not listening to it continued to Glue. — And now it seems I have, but I, unfortunately, can't think of anything... as a child I did not have such toys.

— Who toys — muttered the ferry, and who...

And what says your cute logic? — do not let the Glue. — Something happened contrary to all the laws — isn't it? But if all the laws already known, as some claim, you have to admit that there is "something" that stands above the laws. What do you say?

— I would say that you are right — grimly said ferry.

What? — was amazed at the Glue. — Do you mean it?

— I am not laughing, Glue.

"Nonsense," snapped Clay. Just a new paradox.

— What a paradox... the Glue is a miracle worker?... Maybe write the formula? No, that's all! Return to Earth and become a missionary. I will fly from planet to planet and talking about the wonders... And you'll like a visual aid.

— What! — arms akimbo Glue. — Oh, I'm not ashamed. But only seldom you have to remember hell.

— Maybe within the problem. How do you know?

— I don't know, — agreed the Glue. I know I have it pretty well.

— By the way, how do you do it?

— Very simple — try to imagine pouchetii what you want. Visibly. That's all.

— Oh, shit! — suddenly cried out ferry. — Look!

The glue looked back. The ball was lying against the wall where she had been a bed. He had ballooned to the size of a soccer ball hard and throbbing, shining from inside the shimmering emerald light.

Glue close to the ball and bent over him.

— Your job? he asked.

Emerald immediately moved to ruby. Ball off the floor, jumped a meter and a half up, barely touching the Glue, momentarily implausible stuck at the top, and then dropped down again and turned green.

— How to understand it? — asked distractedly Glue.

— Must be a sort of confirmation, suggested ferry.

— However, with the same success it could be denial.

— M-Yes... — has stretched the Glue, continuing to gaze thoughtfully at the globe. "But," he brightened, — there is an idea!

Glue came to the ball very closely.

— If "Yes," he said separately, then let him disappear...

The glue looked around, but thanks to his efforts, the room is almost empty. For a moment his gaze lingered on the ferry. Glue in the eyes flashed a mischievous lights.

— Well, well, — not a little scared of the ferry.

— What? — innocently said Adhesive. Then I "created" you again.

— Will do... the way you think I am. But it's never quite the same ferry. No, thanks.

— So be it — graciously agreed Glue. — Then, he turned back to the Orb. — If it was "Yes" — let again be the table.

The table appeared in the same second.

— Now, — said Glue is left to figure out what constitutes a "no"... And then you can play the game, which I have fond childhood: to guess when you answer "Yes" or "no".

— Find out is not difficult, — said ferry. He crossed the room and stood beside Adhesive.

— As will be indicated by "no"? he asked, looking at the ball.

This time the ball remained in place, but his emerald color is passed in the

egg-yellow.

— What was it? asked ferry, running his hand wide semicircle in the air. — Magic?..

Egg-yellow color became even more toxic.

— See? said Glue. — You lamented that in the world nothing remains unknown... the Inhabitants of this planet knew more than you and me.

"Wait," shrugged the ferry and turned back to the Orb. — Then there are laws of nature that we behold him and me, earth science is not yet known?

The balloon is red.

— And all what has just happened, obeyed these laws?

The ball flashed ruby light.

Farewell, missionary! laughed Glue. You'll have more time to turn back to yourself and engage in the brokenness of modern physics.

— Matthew did ferry. — Better think about how we can get all that information... Could we get the relevant information? he addressed the ball.

The bowl turned yellow.

— Correctly put the question that ferry, noticed the Glue.

You're right, Clay, it's not a question, rather a disappointment.

— I think I understand. Its so programmed by those who lived here before.

— Thanks for the explanation — I do somehow think about it. But why? Why they didn't want anyone to share their knowledge?

— Maybe the laws of nature not to give in ready, they have to suffer themselves.

— Why then all this phantasmagoria? said ferry.

— I don't know... is it Possible, then, to break our habit of absolute. Your habit...

— Will have to take him to the Ground. There shall understand, ' said ferry.

The ball was again lit in yellow light.

He doesn't want to Land, î remarked Clay.

— What do you mean — does not? In the end, it's only a machine.

Yellow light became blinding.

Ferry took a step towards the ball.

The ball fluttered like a bird caught in a snare.

Speaking of ferry, cried Glue.

— I wanted to spit! Ferry held out his hand.

At the same instant the yellow light went out. The ball took off, slipped between the Adhesive and the ferry, rushed to the closed door and, freely passing through it, disappeared.

Glue and ferry looked at each other, then the remaining intact door.

— God knows what he said to ferry. Twenty centimetres of titanium steel!

The adhesive is recovered.

— In his place I would have done exactly the same — thoughtfully he said.

— Hmmm... ferry sighed. — So we do not know. — For some reason he smiled. — Well, the revolution in physics is delayed.

— Wrong, I know, ' replied Clay. — And a lot.

— Are you talking about?

— We learned that this revolution is inevitable. And this is something.

Of course one should not understand this story in the sense that the nature of any, even the most incredible events and phenomena, wonders, and science in the future will be able to explain even what can never be.

We are talking about something else. The world around us is infinitely varied and inexhaustible. And at any level of development of science it will exist phenomena, not yet explored by man. The phenomenon, of course, do not contradict the natural objective laws of nature is already opened or not yet open.

Any level of our knowledge is relative. And therefore the way scientific research of the world around us, in the apt words of the Academy of Sciences of the Estonian SSR G. I. Naan — road without a finish line!

The universe is a treasure trove of knowledge! Its study has brought to man many new surprising, unexpected discoveries. But the wider the circle of our knowledge, the greater the line of contact with the unknown, the higher the probability of startling surprises that carry us new knowledge.

However, this knowledge does not come by itself. It is mined people in the process of intense scientific activity. Activities that meet the practical needs of the earth civilization, the urgent task of human society. We study the world not as chaotic, but allocated in the process of scientific investigation of those phenomena, the knowledge of which is necessary to achieve our objectives.

It is not excluded that in the Universe in fact exist a highly developed civilization, ahead of us in their development and have more knowledge about the world. However, we cannot and should not tie our future with fantastic hopes for the exchange of information with other intelligent inhabitants of the Universe. Because we can't understand each other or may be because alien civilizations don't exist, these expectations can be delusive.

The level of development achieved by the terrestrial civilization, the greatest progress in the knowledge of the world, the development of techniques and technologies leave no doubt that humanity under appropriate social conditions is able to solve the most complex and difficult problems to solve without any outside help.

The developments in astronomy during the second half of the twentieth century, once again convinced us of this. The last decade has not only brought with it new methods of investigation of celestial phenomena, in particular space technology and turned the in all-wave astronomy the science, but very substantially changed our understanding of the physics of the Universe the nature of what is happening in Pei processes.

In the beginning of the century and the universe and inhabiting its celestial bodies with very few exceptions seemed almost invariable, fixed; it was believed that the space object evolyutsioniruet extremely slowly, smoothly, gradually passing from one stationary state to another stationary state.

However, the twentieth century brought these represent dramatic changes. First of all, it turned out that we live in a non-stationary expansion of the Universe. Then were opened to non-stationary phenomena, accompanied by the release of enormous quantities of energy, a powerful explosive processes.

It became clear that not only the whole universe is changing over time and her past is not the same as her present and future, but literally on all levels of existence of matter flow in nonstationary processes, qualitative transformations of matter occur deep qualitative jump.

In accordance with this changed and the main task of modern astrophysics: it has become an evolutionary science that studies not only the modern state of space objects, and regularities of their origin and development. Knowledge of these laws allows to predict the future state of the planets, stars, galaxies and other celestial bodies that has not only great scientific but also of great practical importance.

Astronomical discovery of the twentieth century brought a completely new vision of the astronomical world: the changing pattern unchanged, a stationary Universe came the picture of the evolving Universe is not only expanding, but literally "exploding". This circumstance gives every reason to consider developments in the science of the Universe in this century, and related to them a radical restructuring of the system of knowledge about the Universe as another revolution in astronomy.

This revolution became an essential part of the unfolding in the second half of this century scientific and technological revolution, covering almost all areas of modern science and their practical application.

Currently, it is possible to consider that the revolution in astronomy that took place before our eyes, is close to completion. But this does not mean that significant discoveries in science about the Universe will be no more. They are a must!

New data on space phenomena continue to rapidly accumulate as a result of ground-based optical and radio astronomical observations, and through research conducted with spacecraft and orbital stations. And among them there are those who, apparently, already open up an entirely new, previously unknown pages infinitely various "books of the Universe."

For example, in world space discovered substantial scale region within which galaxies represent the basic structural units of the Universe, apparently, do not exist. As a result of special calculations performed on the basis of astronomical observations with the help of computers were able to establish that the galaxies that are part of large clusters of superclusters, located mainly

on the "walls" of peculiar cells, giant "cells" resembling a bee. The length of each side of this cell is about 100 million light years. Currently there are several such "voids", including a very impressive size.

For example, astronomers have discovered free from stars and galaxies in an area with a diameter of about 300 million light-years. They studied the distribution of stellar Islands along three closely spaced straight lines, directed in the depths of the Universe. As a result of such sensing, it was found that in selected areas up to a distance of the order of 500 million light years and starting from distances of about 800 million light-years galaxy located quite a lot. But in between these marks, any galaxy like to register failed.

For final refinement of the distribution in space of the Universe of space systems, a lot of work, in particular, to determine the position of tens of thousands of distant galaxies. But the prospects are very attractive — the resulting data will be very important for solving many fundamental problems of modern astrophysics, including to clarify the question of the origin of galaxies.

Incidentally, the presence in the Universe of "voids" in question is in good agreement with the hypothesis of the origin of galaxies, which is currently being developed by academician zel'dovich and his staff.

The study of the spatial structure of the Universe is closely related to the measurement of the distances to distant cosmic objects. In this direction also suggests interesting possibilities. They emerged thanks to the development of x-ray astronomy. The fact that one of the sources of cosmic x-ray radiation is a hot tenuous intergalactic gas that fills the space between galaxies in clusters these star systems. In x-ray clusters of intergalactic gas look like extended nebula.

Studies have shown that electrons in the intergalactic gas interact with the CMB. In this regard, the possibility by comparing observational data in the x-ray and radio wavelengths to determine not only angular, but also the absolute sizes of x-ray nebulae. But if the true is known and the angular size of any remote object, the distance can be calculated using simple trigonometric methods.

It is not excluded, therefore, the possibility that the clouds of intergalactic gas

will serve as the long-awaited benchmarks for measuring cosmic distances.

In General, future development of astronomical research spacecraft reveals a very attractive prospect. We have already talked about how important a role in the development of our ideas about the evolution of the Universe is played by the definition of the value of the average density of matter. A significant contribution to the solution of this problem can make atmosphere study in infrared and x-ray ranges of electromagnetic waves.

But in principle there is the possibility of direct determination of the average density of matter in magnitude of the gravitational field. Any extended space object, such as a galaxy, we see at a certain angle. And the magnitude of this angle depends on distance: the farther away the observed object, so the angle is less. If the space between the observer and the observed object has matter, then according to the General theory of relativity must be the curvature of light rays. At the size it is possible to estimate the amount of matter in the space between the observer and the object. But in order to calculate an average density based on these data, it should also be able to accurately measure the distance to distant galaxies. Concerning one possibility of solving this problem we just mentioned. But there is another way: measure distances using telescopes placed in space orbit and spaced far enough from each other. Currently, after the experiment with the deployment of a radio telescope KRT-10 on the Soviet orbital station "Salyut-6", the technical feasibility of such investigations is quite real.

There is a rapid accumulation of new materials astronomical observations, new facts. And it seems that it is the quantitative accumulation here should cause the next qualitative leap in our knowledge of the Universe, in the understanding of the physics of cosmic processes. Maybe wait for it long.

A team of researchers led by Dr. Lorna Dougan (Dougan Lorna) from Leeds University, UK, analyzed the structure of water in the solution of perchlorate of magnesium - the so-called "simulator of the Martian water" ("mimetic Martin water") – to better understand the possibility of the existence of water in liquid form on the surface of Mars.

Samples of Martian soil that was collected with the help of the lander Phoenix ("Phoenix") in 2009, revealed the presence of calcium and the powerful oxidizers, including perchlorate, magnesium. This gave rise to the

assumption that for solutions of perchlorates could cause the appearance on the surface of Mars, channels and other formations bearing the signs of liquid erosion.

Temperature on the surface of Mars are in the range from about 20 degrees Celsius at the equator to minus 153 degrees Celsius near the poles. The average temperature on the surface of the red planet is minus 55 degrees Celsius and at this temperature the water is, of course, cannot exist on the surface of Mars in liquid form, but concentrated solutions of the perchlorate may not freeze even at such low temperatures, explained Dugan.

After a series of experiments in the laboratory, Oxford ISIS, as well as constructing a computer model of the "simulator of the Martian water", team Dugan was able to better understand the water structure in a solution of perchlorate.

The results of this analysis show that the content in the solution of perchlorate of magnesium has a great influence on the structure of water. The impact of the perchlorate-ion is equivalent to the application to liquid water pressure of 2 billion Pascals or more. The team observed, as was a partial segregation of the ions in the water, and believes that, most likely, this effect prevents the water from freezing.

"This raises a number of interesting considerations about the possibility of the existence of life on Mars. If water on Mars is similar in structure to the water under high pressure, then perhaps we should look for organisms that are adapted to existence under conditions of extremely high pressures, such as bacteria-pedofily living in the depths of the seas on Earth," explained Dugan.

The night sky looks like at full or almost full moon? Here's how: in the bright light of the moon disappear all small and medium stars, and only far away from the moon, individual stars rarely scattered all over the sky, and that they Shine not so brightly as on a moonless night, their brilliance muted and not flashy. That's why most writers and prose writers and poets, describing the lunar night, not to mention stars, and if there are, then without epithets "bright", "brilliant", "pure", "washed"; and without verbs: "shone", "shone", "shimmered", etc.

Still, many writers forget this, and surround full or close to full moon bright starry sky.

Here is how your night Yuri Poor ("Floating white cloud", Sib. "Our contemporary", 1979, No. 3, p. 86): "once Again began to swim out of the depths of the darkening firmament of stars. Their light gained and gained strength and established themselves finally in their constant, smooth tension". But the night two days later: "Olga went out into the yard... a Full moon hung in the sky". But then the Moon was nearly full and in two days before, and, therefore, the stars in the previous excerpt could not Shine in his full potential.

The author uses in this publication, the words "Moon" and "Sun" with capital letters, as is common in astronomical literature. In the quotations from the works of art remains the usual spelling of these words.

But a moonlit night by Boris Polevoy ("Most memorable", Sib. "October", 1979, No. 3, p. 100): "had a cold. Frost under a clear, as if swept round the sky with the full moon and stars so bright that they could be one to inventory".

In the poem of L. Kondyreva "Okolitsa" ("Literary newspaper", 1980, no. 52, December 24) says:

Stars blue millet

The chickens peck from the water.

Jumping in the pines of protein

Lunar nut chewing.

In the novel V. Blackbird "Performance" (Sib. "Friendship of peoples", 1988, № 12, p. 98) the protagonist of Jaroslav Peter tells how he is in the moonlit night took the flax from the field fun: "Who, waddling on plowing comes out on the road, the horses themselves gets to the village, and you're on the rustling sheaves among, and looking for a generous scattering of stars above the head the North star and the Big and Small dipper".

The stars of a moonlit night and in A. Absalyamova ("unquenchable Fire", "Roman-Gazeta", 1960, № 12, p. 6): "Gazov stood for a while in her room the lights came on. Full moon and bright blue stars this time accompanied him one."

Bright stars and the full Moon both Shine and June D. in the poem "In the watermelon field — cold, sting..." ("Literary Russia", 1983, no. 49, December 2):

In the sky the bright stars as logia,

And the moon as a barrel,

Three girth!

Here it would shoot from the gun!

B gave all the moon is rich!

It is not clear from this passage, why does the Moon have to bestow, but still rich, if she's shot from a gun?

New moon (the horns to the left) is visible only in the evening, and he "rises" in the conventional sense, but appears from the sky in the West or South-West. Falling, he an hour or two comes over the horizon. Until midnight the sky is not delayed. Writers often forget this and therefore the new moon loves to play a trick on them.

A. Kuznetsova in the story "Under the storms of cruel fate..." (Sib. "October", 1979, No. 2, p. 52-53) "the silver bucket of the month" roams the sky in the evening and until late at night. "And a cloud rose, dispersed the clouds in different directions, the sky cleared, and looked out the window of the silver bucket of the month". It's evening and, consequently, the "silver ladle" — the month is young, but not old. And then we read: "A silver ladle months have already looked in the kitchen window; the time has passed for midnight."

The night holds the new moon in the sky, and Vladimir Lugovskoy in the poem "Storm" ("Poems", Moscow, Izd. Sovremennik, 1977. p. 80). Besides, he's got a boards: "Boards a month, young and sharp."

V. Gerasimov in the story "Simple name" ("FAV. prod.", M., GIL, 1958, p. 419) holds the new moon even before the morning: "Brovkina woke up before dawn in the early hour, when out the window through the soft scattering of a cloud of shells still gleamed greenish serpiik new moon". In fact, in the mornings you can only see serpiik old month.

Until the morning delays the new moon and M. Alekseev Roman; "Cherry pool": "All night it (Frosya) was guarding the young, recently hatched in a

month, and then, looking at her through the softly swaying branches of the Apple trees" (Coll. Op. at 8 so That 3rd. M., ed. Young guard, 1988, p. 246).

In the poem by A. Yezhov "Sleeping village" (collection of the poetic. "Why come spring", M., ed. "Children's literature", 1988, p. 39) painted this picture:

Summer day. It's getting late.

The day is gone.

The sky is hiding

Star blanket.

Sleep in the beds of children

In the month blinking.

In the soft moonlight

Fade street.

Month above the village

Pours linen thread.

People and trees

Sleep, sweet sleep.

In this picture, much remains unclear. If the Moon is full or close to full, it should not be a "star blankets". And if it is a new moon, as it appeared in the evening, then it should not be in the sky at night.

Riddles Gennady Pikuleva

Interesting riddles defines us and Astrakhan writer Gennady Pikulev in the story "the Unlucky" ("Blue and blue", novels and short stories, M., ed. Sovremennik, 1987).

One early evening he described so: "a month horns floated up from the East over the steppe on a pale purple sky (To windy weather,' said Lucy. — Well, now the rains to anything, cleaning) — a month horns floated upward, like the ancient boat, and the distant beacons lit up the first star when they came to the dormitory" (p. 18-19).

What a jumble of punctuation! However, these punctuation clutter hid the

first astronomical mystery G. Pikuleva. Once a month has horns and is visible in the evening, so he's young. But why is he then sailed from the East when he was supposed to immediately appear in the sky in the West side?

In the same story there is a description, and other early evening: "She stood on tiptoe, gently kissed his cheek, looked at the popup a month and hurried" (p. 26). But night came, and this "month-the boat quietly floated higher and higher" (p. 27).

Here we meet the second mystery G. Pikuleva. If he added nothing to the first mention of the month, we would realize that it rises the full Moon, the more it rises "higher and higher". But comparing this moon with the boat, and since the author had compared with the boat a month with horns, then, obviously, here he means the new moon. But why, then, he comes up over the horizon and rises "above all", then, as duty bound, was to appear in the Western sky in the evening and sink lower and lower.

With a third astronomical mystery G. Pikuleva we meet in the story "the Initial capital" ("Strange love," novels and stories, Volgograd, 1989), where we confusing the following description of the night:

Above the city floated a month, and the lights in his light seemed deathly pale and unnecessary.

If the old man in the hat and goatee with a goatee — said Lida. — Like in the cartoons. (p. 179).

The author wants to keep this month in the sky all night, because then he writes: "In the Park was quiet music, a month-old climbed up above the fall to sleep in the city" (p. 180).

The description of the month in these passages does not allow to doubt that he has horns. But neither young nor old months may not be in the night sky. In addition, the month with horns may not Shine so bright to outshine the lights. It is available only on a full moon.

Astronomy is the science of celestial objects (such as stars, planets, comets and galaxies) and phenomena that originate outside the atmosphere of Earth (such as solar radiance and cosmic radiation). It focuses on the evolution, physics, chemistry, meteorology and motion of celestial bodies, as well as on the formation and development of universes. In Greek astronomy it is the

"law of the stars". Astronomy is one of the oldest Sciences.

Astronomers of early civilizations engaged in methodical observations of the night sky. Since then it has preserved some astronomical devices. However, whatever it was, the invention of the telescope was in the period earlier than the advent of modern science.

Since the beginning of the twentieth century the field of professional astronomy split into two branches: observational astronomy and theoretical astrophysics. Observational astronomy is focused on gathering information, which is necessary to create tools and to use them, and also to be able to process the results. Theoretical astrophysics focuses on the implementation of the results of observations in a computer or analytical models. These two divisions complement one another: theoretical astrophysics seeks to explain the results of observational astronomy. Astronomical observations can be used to test fundamental theories in physics, such as relativity.

Historically, that Amateur astronomers participated in many significant discoveries. Astronomy is one of the few Sciences where Amateurs still play an important role, especially in regard to observations of specific phenomena.

Modern astronomy is not to be confused with astrology the belief system, claiming that human Affairs depend on the positions of celestial bodies. Although these two areas came from the same source, most supporters of other fields of science are aware that these are two completely different systems.

Despite the fact that astronomy has helped mankind to make a huge leap in understanding the universe and its laws, still remains a few questions that are not answered. Perhaps to answer them will be when built new devices, both on the Ground and in space, and there will be a number of discoveries in theoretical and experimental physics. Among these questions – the origin of the spectrum of stellar mass, the existence of life in the universe, particularly life, a reasonable, explanation of the Fermi paradox, the nature of darkness, the period of existence of the universe and the specific purpose of its existence. In astronomy, information usually occurs as a result of analysis of light and other forms of electromagnetic radiation. Useful information can

also be obtained using neutrino detectors. They are used to monitor solar neutrinos, as well as to measure the radiation of supernovas. There are also tools to measure the impact of cosmic rays. In the near future will be invented a device that determine the gravitational wave.

The traditional division between the spheres of astronomy is based on the portion of the electromagnetic spectrum over which you are monitoring. At low frequencies spectrum, radio astronomy detects radiation in the wavelengths ranging from millimeter to decameter. Radio telescope identical to those used during broadcasting, but it is much more sensitive. Microwaves are very important for learning space research relating to radiation.

Infrared astronomy and far infrared spectra, as the name implies, dealing with the analysis of infrared radiation. The most common tool used here is the telescope, where it is fitted with a sensor sensitive to the infrared waves. Infrared radiation is very strongly absorbed by atmospheric condensation, so the Observatory should be located in high, dry areas. Space telescopes warn thermal emission of the atmosphere, and also other negative effects when the atmosphere distorts the infrared and other rays.

It just so happened that most of the information in the field of astronomy appeared due to optical astronomy. It uses a variety of devices: mirrors, lenses, detectors, and film, in order to investigate the light in the spectrum from infrared to ultraviolet. If the light in the middle of the spectrum to allocate as a separate group, then it will deal with the astronomy of the visible light. Eyes can detect light wavelengths of 400-700 nanometers. In addition to the telescope, we use electronic sensors and spectrographs.

More energy sources are under observation and the study of astronomy is highly active. This includes astronomy x-ray astronomy gamma rays, UV illumination of the driving range, as well as industry involved in the study neutrinos and cosmic rays.

Classes of optical and radio astronomy can take place in ground-based observatories, because the Earth's atmosphere is quite transparent, and wavelength are easy to detect. The atmosphere is opaque for such waves, as x-ray, gamma rays, ultraviolet light and, with the exception of the rare "Windows", far infrared radiation spectrum, so the research is conducted

from balloons or space observatories.

Planetary astronomy has benefited by direct observation, provided the spacecraft. In some missions used individual sensors for inspection, other devices could land on a planetary surface and explore the surface, others at a distance gave a report on the composition of the earth, and during some of the flights were even possible simplified laboratory studies.

Physical cosmology, as a branch of astrophysics, is the study of the diverse structure of the universe and concentrated on the fundamental questions of its formation and evolution. Cosmology includes the study of the movement of celestial bodies. for a Long time it was a division of metaphysics. As a science it originated from the principles of Copernicus, who argued that the heavenly bodies obey the same physical laws as the earth, and from Newton's mechanics, which explained the nature of the movement. Physical cosmology, as it is understood today, emerged in the twentieth century with the theory of relativity albert Einstein and the emergence of opportunities for the best research spaces beyond Earth.

The scientific progress of the twentieth century allowed people to reflect on the origin of the universe, resulted in the leading theory of cosmology – the theory of "Big Bang". A relatively small number of scientists still adhere to alternative points of cosmology, but the professionals usually say that it is better big Bang explanation hard to find. Roughly speaking, physical cosmology, deals with a variety of objects in the universe and the universe itself from the very early stages, when it was still smooth to this day.

Cosmology unites the physics of small and large bodies in the universe.

The nucleosynthesis of the big Bang is a theory of formation of the elements in the early universe. It ended when the universe was about three minutes old and its temperature dropped so much that a nuclear reaction had stopped. Since the time of the big Bang were too small, were formed of only the light elements. At this time, a molecule of hydrogen (protons), deuterium, helium-4 and lithium. At that time, as the basic theory of nucleosynthesis was developed more than one year (it was introduced in 1948 by Robert Herman and George, Gamow), it is quite chuvstvitel'naja to criticism, as the specifics of the early universe is still a mystery. Some experts believe that the big Bang

has changed the nature of some sterile neutrino.

Are there planets like Earth which may develop or may already have developed life. So far, the “hunters planets” could not find this. Their list includes about 200 planetary systems, but of a planet like Jupiter, its gravity is not given to form planets like the earth. The opening of another Land not far off, the main thing to look for, and hopes.

To date, the presence of a planet near the star is determined by the shift of the spectral lines of stars. Earlier this method allows you to find the stars, surpassing the Earth several times. Progress will not keep itself waiting, tomorrow with the help of new methods and technology the process of finding planets similar to Earth would be real.

Interesting method of finding planets with the Doppler method is the “shake” of the spectrum. It lies in the fact that not only the star has a gravitational effect on the planet, but the planet affects the star. The wavelength of the spectral emission ranges, it becomes shorter then longer, hence the color spectrum shifts to the blue side in red. But like all method, it is not ideal, the offset spectrum may not be observed in those cases if the orbit of the planet is perpendicular to the line of sight.

The new equipment will use more sophisticated methods of finding planets that are deprived of such shortcomings. The search for planets using the Doppler method, is only possible with optics more powerful than 100 times.

One of the main axiom says that it is necessary to move water where water is life. In 2009, NASA will search for planets in the image of the Earth.

Whether her life? Not the fact! To the question:”are we Alone in the universe?”, possible answer:”We know!”

For the past two or three decades, scientists studying the formation of stellar systems like our Solar reached a consensus on the overall evolutionary concept, which is reflected in a famous review paper 1987, Dr. Frank Shu. Now people call this concept model Shu. In this model, the protoplanetary disks appeared as a result of the collapse of the dense molecular gas shell (hereinafter protozoana shell). The star, located in the center of the protoplanetary disk increases with the accretion (increment) of the material of the protoplanetary disk. Part of the dense gas and dust of the protoplanetary

disk can turn into a (proto)planet. In the end solnechnogorskii system arise after the protoplanetary disk dissipated due to interaction with protostellar wind protostellar radiation and planets.

The problem occurs if you imagine a smooth and axisymmetric structure protostellar shell and the protoplanetary disk. In this case, the estimated speed protostellar accretion according to the model is several orders of magnitude higher than usually observed. This so-called problem of the luminosity was first seen by Dr. Scott Kenyon in 1990. Later, this problem was thoroughly studied by Dr. Neil Evanson, who used data from nearby regions of star formation, stellar collected by the telescope Spitzer. The main argument, which resolves this apparent paradox lies in the fact that the protostar accretion occasionally. Very active stage of growth can occur only for a short period of life of the protostar, and hence can be uncommitted by any astronomical measurement. However, short-term, very active growth of some young stars, pronounced a bright glow in the optical and infrared wavelength, was recorded by some monitoring observations. For example, one variety of young stellar objects (namely FU Orionis objects, also known as FUori (FUors)) is at the stage of strong accretion, during which the accretion rate rapidly increases roughly 100-1000 times, and remains so for several more decades.

Temporal features of the phenomenon of episodic accretion can be explained by the short supply of the protoplanetary disk and thus be associated with the spatial heterogeneous structure of the protoplanetary disk. A series of numerous hydrodynamic simulations conducted by Dr. Eduard Vorobyov and Dr. santanu Basu, suggests that soon after the formation of the protoplanetary disk mass rapid accumulation protostellar from an exploding shell in novopodmoskovny disk can be caused by a complex interaction of matter disk, namely, the gravitational interaction can play a role in the friction of matter of the disc in fragments of the dense gas. These interactions also simultaneously cause a huge gas structures like spiral arms, and gaseous arc. When fragments of a dense gas to fall onto the protostar, they can lead to a sudden increase in the accretion rate of the protostar (figure 1). Protoplanetary disk in the end stabiliziruemost with the ejected material carries away the excess mass and angular momentum.

The study of the group of Baobab Liu of the Institute of astronomy and

astrophysics, Chinese Academy of Sciences was directed to study the characteristics of large gas structures like spiral arms, and gaseous arcs with observations with high angular resolution over the previously discovered Poornima objects. High angular resolution corresponds to the smallest angular scale that we are able to recognize. Any object that has physical size, will have an angular size smaller, the farther it is. At a time when I conducted this study, the required sensitivity, high-resolution images were only achievable using one of the instruments of Subaru telescope 8.2 m, namely High Contrast Instrument for the Subaru Next Generation Adaptive Optics (HiCIAO).

The project focused on exploring how the flow of molecular gas accretion can overcome the strong radiative heat transfer and the pressure emitted by the ionized gas, and then excreted in luminous OB-stars (or star clusters) even after nuclear burning has already begun, it was found that very massive stars are formed predominantly in the center-of-mass explosion, >10 parsec scale, 10^5 - $10^6 M_{\odot}$ giant molecular clouds. In the Central region to ~ 1 parsec exploding giant molecular cloud physical mechanisms, such as those that arise in FU Ori, but are spatially ordered, lead to the formation of highly fragmented, flattened, rotating structures of the dense gas, which consists of dense spiral arms, and many fragments of condensed gas. It was believed that these fragments of dense gas very well shielded from the stellar radiation of heat and ionized gas pressure. Luminous massive stars tend to accumulate their mass through episodic accretion of gas these dense fragments. This hypothesis is very well demonstrates the latest observations with a telescope "Techniques large lattice of millimeter range" (Atacama Large Millimeter Array). For those who believe in the universality of physics, the theory of protoplanetary objects may be based on the same physics, but on other cosmic parameters to ~ 100 times smaller than the spatial scale ~ 100 times smaller than the scale mass.

The detailed structure of the circumstellar material surrounding these young stars accretive, was investigated by carrying out observations with very high angular resolution near-infrared bands using the Subaru 8.2 m telescope. The design of the experiment was focused on actively accretively currently, young stellar objects, as in accordance with our theory, they are more likely to provide complex large-scale structures. On the other hand, is still very difficult to study disk structure at high resolution if they are not lit very

brightly burning, actively accretive the protostar.

Observations found the expected spiral arms and arcs at a distance of 500~1000 a. e. (figure 3), which were not recorded by any previous observation. The observed spiral arms and arcs shall be conclusive evidence of the complex interactions occurring in novoborisovka protoplanetary disk that are associated with episodic accretion or outbursts of accretion in young stellar objects. The morphology and spatial scales of these structures in very good agreement with the theoretical assumptions, as shown in figure 1A. Recent discoveries not only help us to understand how protostar accumulates its final mass. In addition, the localized concentration of the substance in nerazgadannyh younger structures of the protoplanetary disk also implies that planets can form at a much earlier stage of evolutionary development than that expected in the standard scenario of planetary formation. It also allows planets larger than Jupiter to be formed on a wider orbit ranges and not be limited to the formation of the dense inner protoplanetary disks. Thus, the results are crucial to a coherent understanding of the formation and evolution Solnechnogorsky system, and hence for understanding the origin of human civilization.

The next step in the study of the evolution of stellar systems will be conducting observations of high angular resolution at submillimeter and subcentimetre frequency ranges when using the telescope ALMA and the JVLA. These observations can more directly project the density distribution of gas and/or dust in evolving protoplanetary disks. In addition, ALMA observations will provide information about the movement of the gas. Currently, the number of objects is very limited. Most likely, the study will be expanded to monitor young stellar objects, and will also affect those that are currently accretion not too active. From a theoretical perspective the decisive role the observations will play astronomicheskije the study of systems with complex interactions.

Natural satellite of the Earth excites the minds of scholars and ordinary people for many millennia. Even now, having the most modern scientific tools of astronomers and their colleagues from other branches of science can not say exactly how the Moon formed. It is also not possible to know what a Moon several billion years ago. Of course, there are theories and hypotheses on this, but most of the time there are certain flaws.

Whatever it was, but on the moon we will learn a lot. Some discoveries can be unexpected. NASA recently published the results of a study according to which the moon long ago, there was atmosphere. However, not oxygen, there should not be deceived, imagining the pastoral picture with the blue sky, water and living organisms. We are talking about the atmosphere from volcanic gases.

Eruptions apparently, there were so many that the gases emitted by volcanoes, not had time to go into space and stayed on the moon in not too dense atmospheric layers. Of course, it was not a full atmosphere, she left shortly after only to decreased frequency of volcanic eruptions. However "soon" is in geological terms, not human. But, nevertheless, the Moon was not always a dead rock.

Components of the atmosphere was the usual for volcanic emissions. It's carbon monoxide, sulfur dioxide, and other compounds. That eruption was really a lot, almost no one questioned — on the surface of the moon is sufficient evidence. The maximum thickness of the atmosphere has reached 3.5 billion years ago. There was, it continued to exist about 70 million years. Then all the gases just went into space.

The maximum number of gaseous compounds to the surface after lava flows have filled the sea of Tranquility and sea of Rains. These were two very large eruptions that occurred 3.8 and 3.5 billion years ago, respectively. The lava field was studied by astronauts "Apollo" missions 15 and 17. They managed to collect samples of rocks that helped to establish the age of the eruptions and the approximate composition of the gases to escape from below the surface.

During the eruptions came to the surface not only sulphur dioxide, carbon dioxide, but water vapor. "The total volume of water released during the eruptions, twice the volume of water in lake Tahoe". Most of the vapor went into space, but some remained at the lunar poles. Perhaps there still is ice, which formed in ancient times.

It was stated above that the atmosphere was not very dense. But it is compared to Earth or the gas giants. At the same time, the atmosphere was

denser than gas cover Mars today. Plus, the Moon was three times closer to the Earth. No doubt, that Moon is extremely interesting spectacle to the observer of the Earth. It is a pity that on Earth then there were no observers, so to admire and marvel at all that there was no one.

The fact that the moon has water ice — a huge plus for potential colonists of Earth's natural satellite. The U.S. is now increasingly suggests that the moon is first to colonize Mars, but deposits of ice can serve as an important argument in favor of the founding of the colony. Of course, the ice must still be studied in order to understand whether it is suitable for a person, if there are any contaminants that will make it impossible to use as a water source.

Except the poles, water ice on the moon there are craters and other places where no sunlight penetrates. Plus, there are many free energy — the sun's rays illuminate a huge area. And with the help of the energy of the colonists will be able to get fuel for rockets and oxygen to breathe.

NASA has even developed a 16-year program of lunar exploration. First flight, according to the authors, to be held 12 years after the start of the project. Then start regular flights to the satellite of the Earth. The total cost of the project is \$87.7 billion in 16 years, according to the initiators, on the moon there will be a colony "Lomonosov", which will produce about 300 cubic meters of water per year. The water will be used for the needs of the colony and for the production of fuel.

And all this has become possible because billions of years ago on the moon was the most powerful volcanic eruptions with the release of large amounts of gas.

Supernova – the most common and powerful nuclear bombs nature. And this is one of the most useful phenomena to particle physics and astrophysics.

In a supernova, which collapses the core, a huge amount of protons through the absorption of electrons converted into neutrons with the subsequent exit to the outside of the neutrino. The process is one of the most important roles for the weak nuclear force in nature. Somehow – scientists still working on this issue – the resulting shock wave (possibly helping them unknown until

we force?) tear a star apart.

One of the most exciting events in the history of astronomy, was the explosion of a giant blue stars in the largest of our satellite galaxies, the Large Magellanic Cloud, which occurred in 1987. This is a bright spot easy to see to the South of the equator. The astronomers watched the sky with the naked eye in February 1987 I saw in the Cloud the star that there was not to be. This simple observation gave birth to the greatest wave of astronomical activity across the southern half of the Earth, as every astronomer who had such opportunities, hurry to take advantage of this opportunity that occurs once in a lifetime.

A supernova shines so brightly that its light for a time able to surpass the glow of all the containing galaxy. However, only a small part of its energy is emitted in form of light or other forms of energy, which eventually turns into light. Most of the energy of a supernova rushes outward in an invisible form mentioned above neutrino.

Here are some of the most interesting figures taken from the training website of Stephen Meyers, working as an astronomer at the National radio astronomy Observatory Socorro (nm).

Almost all the energy of a supernova in 1987 was transformed into a lightweight weakly-interacting neutrinos. As a result of the collapse of the core was established 1058 neutrinos. 24 February 1987 of the order of 1013 neutrinos from this supernova passed through your body! Body of around one million people on Earth browseinterval with these neutrinos, although, of course, without any consequences.

Yes, that's right – through your body's 10 trillion neutrinos resulting from the explosion of a star, located 160 000 light years – several times further than the center of the milky way. What is still amazing we have the universe.

Thousands of trillions of neutrinos passed through several neutrino detectors, and of them only a couple of dozen reacted with anything. These clashes were registered within 13 seconds. At this point, no one in particular, carefully is not watched to this event, but after the supernova was noticed, the experimenters returned to the data and found data, the flood of neutrinos. It

happened about 20 hours until the first observation of the unexpected stars in the Large Magellanic Cloud. This discovery was the birth of neutrino astronomy, which is now an active area of research.

The study of old photographs led to the discovery of one of them where visible light from the supernova were only 3 hours after arrival of neutrinos on the Earth. As the shock wave of a supernova were to get inside the exploding star outside before the pieces could start to Shine, and the neutrinos created in the explosion, would instantly break through the layers of the star, the delay between the arrival of neutrinos and the arrival of light one would expect.

This story is wonderful and interesting, but why am I talking about her? There are two reasons.

First, recently [the original article is dated 2011 – approx. transl.] we found a relatively close supernova that was very interested in astronomy. But the press showed a lack of understanding of scale.

Many headlines about "the Brightest supernova in 40 years", "The youngest and nearest supernova in decades". I don't think to count the time elapsed from the supernova of 1987 you need a degree in physics.

This supernova is located 20 million light-years – more than 100 times farther than supernova 1987.

The supernova can see lovers, but only in a very good telescope or very good binoculars on a dark night – the naked eye will not be enough. Supernova 1987 was bright enough to see with the naked eye.