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100 நபர்களுக்கு மேல் அரசு பணியில் அமர வைத்துள்ள நிறுவனம்.

## Universe and Space

- "My goal is simple.
- It is a complete understanding of the universe, why it is as it is and why it exists at all."
- We know that there are billions and billions of stars in the universe, although only about 2000 or so are visible to naked eye.
- Universe is commonly defined as the totality of everything that exists or is known to exist.
- The universe consists of galaxies, planets, stars, meteorites, satellites and all other forms of matter and energy.

### GEO Centric Theory

- Earth is spinning and that is why Sun, Moon and stars appear to go around the Earth.
- Can see lot of twinkling objects.
- But a few of them differ from the others.
- They don't twinkle and while the other stars hold a fixed pattern from night to night, these drift.
- They wander across the sky, moving against the backdrop of stars.
- These are called planets.
- Two observations supported the idea that Earth was the center of the Universe.
- From anywhere on the Earth, the Sun appears to revolve around the Earth once in a day.
- The Earth seems to be unmoving from the perspective of an earthbound observer; it feels stationary.
- One can say that Moon is going around the Earth with a period of one day.
- But for a careful observer, it was clear that the Moon was also exhibiting another motion.

- Everyday Moon appears to move from east to west in one day where as it appears to go in a circle from west to east in the background of stars in about 27 days.
- Astronomers like Aryabhata said that Earth is spinning in its axis, that is the cause of apparent daily motion from East to West.
- Whereas the eastward motion of Moon in the celestial sphere with a period of about 27 days.
- The geocentric model (also known as geocentrism), that is a description of the Universe with spherical and spinning Earth at the center and the Sun, Moon, stars, and planets all orbits the Earth emerged in various cultures.
- In Greece, this model was put forth by the Greek philosopher Plato and his disciple Aristotle in 6th century B.C.
- It was standardized by a Greco Roman mathematician Ptolemy in the 2nd Century A.D.
- A similar model is seen in the Siddhantic astronomy in India like Aryabhateeyam of Aryabhata.

### **How moon exhibit phases**

- Astronomers in ancient times also observed certain facts.
- The Purananuru (65) of Sangam literature, the poet Kalathalaiyar singing in appreciation of Cheraman Peruncheralathan says“
- On the day when the full moon appears, the sun and moon look at each other with their bright light.
- In the evening time, one sphere hides behind the mountains.”
- On the full moon day, when the Sun is setting in the west, precisely at the same time, Moon rises at the East.
- That is both Sun and Moon are in the opposite side.
- Likewise when it is waning half moon, the Moon is rises when it is midnight and the waxing half moon rises during noon.
- It is probably easier to understand the waxing and waning of Moon in the order of new moon & full moon and then how the first and third quarter moon (half moon) appear and then the phases in between.
- Sun is the source of light.
- Sun light falls on the spherical earth, but only on the side facing Sun.
- The opposite side of Earth is without sunlight.
- As the Earth spins day and night follows as different parts of Earth appear before the Sun.

- That is at all times one half of Earth is illuminated by Sun and one half is in darkness.
- Like wise at all times one half of Moon is illuminated by Sun and the opposite side is shroud in darkness.
- The moon will appear as half moon.
- The half moon during the waxing period is called as first quarter and the half moon during the waning period is called as third quarter. (figure sun moon and earth are at right angles)
- The word crescent refers to the phases where the moon is less than half illuminated.
- The word gibbous refers to phases where the moon is more than half illuminated.
- Waxing essentially means “growing” or expanding in illumination, and waning means “shrinking” or decreasing in illumination.
- Note all so that these discoveries could be made with naked eye.

## Epicycles

- Moon going around Earth with 27 day period nicely explained its motion.
- However astronomers in ancient times faced problem in explaining the motion of the then known five planets- Mercury, Venus, Mars, Jupiter and Saturn.
- Moon in the background of stars moved everyday eastwards nicely.
- However for example, if we were observing the motion of Mars from January, it would appear to move eastward in the background stars.
- On June 28, we will see a change.
- From that date the Mars would appear to move west rather than its normal eastward motion.
- This reversal of direction of planets is called as ‘retrograde motion’.
- On August 28 once again the Mars would appear to reverse the direction and again on its usual eastward motion in the celestial sphere.
- Usually Jupiter is brighter than Mars, however, around the period of retrograde motion the Mars was much bright than other times; even brighter than Jupiter.
- Venus and Mercury always appeared very close to Sun, and hence never appeared in the midnight sky.
- The brightness of Jupiter also varied again when it exhibited retrograde motion.
- For example in 2018, Jupiter reversed its direction of motion on March 9, 2018 and again resumed its normal eastward motion on July 11, 2018.

- The simple geocentric model, where planets go around the Earth could not explain why the brightness of the planets changed, and why they reversed their directions.
- Change in brightness and retrograde motion would be impossible if we assumed that the planets were at the same distance at all times from Earth.
- astronomers in early times proposed a change
- in the simple geocentric model. This is called as
- epicycle model.
- Ptolemy (2nd cent) in Greece, Aryabhata
- in India and others used the epicycle model
- to explain the motion of the celestial objects.
- Their models were improved by generation of astronomers like Tycho Brahe and Neelakanta Somayaji.
- Although, the model explained many phenomena there were number of mismatches.
- The model was becoming messy.

### **Arrival of telescope.**

- Telescope was invented by Hans Lippershey but Galilio used it for studying the sky for the first time.
- The telescope showed more universe was than visible to naked eye.
- Jupiter had moons going around it and Saturn had mysterious appendage which we now know as rings.
- One of the most startling observations he made was related to telescopic observation of Venus.
- This convinced him to accept the theory of the Polish Astronomer Nicolus Copernicus, that it is not Sun, planets and Stars that go around Earth, but it is Earth and other planets that go around the Sun- heliocentric theory.
- Heliocentric model.
- Dissatisfied with the messy epicycle model Nicolus Copernicus, radically proposed that the model will become simple if we assume Sun is at the center and all planets, including Earth, go around it.
- Suppose, Earth and Mars are on the two sides of the Sun, then Mars would be far and appear dim, compared to when they are on the same side.
- Earth orbit around Sun in 365 days, whereas Mars takes 687 days.
- Earth will overtake Mars.

### However how do we know that actually Sun is at the center or not?

- Galileo found that his observation of Venus gave the observational evidence to support the heliocentric theory.
- Galileo observed Venus in 1610-1611 with a telescope.
- The shape varied from crescent to gibbous.
- Also, the size of the planet varied.
- When the planet was in gibbous phase the size was small, and when it was thin crescent the size was many folds higher.
- If the Venus was going around the Sun, and its orbit is inside that of Earth, Venus would appear always near the Sun in the sky.
- Only if the Venus is revolving around the Sun, it can exhibit gibbous phase, and the size of the gibbous phase smaller than the crescent phase.
- If the Venus was revolving around the Earth, we can never see the gibbous phase of the Venus.

### Origin of the Universe

- Our Sun is a star with a planetary system. Billions of such stars constitute a system called as galaxy.
- The name of our galaxy is, Milky Way.
- When we observed other galaxies we found a strange behavior.
- All the galaxies were appearing to move away from us.
- Further, farther they are faster they appear to move.
- The event when the matter confined in a single point and began to expand is called 'big bang'.
- The Big Bang Theory is the prevailing model of the evolution of the Universe.
- Under this theory, space and time emerged together about 14 billions of years ago.
- Over the next three minutes, the temperature dropped below 1 billion degrees Celsius.
- After 300 000 years, the Universe had cooled to about 3000 degrees.
- At that stage of the evolution of the Universe, it was filled with clouds of hydrogen and helium gas.
- The only direct evidence of the Big Bang itself is a faint glow in space, called cosmic microwave background.
- About 100 million years after the Big Bang, the gas became hot and dense enough for the first stars to form.

- New stars were being born at a rate 10 times higher than in the present-day Universe.
- Large clusters of stars soon became the first galaxies.
- The Hubble Space Telescope and powerful ground-based telescopes are now beginning to find galaxies that were created about one billion years after the Big Bang.
- These small galaxies were much closer together than galaxies are today.
- Collisions were common.
- Like two flames moving towards each other, they merged into bigger galaxies.
- Our Milky Way galaxy came together in this way.

### Building Blocks Of Universe.

- Lot of stellar objects such as stars, planets, asteroids and meteors are the building blocks of our universe.
- **Astronomical unit:** The average distance between the Earth and the Sun is called an astronomical unit.
- It is denoted by 'au'.  
 $1 \text{ au} = 1.496 \times 10^8 \text{ km}$
- **Light year:** The distance travelled by light in one year is called a light year.
- It is denoted by 'ly'.  
 $1 \text{ ly} = 9.4607 \times 10^{12} \text{ km}$
- **Parsec:** A parsec is defined as the distance at which one astronomical unit subtends an angle of one arc second.
- It is denoted by 'pc'.  
 $1 \text{ pc} = 3.2615 \text{ ly} = 3.09 \times 10^{13} \text{ km}$

### Galaxies.

- A galaxy is a large collection of stars or cluster of stars and celestial bodies held together by gravitational attraction.
- Most galaxies range from thousand to ten thousand parsec in diameter.

### Types of galaxies

- There are various types of galaxies such as spiral, elliptical, barred spiral and irregular

## **Spiral Galaxy**

- Spiral galaxies consist of a flat, rotating disk containing stars, gas and dust, and a central concentration of stars known as the bulge.
- The spiral arms are sites of ongoing star formation and are brighter than the surrounding disc because of the young, hot stars that inhabit them.

## **Elliptical Galaxy**

- An elliptical galaxy is a type of galaxy having an approximately ellipsoidal shape and a smooth image.
- Elliptical galaxies are three-dimensional
- Interestingly Stars found inside of elliptical galaxies are on an average much older than stars found in spiral galaxies.
- Elliptical galaxies tend to be surrounded by large numbers of globular clusters.

## **Irregular Galaxy**

- An irregular galaxy is a galaxy that does not have a distinct regular shape, unlike a spiral or an elliptical galaxy, they are often chaotic in appearance, with neither a nuclear bulge nor any trace of spiral arm structure.
- About one forth of the galaxies found so far are of this type.
- Irregular galaxies may contain abundant amounts of gas and dust.

## **Barred Spiral**

- A barred spiral galaxy is a spiral galaxy with a central bar-shaped structure composed of Stars.
- Bars are found in approximately in two-thirds to one third of all spiral galaxies.
- The Milky Way Galaxy, where our own Solar System is located, is classified as a barred spiral galaxy.

## **Milky Way**

- The Milky Way is the galaxy in which our solar system is located.
- The diameter of Milky Way is over 100,000 light years.
- It includes many other celestial bodies of gases, clouds of dust, dead stars, newly born stars, etc.
- It is also thought to contain at least 100 billion stars.
- The galaxy that is closest to our Milky Way is Andromeda.
- In Indian mythology, this patch called as Akasha Ganga.

- Galileo Galili first resolved the band of light into individual stars with his telescope in 1610.
- Until the early 1920s, most astronomers thought that the Milky Way contained all the stars in the Universe.
- Observations by Edwin Hubble showed that the Milky Way is just one of many galaxies.
- Our solar system is located within the disk of the galaxy, about 27,000 light years away from the centre of the galaxy.
- The solar system travels at an average speed of 828,000 km/h.
- Even at this rapid speed, the solar system would take about 230 million years to travel all the way around the Milky Way.
- Tucked inside the very center of the galaxy is a monstrous black hole, billions of times as massive as the sun.

## Constellation

- A constellation is a recognizable pattern of stars in the night sky when viewed from the Earth.
- International Astronomical Union has classified 88 constellations to cover the entire celestial sphere.
- Many of the old constellations have Greek or Latin names and are often named after mythological characters.
- Ursa Major (Saptha Rishi Mandalam) is a large constellation and it covers a large part of the sky.
- A group of seven bright stars known as big dipper (seven Sages in Indian astronomy).
- Ursa Minor in Latin means 'the little bear' it lies in the northern sky.
- The Pole star – Polaris (Dhruva) lies within this constellation.
- The main group, 'little dipper', consists of seven stars and is quite similar to that found in Ursa Major.
- Orion was a hunter in Greek mythology.
- The constellation comprises around 81 stars out of which all but 10 are too faint to be seen with naked eye.

Name of Constellations	
Indian Name	English Name
Mesham	Aeries



Rishabham	Taurus
Midhunam	Gemini
Kadakam	Cancer
Simmam	Leo
Kanni	Virgo
Thulam	Libra
Vrischikam	Scorpio
Dhanusu	Sagittarius
Makaram	Capricorn
Kumbam	Aquarius
Meenam	Pisces

## Stars

- A Star is a luminous heavenly body that radiate energy.
- With naked eyes, we can see nearly 3000 stars in the night sky and many more with the help of a telescope.
- The Sun is the nearest star to the Earth.
- The next nearest star is Alpha Centauri.

## Satellites

- An object that revolves around a planet in a stable and consistent orbit is called a satellite.
- Satellites can be classified into two categories – natural and artificial.

## Natural satellites

- All natural objects revolving around a planet are natural satellites.
- They are also called moons.
- Most moons are spherical, the ones that are not usually asteroids or meteors that were captured by the strong gravity of a planet.
- All planets except mercury and Venus in our solar system have moons.
- Earth has only one moon- whereas planets like Jupiter and Saturn have more than 60 moons.

## Artificial satellites

- Artificial satellites are man-made objects placed in an orbit to rotate around a planet – usually the Earth.
- The world's first artificial satellite launched was Sputnik-1 by Russia, Aryabhata was the first satellite launched by India.
- These satellites are used in television and radio transmission, studying agriculture yield, locating mineral resources, weather forecasting, locate different places on earth.

## ISRO

- The Indian Space Research Organisation (ISRO) is the space agency of the Government of India headquartered in the city of Bangalore.
- Its vision is to “harness space technology for national development while pursuing space science research and planetary exploration.”
- Subrahmanyan Chandrasekhar (19 October 1910 – 21 August 1995) was an Indian American astrophysicist who spent his professional life in the United States.
- He was awarded the 1983 Nobel Prize for Physics with William A Fowler.
- His mathematical treatment of stellar evolution yielded many of the best current theoretical models of the later evolutionary stages of massive stars and black holes.
- The Chandrasekhar limit is named after him.
- Chandrasekhar worked on a wide variety of physical problems in his lifetime.
- Formed in 1969, ISRO superseded the erstwhile Indian National Committee for Space Research (INCOSPAR) established in 1962 by the Scientist Vikram Sarabhai.
- It is managed by the Department of Space, which reports to the Prime Minister of India.
- ISRO built India's first satellite, Aryabhata, which was launched by the Soviet Union on 19 April 1975.
- In 1980, Rohini became the first satellite to be placed in orbit by an Indian-made launch vehicle, SLV-3.
- ISRO subsequently developed two other rockets: the Polar Satellite Launch Vehicle (PSLV) for launching satellites into polar orbits and the Geosynchronous Satellite Launch Vehicle (GSLV) for placing satellites into geostationary orbits.
- Satellite navigation systems like GAGAN and IRNSS have been deployed.

- In January 2014, ISRO used an indigenous cryogenic engine in a GSLV-D5 launch of the GSAT-14.
- ISRO sent a lunar orbiter, Chandrayan -1, on 22 October 2008 and a Mars orbiter, Mars Orbiter Mission, on 5 November 2013, entered Mars orbit on 24 September 2014, making India the first nation to succeed on its first attempt to Mars, and ISRO the fourth space agency in the world as well as the first space agency in Asia to reach Mars orbit.
- On 18 June 2016 ISRO set a record with a launch of 20 satellites in a single payload.
- On 15 February 2017, ISRO launched 104 satellites in a single rocket (PSLV-C37) and created a world record.
- ISRO launched its heaviest rocket, Geosynchronous Satellite Launch Vehicle-Mark III (GSLV-Mk III), on 5 June 2017 and placed a communications satellite GSAT-19 in orbit.
- With this launch, ISRO became capable of launching 4 ton heavy satellites.
- ISRO launched Chandran 2 on July 22, 2019, Geosynchronous Satellite Launch Vehicle (GSLV-Mk III).
- It entered the Moon's orbit on August 20, 2019 and its lander landed on the Moon on September 7.
- In 1989, Galileo Galilei was memorialized with the launch of a Jupiter-bound space probe bearing his name.
- During its 14-year voyage, the Galileo space probe and its detachable mini-probe, visited Venus, the asteroid Gaspra, observed the impact of Comet Shoemaker-Levy 9 on Jupiter, Europa, Callisto, IO, and Amalthea.
- In order to avoid the possible contamination of one of Jupiter's moons, the Galileo space probe was purposely crashed into Jupiter at the end of its mission in September 2003.
- After completing his studies at MIT, he designed an aircraft named 'Nandhi' using indigenous materials with the help of indigenous technologists, He operated that flight himself
- He took charge as the Director of Indian Defence Research Development Organisation and the scientific advisor to the Defence Ministry of India in 1983
- Kalam successfully launched the 'Rohini-1' satellite using the India's first satellite launch vehicle SLV-3 in 1980.
- He acted as the Project Director when the missiles Thrishul, Agni, Prithvi, Nag and Akash were designed in the Indian Defence

- Abdul Kalam played a vital role in the nuclear explosion test project in Pokran named “Operation Sakthi” in 1999.
- The Government of India awarded him the Bharatha Ratna.
- He was the President of India during the period from 2002-2007
- India for the first time experimented nuclear explosion test named ‘Smiling Buddha’ in 1974.
- Kalam was one among the sixty Aeronautical Engineers in this project
- Kalam worked in five missile projects of India.
- He was the most important behind the designing defence rocket of India.
- The missile man who quoted “Man needs difficulties because to enjoy the success they are needed to and you have to dream before your dreams can come true” lives among us even after his death.
- Let’s also sacrifice for the country like him