The solar system is a planetary system composed of a sun as the central star, and generally, the planets are organized around the Sun. Sun It is a star, and it is the main star of our solar system. The main stars are generally large, and in most solar systems, they form the central axis. This star generates a lot of gravitational attraction on the rest of the planets, which is why the planets are formed around a main star. How was the sun generated? What is the density of the sun? The density of the sun is approximately 150 gm/cm^3. What is the diameter of the sun? The sun is an enormous star with a diameter of 1.4 million kilometers. What is the sun made of? The sun is composed of hot gases that represent almost all of its total mass, accounting for 99.8% of the sun's mass. If the sun were hollow, more than a million Earth-like planets could fit inside it. What is the temperature of the sun? The temperature of the sun can reach up to 15.5 million degrees Celsius in the core, and on its surface, it reaches 5500 degrees Celsius. The sun is composed of several parts, and its structure is as follows: Solar Structure Thanks to the structure of the sun, some solar phenomena can affect the Earth. The sun emits energy that propagates through space at the speed of light, and the time it takes to travel the distance from the sun to Earth is 8 minutes and 18 seconds. The sun provides 99.7% of the energy used by all natural processes, allowing the temperature on Earth to be constant and enabling life on the planet. The Sun was created approximately 4650 million years ago, thanks to large molecular clouds of gas and dust left by previous generations of stars. Gravity gathered all the materials, and the temperatures and pressures in the center of the cloud were extreme. Due to the high temperature, nuclear fusion reactions started, and from this event, the sun emerged.

A star is a celestial body that shines with its own light. They can also be defined as cosmic energy engines that produce heat, light, ultraviolet rays, X-rays, and other forms of radiation. They are composed almost entirely of gas and plasma.

The sun is composed of several parts, which are: Core: It contains 40% of the sun's mass, less than 2% of the total volume, occupies approximately a quarter of the solar radius, and generates 90% of its energy through a thermonuclear fusion process. Radiative Zone: This layer surrounds the core and contains such dense gas that photons or electromagnetic radiation coming from the core take hundreds of thousands of years to pass through this zone to reach the sun's surface. The energy generated in the core diffuses through the radiative zone by atomic absorption and emission. This zone is located at a distance of 160,000 km to 485,000 km from the solar center. Convective Zone: This is a highly turbulent zone where plasma circulates, and hot gases rise, cool, and descend. This circulation is the primary mechanism for transferring energy to the solar surface. These convective processes can be observed on the sun's surface as small granules and supergranules, which appear as cells approximately 3,000 km in radius. Photosphere: It is the visible surface of the sun; this zone surrounds the convective zone and has a thickness of approximately 300 km. It is gaseous and of low density. The gases in the photosphere are highly ionized and capable of absorbing and emitting radiation. Dark areas called sunspots can be observed in this zone. Solar flares, the most powerful explosions in the solar system, also occur in this region. Chromosphere: Located above the photosphere, it is a thin region of gas that appears reddish-orange and is about 10,000 km thick. It is generally not visible to the naked eye as the photosphere's light dominates, but it can be seen during a solar eclipse. It can also be seen in solar prominences. Corona: It is the thin outer atmosphere composed of a halo, which can only be seen during total solar eclipses.

In the sun's core, several reactions occur, one of which is a fusion reaction where hydrogen is transformed into helium. The hydrogen in the sun's core is ionized into protons, which fuse to form helium nuclei, releasing energy in the process.

Small particles of light called photons carry this energy through the radiative zone to the upper layer of the interior, known as the convective zone. There, the movement of boiling gases carries the energy to the surface. This journey takes over a million years.

Also known as solar flares, they are sudden explosions of energy caused by entanglement, crossing, or reorganization of magnetic field lines near sunspots. As magnetic field lines can easily become entangled, they can create solar flares that release a lot of radiation into space, often accompanied by solar ejections.

The sun has several phenomena, including:

Coronal mass ejections

Solar wind

Geomagnetic storms

Sunspots

Solar flares

SOLAR CYCLE The sun also has a certain cycle that occurs every 11 years. In each cycle, the sun can shine more or less, and depending on the number of sunspots, it can affect Earth's climate. The number of sunspots varies over time, lasting a few days or even weeks before disappearing, while new ones appear. The solar cycle changes approximately every 11 years.

Sunspots are areas of the sun's surface that appear dark because they are the coolest parts of the solar surface. Despite this, they can have temperatures between 4200 and 6000 degrees Celsius. The size of a sunspot is similar to that of a planet. Sunspots are relatively cool because very strong magnetic fields prevent some of the sun's heat from reaching the surface.

A solar prominence, sometimes called a filament, is a large, bright gaseous feature that extends outward from the sun's surface, often in the shape of a loop. These prominences are anchored to the sun's surface in the photosphere and extend outward into the corona. They can be understood as gas eruptions rising from the sun's surface. Prominences are generated by magnetic fields formed inside the sun and erupt through its surface into the solar atmosphere.

They are giant clouds of plasma made of radiation and solar wind that detach from the sun during the solar cycle's maximum activity period. They can be very dangerous as they can damage electrical circuits, transformers, and communication systems if they reach Earth and their magnetic field is oriented southward, reducing Earth's magnetic field for a period.

Solar wind is a stream of charged particles expelled from the upper atmosphere of the sun (although it can also come from any star). This wind mainly consists of electrons and protons, and the flow of particles varies in temperature and speed over time. The particles can escape the sun's gravity due to their high kinetic energy and the high temperature of the corona.

Solar wind creates the heliosphere, a giant bubble in the interstellar medium that surrounds the solar system. Earth is protected from solar wind by its magnetic field, which deflects most of the charged particles, with many trapped in the Van Allen radiation belt. Solar wind can only be observed on Earth when it is strong enough to generate phenomena like auroras and geomagnetic storms. These occur when the solar wind expands into the magnetosphere, causing the geospheric plasma to expand and atmospheric matter to escape into the solar wind.

A geomagnetic storm is a temporary disturbance of Earth's magnetosphere, associated with a coronal mass ejection, a corona hole, or a solar flare. It is a shock wave of solar wind that reaches Earth between 24 and 36 hours after the event. It only occurs if the shock wave travels toward Earth. The pressure of the solar wind on the magnetosphere will increase or decrease depending on solar activity.

Solar radiation is the energy emitted by the sun, propagating in all directions through space via electromagnetic waves generated by thermonuclear fusion and emitted by the solar surface. There are four types of solar radiation:

UVB: UVB radiation consists of invisible rays that are part of the energy coming from the sun, usually accompanied by UVA rays but in a much smaller amount.

UVA: Known mostly as ultraviolet light, it is a type of radiation produced by the sun, with a wavelength between approximately 100 nm and 400 nm, forming part of sunlight.

Visible light: Visible light is the portion of radiation that humans can see and allows us to see around us. It makes up about 45% of the solar radiation that reaches human skin.

Infrared: This type of electromagnetic radiation has a longer wavelength than visible light and generates heat, responsible for the temperature felt from sunlight.

X-rays: These are a form of electromagnetic radiation similar to visible light but with higher energy and can penetrate most objects, including the human body.

Some movements performed by celestial bodies are: Translation: This is the movement a celestial body makes around another due to gravitational attraction forces between them. Rotation: It is the movement a celestial body makes by spinning around its own axis, although not all bodies perform this action. Exosphere: This refers to the atmospheric layer where gases disperse until reaching a composition similar to that of outer space.

The smallest planet in our solar system and nearest to the Sun, Mercury is only slightly larger than Earth's Moon. From the surface of Mercury, the Sun would appear more than three times as large as it does when viewed from Earth, and the sunlight would be as much as seven times brighter.

Mercury's surface temperatures are both extremely hot and cold. Because the planet is so close to the Sun, day temperatures can reach highs of 800°F (430°C). Without an atmosphere to retain that heat at night, temperatures can dip as low as -290°F (-180°C).

Despite its proximity to the Sun, Mercury is not the hottest planet in our solar system – that title belongs to nearby Venus, thanks to its dense atmosphere. But Mercury is the fastest planet, zipping around the Sun every 88 Earth days.

Mercury is appropriately named for the swiftest of the ancient Roman gods.

Mercury's environment is not conducive to life as we know it. The temperatures and solar radiation that characterize this planet are most likely too extreme for organisms to adapt to.

With a radius of 1,516 miles (2,440 kilometers), Mercury is a little more than 1/3 the width of Earth. If Earth were the size of a nickel, Mercury would be about as big as a blueberry.

From an average distance of 36 million miles (58 million kilometers), Mercury is 0.4 astronomical units away from the Sun. One astronomical unit (abbreviated as AU), is the distance from the Sun to Earth. From this distance, it takes sunlight 3.2 minutes to travel from the Sun to Mercury.

Mercury's highly eccentric, egg-shaped orbit takes the planet as close as 29 million miles (47 million kilometers) and as far as 43 million miles (70 million kilometers) from the Sun. It speeds around the Sun every 88 days, traveling through space at nearly 29 miles (47 kilometers) per second, faster than any other planet.

Mercury spins slowly on its axis and completes one rotation every 59 Earth days. But when Mercury is moving fastest in its elliptical orbit around the Sun (and it is closest to the Sun), each rotation is not accompanied by sunrise and sunset like it is on most other planets. The morning Sun appears to rise briefly, set, and rise again from some parts of the planet's surface. The same thing happens in reverse at sunset for other parts of the surface. One Mercury solar day (one full day-night cycle) equals 176 Earth days – just over two years on Mercury.

Mercury's axis of rotation is tilted just 2 degrees with respect to the plane of its orbit around the Sun. That means it spins nearly perfectly upright and so does not experience seasons as many other planets do.

Mercury doesn't have moons.

Mercury doesn't have rings.

Mercury formed about 4.5 billion years ago when gravity pulled swirling gas and dust together to form this small planet nearest the Sun. Like its fellow terrestrial planets, Mercury has a central core, a rocky mantle, and a solid crust.

Mercury is the second densest planet, after Earth. It has a large metallic core with a radius of about 1,289 miles (2,074 kilometers), about 85% of the planet's radius. There is evidence that it is partly molten or liquid. Mercury's outer shell, comparable to Earth's outer shell (called the mantle and crust), is only about 400 kilometers (250 miles) thick.

Mercury's surface resembles that of Earth's Moon, scarred by many impact craters resulting from collisions with meteoroids and comets. Craters and features on Mercury are named after famous deceased artists, musicians, or authors, including children's author Dr. Seuss and dance pioneer Alvin Ailey.

Very large impact basins, including Caloris (960 miles or 1,550 kilometers in diameter) and Rachmaninoff (190 miles, or 306 kilometers in diameter), were created by asteroid impacts on the planet's surface early in the solar system's history. While there are large areas of smooth terrain, there are also cliffs, some hundreds of miles long and soaring up to a mile high. They rose as the planet's interior cooled and contracted over the billions of years since Mercury formed.

Most of Mercury's surface would appear greyish-brown to the human eye. The bright streaks are called "crater rays." They are formed when an asteroid or comet strikes the surface. The tremendous amount of energy that is released in such an impact digs a big hole in the ground, and also crushes a huge amount of rock under the point of impact. Some of this crushed material is thrown far from the crater and then falls to the surface, forming the rays. Fine particles of crushed rock are more reflective than large pieces, so the rays look brighter. The space environment – dust impacts and solar-wind particles – causes the rays to darken with time.

Temperatures on Mercury are extreme. During the day, temperatures on the surface can reach 800 degrees Fahrenheit (430 degrees Celsius). Because the planet has no atmosphere to retain that heat, nighttime temperatures on the surface can drop to minus 290 degrees Fahrenheit (minus 180 degrees Celsius).

Mercury may have water ice at its north and south poles inside deep craters, but only in regions in permanent shadows. In those shadows, it could be cold enough to preserve water ice despite the high temperatures on sunlit parts of the planet.

Instead of an atmosphere, Mercury possesses a thin exosphere made up of atoms blasted off the surface by the solar wind and striking meteoroids. Mercury's exosphere is composed mostly of oxygen, sodium, hydrogen, helium, and potassium.

Mercury's magnetic field is offset relative to the planet's equator. Though Mercury's magnetic field at the surface has just 1% the strength of Earth's, it interacts with the magnetic field of the solar wind to sometimes create intense magnetic tornadoes that funnel the fast, hot solar wind plasma down to the surface of the planet. When the ions strike the surface, they knock off neutrally charged atoms and send them on a loop high into the sky.

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Venus is the second planet from the Sun, and our closest planetary neighbor. It's the hottest planet in our solar system, and is sometimes called Earth's twin.

Venus is the second planet from the Sun, and Earth's closest planetary neighbor. Venus is the third brightest object in the sky after the Sun and Moon. Venus spins slowly in the opposite direction from most planets.

Venus is similar in structure and size to Earth, and is sometimes called Earth's evil twin. Its thick atmosphere traps heat in a runaway greenhouse effect, making it the hottest planet in our solar system with surface temperatures hot enough to melt lead. Below the dense, persistent clouds, the surface has volcanoes and deformed mountains.

The ancient Romans could easily see seven bright objects in the sky: the Sun, the Moon, and the five brightest planets: Mercury, Venus, Mars, Jupiter, and Saturn. They named the objects after their most important gods.

Venus is named for the ancient Roman goddess of love and beauty, who was known as Aphrodite to the ancient Greeks. Most features on Venus are named for women. It’s the only planet named after a female god.

Thirty miles up (about 50 kilometers) from the surface of Venus temperatures range from 86 to 158 Fahrenheit (30 to 70 Celsius). This temperature range could accommodate Earthly life, such as “extremophile” microbes. And atmospheric pressure at that height is similar to what we find on Earth’s surface.

At the tops of Venus’ clouds, whipped around the planet by winds measured as high as 224 mph (360 kph), we find another transformation. Persistent, dark streaks appear. Scientists are so far unable to explain why these streaks remain stubbornly intact, even amid hurricane-force winds. They also have the odd habit of absorbing ultraviolet radiation.

The most likely explanations focus on fine particles, ice crystals, or even a chemical compound called iron chloride. Although it's much less likely, another possibility considered by scientists who study astrobiology is that these streaks could be made up of microbial life, Venus-style. Astrobiologists note that ring-shaped linkages of sulfur atoms, known to exist in Venus' atmosphere, could provide microbes with a kind of coating that would protect them from sulfuric acid. These handy chemical cloaks would also absorb potentially damaging ultraviolet light and re-radiate it as visible light.

Some of the Russian Venera probes did, indeed, detect particles in Venus' lower atmosphere about a micron in length – roughly the same size as a bacterium on Earth.

None of these findings provide compelling evidence for the existence of life in Venus' clouds. But the questions they raise, along with Venus' vanished ocean, its violently volcanic surface, and its hellish history, make a compelling case for missions to investigate our temperamental sister planet. There is much, it would seem, that she can teach us.

Venus orbits the Sun from an average distance of 67 million miles (108 million kilometers), or 0.72 astronomical units. One astronomical unit (abbreviated as AU), is the distance from the Sun to Earth. From this distance, it takes sunlight about six minutes to travel from the Sun to Venus.

Earth's nearness to Venus is a matter of perspective. The planet is nearly as big around as Earth. Its diameter at its equator is about 7,521 miles (12,104 kilometers), versus 7,926 miles (12,756 kilometers) for Earth. From Earth, Venus is the brightest object in the night sky after our own Moon. The ancients, therefore, gave it great importance in their cultures, even thinking it was two objects: a morning star and an evening star. That's where the trick of perspective comes in.

Because Venus' orbit is closer to the Sun than ours, the two of them – from our viewpoint – never stray far from each other. The ancient Egyptians and Greeks saw Venus in two guises: first in one orbital position (seen in the morning), then another (your "evening" Venus), just at different times of the year.

At its nearest to Earth, Venus is about 24 million (about 38 million kilometers) distant. But most of the time the two planets are farther apart; Mercury, the innermost planet, actually spends more time in Earth's proximity than Venus.

One more trick of perspective: how Venus looks through binoculars or a telescope. Keep watch over many months, and you'll notice that Venus has phases, just like our Moon – full, half, quarter, etc. The complete cycle, however, new to full, takes 584 days, while our Moon takes just a month. And it was this perspective, the phases of Venus first observed by Galileo through his telescope, that provided the key scientific proof for the Copernican heliocentric nature of the solar system.

Spending a day on Venus would be quite a disorienting experience – that is, if your spacecraft or spacesuit could protect you from temperatures in the range of 900 degrees Fahrenheit (475 Celsius). For one thing, your "day" would be 243 Earth days long – longer even than a Venus year (one trip around the Sun), which takes only 225 Earth days. For another, because of the planet's extremely slow rotation, sunrise to sunset would take 117 Earth days. And by the way, the Sun would rise in the west and set in the east, because Venus spins backward compared to Earth.

While you're waiting, don't expect any seasonal relief from the unrelenting temperatures. On Earth, with its spin axis tilted by about 23 degrees, we experience summer when our part of the planet (our hemisphere) receives the Sun's rays more directly – a result of that tilt. In winter, the tilt means the rays are less direct. No such luck on Venus: Its very slight tilt is only three degrees, which is too little to produce noticeable seasons.

Venus is one of only two planets in our solar system that doesn't have a moon, but it does have a quasi-satellite that has officially been named Zoozve. This object was discovered on Nov. 11, 2002, by Brian Skiff at the Lowell Observatory Near-Earth-Object Search (LONEOS) in Flagstaff, Arizona, a project funded by NASA that ended in February 2008.

Quasi-satellites, sometimes called quasi-moons, are asteroids that orbit the Sun while staying close to a planet. A quasi-satellite's orbit usually is more oblong and less stable than the planet's orbit. In time, the shape of a quasi-satellite's orbit may change and it may move away from the planet.

According to the International Astronomical Union (IAU), the organization that names space objects, Zoozve is the first-identified quasi-satellite of a major planet. Earth also has quasi-satellites, including a small asteroid discovered in 2016.

Based on its brightness, scientists at NASA’s Jet Propulsion Laboratory (JPL) estimate Zoozve ranges in size from 660 feet (200 meters) to 1,640 feet (500 meters) across.

Interestingly, Zoozve also orbits relatively close to Earth but does not pose a threat to our planet. For the next 175 years, the closest Zoozve will get to Earth is in the year 2149 when it will be about 2.2 million miles (3.5 million kilometers) away, or about 9 times the distance from Earth to the Moon.

After the discovery in 2002, Skiff reported his finding to the Minor Planet Center, which is funded by a Near-Earth Object (NEO) Observations Program grant from NASA’s Planetary Defense Coordination Office. At that time, it was given the provisional name 2002 VE68. Skiff said he didn’t realize the asteroid’s importance and forgot about the object until a radio show host reached out to him in 2023 about naming it Zoozve.

Soon after Skiff’s discovery, a team of astronomers, including Seppo Mikkola with the University of Turku in Finland and Paul Wiegert with the University of Western Ontario in London, determined that the object was the first of its kind to be discovered. They think that Zoozve may have been a companion to Venus for at least 7,000 years, and that Earth’s gravity helped push Zoozve into its present orbit.

The name Zoozve comes from a child's poster of the solar system. The artist, Alex Foster, saw “2002 VE68” on a list of solar system objects, wrote down “2002 VE,” and then misread his own handwriting as “Zoozve.”

Latif Nasser, co-host of the WNYC Studios show Radiolab, tracked down the source of the mistake with the help of Liz Landau, a NASA senior communications specialist. Nasser suggested that Skiff request that the IAU officially name the asteroid Zoozve. Skiff agreed, and the name Zoozve was approved in February 2024.

Venus has no rings.

A critical question for scientists who search for life among the stars: How do habitable planets get their start? The close similarities of early Venus and Earth, and their very different fates, provide a kind of test case for scientists who study planet formation. Similar size, similar interior structure, both harboring oceans in their younger days. Yet one is now an inferno, while the other is the only known world to host abundant life. The factors that set these planets on almost opposite paths began, most likely, in the swirling disk of gas and dust from which they were born. Somehow, 4.6 billion years ago that disk around our Sun accreted, cooled, and settled into the planets we know today. Better knowledge of the formation history of Venus could help us better understand Earth – and rocky planets around other stars.

If we could slice Venus and Earth in half, pole to pole, and place them side by side, they would look remarkably similar. Each planet has an iron core enveloped by a hot-rock mantle; the thinnest of skins forms a rocky, exterior crust. On both planets, this thin skin changes form and sometimes erupts into volcanoes in response to the ebb and flow of heat and pressure deep beneath.

On Earth, the slow movement of continents over thousands and millions of years reshapes the surface, a process known as “plate tectonics.” Something similar might have happened on Venus early in its history. Today a key element of this process could be operating: subduction, or the sliding of one continental “plate” beneath another, which can also trigger volcanoes. Subduction is believed to be the first step in creating plate tectonics.

NASA’s Magellan spacecraft, which ended a five-year mission to Venus in 1994, mapped the broiling surface using radar. Magellan saw a land of extreme volcanism – a relatively young surface, one recently reshaped (in geologic terms), and chains of towering mountains.

An analysis of data from Magellan’s radar finds two volcanoes erupted in the early 1990s. This adds to the 2023…

The Soviet Union sent a series of probes to Venus between 1961 and 1984 as part of its Venera program (Venera is Russian for Venus). Ten probes made it to the surface, and a few functioned briefly after landing. The longest survivor lasted two hours; the shortest, 23 minutes. Photos snapped before the landers fried show a barren, dim, and rocky landscape, and a sky that is likely some shade of sulfur yellow.

Volcanoes and tectonic forces appear to have erased most traces of the early surface of Venus. Newer computer models indicate the resurfacing may have happened piecemeal over an extended period of time. The average age of surface features could be as young as 150 million years, with some older surfaces mixed in.

Venus has valleys and high mountains dotted with thousands of volcanoes. Its surface features – most named for both real and mythical women – include Ishtar Terra, a rocky, highland area around the size of Australia near the north pole, and an even larger, South-America-sized region called Aphrodite Terra that stretches across the equator. One mountain reaches 36,000 feet (11 kilometers), higher than Mt. Everest. Notably, except for Earth, Venus has by far the fewest impact craters of any rocky planet.

Other notable features of the Venus landscape include:

Venus' atmosphere is one of extremes. With the hottest surface in the solar system, apart from the Sun itself, Venus is hotter even than the innermost planet, charbroiled Mercury. The atmosphere is mostly carbon dioxide – the same gas driving the greenhouse effect on Venus and Earth – with clouds composed of sulfuric acid. And at the surface, the hot, high-pressure carbon dioxide behaves in a corrosive fashion. But higher up in the atmosphere, temperatures and pressure begin to ease.

Even though Venus is similar in size to Earth and has a similar-sized iron core, the planet does not have its own internally generated magnetic field. Instead, Venus has what is known as an induced magnetic field. This weak magnetic field is created by the interaction of the Sun's magnetic field and the planet's outer atmosphere. Ultraviolet light from the Sun excites gases in Venus' outermost atmosphere; these electrically excited gases are called ions, and thus this region is called the ionosphere (Earth has an ionosphere as well). The solar wind – a million-mile-per-hour gale of electrically charged particles streaming continuously from the Sun – carries with it the Sun's magnetic field. When the Sun's magnetic field interacts with the electrically excited ionosphere of Venus, it creates or induces, a magnetic field there. This induced magnetic field envelops the planet and is shaped like an extended teardrop, or the tail of a comet, as the solar wind blows past Venus and outward into the solar system.

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Earth – our home planet – is the third planet from the Sun, and the fifth largest planet. It's the only place we know of inhabited by living things.

23.9 hours

365.25 days

93,327,712 miles / 150,196,428 kilometers

8.350022 minutes

While Earth is only the fifth largest planet in the solar system, it is the only world in our solar system with liquid water on the surface. Just slightly larger than nearby Venus, Earth is the biggest of the four planets closest to the Sun, all of which are made of rock and metal.

Earth is the only planet in the solar system whose English name does not come from Greek or Roman mythology. The name was taken from Old English and Germanic. It simply means "the ground." There are, of course, many names for our planet in the thousands of languages spoken by the people of the third planet from the Sun.

The name Earth is at least 1,000 years old. All of the planets, except for Earth, were named after Greek and Roman gods and goddesses. However, the name Earth is a Germanic word, which simply means “the ground.”

Earth has a very hospitable temperature and mix of chemicals that have made life abundant here. Most notably, Earth is unique in that most of our planet is covered in liquid water, since the temperature allows liquid water to exist for extended periods of time. Earth's vast oceans provided a convenient place for life to begin about 3.8 billion years ago.

Some of the features of our planet that make it great for sustaining life are changing due to the ongoing effects of climate change.

With an equatorial diameter of 7926 miles (12,760 kilometers), Earth is the biggest of the terrestrial planets and the fifth largest planet in our solar system.

From an average distance of 93 million miles (150 million kilometers), Earth is exactly one astronomical unit away from the Sun because one astronomical unit (abbreviated as AU), is the distance from the Sun to Earth. This unit provides an easy way to quickly compare planets' distances from the Sun.

It takes about eight minutes for light from the Sun to reach our planet.

As Earth orbits the Sun, it completes one rotation every 23.9 hours. It takes 365.25 days to complete one trip around the Sun. That extra quarter of a day presents a challenge to our calendar system, which counts one year as 365 days. To keep our yearly calendars consistent with our orbit around the Sun, every four years we add one day. That day is called a leap day, and the year it's added to is called a leap year.

Earth's axis of rotation is tilted 23.4 degrees with respect to the plane of Earth's orbit around the Sun. This tilt causes our yearly cycle of seasons. During part of the year, the northern hemisphere is tilted toward the Sun, and the southern hemisphere is tilted away. With the Sun higher in the sky, solar heating is greater in the north producing summer there. Less direct solar heating produces winter in the south. Six months later, the situation is reversed. When spring and fall begin, both hemispheres receive roughly equal amounts of heat from the Sun.

Earth is the only planet that has a single moon. Our Moon is the brightest and most familiar object in the night sky. In many ways, the Moon is responsible for making Earth such a great home. It stabilizes our planet's wobble, which has made the climate less variable over thousands of years.

Earth sometimes temporarily hosts orbiting asteroids or large rocks. They are typically trapped by Earth's gravity for a few months or years before returning to an orbit around the Sun. Some asteroids will be in a long “dance” with Earth as both orbit the Sun.

Some moons are bits of rock that were captured by a planet's gravity, but our Moon is likely the result of a collision billions of years ago. When Earth was a young planet, a large chunk of rock smashed into it, displacing a portion of Earth's interior. The resulting chunks clumped together and formed our Moon. With a radius of 1,080 miles (1,738 kilometers), the Moon is the fifth largest moon in our solar system (after Ganymede, Titan, Callisto, and Io).

The Moon is an average of 238,855 miles (384,400 kilometers) away from Earth. That means 30 Earth-sized planets could fit in between Earth and its Moon.

Earth has no rings.

When the solar system settled into its current layout about 4.5 billion years ago, Earth formed when gravity pulled swirling gas and dust in to become the third planet from the Sun. Like its fellow terrestrial planets, Earth has a central core, a rocky mantle, and a solid crust.

Earth is composed of four main layers, starting with an inner core at the planet's center, enveloped by the outer core, mantle, and crust.

The inner core is a solid sphere made of iron and nickel metals about 759 miles (1,221 kilometers) in radius. There the temperature is as high as 9,800 degrees Fahrenheit (5,400 degrees Celsius). Surrounding the inner core is the outer core. This layer is about 1,400 miles (2,300 kilometers) thick, made of iron and nickel fluids.

In between the outer core and crust is the mantle, the thickest layer. This hot, viscous mixture of molten rock is about 1,800 miles (2,900 kilometers) thick and has the consistency of caramel. The outermost layer, Earth's crust, goes about 19 miles (30 kilometers) deep on average on land. At the bottom of the ocean, the crust is thinner and extends about 3 miles (5 kilometers) from the seafloor to the top of the mantle.

Like Mars and Venus, Earth has volcanoes, mountains, and valleys. Earth's lithosphere, which includes the crust (both continental and oceanic) and the upper mantle, is divided into huge plates that are constantly moving. For example, the North American plate moves west over the Pacific Ocean basin, roughly at a rate equal to the growth of our fingernails. Earthquakes result when plates grind past one another, ride up over one another, collide to make mountains, or split and separate.

Earth's global ocean, which covers nearly 70% of the planet's surface, has an average depth of about 2.5 miles (4 kilometers) and contains 97% of Earth's water. Almost all of Earth's volcanoes are hidden under these oceans. Hawaii's Mauna Kea volcano is taller from base to summit than Mount Everest, but most of it is underwater. Earth's longest mountain range is also underwater, at the bottom of the Arctic and Atlantic oceans. It is four times longer than the Andes, Rockies and Himalayas combined.

Near the surface, Earth has an atmosphere that consists of 78% nitrogen, 21% oxygen, and 1% other gases such as argon, carbon dioxide, and neon. The atmosphere affects Earth's long-term climate and short-term local weather and shields us from much of the harmful radiation coming from the Sun. It also protects us from meteoroids, most of which burn up in the atmosphere, seen as meteors in the night sky, before they can strike the surface as meteorites.

Our planet's rapid rotation and molten nickel-iron core give rise to a magnetic field, which the solar wind distorts into a teardrop shape in space. (The solar wind is a stream of charged particles continuously ejected from the Sun.) When charged particles from the solar wind become trapped in Earth's magnetic field, they collide with air molecules above our planet's magnetic poles. These air molecules then begin to glow and cause aurorae, or the northern and southern lights.

The magnetic field is what causes compass needles to point to the North Pole regardless of which way you turn. But the magnetic polarity of Earth can change, flipping the direction of the magnetic field. The geologic record tells scientists that a magnetic reversal takes place about every 400,000 years on average, but the timing is very irregular. As far as we know, such a magnetic reversal doesn't cause any harm to life on Earth, and a reversal is very unlikely to happen for at least another thousand years. But when it does happen, compass needles are likely to point in many different directions for a few centuries while the switch is being made. And after the switch is completed, they will all point south instead of north.

Our home planet Earth is a rocky, terrestrial planet. It has a solid and active surface with mountains, valleys, canyons, plains and so much more. Earth is special because it is an ocean planet. Water covers 70% of Earth's surface. Earth's atmosphere is made mostly of nitrogen and has plenty of oxygen for us to breathe. The atmosphere also protects us from incoming meteoroids, most of which break up before they can hit the surface.

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Our Solar System

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Mars – the fourth planet from the Sun – is a dusty, cold, desert world with a very thin atmosphere. This dynamic planet has seasons, polar ice caps, extinct volcanoes, canyons and weather.

Mars is one of the most explored bodies in our solar system, and it's the only planet where we've sent rovers to roam the alien landscape. NASA missions have found lots of evidence that Mars was much wetter and warmer, with a thicker atmosphere, billions of years ago.

Mars was named by the Romans for their god of war because its reddish color was reminiscent of blood. The Egyptians called it "Her Desher," meaning "the red one."

Even today, it is frequently called the "Red Planet" because iron minerals in the Martian dirt oxidize, or rust, causing the surface to look red.

Mars was named by the ancient Romans for their god of war because its reddish color was reminiscent of blood. Other civilizations also named the planet for this attribute – for example, the Egyptians called it "Her Desher," meaning "the red one." Even today, it is frequently called the "Red Planet" because iron minerals in the Martian dirt oxidize, or rust, causing the surface to look red.

Scientists don't expect to find living things currently thriving on Mars. Instead, they're looking for signs of life that existed long ago, when Mars was warmer and covered with water.

With a radius of 2,106 miles (3,390 kilometers), Mars is about half the size of Earth. If Earth were the size of a nickel, Mars would be about as big as a raspberry.

From an average distance of 142 million miles (228 million kilometers), Mars is 1.5 astronomical units away from the Sun. One astronomical unit (abbreviated as AU), is the distance from the Sun to Earth. From this distance, it takes sunlight 13 minutes to travel from the Sun to Mars.

As Mars orbits the Sun, it completes one rotation every 24.6 hours, which is very similar to one day on Earth (23.9 hours). Martian days are called sols – short for "solar day." A year on Mars lasts 669.6 sols, which is the same as 687 Earth days.

Mars' axis of rotation is tilted 25 degrees with respect to the plane of its orbit around the Sun. This is another similarity with Earth, which has an axial tilt of 23.4 degrees. Like Earth, Mars has distinct seasons, but they last longer than seasons here on Earth since Mars takes longer to orbit the Sun (because it's farther away). And while here on Earth the seasons are evenly spread over the year, lasting 3 months (or one quarter of a year), on Mars the seasons vary in length because of Mars' elliptical, egg-shaped orbit around the Sun.

Spring in the northern hemisphere (autumn in the southern) is the longest season at 194 sols. Autumn in the northern hemisphere (spring in the southern) is the shortest at 142 days.

Northern winter/southern summer is 154 sols, and northern summer/southern winter is 178 sols.

Mars has two small moons, Phobos and Deimos, that may be captured asteroids. They're potato-shaped because they have too little mass for gravity to make them spherical.

The moons get their names from the horses that pulled the chariot of the Greek god of war, Ares.

Phobos, the innermost and larger moon, is heavily cratered, with deep grooves on its surface. It is slowly moving towards Mars and will crash into the planet or break apart in about 50 million years.

Deimos is about half as big as Phobos and orbits two and a half times farther away from Mars. Oddly-shaped Deimos is covered in loose dirt that often fills the craters on its surface, making it appear smoother than pockmarked Phobos.

Go farther. Explore the Moons of Mars ›

Mars has no rings. However, in 50 million years when Phobos crashes into Mars or breaks apart, it could create a dusty ring around the Red Planet.

When the solar system settled into its current layout about 4.5 billion years ago, Mars formed when gravity pulled swirling gas and dust in to become the fourth planet from the Sun. Mars is about half the size of Earth, and like its fellow terrestrial planets, it has a central core, a rocky mantle, and a solid crust.

Mars has a dense core at its center between 930 and 1,300 miles (1,500 to 2,100 kilometers) in radius. It's made of iron, nickel, and sulfur. Surrounding the core is a rocky mantle between 770 and 1,170 miles (1,240 to 1,880 kilometers) thick, and above that, a crust made of iron, magnesium, aluminum, calcium, and potassium. This crust is between 6 and 30 miles (10 to 50 kilometers) deep.

The Red Planet is actually many colors. At the surface, we see colors such as brown, gold, and tan. The reason Mars looks reddish is due to oxidization – or rusting – of iron in the rocks, regolith (Martian “soil”), and dust of Mars. This dust gets kicked up into the atmosphere and from a distance makes the planet appear mostly red.

Interestingly, while Mars is about half the diameter of Earth, its surface has nearly the same area as Earth’s dry land. Its volcanoes, impact craters, crustal movement, and atmospheric conditions such as dust storms have altered the landscape of Mars over many years, creating some of the solar system's most interesting topographical features.

A large canyon system called Valles Marineris is long enough to stretch from California to New York – more than 3,000 miles (4,800 kilometers). This Martian canyon is 200 miles (320 kilometers) at its widest and 4.3 miles (7 kilometers) at its deepest. That's about 10 times the size of Earth's Grand Canyon.

Mars is home to the largest volcano in the solar system, Olympus Mons. It's three times taller than Earth's Mt. Everest with a base the size of the state of New Mexico.

Mars appears to have had a watery past, with ancient river valley networks, deltas, and lakebeds, as well as rocks and minerals on the surface that could only have formed in liquid water. Some features suggest that Mars experienced huge floods about 3.5 billion years ago.

There is water on Mars today, but the Martian atmosphere is too thin for liquid water to exist for long on the surface. Today, water on Mars is found in the form of water-ice just under the surface in the polar regions as well as in briny (salty) water, which seasonally flows down some hillsides and crater walls.

Mars has a thin atmosphere made up mostly of carbon dioxide, nitrogen, and argon gases. To our eyes, the sky would be hazy and red because of suspended dust instead of the familiar blue tint we see on Earth. Mars' sparse atmosphere doesn't offer much protection from impacts by such objects as meteorites, asteroids, and comets.

The temperature on Mars can be as high as 70 degrees Fahrenheit (20 degrees Celsius) or as low as about -225 degrees Fahrenheit (-153 degrees Celsius). And because the atmosphere is so thin, heat from the Sun easily escapes this planet. If you were to stand on the surface of Mars on the equator at noon, it would feel like spring at your feet (75 degrees Fahrenheit or 24 degrees Celsius) and winter at your head (32 degrees Fahrenheit or 0 degrees Celsius).

Occasionally, winds on Mars are strong enough to create dust storms that cover much of the planet. After such storms, it can be months before all of the dust settles.

Mars has no global magnetic field today, but areas of the Martian crust in the southern hemisphere are highly magnetized, indicating traces of a magnetic field from 4 billion years ago.

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Jupiter is a world of extremes. It's the largest planet in our solar system – if it were a hollow shell, 1,000 Earths could fit inside. It's also the oldest planet, forming from the dust and gases left over from the Sun's formation 4.5 billion years ago. But it has the shortest day in the solar system, taking only 10.5 hours to spin around once on its axis.

Jupiter's signature stripes and swirls are actually cold, windy clouds of ammonia and water, floating in an atmosphere of hydrogen and helium. The dark orange stripes are called belts, while the lighter bands are called zones, and they flow east and west in opposite directions. Jupiter’s iconic Great Red Spot is a giant storm bigger than Earth that has raged for hundreds of years.

The king of planets was named for Jupiter, king of the gods in Roman mythology. Most of its moons are also named for mythological characters, figures associated with Jupiter or his Greek counterpart, Zeus.

Jupiter, being the biggest planet, gets its name from the king of the ancient Roman gods.

Jupiter’s environment is probably not conducive to life as we know it. The temperatures, pressures, and materials that characterize this planet are most likely too extreme and volatile for organisms to adapt to.

While planet Jupiter is an unlikely place for living things to take hold, the same is not true of some of its many moons. Europa is one of the likeliest places to find life elsewhere in our solar system. There is evidence of a vast ocean just beneath its icy crust, where life could possibly be supported.

With a radius of 43,440.7 miles (69,911 kilometers), Jupiter is 11 times wider than Earth. If Earth were the size of a grape, Jupiter would be about as big as a basketball.

From an average distance of 484 million miles (778 million kilometers), Jupiter is 5.2 astronomical units away from the Sun. One astronomical unit (abbreviated as AU), is the distance from the Sun to Earth. From this distance, it takes sunlight 43 minutes to travel from the Sun to Jupiter.

Jupiter has the shortest day in the solar system. One day on Jupiter takes only about 10 hours (the time it takes for Jupiter to rotate or spin around once), and Jupiter makes a complete orbit around the Sun (a year in Jovian time) in about 12 Earth years (4,333 Earth days).

Its equator is tilted with respect to its orbital path around the Sun by just 3 degrees. This means Jupiter spins nearly upright and does not have seasons as extreme as other planets do.

With four large moons and many smaller moons, Jupiter forms a kind of miniature solar system.

Jupiter has 95 moons that are officially recognized by the International Astronomical Union. The four largest moons – Io, Europa, Ganymede, and Callisto – were first observed by the astronomer Galileo Galilei in 1610 using an early version of the telescope. These four moons are known today as the Galilean satellites, and they're some of the most fascinating destinations in our solar system.

Io is the most volcanically active body in the solar system. Ganymede is the largest moon in the solar system (even bigger than the planet Mercury). Callisto's very few small craters indicate a small degree of current surface activity. A liquid-water ocean with the ingredients for life may lie beneath the frozen crust of Europa, the target of NASA's Europa Clipper mission slated to launch in 2024.

› More on Jupiter's Moons

Discovered in 1979 by NASA's Voyager 1 spacecraft, Jupiter's rings were a surprise. The rings are composed of small, dark particles, and they are difficult to see except when backlit by the Sun. Data from the Galileo spacecraft indicate that Jupiter's ring system may be formed by dust kicked up as interplanetary meteoroids smash into the giant planet's small innermost moons.

Jupiter took shape along with rest of the solar system about 4.5 billion years ago. Gravity pulled swirling gas and dust together to form this gas giant. Jupiter took most of the mass left over after the formation of the Sun, ending up with more than twice the combined material of the other bodies in the solar system. In fact, Jupiter has the same ingredients as a star, but it did not grow massive enough to ignite.

About 4 billion years ago, Jupiter settled into its current position in the outer solar system, where it is the fifth planet from the Sun.

The composition of Jupiter is similar to that of the Sun – mostly hydrogen and helium. Deep in the atmosphere, pressure and temperature increase, compressing the hydrogen gas into a liquid. This gives Jupiter the largest ocean in the solar system – an ocean made of hydrogen instead of water. Scientists think that, at depths perhaps halfway to the planet's center, the pressure becomes so great that electrons are squeezed off the hydrogen atoms, making the liquid electrically conducting like metal. Jupiter's fast rotation is thought to drive electrical currents in this region, with the spinning of the liquid metallic hydrogen acting like a dynamo, generating the planet's powerful magnetic field.

Deeper down, Jupiter's central core had long been a mystery. Scientists theorized Jupiter was a mostly homogeneous mix of hydrogen and helium gases, surrounding a small, solid core of heavier elements – ice, rock, and metal formed from debris and small objects swirling around that area of the embryonic solar system 4 billion years ago.

NASA's Juno spacecraft, measuring Jupiter's gravity and magnetic field, found data suggesting the core is much larger than expected, and not solid. Instead, it's partially dissolved, with no clear separation from the metallic hydrogen around it, leading researchers to describe the core as dilute, or "fuzzy."

As a gas giant, Jupiter doesn't have a true surface. The planet is mostly swirling gases and liquids. While a spacecraft would have nowhere to land on Jupiter, it wouldn't be able to fly through unscathed either. The extreme pressures and temperatures deep inside the planet crush, melt, and vaporize spacecraft trying to fly into the planet.

Jupiter's appearance is a tapestry of colorful stripes and spots – the cloud bands that encircle the planet, and the cyclonic storms dotting it from pole to pole. The gas planet likely has three distinct cloud layers in its "skies" that, taken together, span about 44 miles (71 kilometers). The top cloud is probably made of ammonia ice, while the middle layer is likely made of ammonium hydrosulfide crystals. The innermost layer may be made of water ice and vapor.

The vivid colors you see in thick bands across Jupiter may be plumes of sulfur and phosphorus-containing gases rising from the planet's warmer interior. Jupiter's fast rotation – spinning once every 10 hours – creates strong jet streams, separating its clouds into dark belts and bright zones across long stretches.

With no solid surface to slow them down, Jupiter's spots can persist for many years. Stormy Jupiter is swept by over a dozen prevailing winds, some reaching up to 335 miles per hour (539 kilometers per hour) at the equator. The Great Red Spot, a swirling oval of clouds twice as wide as Earth, has been observed on the giant planet for more than 300 years. More recently, three smaller ovals merged to form the Little Red Spot, about half the size of its larger cousin.

Findings from NASA's Juno probe released in October 2021 provide a fuller picture of what's going on below those clouds. Data from Juno shows that Jupiter's cyclones are warmer on top, with lower atmospheric densities, while they are colder at the bottom, with higher densities. Anticyclones, which rotate in the opposite direction, are colder at the top but warmer at the bottom.

The findings also indicate these storms are far taller than expected, with some extending 60 miles (100 kilometers) below the cloud tops and others, including the Great Red Spot, extending over 200 miles (350 kilometers). This surprising discovery demonstrates that the vortices cover regions beyond those where water condenses and clouds form, below the depth where sunlight warms the atmosphere.

The height and size of the Great Red Spot mean the concentration of atmospheric mass within the storm potentially could be detectable by instruments studying Jupiter's gravity field. Two close Juno flybys over Jupiter's most famous spot provided the opportunity to search for the storm's gravity signature and complement the other results on its depth.

With their gravity data, the Juno team was able to constrain the extent of the Great Red Spot to a depth of about 300 miles (500 kilometers) below the cloud tops.

Belts and Zones In addition to cyclones and anticyclones, Jupiter is known for its distinctive belts and zones – white and reddish bands of clouds that wrap around the planet. Strong east-west winds moving in opposite directions separate the bands. Juno previously discovered that these winds, or jet streams, reach depths of about 2,000 miles (roughly 3,200 kilometers). Researchers are still trying to solve the mystery of how the jet streams form. Data collected by Juno during multiple passes reveal one possible clue: that the atmosphere's ammonia gas travels up and down in remarkable alignment with the observed jet streams.

Juno's data also shows that the belts and zones undergo a transition around 40 miles (65 kilometers) beneath Jupiter's water clouds. At shallow depths, Jupiter's belts are brighter in microwave light than the neighboring zones. But at deeper levels, below the water clouds, the opposite is true – which reveals a similarity to our oceans.

Polar Cyclones Juno previously discovered polygonal arrangements of giant cyclonic storms at both of Jupiter’s poles – eight arranged in an octagonal pattern in the north and five arranged in a pentagonal pattern in the south. Over time, mission scientists determined these atmospheric phenomena are extremely resilient, remaining in the same location.

Juno data also indicates that, like hurricanes on Earth, these cyclones want to move poleward, but cyclones located at the center of each pole push them back. This balance explains where the cyclones reside and the different numbers at each pole.

The Jovian magnetosphere is the region of space influenced by Jupiter's powerful magnetic field. It balloons 600,000 to 2 million miles (1 to 3 million kilometers) toward the Sun (seven to 21 times the diameter of Jupiter itself) and tapers into a tadpole-shaped tail extending more than 600 million miles (1 billion kilometers) behind Jupiter, as far as Saturn's orbit. Jupiter's enormous magnetic field is 16 to 54 times as powerful as that of the Earth. It rotates with the planet and sweeps up particles that have an electric charge. Near the planet, the magnetic field traps swarms of charged particles and accelerates them to very high energies, creating intense radiation that bombards the innermost moons and can damage spacecraft.

Jupiter's magnetic field also causes some of the solar system's most spectacular aurorae at the planet's poles.

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Saturn is the sixth planet from the Sun, and the second-largest planet in our solar system.

Like fellow gas giant Jupiter, Saturn is a massive ball made mostly of hydrogen and helium. Saturn is not the only planet to have rings, but none are as spectacular or as complex as Saturn's. Saturn also has dozens of moons.

From the jets of water that spray from Saturn's moon Enceladus to the methane lakes on smoggy Titan, the Saturn system is a rich source of scientific discovery and still holds many mysteries.

The farthest planet from Earth discovered by the unaided human eye, Saturn has been known since ancient times. The planet is named for the Roman god of agriculture and wealth, who was also the father of Jupiter.

Saturn's environment is not conducive to life as we know it. The temperatures, pressures, and materials that characterize this planet are most likely too extreme and volatile for organisms to adapt to.

While planet Saturn is an unlikely place for living things to take hold, the same is not true of some of its many moons. Satellites like Enceladus and Titan, home to internal oceans, could possibly support life.

With an equatorial diameter of about 74,897 miles (120,500 kilometers), Saturn is 9 times wider than Earth. If Earth were the size of a nickel, Saturn would be about as big as a volleyball.

From an average distance of 886 million miles (1.4 billion kilometers), Saturn is 9.5 astronomical units away from the Sun. One astronomical unit (abbreviated as AU), is the distance from the Sun to Earth. From this distance, it takes sunlight 80 minutes to travel from the Sun to Saturn.

Saturn has the second-shortest day in the solar system. One day on Saturn takes only 10.7 hours (the time it takes for Saturn to rotate or spin around once), and Saturn makes a complete orbit around the Sun (a year in Saturnian time) in about 29.4 Earth years (10,756 Earth days).

Its axis is tilted by 26.73 degrees with respect to its orbit around the Sun, which is similar to Earth's 23.5-degree tilt. This means that, like Earth, Saturn experiences seasons.

Saturn is home to a vast array of intriguing and unique worlds. From the haze-shrouded surface of Titan to crater-riddled Phoebe, each of Saturn's moons tells another piece of the story surrounding the Saturn system. As of June 8, 2023, Saturn has 146 moons in its orbit, with others continually awaiting confirmation of their discovery and official naming by the International Astronomical Union (IAU).

Saturn's rings are thought to be pieces of comets, asteroids, or shattered moons that broke up before they reached the planet, torn apart by Saturn's powerful gravity. They are made of billions of small chunks of ice and rock coated with other materials such as dust. The ring particles mostly range from tiny, dust-sized icy grains to chunks as big as a house. A few particles are as large as mountains. The rings would look mostly white if you looked at them from the cloud tops of Saturn, and interestingly, each ring orbits at a different speed around the planet.

Saturn's spokes are transient features that rotate along with the rings.

Saturn's ring system extends up to 175,000 miles (282,000 kilometers) from the planet, yet the vertical height is typically about 30 feet (10 meters) in the main rings. Named alphabetically in the order they were discovered, the rings are relatively close to each other, with the exception of a gap measuring 2,920 miles (4,700 kilometers) in width called the Cassini Division that separates Rings A and B. The main rings are A, B, and C. Rings D, E, F, and G are fainter and more recently discovered.

Starting at Saturn and moving outward, there is the D ring, C ring, B ring, Cassini Division, A ring, F ring, G ring, and finally, the E ring. Much farther out, there is the very faint Phoebe ring in the orbit of Saturn's moon Phoebe.

Saturn took shape when the rest of the solar system formed about 4.5 billion years ago when gravity pulled swirling gas and dust in to become this gas giant. About 4 billion years ago, Saturn settled into its current position in the outer solar system, where it is the sixth planet from the Sun. Like Jupiter, Saturn is mostly made of hydrogen and helium, the same two main components that make up the Sun.

Like Jupiter, Saturn is made mostly of hydrogen and helium. At Saturn's center is a dense core of metals like iron and nickel surrounded by rocky material and other compounds solidified by intense pressure and heat. It is enveloped by liquid metallic hydrogen inside a layer of liquid hydrogen –similar to Jupiter's core but considerably smaller.

It's hard to imagine, but Saturn is the only planet in our solar system with an average density that is less than water. The giant gas planet could float in a bathtub if such a colossal thing existed.

As a gas giant, Saturn doesn’t have a true surface. The planet is mostly swirling gases and liquids deeper down. While a spacecraft would have nowhere to land on Saturn, it wouldn’t be able to fly through unscathed either. The extreme pressures and temperatures deep inside the planet would crush, melt, and vaporize any spacecraft trying to fly into the planet.

Saturn is blanketed with clouds that appear as faint stripes, jet streams, and storms. The planet is many different shades of yellow, brown, and gray.

Winds in the upper atmosphere reach 1,600 feet per second (500 meters per second) in the equatorial region. In contrast, the strongest hurricane-force winds on Earth top out at about 360 feet per second (110 meters per second). And the pressure – the same kind you feel when you dive deep underwater – is so powerful it squeezes gas into a liquid.

Saturn's north pole has an interesting atmospheric feature – a six-sided jet stream. This hexagon-shaped pattern was first noticed in images from the Voyager I spacecraft and has been more closely observed by the Cassini spacecraft since. Spanning about 20,000 miles (30,000 kilometers) across, the hexagon is a wavy jet stream of 200-mile-per-hour winds (about 322 kilometers per hour) with a massive, rotating storm at the center. There is no weather feature like it anywhere else in the solar system.

Saturn's magnetic field is smaller than Jupiter's but still 578 times as powerful as Earth's. Saturn, the rings, and many of the satellites lie totally within Saturn's enormous magnetosphere, the region of space in which the behavior of electrically charged particles is influenced more by Saturn's magnetic field than by the solar wind.

Aurorae occur when charged particles spiral into a planet's atmosphere along magnetic field lines. On Earth, these charged particles come from the solar wind. Cassini showed that at least some of Saturn's aurorae are like Jupiter's and are largely unaffected by the solar wind. Instead, these aurorae are caused by a combination of particles ejected from Saturn's moons and Saturn's magnetic field's rapid rotation rate. But these "non-solar-originating" aurorae are not completely understood yet.

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Uranus is the seventh planet from the Sun, and it has the third largest diameter of planets in our solar system. Uranus appears to spin sideways.

Uranus is a very cold and windy world. The ice giant is surrounded by 13 faint rings and 28 small moons. Uranus rotates at a nearly 90-degree angle from the plane of its orbit. This unique tilt makes Uranus appear to spin sideways, orbiting the Sun like a rolling ball.

Uranus was the first planet found with the aid of a telescope. It was discovered in 1781 by astronomer William Herschel, although he originally thought it was either a comet or a star. It was two years later that the object was universally accepted as a new planet, in part because of observations by astronomer Johann Elert Bode.

William Herschel tried unsuccessfully to name his discovery Georgium Sidus after King George III. Instead, the planet was named for Uranus, the Greek god of the sky, as suggested by Johann Bode.

Uranus' environment is not conducive to life as we know it. The temperatures, pressures, and materials that characterize this planet are most likely too extreme and volatile for organisms to adapt to.

With an equatorial diameter of 31,763 miles (51,118 kilometers), Uranus is four times wider than Earth. If Earth was the size of a nickel, Uranus would be about as big as a softball.

From an average distance of 1.8 billion miles (2.9 billion kilometers), Uranus is about 19 astronomical units away from the Sun. One astronomical unit (abbreviated as AU), is the distance from the Sun to Earth. From this distance, it takes sunlight 2 hours and 40 minutes to travel from the Sun to Uranus.

One day on Uranus takes about 17 hours. This is the amount of time it takes Uranus to rotate, or spin once around its axis. Uranus makes a complete orbit around the Sun (a year in Uranian time) in about 84 Earth years (30,687 Earth days).

Uranus is the only planet whose equator is nearly at a right angle to its orbit, with a tilt of 97.77 degrees. This may be the result of a collision with an Earth-sized object long ago. This unique tilt causes Uranus to have the most extreme seasons in the solar system. For nearly a quarter of each Uranian year, the Sun shines directly over each pole, plunging the other half of the planet into a 21-year-long, dark winter.

Uranus is also one of just two planets that rotate in the opposite direction than most of the planets. Venus is the other.

Uranus has 28 known moons. While most of the satellites orbiting other planets take their names from Greek or Roman mythology, Uranus' moons are unique in being named for characters from the works of William Shakespeare and Alexander Pope.

All of Uranus' inner moons appear to be roughly half water ice and half rock. The composition of the outer moons remains unknown, but they are likely captured asteroids.

Uranus has two sets of rings. The inner system of nine rings consists mostly of narrow, dark grey rings. There are two outer rings: the innermost one is reddish like dusty rings elsewhere in the solar system, and the outer ring is blue like Saturn's E ring.

In order of increasing distance from the planet, the rings are called Zeta, 6, 5, 4, Alpha, Beta, Eta, Gamma, Delta, Lambda, Epsilon, Nu, and Mu. Some of the larger rings are surrounded by belts of fine dust.

Following in the footsteps of the Neptune image released in 2022, NASA's James Webb Space Telescope has taken a stunning…

Uranus took shape when the rest of the solar system formed about 4.5 billion years ago – when gravity pulled swirling gas and dust in to become this ice giant. Like its neighbor Neptune, Uranus likely formed closer to the Sun and moved to the outer solar system about 4 billion years ago, where it is the seventh planet from the Sun.

Uranus is one of two ice giants in the outer solar system (the other is Neptune). Most (80% or more) of the planet's mass is made up of a hot dense fluid of "icy" materials – water, methane, and ammonia – above a small rocky core. Near the core, it heats up to 9,000 degrees Fahrenheit (4,982 degrees Celsius).

Uranus is slightly larger in diameter than its neighbor Neptune, yet smaller in mass. It is the second least dense planet; Saturn is the least dense of all.

Uranus gets its blue-green color from methane gas in the atmosphere. Sunlight passes through the atmosphere and is reflected back out by Uranus' cloud tops. Methane gas absorbs the red portion of the light, resulting in a blue-green color.

As an ice giant, Uranus doesn't have a true surface. The planet is mostly swirling fluids. While a spacecraft would have nowhere to land on Uranus, it wouldn't be able to fly through its atmosphere unscathed either. The extreme pressures and temperatures would destroy a metal spacecraft.

Uranus' atmosphere is mostly hydrogen and helium, with a small amount of methane and traces of water and ammonia. The methane gives Uranus its signature blue color.

While Voyager 2 saw only a few discrete clouds, a Great Dark Spot, and a small dark spot during its flyby in 1986 – more recent observations reveal that Uranus exhibits dynamic clouds as it approaches equinox, including rapidly changing bright features.

Uranus' planetary atmosphere, with a minimum temperature of 49K (-224.2 degrees Celsius) makes it even colder than Neptune in some places.

Wind speeds can reach up to 560 miles per hour (900 kilometers per hour) on Uranus. Winds are retrograde at the equator, blowing in the reverse direction of the planet's rotation. But closer to the poles, winds shift to a prograde direction, flowing with Uranus' rotation.

Uranus has an unusual, irregularly shaped magnetosphere. Magnetic fields are typically in alignment with a planet's rotation, but Uranus' magnetic field is tipped over: the magnetic axis is tilted nearly 60 degrees from the planet's axis of rotation, and is also offset from the center of the planet by one-third of the planet's radius.

Uranus has auroras, but they are not in line with the poles like they are on Earth, Jupiter, and Saturn. This is due to the planet's lopsided magnetic field.

The magnetosphere tail behind Uranus opposite the Sun extends into space for millions of miles. Its magnetic field lines are twisted by Uranus' sideways rotation into a long corkscrew shape.

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Neptune is the eighth and most distant planet in our solar system.

Dark, cold, and whipped by supersonic winds, ice giant Neptune is more than 30 times as far from the Sun as Earth. Neptune is the only planet in our solar system not visible to the naked eye. In 2011 Neptune completed its first 165-year orbit since its discovery in 1846.

Neptune is so far from the Sun that high noon on the big blue planet would seem like dim twilight to us. The warm light we see here on our home planet is roughly 900 times as bright as sunlight on Neptune.

The ice giant Neptune was the first planet located through mathematical calculations. Using predictions made by Urbain Le Verrier, Johann Galle discovered the planet in 1846. The planet is named after the Roman god of the sea, as suggested by Le Verrier.

Neptune's environment is not conducive to life as we know it. The temperatures, pressures, and materials that characterize this planet are most likely too extreme, and volatile for organisms to adapt to.

With an equatorial diameter of 30,775 miles (49,528 kilometers), Neptune is about four times wider than Earth. If Earth were the size of a nickel, Neptune would be about as big as a baseball.

From an average distance of 2.8 billion miles (4.5 billion kilometers), Neptune is 30 astronomical units away from the Sun. One astronomical unit (abbreviated as AU), is the distance from the Sun to Earth. From this distance, it takes sunlight 4 hours to travel from the Sun to Neptune.

One day on Neptune takes about 16 hours (the time it takes for Neptune to rotate or spin once). And Neptune makes a complete orbit around the Sun (a year in Neptunian time) in about 165 Earth years (60,190 Earth days).

Sometimes Neptune is even farther from the Sun than dwarf planet Pluto. Pluto's highly eccentric, oval-shaped orbit brings it inside Neptune's orbit for a 20-year period every 248 Earth years. This switch, in which Pluto is closer to the Sun than Neptune, happened most recently from 1979 to 1999. Pluto can never crash into Neptune, though, because for every three laps Neptune takes around the Sun, Pluto makes two. This repeating pattern prevents close approaches of the two bodies.

Neptune’s axis of rotation is tilted 28 degrees with respect to the plane of its orbit around the Sun, which is similar to the axial tilts of Mars and Earth. This means that Neptune experiences seasons just like we do on Earth; however, since its year is so long, each of the four seasons lasts for over 40 years.

Neptune has 16 known moons. Neptune's largest moon Triton was discovered on Oct. 10, 1846, by William Lassell, just 17 days after Johann Gottfried Galle discovered the planet. Since Neptune was named for the Roman god of the sea, its moons are named for various lesser sea gods and nymphs in Greek mythology.

Triton is the only large moon in the solar system that circles its planet in a direction opposite to the planet's rotation (a retrograde orbit), which suggests that it may once have been an independent object that Neptune captured. Triton is extremely cold, with surface temperatures around minus 391 degrees Fahrenheit (minus 235 degrees Celsius). And yet, despite this deep freeze at Triton, Voyager 2 discovered geysers spewing icy material upward more than 5 miles (8 kilometers). Triton's thin atmosphere, also discovered by Voyager, has been detected from Earth several times since, and is growing warmer, but scientists do not yet know why.

Neptune has at least five main rings and four prominent ring arcs that we know of so far. Starting near the planet and moving outward, the main rings are named Galle, Leverrier, Lassell, Arago, and Adams. The rings are thought to be relatively young and short-lived.

Neptune's ring system also has peculiar clumps of dust called arcs. Four prominent arcs named Liberté (Liberty), Egalité (Equality), Fraternité (Fraternity), and Courage are in the outermost ring, Adams. The arcs are strange because the laws of motion would predict that they would spread out evenly rather than stay clumped together. Scientists now think the gravitational effects of Galatea, a moon just inward from the ring, stabilizes these arcs.

Neptune took shape when the rest of the solar system formed about 4.5 billion years ago when gravity pulled swirling gas and dust in to become this ice giant. Like its neighbor Uranus, Neptune likely formed closer to the Sun and moved to the outer solar system about 4 billion years ago.

Neptune is one of two ice giants in the outer solar system (the other is Uranus). Most (80% or more) of the planet's mass is made up of a hot dense fluid of "icy" materials – water, methane, and ammonia – above a small, rocky core. Of the giant planets, Neptune is the densest.

Scientists think there might be an ocean of super hot water under Neptune's cold clouds. It does not boil away because incredibly high pressure keeps it locked inside.

Neptune does not have a solid surface. Its atmosphere (made up mostly of hydrogen, helium, and methane) extends to great depths, gradually merging into water and other melted ices over a heavier, solid core with about the same mass as Earth.

Neptune's atmosphere is made up mostly of hydrogen and helium with just a little bit of methane. Neptune's neighbor Uranus has a similar makeup; the methane absorbs other colors but reflects blue, giving these ice giants their similar hue. Many images of Neptune, coming from the Voyager 2 flyby in 1989, show Neptune as a much deeper blue. This was because the Voyager team tweaked the images, to better reveal clouds and other distinctive features on the planet, compared to the hazy, uniform view of Uranus that Voyager 2 had captured in 1986. Researchers in 2024 re-processed the images, showing the planets look much more alike than many thought.

Neptune is our solar system's windiest world. Despite its great distance and low energy input from the Sun, Neptune's winds can be three times stronger than Jupiter's and nine times stronger than Earth's. These winds whip clouds of frozen methane across the planet at speeds of more than 1,200 miles per hour (2,000 kilometers per hour). Even Earth's most powerful winds hit only about 250 miles per hour (400 kilometers per hour).

In 1989 a large, oval-shaped storm in Neptune's southern hemisphere dubbed the "Great Dark Spot" was large enough to contain the entire Earth. That storm has since disappeared, but new ones have appeared on different parts of the planet.

The main axis of Neptune's magnetic field is tipped over by about 47 degrees compared with the planet's rotation axis. Like Uranus, whose magnetic axis is tilted about 60 degrees from the axis of rotation, Neptune's magnetosphere undergoes wild variations during each rotation because of this misalignment. The magnetic field of Neptune is about 27 times more powerful than that of Earth.

Sun

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Kuiper Belt

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From lighting up our skies to maintaining a geological record of our solar system's history, Earth's closest celestial neighbor plays a pivotal role in the studies of our planet and our solar system.

The Moon is about 27% the size of Earth.

We always see the same side of the Moon.

The Moon has a solid, rocky surface.

There's no rain or wind, but there is weather.

24 humans and more than 100 robots visited.

Earth's Moon is the brightest and largest object in our night sky. The Moon makes Earth a more livable planet by moderating our home planet's wobble on its axis, leading to a relatively stable climate. It also causes tides, creating a rhythm that has guided humans for thousands of years.

The Moon was likely formed after a Mars-sized body collided with Earth several billion years ago.

Earth's only natural satellite is simply called "the Moon" because people didn't know other moons existed until Galileo Galilei discovered four moons orbiting Jupiter in 1610. In Latin, the Moon was called Luna, which is the main adjective for all things Moon-related: lunar.

This visualization shows the Moon's phase at hourly intervals throughout 2024, as viewed from the Northern Hemisphere.

Why can I see the Moon during the day? And other frequently asked questions about our Moon.

When the full moon is a little bit closer to us than usual, it appears especially large and bright in the sky.

What does “weather” mean on a world with practically no atmosphere? Explore extreme lunar surface conditions here.

There’s water on the Moon. Follow the thread of discoveries that led up to the confirmation of its presence in 2020.

Several theories vie for dominance but most agree on one thing — Earth's Moon was born from destruction.

As distant as the Moon may seem, its gravitational pull on Earth plays a huge role in the formation of tides.

The Moon's far side gets as much sunlight as its near side.

Like Earth, the Moon has a day side and a night side, which change as the Moon rotates. The Sun always illuminates half of the Moon while the other half remains dark. NASA’s LRO mission has used its seven science instruments to map the entire lunar surface, including the Moon's near and far sides, down to a scale of one meter.

NASA’s interactive map for observing the Moon each day of the year.

Spend the next month getting to know the Moon.

On Sept 14, 2024, celebrate lunar observation, science, and exploration.

NASA to Measure Moonquakes With Help From InSight Mars Mission

Good Night, Moon

NASA’s New Mobile Launcher Stacks Up for Future Artemis Missions

A Moonlit Trio

Navigating the Moon with Art

Facts About Earth

Mars

Saturn

Uranus

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The Sun is the star at the heart of our solar system. Its gravity holds the solar system together, keeping everything – from the biggest planets to the smallest bits of debris – in its orbit.

The Sun's gravity holds the solar system together, keeping everything – from the biggest planets to the smallest particles of debris – in its orbit. The connection and interactions between the Sun and Earth drive the seasons, ocean currents, weather, climate, radiation belts and auroras. Though it is special to us, there are billions of stars like our Sun scattered across the Milky Way galaxy.

The Sun has many names in many cultures. The Latin word for Sun is “sol,” which is the main adjective for all things Sun-related: solar.

The Sun has inspired us since ancient times. It’s central to mythology and religion in cultures around the world, including the ancient Egyptians, the Aztecs of Mexico, Native American tribes of North and South America, the Chinese, and many others.

Countless musicians have written songs about the Sun. The Beatles had a hit in 1969 with “Here Comes the Sun.” Other popular songs that reference the Sun include: “Walkin’ on the Sun” by Smashmouth; “Ain’t No Sunshine” by Bill Withers; “Walking on Sunshine” by Katrina and the Waves; “Pocketful of Sunshine” by Natasha Bedingfield; and “Let the Sunshine In” by the Fifth Dimension.

If you're Superman or a fellow Kryptonian of comic book fame, your powers are heightened by the yellow glow of our Sun. There are several science fiction films featuring the Sun in the storyline.

Everything you need to know about viewing the 2023 Annular Solar Eclipse and the 2024 Total Solar Eclipse.

It is not safe to look directly at the Sun without specialized eye protection for solar viewing.

Scientists, engineers, and educators who are passionate about making heliophysics accessible to everyone.

How NASA Tracked the Most Intense Solar Storm in Decades

2024 Total Solar Eclipse: Prediction vs. Reality

NASA Scientists Gear Up for Solar Storms at Mars

NASA Observations Find What Helps Heat Roots of ‘Moss’ on Sun

The April 8 Total Solar Eclipse: Through the Eyes of NASA

Facts and activities for K-4 explorers.

Images and videos of scientific interest.

Mercury

Venus

Facts About Earth

Mars

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Mars has two moons, Phobos and Deimos. Both are thought to be captured asteroids, or debris from early in the formation of our solar system. Phobos is the larger of Mars' two moons. It orbits Mars three times a day, and is so close to the planet's surface that in some locations on Mars it cannot always be seen. Phobos is nearing Mars at a rate of six feet (1.8 meters) every hundred years. At that rate, it will either crash into Mars in 50 million years or break up into a ring. Deimos is the smaller moon. It orbits Mars every 30 hours.

Mars

August 1877

2

Asaph Hall

Phobos is on a collision course with Mars.

Deimos is a small and lumpy, heavily cratered object.

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Jupiter has 95 moons that have been officially recognized by the International Astronomical Union. But the number doesn't capture the complexity of the Jovian system of moons, rings and asteroids. The giant planet has thousands of small objects in its orbit. Scientists are getting so good at spotting tiny moons orbiting distant, giant planets that the International Astronomical Union has decided the smallest will no longer be given mythological names unless they are of “significant” scientific interest.

Jovian System

Jan. 7, 1610

95

Europa Clipper

Jupiter's four largest moons were the first moons discovered beyond Earth. They are called the Galilean satellites after Italian astronomer Galileo Galilei, who is credited with their discovery in 1610. German astronomer Simon Marius observed them around the same time, but is largely forgotten because he published his findings after Galileo. But the names Marius proposed for the moons in 1614 (mythological characters associated with Jupiter, suggested to him by fellow astronomer Johannes Kepler) are the ones we use today — Ganymede, Callisto, Io, and Europa. Here they are in order of size:

Ganymede is Jupiter's largest moon, and the largest moon in our solar system. It's even bigger than Mercury, and Pluto.

Callisto is Jupiter’s second largest moon and the third largest moon in our solar system.

Io is Jupiter's third largest moon, and the most volcanically active world in our solar system.

Europa is Jupiter's fourth largest moon. It's about 90% the size of Earth’s Moon.

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The Saturn system teems with natural satellites, from planet-sized Titan to small oddballs, shaped like potatoes or ravioli.

As of June 8, 2023, Saturn has 146 moons in its orbit. The moons range in size from larger than the planet Mercury – the giant moon Titan – to as small as a sports arena. The small moon Enceladus has a global ocean under a thick, icy shell. Scientists have identified both moons as high-priority science destinations for future deep space missions.

Saturn's moons shape, contribute to, and also collect material from Saturn's rings and magnetosphere.

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Uranus has 28 known moons, including five major moons: Miranda, Ariel, Umbriel, Titania, and Oberon.

The moons are sometimes called the "literary moons" because they are named for Shakespearean characters, along with a couple of the moons being named for characters from the works of Alexander Pope.

The most recently discovered moon was first spotted in November 2023. It's currently designated at S/2023 U1, and will eventually be named for a literary character like the other moons of Uranus.

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We don't know if William Lassell had a celebratory beverage after he discovered Neptune's moon, Triton, but beer helped make the finding possible. Lassell was one of 19th century England's grand amateur astronomers. He used the fortune he made in the brewery business to finance his telescopes. He spotted Triton on Oct. 10, 1846 – just 17 days after a Berlin observatory discovered Neptune. Scientists using telescopes and spacecraft have found more moons, bringing the total number of moons orbiting this distant, giant world to 16. More ›

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Our solar system's small bodies pack big surprises.

Rocky leftovers from planet formation.

Cosmic snowballs of gas and dust.

Bits of debris that fall through the atmosphere.

Protect Earth from impacts.

Asteroids, comets, and meteors are chunks of rock, ice, and metal left over from the formation of our solar system 4.6 billion years ago. They are a lot like a fossil record of our early solar system.

There are currently about 1.3 million known asteroids, and more than 3,800 known comets.

NASA Lucy Images Reveal Asteroid Dinkinesh to be Surprisingly Complex

NASA's OSIRIS-APEX Unscathed After Searing Pass of Sun

NASA's Psyche Fires Up Its Sci-Fi-Worthy Thrusters

Hubble Goes Hunting for Small Main Belt Asteroids

NASA's NEOWISE Extends Legacy With Decade of Near-Earth Object Data

To date, NASA-sponsored surveys have provided over 95% of all Near-Earth Object discoveries.

NASA

Planetary Defense Coordination Office (PDCO)

Activities that can be done at home as well as videos, animations, stories, and articles.

Facts and activities for K-4 explorers.

Shooting stars are actually bits of debris that fall through our atmosphere.

NASA explores the unknown in air and space, innovates for the benefit of humanity, and inspires the world through discovery.

Asteroids, sometimes called minor planets, are rocky, airless remnants left over from the early formation of our solar system about 4.6 billion years ago.

The current known asteroid count is at least 1,351,400.

Most of this ancient space rubble can be found orbiting the Sun between Mars and Jupiter within the main asteroid belt. Asteroids range in size from Vesta – the largest at about 329 miles (530 kilometers) in diameter – to bodies that are less than 33 feet (10 meters) across. The total mass of all the asteroids combined is less than that of Earth's Moon.

The total mass of all the asteroids in the main asteroid belt combined is less than that of Earth's Moon.

During the close approach of 2008 OS7 with Earth on Feb. 2, the agency's Deep Space Network planetary radar gathered…

The Center for NEO Studies (CNEOS) computes high-precision orbits for Near-Earth Objects (NEOs) in support of NASA's Planetary Defense Coordination Office.

An alphabetical list of asteroid names.

Kuiper Belt

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Comets are frozen leftovers from the formation of the solar system composed of dust, rock, and ices. They range from a few miles to tens of miles wide, but as they orbit closer to the Sun, they heat up and spew gases and dust into a glowing head that can be larger than a planet. This material forms a tail that stretches millions of miles.

Comets are cosmic snowballs of frozen gases, rock, and dust that orbit the Sun. When frozen, they are the size of a small town. When a comet's orbit brings it close to the Sun, it heats up and spews dust and gases into a giant glowing head larger than most planets. The dust and gases form a tail that stretches away from the Sun for millions of miles. There are likely billions of comets orbiting our Sun in the Kuiper Belt and even more distant Oort Cloud.

The current number of known comets is about 3,944.

Explore images of asteroids and comets taken by NASA's robotic spacecraft.

Fact sheets, FAQs, and information about missions to explore comets.

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They're all related to the flashes of light called "shooting stars" sometimes seen streaking across the sky. But we call the same object by different names, depending on where it is.

Kuiper Belt

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Oort's cloud is the most distant region of our solar system, many times further than the distant Kuiper belt.While the orbits of the planets and even Kuiper's belt are mainly found in the same flat disc around the sun, it is believed that Oort's cloud is a giant spherical shell that surrounds the rest of the solar system.The rotation movement of the planetary disk from which the planets were formed can be seen as a result of the conservation of the angular momentum where any angular movement of the cloud from which the solar system was formed is accentuated by the "skater effectrotary".When the dough approaches the axis of rotation, the angular velocity increases.But external gaseous material such as water molecules may not completely share that angular momentum and remain as an almost spherical cloud.Subsequent condensation and accumulation could produce pieces of frozen material.

It is suspected that Oort's cloud is the source of comets, partly because the periods of some of the comets are very long.For example, comet C/2013 A1 Siding Spring, which took a step very close to Mars in 2014, will not return to the interior solar system for approximately 740,000 years.(Artistic conception of the comet near NASA Mars).

Image of Wikipedia Although it is believed that the long period comets observed between the planets originate in the Oort cloud, no object has been observed in the distant Oort cloud, so for the moment it is a theoretical concept.But it is still the most accepted explanation of the origin of the long period comets.Dutch astronomasteroids and Kuiper's belt.A of the Sun. The outer edge is even more uncertain, perhaps 10,000 or even 100,000 UA.That large number is more than a room on the road to the closest star, next Centauri.It is considered that it extends more than a thousand times farther from the sun than Kuiper's belt.

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Beyond the orbit of Neptune, between approximately 30 and 100 Astronomical Units (AU) from the Sun, lies another collection of objects forming a belt similar to the asteroid belt.

This region is known as the Kuiper Belt, named after Gerard Kuiper, a pioneer in planetary astronomy. A number of Kuiper Belt Objects (KBOs) with diameters ranging from 100 to 400 kilometers have been discovered. It is believed that the Kuiper Belt is the origin of many short-period comets. Pluto and its moon, Charon, are similar to KBOs, which is one of the reasons Pluto was reclassified from its status as a full planet.

While the objects in the main asteroid belt are mostly rocky, it is believed that the objects in the Kuiper Belt are primarily composed of ice. In addition to water ice, there may be significant amounts of frozen methane and ammonia. Besides Pluto, two other dwarf planets, Haumea and Makemake, are considered part of the Kuiper Belt. The Kuiper Belt object 2014 MU69, also known as Arrokoth, became a target for the New Horizons spacecraft after it passed Pluto.

In July 2005, a team of scientists announced the discovery of a Kuiper Belt object similar in size to Pluto, named Eris. Eris orbits the Sun once every 560 years, with its distance from the Sun varying between approximately 38 and 98 AU. (In comparison, Pluto's orbit ranges from 29 to 49 AU.) Eris has a small moon named Dysnomia. Eris, Pluto, and the asteroid Ceres are classified as dwarf planets.

The Kuiper Belt is a fascinating region that continues to reveal new insights about the outer Solar System and the formation of planetary bodies. For more detailed information, you can visit [NASA's Solar System Exploration page](#) .

The first artificial satellite of the Earth was the Russian Sputnik.The year of the 1957 launch marked the beginning of the space era.The first US satellite was the Explorer, who discovered the Van Allen Interior radiation belt.The Vangaurd rocket series in the late 50s also contributed.The Pioneer series began with the 1-3 in 1958, giving new data about the Earth, including the discovery of the second belt of Van Allen.

Sputnik 1 was the first artificial satellite of the Earth successfully.It was launched by the Soviet Union in October 1957. It was an aluminum sphere of 58 cm in diameter with a mass of 83 kg.He moved in orbit around the earth in 96.2 minutes, in an elliptical orbit with apogee of 946 kilometers, and perigns of 227 kilometers.He carried instruments that transmitted data on cosmic rays, meteorites, temperature and air density.It lasted 57 days before decaying of the orbit that led him to a reentry of fire in the atmosphere.

Sputnik 2 was released on November 3, 1957 with a dog on board and transmitted the first physiological data from space.Sputnik 2 remained in space for 162 days.The US launched its first satellite, Explorer 1, on January 31, 1958 while Sputnik 2 was still in space.

The Sputnik 3, launched on May 15, 1958, was a massive spacecraft of 1,327 kg, which spent two years high by measuring solar radiation, cosmic rays, and magnetic fields.

Encouraged by the previous launch of the Sputnik of the Soviet Union, the US launched its first satellite, the explorer 1, on January 31, 1958. It was a cylindrical spacecraft 15 cm in diameter and a length of 203 cm witha mass of 14 kg.He transmitted measurements of cosmic rays for 112 days and gave the first satellite data on radiation.

These data led to the discovery of Van Allen's belts.He had a Geiger counter for radiation detection.

After the launch of the Vanguard 2, the explorer 3 was launched on March 26, 1958.

The Vangaurd 2 was launched by the US on March 17, 1958. It transmitted data that allowed the precise measurement of the Earth and showed that the Earth has a pear form slightly.The Vangaurd had a solar cell matrix to feed it and was able to transmit signals for more than six years.

The Apollo 11 and 12 missions successfully landed on smooth lunar mares, while Apollo missions 14 through 17 targeted more rugged and mountainous regions to collect a wider variety of samples.

Apollo 7: Launched on October 11, 1968, this was the first manned mission of the Apollo program. It was an 11-day Earth orbital mission for three astronauts, providing the opportunity to test the command module. It was also the first manned launch of the Saturn 1B launch vehicle.

Apollo 8: Launched on December 21, 1968, it was the first manned spacecraft to orbit the Moon. During this mission, astronaut William Anders took the famous "Earthrise" photograph.

Apollo 9 and 10: These missions orbited the Moon and carried the lunar module for testing, but did not plan to land. Apollo missions 8 through 10 were launched with the Saturn V launch vehicle.

Apollo 11: Launched on July 16, 1969, it made history as the first manned Moon landing. Neil Armstrong was the first human to walk on the Moon, followed by Buzz Aldrin.

Apollo 12: Launched on November 14, 1969, this mission landed the lunar module 200 meters from the Surveyor 3 probe. The second manned lunar landing mission included astronauts Charles (Pete) Conrad, Richard F. Gordon, and Alan L. Bean. They achieved a precision landing using the onboard automatic guidance system, crucial for future missions exploring the more rugged lunar highlands.

During Apollo 12, there were two EVAs (extravehicular activities) on the lunar surface. The first EVA lasted four hours, during which they set up a solar wind experiment and collected lunar samples. In the second EVA, they covered 1,311 meters while collecting more samples, mostly basalt. Radiometric dating showed these samples were hundreds of millions of years younger than those from Apollo 11.

After departing the lunar surface, the descent stage was remotely guided to impact the Moon's surface to provide a seismic source for the seismic detection equipment left on the Moon.

Apollo 13: Launched on April 11, 1970, this mission experienced an explosion en route, leading to the crew circumnavigating the Moon and returning safely to Earth. The mission faced early challenges, including a premature engine shutdown and a subsequent unrelated explosion in the service module. The crew took refuge in the lunar module and returned to Earth after a single pass around the Moon.

The image shown is a full -size engineering model, of the Surveyor Robotics Lunar spacecraft, on the beach in Los Angeles.The Surveyors threw themselves into the moon between 1966 and 1968 to make soft landings, as precursors of Apollo's astronaut missions.The successful missions were the Surveyor 1 on June 2, 1966, La Surveyor 3 on 1967 and the Surveyor 7 on January 9, 1968.

This view near the Tycho crater is part of a circular mosaic of hundreds of TV photos, taken by the Surveyor 7 on January 1968. The large rock in the foreground has 60 cm (2 feet) wide.At the bottom on the right there is a 6.1 m (20 feet) rock about 366 meters (400 yards) away.The hills in the center of the horizon are a little less than 13 km (8 miles) away.

Surveyor 7 was launched on January 6, 1968 and the soft landing on the Moon, occurred on January 9.The ship returned with 21,038 television images and data from other experiments.The Surveyor 7 operated during a second lunar day.The last signal was received on February 20, about 18 hours before the Lunar Sun

The Surveyor program made detailed images of the Moon in preparation of the subsequent lunar exploration missions.

The Apollo 12 mission alunizó in view of the Surveyor 3 probe on the moon.

The Pioneer series was a long-term space of space probes, which began with the pioneers 1-3 in 1958, which never went far from the earth, but which provided new data on this, Van Allen's belts, the fieldsmagnetic, etc.The Pioneer 4 reached less than 60,000 kilometers from the moon in 1959, but it was eclipsed by the Soviet moon that had gone to 7,500 kilometers two months before.After intervening in deep space probes that gave a lot of information about the sun, the pioneer 10 was launched out, towards Jupiter.After passing through the unharmed asteroid belt, the pioneer 10 passed Jupiter on December 3, 1973 and continued to send data after having passed the Pluto orbit, in April 1983.

The Pioneer 11 was launched in April 1973 and arrived in Saturn on September 1, 1979. It reached 21,000 kilometers from Saturn and only 2,000 to 10,000 km below the visible rings.The Pioneer Venus was launched on May 20, 1978 and was inserted into an orbit around Venus on December 4, 1978 (a 198 -day trip).The Pioneer Venus launched a "multisanda" that consisted of five separate instrument packages, on August 8, 1978, and arrived in Venus on December 9, 1978 (a 123 -day trip).At this point he made a descent of one hour to the surface of Venus, returning information on the variation of the density, temperature, and chemical composition of the atmosphere with the height.The orbiter stayed at an altitude of 150 km and mapped most of the planet's surface.

The Pioneer 4 was the first US spacecraft to escape from the earth.It was thrown on March 3, 1959 and passed the moon at a distance of 60,000 km (37,300 miles).It was followed up to 655,000 kilometers before its batteries were exhausted in approximately 84 hours.The pioneer 3 was the same type of ship.It was launched on December 6, 1958, reached an altitude of 101,367 kilometers, but could not escape the severity of the earth.He resent the atmosphere after 38 hours.The Geiger-Mueller counters aboard the pioneers 3 and 4, discovered and mapped Van Allen's second radiation belt around the earth.

The US Mariner Safe series explored the interior solar system, obtaining information about Mercury, Venus, and Mars.Mariner 2 was the first space probe successfully and the first spacecraft to visit a planet.Venus passed to about 34,758 kilometers on December 14, 1962. The Mariner 4 explored Mars at low resolution in 1965 and the Mariners 6 and 7 obtained an appearance of greater resolution in 1969. The Mariner 9 Cartography the complete surface of Mars in 1971 and1972, sending 7,329 photographs closely.Mariner 9 reached the Martian orbit on November 13, 1971 in the midst of a huge dust storm that completely obscured the surface for weeks.When the dust dissipated, characteristics were found as notable as the Olympus mons volcano, 24 kilometers (15 miles), three times higher than Mount Everest.The Mariner 10 cartography the surface of Mercury in 1974, as part of a fortuitous orbit assisted by gravity with Venus.

Mariner 2 was the first space probe successfully and the first spacecraft to visit a planet.Data were collected for three months, through Venus to about 34,758 kilometers on December 14, 1962.

The Mariner 2 discovered the solar wind, the flow of loaded particles that escape from the sun to supersonic speeds.

The magnetometer on board failed to measure the magnetic field of Venus, which was a surprise since Venus should be similar in composition to the earth.Venus has a specific density of 5.24 compared to 5.5 of the earth, so it must also have an iron core.The Venus rotation period is 243 days, so it does not seem to be quick enough to produce the dynamo effect that is accredited in the production of the Earth's magnetic field.

An extended Mariner series member, Mariner 9, maided the full surface of Mars in 1971 and 1972, sending 7,329 photographs closely.Mariner 9 reached the orbit of Mars on November 13, 1971 in the middle of a huge dust storm that completely darkened the surface for weeks.When the dust dissipated, characteristics were found as notable as the Olympus mons volcano, 24 kilometers (15 miles), three times higher than Mount Everest.

The resolution of the images of the Mariner 9, was approximately 1 km.

When Mariner 10 went through Venus on February 5, 1974 at a distance of 5,770 km, he won the energy of the collision in what is called gravity assisted maneuver.This was an especially favorable maneuver, because the project directors discovered that the orbit could refine to make a loop around mercury and return to Venus twice the orbital period of Mercury, so that it could make a loop backwardsTo observe Mercury again each second orbit.So instead of a look at Mercurio, the Mariner ship got three flying before its fuel was exhausted.

With the landing purpose on Mars, in 1975 two Viking ships were thrown from the earth.The discovery for the sailor of rivers and lake beds on the surface, revived the visions of life on Mars, and the Viking ships were equipped with experiments to try bacterial life.The Viking ship consisted of an orbiting module and a landing.The landing module descended to the surface with the help of a thermal shield, a parachute, and retrocohetes.

Through spectroscopy, the orbiters were able to establish that the residual polar caps were in fact, water ice.The landing modules did not find evidence of life, but collected huge amounts of data on the composition of the soil and air.These air composition data were valuable later, to identify meteorites found in Antarctica as from Mars.

The Viking orbiter captured images of the two Mars moons in 1977.

The Voyager I was launched on September 5, 1977. Jupiter and its satellites explored and moved to explore Saturn and others.The maximum approach to Jupiter was March 5, 1979. The signal transit time to Jupiter is about 40 minutes.His maximum approach to Saturn (126,000 km) was 1980's Nov.

This era of space exploration led us to the point of observing and photographing the earth from space.Voyager I provided one of the iconic photos of space, the pale blue point.

General Voyager Travel Information

The Voyager II was launched on August 20, 1977 and had its maximum approach of interaction with Jupiter on July 9, 1979. The detailed information about Jupiter, Saturn and the outer planets came from the Voyager I and II.

The Voyager I and the Voyager II considerably expanded our knowledge of the outer planets

The Galileo spacecraft launched on October 19, 1989, was designed to study Jupiter.After six years and around 4 billion kilometers, he arrived in Jupiter on December 7, 1995. The distance between the orbits of the Earth and Jupiter is approximately 624 million kilometers.A 23 -month -old Jupiter system survey was scheduled.The total cost of the mission was approximately 1.6 billion dollars.

Originally scheduled to be launched from the space ferry in 1985, it would have been to Jupiter in 1987. LANGE DANGES, THE CHALLENGER disaster in 1986, and the movement of the planets, put it on a much more slow and more tortuous path towardsJupiter.

Galileo has been promoted during his journey through maneuvers assisted by gravity around Venus in 1990, around the Earth in 1990 and 1992, and around the Asteróid Gaspra in 1991. He also had an overflow close to the IDA Asteroid, in which he discoveredA small round trip, about 1.6 kilometers in diameter.

In 1994, Galileo was the only instrument in the position of seeing the real impacts of the comet Shoemaker-Levy 9 against the surface of Jupiter.

Galileo's trip was plagued with difficulties such as the failure in the deployment of the main antenna.This forced the rewriting of the spacecraft aboard software, to use the safety antenna.An on -board recorder had to store information during the slowest transmission to the earth through that smaller antenna.

The Jupiter probe separated from the spacecraft in July 1995, in preparation for the meeting with Jupiter in December.Galileo entered orbit around Jupiter on December 7, 1995.

The Galileo spacecraft launched on October 19, 1989, was designed for a study by Jupiter.Multiple delays in the launch of Galileo required the calculation of a much slower and more tortuous route to Jupiter.This path required gravitational assistance or Honda maneuvers around Venus, twice around the earth and encounters with two Gaspra and Ida asteroids, on the road to Jupiter.

Considering that the distance between the orbits of the Earth and Jupiter is approximately 624 million kilometers, Galileo traveled 4 billion on his six -year trip to the largest planet.

Throwed in October 1990, Ulises will explore the polar regions of the Sun. It has an orbit that oscillates away from the ecliptic plane, giving it a privileged point from which to study the Sun. It measures radiofrequency emissions produced by high -energy electrons expelled byThe Sun. These electrons follow the lines of the magnetic field of the sun, and their interaction with the plasma of the solar wind generates radio emissions called radius bursts of type III.

Ulises used a gravitational assistance maneuver with Jupiter, to turn its orbital plane away from the eclipticRadio, has a long 72.5 meter dipole antenna, and a sensitive receiver with 76 discrete frequency channels between 1 and 940 kHz.Radio outbreaks farther from the sun have lower characteristic frequencies, so the multibande detector can map the bursts at different distances to represent the magnetic field of the sun.

Electrons from the sun travel at speeds in the range of 0.1 to 0.3C, so that they sweep the radius of the earth's orbit in about 30 minutes.This allows the mapping of a magnetic field line in a short period of time to obtain an almost instantaneous drawing of the magnetic field of the Sun. It has been found that the field lines have a spiral shape, as it had been predicted as a result of the solar wind towardsthe exterior and the rotation of the sun. The shape is called a spiral of Archimedes.

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The Magallanes spacecraft began to be photographed from the radar of the Venus surface on 1990 Sep, with wavelengths in the range of CMs.Synthetic opening radar was used to reveal details as small as 120 meters in diameter, increasing the previous resolution by a factor of 10. The five -year project of Magellan consisted in the mapping of the entire surface of Venus, as well as theMariner 9 mapped Mars in 1971 and 1972.

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Run from Cabo Cañaveral aboard a titan rocket on September 25, 1992, this mission to Mars of 900 million dollars was the first in 17 years.The 450 million miles flight took 11 months.The 5,700 -pound ship planned to get to Mars in August 1993 and spend a whole marcian year, 687 terrestrial days, mapping the surface from an altitude of 240 miles.There have been 20 previous missions from the US and the Soviet Union to Mars.The Mars Explorer will turn the planet every 2 hours, going through the same place every 7 days and will return more information than all the previous missions combined.High resolution cameras will resolve details as small as 10 feet.The spectrometers will evaluate the abundance of elements on the surface and map the mineral content of the rocks.A map of

Mars's frost will be traced and examined the composition of the clouds in their thin carbon dioxide atmosphere.The maps will be used to select the sites for two manned spacecraft and two planned soil penetration probes.

The last mission of the US to Mars was the landing of two viking spacecraft in 1976.

The Cassini mission is a large -scale project designed to study Jupiter and Saturn.It is a bit in the great tradition of the Voyager missions of the late 70s, and has some elements in common with the most recent Galileo mission.

Cassini is an international space exploration mission.The Huygens probe, built by the European Space Agency, will be launched to Titan, one of Saturn's moons.Some of the experimental teams was provided by the Italian Space Agency.

The plan is that Cassini travels more than 2.2 billion miles for more than a decade, carrying 18 experimental instruments.

From the introduction of the NASA/JPL Cassini site: "Cassini completed its initial four - year mission to explore the Saturn system in June 2008 and the first extended mission, called Cassini Equinox Mission, in September 2010. Now, theSpace savory still in good physical condition, is trying to make exciting new discoveries in an extended mission called Cassini Solstice Mission.May 2017. The Summer Solstice of the North marks the beginning of the summer in the northern hemisphere and winter in the southern hemisphere.A complete seasonal period.He landed on the surface of Titan on January 14, 2005 and returned a spectacular resolution.The 12 Cassini instruments returned a daily flow of data from the Saturn system from the moment of its arrival in Saturn in 2004 until its immersion directed in Saturn on September 15, 2017.

Reference:

Cassini Solite Mission Jupiter and the Lun

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NASA's description: "The James Webb space telescope will be a great infrared telescope with a 6.5 meter primary mirror."The telescope was launched on December 25, 2021. The JWST will be the main observatory of the next decade and will serve thousands of astronomers around the world.He will study all the phases of the history of our universe, from the first luminous flashes after the Big Bang, the formation of solar systems capable of hosting life on planets such as Earth, until the evolution of our own solar system. "

In comparison, its predecessor, the Hubble space telescope, had a 2.4 m mirror.and was located in an orbit at 570 km from the earth ..

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References:

Description of the NASA orbit of James Webb

Description of the NASA orbit of James Webb

James Webb orbit

The Hubble telescope has only a 2.4 -meter mirror, but located outside the Earth's atmosphere, it has exceeded much larger instruments established on ground.The image quality was severely affected by an unduly settled main mirror, but this problem was overcome by a repair mission in December 1993. A sample of images of the hubble image of a galaxy before and after repair.Galaxy environment above.Melnick-34 star images before and after repair.Hubble Jupiter image.Image of the deep space of the Hubble.NASA image.Since the Hubble is in an orbit close to the earth, its perspective in space is very similar to that of a base telescope on the earth.However, the absence of the blurred effects of the atmosphere provides it with a much clearer vision of the universe.It has a resolution of 0.014 seconds of arc, compared to the angular size of 1800 seconds of arch of the moon.A second arc on the moon corresponds to around 1.92 kilometers on its surface, so the Hubble has a resolution of about 27 meters above the surface of the moon.

Images of the Hubblem-16 Space Telescope Depocampo Ultra-Profundo

NGC-2440 cat ...

The instruments of the Hubble Chamber of great angle and planetary

James Space Telescope

Webb

Since the Hubble is in an orbit close to the earth, its perspective in space is very similar to that of a base telescope on the earth.However, the absence of the blurred effects of the atmosphere provides it with a much clearer vision of the universe.It has a resolution of 0.014 seconds of arc, compared to the angular size of 1800 seconds of arch of the moon.A second arc on the moon corresponds to around 1.92 kilometers on its surface, so the Hubble has a resolution of about 27 meters above the surface of the moon.

The Skylab was a manned aircraft in orbit, which included the mount of the Apollo Telescope (a solar observatory) and with capacity for a series of experiments.It was four releases, the first unmanned to display the first unit.The Skylab 1 itself was launched on May 14, 1973 and was the first manned flight during the period from May 25 to June 22, 1973. He had to deal with the failure of deployment of the thermal shield over the Skylab 1. achievedRepair, the mission was a success.The Skylab 3 was released on July 28, 1973 and landed in the Pacific on September 25.The third and last manned period was a mission of 84 days from November 16, 1973 to February 8, 1974.

For 14 years, the ambitious Soviet Space Station remained in space, reaching a series of milestones in living the space, and providing a lot of experience in the continuous operation of a space station.His last years were problematic due to many maintenance problems, and the plan at the end of 2000 was to get rid of him in the Pacific Ocean in 2001.

February 2001, MIR sank into the Pacific Ocean.ive the mirp to the American businessman Dennis Tito to go to the station as "space tourist".he project could not afford to bring them back.

In all the directions of the space, there is a uniform background radiation, which is in the spectrum microwave region.It shows the dependence of the "black body" radiator at a temperature of 3 Kelvins, of the wavelength.It is considered to be the remnant of the radiation emitted at the time when the expansion of the universe became transparent at a temperature of about 3000K.The discovery of the 3K microwave background radiation, was one of the crucial steps that led to the calculation of the standard cosmology model of the "Big Bang", and its role in anticipating the relative populations of estimated particles and photons.Recent research using the absolute spectrophotometer of distant infrared (FIRAS), aboard the COBE satellite, have given a temperature of 2,725 +/- 0.002 K. The previous experiments had demonstrated some anisotropy of the background radiation, due to the solar system movement, but Cobe collected data, showing fluctuations in the cosmic background.In the cosmology of the Big Bang, some fluctuations are necessary in the cosmic background, which provide sufficient non-uniformity, to give rise to the formation of galaxies.The apparent uniformity of the background radiation is the basis of the "galaxy formation problem" in the cosmology of the Big Bang.The most recent WMAP mission gave a much greater resolution image of anisotropies in cosmic background radiation.

The round figure of 109 photons per nuclear particle, is the "most important quantitative conclusion that emerges from the measurements of microwave background radiation ..." (Weinberg P66-70).This allowed the conclusion that galaxies and stars could not have begun to form until the temperature fell below 3000K.Next, atoms could be formed and eliminated the opacity of the expansion of the universe, the light could come out and relieve the radiation pressure.The formation of stars and galaxies could not happen, until the gravitational attraction could overcome the abroad radiation pressure, and to 109 photons/bariones, a "mass of jean" would be needed with a criticism of one million times that of a large galaxy.With the formation of atoms and a transparent universe, the mass of jeans fell to about 10-6 the mass of a galaxy, allowing gravitational grouping.

The 3K cosmic background provides fundamental evidence for cosmological models.The 3K background implies approximately 5.5 x 105 photons/liter.This is based on the radiation energy density and average energy per photon at this temperature.The density of estimated bariones, has a range that goes twice the critical density of 6 x 10-3/liter, to the lower end of a visible galaxy, 3 x 10-5/liter.This gives a range that ranges from 1 x 108, to 2 x 1010 photons/bariones.This is estimated by the number of photons per bariones, which was crucial in the Big Bang calculations.In the modeling of nucleosynthesis in the Big Bang, including the proportion of hydrogen/helium, the relative population of barions and photons, agrees with the observations.

When the amounts of D, 3He, and 7li are traced and examined, and are part of the Big Bang model, the photon barion ratio is more strongly limited.The Partle Data Group gives a proportion of barions/photons η between

As the conservation of the number of barions is a strong conservation principle, it is inferred that the ratio of photon to bariones is constant through the expansion process.No process known in nature changes the number of barions.

In the cosmic microwave background radiation, there is an anisotropy of about 0.1%, which is attributed to the Doppler displacement originated by the movement of the solar system through radiation.The Partle Data Group reports that asymmetry has mostly a dipole nature, with a magnitude of 1.23 x 10-3.This value is used to calculate the speed of approximately 600 m/s for the Earth, compared to an observer that was kept in line with the general expansion.

NASA's cosmic background explorer (COBE) satellite was launched to explore the cosmic microwave background radiation.The data points are overlapping on the curve of a black body theorist.

The adjustment with the Planck's radiation formula is so precise, that it provides a powerful confirmation of the idea that it is a remnant of the expansion of the Big Bang.

This dating was adapted from Math, J. C., et al., Astro.Jour354, L37 (1990).

Cobe data has been so precise, that fluctuations in that radiation have been discovered, which are important for cosmological calculations of the Big Bang.Cobe holds three main instruments, a differential microwave radiometer, an absolute spectrophotometer of distant infrared (cooled to 1.6k per liquid helium), and the diffuse infrared background experimenter, also to 1.6k.The infrared instrument will measure infrared spectra, which are supposed to be uniform, but any unexpected variation could indicate the presence of energy sources that could have driven turbulence to trigger the formation of galaxies.The sensitivity of infrared instruments is 100 times higher than the one achieved from the surface of the Earth.The infrared background experimenter will look distant from primordial galaxies and other celestial objects that were formed after the Big Bang.

John C. Math of the NASA Goddard Spaceflight Center and George F. Smoot of Lawrence Berkeley National Laboratory, were awarded the Nobel Prize in Physics in 2006, for the work associated with the Cobe satellite.

The panorama has been clarified even more for the recent WMAP mission, which provided an image of greater resolution of temperature fluctuations.

The International Space Station is an orbital laboratory that is under construction by a world association of 16 nations.There are plans for six laboratory modules that will be built using supplies and personnel of about 40 space flights in five years.The first flight was raised by a Russian rocket proton in November 1998 and the Endeavor space ferry launched by the US in December 1998 with the unit module.

In early 1930, an astronomer working at the Lowell Observatory in the United States made a discovery that would ultimately initiate a dramatic change in the way we look at our Solar System. The young astronomer was Clyde Tombaugh, an observing assistant working at the observatory made famous by the great astronomer Percival Lowell. Tombaugh was continuing the search for an elusive planet — Planet X — that astronomers of the time had incorrectly believed to be responsible for perturbing the orbits of Uranus and Neptune.

After spending numerous nights at the telescope and months tediously scanning his data for the telltale signs of a planet – slight movements of the same body between two images (in those days, on photographic plates) of the sky taken at different times — Tombaugh made a discovery. While comparing two photographic plates to search for this slight movement, Tombaugh noticed a small object moving only a few millimetres near the constellation Gemini. Tombaugh had found his new planet! (Stern & Mitton, 2005)

The object Tombaugh discovered was eventually named Pluto, a name officially adopted by the American Astronomical Society, the Royal Astronomical Society in the UK, and the International Astronomical Union. It is a frigid world, billions of kilometres from the Sun, and 30 times less massive than the then-smallest known planet, Mercury. But Pluto is not alone: its five satellites were later discovered. The largest, Charon, was discovered in 1978 (Buie et al., 2006). The smaller four were discovered using the Hubble Space Telescope between 2005 and 2012 (Stern et al. 2018) and are officially named Nix, Hydra, Kerberos and Styx by the IAU (Aksnes, 2006; Showalter et al., 2013).

In the decades following Pluto’s discovery, astronomers postulated that there might be a belt of objects beyond the orbit of Neptune. In 1992, this was finally validated by David Jewitt and Jane Luu from the University of Hawaii. They discovered (Jewitt and Luu 1993) the first in a special class of objects orbiting beyond Neptune, known as Kuiper Belt Objects, which have major implications for Solar System formation theory. Today, we know of more than 1000 objects that orbit in the so-called transneptunian region; these bodies are often referred to as Trans-Neptunian Objects (TNOs).

Due to the influx of TNO discoveries, it was inevitable that one or more might be found to rival Pluto in size. In 2003, Mike Brown (Caltech), Chad Trujillo (International Gemini Observatory) and David Rabinowitz (Yale University) searched the edge of our Solar System from the Palomar Observatory in the United States. They imaged a region of the sky that showed an object moving relative to the background stars, just as Clyde Tombaugh did decades earlier. Later analysis showed that they discovered another cold world: slightly larger than Pluto and orbiting the Sun (Brown et al., 2004). Subsequent observations (Brown, 2006) showed that the new object, initially named 2003 UB313 according to the IAU's naming protocol, was more massive than Pluto and that it, too, had a satellite. The team found several objects that did not resemble any of the 8 planets we consider today but were large enough to be compared to Pluto. These discoveries prompted astronomers to ask the question: "What constitutes a planet?"

The IAU has been responsible for naming planetary bodies and their satellites since the early 1900s. As Professor Ron Ekers, former President of the IAU, explained in the newspaper of the 2006 IAU General Assembly:

Such decisions and recommendations are not enforceable by any national or international law; rather they establish conventions that are meant to help our understanding of astronomical objects and processes. Hence, IAU recommendations should rest on well-established scientific facts and have a broad consensus in the community concerned. (p. 4)

The IAU created a committee to gather opinions from a broad range of scientific interests, with input from professional astronomers, planetary scientists, historians, science publishers, writers and educators. Thus the Planet Definition Committee of the IAU Executive Committee was formed to carefully gather these opinions and deliberations over the course of two years. The Committee prepared a draft resolution to present to the members of the IAU. After the final meeting in Paris, the draft resolution was completed. Professor Owen Gingerich, Chair of the IAU Planet Definition Committee, described one crucial aspect of the resolution: “we wanted to avoid arbitrary cut-offs simply based on distances, periods, magnitudes, or neighbouring objects” (Gingerich, 2006). The adopted definition is, instead, based on our understanding of the physics of planet formation.

The word planet comes from the Greek word for wanderer: planets were originally defined as objects that moved in the night sky with respect to a background of fixed stars. It wasn't until the 2006 IAU General Assembly in Prague that astronomers attempted to agree upon a formal definition of the word. Modern science provides a wealth of information, and many scientific studies have been used to help astronomers formulate their definition. For example, observations in the outer regions of the Solar System found objects that are comparable in size to Pluto. These discoveries, and more, called into question whether these newly found objects should also be considered planets or if they should comprise their own class of objects in the Solar System.

The draft proposal for the definition of a planet was debated vigorously by astronomers at the 2006 IAU General Assembly, and a new version slowly took shape. This new version was more acceptable to the majority and was presented to the members of the IAU for a vote at the Closing Ceremony of the General Assembly. By the end of the Prague General Assembly, IAU members voted that the definition of a planet in the Solar System would be as follows:

A celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighbourhood around its orbit. (p. 1)

More generally, a planet:

orbits its host star, just as the Earth and Jupiter orbit the Sun,

is large enough to be mostly round, and

must have an important influence on the orbital stability of the other objects in its neighbourhood.

Newly discovered objects will be classified by a review committee within the IAU. The review process will include an evaluation based on the best available data that demonstrate whether the physical properties of the object satisfy the IAU definitions. It is likely that for many objects, several years may be required to gather sufficient data.

Today, the resolution remains in place and is a testament to the fluid nature of science and how our view of the Universe continues to evolve with changes made by observations, measurements and theory. The continued and vibrant discussions on the topic also show how hard it is to classify objects into well-defined classes. The Universe does not like to be put in “boxes”. Everything is a continuum: comets can behave like asteroids, and brown dwarfs can be stars. So, too, can dwarf planets share the same qualities as planets.

The 2006 IAU Resolution means that the Solar System officially consists of eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. In the same resolution, a new distinct class of objects, called dwarf planets, was also defined. A dwarf planet is an object in orbit around the Sun that is large enough to pull itself into a nearly round shape but has not been able to clear its orbit of debris. Generally, dwarf planets are smaller than Mercury. A dwarf planet may also orbit in a zone that has many other objects in it. For example, an object within the asteroid belt is in a zone with many other objects that are all about the same size. Pluto now falls into the dwarf planet category because it resides within a zone of other objects that might cross its orbital path, known as the Trans-Neptunian region. Pluto is additionally recognised as an important prototype of a new class of Trans-Neptunian Objects: plutoids. Defining this class of objects helps astronomers distinguish different types of dwarf planets in our Solar System.

The term small Solar System body was introduced along with dwarf planet in the 2006 IAU General Assembly resolution. This is a term to encompass all objects orbiting the Sun that are too small (that is, not sufficiently massive) to satisfy the definition of a planet or dwarf planet.

Aside from Pluto, there are four currently recognised dwarf planets in our Solar System: Ceres, Haumea, Makemake and Eris.

When Ceres was first discovered orbiting within the asteroid belt between Mars and Jupiter in 1801, it was called a planet. However, due to the technology at the time, astronomers could not resolve the size and shape of Ceres, and as numerous other bodies were discovered in the same region, Ceres lost its planetary status. As technology improved, astronomers discovered that Ceres is a bit less than half the size of Pluto and is large enough to have self-gravity, pulling itself into a nearly round shape (Thomas, 2005). Because it orbits the Sun within the asteroid belt, Ceres is a good example of an object that does not orbit in a clear path: there are many asteroids that can come close to the orbital path of Ceres.

In the early 2000s, astronomers used the Hubble Space Telescope to observe a TNO originally named 2003 UB313 but later renamed Eris, after the Greek god of discord and strife. The data showed that Eris is as large as, or perhaps larger than, Pluto (Brown, 2006) and, importantly, that it has a satellite, later named Dysnomia after Eris’s daughter, the

Greek demon of lawlessness. By tracking the motions of Dysnomia around Eris, astronomers were able to measure the mass of Eris very accurately. They found that Eris is almost 30% more massive than Pluto! Because Eris orbits in the Trans-Neptunian region and other TNOs might come close to its orbit, Eris is considered a dwarf planet.

Around the same time, Haumea and Makemake were also discovered. Like all TNOs, and according to IAU naming guidelines, these two objects were eventually named for mythological beings associated with creation: Makemake is the creator of humanity to the Rapa Nui, and Haumea is the Hawaiian goddess of fertility and childbirth. Haumea is thought to be oblong, covered in ice, have two moons (Hi'iaka and Namaka), and a ring. Makemake is a round, reddish world with a single moon, currently designated S/2015 (136472) 1. It is the second brightest — and second largest — Kuiper Belt object, other than Pluto.

This isn't the end of the story for dwarf planets in our Solar System. In the coming years, some of the largest asteroids and some Trans-Neptunian Objects may be considered for dwarf planet status. The precise number is still unknown, as we are always discovering new small bodies in our Solar System. There may be dozens or perhaps even more than a hundred waiting to be discovered!

On 14 July 2015, NASA's New Horizons spacecraft flew past Pluto (Young et al., 2008), providing numerous observations that have dramatically altered our knowledge about the dwarf planet Pluto and its five moons. The images established that Pluto's diameter is actually larger than that of Eris, despite what was previously thought. As such, Pluto regained its spot as the largest TNO. The images also revealed a remarkable landscape containing a variety of landforms, including broad plains, mountain ranges several kilometres high, and evidence of volcanoes.

Pluto is unusual for its diversity of surface compositions and colours. Some regions are as bright as snow, and others are as dark as charcoal. Colour imaging and other data revealed a highly complex distribution of surface ices, including nitrogen, carbon monoxide, water, and methane, as well as their chemical byproducts produced by prolonged exposure to solar radiation. In addition, scientists have found that some surfaces on Pluto are entirely free of visible craters, indicating that they have been created or have changed in the recent past. On the other hand, other surfaces are heavily cratered and appear to be extremely old. Pluto is shrouded by a cold, nitrogen--dominated atmosphere that contains a thin haze layer that extends about 150 km above Pluto's surface.

New Horizons also got a good look at Pluto's moons. It found that the largest moon, Charon, displays impressive tectonics, a puzzlingly dark polar terrain, a potentially differentiated internal structure, and no signs of an atmosphere (Moore et al., 2016). New Horizons discovered puzzling new facts (Lakdawalla, 2015) about the smaller satellites Hydra and Nix, too: their surfaces are brighter than expected, meaning their surfaces contain a high amount of water ice. No new satellites were detected, and no rings were found. The environment around Pluto is clearly a fascinating one!

These results raise fundamental questions about how a small, cold object can remain active over the age of the Solar System. They demonstrate that dwarf planets can be every bit as scientifically interesting as planets.

We would like to acknowledge the contributions of Division F President, Antonella Barucci, Division F Past President, Nader Haghighipour, Organizing Committee Members of Commission F4 Asteroids, Comets & Transneptunian Objects, Joe Masiero and Jorge Marcio Ferreira Carvano, and the IAU Director of Communications, Lars Lindberg Christensen (originator of the first version of this Theme) and OAO Deputy Director Kelly Blumenthal.

Q: What new terms are used in the official IAU definition?

A: There are three new terms adopted as official definitions by the IAU. The terms are planet, dwarf planet and small Solar System body.

Q: Does a body have to be perfectly spherical to be called a planet?

A: No. For example, the rotation of a body can slightly distort the shape so that it is not perfectly spherical. Earth, for example, has a slightly greater diameter measured at the equator than measured at the poles.

Q: Based on this new definition, how many planets are there in our Solar System?

A: There are eight planets in our Solar System; Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune. To remember this, you can use the mneumonic courtesy of Indiana University professor, Phylis Lugger: My Very Educated Mother Just Served Us Nachos.

Q: Is that all, only eight planets?

A: No. In addition to the eight planets, there are also five known dwarf planets: Pluto, Ceres, Eris, Makemake, and Haumea. Many more dwarf planets are likely to be discovered soon.

Q: Jupiter and Saturn, for example, have large spherical satellites in orbit around them. Are these large spherical satellites now to be called dwarf planets?

A: No. All of the large satellites of Jupiter (for example, Europa) and Saturn (for example, Titan) orbit around a common centre of gravity (called the barycentre) that is deep inside their massive planet. Regardless of the large size and shapes of these orbiting bodies, the location of the barycentre inside the massive planet is one of the key factors that defines large orbiting bodies such as Europa and Titan as satellites rather than planets.

Q: Jupiter has asteroids leading and trailing its orbit. Should Jupiter be considered a dwarf planet because it has not cleared its orbit?

A: No. One of the main theories for the formation of this class of asteroids is that they were captured by Jupiter as it migrated to its present location early in the history of the Solar System. The asteroids are clustered around two stable points in Jupiter's orbit and have been corralled into their present orbits by Jupiter's gravitational force. These objects clearly have very different properties than those found in the "unclear" orbits of dwarf planets.

Q: What is an object called that is too small to be either a planet or dwarf planet?

A: All objects that orbit the Sun that are too small to form a nearly spherical shape are now defined as small Solar System bodies. This class currently includes most of the Solar System asteroids, near-Earth objects (NEOs), Mars and Jupiter Trojan asteroids, most Centaurs, most Trans-Neptunian Objects (TNOs) and comets.

Q: Is the term minor planet still to be used?

A: The term minor planet may still be used. Generally, however, the term small Solar System body is preferred.

Q: Are there additional planet candidates currently being considered?

A: No. None appear likely in our Solar System. However, there are planet discoveries galore around other stars.

Q: What are plutoids?

A: Plutoids (Bowell et al., 2008) are celestial bodies in orbit around the Sun at a distance greater than Neptune that are sufficiently large to form a nearly spherical shape and that have not cleared the neighbourhood around their orbit. Satellites of plutoids are not plutoids themselves, even if they are massive enough to be nearly round. The two known and named plutoids are Pluto and Eris. We expect that more plutoids will be named as science progresses and new discoveries are made.

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Q: Based on this new definition, how many planets are there in our Solar System?

A: There are eight planets in our Solar System; Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune. To remember this, you can use the mneumonic courtesy of Indiana University professor, Phylis Lugger: My Very Educated Mother Just Served Us Nachos.

Q: Is that all, only eight planets?

A: No. In addition to the eight planets, there are also five known dwarf planets: Pluto, Ceres, Eris, Makemake, and Haumea. Many more dwarf planets are likely to be discovered soon.

Q: Jupiter and Saturn, for example, have large spherical satellites in orbit around them. Are these large spherical satellites now to be called dwarf planets?

A: No. All of the large satellites of Jupiter (for example, Europa) and Saturn (for example, Titan) orbit around a common centre of gravity (called the barycentre) that is deep inside their massive planet. Regardless of the large size and shapes of these orbiting bodies, the location of the barycentre inside the massive planet is one of the key factors that defines large orbiting bodies such as Europa and Titan as satellites rather than planets.

Q: Jupiter has asteroids leading and trailing its orbit. Should Jupiter be considered a dwarf planet because it has not cleared its orbit?

A: No. One of the main theories for the formation of this class of asteroids is that they were captured by Jupiter as it migrated to its present location early in the history of the Solar System. The asteroids are clustered around two stable points in Jupiter's orbit and have been corralled into their present orbits by Jupiter's gravitational force. These objects clearly have very different properties than those found in the "unclear" orbits of dwarf planets.

Q: What is an object called that is too small to be either a planet or dwarf planet?

A: All objects that orbit the Sun that are too small to form a nearly spherical shape are now defined as small Solar System bodies. This class currently includes most of the Solar System asteroids, near-Earth objects (NEOs), Mars and Jupiter Trojan asteroids, most Centaurs, most Trans-Neptunian Objects (TNOs) and comets.

Q: Is the term minor planet still to be used?

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Q: What is an object called that is too small to be either a planet or dwarf planet?

A: All objects that orbit the Sun that are too small to form a nearly spherical shape are now defined as small Solar System bodies. This class currently includes most of the Solar System asteroids, near-Earth objects (NEOs), Mars and Jupiter Trojan asteroids, most Centaurs, most Trans-Neptunian Objects (TNOs) and comets.

Q: Is the term minor planet still to be used?

A: The term minor planet may still be used. Generally, however, the term small Solar System body is preferred.

Q: Are there additional planet candidates currently being considered?

A: No. None appear likely in our Solar System. However, there are planet discoveries galore around other stars.

Q: What are plutoids?

A: Plutoids (Bowell et al., 2008) are celestial bodies in orbit around the Sun at a distance greater than Neptune that are sufficiently large to form a nearly spherical shape and that have not cleared the neighbourhood around their orbit. Satellites of plutoids are not plutoids themselves, even if they are massive enough to be nearly round. The two known and named plutoids are Pluto and Eris. We expect that more plutoids will be named as science progresses and new discoveries are made.

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Below, check out a visualization of the April 8, 2024, total solar eclipse!

What's the difference between a lunar eclipse and a solar eclipse?

A solar eclipse happens when the Moon gets in the way of the Sun's light and casts its shadow on Earth. That means during the day, the Moon moves over the Sun and it gets dark. Isn't it strange that it gets dark in the middle of the day?

This total eclipse happens about every year and a half somewhere on Earth. A partial eclipse, when the Moon doesn't completely cover the Sun, happens at least twice a year somewhere on Earth.

Note: This diagram is not to scale. Credit: NASA/JPL-Caltech

A total solar eclipse was visible over the continental United States on Aug. 21, 2017. This image was captured in Hopkinsville, Kentucky during the 2017 eclipse. Credit: NASA/MSFC/Joseph Matus

But not everyone experiences every solar eclipse. Getting a chance to see a total solar eclipse is rare. The Moon's shadow on Earth isn't very big, so only a small portion of places on Earth will see it. You have to be on the sunny side of the planet when it happens. You also have to be in the path of the Moon's shadow.

On average, the same spot on Earth only gets to see a solar eclipse for a few minutes about every 375 years!

Caution!

Eye Safety During a Total Solar Eclipse

Except during the brief total phase of a total solar eclipse, when the Moon completely blocks the Sun's bright face, it is not safe to look directly at the Sun without specialized eye protection for solar viewing.

For safety information, visit the NASA Eclipse Safety Page.

During a lunar eclipse, Earth gets in the way of the Sun's light hitting the Moon. That means that during the night, a full moon fades away as Earth's shadow covers it up.

The Moon can also look reddish because Earth's atmosphere absorbs the other colors while it bends some sunlight toward the Moon. Sunlight bending through the atmosphere and absorbing other colors is also why sunsets are orange and red.

During a total lunar eclipse, the Moon is shining from all the sunrises and sunsets occurring on Earth!

Note: This diagram is not to scale. Credit: NASA/JPL-Caltech

The Moon appeared a reddish color during a total lunar eclipse on Jan. 21, 2019 Credit: Public Domain

You might be wondering why we don’t have a lunar eclipse every month as the Moon orbits Earth. It’s true that the Moon goes around Earth every month, but it doesn’t always get in Earth’s shadow. The Moon’s path around Earth is tilted compared to Earth’s orbit around the Sun. The Moon can be behind Earth but still get hit by light from the Sun.

In this diagram, you can see that the Moon’s orbit around Earth is at a tilt. This is why we don’t get a lunar eclipse every month. This diagram is not to scale: the Moon is much farther away from Earth than shown here. Credit: NASA/JPL-Caltech

Because they don’t happen every month, a lunar eclipse is a special event. Unlike solar eclipses, lots of people get to see each lunar eclipse. If you live on the nighttime half of Earth when the eclipse happens, you’ll be able to see it.

It’s easy to get these two types of eclipses mixed up. An easy way to remember the difference is in the name. The name tells you what gets darker when the eclipse happens. In a solar eclipse, the Sun gets darker. In a lunar eclipse, the Moon gets darker.

The Earth is subject to various types of movements. The main movements of the Earth are defined with reference to the Sun and include: rotation, translation, precession, nutation, Chandler wobble, and perihelion precession.

Rotation This is the movement the Earth makes by spinning on its axis, which intersects the surface at two points called poles. This rotation is from west to east, meaning that for an observer in space above the Earth's North Pole, this movement is counterclockwise. A complete rotation, using the stars as a reference, takes 23 hours, 56 minutes, and 4.1

seconds and is called a sidereal day. If we use the Sun as a reference, the same meridian passes in front of our star every 24 hours, known as a solar day. The approximately 3 minutes and 56 seconds difference is because in that time, the Earth has advanced in its orbit and must rotate a bit more than a sidereal day to complete a solar day.

Translation This is the movement by which the planet Earth orbits the Sun in an elliptical path in 365 days and slightly less than 6 hours. For an observer in space above the Earth's North Pole, this movement is also counterclockwise, and logically, seen from the South Pole, this movement is clockwise. Since the calendar records 365 full days, the beginning of each year is gradually advancing, which is approximately compensated by making one out of every slightly more than four years, called a leap year, have 366 days. The cause of the translation movement is the action of gravity, leading to a series of changes that, like the day, allow for the measurement of time. Taking the Sun as a reference, we get what is called a tropical year, the period necessary for the seasons to repeat. It lasts 365 days, 5 hours, 48 minutes, and 45 seconds. The movement describes an elliptical trajectory of 930 million kilometers, at an average distance from the Sun of approximately 150 million kilometers, 1 AU (astronomical unit: 149,597,871 km) or 8.317 light minutes. From this, it can be deduced that the Earth travels along its orbit at an average speed of 106,200 km/h (29.5 km/s).

Elliptical Orbit The Earth's trajectory or orbit is elliptical. The Sun occupies one of the foci of the ellipse, and due to the orbit's eccentricity, the distance between the Sun and the Earth varies throughout the year. In early January, the closest proximity to the Sun occurs, known as perihelion, at a distance of 147.5 million kilometers, while in early July, the maximum distance, called aphelion, is reached, at a distance of 152.6 million kilometers.

Axial Tilt As observed in the above diagram, the Earth's axis forms an angle of about 23.5° relative to the ecliptic's normal, a phenomenon called the obliquity of the ecliptic. This tilt, combined with translation, results in long periods of several months of continuous light and darkness at the geographic poles, in addition to causing the seasons, derived from changes in the angle of solar radiation incidence and the duration of daylight hours produced by this obliquity.

Precession The precession of the equinoxes (the slow and gradual change in the orientation of the Earth's rotation axis) is due to the Earth's precession movement caused by the torque exerted by the Earth-Sun system based on the inclination of the Earth's rotation axis relative to the Earth's orbital plane (currently about 23°43'). This movement is completed every 25,776 years, and an observer in space above the North Pole would see it as a clockwise rotation.

Nutation The Earth's axial tilt varies from 23° to 27°, influenced (among other causes) by tectonic movements. In February 2010, an 8.8° Richter earthquake in Chile caused an approximately 8 cm variation in the Earth's axis. Similarly, the 2004 Southeast Asian tsunami shifted the Earth's axis by 17.8 cm.

Chandler Wobble This is a small oscillation of the Earth's rotation axis that adds 0.7 arcseconds over a 433-day period to the precession of the equinoxes. Discovered by

American astronomer Seth Carlo Chandler in 1891, the causes remain unknown, although several theories have been proposed, including climatic fluctuations affecting atmospheric mass distribution, possible geophysical movements beneath the Earth's crust, and variations in oceanic salinity. The Chandler wobble and other minor effects are collectively referred to as polar motion.

Apsidal Precession In the translation movement, the Earth describes an ellipse around the Sun, occupying one of the ellipse's foci, but the other focus is not static; it also rotates slowly by a small angle of 3.84 arcseconds per century around the Sun in the same direction as the orbit. This rotation of the ellipse's free focus is known as apsidal precession or perihelion precession, the moment of the Earth's closest distance to the Sun. Logically, the aphelion, or the farthest distance from the Sun, also experiences this advancement, which, although angularly equal, is even greater tangentially. This movement has a period of about 34,285,714 years.

Milankovitch Cycles Orbital variations or Milankovitch cycles describe the combined effects that changes in the Earth's movements have on the climate over thousands of years. The term was coined after studies by Serbian astronomer and geophysicist Milutin Milankovitch. In the 1920s, he theorized that resulting variations caused cyclical changes in solar radiation reaching the Earth's surface, significantly influencing climate change patterns on Earth.

Similar astronomical theories had been anticipated during the 19th century by Joseph Adhemar, James Croll, and others, but verification was complex due to the lack of relevant fossil data and unclear periods important for checking the past.

Meteors A meteor is the phenomenon resulting from a particle of matter (meteoroid) entering the atmosphere at high speed. The vaporization of the particle due to its collision with air molecules produces a luminosity that makes this phenomenon observable. Its duration is usually a fraction of a second. The height at which the meteor becomes visible is around 100 kilometers, although it depends somewhat on the penetration speed, with faster particles evaporating at higher altitudes. Particles ranging in size from a tenth of a millimeter to a few centimeters are completely consumed above 50 kilometers, although the great brightness and transverse speed of some may make them appear closer to the observer. Only a few meteoroids, with an initial mass sufficiently large (>1 kg) and very solid consistency (rocky, metallic), reach the ground each day, becoming meteorites.

At certain times of the year, an increased rate of meteors appears from a given region of the sky (radiant), indicating a common origin. This is known as a meteor shower and is associated with cometary debris left along the Earth's orbit in successive passes near the Sun.

The most important meteor showers observed throughout the year are listed in the following table:

Meteor Showers

Meteor showers occur when Earth passes through debris left by comets, leading to an increased rate of meteors from a specific region of the sky (radiant). The table below lists the most important meteor showers observed throughout the year:

Quadrantids: Active in early January, with a peak around January 3-4. Known for producing bright meteors and, occasionally, fireballs.

Lyrids: Active from mid to late April, peaking around April 22. Noted for fast and bright meteors.

Eta Aquarids: Active in early May, peaking around May 5-6. Associated with Halley's Comet.

Perseids: Active from mid-July to late August, peaking around August 12. One of the most reliable and popular showers.

Orionids: Active from early October to early November, peaking around October 21.Also linked to Halley's Comet.

Leonids: Active in November, peaking around November 17. Known for producing spectacular meteor storms every 33 years.

Geminids: Active in December, peaking around December 13-14. Renowned for bright, multicolored meteors and high activity rates.

Meteor showers are named after the constellation from which the meteors appear to radiate. For example, the Perseids originate from the constellation Perseus.

The diurnal meteor showers, such as the Arietids and Zeta Perseids in June, are only observable with radar. Radar observation is based on radio waves being reflected by ionized gases in the upper atmosphere.

On average, the Perseids are the third most active meteor shower of the year. Both the Quadrantids (in January) and the Geminids (in December) typically generate more meteors per hour. Although more irregular, the Leonids (in mid-November) can be just as spectacular as the Perseids.