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## Introduction The Sun is a 4.5 billion-year-old yellow dwarf star a hot glowing ball of hydrogen and helium at the center of our solar system.

Its about 93 million miles (150 million kilometers) from Earth and its our solar systems only star. Without the Suns energy, life as we know it could not exist on our home planet. From our vantage point on Earth, the Sun may appear like an unchanging source of light and heat in the sky. But the Sun is a dynamic star, constantly changing and sending energy out into space. The science of studying the Sun and its influence throughout the solar system is called heliophysics. The Sun is the largest object in our solar system. Its diameter is about 865,000 miles (1.4 million kilometers). Its gravity holds the solar system together, keeping everything from the biggest planets to the smallest bits of debris in orbit around it. Even though the Sun is the center of our solar system and essential to our survival, its only an average star in terms of its size. Stars up to 100 times larger have been found. And many solar systems have more than one star. By studying our Sun, scientists can better understand the workings of distant stars. The hottest part of the Sun is its core, where temperatures top 27 million F (15 million C). The part of the Sun we call its surface the photosphere is a relatively cool 10,000 F (5,500 C). In one of the Suns biggest mysteries, the Suns outer atmosphere, the corona, gets hotter the farther it stretches from the surface. The corona reaches up to 3.5 million F (2 million C) much, much hotter than the photosphere. Dec. 2, 2020, marked the 25th anniversary of the Solar and Heliospheric Observatory, or SOHO. Since its launch, the mission has kept watch on the Sun. Namesake Namesake The Sun has been called by many names. The Latin word for Sun is sol, which is the main adjective for all things Sun-related: solar. Helios, the Sun god in ancient Greek mythology, lends his name to many Sun-related terms as well, such as heliosphere and helioseismology. Potential for Life Potential for Life The Sun could not harbor life as we know it because of its extreme temperatures and radiation. Yet life on Earth is only possible because of the Suns light and energy. Size and Distance Size and Distance Our Sun is a medium-sized star with a radius of about 435,000 miles (700,000 kilometers). Many stars are much larger but the Sun is far more massive than our home planet; it would take more than 330,000 Earths to match the mass of the Sun, and it would take 1.3 million Earths to fill the Sun's volume. The Sun is about 93 million miles (150 million kilometers) from Earth. Its nearest stellar neighbor is the Alpha Centauri triple star system: red dwarf star Proxima Centauri is 4.24 light-years away, and Alpha Centauri A and B two sunlike stars orbiting each other are 4.37 light-years away. A light-year is the distance light travels in one year, which equals about 6 trillion miles (9.5 trillion kilometers). Orbit and Rotation Orbit and Rotation The Sun is located in the Milky Way galaxy in a spiral arm called the Orion Spur that extends outward from the Sagittarius arm. This illustration shows the spiral arms of our Milky Way galaxy. Our Sun is in the Orion Spur. Credit: NASA/Adler/U. Chicago/Wesleyan/JPL-Caltech | Full caption and image The Sun orbits the center of the Milky Way, bringing with it the planets, asteroids, comets, and other objects in our solar system. Our solar system is moving with an average velocity of 450,000 miles per hour (720,000 kilometers per hour). But even at this speed, it takes about 230 million years for the Sun to make one complete trip around the Milky Way. The Sun rotates on its axis as it revolves around the galaxy. Its spin has a tilt of 7.25 degrees with respect to the plane of the planets orbits. Since the Sun is not solid, different parts rotate at different rates. At the equator, the Sun spins around once about every 25 Earth days, but at its poles, the Sun rotates once on its axis every 36 Earth days. Moons As a star, the Sun doesnt have any moons, but the planets and their moons orbit the Sun. Rings Rings The Sun would have been surrounded by a disk of gas and dust early in its history when the solar system was first forming, about 4.6 billion years ago. Some of that dust is still around today, in several dust rings that circle the Sun. They trace the orbits of planets, whose gravity tugs dust into place around the Sun. Formation Formation The Sun formed about 4.6 billion years ago in a giant, spinning cloud of gas and dust called the solar nebula. As the nebula collapsed under its own gravity, it spun faster and flattened into a disk. Most of the nebula's material was pulled toward the center to form our Sun, which accounts for 99.8% of our solar systems mass. Much of the remaining material formed the planets and other objects that now orbit the Sun. (The rest of the leftover gas and dust was blown away by the young Sun's early solar wind.) Like all stars, our Sun will eventually run out of energy. When it starts to die, the Sun will expand into a red giant star, becoming so large that it will engulf Mercury and Venus, and possibly Earth as well. Scientists predict the Sun is a little less than halfway through its lifetime and will last another 5 billion years or so before it becomes a white dwarf. Structure Structure The Sun is a huge ball of hydrogen and helium held together by its own gravity. The Sun has several regions. The interior regions include the core, the radiative zone, and the convection zone. Moving outward the visible surface or photosphere is next, then the chromosphere, followed by the transition zone, and then the corona the Suns expansive outer atmosphere. Once material leaves the corona at supersonic speeds, it becomes the solar wind, which forms a huge magnetic "bubble" around the Sun, called the heliosphere. The heliosphere extends beyond the orbit of the planets in our solar system. Thus, Earth exists inside the Suns atmosphere. Outside the heliosphere is interstellar space. The core is the hottest part of the Sun. Nuclear reactions here where hydrogen is fused to form helium power the Suns heat and light. Temperatures top 27 million F (15 million C) and its about 86,000 miles (138,000 kilometers) thick. The density of the Suns core is about 150 grams per cubic centimeter (g/cm). That is approximately 8 times the density of gold (19.3 g/cm) or 13 times the density of lead (11.3 g/cm). Energy from the core is carried outward by radiation. This radiation bounces around the radiative zone, taking about 170,000 years to get from the core to the top of the convection zone. Moving outward, in the convection zone, the temperature drops below 3.5 million F (2 million C). Here, large bubbles of hot plasma (a soup of ionized atoms) move upward toward the photosphere, which is the layer we think of as the Sun's surface. Surface Surface The Sun doesnt have a solid surface like Earth and the other rocky planets and moons. The part of the Sun commonly called its surface is the photosphere. The word photosphere means "light sphere" which is apt because this is the layer that emits the most visible light. Its what we see from Earth with our eyes. (Hopefully, it goes without saying but never look directly at the Sun without protecting your eyes.) Although we call it the surface, the photosphere is actually the first layer of the solar atmosphere. It's about 250 miles thick, with temperatures reaching about 10,000 degrees Fahrenheit (5,500 degrees Celsius). That's much cooler than the blazing core, but it's still hot enough to make carbon like diamonds and graphite not just melt, but boil. Most of the Sun's radiation escapes outward from the photosphere into space. Atmosphere Atmosphere Above the photosphere is the chromosphere, the transition zone, and the corona. Not all scientists refer to the transition zone as its own region it is simply the thin layer where the chromosphere rapidly heats and becomes the corona. The photosphere, chromosphere, and corona are all part of the Suns atmosphere. (The corona is sometimes casually referred to as the Suns atmosphere, but it is actually the Suns upper atmosphere.) The Suns atmosphere is where we see features such as sunspots, coronal holes, and solar flares. Visible light from these top regions of the Sun is usually too weak to be seen against the brighter photosphere, but during total solar eclipses, when the Moon covers the photosphere, the chromosphere looks like a fine, red rim around the Sun, while the corona forms a beautiful white crown ("corona" means crown in Latin and Spanish) with plasma streamers narrowing outward, forming shapes that look like flower petals. In one of the Suns biggest mysteries, the corona is much hotter than the layers immediately below it. (Imagine walking away from a bonfire only to get warmer!) The source of coronal heating is a major unsolved puzzle in the study of the Sun. Magnetosphere Magnetosphere The Sun generates magnetic fields that extend out into space to form the interplanetary magnetic field the magnetic field that pervades our solar system. The field is carried through the solar system by the solar wind a stream of electrically charged gas blowing outward from the Sun in all directions. The vast bubble of space dominated by the Suns magnetic field is called the heliosphere. Since the Sun rotates, the magnetic field spins out into a large rotating spiral, known as the Parker spiral. This spiral has a shape something like the pattern of water from a rotating garden sprinkler. The Sun doesn't behave the same way all the time. It goes through phases of high and low activity, which make up the solar cycle. Approximately every 11 years, the Suns geographic poles change their magnetic polarity that is, the north and south magnetic poles swap. During this cycle, the Sun's photosphere, chromosphere, and corona change from quiet and calm to violently active. The height of the Suns activity cycle, known as solar maximum, is a time of greatly increased solar storm activity. Sunspots, eruptions called solar flares, and coronal mass ejections are common at solar maximum. The latest solar cycle Solar Cycle 25 started in December 2019 when solar minimum occurred, according to the Solar Cycle 25 Prediction Panel, an international group of experts co-sponsored by NASA and NOAA. Scientists now expect the Suns activity to ramp up toward the next predicted maximum in July 2025. Solar activity can release huge amounts of energy and particles, some of which impact us here on Earth. Much like weather on Earth, conditions in space known as space weather are always changing with the Suns activity. "Space weather" can interfere with satellites, GPS, and radio communications. It also can cripple power grids, and corrode pipelines that carry oil and gas. The strongest geomagnetic storm on record is the Carrington Event, named for British astronomer Richard Carrington who observed the Sept. 1, 1859, solar flare that triggered the event. Telegraph systems worldwide went haywire. Spark discharges shocked telegraph operators and set their telegraph paper on fire. Just before dawn the next day, skies all over Earth erupted in red, green, and purple auroras the result of energy and particles from the Sun interacting with Earths atmosphere. Reportedly, the auroras were so brilliant that newspapers could be read as easily as in daylight. The auroras, or Northern Lights, were visible as far south as Cuba, the Bahamas, Jamaica, El Salvador, and Hawaii. Another solar flare on Marçh 13, 1989, caused geomagnetic storms that disrupted electric power transmission from the Hydro Quebec generating station in Canada, plunging 6 million people into darkness for 9 hours. The 1989 flare also caused power surges that melted power transformers in New Jersey. In December 2005, X-rays from a solar storm disrupted satellite-to-ground communications and Global Positioning System (GPS) navigation signals for about 10 minutes. NOAAs Space Weather Prediction Center monitors active regions on the Sun and issues watches, warnings, and alerts for hazardous space weather events. Resources Resources Our solar system has eight planets, and five dwarf planets. About 1.4 million asteroids, and about 4,000 comets are in our solar system. Our solar system has hundreds of moons. Our solar system is in one of the Milky Way galaxies spiral arms called the Orion Spur. Our solar system takes about 230 million years to orbit the galactic center. The Milky Way is a barred spiral galaxy. Our solar system has many worlds with many types of atmospheres. The four giant planets and at least one asteroid have rings. More than 300 robotic spacecraft have left Earth's orbit, and 24 U.S. astrnauts have traveled to the Moon. So far, Earth is the only place we've found life in our solar system. Jupiters moon Ganymede is proving to be a fascinating world. Not only is it the largest moon in our solar system, bigger than the planet Mercury and the dwarf planet Pluto, but NASAs Hubble Space Telescope has found the best evidence yet for an underground saltwater ocean on Ganymede. The ocean is thought to have more water than all the water on Earth's surface. Ganymedes ocean is estimated to be 60 miles (100 kilometers) thick 10 times deeper than Earth's ocean and is believed to be buried under a 95-mile- (150-kilometer-) thick crust of mostly ice. Identifying liquid water is crucial in the search for habitable worlds beyond Earth and in the search for life as we know it. Hubble images of Ganymede's auroral belts (colored blue for illustration) are overlaid on a Galileo orbiter image of the moon. The amount of rocking of the moon's magnetic field suggests that the moon has a subsurface saltwater ocean. Credit: NASA/ESA Ganymede is the only moon known to have its own magnetic field a discovery made by NASAs Galileo spacecraft in 1996. The magnetic field causes auroras, which are ribbons of glowing, hot, electrified gas, in regions circling the north and south poles of the moon. Because Ganymede is close to Jupiter, its magnetic field is embedded in, or lies within, Jupiters magnetic field. When Jupiters magnetic field changes, the auroras on Ganymede also change, rocking back and forth. It was by watching the rocking motion of the two auroras, that a team of scientists led by Joachim Saur of the University of Cologne in Germany came up with the idea of using the Hubble space telescope to learn more about the inside of the moon. This image of the dark side of Ganymede was obtained by Junos Stellar Reference Unit navigation camera during its June 7, 2021, flyby of the moon. Credit: NASA/JPL-Caltech/SwRI | Full image and caption Ganymede has two distinct types of terrain: large, bright regions of ridges, and grooves that slice across older, darker terrains. This suggests to scientists that Ganymede's crust has been under tension from global tectonic processes. NASAs Juno spacecraft took the most recent images of Ganymedes surface during flybys in June 2021. Ganymede was discovered by Italian astronomer Galileo Galilei on Jan. 7, 1610. The discovery, along with his discovery of three other large moons around Jupiter, was the first time a moon was discovered orbiting a planet other than Earth. The discovery eventually led to the understanding that planets in our solar system orbit the Sun, instead of our solar system revolving around Earth. (Jupiter now has 53 named moons and 26 provisional moons awaiting confirmation of discovery). Namesake Namesake In mythology, Ganymede ("GÁN uh meed") was a beautiful young boy who was carried to Olympus by Zeus (the Greek equivalent of the Roman god Jupiter) disguised as an eagle. Ganymede became the cupbearer of the Olympian gods. Potential for Life Potential for Life A computer model of Ganymedes interior created in 2014 supported the idea that the development of primitive life might be possible there. The model indicated the icy moons rocky sea bottom might be in contact with salt water and rock interacting are key for the development of life. Size and Distance Size and Distance Ganymede has a radius of 1,635 miles (2,631 kilometers) and is the largest moon in our solar system. Its bigger than Mercury and Pluto. Ganymede is about 665,000 miles (1.07 million kilometers) from Jupiter, which orbits about 484 million miles (778 million kilometers) from the Sun. 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 the Jovian system. Orbit and Rotation Orbit and Rotation Ganymede orbits Jupiter at a distance of 665,000 miles (1,070,000 kilometers), making it third in distance from Jupiter among the Galilean satellites: Io: 262,200 miles (422,000 kilometers) Europa: 417,000 mi (671,000 kilometers) Ganymede 665,000 miles (1,070,000 kilometers) Callisto: 1,170,000 mi (1,883,000 kilometers) Ganymede completes an orbit around Jupiter about every seven Earth days (7.155). Ganymede orbits the Sun along with Jupiter and its other satellites every 12 Earth years. Ganymede, Io, and Europa are in what is called a resonance every time Ganymede orbits Jupiter once, Europa orbits twice, and Io orbits four times. This pattern in their orbits is called orbital resonance. (Jupiters other large moon Callisto is not part of the orbital resonance, seemingly because it was too far away from Jupiter early in the moons' history for its orbit to be pulled inward toward Jupiter.) Over time, the orbits of most large satellites or planets tend to become circular, but that isn't the case for these three. Their resonance forces their orbits to become slightly elliptical, or eccentric. The satellites line up with one another at the same points in their orbits over and over, giving each other a small gravitational tug that keeps their orbits from becoming circular. Ganymede is tidally locked, meaning that like Earths Moon, the same side of Ganymede always faces Jupiter. The other three Galilean moons are also tidally locked. Moons Moons Ganymede does not have moons. Rings Rings Ganymede does not have rings. Formation Formation Ganymede and Jupiters other large moons (Io, Europa, and Callisto) likely formed from leftover material after Jupiter condensed out of the initial cloud of gas and dust surrounding the Sun, early in the history of our solar system. Ganymede is likely about the same age as the rest of the solar system about 4.5 billion years old. NASAs Juno spacecraft is currently orbiting Jupiter with the main goal of learning more about the origin and evolution of Jupiter and its satellites. Scientists think that understanding Jupiter will provide critical knowledge about our solar system, and the planetary systems being discovered around other stars. Structure Structure Ganymede has three main layers: A metallic iron core at its center, a spherical shell of rock (mantle) surrounding the core, and a spherical shell of mostly ice surrounding the rock shell. The surface is the very top of the ice shell. Scientists have discovered irregular lumps beneath Ganymedes icy surface. These irregular masses may be rock formations, supported by Ganymede's icy shell for billions of years. Computer models show Ganymede might have ice and oceans stacked up in several layers like a club sandwich. Scientists first suspected Ganymede had an underground ocean in the 1970s. The Galileo spacecraft discovered Ganymede's magnetic field in 1996, providing evidence to support the theory. NASAs Hubble Space Telescope has found more evidence for an underground saltwater ocean, and evidence of a thin oxygen atmosphere on Ganymede. Surface Surface Spacecraft images of Ganymede show its surface is a mix of two types of terrain. Forty percent of the surface is covered by highly cratered dark regions, and the remaining sixty percent is covered by a light grooved terrain, which forms intricate patterns across the moon. Some of the groove ridges are as high as 2,000 feet (700 meters), and the grooves run for thousands of miles across Ganymede's surface. The large craters on Ganymede are mostly flat, probably due to settling in the soft icy surface. Both bright and dark rays of ejecta can be seen around Ganymede's craters. In 2004, scientists discovered irregular lumps beneath the icy surface of Ganymede. The irregular masses may be rock formations, supported by Ganymede's icy shell for billions of years. This tells scientists that the ice is probably strong enough, at least near the surface, to support such rock masses from sinking to the bottom of the ice. However, this anomaly could also be caused by piles of rock at the bottom of the ice. Atmosphere Atmosphere Astronomers using the Hubble Space Telescope have found evidence of a thin oxygen atmosphere on Ganymede. The researchers think the oxygen is coming from Ganymedes icy surface. Ganymede is much colder than Earth, with daytime surface temperatures ranging from Earth's -297 to -171 degrees Fahrenheit (90 to 160 Kelvin). Jupiter and its moons receive less than 1/30th the amount of sunlight that the Earth does, and Ganymede doesnt have a dense atmosphere to trap heat. Magnetosphere Magnetosphere The Galileo spacecraft, the first to orbit Jupiter, made the major discovery that Ganymede has its own magnetosphere a region of charged particles that surrounds many planets but had never before been found around a moon. Galileo even captured sounds of whistling and static caused by Ganymede's magnetosphere. Resources Resources IntroductionSaturn's largest moon, Titan, is an icy world whose surface is completely obscured by a golden hazy atmosphere. Titan is the second largest moon in our solar system. Only Jupiters moon Ganymede is larger, by just 2 percent. Titan is bigger than Earth's moon, and larger than even the planet Mercury. This mammoth moon is the only moon in the solar system with a dense atmosphere, and its the only world besides Earth that has standing bodies of liquid, including rivers, lakes and seas, on its surface. Like Earth, Titans atmosphere is primarily nitrogen, plus a small amount of methane. It is the sole other place in the solar system known to have an earthlike cycle of liquids raining from clouds, flowing across its surface, filling lakes and seas, and evaporating back into the sky (akin to Earths water cycle). Titan is also thought to have a subsurface ocean of water. Size and Distance Size and Distance Titan has a radius of about 1,600 miles (2,575 kilometers), and is nearly 50 percent wider than Earths moon. Titan is about 759,000 miles (1.2 million kilometers) from Saturn, which itself is about 886 million miles (1.4 billion kilometers) from the Sun, or about 9.5 astronomical units (AU). One AU is the distance from Earth to the Sun. Light from the Sun takes about 80 minutes to reach Titan; because of the distance, sunlight is about 100 times fainter at Saturn and Titan than at Earth. Orbit and Rotation Orbit and Rotation Titan takes 15 days and 22 hours to complete a full orbit of Saturn. Titan is also tidally locked in synchronous rotation with Saturn, meaning that, like Earths Moon, Titan always shows the same face to the planet as it orbits. Saturn takes about 29 Earth years to orbit the Sun (a Saturnian year), and Saturns axis of rotation is tilted like Earths, resulting in seasons. But Saturns longer year produces seasons that each last more than seven Earth years. Since Titan orbits roughly along Saturns equatorial plane, and Titans tilt relative to the sun is about the same as Saturns, Titans seasons are on the same schedule as Saturnsseasons that last more than seven Earth years, and a year that lasts 29 Earth years. Structure Structure Titans internal structure isnt entirely known, but one model based on data from the Cassini-Huygens mission suggests Titan has five primary layers. The innermost layer is a core of rock (specifically, water-bearing silicate rock) about 2,500 miles (4,000 kilometers) in diameter. Surrounding the core is a shell of water icea special type called ice-VI that is only found at extremely high-pressures. The high-pressure ice is surrounded by a layer of salty liquid water, on top of which sits an outer crust of water ice. This surface is coated with organic molecules that have rained or otherwise settled out of the atmosphere in the form of sands and liquids. The surface is huggy by a dense atmosphere. Formation Formation Scientists arent certain about Titans origin. However, its atmosphere provides a clue. Several instruments on the NASA and ESA Cassini-Huygens mission measured the isotopes nitrogen-14 and nitrogen-15 in Titans atmosphere. The instruments found Titans nitrogen isotope ratio most resembles that found in comets from the Oort Cloudsa sphere of hundreds of billions of icy bodies thought to orbit the Sun at a distance between 5,000 and 100,000 astronomical units from the Sun (Earth is about one astronomical unit from the Sunroughly 93 million miles or 150 million kilometers). Titans atmospheric nitrogen ratio suggests the moons building blocks formed early in the solar system's history, in the same cold disk of gas and dust that formed the Sun (called the protosolar nebula), rather than forming in the warmer disk of material that Saturn later formed from (called the Saturn sub-nebula). Surface Surface The surface of Titan is one of the most Earthlike places in the solar system, albeit at vastly colder temperatures and with different chemistry. Here it is so cold (-290 degrees Fahrenheit or -179 degrees Celsius) that water ice plays the role of rock. Titan may have a thick, orange-colored haze that makes the moon's surface difficult to view from space. (Spacecraft and telescopes can, however, see through the haze at certain wavelengths of light outside of those visible to human eyes.) Some of the heavy, carbon-rich compounds settle to the moons surface;these hydrocarbons play the role of sand in Titans vast dune fields. And methane condenses into clouds that occasionally drench the surface in methane storms. The methane in Titans atmosphere is what makes its complex atmospheric chemistry possible, but where all that methane comes from is a mystery. Because sunlight continuously breaks down methane in Titans atmosphere, some source must be replenishing it or it would be depleted over time. Researchers suspect methane could be belched into Titan's atmosphere by cryovolcanismvolcanoes releasing chilled water instead of molten rock lavabut theyre not certain if this or some other process is responsible. Potential for Life Potential for Life The Cassini spacecrafts numerous gravity measurements of Titan revealed that the moon is hiding an underground ocean of liquid water (likely mixed with salts and ammonia). The European Space Agency's Huygens probe also measured radio signals during its descent to the surface, in 2005, that strongly suggested the presence of an ocean 35 to 50 miles (55 to 80 kilometers) below the icy ground. The discovery of a global ocean of liquid water adds Titan to the handful of worlds in our solar system that could potentially contain habitable environments. Additionally, Titans rivers, lakes and seas of liquid methane and ethane might serve as a habitable environment on the moons surface, though any life there would likely be very different from Earths life. Thus, Titan could potentially harbor environments with conditions suitable for lifeemancing both life as we know it (in the subsurface ocean) and life as we dont know it (in the hydrocarbon liquid on the surface). Although there is so far no evidence of life on Titan, its complex chemistry and unique environments are certain to make it a destination for continued exploration. You are using an outdated browser. Please upgrade your browser to improve your experience.IntroductionThe planetary system we call home is located in an outer spiral arm of the Milky Way galaxy. Our solar system consists of our star, the Sun, and everything bound to it by gravity the planets Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune, dwarf planets such as Pluto, dozens of moons, and millions of asteroids, comets, and meteoroids. Beyond our own solar system, there are more planets than stars in the night sky. So far, we have discovered thousands of planetary systems orbiting other stars in the Milky Way, with more planets being found. Most of the hundreds of billions of stars in our galaxy are thought to have planets of their own, and the Milky Way is but one of perhaps 100 billion galaxies in the universe. While our planet is in some ways a mere speck in the vast cosmos, we have a lot of company out there. It seems that we live in a universe packed with planets a web of countless stars accompanied by families of objects, perhaps some with life of their own. Namesake Namesake There are many planetary systems like ours in the universe, with planets orbiting a hot star. Our planetary system is called the solar system because we use the word solar to describe things related to our star, after the Latin word for Sun, "solis." Size and Distance Size and Distance Our solar system extends much farther than the eight planets that orbit the Sun. The solar system also includes the Kuiper Belt that lies past Neptune's orbit. This is a sparsely occupied ring of icy bodies, almost all smaller than the most popular Kuiper Belt Object dwarf planet Pluto. NASAs New Horizons spacecraft captured this high-resolution enhanced color view of Pluto on July 14, 2015. Credit: NASA/JHUAPL/SwRI | Full caption and image Beyond the fringes of the Kuiper Belt is the Oort Cloud. This giant spherical shell surrounds our solar system. It has never been directly observed, but its existence is predicted based on mathematical models and observations of comets that likely originate there. The Oort Cloud is made of icy pieces of space debris - some bigger than mountains orbiting our Sun as far as 1.6 light-years away. This shell of material is thick, extending from 5,000 astronomical units to 100,000 astronomical units. One astronomical unit (or AU) is the distance from the Sun to Earth, or about 93 million miles (150 million kilometers). The Oort Cloud is the boundary of the Sun's gravitational influence, where orbiting objects can turn around and return closer to our Sun. The Sun's heliosphere doesn't extend quite as far. The heliosphere is the bubble created by the solar wind a stream of electrically charged gas blowing outward from the Sun in all directions. The boundary where the solar wind is abruptly slowed by pressure from interstellar gases is called the termination shock. This edge occurs between 80-100 astronomical units. Two NASA spacecraft launched in 1977 have crossed the termination shock: Voyager 1 in 2004 and Voyager 2 in 2007. Voyager 1 went interstellar in 2012 and Voyager 2 joined it in 2018. But it will be many thousands of years before the two Voyagers exit the Oort Cloud. Moons Moons There are more than 200 known moons in our solar system and several more awaiting confirmation of discovery. Of the eight planets, Mercury and Venus are the only ones with no moons. The giant planets Jupiter and Saturn lead our solar systems moon counts. In some ways, the swarms of moons around these worlds resemble mini versions of our solar system. Pluto, smaller than our own moon, has five moons in its orbit, including the Charon, a moon so large it makes Pluto wobble. Even tiny asteroids can have moons. In 2017, scientists found asteroid 3122 Florence had two tiny moons. These six narrow-angle color images were made from the first-ever 'portrait' of the solar system taken by Voyager 1, which was more than 4 billion miles from Earth and about 32 degrees above the ecliptic. Credit: NASA Planetary Photojournal Formation Formation Our solar system formed about 4.5 billion years ago from a dense cloud of interstellar gas and dust. The cloud collapsed, possibly due to the shockwave of a nearby exploding star, called a supernova. When this dust cloud collapsed, it formed a solar nebula a spinning, swirling disk of material. At the center, gravity pulled more and more material in. Eventually, the pressure in the core was so great that hydrogen atoms began to combine and form helium, releasing a tremendous amount of energy. With that, our Sun was born, and it eventually amassed more than 99% of the available matter. Matter farther out in the disk was also clumping together. These clumps smashed into one another, forming larger and larger objects. Some of them grew big enough for their gravity to shape them into spheres, becoming planets, dwarf planets, and large moons. In other cases, planets did not form; the asteroid belt is made of bits and pieces of the early solar system that could never quite come together into a planet. Other smaller leftover pieces became asteroids, comets, meteoroids, and small, irregular moons. Structure Structure The order and arrangement of the planets and other bodies in our solar system is due to the way the solar system formed. Nearest to the Sun, only rocky material could withstand the heat when the solar system was young. For this reason, the first four planets Mercury, Venus, Earth, and Mars are terrestrial planets. They are all small with solid, rocky surfaces. Meanwhile, materials we are used to seeing as ice, liquid, or gas settled in the outer regions of the young solar system. Gravity pulled these materials together, and that is where we find gas giants Jupiter and Saturn, and the ice giants Uranus and Neptune.

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