The **Solar System** or **solar system** consists of the Sun and the other celestial objects gravitationally bound to it: the eight planets, their 166 known moons,[1] three dwarf planets (Ceres, Pluto, and Eris and their four known moons), and billions of small bodies. This last category includes asteroids, Kuiper belt objects, comets, meteoroids, and interplanetary dust.

Major features of the Solar System; sizes and distances not to scale. From left to right): Pluto, Neptune, Uranus, Saturn, Jupiter, the asteroid belt, the Sun, Mercury, Venus, Earth and its Moon, and Mars. A comet is also seen on the left.

In broad terms, the charted regions of the Solar System consist of the Sun, four terrestrial **inner planets**, an asteroid belt composed of small rocky bodies, four gas giant **outer planets**, and a second belt, called the Kuiper belt, composed of icy objects. Beyond the Kuiper belt is the scattered disc, the heliopause, and ultimately the hypothetical Oort cloud.

In order of their distances from the Sun, the planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Six of the eight planets are in turn orbited by natural satellites, usually termed "moons" after Earth's Moon, and each of the outer planets is encircled by planetary rings of dust and other particles. All the planets except Earth are named after gods and goddesses from Greco-Roman mythology. The three dwarf planets are Pluto, the largest known Kuiper belt object; Ceres, the largest object in the asteroid belt; and Eris, which lies in the scattered disc.

See also: Definition of planet

Objects orbiting the Sun are divided into three classes: planets, dwarf planets, and small Solar System bodies.

Planets and dwarf planets of the Solar System; while the sizes are to scale, the relative distances from the Sun are not.

A planet is any body in orbit around the Sun that a) has enough mass to form itself into a spherical shape and b) has cleared its immediate neighbourhood of

On August 24 2006 the International Astronomical Union defined the term "planet" for the first time, excluding Pluto and reclassifying it under the new category of dwarf planet along with Eris and Ceres.[2]

A dwarf planet is not required to clear its neighbourhood of other celestial bodies. Other objects that may become classified as dwarf planets are Sedna, Orcus, and Quaoar.

From the time of its discovery in 1930 until 2006, Pluto was considered the Solar System's ninth planet. But in the late 20th and early 21st centuries, many objects similar to Pluto were discovered in the outer Solar System, most notably Eris, which is slightly larger than Pluto.

The remainder of the objects in orbit around the Sun are small Solar System bodies (SSSBs).[3]

Natural satellites, or moons, are those objects in orbit around planets, dwarf planets and SSSBs, rather than the Sun itself.

A planet's distance from the Sun varies in the course of its year. Its closest approach to the Sun is called its perihelion, while its farthest distance from the Sun is called its aphelion.

Astronomers usually measure distances within the Solar System in astronomical units (AU). One AU is the approximate distance between the Earth and the Sun, or roughly 149,598,000 km (93,000,000 mi). Pluto is roughly 38 AU from the Sun while Jupiter lies at roughly 5.2 AU. One light year, the best known unit of interstellar distance, is roughly 63,240 AU.

Informally, the Solar System is sometimes divided into separate zones. The **inner Solar System** includes the four terrestrial planets and the main asteroid belt. Some define the **outer Solar System** as comprising everything beyond the asteroids.[4] Others define it as the region beyond Neptune, with the four gas giants considered a separate "middle zone".[5]

The ecliptic viewed in sunlight from behind the Moon in this Clementine image. From left to right: Mercury, Mars, Saturn.

The principal component of the Solar System is the Sun, a main sequence G2 star that contains 99.86% of the system's known mass and dominates it gravitationally.[6] Jupiter and Saturn, the Sun's two largest orbiting bodies, account for more than 90% of the system's remaining mass.

Most large objects in orbit around the Sun lie near the plane of Earth's orbit, known as the ecliptic. The planets are very close to the ecliptic while comets and Kuiper belt objects are usually at significantly greater angles to it.

All of the planets and most other objects also orbit with the Sun's rotation in a counter-clockwise direction as viewed from a point above the Sun's north pole. There are exceptions, such as Halley's Comet.

Objects travel around the Sun following Kepler's laws of planetary motion. Each object orbits along an approximate ellipse with the Sun at one focus of the ellipse. The closer an object is to the Sun, the faster it moves. The orbits of the planets are nearly circular, but many comets, asteroids and objects of the Kuiper belt follow highly-elliptical orbits.

The orbits of the bodies in the Solar System to scale (clockwise from top left)

To cope with the vast distances involved, many representations of the Solar System show orbits the same distance apart. In reality, with a few exceptions, the farther a planet or belt is from the Sun, the larger the distance between it and the previous orbit. For example, Venus is approximately 0.33 AU farther out than Mercury, while Saturn is 4.3 AU out from Jupiter, and Neptune lies 10.5 AU out from Uranus. Attempts have been made to determine a correlation between these orbital distances (see Titius-Bode law), but no such theory has been accepted.

Artist's conception of a protoplanetary disk

The Solar System is believed to have formed according to the nebular hypothesis, first proposed in 1755 by Immanuel Kant and independently formulated by Pierre-Simon Laplace.[7] This theory holds that 4.6 billion years ago the Solar System formed from the gravitational collapse of a giant molecular cloud. This initial cloud was likely several light-years across and probably birthed several stars.[8] Studies of ancient meteorites reveal traces of elements only formed in the hearts of very large exploding stars, indicating that the Sun formed within a star cluster, and in range of a number of nearby supernovae explosions. The shock wave from these supernovae may have triggered the formation of the Sun by creating regions of overdensity in the surrounding nebula, allowing gravitational forces to overcome internal gas pressures and cause collapse.[9]

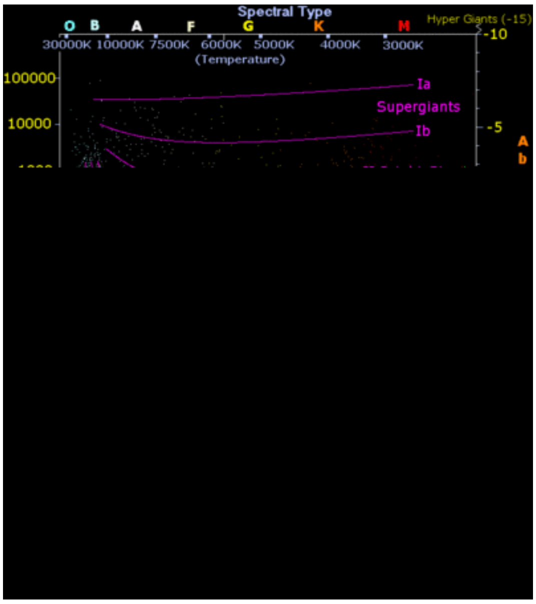
The region that would become the Solar System, known as the pre-solar nebula,[10] had a diameter of between 7000 and 20,000 AU[11] [12] and a mass just over that of the Sun (by between 0.1 and 0.001 solar masses).[13] As the nebula collapsed, conservation of angular momentum made it rotate faster. As the material within the nebula condensed, the atoms within it began to collide with increasing frequency. The centre, where most of the mass collected, became increasingly hotter than the surrounding disc.[14] As

The Sun as seen from Earth

The Sun is the Solar System's parent star, and far and away its chief component. Its large mass gives it an interior density high enough to sustain nuclear fusion, which releases enormous amounts of energy, mostly radiated into space as electromagnetic radiation such as visible light.

The Sun is classified as a moderately large yellow dwarf, but this name is misleading as, compared to stars in our galaxy, the Sun is rather large and bright. Stars are classified by the Hertzsprung-Russell diagram, a graph which plots the brightness of stars against their surface temperatures. Generally, hotter stars are brighter. Stars following this pattern are said to be on the main sequence; the Sun lies right in the middle of it. However, stars brighter and hotter than the Sun are rare, while stars dimmer and cooler are common.[28]

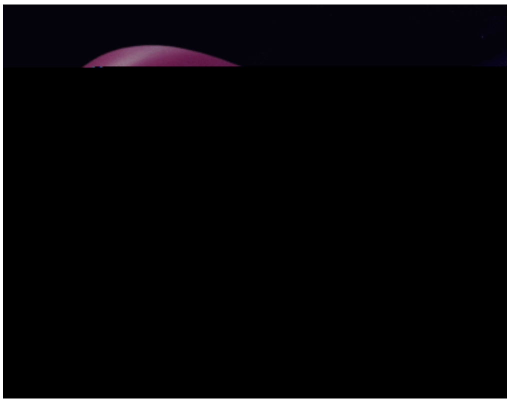
It is believed that the Sun's position on the main sequence puts it in the "prime of life" for a star, in that it has not yet exhausted its store of hydrogen for nuclear fusion. The Sun is growing brighter; early in its history it was 75 percent as bright as it is today.[29]



The Hertzsprung-Russell diagram; the main sequence is from bottom right to top left.

Calculations of the ratios of hydrogen and helium within the Sun suggest it is halfway through its life cycle. It will eventually move off the main sequence and become larger, brighter, cooler and redder, becoming a red giant in about five billion years.[30] At that point its luminosity will be several thousand times its present value.

The Sun is a population I star; it was born in the later stages of the universe's evolution. It contains more elements heavier than hydrogen and helium ("metals" in astronomical parlance) than older population II stars.[31] Elements heavier than hydrogen and helium were formed in the cores of ancient and exploding stars, so the first generation of stars had to die before the universe could be enriched with these atoms. The oldest stars contain few metals, while stars born later have more. This high metallicity is thought to have been crucial to the Sun's developing a planetary system, because planets form from accretion of metals.[32]



The heliospheric current sheet

Along with light, the Sun radiates a continuous stream of charged particles (a plasma) known as the solar wind. This stream of particles spreads outwards at roughly 1.5 million kilometres per hour,[33] creating a tenuous atmosphere (the heliosphere) that permeates the Solar System out to at least 100 AU (see heliopause). This is known as the interplanetary medium. The Sun's 11-year sunspot cycle and frequent solar flares and coronal mass ejections disturb the heliosphere, creating space weather.[34] The Sun's rotating magnetic field acts on the interplanetary medium to create the heliospheric current sheet, the largest structure in the solar system.[35]

Aurora australis seen from orbit.

Earth's magnetic field protects its atmosphere from interacting with the solar wind. Venus and Mars do not have magnetic fields, and the solar wind causes their atmospheres to gradually bleed away into space.[36] The interaction of the solar wind with Earth's magnetic field creates the aurorae seen near the magnetic poles.

Cosmic rays originate outside the Solar System. The heliosphere partially shields the Solar System, and planetary magnetic fields (for planets which have them) also provide some protection. The density of cosmic rays in the interstellar medium and the strength of the Sun's magnetic field change on very long timescales, so the level of cosmic radiation in the Solar System varies, though by how much is unknown.[37]

The interplanetary medium is home to at least two disc-like regions of cosmic dust. The first, the zodiacal dust cloud, lies in the inner Solar System and causes zodiacal light. It was likely formed by collisions within the asteroid belt brought on by interactions with the planets.[38] The second extends from about 10 AU to about 40 AU, and was probably created by similar collisions within the Kuiper belt.[39] [40]

The inner Solar System is the traditional name for the region comprising the terrestrial planets and asteroids. Composed mainly of silicates and metals, the objects of the inner Solar System huddle very closely to the Sun; the radius of this entire region is shorter than the distance between Jupiter and Saturn. This region was, in old parlance, denoted inner space; the area outside the asteroid belt was denoted outer space.

Main article: Terrestrial planet

The four inner or terrestrial planets have dense, rocky compositions, few or no moons, and no ring systems. They are composed largely of minerals with high melting points, such as the silicates which form their solid crusts and semi-liquid mantles, and metals such as iron and nickel, which form their cores. Three of the four inner planets (Venus, Earth and Mars) have substantial atmospheres; all have impact craters and tectonic surface features such as rift valleys and volcanoes. The term *inner planet* should not be confused with *inferior planet*, which designates those planets which are closer to the Sun than Earth is (i.e. Mercury and Venus).

The inner planets. From left to right: Mercury, Venus, Earth, and Mars (sizes to scale)

Mercury

Mercury (0.4 AU) is the closest planet to the Sun and the smallest planet (0.055 Earth masses). Mercury has no natural satellites, and its only known geological features besides impact craters are "wrinkle-ridges", probably produced by a period of contraction early in its history.[41] Mercury's almost negligible atmosphere consists of atoms blasted off its surface by the solar wind.[42] Its relatively large iron core and thin mantle have not yet been adequately explained. Hypotheses include that its outer layers were stripped off by a giant impact, and that it was prevented from fully accreting by the young Sun's energy.[43][44]

Venus

Venus (0.7 AU) is close in size to Earth (0.815 Earth masses) and, like Earth, has a thick silicate mantle around an iron core, a substantial atmosphere and evidence of internal geological activity. However, it is much drier than Earth and its atmosphere is ninety times as dense. Venus has no natural satellites. It is the hottest planet, with surface temperatures over 400 °C, most likely due to the amount of greenhouse gases in the atmosphere.[45] No definitive evidence of current geological activity has been detected on Venus, but it has no magnetic field that would prevent depletion of its substantial atmosphere, which suggests that its atmosphere is regularly replenished by volcanic eruptions.[46]

Earth

Earth (1 AU) is the largest and densest of the inner planets, the only one known to have current geological activity, and the only planet known to have life. Its liquid hydrosphere is unique among the terrestrial planets, and it is also the only planet where plate tectonics has been observed. Earth's atmosphere is radically different from those of the other planets, having been altered by the presence of life to contain 21% free oxygen.[47] It has one satellite, the Moon, the only large satellite of a terrestrial planet in the Solar System.

Mars

Mars (1.5 AU) is smaller than Earth and Venus (0.107 Earth masses). It possesses a tenuous atmosphere of mostly carbon dioxide. Its surface, peppered with vast volcanoes such as Olympus Mons and rift valleys such as Valles Marineris, shows geological activity that may have persisted until very recently.[48] Mars has two tiny natural satellites (Deimos and Phobos) thought to be captured asteroids.[49]

Main article: Asteroid belt

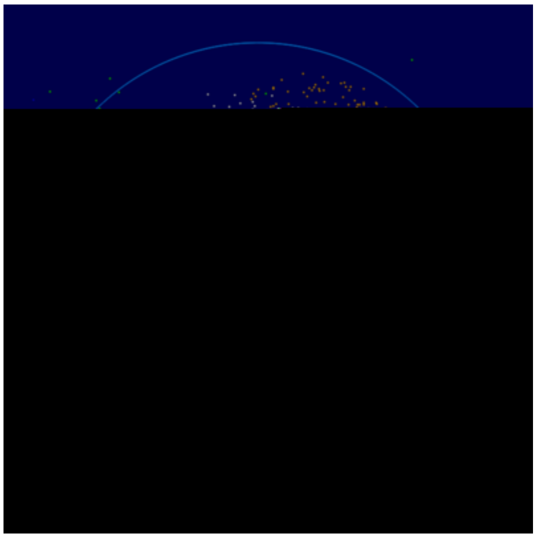


Image of the main asteroid belt and the Trojan asteroids

Asteroids are mostly small Solar System bodies composed mainly of rocky and metallic non-volatile minerals.

The main asteroid belt occupies the orbit between Mars and Jupiter, between 2.3 and 3.3 AU from the Sun. It is thought to be remnants from the Solar System's formation that failed to coalesce because of the gravitational interference of Jupiter.

Asteroids range in size from hundreds of kilometres across to microscopic. All asteroids save the largest, Ceres, are classified as small Solar System bodies, but some asteroids such as Vesta and Hygieia may be reclassed as dwarf planets if they are shown to have achieved hydrostatic equilibrium.

The asteroid belt contains tens of thousands, possibly millions, of objects over one kilometre in diameter.[50] Despite this, the total mass of the main belt is unlikely to be more than a thousandth of that of the Earth.[51] The main belt is very sparsely populated; spacecraft routinely pass through without incident. Asteroids with diameters between 10 and 10^{-4} m are called meteoroids.[52]

Ceres

Ceres

Ceres (2.77 AU) is the largest body in the asteroid belt and its only dwarf planet. It has a diameter of slightly under 1000 km, large enough for its own gravity to pull it into a spherical shape. Ceres was considered a planet when it was discovered in the 19th century, but was reclassified as an asteroid in the 1850s as further observation revealed additional asteroids.[53] It was again reclassified in

2006 as a dwarf planet.

Asteroid groups

Asteroids in the main belt are divided into asteroid groups and families based on their orbital characteristics. Asteroid moons are asteroids that orbit larger asteroids. They are not as clearly distinguished as planetary moons, sometimes being almost as large as their partners. The asteroid belt also contains main-belt comets[54] which may have been the source of Earth's water.

Trojan asteroids are located in either of Jupiter's L_4 or L_5 points (gravitationally stable regions leading and trailing a planet in its orbit); the term "Trojan" is also used for small bodies in any other planetary or satellite Lagrange point. Hilda asteroids are in a 2:3 resonance with Jupiter; that is, they go around the Sun three times for every two Jupiter orbits.

The inner Solar System is also dusted with rogue asteroids, many of which cross the orbits of the inner planets.

The middle region of the Solar System is home to the gas giants and their planet-sized satellites. Many short period comets, including the centaurs, also lie in this region. It has no traditional name; it is occasionally referred to as the "outer Solar System", although recently that term has been more often applied to the region beyond Neptune. The solid objects in this region are composed of a higher proportion of "ices" (water, ammonia, methane) than the rocky denizens of the inner Solar System.

The four outer planets, or gas giants (sometimes called Jovian planets), collectively make up 99 percent of the mass known to orbit the Sun. Jupiter and Saturn's atmospheres are largely hydrogen and helium. Uranus and Neptune's atmospheres have a higher percentage of €ices•, such as water, ammonia and methane. Some astronomers suggest they belong in their own category, €ice giants.•[55] All four gas giants have rings, although only Saturn's ring system is easily observed from Earth. The term *outer planet* should not be confused with *superior planet*, which designates planets outside Earth's orbit (the outer planets and Mars).

From top to bottom: Neptune, Uranus, Saturn, and Jupiter (not to scale)

Jupiter

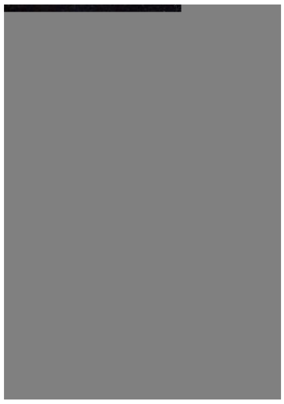
Jupiter (5.2 AU), at 318 Earth masses, masses 2.5 times all the other planets put together. It is composed largely of hydrogen and helium. Jupiter's strong internal heat creates a number of semi-permanent features in its atmosphere, such as cloud bands and the Great Red Spot. Jupiter has sixty-three known satellites. The four largest, Ganymede, Callisto, Io, and Europa, show similarities

Neptune

Neptune (30 AU), though slightly smaller than Uranus, is more massive (equivalent to 17 Earths) and therefore denser. It radiates more internal heat, but not as much as Jupiter or Saturn.[59] Neptune has thirteen known satellites. The largest, Triton, is geologically active, with geysers of liquid nitrogen.[60] Triton is the only large satellite with a retrograde orbit. Neptune is accompanied in its orbit by a number of minor planets in a 1:1 resonance with it, termed Neptune Trojans.

Main article: Comet

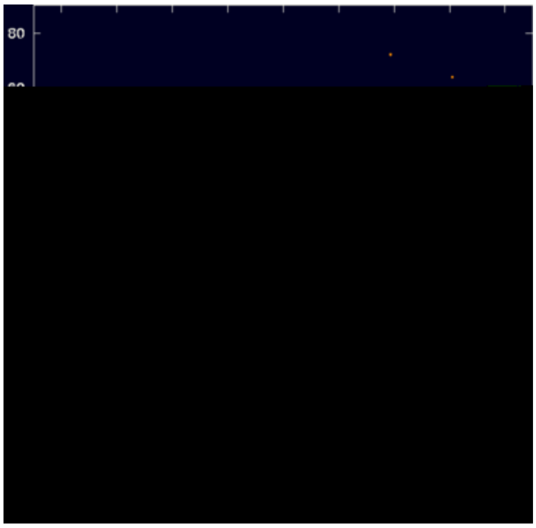
Comets are small Solar System bodies, usually only a few kilometres across, composed largely of volatile ices. They have highly eccentric orbits, generally a perihelion within the orbits of the inner planets and an aphelion far beyond Pluto. When a comet enters the inner Solar System, its proximity to the Sun causes its icy surface to sublimate and ionise, creating a coma: a long tail of gas and dust often visible to the naked eye.



Comet Hale-Bopp

The area beyond Neptune, often called the outer Solar System or the "trans-Neptunian region", is still largely unexplored. It appears to consist overwhelmingly of small worlds (the largest having a diameter only a fifth that of the Earth and a mass far smaller than that of the Moon) composed mainly of rock and ice.

Main article: Kuiper belt



Plot of all known Kuiper belt objects, set against the four outer planets

The Kuiper belt, the region's first formation, is a great ring of debris similar to the asteroid belt, but composed mainly of ice. It extends between 30 and 50 AU from the Sun. This region is thought to be the source of short-period comets. It is composed mainly of small Solar System bodies, but many of the largest Kuiper belt objects, such as Quaoar, Varuna, , and Orcus, may be reclassified as dwarf planets. There are estimated to be over 100,000 Kuiper belt objects with a diameter greater than 50 km, but the total mass of the Kuiper belt is thought to be only a tenth or even a hundredth the mass of the Earth.[67] Many Kuiper belt objects have multiple satellites, and most have orbits that take them outside the plane of the ecliptic.

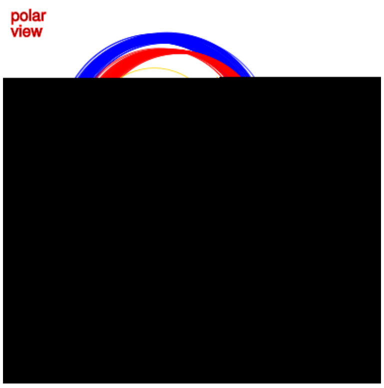


Diagram showing the resonant and classical Kuiper belt

The Kuiper belt can be roughly divided into the "resonant" belt and the "classical" belt. The resonant belt consists of objects with orbits linked to that of Neptune (e.g. orbiting twice for every three Neptune orbits, or once for every two). The resonant belt actually begins within the orbit of Neptune itself. The classical belt consists of objects having no resonance with Neptune, and planet. Pluto has a relatively eccentric orbit inclined 17 degrees to the ecliptic plane and ranging from 29.7 AU from the Sun at perihelion (within the orbit of Neptune) to 49.5 AU at aphelion.

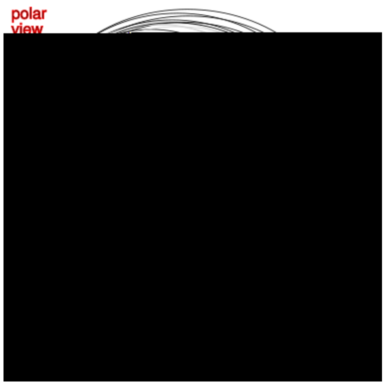
It is unclear whether Charon, Pluto's largest moon, will continue to be classified as such or as a dwarf planet itself. Both Pluto and Charon orbit a barycenter of gravity above their surfaces, making Pluto-Charon a binary system. Two much smaller moons, Nix and Hydra, orbit Pluto and Charon.

Pluto and its three known moons

Pluto lies in the resonant belt, having a 3:2 resonance with Neptune (it orbits twice round the Sun for every three Neptunian orbits). Kuiper belt objects whose orbits share this resonance are called plutinos.[70]

Main article: Scattered disc

The scattered disc overlaps the Kuiper belt but extends much further outwards. Scattered disc objects are believed to come from the Kuiper belt, having been ejected into erratic orbits by the gravitational influence of Neptune's early outward migration. Most scattered disc objects (SDOs) have perihelia within the Kuiper belt but aphelia as far as 150 AU from the Sun. SDOs' orbits are also highly inclined to the ecliptic plane, and are often almost perpendicular to it. Some astronomers consider the scattered disc to be merely another region of the Kuiper belt, and describe scattered disc objects as "scattered Kuiper belt objects."[71]



Black: scattered; blue: classical; green: resonant

Eris and its moon Dysnomia

Eris

Eris (68 AU average) is the largest known scattered disc object, and caused a debate about what constitutes a planet, since it is at least 5% larger than Pluto with an estimated diameter of 2400 km (1500 mi). It is the largest of the known dwarf planets.[72] It has one moon, Dysnomia. Like Pluto, its orbit is highly eccentric, with a perihelion of 38.2 AU (roughly Pluto's distance from the Sun) and an aphelion of 97.6 AU, and steeply inclined to the ecliptic plane.

The point at which the Solar System ends and interstellar space begins is not precisely defined, since its outer boundaries are shaped by two separate forces: the solar wind and the Sun's gravity. The solar wind is believed to surrender to the interstellar medium at roughly four times Pluto's distance. However, the Sun's Roche sphere, the effective range of its gravitational influence, is believed to extend up to a thousand times farther.

The Voyagers entering the heliosheath

The heliosphere is divided into two separate regions. The solar wind travels at its maximum velocity out to about 95 AU, or three times the orbit of Pluto. The edge of this region is the termination shock, the point at which the solar wind collides with the opposing winds of the interstellar medium. Here the wind slows, condenses and becomes more turbulent, forming a great oval structure known as the heliosheath that looks and behaves very much like a comet's tail, extending outward for a further 40 AU at its stellar-windward side, but tailing many times that distance in the opposite direction. The outer boundary of the heliosphere, the heliopause, is the point at which the solar wind finally terminates, and is the beginning of interstellar space.[73]

The shape and form of the outer edge of the heliosphere is likely affected by the fluid dynamics of interactions with the interstellar medium,[74] as well as solar magnetic fields prevailing to the south, e.g. it is bluntly shaped with the northern hemisphere extending 9 AU (roughly 900 million miles) farther than the southern hemisphere. Beyond the heliopause, at around 230 AU, lies the bow shock, a plasma "wake" left by the Sun as it travels through the Milky Way.[75]

No spacecraft have yet passed beyond the heliopause, so it is impossible to know for certain the conditions in local interstellar space. How well the heliosphere shields the Solar System from cosmic rays is poorly understood. A dedicated mission beyond the heliosphere has been suggested.[76] [77]

Main article: Timeline of solar system astronomy

A replica of Isaac Newton's telescope

The first exploration of the Solar System was conducted by telescope, when astronomers first began to map those objects too faint to be seen with the naked eye.

Galileo Galilei was the first to discover physical details about the individual bodies of the Solar System. He discovered that the Moon was cratered, that the Sun was marked with sunspots, and that Jupiter had four satellites in orbit around it.[94] Christiaan Huygens followed on from Galileo's discoveries by discovering Saturn's moon Titan and the shape of the rings of Saturn.[95] Giovanni Domenico Cassini later discovered four more moons of Saturn, the Cassini division in Saturn's rings, and the Great Red Spot of Jupiter.[96]

Edmond Halley realised in 1705 that repeated sightings of a comet were in fact recording the same object, returning regularly once every 75,76 years. This was the first evidence that anything other than the planets orbited the Sun.[97]

In 1781, William Herschel was looking for binary stars in the constellation of Taurus when he observed what he thought was a new comet. In fact, its orbit revealed that it was a new planet, Uranus, the first ever discovered.[98]

Giuseppe Piazzi discovered Ceres in 1801, a small world between Mars and Jupiter that was initially considered a new planet. However, subsequent discoveries of thousands of other small worlds in the same region led to their eventual reclassification as asteroids.[99]

By 1846, discrepancies in the orbit of Uranus led many to suspect a large planet must be tugging at it from farther out. Urbain Le Verrier's calculations eventually led to the discovery of Neptune.[100] The excess perihelion precession of Mercury's orbit led Le Verrier to postulate the intra-Mercurian planet Vulcan in 1859 , but that would turn out to be a red herring.

Further apparent discrepancies in the orbits of the outer planets led Percival Lowell to conclude that yet another planet, " belt; an icy analogue to the asteroid belt of which such objects as Pluto and Charon were deemed a part.[102] [103]

Mike Brown, Chad Trujillo and David Rabinowitz announced the discovery of Eris in 2005, a scattered disc object larger than Pluto and the largest object discovered in orbit round the Sun since Neptune.[104]

Artist's conception of Pioneer 10, which passed the orbit of Pluto in 1983. The last transmission was received in January 2003, sent from

A photo of Earth (circled) taken by Voyager 1, 6 billion km (4 billion miles) away. The streaks of light are diffraction spikes radiating from the Sun (off frame to the left).

The first probe to explore the outer planets was *Pioneer 10*, which flew by Jupiter in 1973. *Pioneer 11* was the first to visit Saturn, in 1979. The *Voyager* probes performed a grand tour of the outer planets following their launch in 1977, with both probes passing Jupiter in 1979 and Saturn in 1980 , 1981. *Voyager 2* then went on to make close approaches to Uranus in 1986 and Neptune in 1989. The *Voyager* probes are now far beyond Neptune's orbit, and are on course to find and study the termination shock, heliosheath, and heliopause. According to NASA, both *Voyager* probes have encountered the termination shock at a distance of approximately 93 AU from the Sun.[106] [107]

The first flyby of a comet occurred in 1985, when the International Cometary Explorer (ICE) passed by the comet Giacobini-Zinner,[108] while the first flybys of asteroids were conducted by the *Galileo* spaceprobe, which imaged both 951 Gaspra (in 1991) and 243 Ida (in 1993) on its way to Jupiter.

No Kuiper belt object has yet been visited by a spacecraft. Launched on January 19 2006, the *New Horizons* probe is currently en route to becoming the first man-made spacecraft to explore this area. This unmanned mission is scheduled to fly by Pluto in July 2015. Should it prove feasible, the mission will then be extended to observe a number of other Kuiper belt objects.[109]

In 1966, the Moon became the first Solar System body beyond Earth to be orbited by an artificial satellite (*Luna 10*), followed by Mars in 1971 (*Mariner 9*), Venus in 1975 (*Venera 9*), Jupiter in 1995 (*Galileo*), the asteroid 433 Eros in 2000 (*NEAR Shoemaker*), and Saturn in 2004 (*Cassini€Huygens*). The MESSENGER probe is currently en route to commence the first orbit of Mercury in 2011, while the *Dawn* spacecraft is currently set to orbit the asteroid Vesta in 2011 and the dwarf planet Ceres in 2015.

The first probe to land on another Solar System body was the Soviet *Luna 2* probe, which impacted the Moon in 1959. Since then, increasingly distant planets have been reached, with probes landing on or impacting the surfaces of Venus in 1966 (*Venera 3*), Mars in 1971 (*Mars 3*, although a fully successful landing didn't occur until *Viking 1* in 1976), the asteroid 433 Eros in 2001 (*NEAR Shoemaker*), and Saturn's moon Titan (*Huygens*) and the comet Tempel 1 (*Deep Impact*) in 2005. The *Galileo* orbiter also dropped a probe into Jupiter's atmosphere in 1995; since Jupiter has no physical surface, it was destroyed by increasing temperature and pressure as it descended.

To date, only two worlds in the Solar System, the Moon and Mars, have been visited by mobile rovers. The first rover to visit another celestial body was the Soviet *Lunokhod 1*, which landed on the Moon in 1970. The first to visit another planet was Sojourner, which travelled 500 metres across the surface of Mars in 1997. The only manned rover to visit another world was NASA's Lunar rover, which travelled with Apollos 15, 16 and 17 between 1971 and 1972.

Manned exploration of the Solar System is currently confined to Earth's immediate environs. The first human being to reach space (defined as an altitude of over 100 km) and to orbit the Earth was Yuri Gagarin, a Soviet cosmonaut who was launched in *Vostok 1* on April 12, 1961. The first man to walk on the surface of another Solar System body was Neil Armstrong, who stepped onto the Moon on July 21, 1969 during the *Apollo 11* mission. The United States' Space Shuttle is the only reusable spacecraft to successfully make multiple orbital flights. The first orbital space station to host more than one crew was NASA's Skylab, which successfully held three crews from 1973 to 1974. The first true human settlement in space was the Soviet space station Mir, which was continuously occupied for close to ten years, from 1989 to 1999. It was decommissioned in 2001, and its successor, the International Space Station, has maintained a continuous human presence in space since then. In 2004, SpaceShipOne became the first privately funded vehicle to reach space on a suborbital flight. That same year, President George W. Bush announced the Vision for Space Exploration,

- Solar system model
- Space colonization
- Solar System in fiction
- Celestia , Space-simulation on your computer (OpenGL)
- Family Portrait (Voyager)
- The Parable of the Solar System Model

1. Capitalization of the name varies. The IAU, the authoritative body regarding astronomical nomenclature, specifies capitalizing the names of all individual astronomical objects (**Solar System**). However, the name is commonly rendered in lower case (**solar system**) including in the *Oxford English Dictionary*, *Merriam-Webster*'*s 11th Collegiate Dictionary*, and *Encyclopædia Britannica*.
2. The mass of the Solar System excluding the Sun, Jupiter and Saturn can be determined by adding together all the calculated masses for its largest objects and using rough calculations for the masses of the Oort cloud (estimated at roughly 3 Earth masses),[110] the Kuiper Belt (estimated at roughly 0.1 Earth mass)[111] and the asteroid belt (estimated to be 0.0005 Earth mass)[112] for a total, rounded upwards, of ~37 Earth masses, or 8.9 percent the combined mass of Jupiter and Saturn.

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