



# Solar system

**The solar system includes the Sun and the bodies that orbit it—the planets, their moons, comets, asteroids, and meteors. The stars that appear in the night sky may be the centers of their own solar systems.**

The solar system has eight planets and a great many smaller bodies moving around a single star, called the Sun. The solar system is divided into two halves, which gives astronomers an important clue to how it formed. The first four planets away from the Sun—Mercury, Venus, Earth, and Mars—are solid planets consisting of rock and metal. They are called the terrestrial planets because their structures are similar to Earth's.

Beyond Mars lies a ring of large rocks called the asteroid belt. This is the dividing line of the solar system. In the outer reaches of the solar system are four giant planets—Jupiter, Saturn, Uranus, and Neptune. They are all much larger than the terrestrial planets. They have small rocky cores, but most of the mass of these planets consists of thick gases and ices. Jupiter and Saturn are known as gas giants, while Uranus and Neptune are the ice giants.

The fact that the planets split into two distinct groups is one clue to the way in which the solar system formed. Another clue is that 99 percent of the material in the solar system is concentrated in the Sun. In terms of mass, the planets are not important. However, the planets and their moons account for 99 percent of the solar system's motion, as they rotate about their axes and move in their orbits.

## Origin of the solar system

According to radioactive dating of meteorites and moon samples, the Sun and planets formed 4.5 billion years ago. The planets grew out of the material left over from the formation of the Sun.

Even now, astronomers can see stars forming in space. They are born inside nebulas—giant clouds of gas, dust, and ice. A nebula gradually shrinks under the inward pull of its own gravity. The nebula then breaks up into smaller, denser clumps, which are the first stages of new solar systems.

At the center of the clump, the density of the gas increases rapidly as the clump shrinks. As the gases at the center are pressed together more tightly, they heat up. Eventually, the temperature and pressure at the center of the clump become so extreme that nuclear fusion takes place. This reaction involves two hydrogen atoms merging to make an atom of helium. This fusion releases huge amounts of heat and light. The clump of gas has now become a star.

Not all the gas, dust, and ice of the shrinking cloud falls into the star at its center. As it shrinks, the cloud spins more quickly, and this spreads the contents of the cloud out into a disk shape. The planets are formed from this disk by a process known as accretion; material gradually builds up, forming larger and larger bodies.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Distance from Sun, millions of miles (km)	36 (58)	67 (108)	93 (150)	142 (228)	486 (778)	891 (1,427)	1,794 (2,871)	2,815 (4,504)	3,666 (5,900)
Period of revolution about Sun (year)	88 days	225 days	365 days	687 days	11.9 years	29.5 years	84 years	165 years	248 years
Rotation period relative to stars	59 days (W to E)	243 days (E to W)	23 hr 56 min (W to E)	24 hr 37 min (W to E)	9 hr 55 min (W to E)	10 hr 39 min (W to E)	17 hr 14 min (E to W)	16 hr 6 min (W to E)	6 days 9 hr (E to W)
Day length	176 days	120 days	24 hours	24 hr 39 min	9 hr 50 min	10 hr 14 min	17 hr 14 min	16 hr 6 min	6 days 9 hr
Diameter, miles (km)	3,048 (4,878)	7,563 (12,102)	7,972 (12,756)	4,245 (6,792)	89,365 (142,984)	75,355 (120,536)	31,949 (51,118)	30,955 (49,528)	1,438 (2,302)
Mass (relative to Earth)	0.055	0.81	1.00	0.11	318	95	15	17	0.002
Satellites (as of 2004)	0	0	1	2	62	37	27	13	1

## Building the planets

In the doughnut-shaped cloud orbiting the young star, the tiny dust and ice grains often crash into each other. Sometimes they stick together, forming loose, lightweight fluffy balls. As these bodies grow, their gravitational pull also increases, and they begin to attract each other. This drives the second stage of growth, with bodies sticking together.

Many millions of bodies would make a single solid, called a planetesimal, a few miles across. Near the young Sun, the temperature would have been so high that all the ices in the planetesimals would melt and evaporate, leaving planetesimals made of rocks and metals. Farther away from the Sun, it would have been colder, so the planetesimals would be mostly ice, with only small amounts of rock.

In the third stage of planet formation, the ten billion or so planetesimals orbiting around the Sun came together. Planetesimals that passed near each other would be pulled together, forming larger planetesimals. The largest planetesimals would gradually have swept up nearby smaller ones. In this way, all the small planetesimals would blend into the planets seen today.

In the cold outer parts of the solar system, the forming planets would have pulled thick atmospheres of gas around them. In the inner part of the solar system, the rocky Earth-like planets may have had temporary atmospheres, but these would have been blown away by the heat of the Sun. According to geologists, the atmospheres of the inner planets have leaked out through volcanoes.

## Sweeping up

However, there is one other problem to be solved. Astronomers believe that the shrinking gas clump needed to form the Sun would have had much more mass than is present in the solar system today. In fact, about 90 percent of the original cloud that collapsed to form the solar system has vanished. Where has it gone? It has probably been blown away by the energy of the Sun.

Astronomers studying young stars have found that strong winds of gas are blowing away from them. Such stars are known as T Tauri stars, after the first of their kind to be observed (in the constellation Taurus). T Tauri stars are surrounded by clouds of gas that seem to be scattering as a result of the energy being radiated by the young, powerful star. This is the same process that cleaned up Earth's solar system.

## Solar wind

Even now, a gentle wind blows outward from the Sun. This solar wind is a stream of atomic particles that flows through the solar system. The solar wind was much more energetic in the early days of the solar system. The solar wind could have stripped the atmospheres from the inner planets and scattered the gases that had not collected into planets. It could also have slowed down the speed of the Sun's rotation.

Even with the leftover gas swept out of the solar system, the cleaning-up operation was not yet complete. A number of planetesimals were too heavy for the solar wind to sweep away and continued to orbit the Sun. Some of these settled down into orbits between Mars and Jupiter and formed the asteroid belt. The gravity of Jupiter prevented them from gathering together into a planet. Others were captured by the planets to form moons. Still others, which formed in the cold outer parts of the solar system, stayed in a belt beyond the known planets called the Kuiper belt. Even farther out, icy planetesimals formed a cloud around the solar system. This sphere is called the Oort cloud. Occasionally, members of the Kuiper belt or Oort cloud are pulled into the center of the solar system on very long orbits. These bodies are called comets. As it approaches the Sun, the ice on a comet's surface begins to evaporate, producing a long glowing tail that points away from the Sun.

Finally, many of the smaller objects that had failed to hit the planets the first time were gradually swept up by the planets in their final stages of accretion. For more than 700 million years, asteroid-sized bodies and smaller meteorites have slammed into the planets and have ground their surfaces to powder. The surfaces of Mercury, Mars, and the moons of the planets now show the results of this bombardment, and the process has not entirely ceased—small rocks from space often blaze their way into Earth's atmosphere.

## Other solar systems?

Planets seem to be a normal by-product of the birth of stars, so astronomers are looking for other solar systems in space. However, planets are so small compared to their stars that they are difficult to spot. Many disk-shaped clouds around young stars are probably filled with planetesimals. To date, nearly 150 planets have been found through the visible wobble of the stars they revolve around.

**See also:** [SPACE PROBE](#); [STAR](#); [SUN](#).

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