

Solar System

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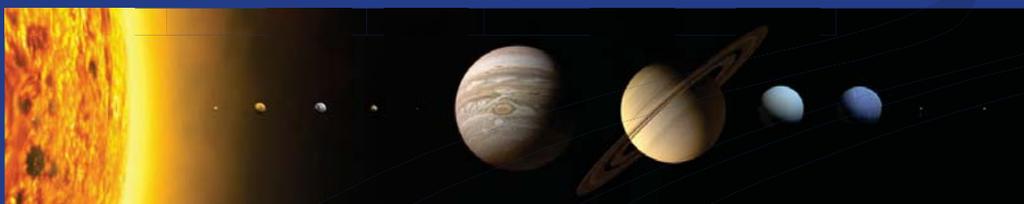


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What is the Solar System?

The Sun and all the bodies that revolve around it, connected by gravity.

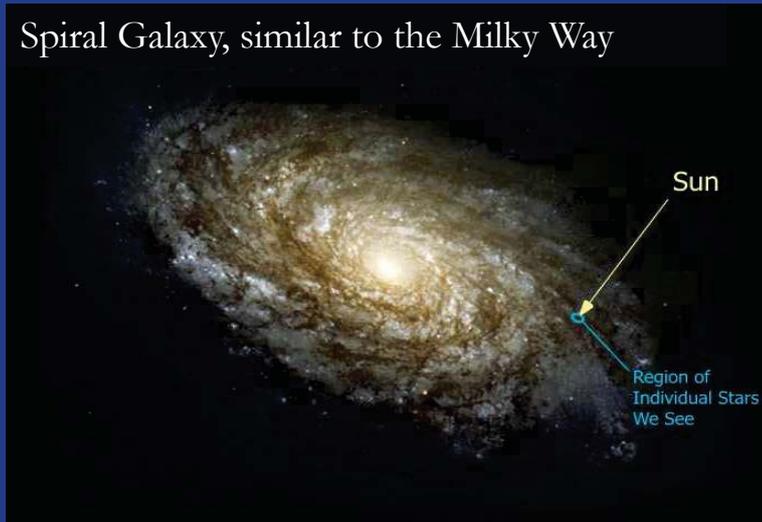
- 8 planets
- natural satellites of the planets
- dwarf planets (Ceres, Pluto, Haumea, Makemake, Eris ...)
- small bodies: meteorites, comets, asteroids, dust, Kuiper belt objects, etc..



Where is the solar system?

It's in the **Orion Arm** of the spiral arms of the **Milky Way**.

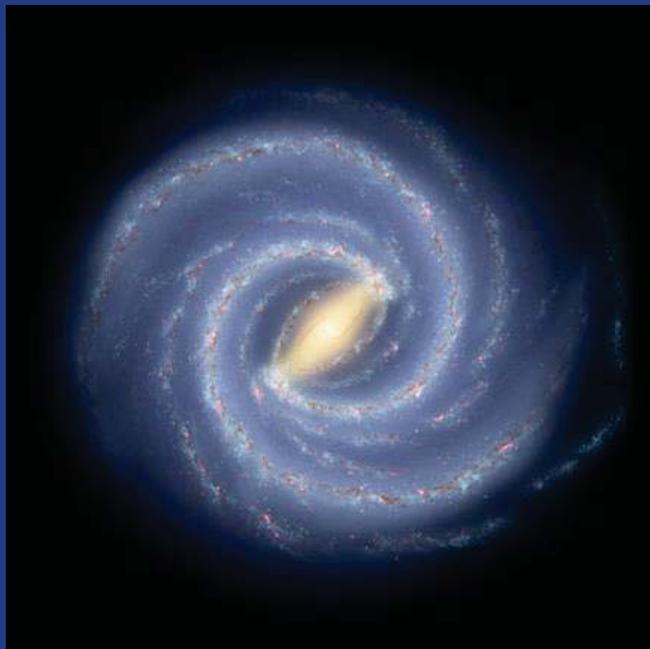
Spiral Galaxy, similar to the Milky Way



The Milky Way contains 200,000 million stars. And the diameter is about 100,000 light years.



The solar system is at a distance of 25,000 light years from the galaxy center (\sim half the radius), and takes about 250 million years to orbit the center. The speed is 220 km / s (800,000 km / h)



Model of the Milky Way from the Spitzer infrared observations, our galaxy is a barred spiral.



SUN

Is 4600 million years old, and is in the middle of its life. Every second, the Sun's core converts 4 million tons of matter into energy, generating a lot of neutrinos and solar radiation

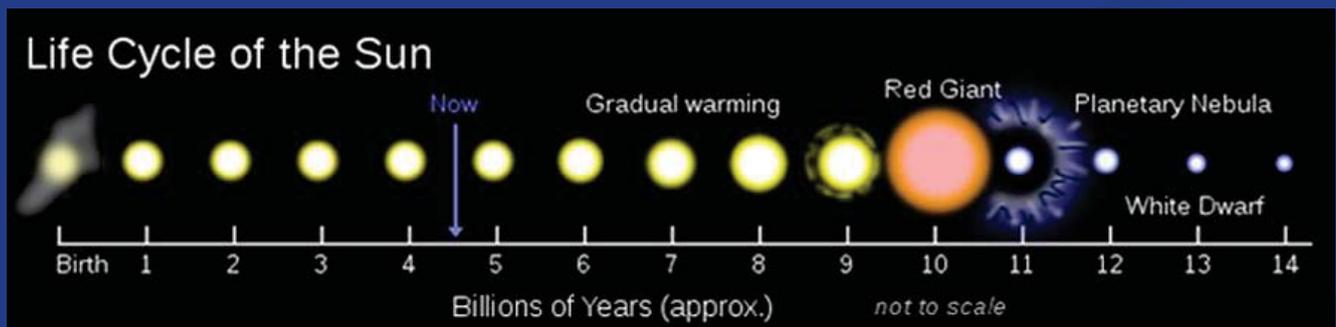


74% of the sun is H, 25% is He and the rest are heavier elements



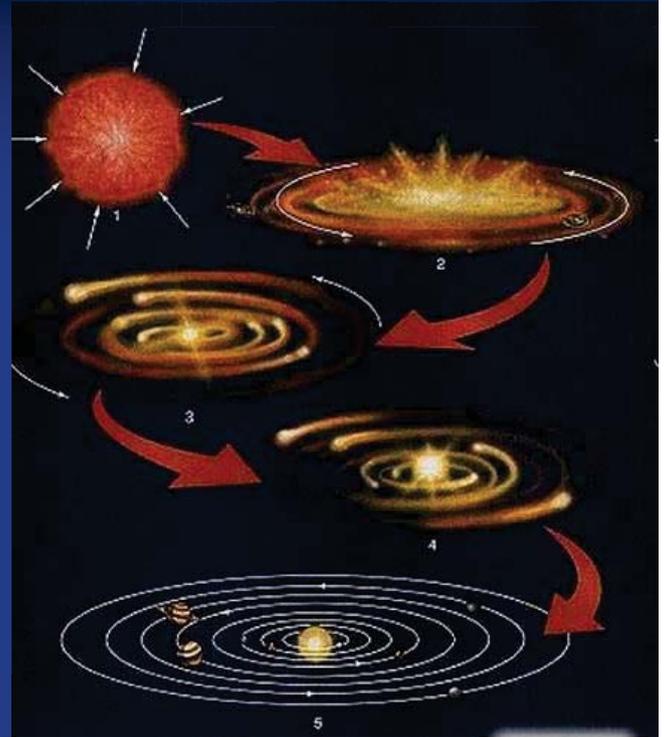
The life cycle of the Sun

In 5 billion years, the Sun will swell and become a red giant. After ejecting the outer layers, creating a planetary nebula, the core will be a small star called a white dwarf that will cool slowly.



The formation of the Solar System

- ❑ 4,600 million years ago there was a gas cloud, ~ 100 AU in diameter and three times the mass of the Sun.
- ❑ A strong disturbance (possibly a neighboring supernova) made the change to the gravitational force of the gas pressure and the collapse began.
- ❑ The contraction made it hotter, as conservation of angular momentum made it rotate faster and faster.



PLANETS



XXVI IAU-AG, Praga, 2006:

In the SS, a **planet** is a celestial body that:

- It is in orbit around the Sun
- It has enough mass to be spherical (diameter ~ 1000 km)
- No other bodies in its orbit ("has cleared the neighborhood")

A body that meets only the first two criteria is classified as a "**dwarf planet**".

A body that meets only the first criterion is called "**small solar system body**".

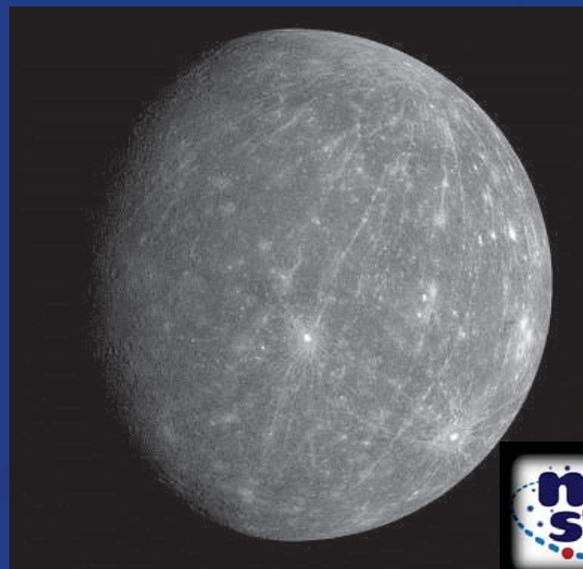


MERCURY

- It is the closest planet to the Sun and the smallest of the SS.
- It is a terrestrial-type planet with a silicate rock surface.
- It is named after the Roman god Mercury



- It can be observed just before sunrise or just after sunset near the Sun
- Two spacecraft flew by it: Mariner 10 (3 times in 1974-1975) and Messenger (2 times in 2008). The photos show a very similar surface to our Moon.

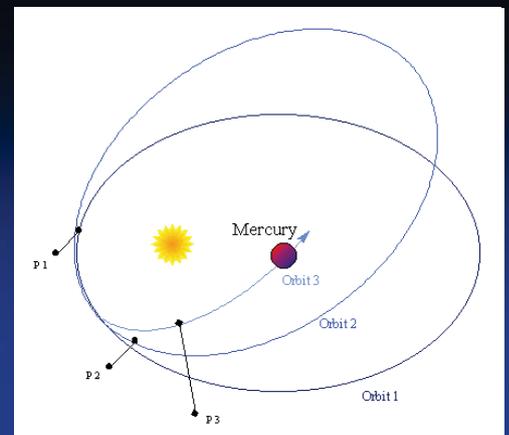


The largest crater is the Caloris Basin with a diameter of 1500 km. The impact that caused it formed surface waves at the antipodes.



The precession of the perihelion of Mercury

The precession of the perihelion of Mercury is faster than the forecasts of classical celestial mechanics.



This advancement of perihelion was predicted by the general theory of relativity by Einstein.

The cause is the curvature of space by the mass of the Sun. It was a litmus test for the validity of Einstein's theory.

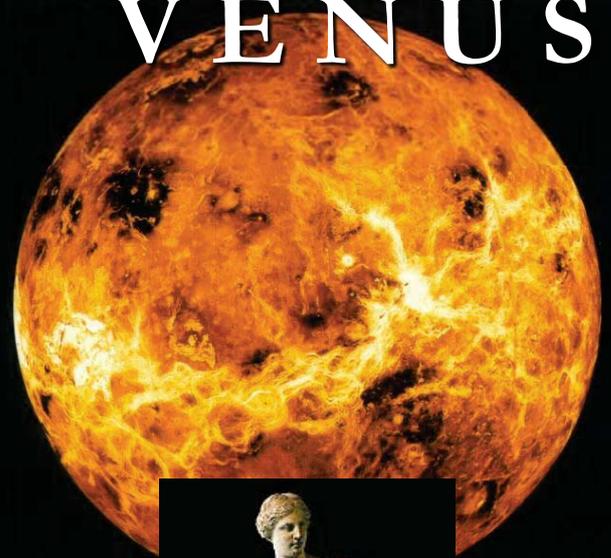


VENUS

It is the brightest body in the sky after the Sun and Moon.

It is known as "morning star" (seen near sunrise) or "evening star" (seen near sunset).

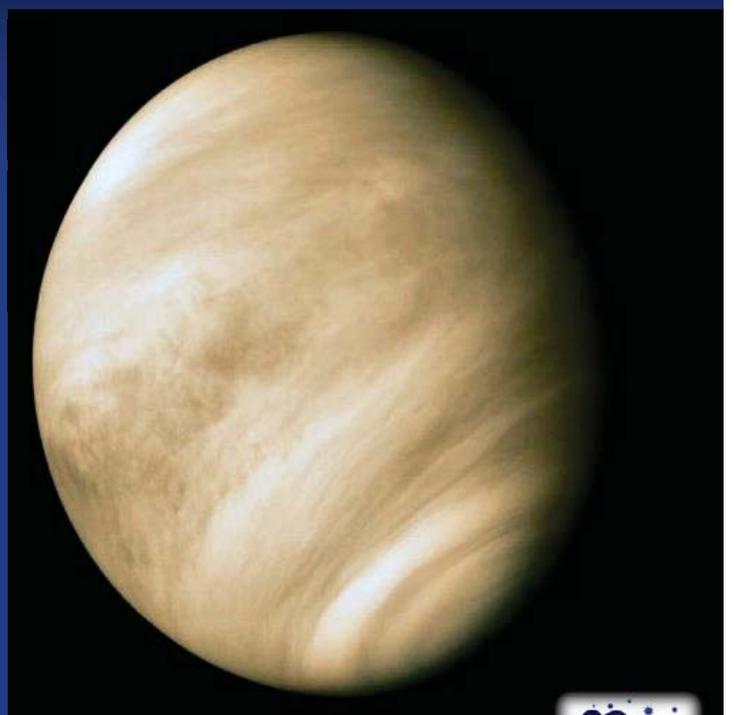
Venus was named after the Roman goddess of love and beauty.

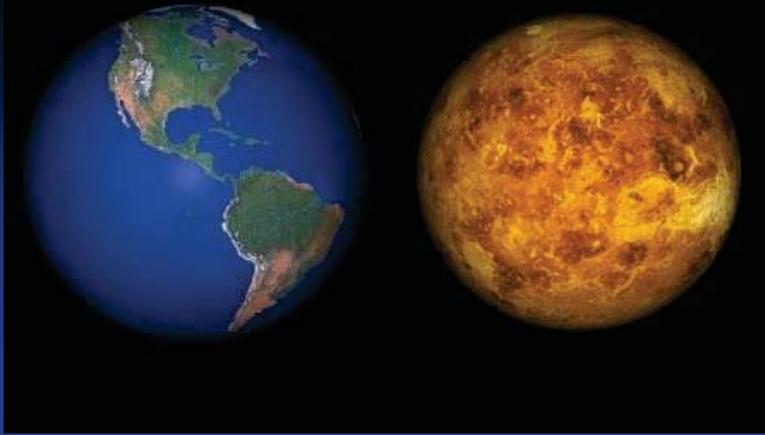


No natural satellites or magnetic field.

It's the only planet with retrograde motion (rotates in reverse as it revolves around the Sun).

A Venusian year lasts 224 Earth days. A Venusian day is 243 Earth days.





The dimensions and geological structure are similar to those in Earth.

- ❑ The mixture of dense clouds CO_2 and sulfur dioxide emissions create the greatest effect of all the SS, with the temperatures reaching 460°C , higher than that of Mercury.
- ❑ The atmospheric pressure is 100 times that of Earth.
- ❑ There is also rain clouds of sulfuric acid.



The transit of Venus

When Venus passes between the Earth and the Sun, its shadow falls across the solar disk.

This event occurs rarely, in pairs eight years apart. The next will be over a century from now.

The last pair were 8 June 2004 and 5 to 6 June 2012. There will not be another until December 11, 2117



EARTH



- ❑ It is the 5th planet in size, and the largest of the terrestrial planets.
- ❑ It is the only one in the universe that we know that harbors life.
- ❑ It was formed 4,570 million years ago.
- ❑ 71% of the surface is covered with water. Only 29% is solid and dry.



- ❑ Its only natural satellite, the Moon, began to orbit soon after the formation of the Earth.
- ❑ The Moon causes tides. It has an influence on the stability constant of the earth's rotation.
- ❑ The Moon slows the rotation of the Earth. And the Earth accelerates the movement of the moon and therefore moves away 4 cm per year.

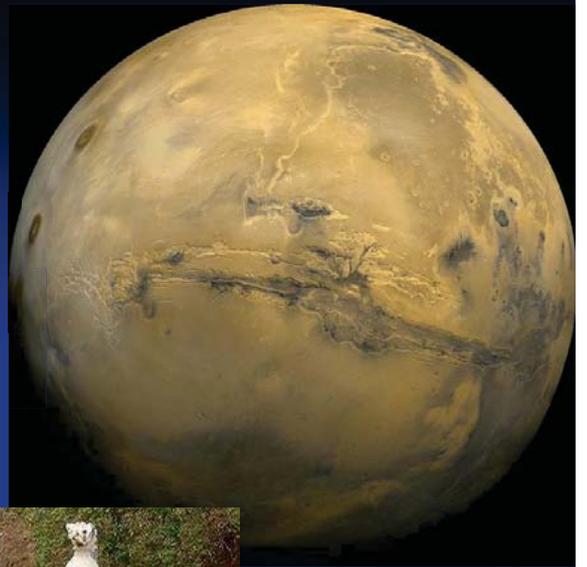


MARS

Visible to the unaided eye, it is less bright than Venus, and in the most favorable oppositions, it becomes brighter than Jupiter.

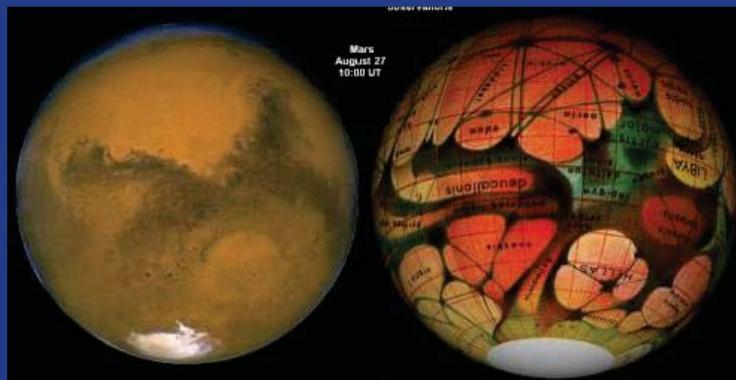
Its diameter is half Earth.

Named after the Roman god of war, Mars, due to its reddish color.



It has been an inspiration for many science fiction authors ("alien" = "Martian").

One reason for this were the famous "canals", named in 1858 by Giovanni Schiaparelli, thought by some to be like human constructions.



Its color is due to red iron oxide (hematite) located on the surface.



Mars has the highest mountain in the SS (the volcano Olympus Mons), with a height of 25 km, and the longest canyon (Valles Marineris), with an average depth of 6 km and 5000 km in length.



The Martian day is 24 hours and 39 minutes land.
The Martian year is 1.88 Earth years.



There are traces of an active hydrosphere, which indicates that there was once water on Mars.



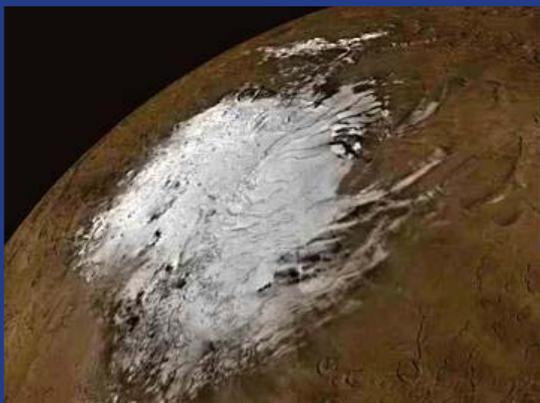
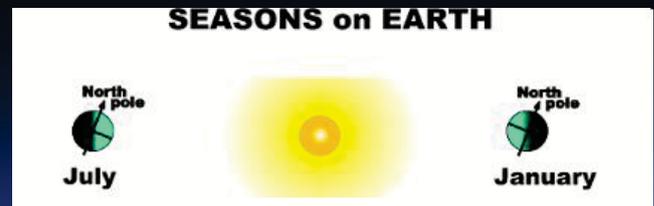
The water may be now frozen underground



Mars is covered with a thin atmosphere composed mostly of CO₂. The atmospheric pressure is one-hundredth that of Earth.



The axial tilt of Mars is similar to Earth's, so there are seasons on Mars as on Earth.



It has two ice caps, ice and CO₂. Its size varies greatly with the seasons, due to CO₂ and water exchange with the atmosphere.



It has two moons, Phobos and Deimos, 25 km and 15 km, which orbit at 6,000 and 20,000 km. They are probably asteroids captured by the planet.



The distance between us varies greatly. It is less in opposition, when it is opposite the Sun as seen from Earth. The time of closest approach is about every two years.

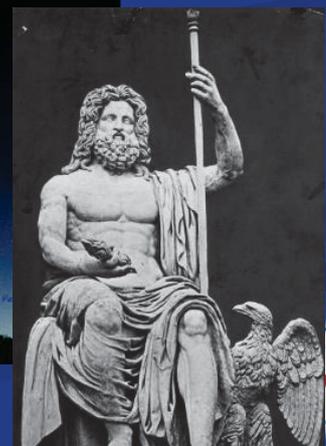


JUPITER

Jupiter is the largest planet in the entire SS.

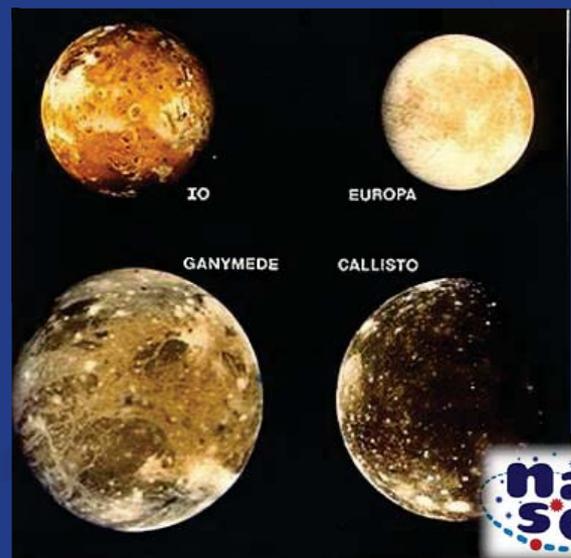
It is the 4th brightest object in the sky after the Sun, Moon, Venus and Mars.

It is named after the chief of the gods

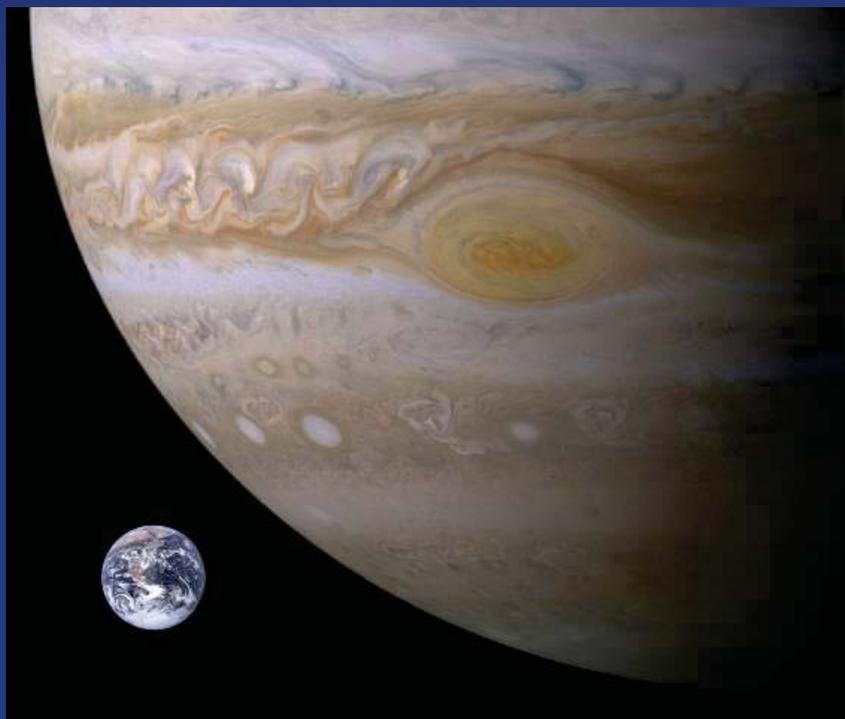


The discovery of its four large moons, Io, Europa, Ganymede and Callisto by Galileo Galilei and Simon Marius in 1610 was the first detection of an apparent movement focused not on Earth.

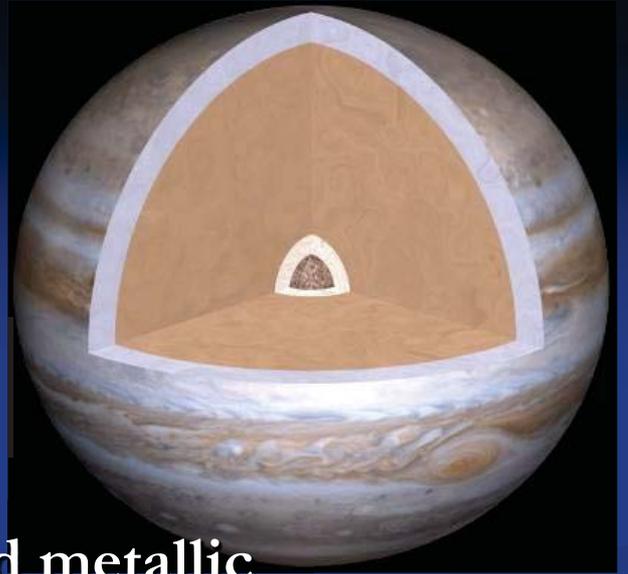
It was an important test for the heliocentric theory.



- its diameter is 11 times the Earth
- its mass, times 318
- its volume, 1,300 times



Jupiter probably has a small solid core of between 10 and 15 Earth masses.



Most of the planet is liquid metallic hydrogen. Since it is a good electrical conductor, it is the origin of Jupiter's intense magnetic field.

It also has traces of methane, water and ammonia, which give color to the surface.



Great Red Spot is an oval of 12,000 x 25,000 km, big enough to cover two Earths.

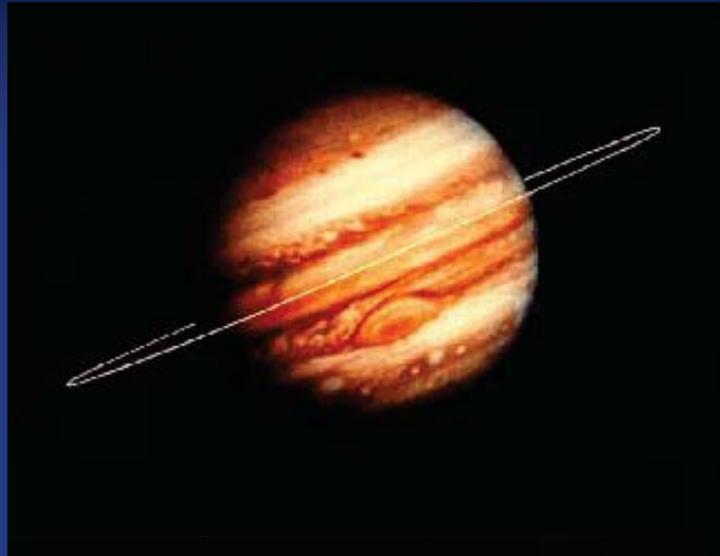
It is an anticyclone, whose clouds are higher and cooler than the peripheral areas.



imagen cortesía NASA/JPL-Caltech

Jupiter and the other gas planets have high velocity winds, grouped in bands that go in opposite directions.



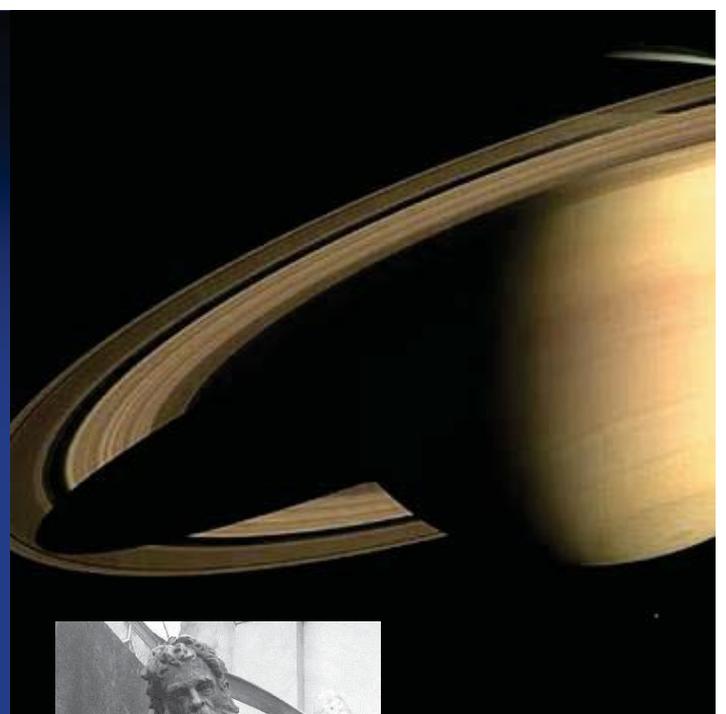


Jupiter has rings like Saturn, but much smaller and darker, not containing ice.



SATURN

- Gaseous giant planet, 2nd in mass and volume, after Jupiter.
- Made primarily of hydrogen.
- Named after the Roman god Saturn.



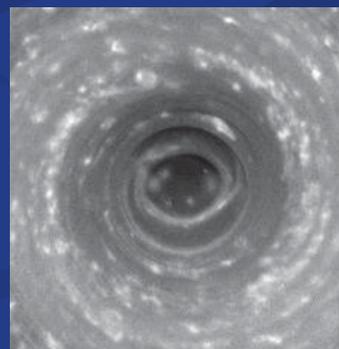
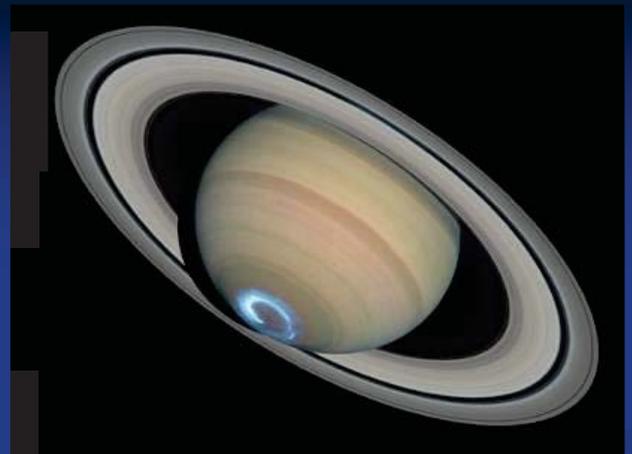


- It is the only entire SS planet having an average density less than water: 0.69 g/cm^3 .
- Its shape is an oblate spheroid. Its polar and equatorial diameters differ by 10% because of its rapid rotation and very fluid composition.



The atmosphere of Saturn has parallel bands that are less distinct than Jupiter.

In 2006, NASA observed a large storm in the south pole, which looked like an eye.

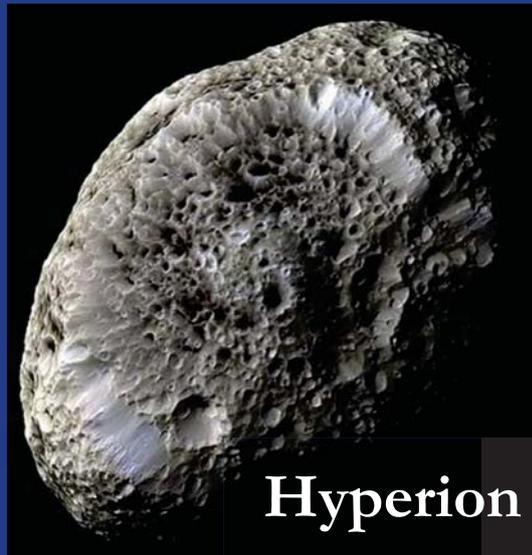


Rings are very bright, being formed by dust and small pieces of ice.



- ❑ Saturn has 7 moons large enough to take a spherical shape under the influence of gravity and many small irregular moons.
- ❑ Titan is the largest of them, larger than Mercury or Pluto and the only moon in SS with a dense atmosphere.

Titan

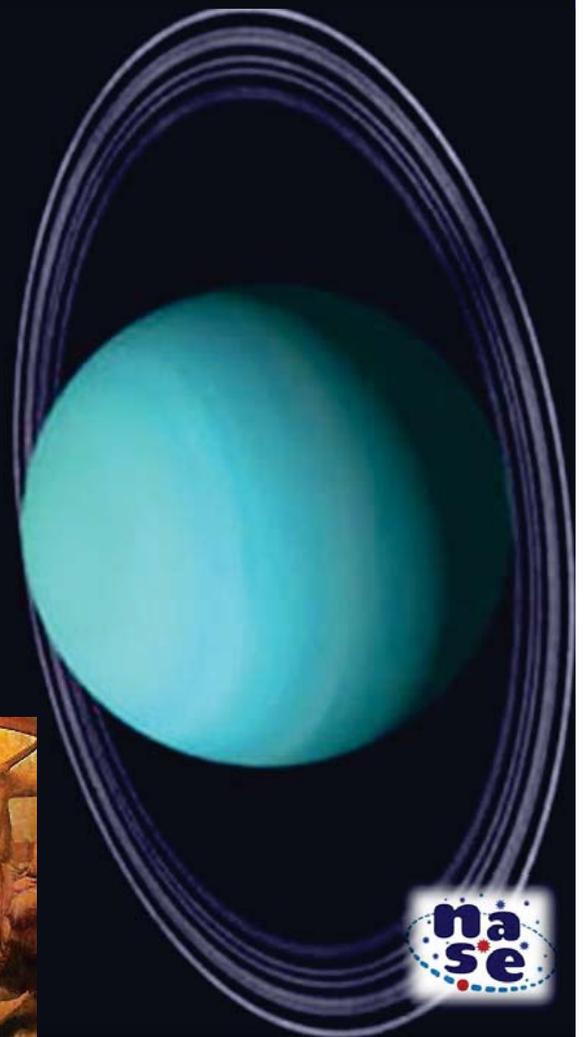


Hyperion

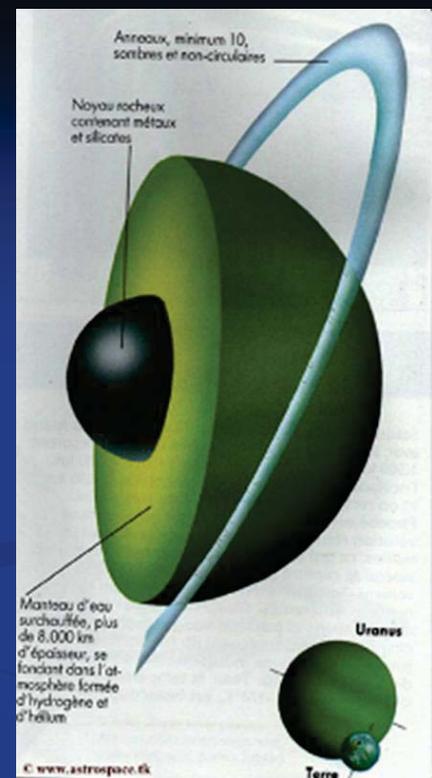


URANUS

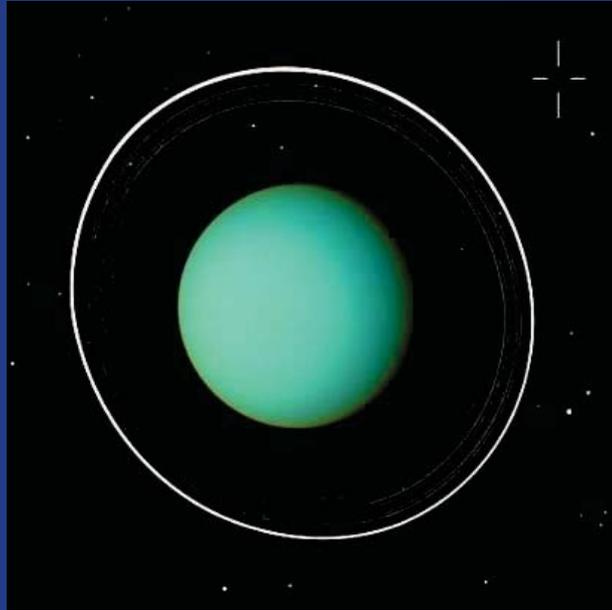
- ❑ The god Uranus was the father of Cronus (Saturn) and grandfather of Zeus (Jupiter).
- ❑ It is the first planet discovered in modern times, by William Herschel in 1781 with a telescope.



- ❑ Its average distance from the Sun is 3000 million km.
- ❑ The period of revolution around the Sun Uranus is 84 Earth years.
- ❑ The rotation period of the interior of Uranus is 17 h 14 min. But near the equator the surface makes a full rotation in less than 14 hours.
- ❑ The inside may have a solid core of iron silicates, surrounded by a mantle of ice water, He, methane and ammonia, followed by a layer of H and He, first liquid, then gas in the atmosphere outside.



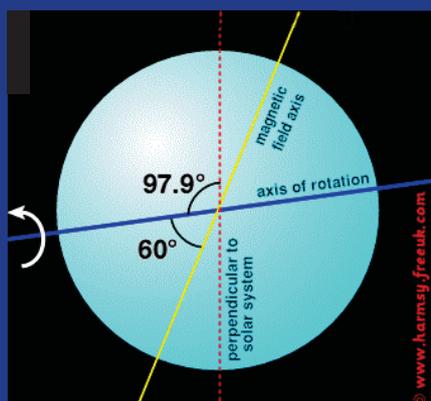
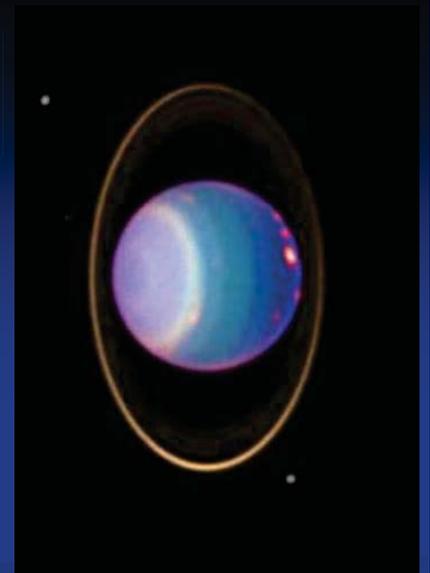
The blue-green color is due to the presence of methane in the atmosphere that absorbs red and infrared.



Uranus is turned sideways. Its axis of rotation is nearly in its plane of revolution around the Sun.

The 13 rings and satellites are also in this plane..

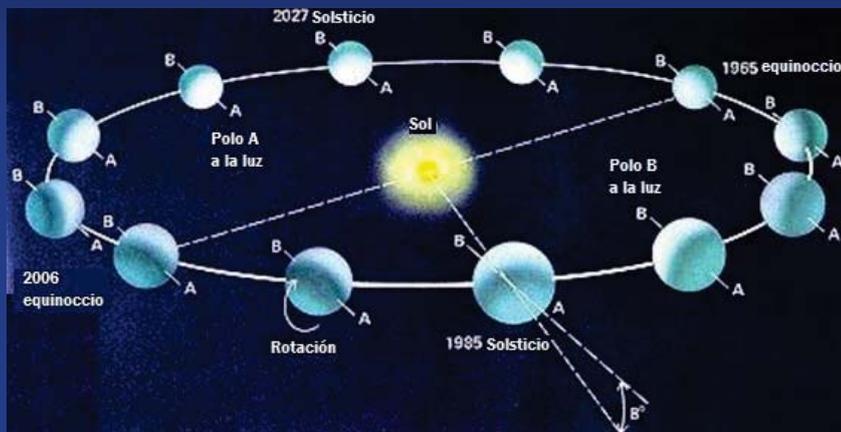
There must have been a catastrophic collision with another body to create this situation.



However its magnetic axis is tipped over 60 degrees from the axis of rotation.



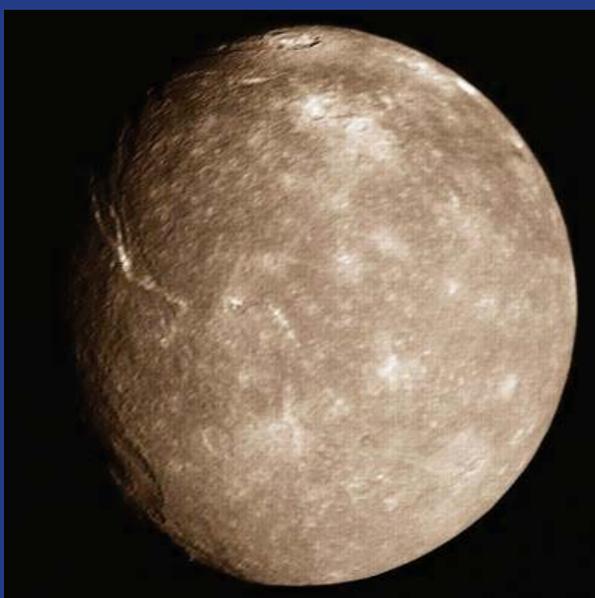
Uranus moves on its orbit the sun exposing its N pole and later its S pole.



One consequence of this approach is that the polar regions receive more energy than the equatorial region.



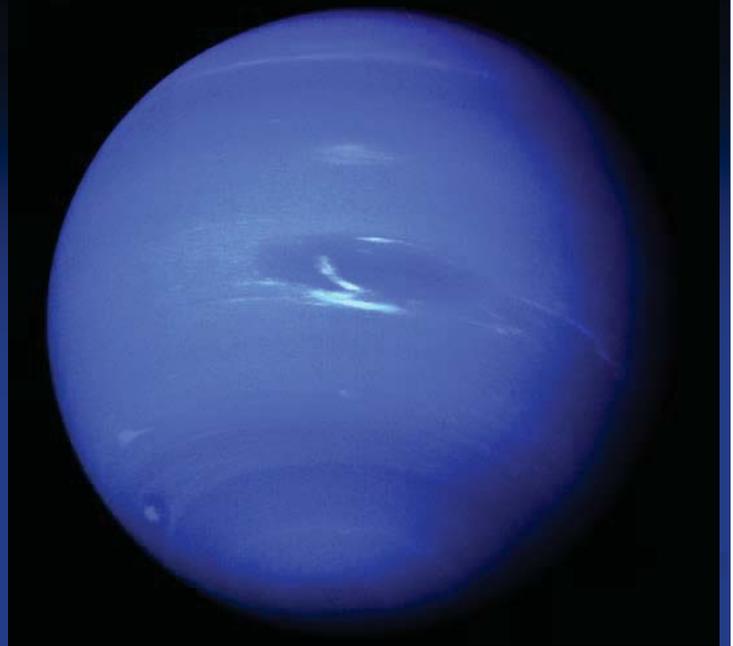
Urano has at least 27 moons.
The first were discovered by William Herschel in 1787: Titania and Oberon.



NEPTUNE

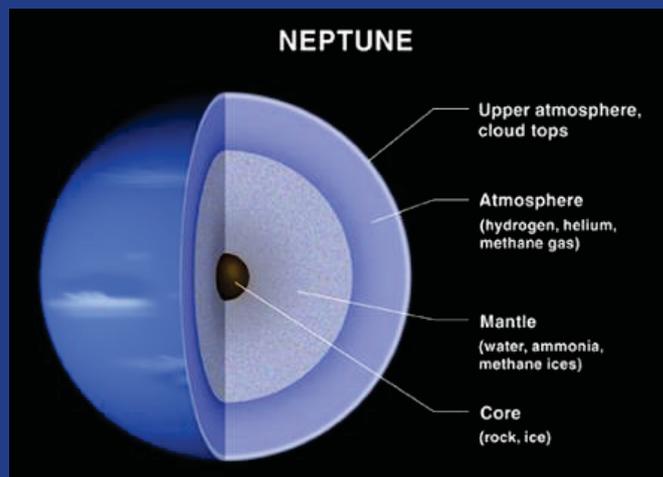
Named after the Roman god of the sea, Neptune

It was discovered by Johann Gottfried Galle in 1847.



Neptune has a solid core of silicates and iron, almost as large as Earth.

Above the core is a mantle of ice, methane, H and He.





It has a dark rings whose origin is unknown.

Its blue color comes from methane that absorbs red light.

There are very fast winds, blowing at over 2000 km / h.



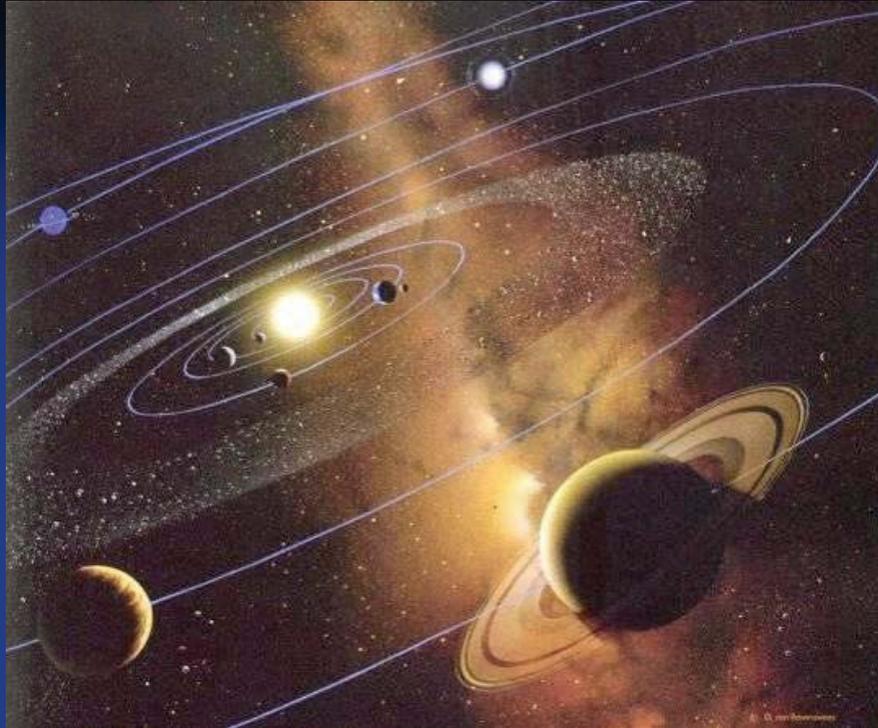
It has been visited only once, by the Voyager 2, in 1989.



Voyager 2 observed a Great Dark Spot, which could be the size of the "Great Red Spot" on Jupiter.

It has at least 13 moons.
The most important of these is Triton.



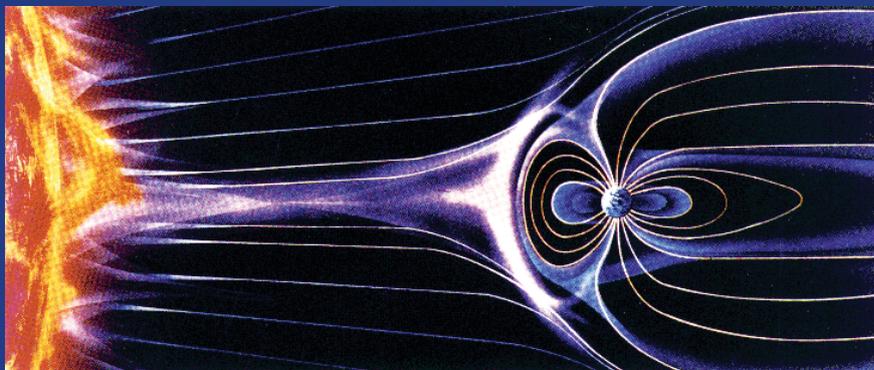


OTHER BODIES OF THE SOLAR SYSTEM



The interplanetary medium

In addition to light, the Sun radiates a continuous stream of charged particles (plasma) called the solar wind.



This flow is dissipated at a rate of 1.5 million km h, creating the heliosphere, a thin atmosphere that bathes the entire SS to approx. 100 AU, marking the heliopause (1 AU = 150×10^6 km).



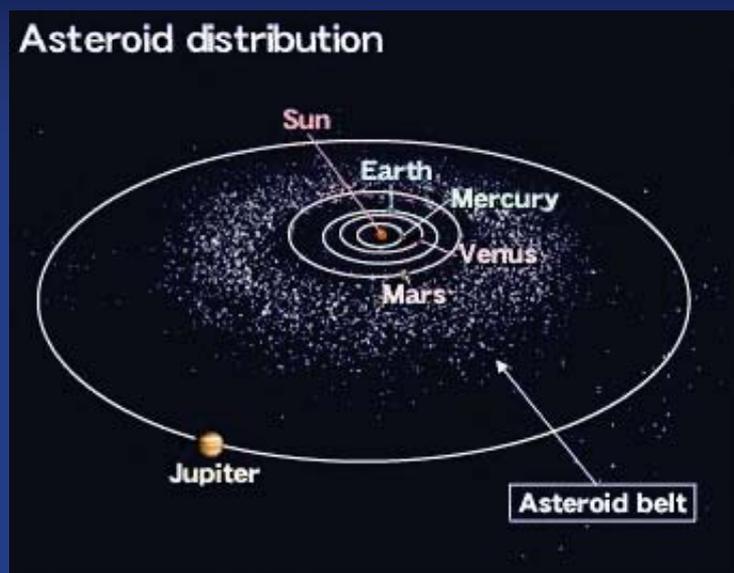
The Earth's magnetic field protects our planet from the solar wind. The interaction between the solar wind and Earth's magnetic field produces the aurora.



The heliosphere ensures the SS partial protection from cosmic rays, with stronger protection for planets with a magnetic field.



THE ASTEROID BELT



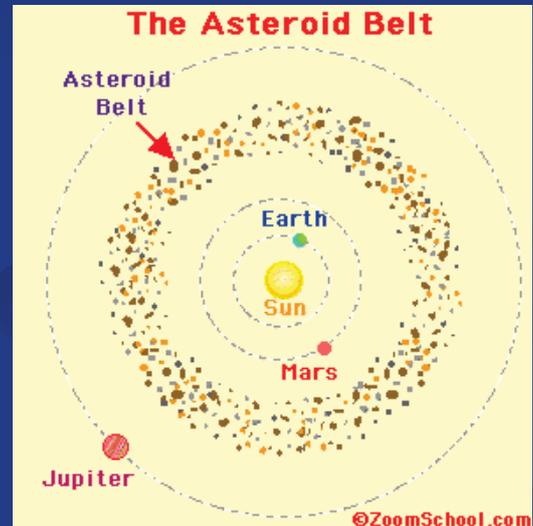
These are rocks that occupy an orbit between Mars and Jupiter, at a distance from 2.3 to 3.3 AU from the Sun



Could be remnants from the formation of SS, which have failed to join the gravitational interference of Jupiter

The size of asteroids ranges from several hundreds of kilometers to microscopic dust.

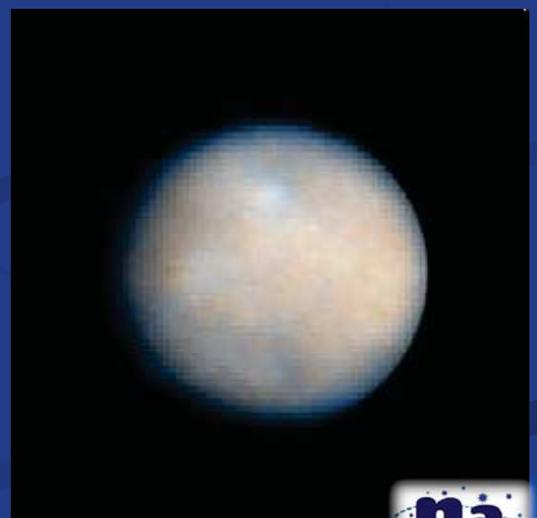
There are millions, but their total mass is only 4% that of our moon.



CERES

At 2.77 AU, Ceres is the largest body in the asteroid belt, and the only one of them cataloged in 2006 as a dwarf planet.

Discovered in 1801 by Giuseppe Piazzi was considered a planet until 1850 when others find many similar objects.



With a diameter of about 1,000 km, is large enough for its gravity to give spherical shape.

All except the largest, Ceres, are considered small bodies, although some of them as Vesta and Hygeia could be classified as dwarf planets if shown to reach the hydrostatic equilibrium.



COMETS

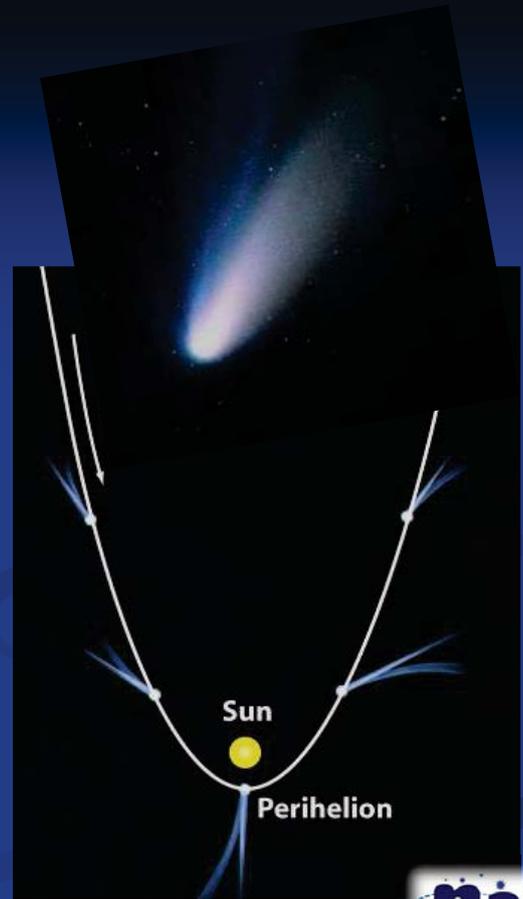


Comets are small bodies of the SS, a few kilometers, made of volatile ices



They have highly eccentric orbits with perihelion near the Sun, while the aphelion is beyond Pluto.

When a comet approaches the Sun, sublimation occurs and ionization of the surface creates long tails of gas and dust.

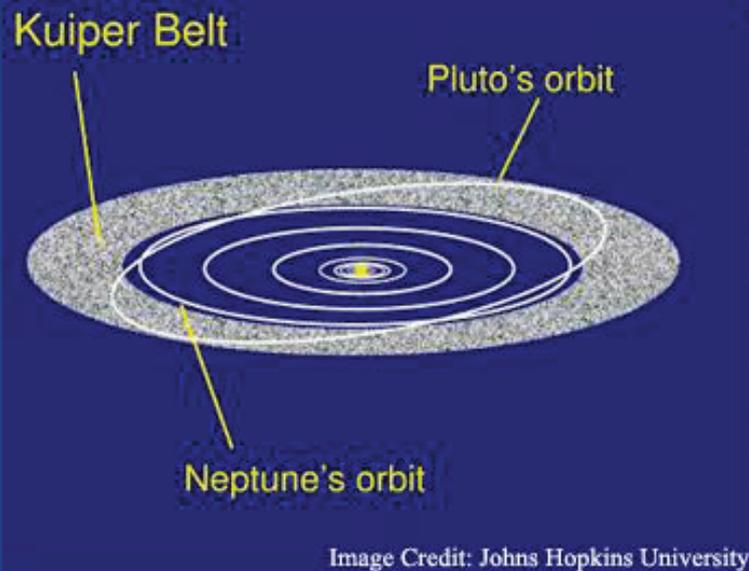


There are comets like Halley, short-period (<200 years). Since they are in the plane of the ecliptic, they seem to originate in the Kuiper belt.

Other comets, such as Hale-Bopp, returning every few thousand years, are not in the plane of the ecliptic. These may originate in a spherical cloud called the Oort Cloud.



KUIPER BELT



They are objects of a large ring, made mostly of ice. They are also known as Trans-Neptunian Objects (TNO).

The largest are dwarf planets



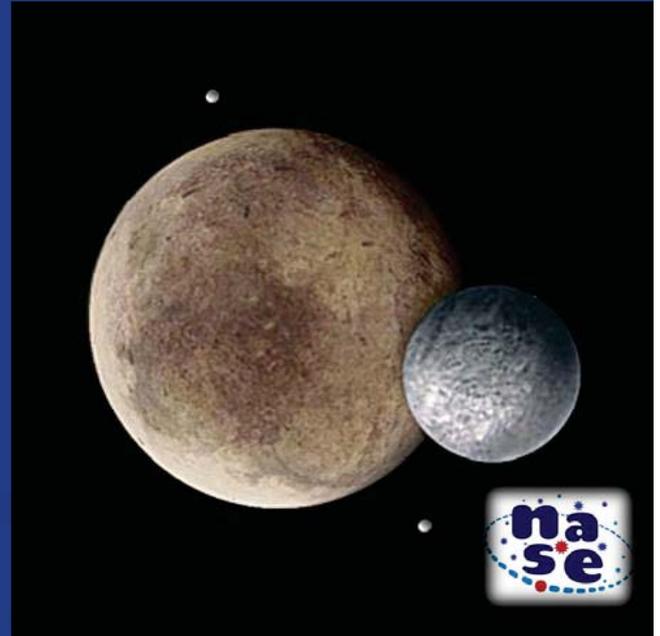
Largest known trans-Neptunian objects (TNOs)



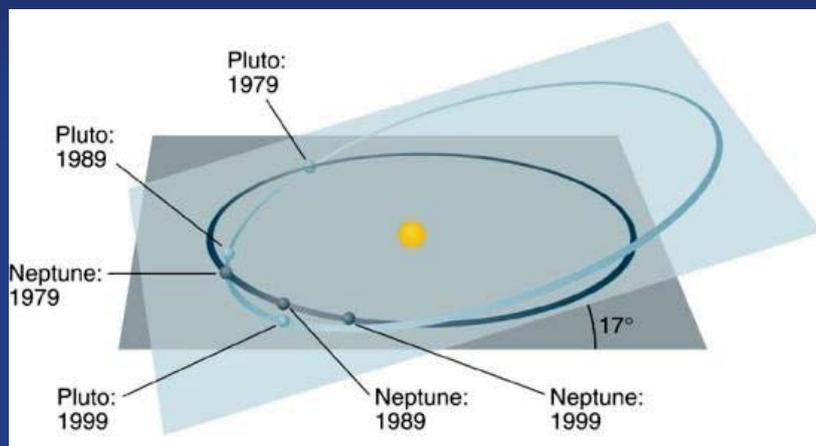
PLUTO

Pluto was discovered in 1930, and it was considered planet until 2006

Far from the Sun with perihelion 29.7 AU and aphelion 49.5 AU.



• Pluto is in resonance to Neptune and completes two orbits when Neptune has completed three.



• It has an eccentric orbit inclined 17° to the plane of the ecliptic.



Charon is the largest moon of Pluto. Both revolve around their center of gravity, always showing the same face.



Two other small satellites are Nix and Hydra; this pair orbits Pluto-Charon. There are also two recently discovered moons.



**Many Thanks
for your attention!**

