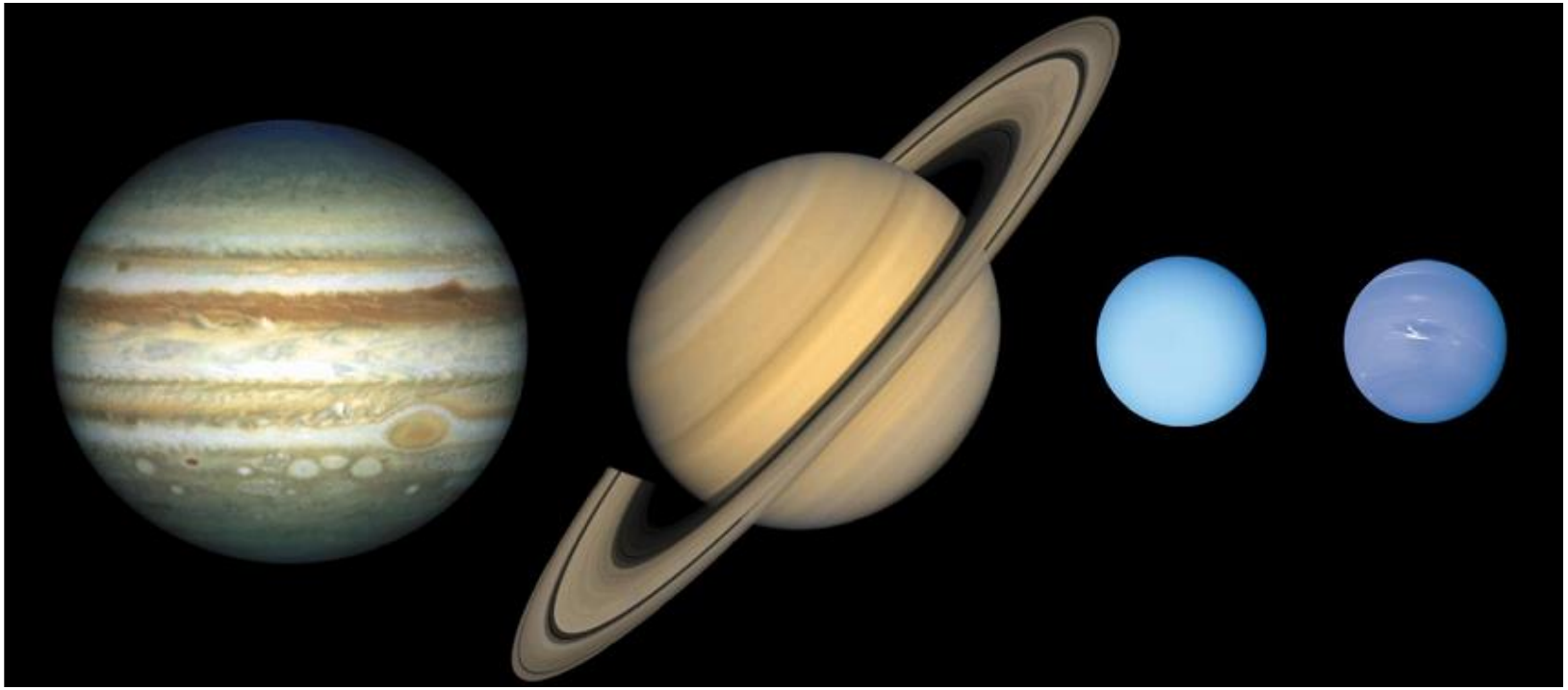
Lesson 10

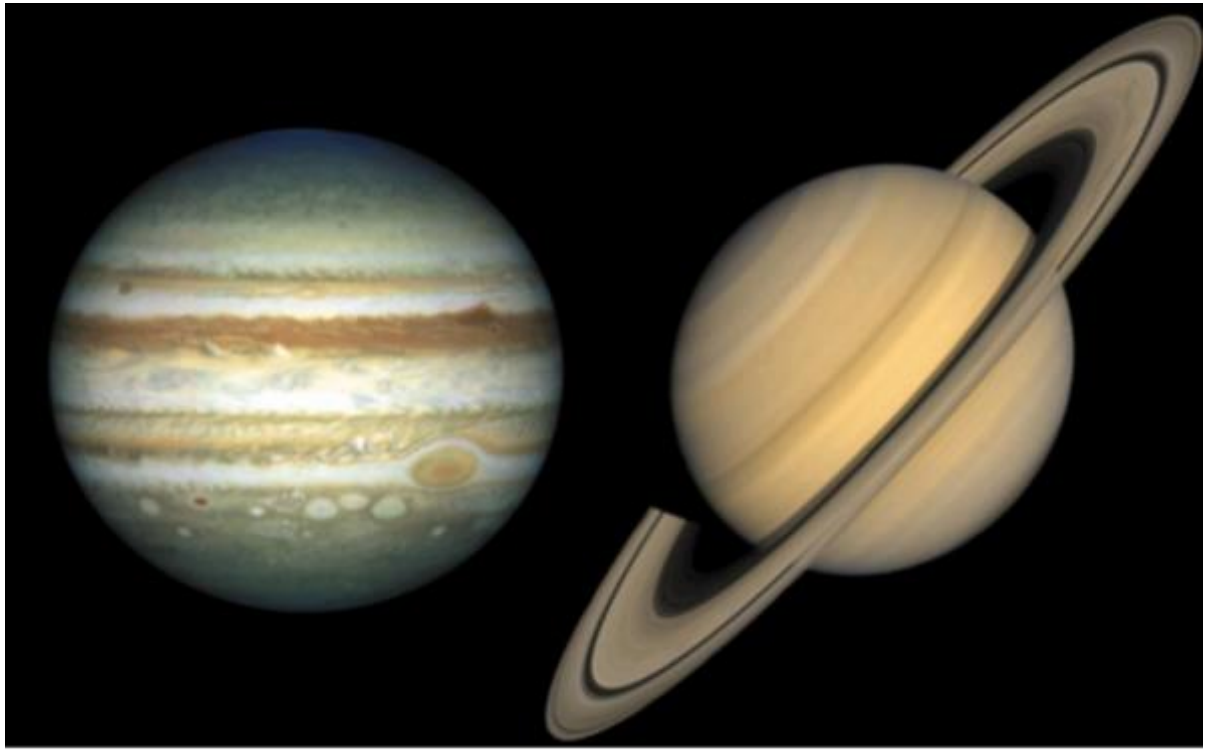
Jupiter

Jovian Planets: "God-like, Jupiter like"

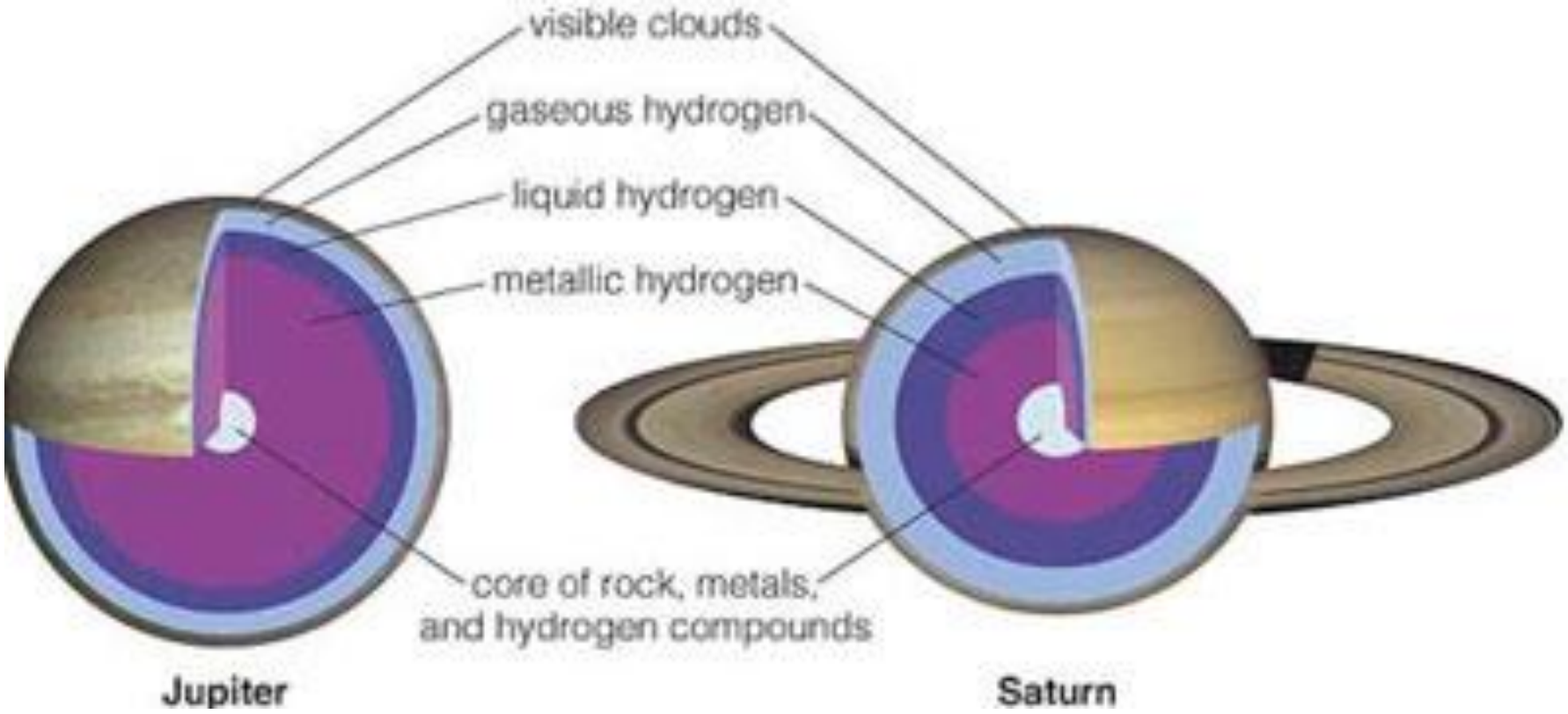


Jupiter, Saturn, Uranus, & Neptune

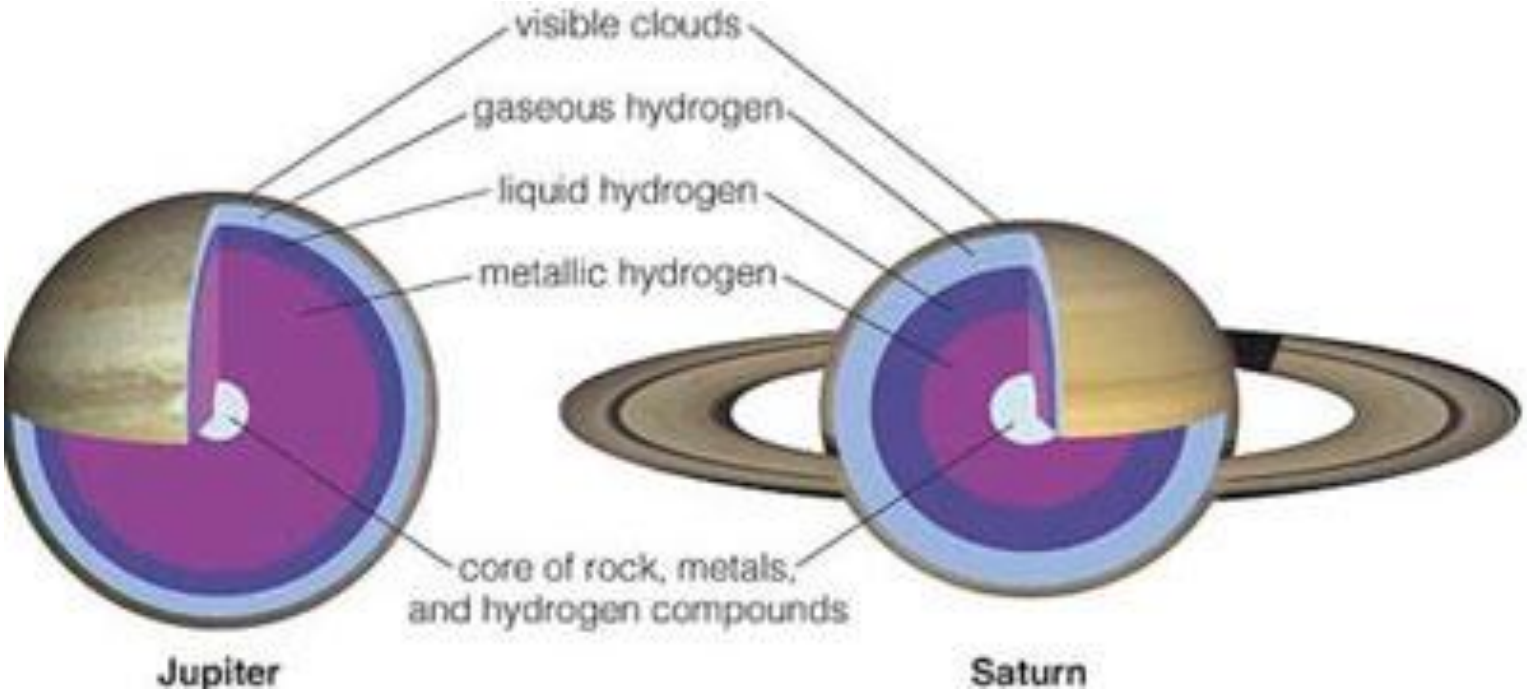
- Very large in size
- Outer solar system. Orbits farther from Sun.
- Made of gas with no solid surfaces.



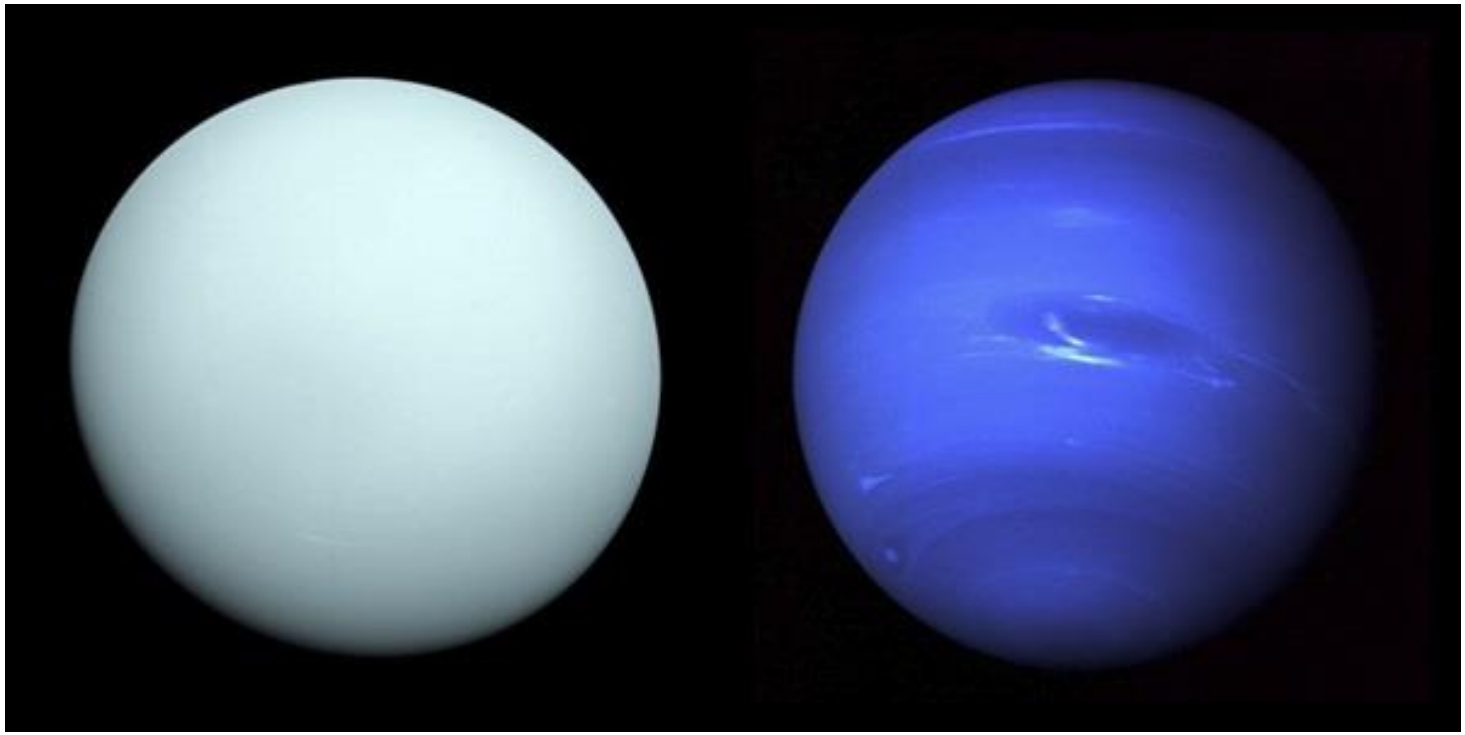
Jupiter and Saturn are called the **Gas Giant planets**. More than 80% of their masses is the massive **hydrogen gas atmosphere** and a thick middle layer of **metallic hydrogen.** The atmosphere has some helium and traces of sulfur, nitrogen and other lighter elements. Gas giant planets have very small icy and rocky cores.



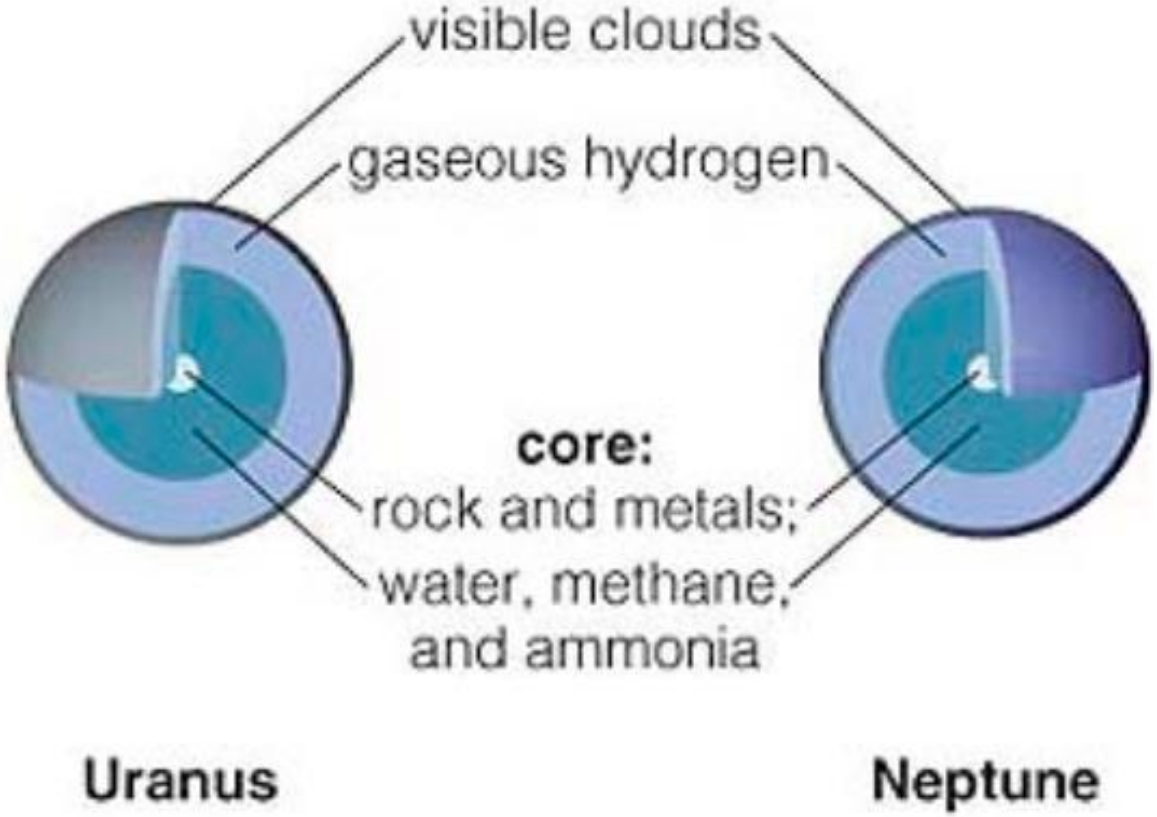
Cross-sections of the theoretical interiors of the gas giant planets.



Metallic hydrogen is a bizarre form of hydrogen. The hydrogen gas is compressed by very strong gravity and by the pressure of the atmosphere above into a very dense layer that flow like a very dense liquid. The hydrogen atoms are so tightly packed together the hydrogen looks and behaves like pure molten metal. The electrons flow from hydrogen atom to atom and create electrical currents.

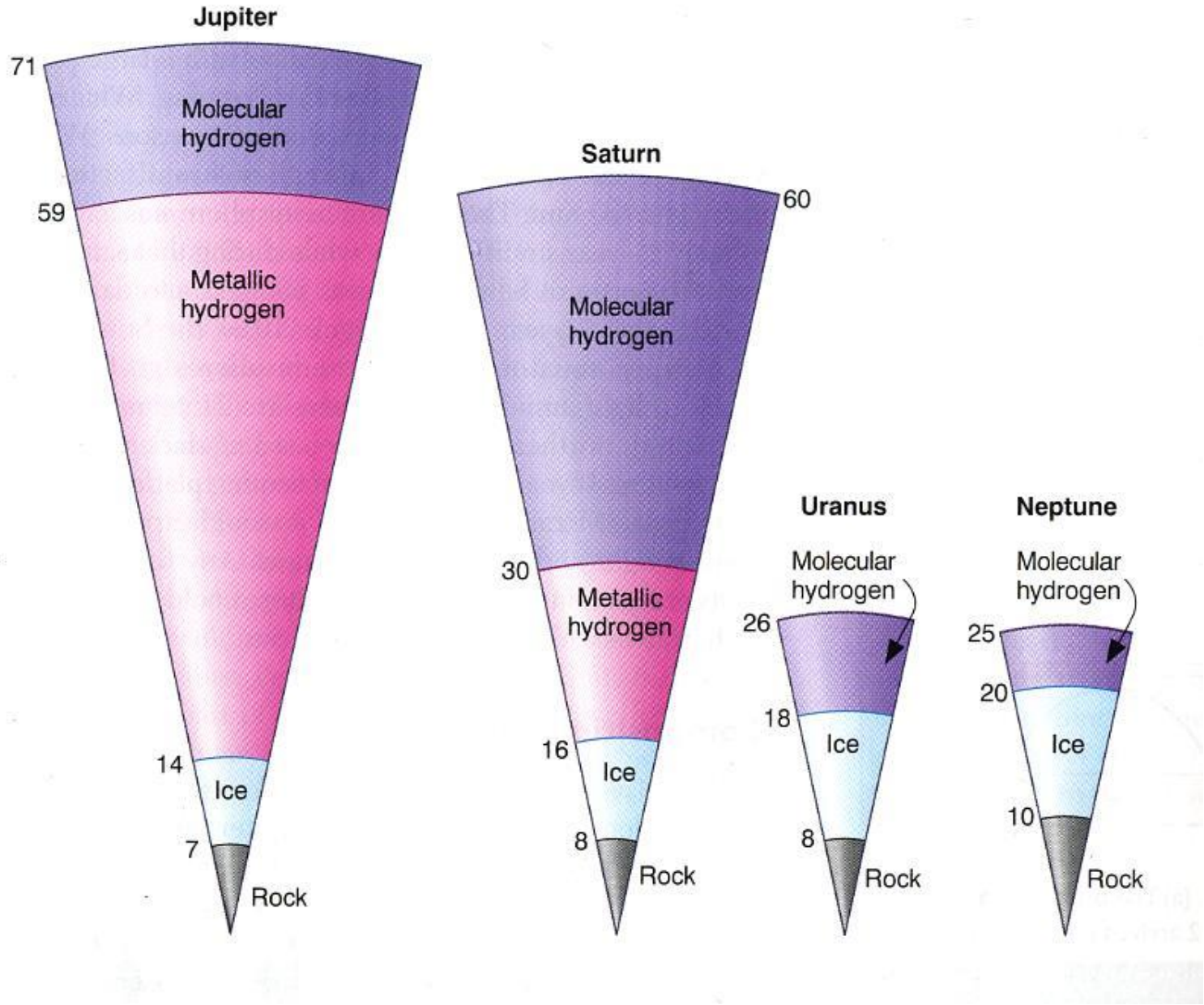


Uranus and Neptune are called the **Ice Giant planets**. They have much thinner atmospheres of hydrogen and helium gases, and much larger mantles and cores relative to their size. Their mantles are made of slushy water ice, methane ice, and ammonia ice. Their cores are dense rock with traces of heavy metals.



Cross-sections of the theoretical interiors of the ice giant planets.

Cross sections of Jovian Planets



Gas Giant and Ice Giant planets have very low bulk densities compared to Terrestrial planets (3.9-5.7 g/cm^3).

- Jupiter: 1.33 g/cm^3
- Saturn: 0.69 g/cm^3
- Uranus: 1.29 g/cm^3
- Neptune: 1.64 g/cm^3

Their masses are 16-300 times greater than Earths', but their huge gaseous volumes make them much less dense.

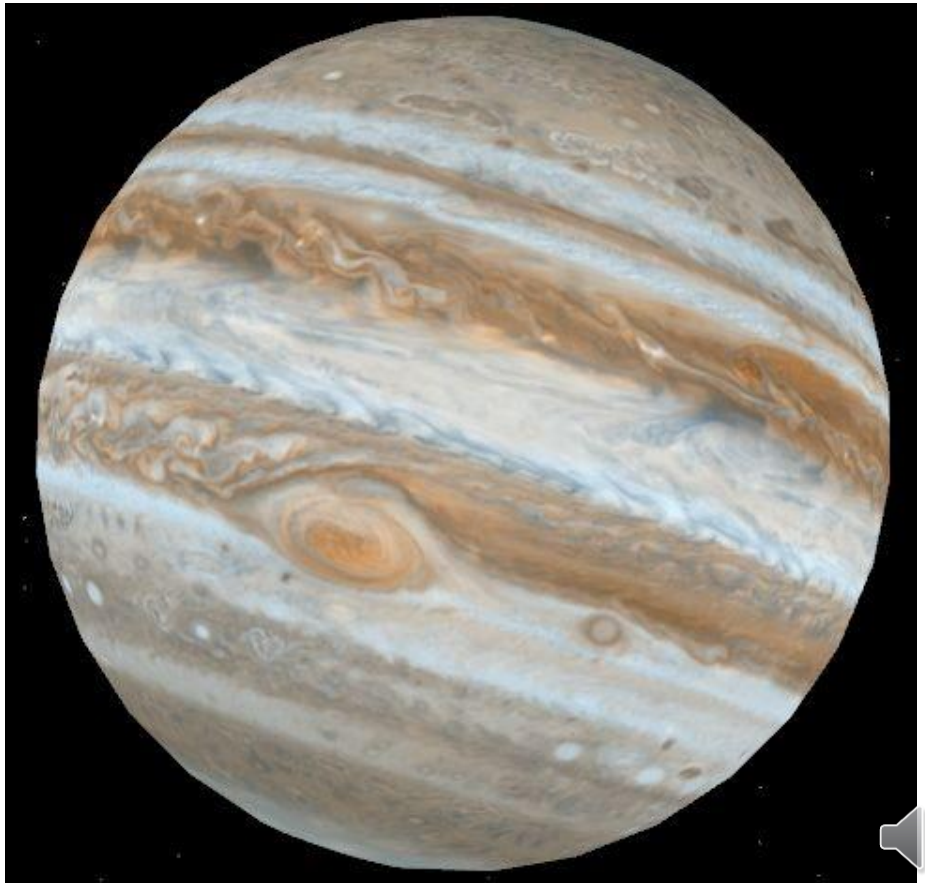
The Jovian planets have very fast rotation (day-night cycles) compared to terrestrial planets. Larger planets with larger masses have greater angular momentums.

- Jupiter: 9.84 hrs
- Saturn: 10.7 hrs
- Uranus: 17.2 hrs
- Neptune: 16.1 hrs

JUPITER

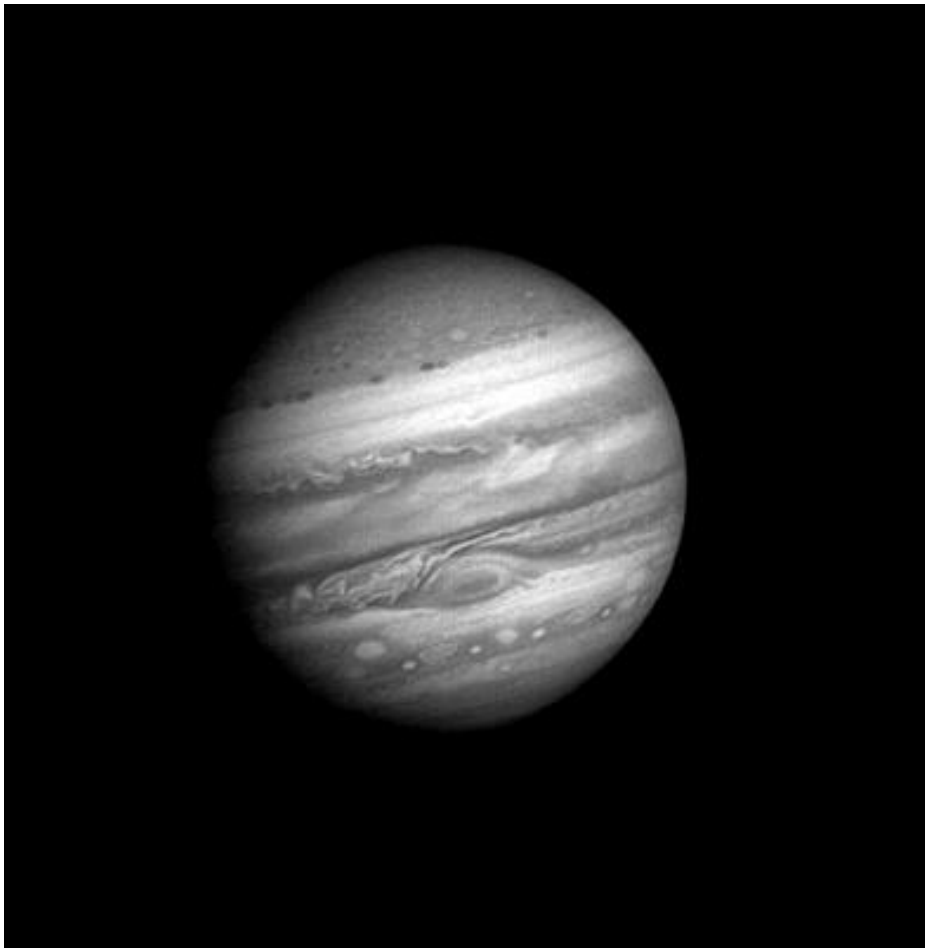
- Fifth planet from the sun.
- Largest planet in the solar system
- Equatorial diameter = 1.43×10^5 km
- Planetary mass = 1.90×10^{27} kg (320-times Earth)
- Bulk density = 1.33 g/cm^3
- Mean orbital radius = 7.78×10^8 km (5.2 AU)
- Orbital period = 11.9 years
- Rotational period = 9.84 hours
- 79 moons
- Mostly H_2 and He gases, with yellowish sulfurous clouds

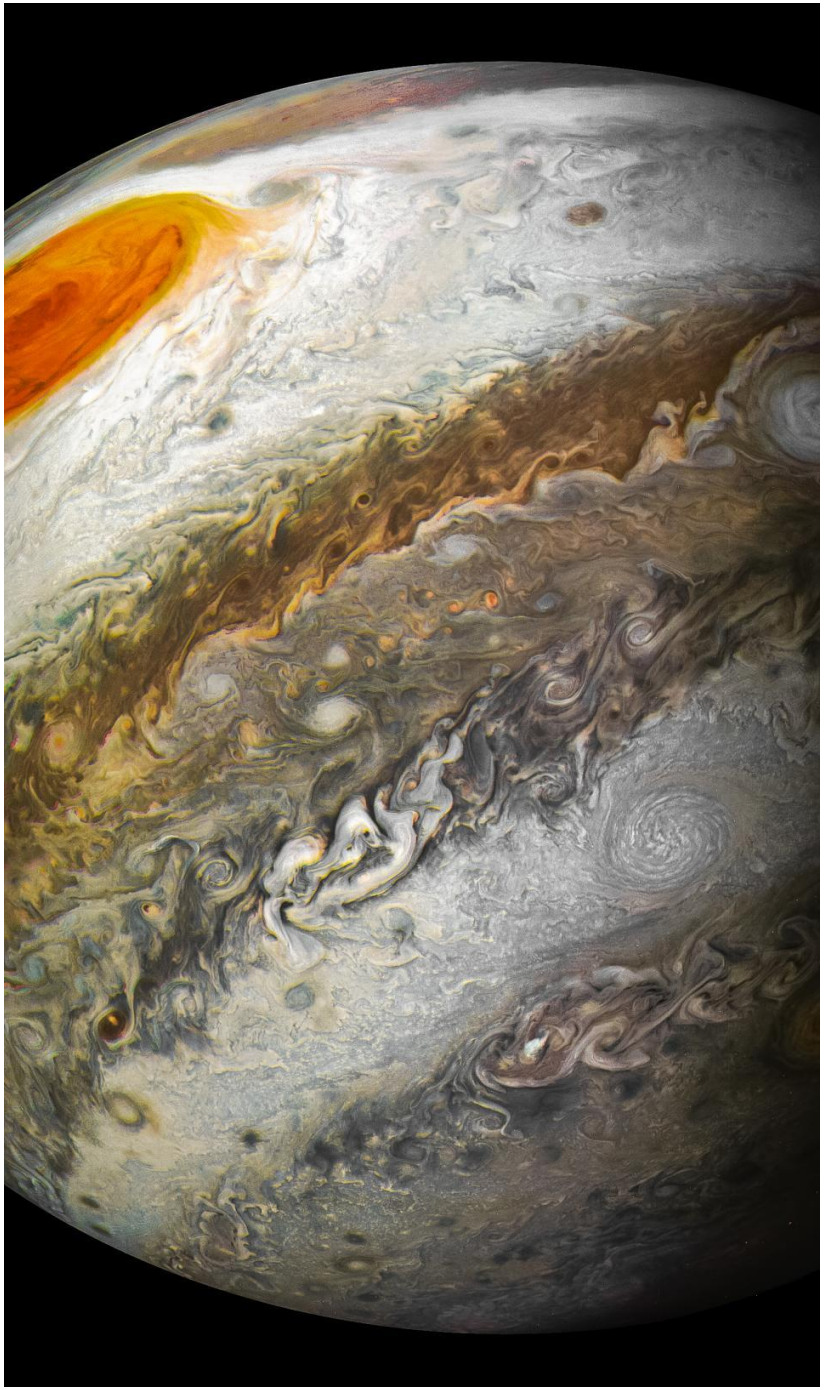
The alternating bands of moving gases in the atmosphere are different colors because they are at different temperatures and made of different gases. The clouds in the upper atmosphere are made of sulfur, ammonia, and hydrocarbons.



The alternating cloud bands move at different rates and different directions (west to east, and east to west) because of the differential rotation of Jupiter's atmosphere and the Coriolis effect.

Video was taken by Voyager I in 1979, the first close-up fly-by of Jupiter.





Jupiter's atmosphere has hundreds of cyclonic and anticyclonic storms. Some are similar to hurricanes on Earth.

The large rotating storms are caused by Jupiter's very fast rotation, convection in the atmosphere, and the Coriolis effect.

White storms in Jupiter's southern hemisphere centered around the 40ºS latitude. These are cyclones, the gases are rising with low pressure. The diameter of the storms are the same diameter as the Earth.

Great Red Spot is the largest anticyclonic storm. The Great Red Spot is located in Jupiter's southern hemisphere near the 30º S latitude. It is a region of high atmospheric pressure, the gases are heavy and moving downward as they rotate.

The Great Red Spot is three-times wider than the diameter of the Earth.

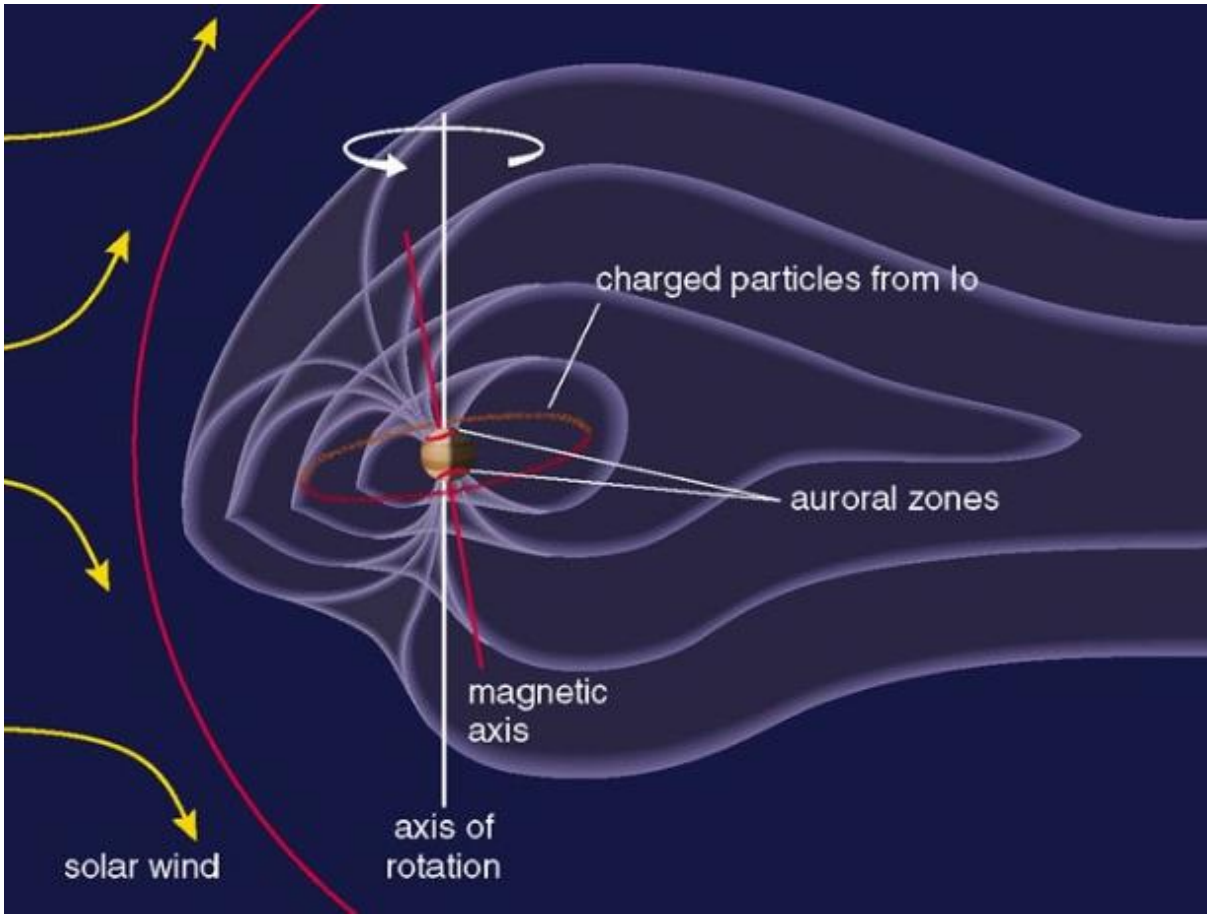
The **Great Red Spot** was seen by **Galileo** in 1610 through his telescope. The storm has persisted for a minimum of 400 consecutive years.

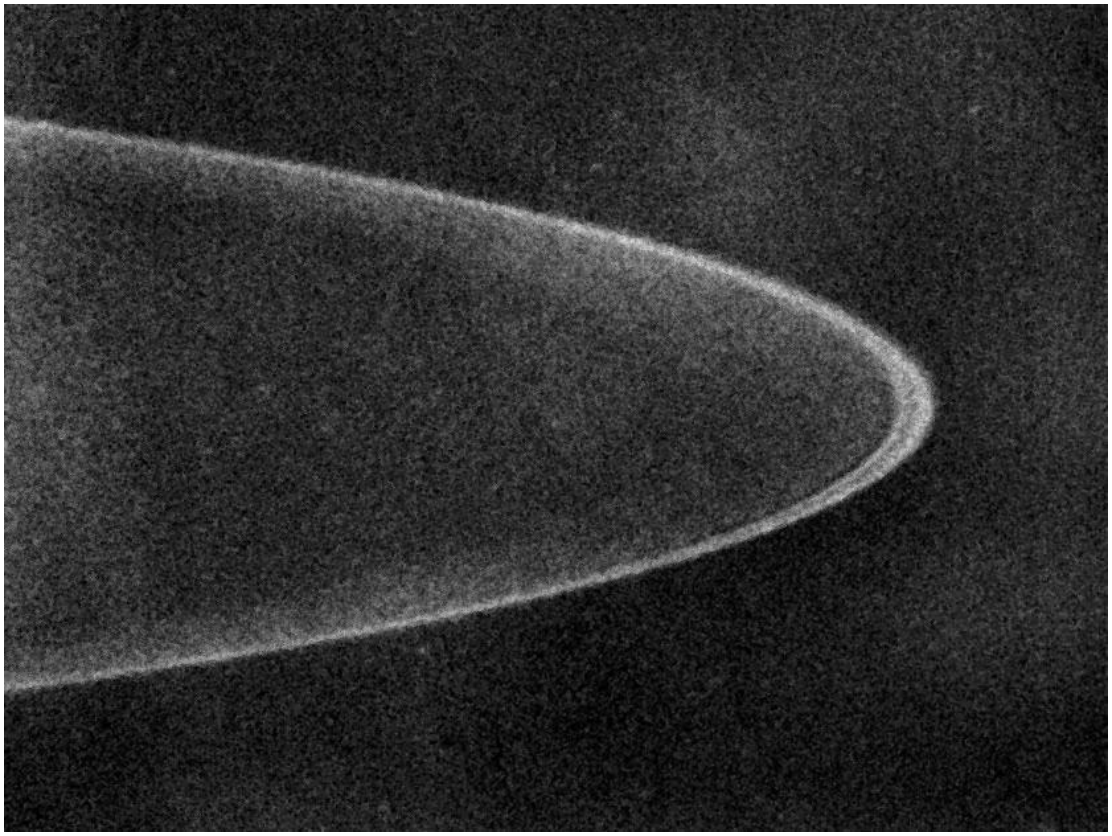
The weather, storms, and atmospheric circulation on Jupiter are not caused by the heating from sunlight. Jupiter is cold and lies too far from the sun. They are caused by circulation of heat from Jupiter's massive interior.

The temperatures of Jupiter's atmosphere and metallic hydrogen layers increases very quickly from the outside in.

The pressure of the gases pulled inward by Jupiter's immense gravity heats the interior to temperatures hotter than Earth's core. Similar effect as to the Sun's interior.

Jupiter has the strongest magnetic field of all planets. Jupiter's magnetic field is caused by the fast rotation mixing and swirling the gigantic zone of metallic hydrogen below its atmosphere.





Jupiter has a ring system. The rings are made of dust orbiting Jupiter. The main ring is the darkest and densest. Two very small moons orbit Jupiter within the rings.

Jupiter's rings have only been photographed a few times. The picture is from Voyager I in 1979. The rings are so thin that they can only be imaged by spacecraft as they look back on Jupiter with the Sun in the background.