Lesson 13

Dwarf Planets, Comets, & Moons

In order for body to be a true planet:

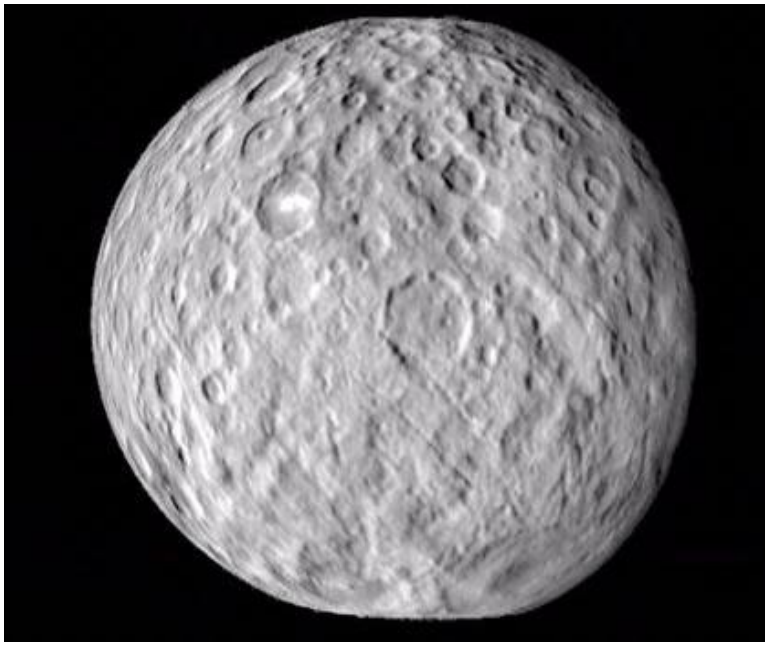
1. Must have a mass great enough to accrete (form) into a spheroid shape (a ball).
2. Must orbit the sun in a stable orbit with a regular periodicity (same amount of time each orbit)
3. Cannot orbit another body, such a larger planet.
4. Its orbit cannot cross the orbit of another planet.
5. Must have swept its orbit clear of all ice, dust, asteroids, planetesimals. It must be the only object in its orbit path.

(International Astronomical Union, 2006)

What is a dwarf planet?

1. Must have a mass great enough to accrete (form) into a spheroid shape (a ball).
2. Must orbit the sun in a stable orbit with a regular periodicity (same amount of time each orbit)
3. Cannot orbit another body, such a larger planet.

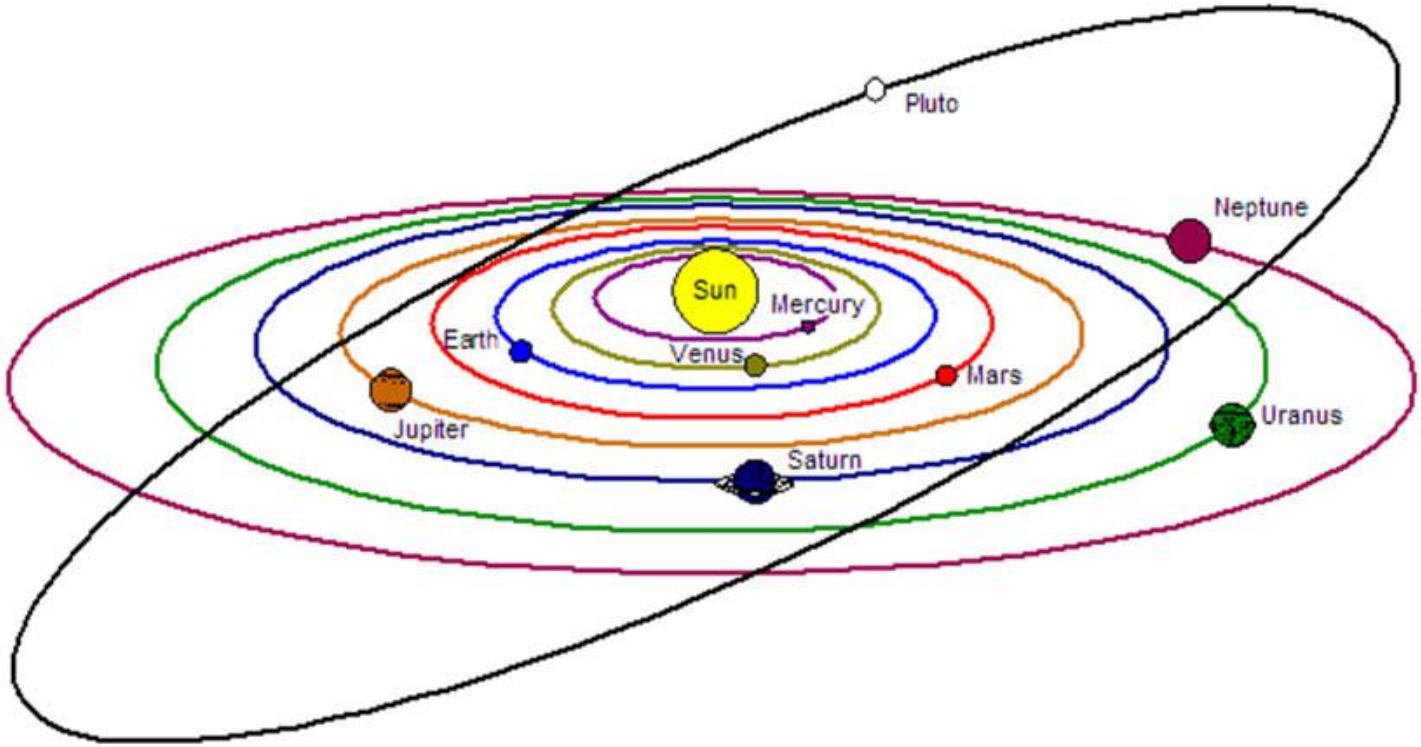
4. It may cross the orbit of another planet (Pluto for example)
5. The body as NOT swept its orbit clear of all ice, dust, asteroids, and planetesimals. Space debris in its orbit.



Ceres (above) and Pluto (below) are *dwarf planets.*

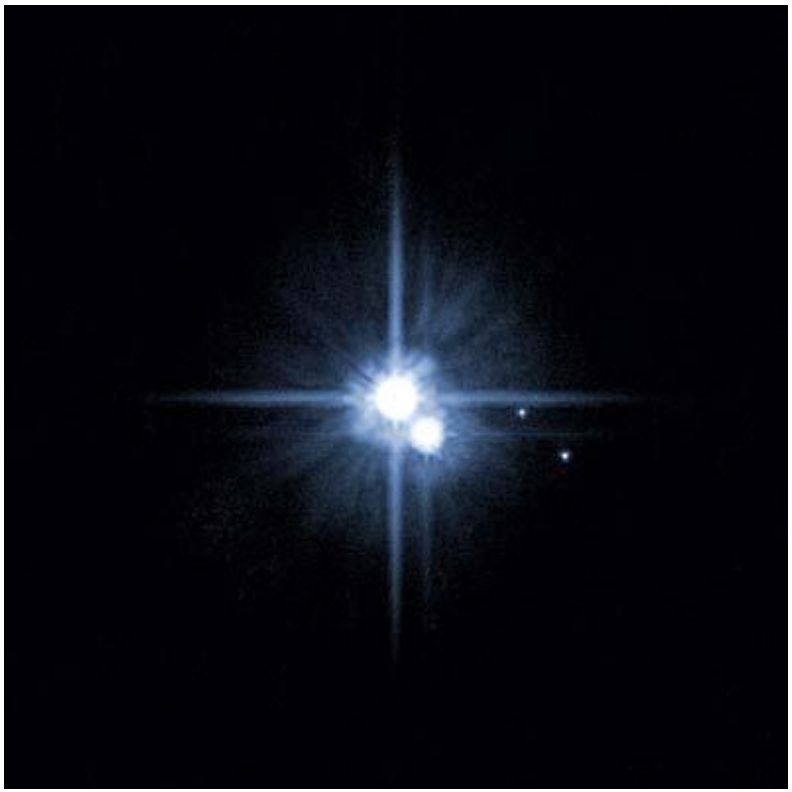
- Spherical in shape.
- Orbit the Sun in a well-defined period.
- They do nor orbit another planet or body.

They HAVE not swept their orbits clear of debris. Pluto lies at the edge of the Kuiper Belt surrounded by comets, ice, and dust. Ceres is surrounded by asteroids in the asteroid belt.



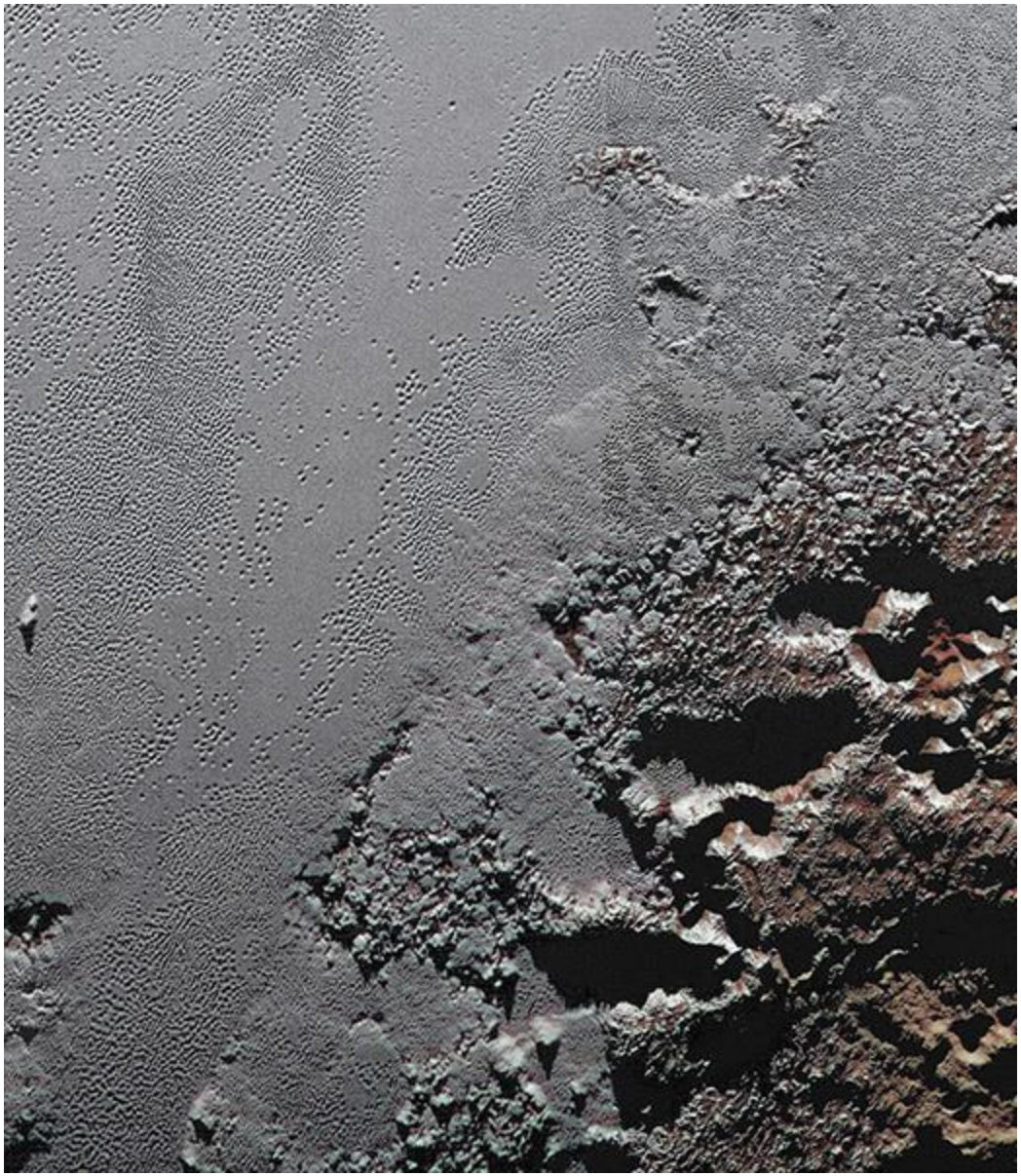
- Pluto's orbital period is 248 years.
- Pluto's orbit does not lie parallel to the plane of the ecliptic—offset by 17º.
- Pluto's extreme elliptical orbit allows for it to cross inside of Neptune's orbit for 20 years.

Pluto as observed by Hubble Space Telescope (1999) and by New Horizons (2015)



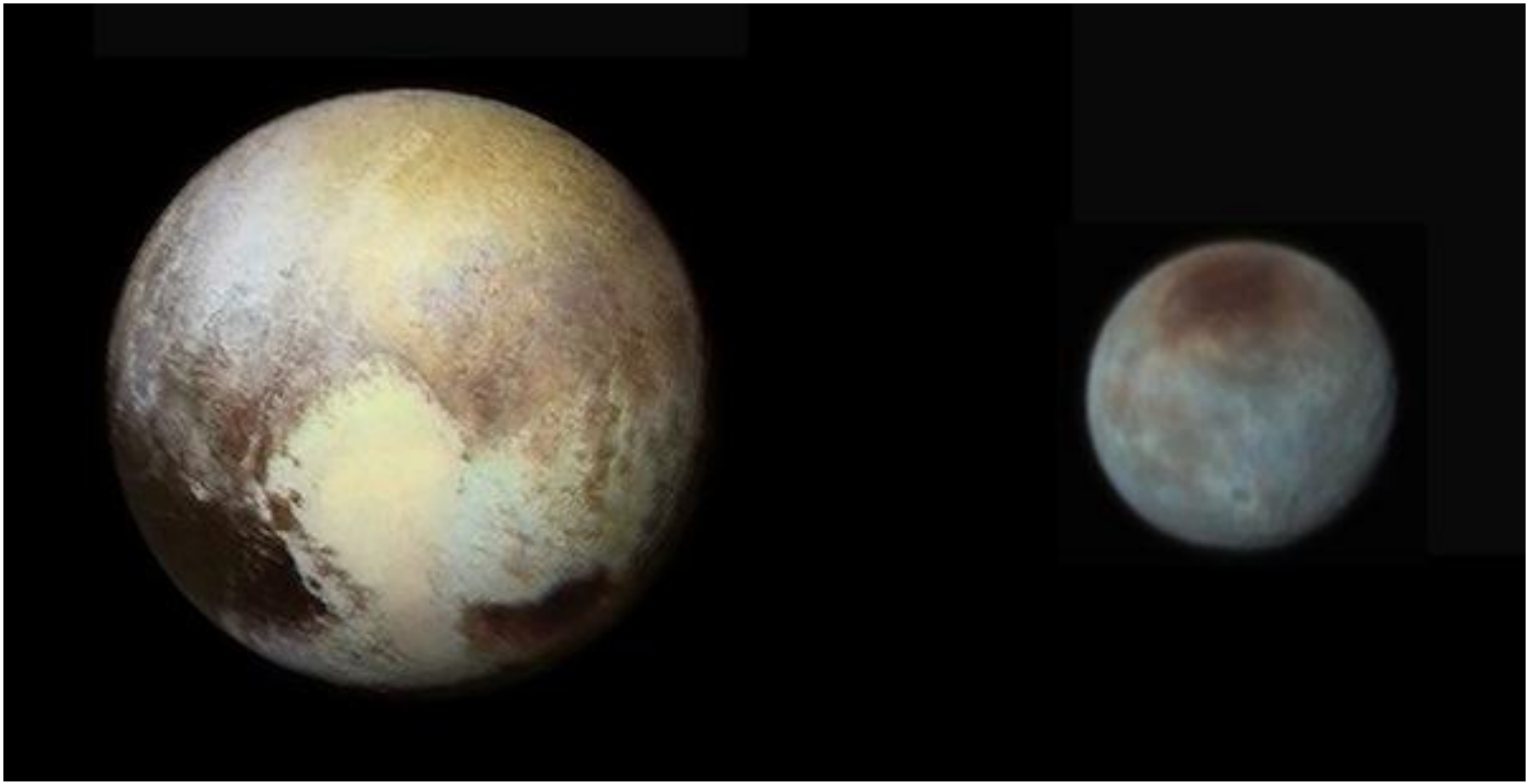
Pluto was not visited by Voyager II. The first spacecraft to visit Pluto was New Horizons in 2015.

Plutonian moons: Charon, Hydra, Nix, Styx, Kerberos



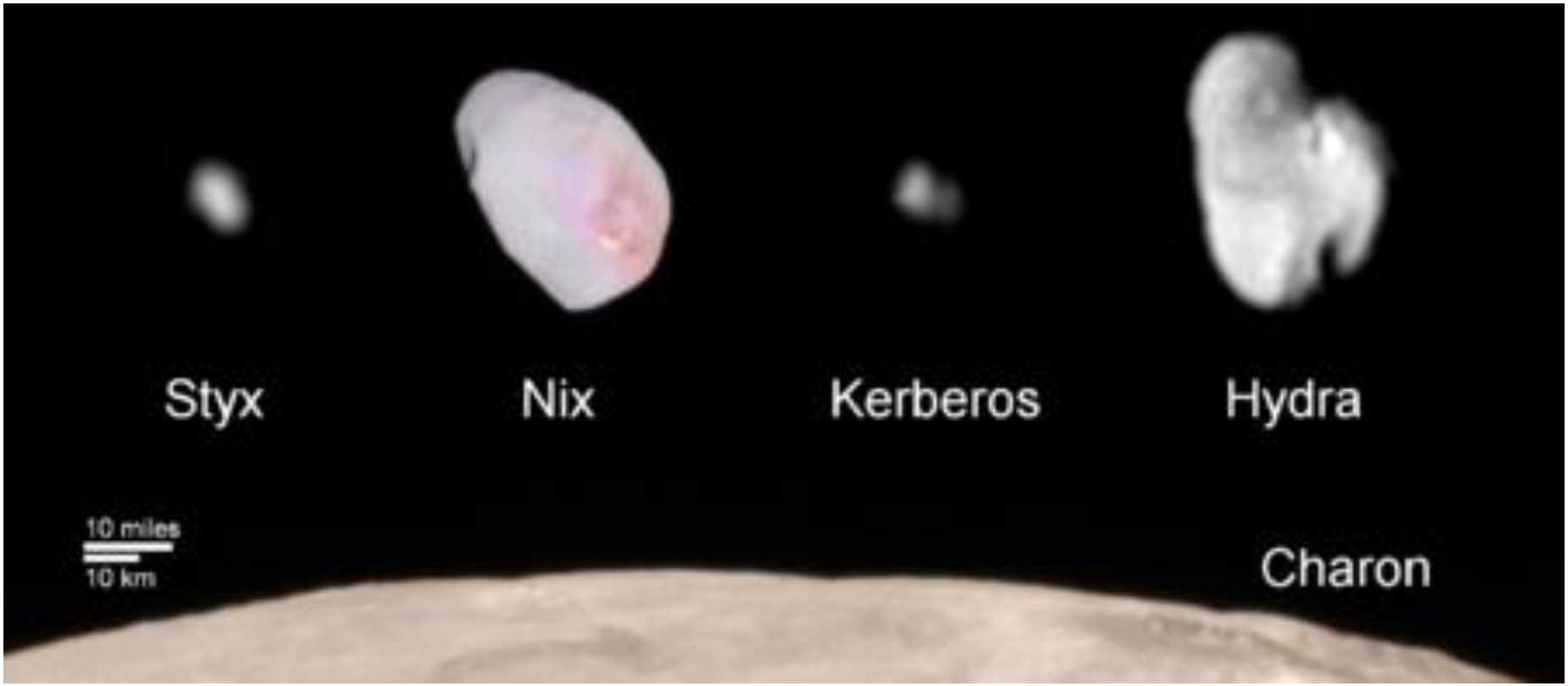
Pluto has a pinkish white surface covered by glaciers and ice fields. Some regions have very tall icy mountain ranges.

The ice is mostly made of frozen nitrogen and frozen ammonia. The falling snow is pink and red.



Pluto's moon Charon is most likely another ice dwarf planet that became gravitationally associated with Pluto. Because Pluto and Charon are similar in size (Pluto is 4-times more massive), they actually orbit each other.

Pluto's four very small moons are most likely captured comets from the Kuiper Belt.



Ice dwarf planet: (sometimes called Plutoids) are **s**mall icy worlds similar in size and composition to Pluto, and are located within the Kuiper Belt region of the solar system.

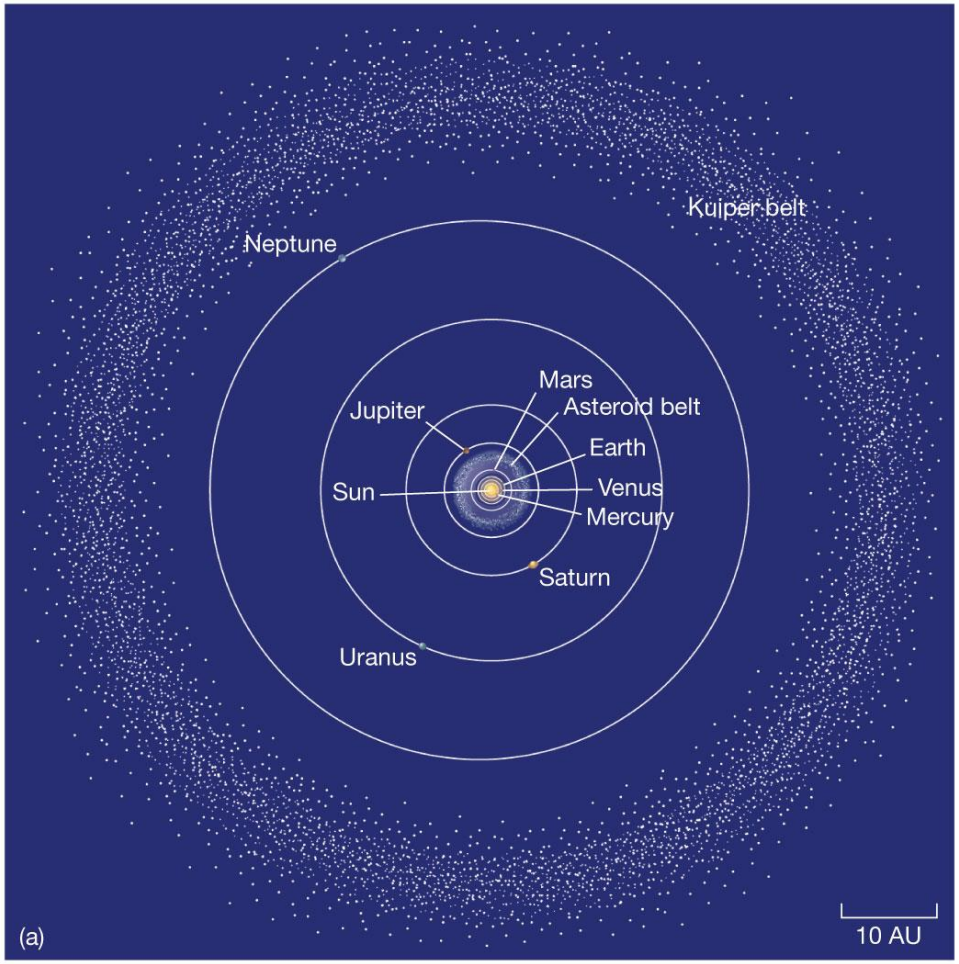
Trans-Neptunian Objects are any larger bodies (dwarf planets, comets) that originated from regions beyond Neptune's orbit like the Kuiper Belt and the Oort Cloud.

Kuiper Belt Objects tend to refer to comets and asteroids that lie entirely within the Kuiper Belt.

Largest of the **trans-Neptunian objects** that lie within the Kuiper Belt.

Pluto was discovered in 1930. The other ice dwarf planets were identified and named 2002-2006. They were discovered by the Hubble Space Telescope.

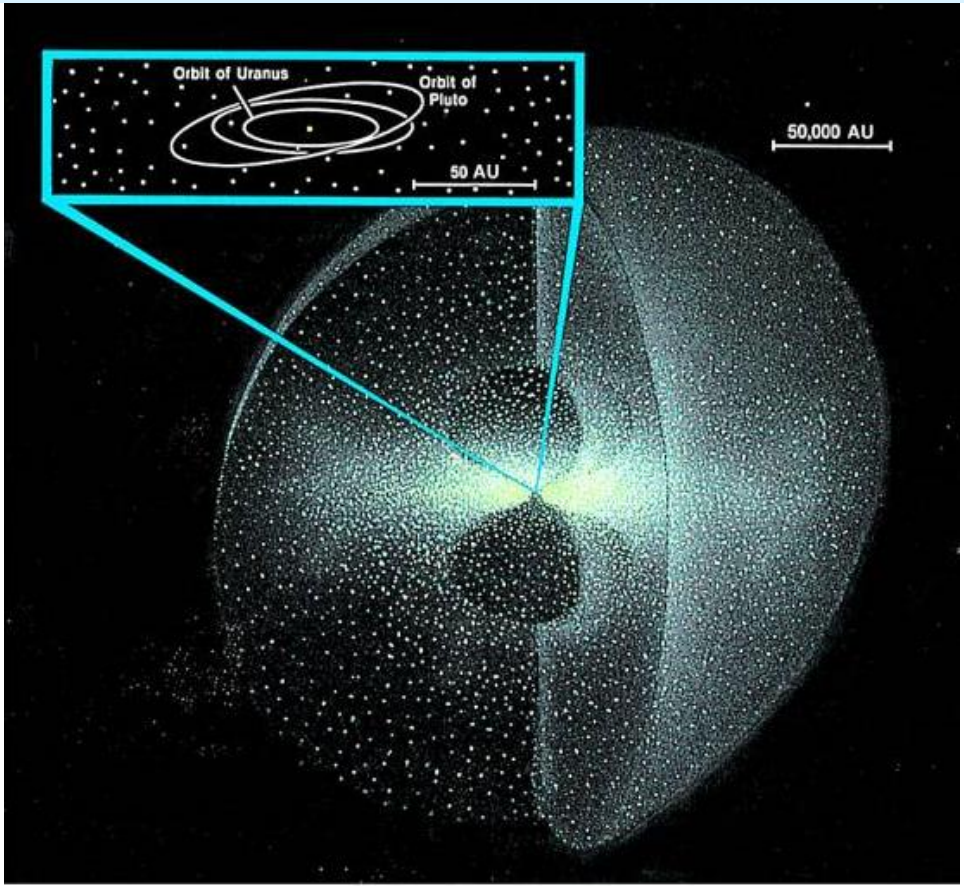
Kuiper Belt: The region of the solar system (30-50 AU from the sun) beyond Neptune's orbit that contains billions of orbiting icy bodies and **short period comets**.



Over 700 identified TNO/KBO that have diameters of 100 km or more.

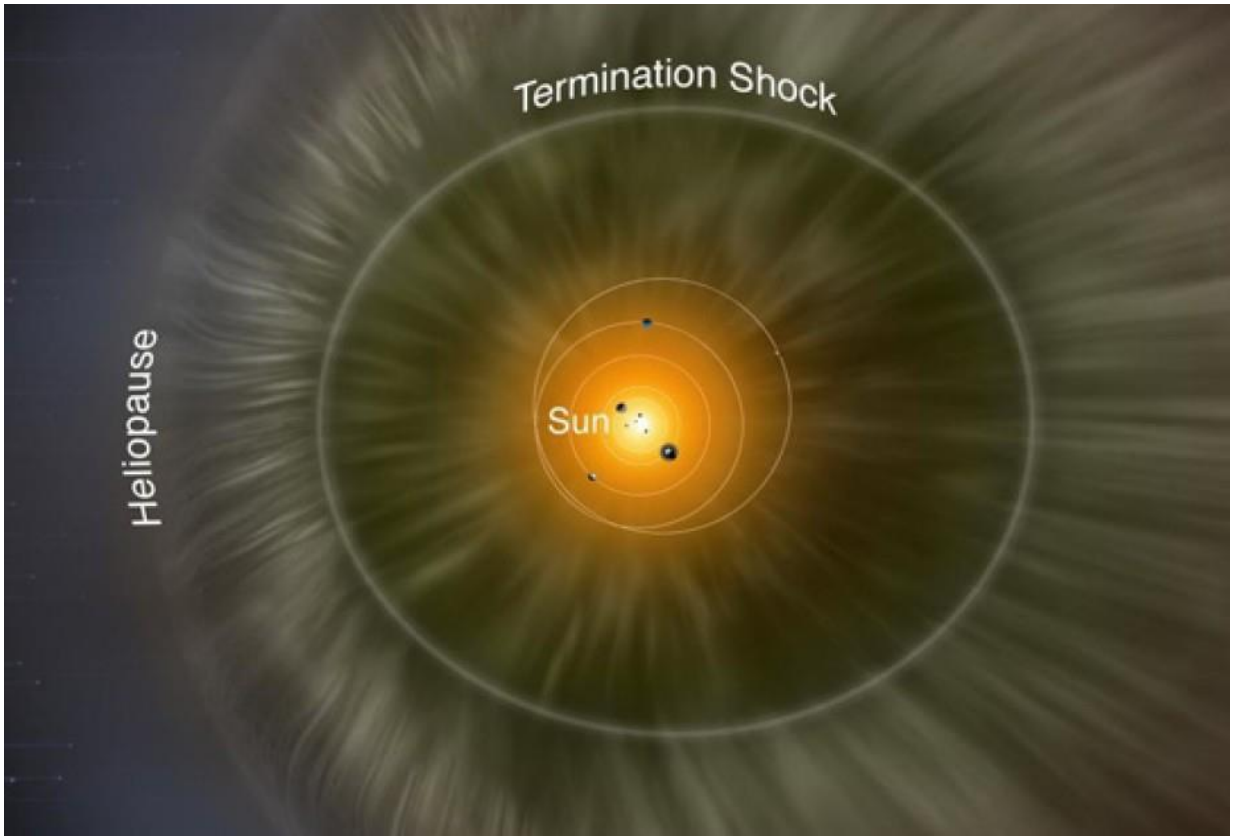
Oort Cloud: Immense spherical cloud bubble that surrounds the solar system disk, made of trillions of small icy bodies.

- Distance extends from 5,000-100,000 astronomical units from the Sun.



Source of most **long-period comets**.

The Oort cloud materisls are the left-over remains of the original nebular material from which the solar system formed.

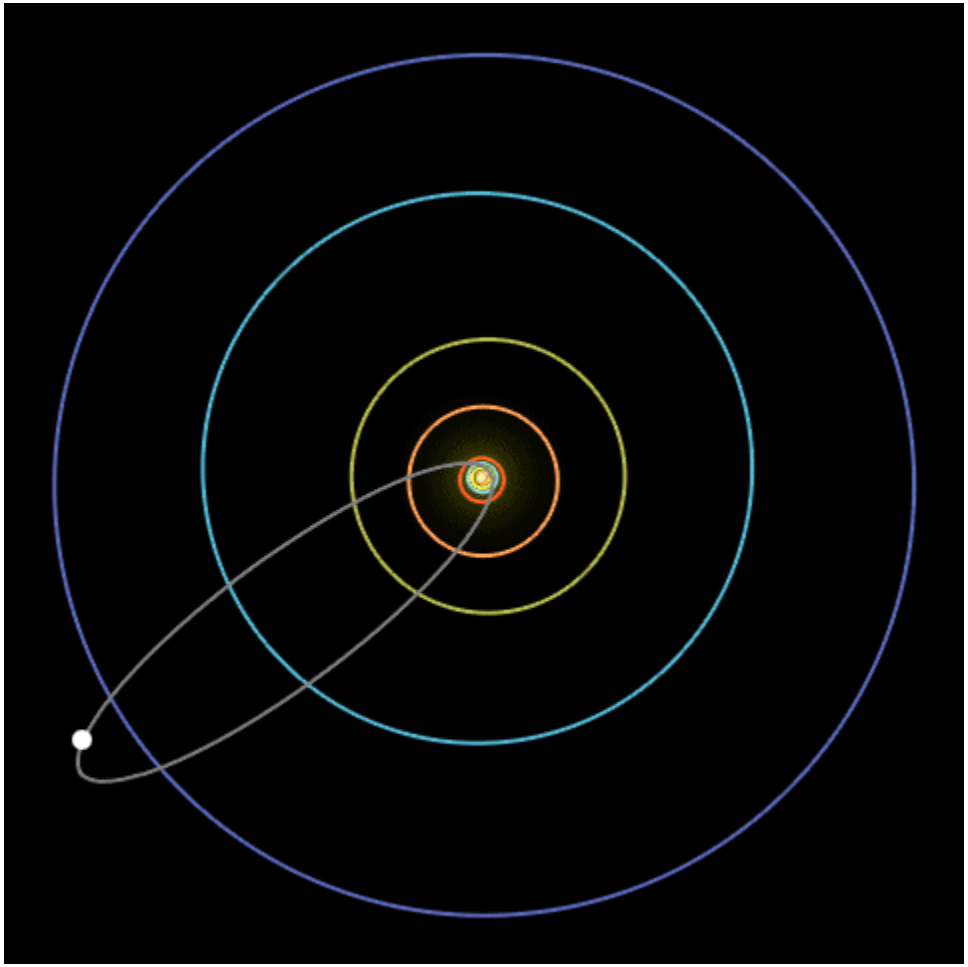


Beyond the Kuiper Belt is a boundary called the **heliopause**. The heliopause represents the farthest distance away from the sun in which the solar wind is strong enough to deflect interstellar energy. Beyond the heliopause, the interstellar energy is stronger.

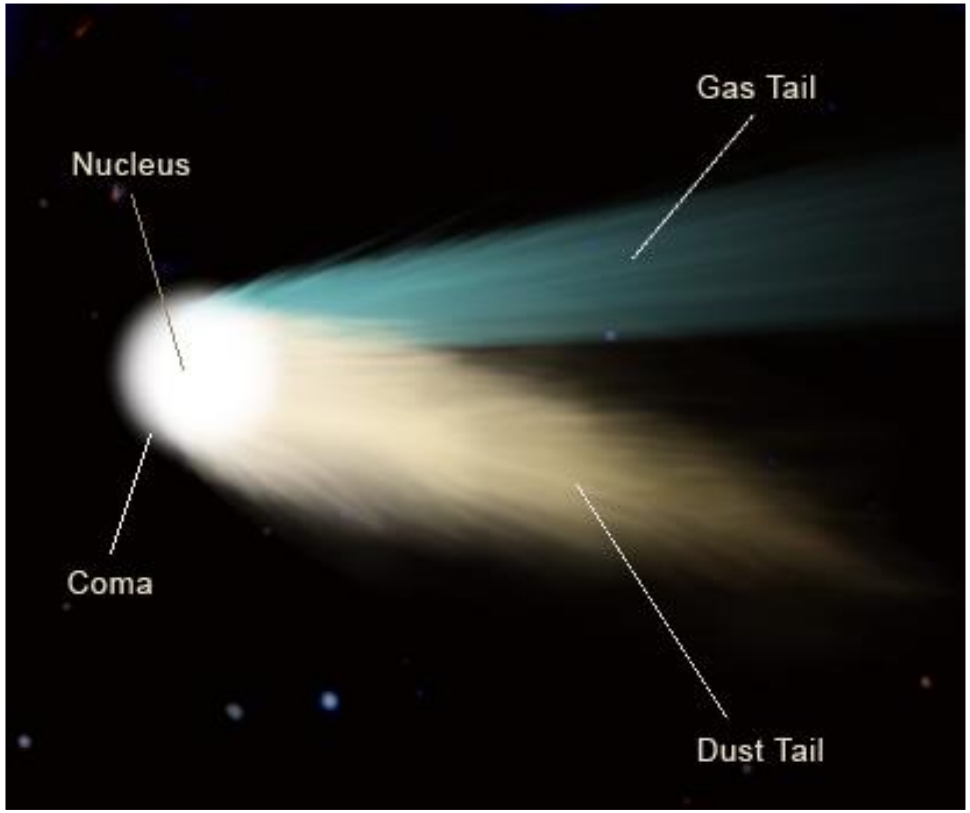
Comets

Comets are small icy bodies that orbit the Sun in highly elliptical orbits with regular periodicity.

- **Long period comets**: orbital periods longer than 200 years. Usually from the Oort Cloud.
- **Short period comets**: orbital periods shorter than 200 years. Usually from the Kuiper Belt.



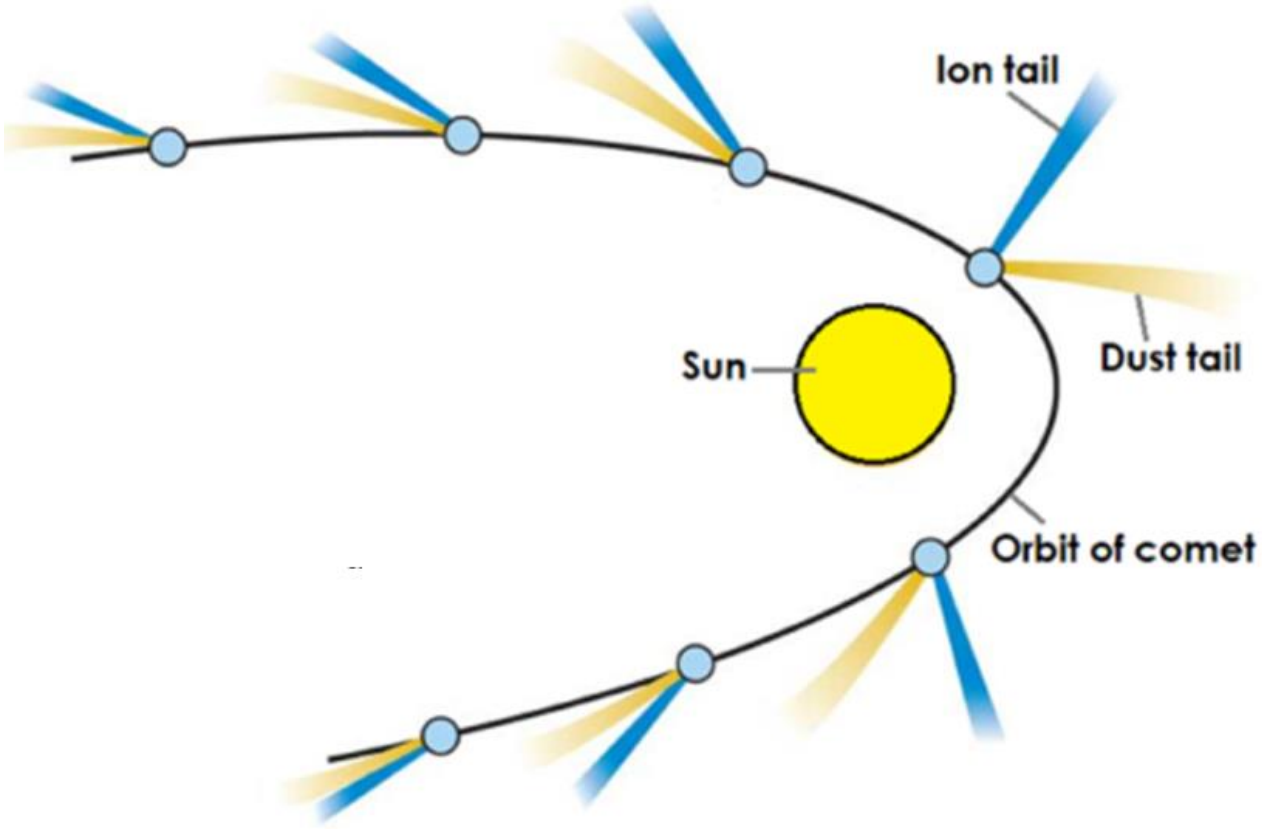
The orbits of comets are extreme ellipses. Most of their obit lies in the Kuiper Belt or beyond, and their perihelion is inside the asteroid belt. Comet orbits also do not align with the plane of the ecliptic. They can enter the inner solar system at any angle



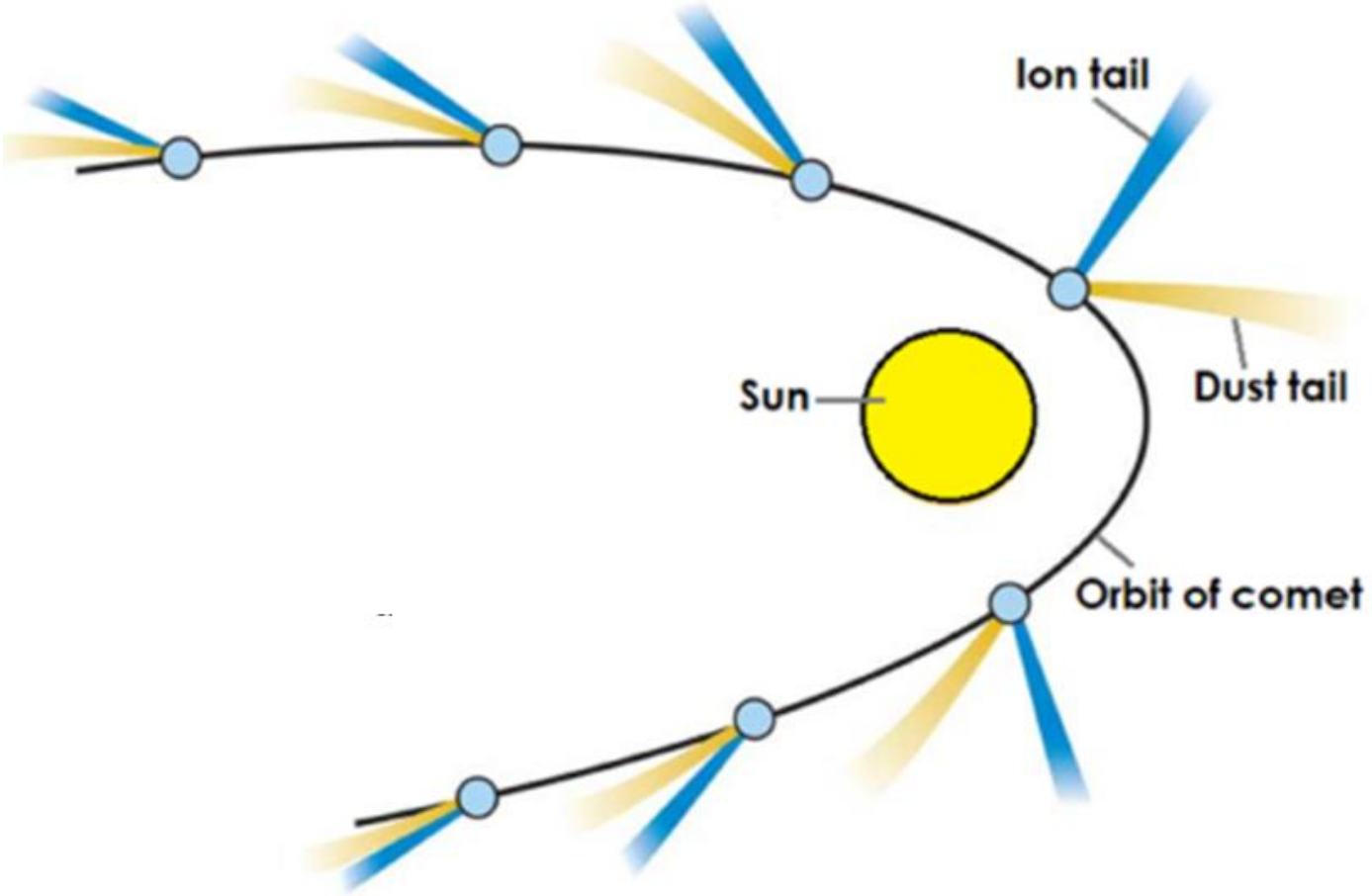
The **nucleus** of the comet is the solid ice and rock body of the comet.

The **coma** of the comet is the clouds of gas, ions, and dust surrounding the nucleus. The solar wind and heat from the sun melts and sublimes the icy surface of the comet. It also chips away at the rock in the nucleus. The heating, subliming and chipping of the nucleus creates the coma..

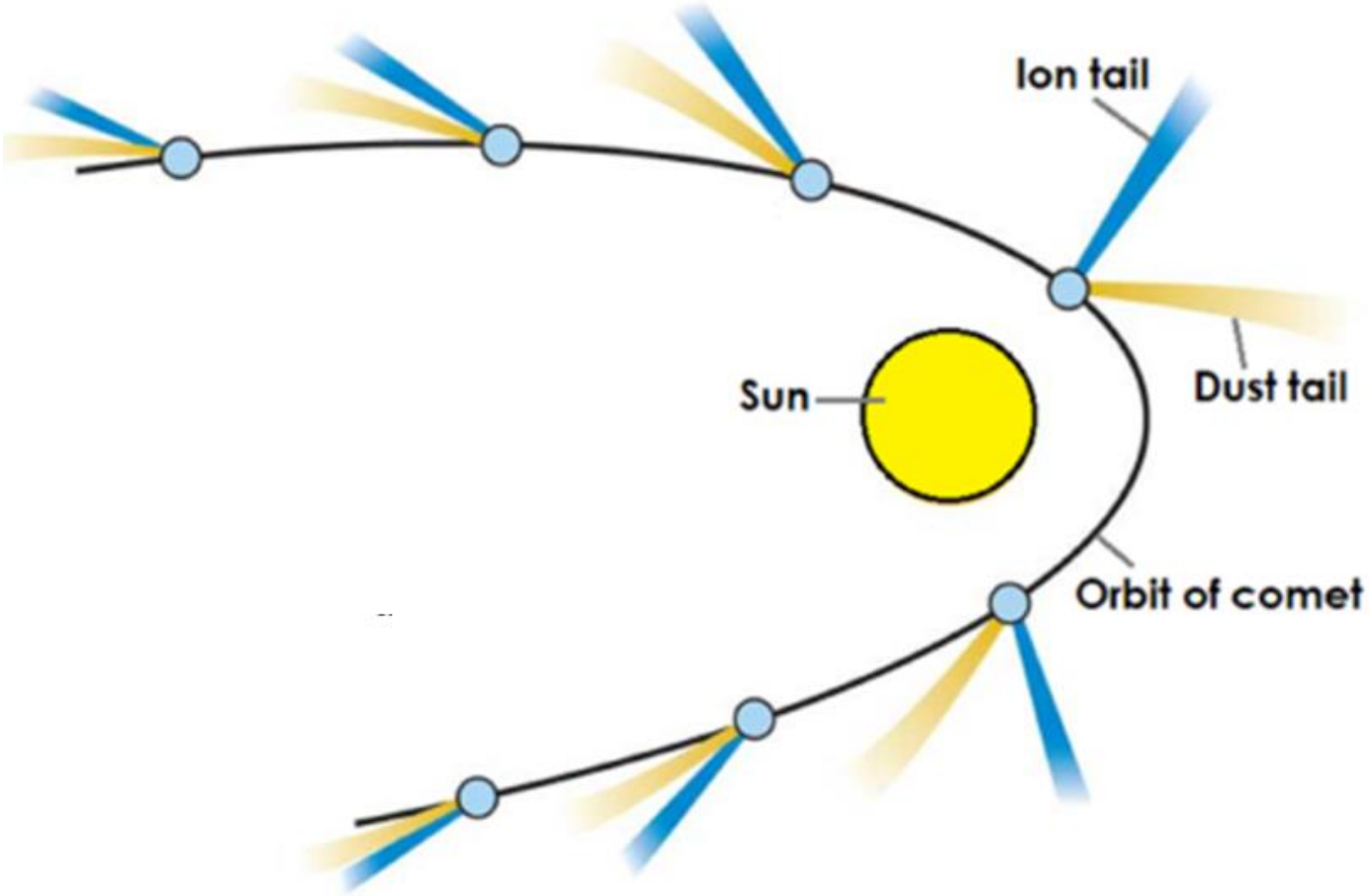
The tails of comets are created by the solar wind sweeping across the nucleus of the comet and blowing away the materials in the coma. As the comet gets closer to the sun, the solar wind is more intense. The heat from the sunlight is also more intense.

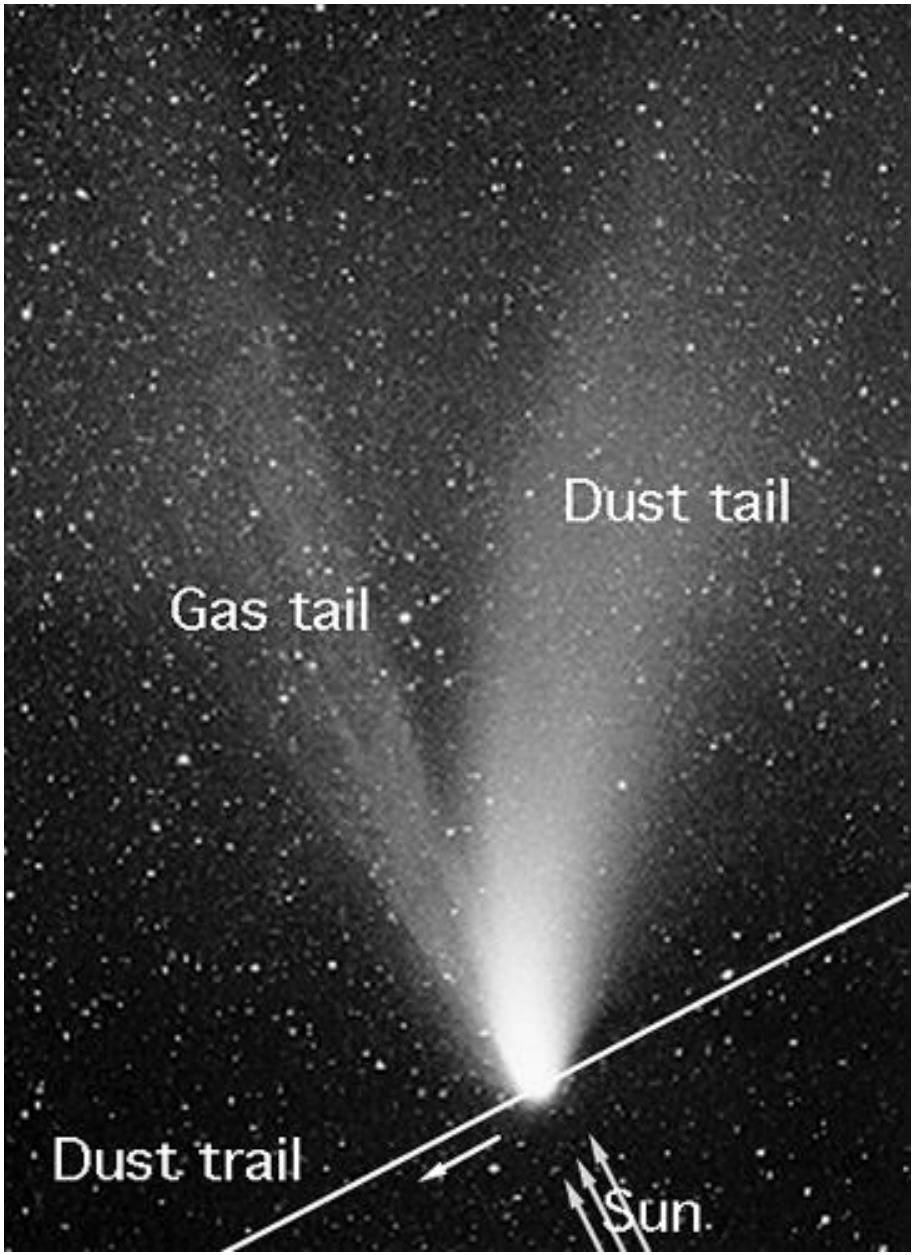


The dust tail and the ion tails always point away from the Sun regardless of the comet's position in its orbit. Additionally, the comet's tails get longer the closer they are to the Sun.

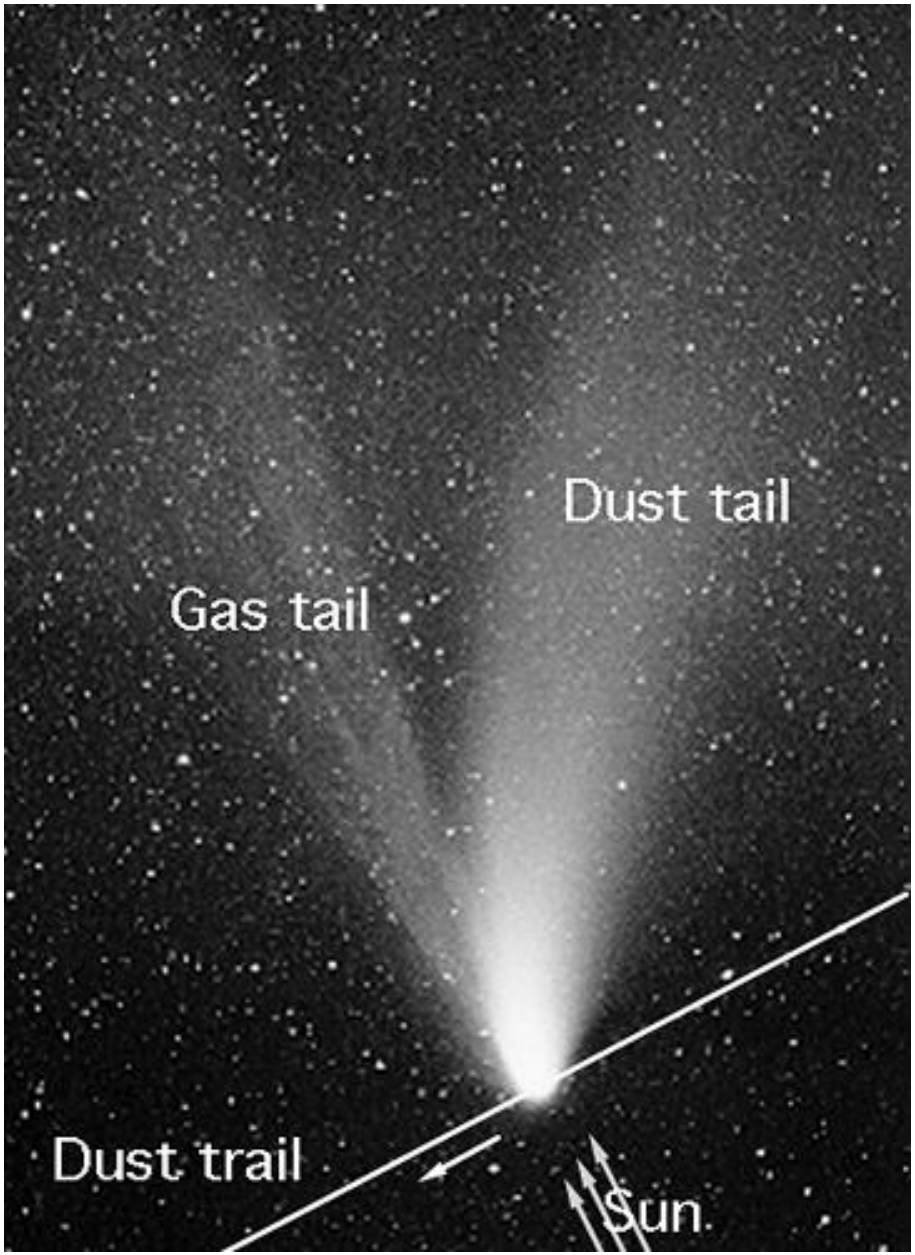


The ion tail points directly opposite of the Sun. The dust tail points away from the Sun, but curves in the direction of the comet's orbit path.





Dust tail is stream of dust and small chunks of rock that are dispersed by the comet as the ice in the nucleus of the comet sublimes. The materials in the dust tail are solids. The tail curves because the solid particles are left behind in space as the comet moves away.



Ion tail (or the gas tail) is the whispy tail of gas and charged particles that are swept off the nucleus. The solar wind, made of charged particles and electrons, sweeps the ions from the comet away.

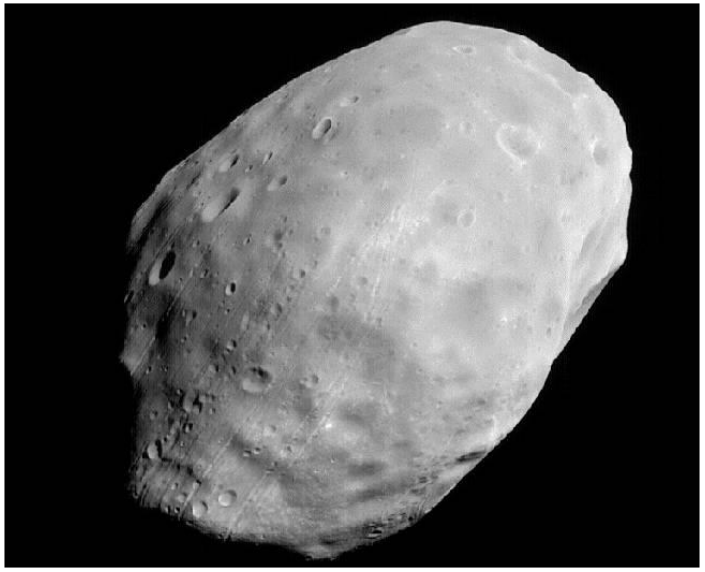
Comet Hale-Bopp 1997

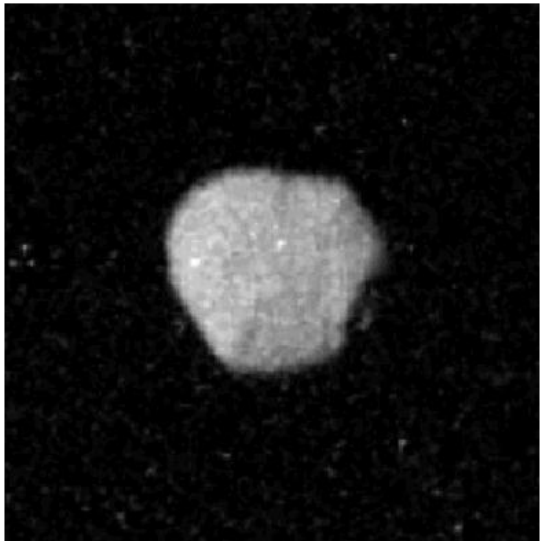
Satellites

Natural Satellites: objects that exist in stable orbits around planets.

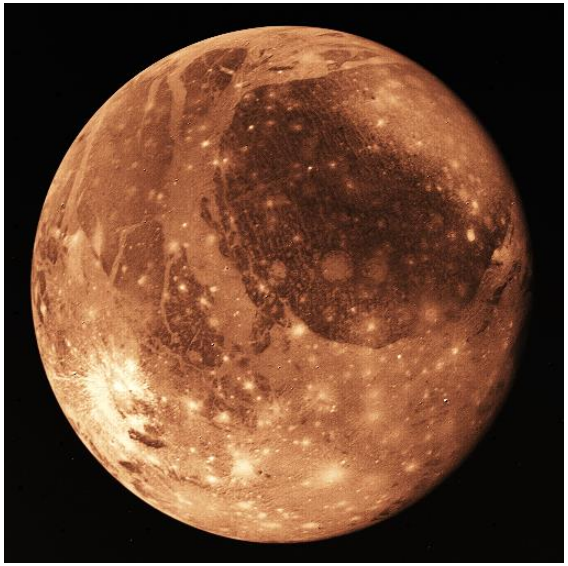
- Moons that form naturally with planet
  - Larger, more massive, and spherical
  - Orbit near the equatorial plane
- Captured asteroids and comets
  - Very small and irregular in shape
  - Eccentric orbits, sometimes not aligned with planet's equator
- Captured ice dwarf planets
  - Around gas and ice giant planets

Captured comets or asteroids (Phobos, Proteus, and Nereid) are tiny, have irregular shapes, and have very elliptical orbits that deviate from the plane of their planets' equators (Mars, Saturn, and Neptune).



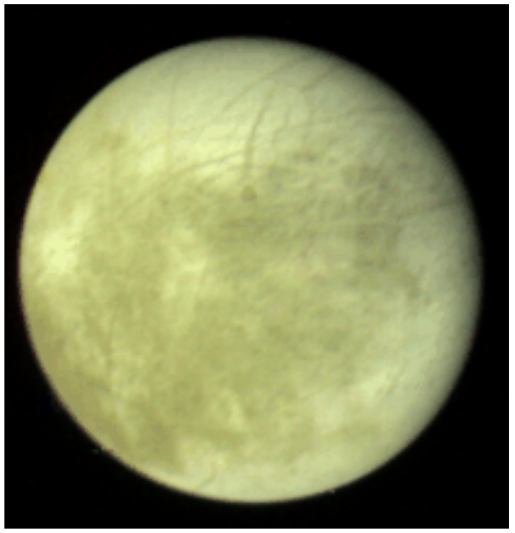


Ganymede



Callisto

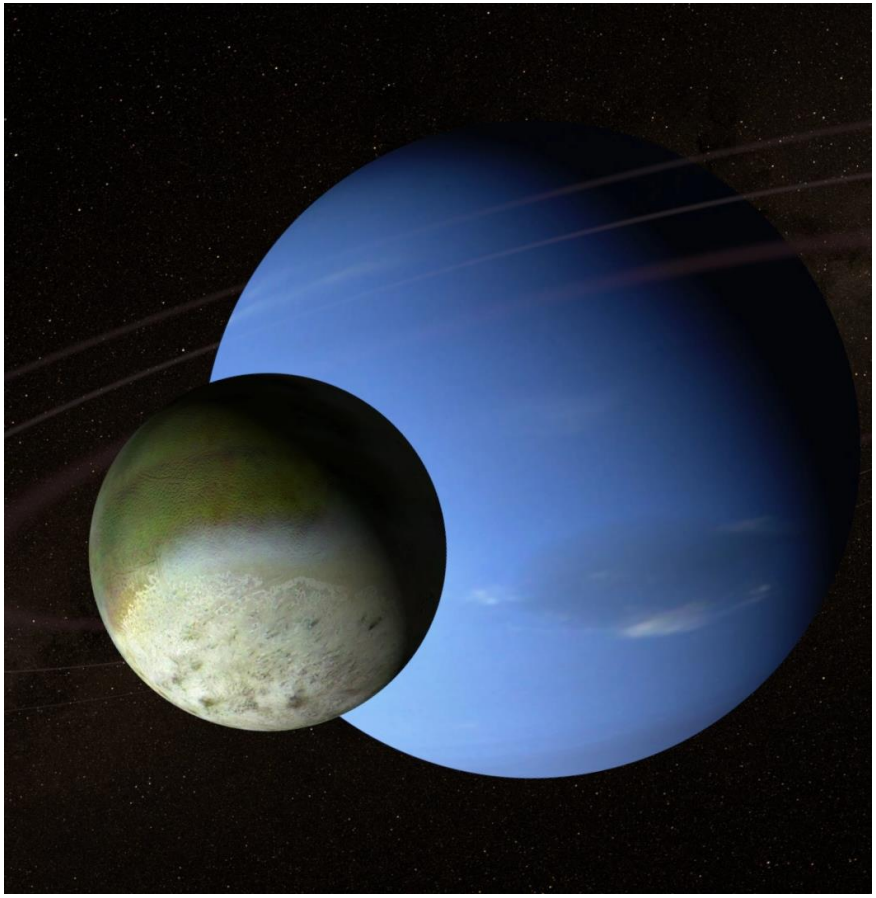
Europa

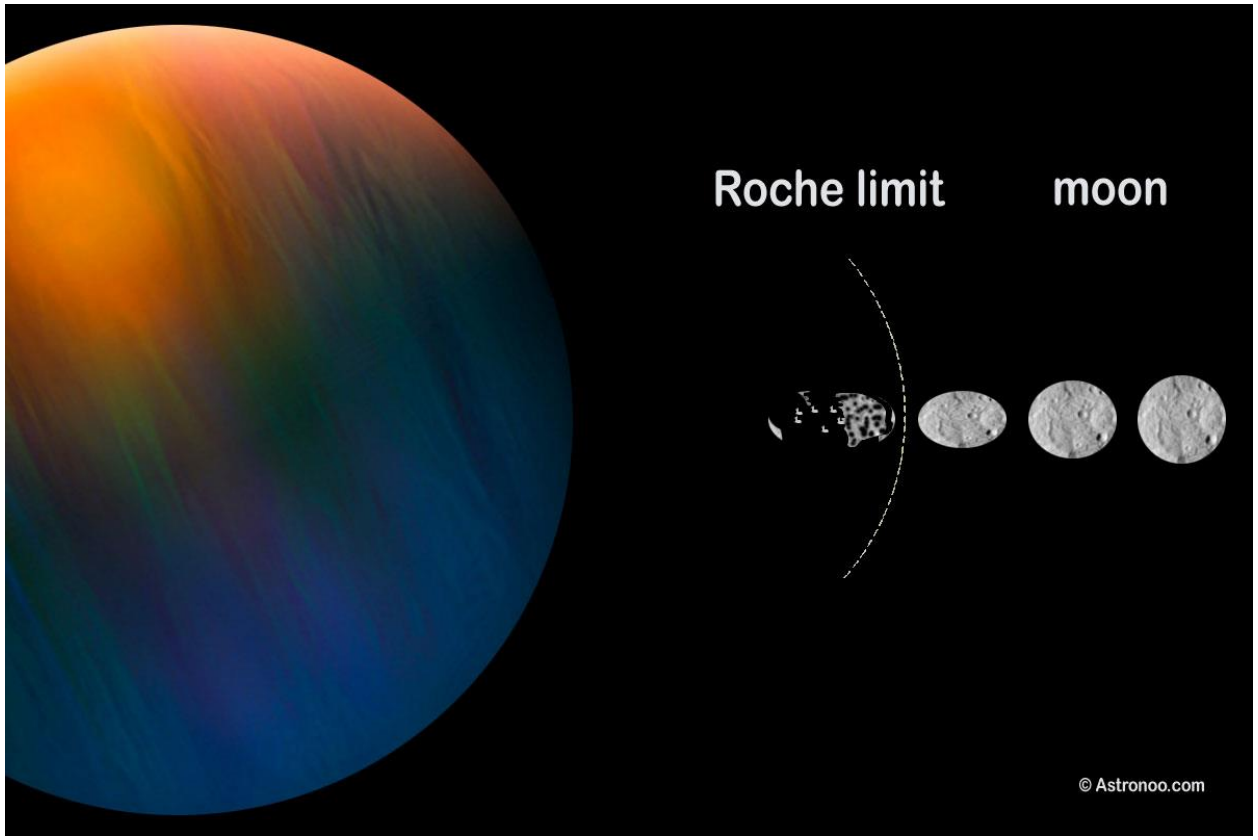


Io

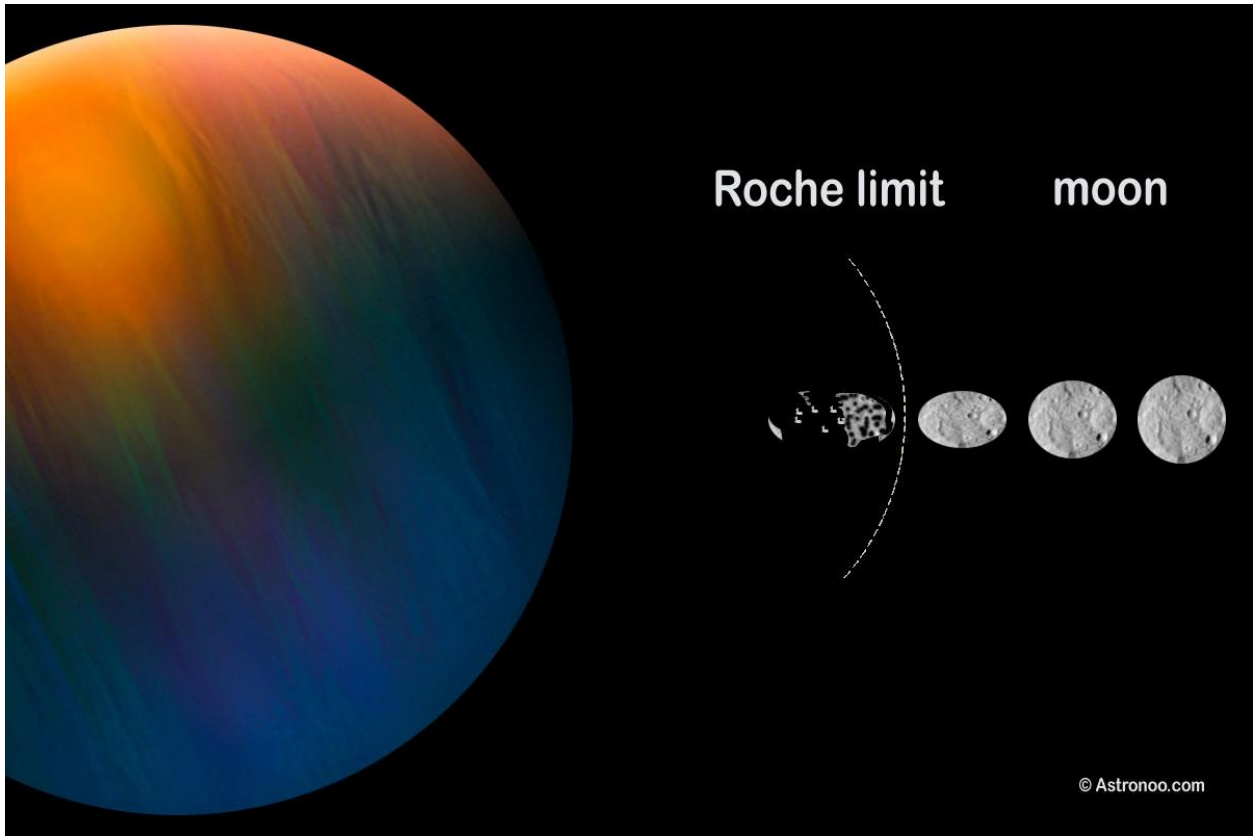
The four largest moons of Jupiter formed at the same time that Jupiter formed. They orbit Jupiter in the plane parallel to Jupiter's equator.

Triton and **Charon** (Neptune and Pluto) are thought to be captured ice dwarf planets from the Kuiper Belt that became gravitationally linked their respective planet and ice dwarf planet.

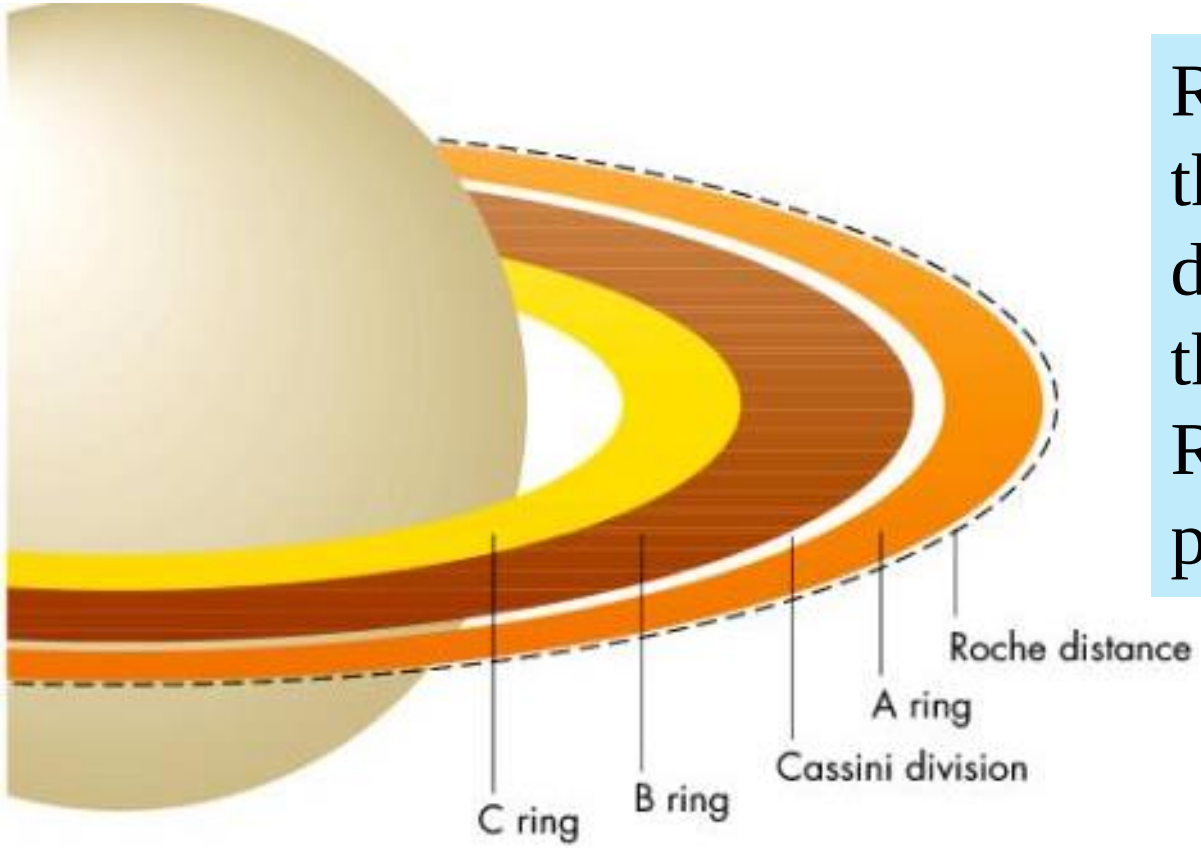




The **Roche limit** is the minimum distance to which a large moon can approach its planet without being torn apart by tidal forces (gravitational stretching). The gravitational pull by the planet on the moon is stronger than the moon's internal gravity. The moon will be pulled apart.



When the moon is farther away from the planet than the Roche limit, the moon's internal gravity is strong enough to keep the moon as a solid cohesive body.



Ring systems are thought to form from disintegrated moons that were inside the Roche limit of the planet.

The ring systems of the Jovian planets lie inside the Roche limit. No moons can form inside the ring disk. Moons can only remain intact beyond the Roche limit.