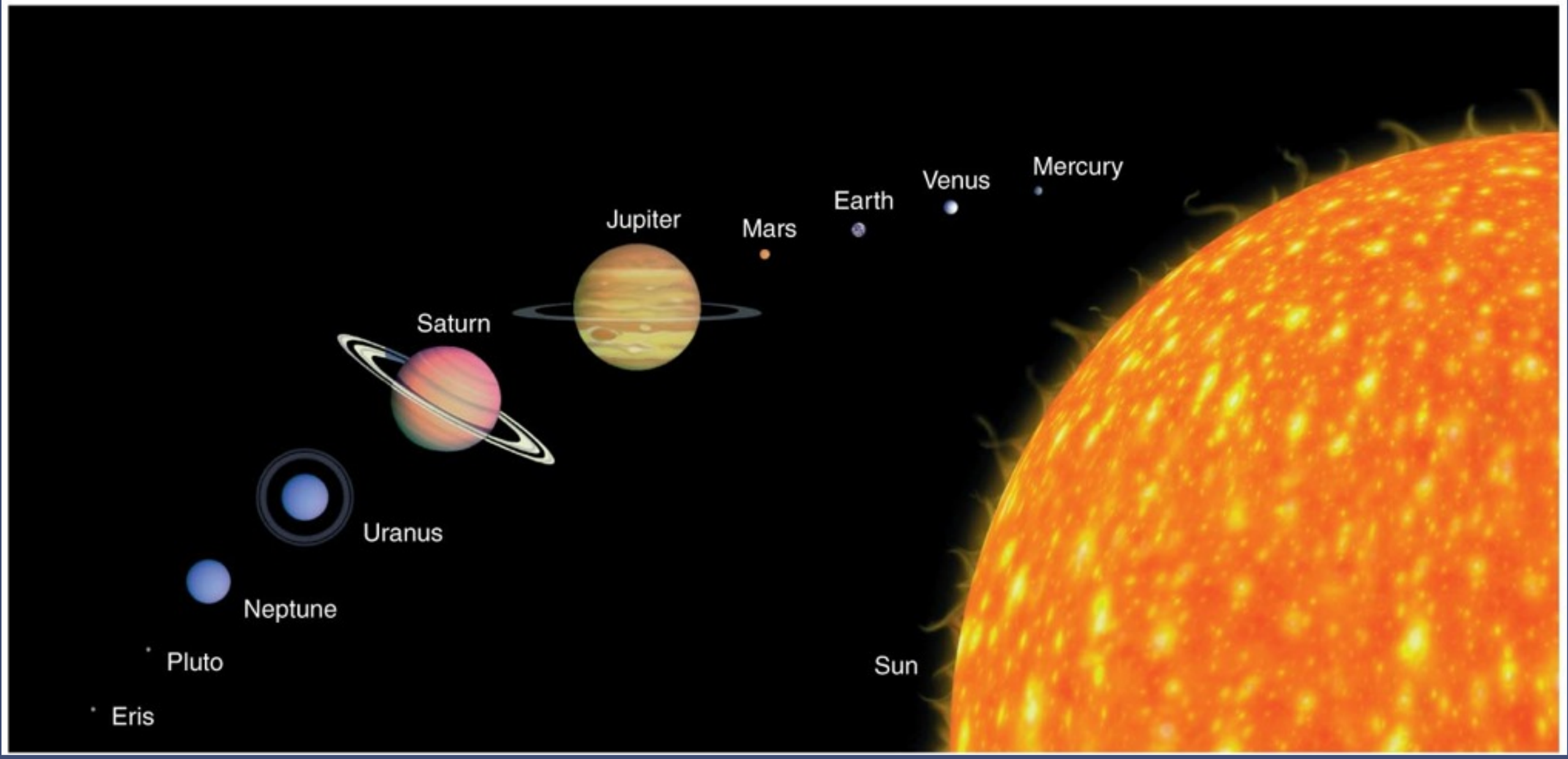
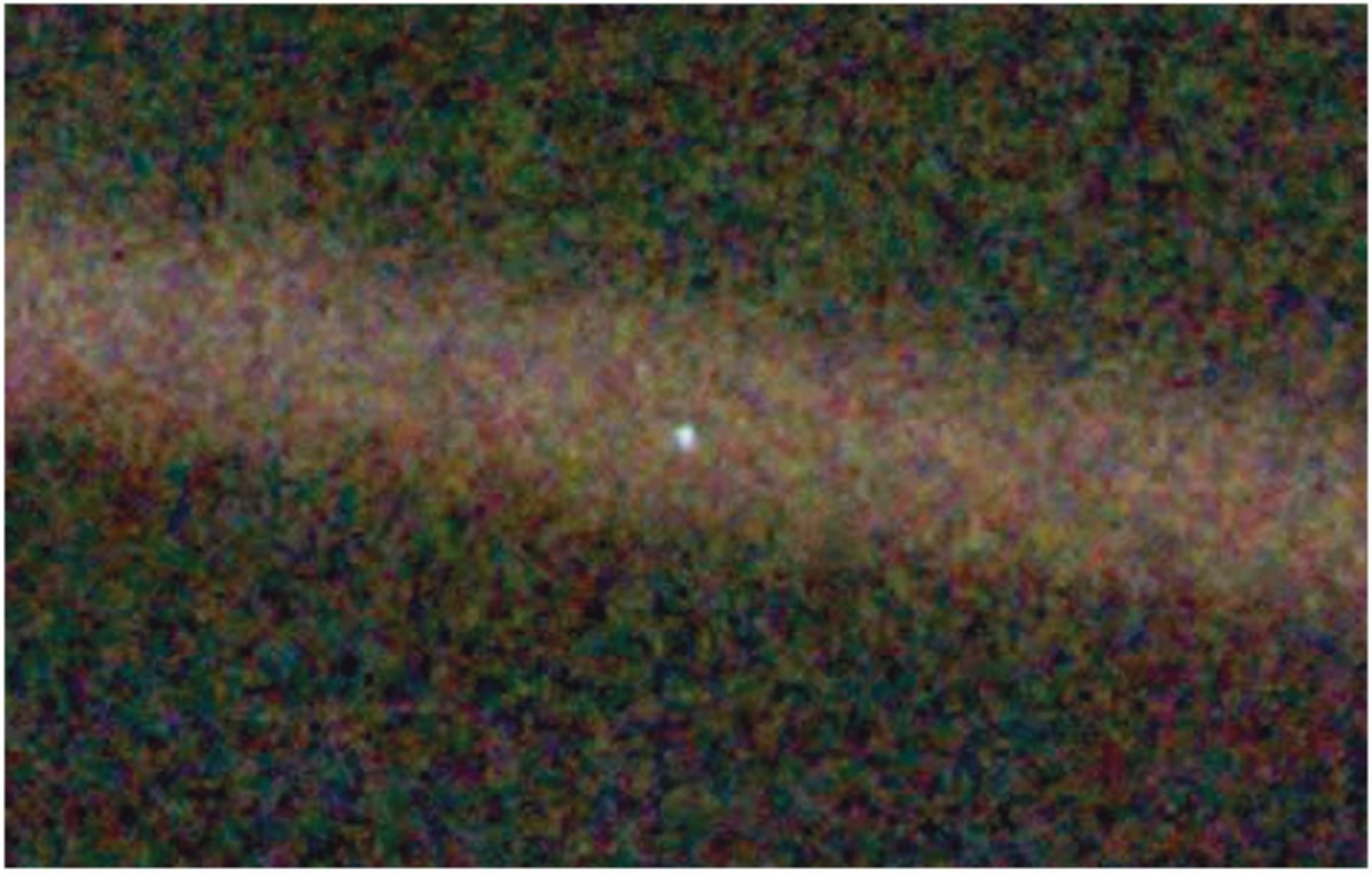
Planets

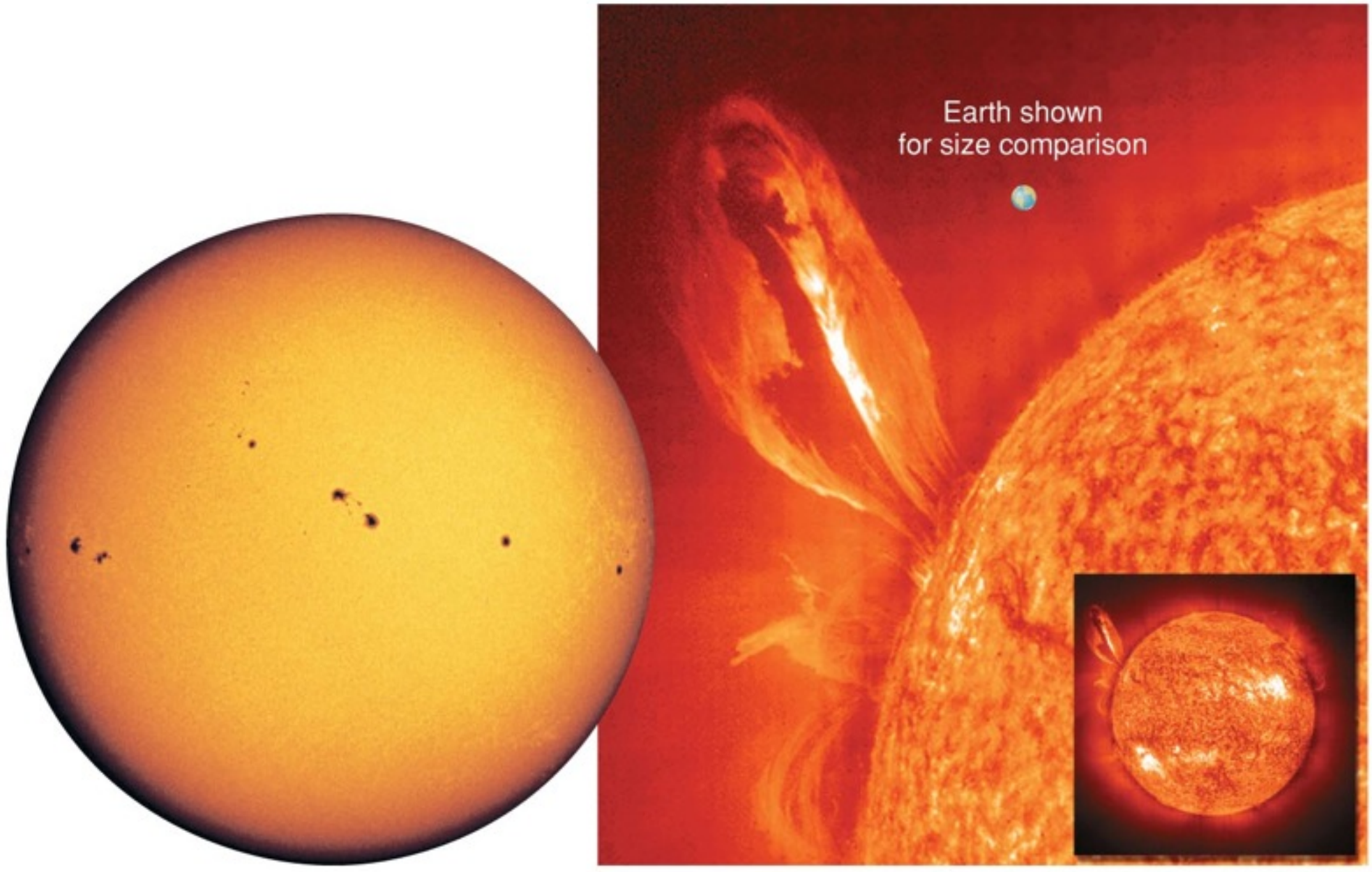

Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune
Pluto
Eris
Sun

Our Planetary System



- Earth, as viewed by the *Voyager* spacecraft

Sun

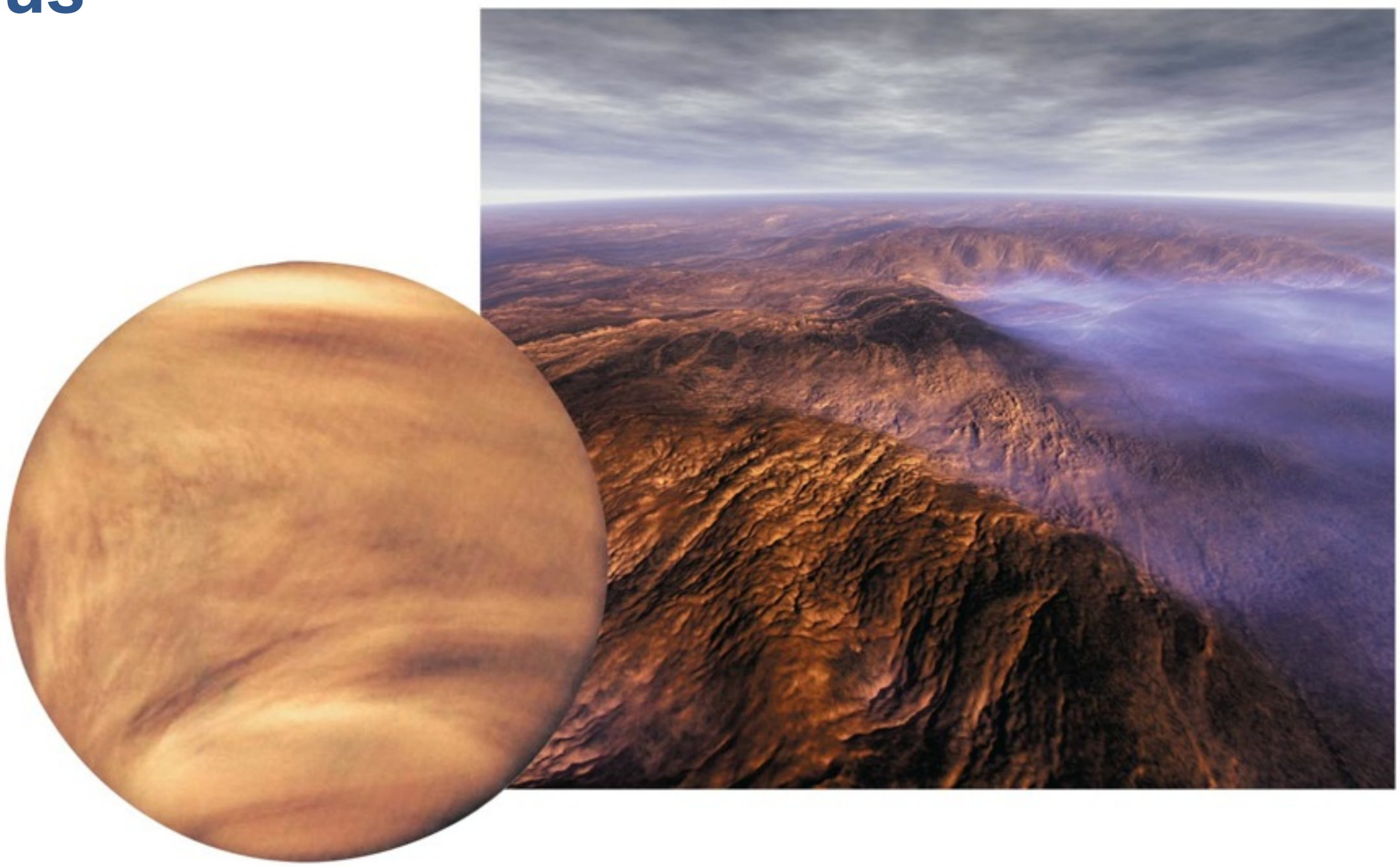


- Over 99.9% of solar system's mass
- Made mostly of H/He gas (plasma)
- Converts 4 million tons of mass into energy each second

Mercury

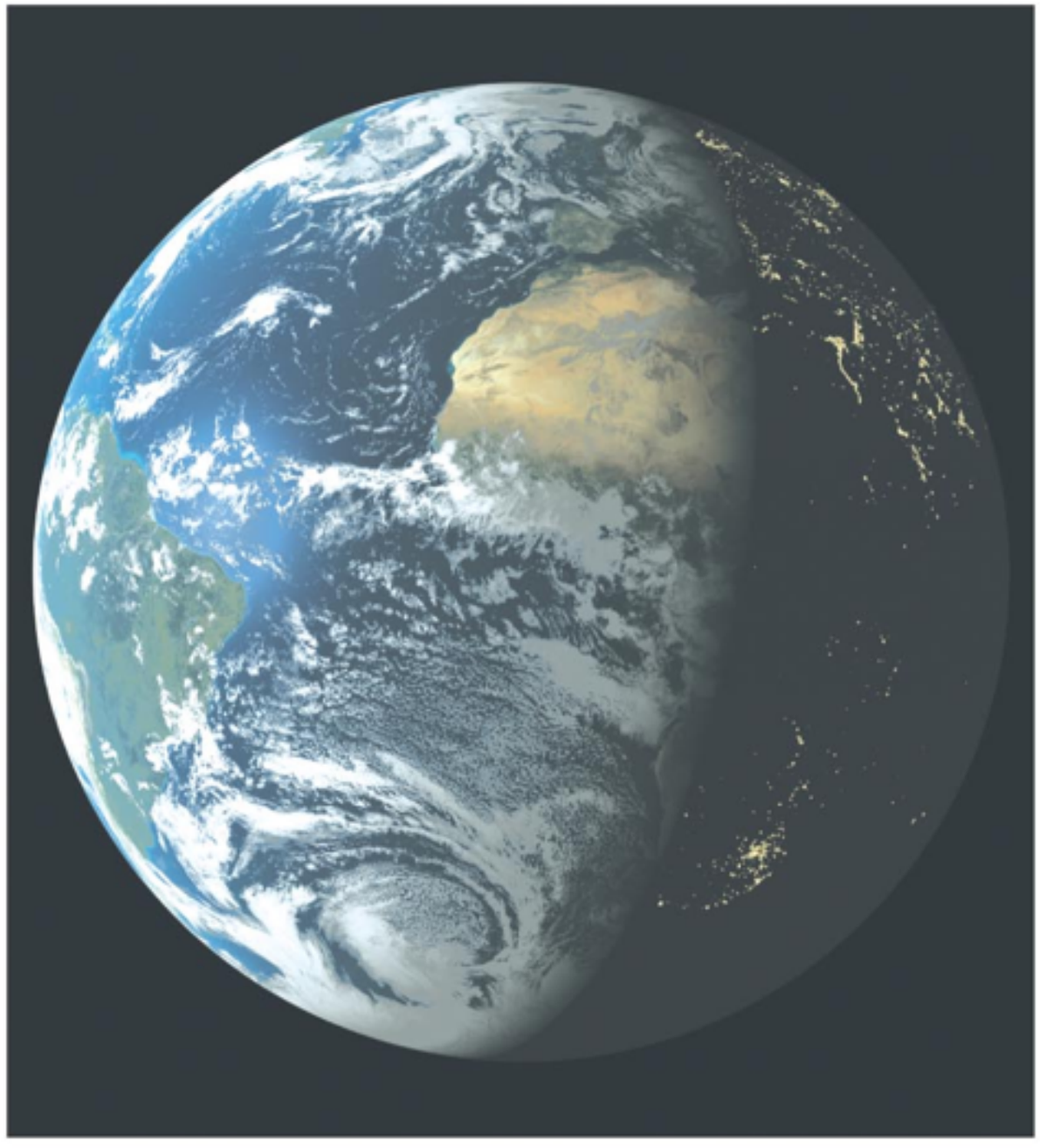
- Made of metal and rock; large iron core
- Desolate, cratered; long, tall, steep cliffs
- Very hot, very cold: 425°C (day), –170°C (night)

Venus



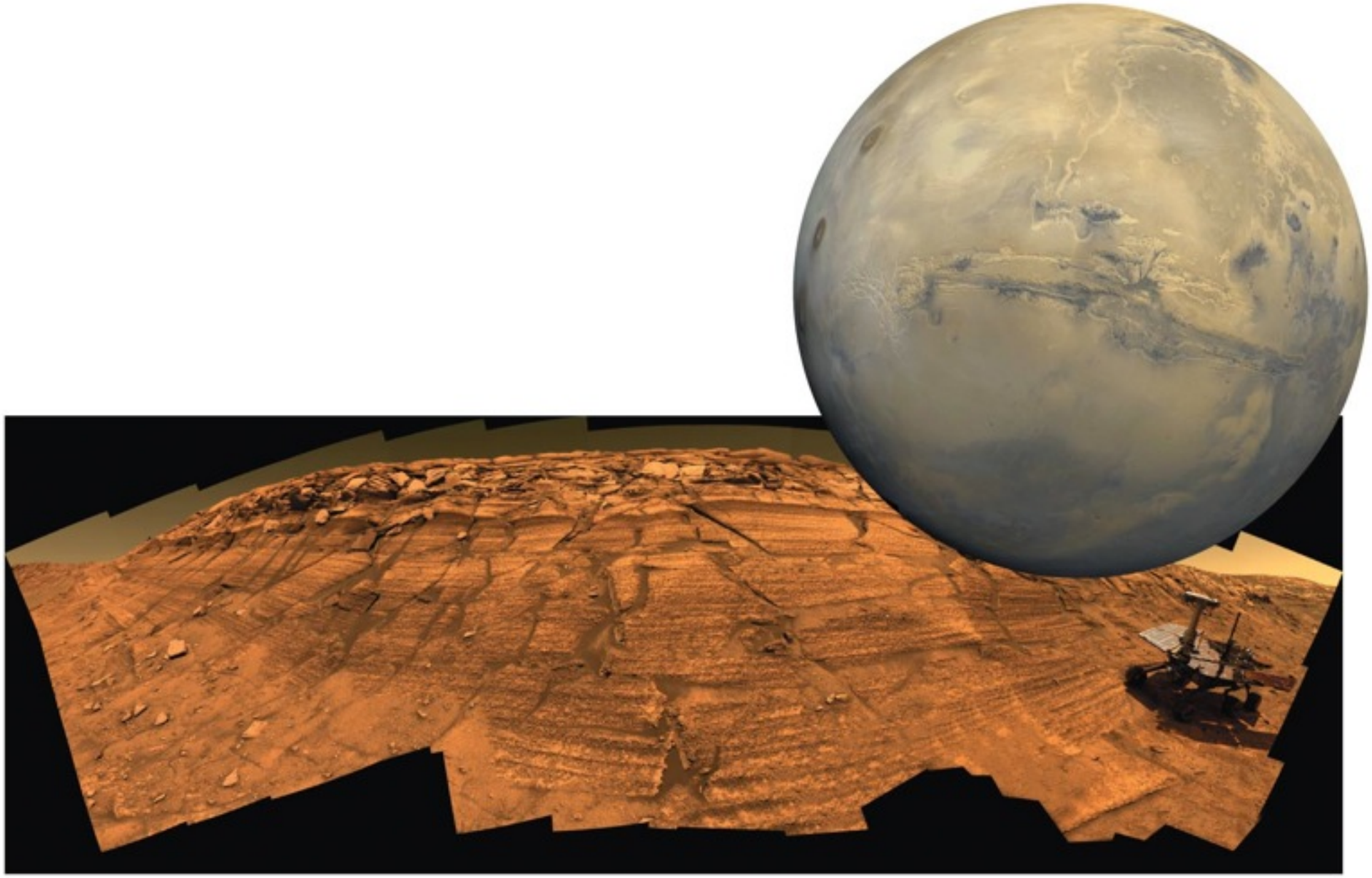
- Nearly identical in size to Earth; surface hidden by clouds
- Hellish conditions due to an extreme **greenhouse effect**
- Even hotter than Mercury: 470°C, day and night

Earth



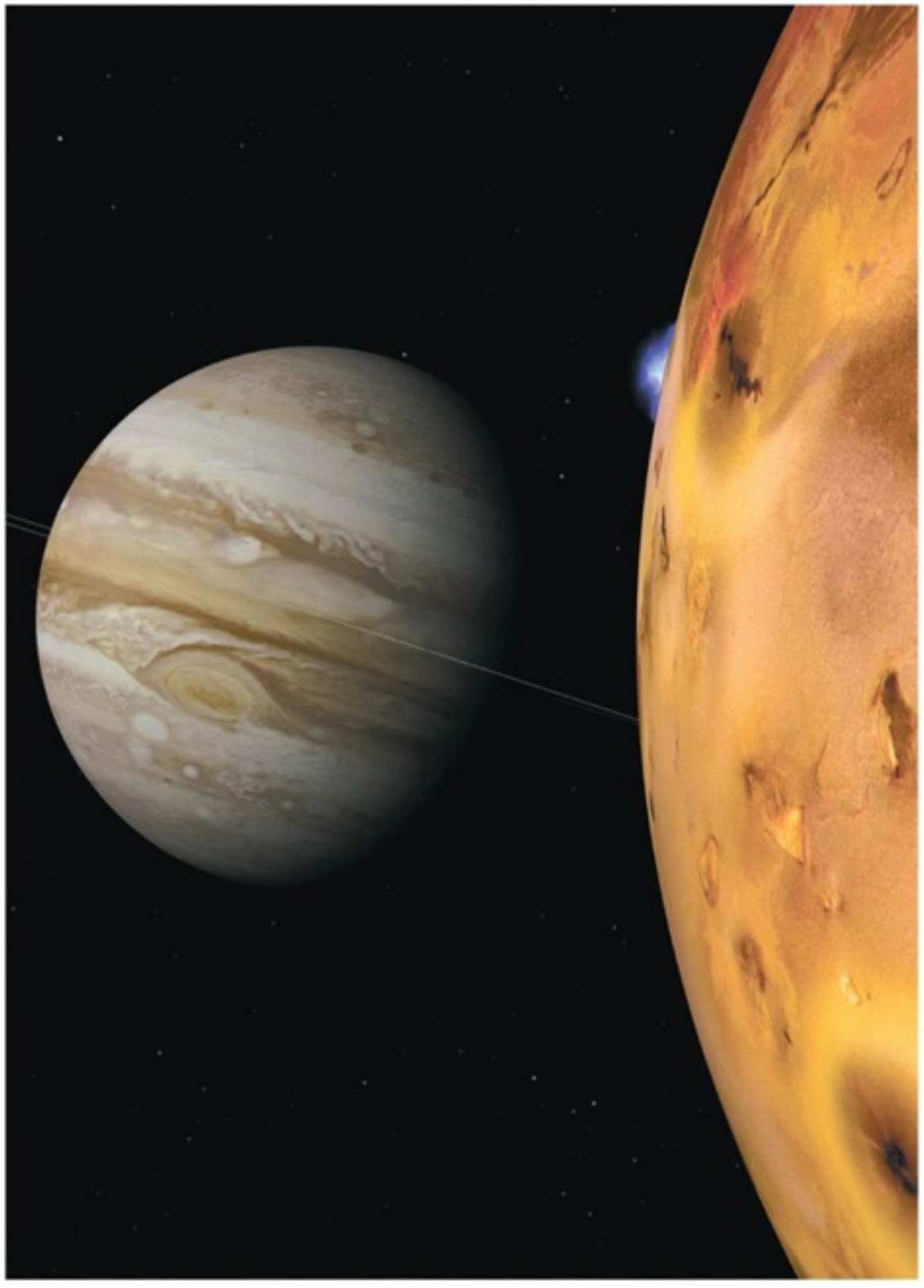
- An oasis of life
- The only surface liquid water in the solar system
- A surprisingly large moon

Mars



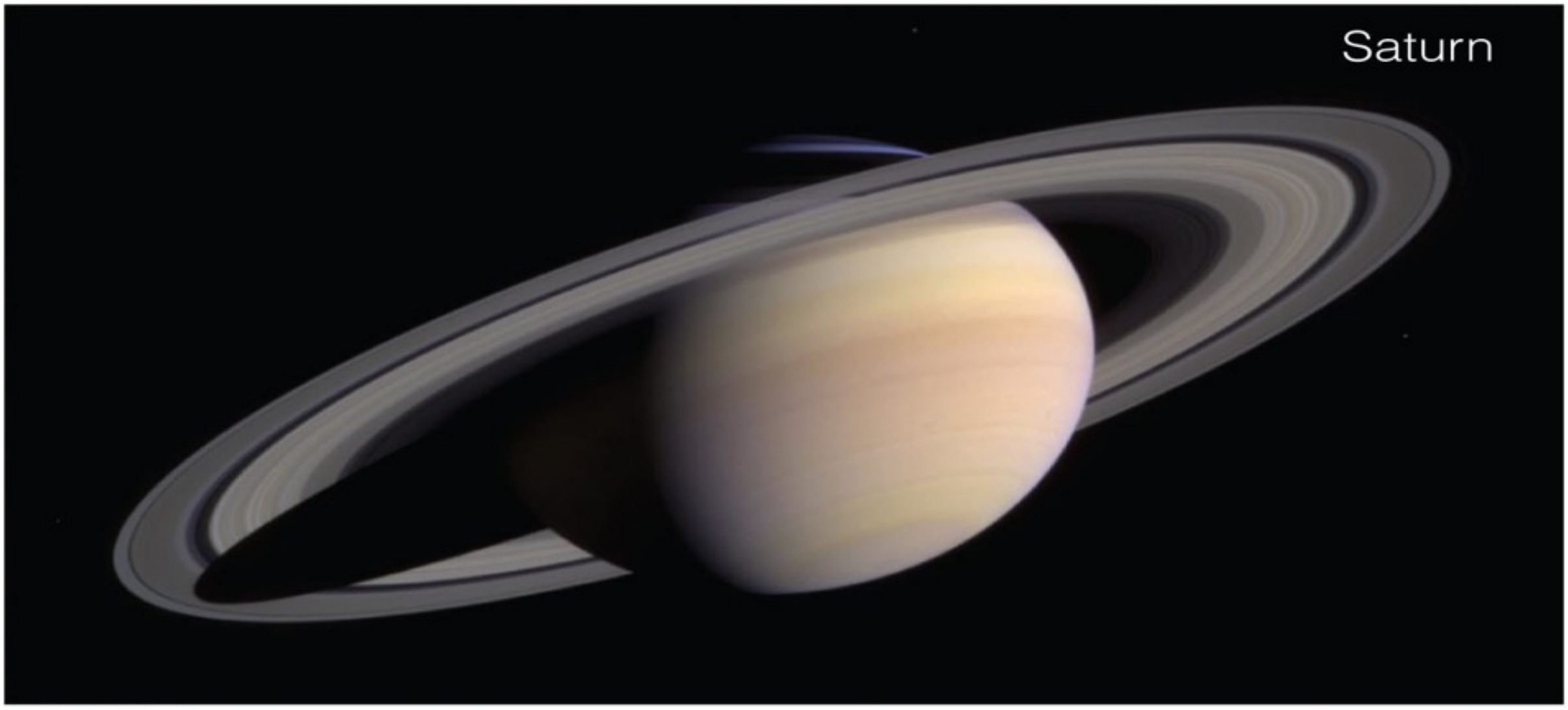
- Giant volcanoes, a huge canyon, polar caps, more
- Water flowed in distant past; could there have been life?

Jupiter



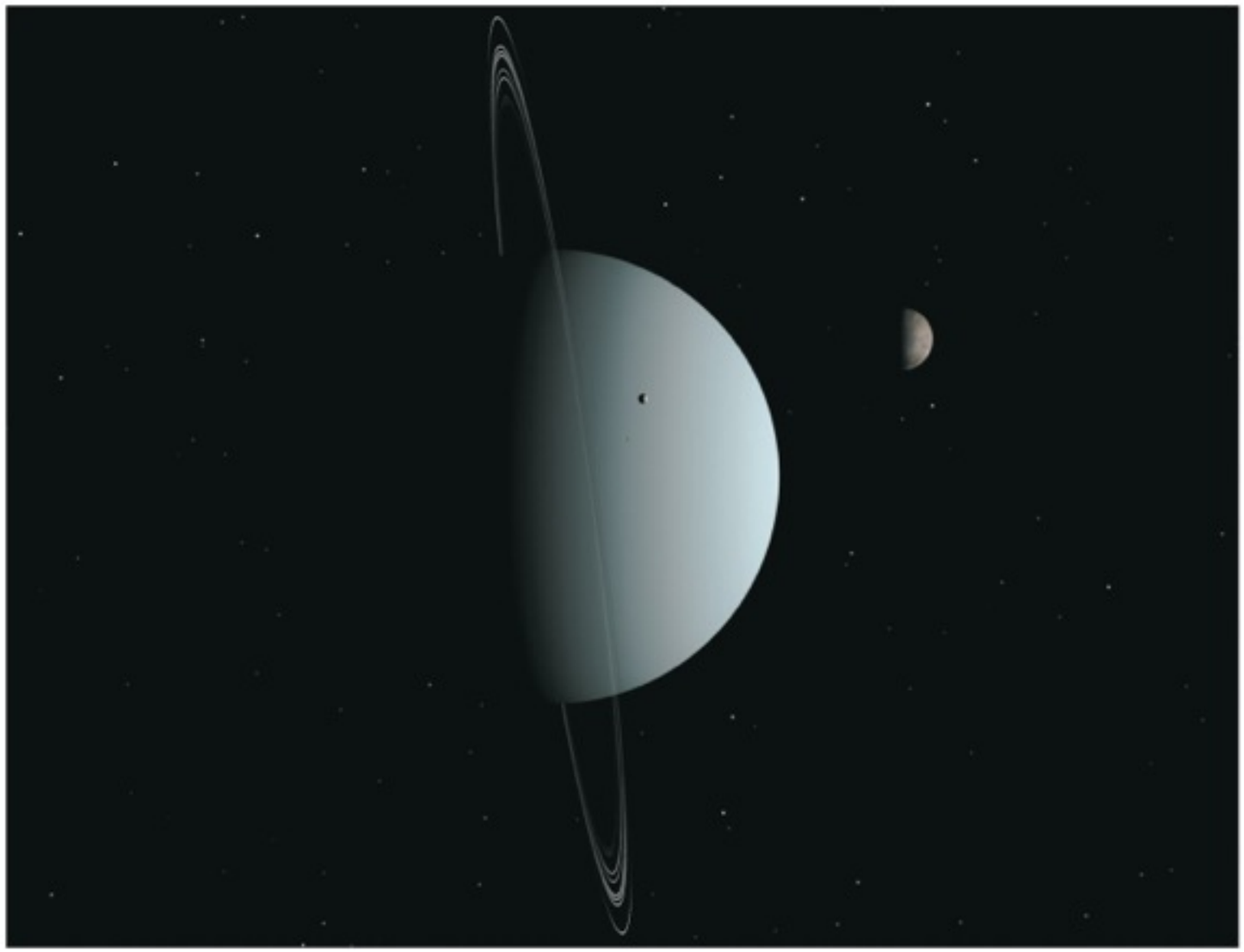
- Much farther from Sun than inner planets
- Mostly H/He; no solid surface
- 300 times more massive than Earth
- Many moons, rings

Saturn



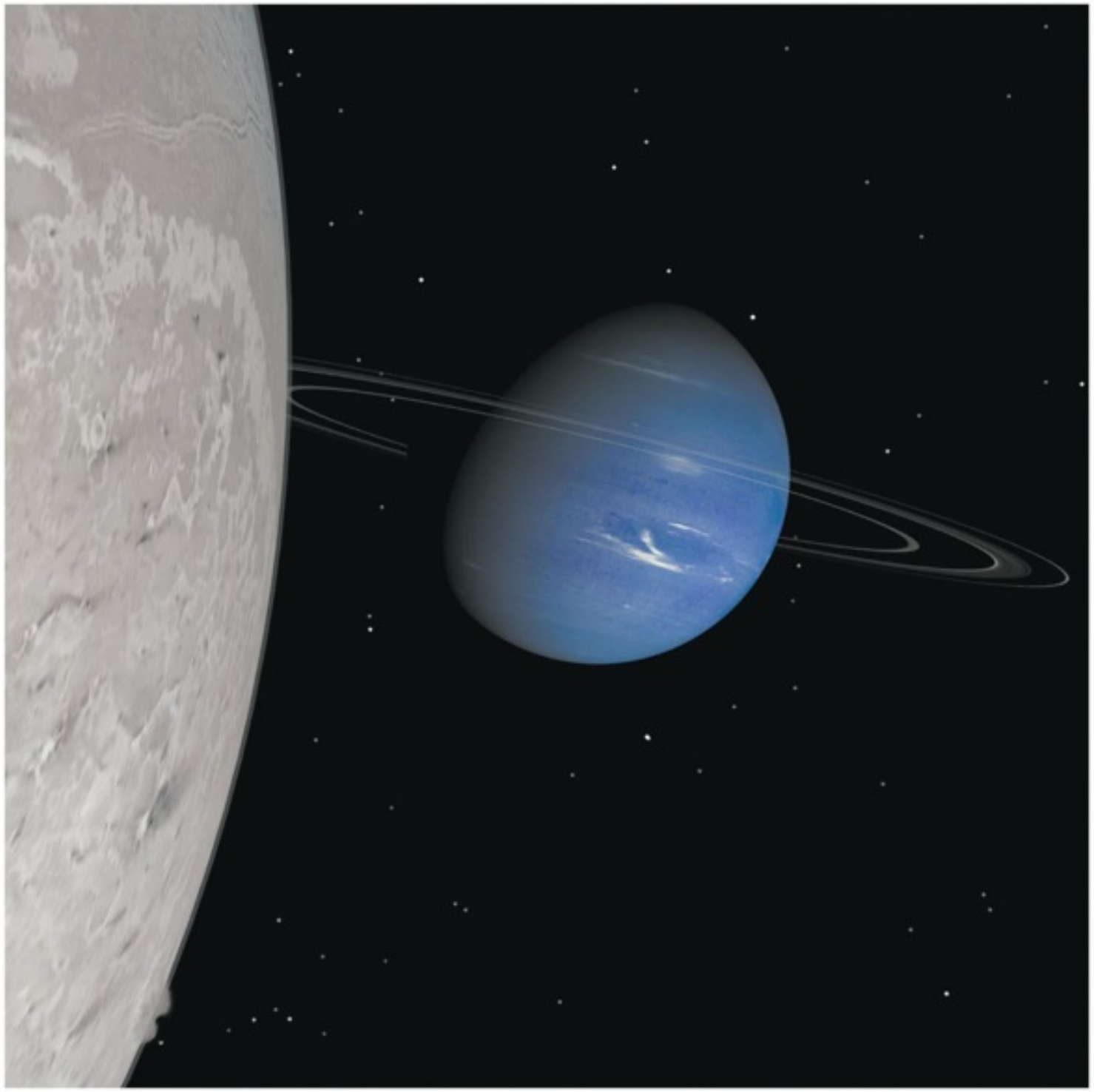
- Giant and gaseous like Jupiter
- Spectacular rings
- Many moons, including cloudy Titan

Uranus



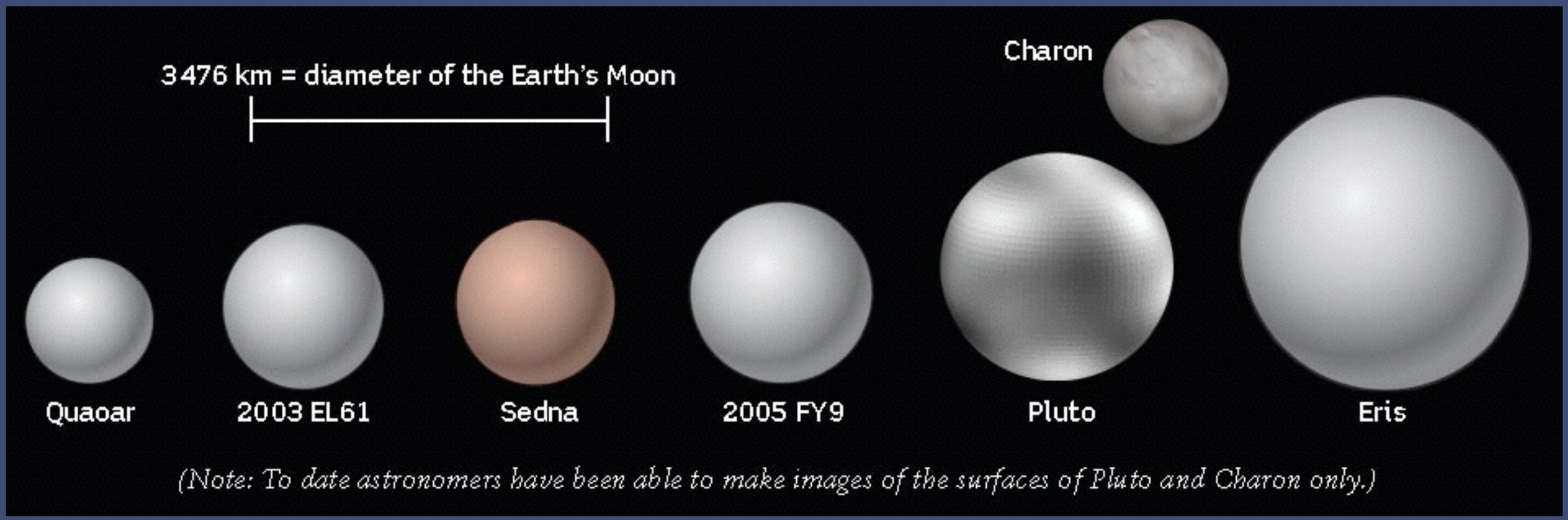
- Smaller than Jupiter/Saturn; much larger than Earth
- Made of H/He gas and **hydrogen compounds** (H_2O, NH_3, CH_4)
- Extreme axis tilt
- Moons and rings

Neptune

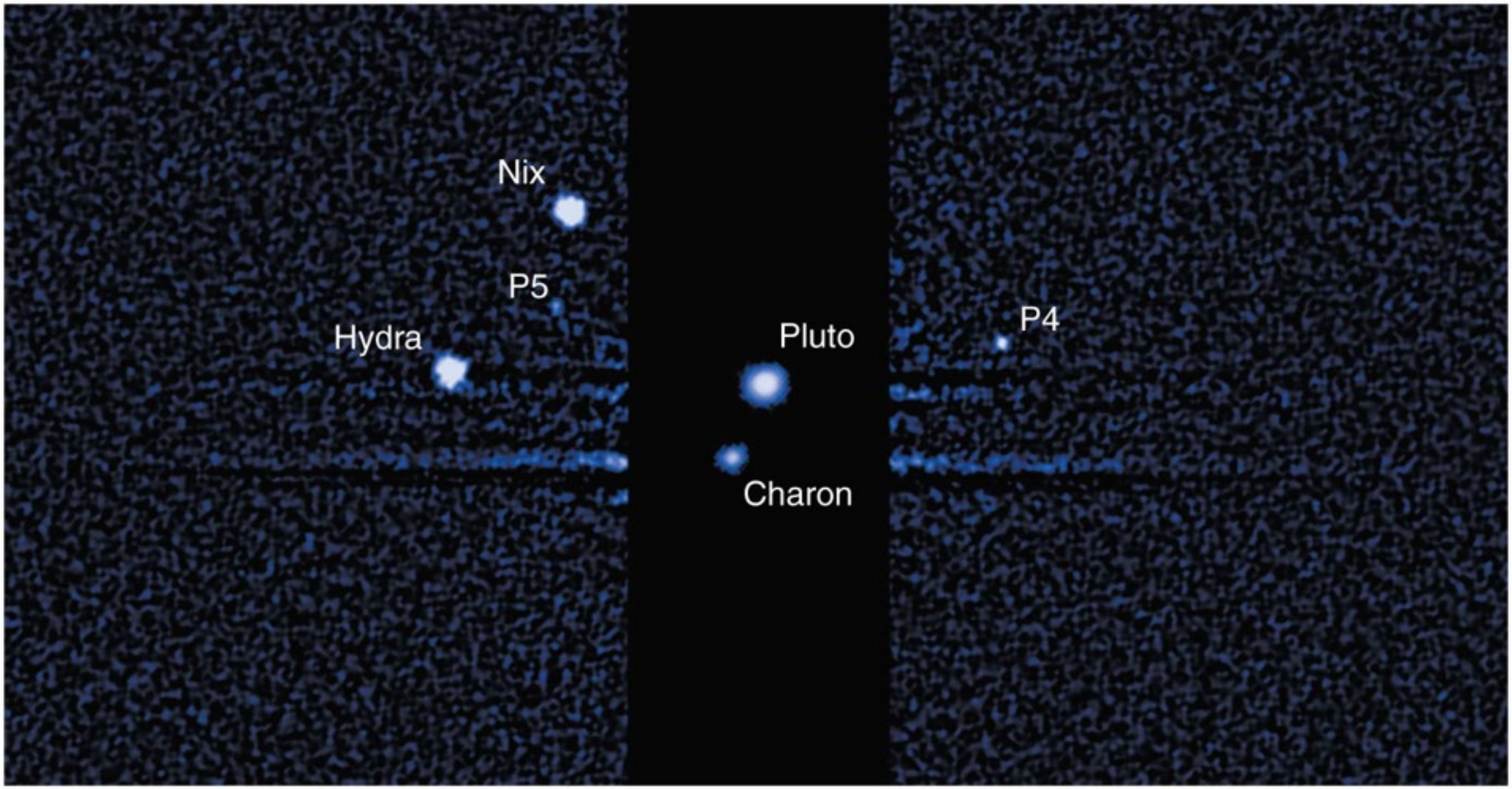


- Similar to Uranus (except for axis tilt)
- Many moons (including Triton)

Dwarf Planets



Dwarf Planets: Pluto, Eris, and more



- Much smaller than major planets
- Icy, comet-like composition
- Pluto's main moon (Charon) is of similar size

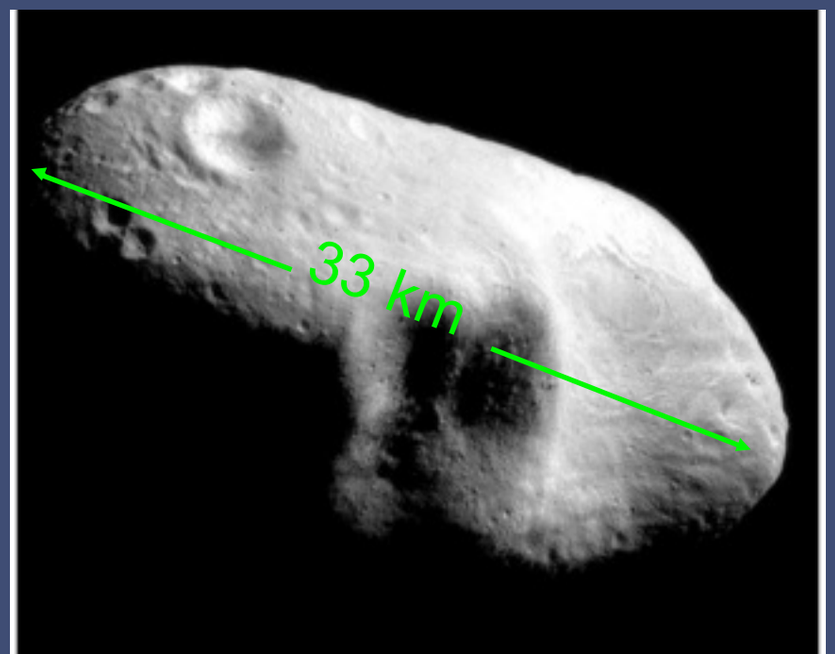
Moons

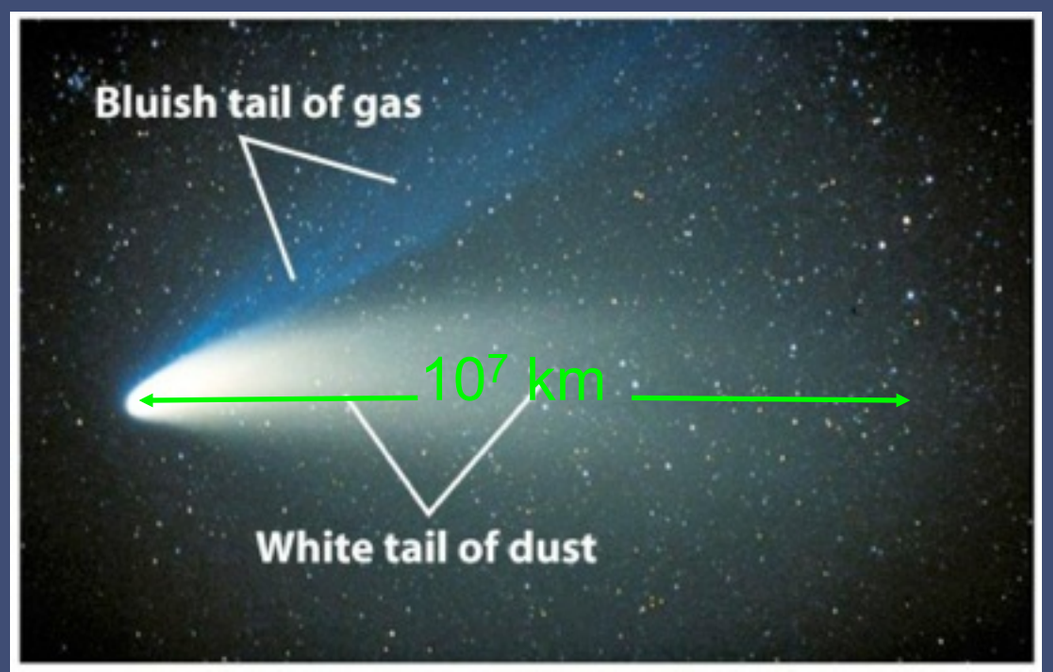
- Orbit planets
- Ganymede & Titan are larger than Mercury
- All 7 of these moons are larger than Pluto

Moon	Io	Europa	Ganymede	Callisto	Titan	Triton
Parent planet	Earth	Jupiter	Jupiter	Jupiter	Jupiter	Saturn	Neptune
Diameter (km)	3476	3642	3130	5268	4806	5150	2706
Mass (kg)	7.35×10^{22}	8.93×10^{22}	4.80×10^{22}	1.48×10^{23}	1.08×10^{23}	1.34×10^{23}	2.15×10^{22}
Average density (kg/m^3)	3340	3530	2970	1940	1850	1880	2050
Substantial atmosphere?	No	No	No	No	No	Yes	No

Solar System Debris

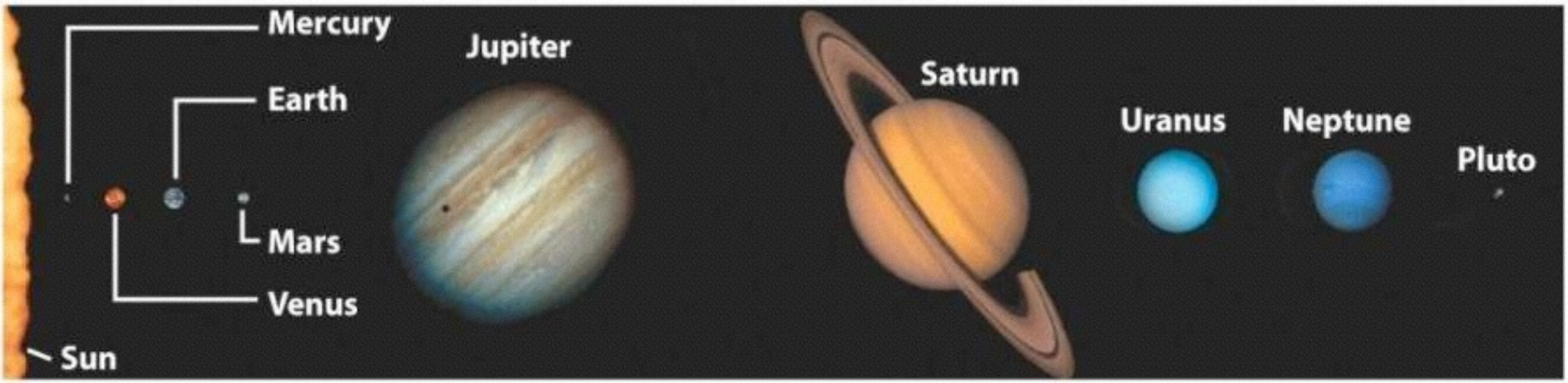
- Asteroids
  - Small, rocky objects
  - Most orbit the Sun in the asteroid belt between Mars & Jupiter
- Comets
  - Usually made of dust & ice
  - Something like a dirty, frozen slushball in space
  - Generally found in outer parts of Solar System (beyond Neptune)



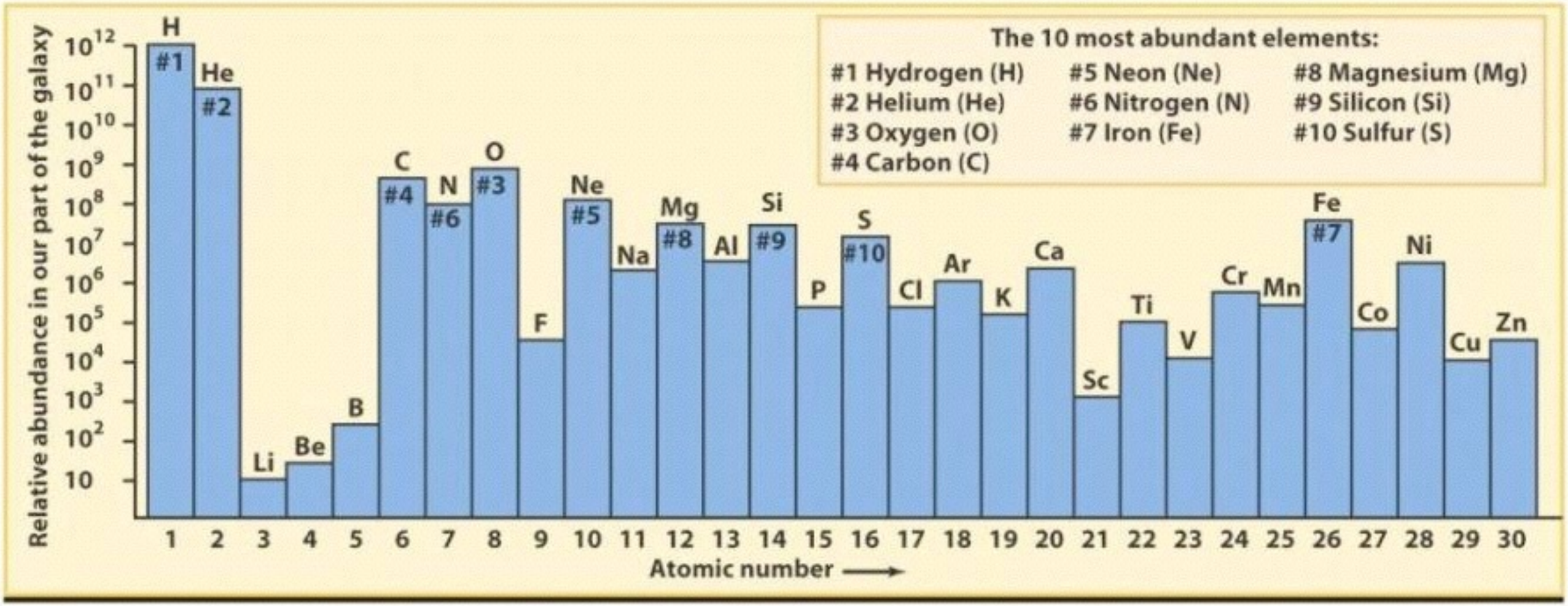


Planets

Terrestrial ⟷ Jovian



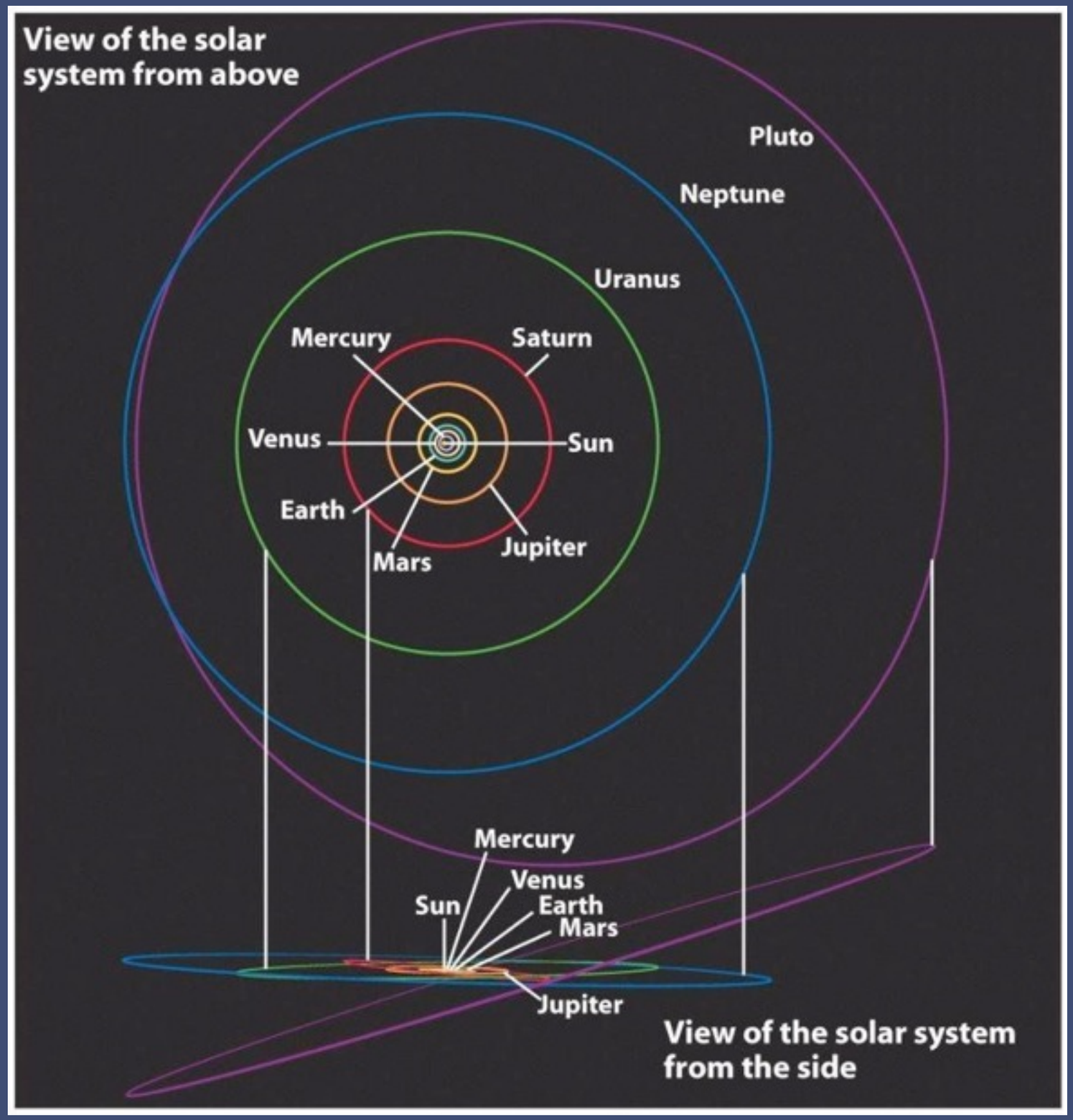
Chemistry of the Solar Neighborhood



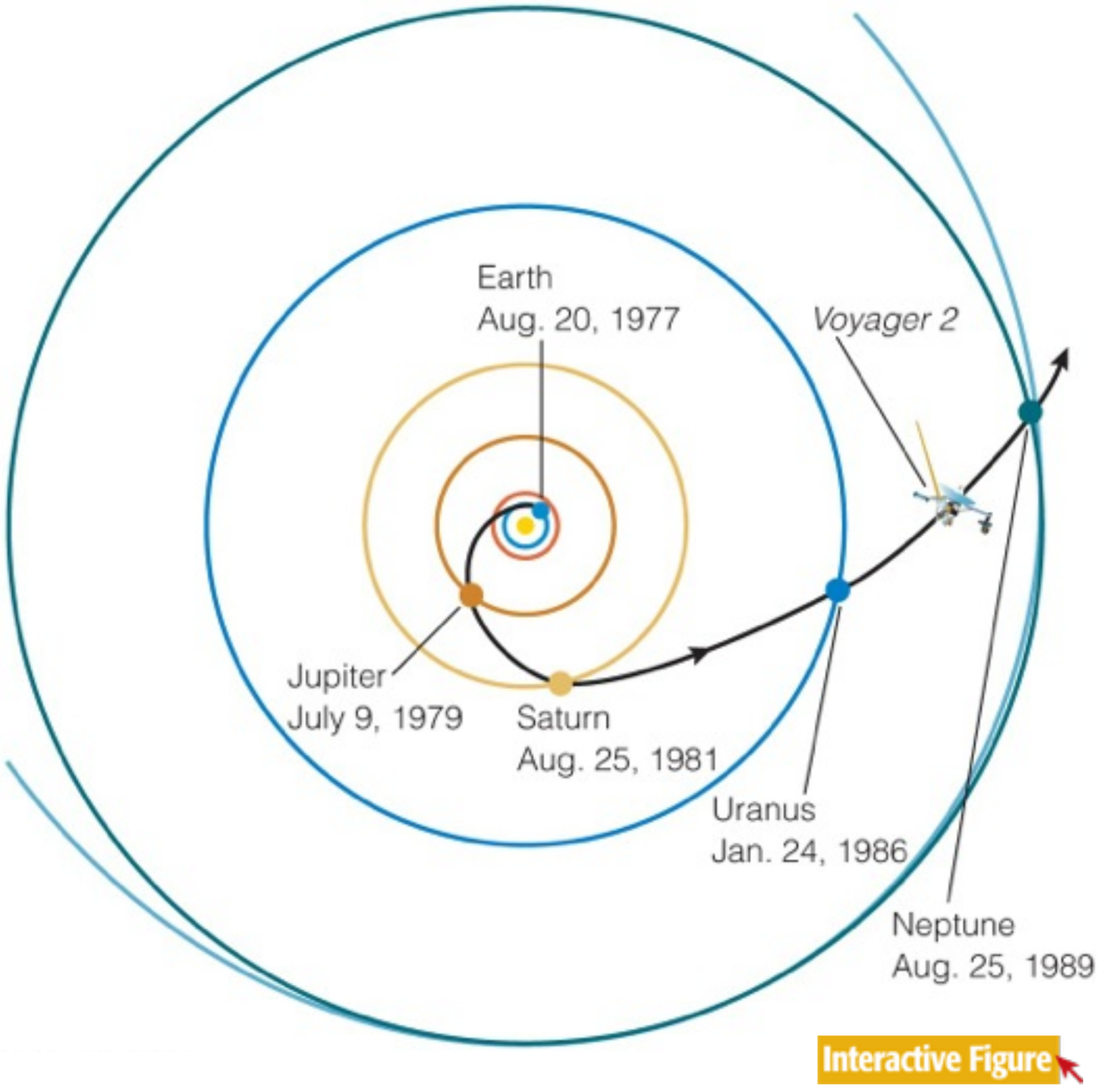
- Big Bang only produced H, He, Li, Be
- Everything else has been produced in the life cycle of stars
  - –we're all star dust!

Key Observations

- Planets all orbit the Sun in the same direction
- Planets all orbit close to the ecliptic plane (except Pluto)
- Sun spins in same direction as the planets orbit



Flybys

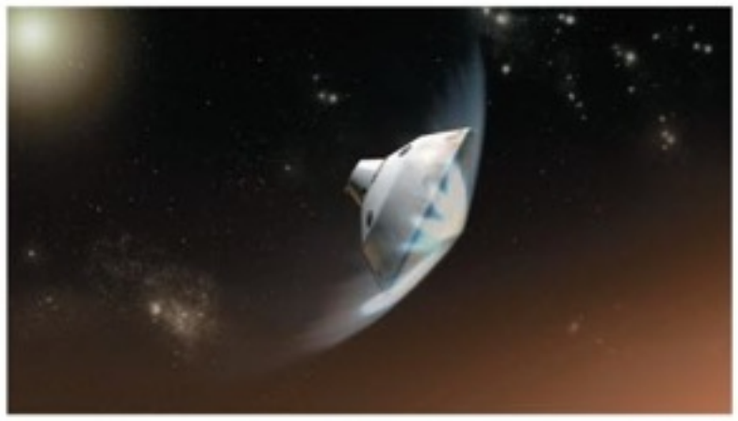


- A flyby mission flies by a planet just once.
- Cheaper than other mission but less time to gather data

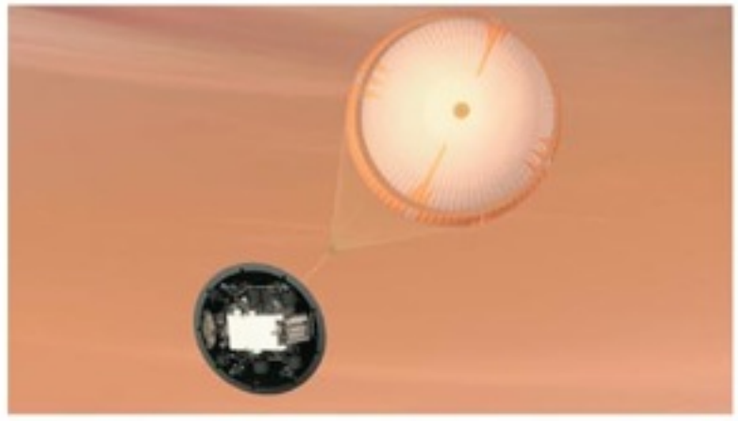
Orbiters

- Go into orbit around another world
- More time to gather data but cannot obtain detailed information about world's surface

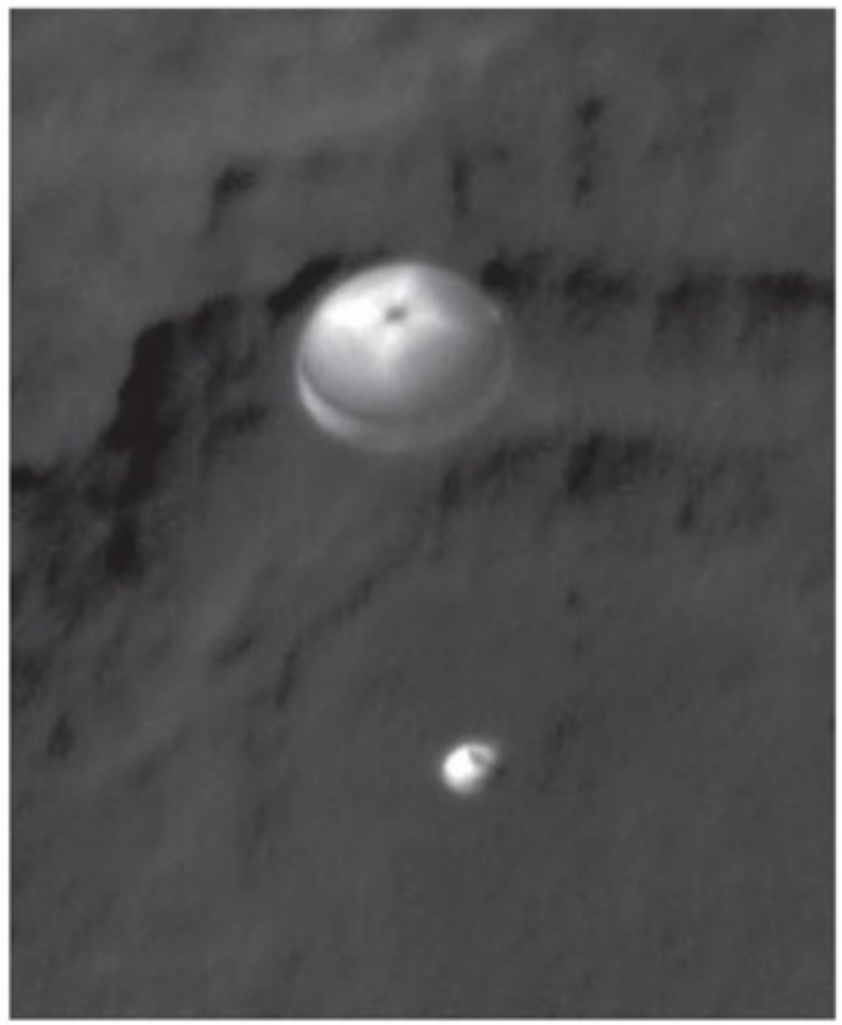
Probes or Landers



1 Friction slows spacecraft as it enters Mars atmosphere.



2 Parachute slows spacecraft to about 350 km/hr.



As it flew overhead, the *Mars Reconnaissance Orbiter* took this photo of the spacecraft with its parachute deployed.

3 Rockets slow spacecraft to halt; "sky crane" tether lowers rover to surface.

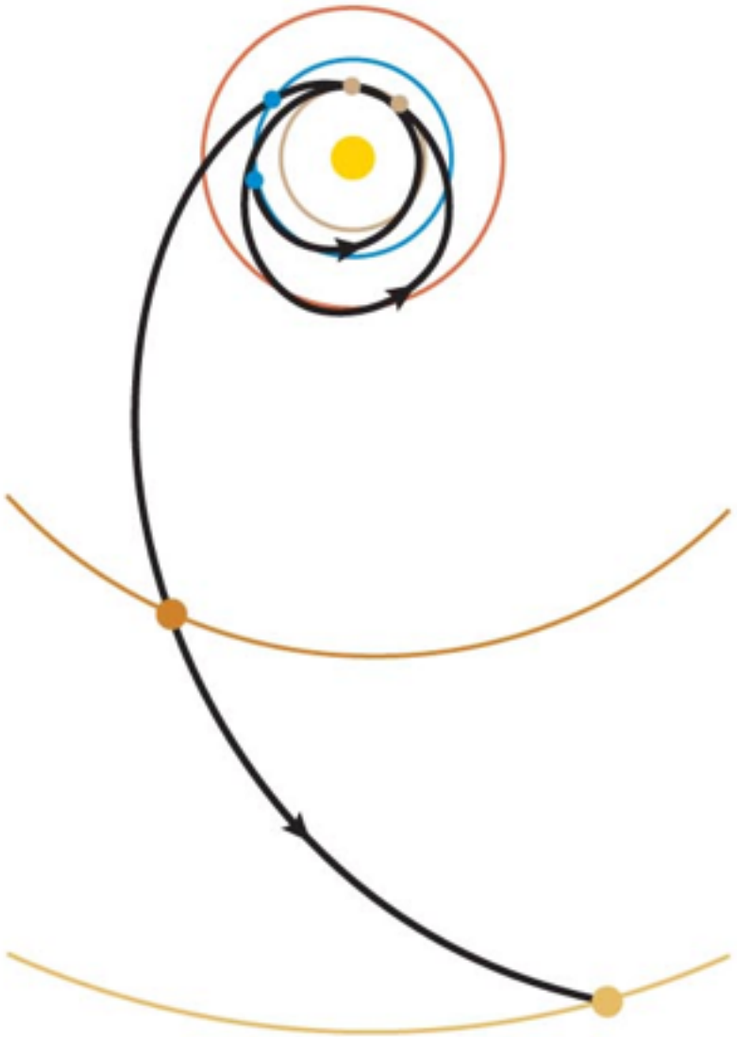
4 Tether released, the rocket heads off to crash a safe distance away.

- Land on surface of another world
- Explore surface in detail

Sample Return Missions

- Land on surface of another world
- Gather samples
- Spacecraft designed to blast off other world and return to Earth
- *Apollo* missions to Moon are one example, *Hyabusa* to an asteroid is another.

Combination Spacecraft



- *Cassini/Huygens* mission contains both an orbiter (*Cassini*) and a lander (*Huygens*).