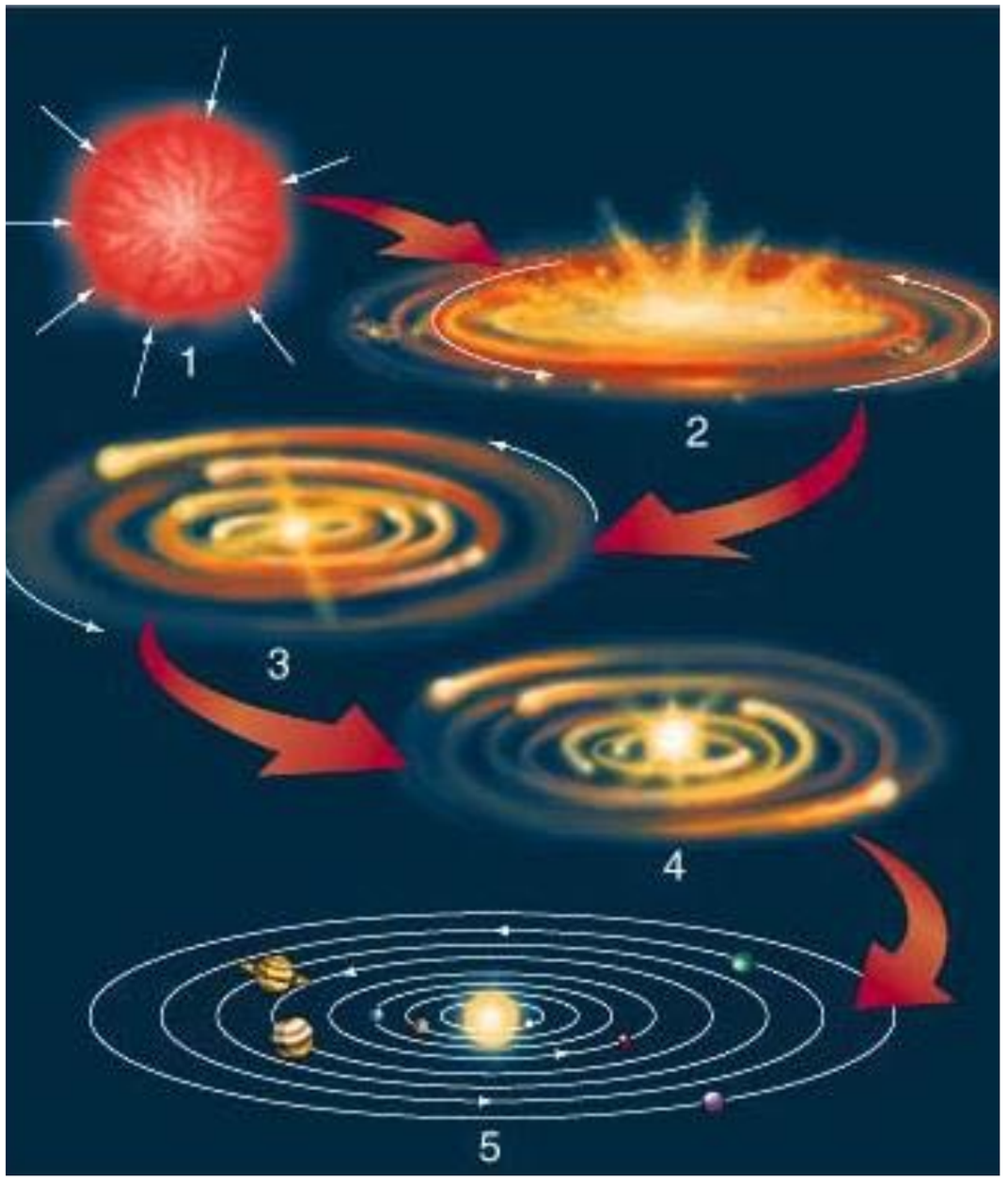
Today

- Solar System
  - contents
  - formation

- Homework due

- Office of Education Abroad



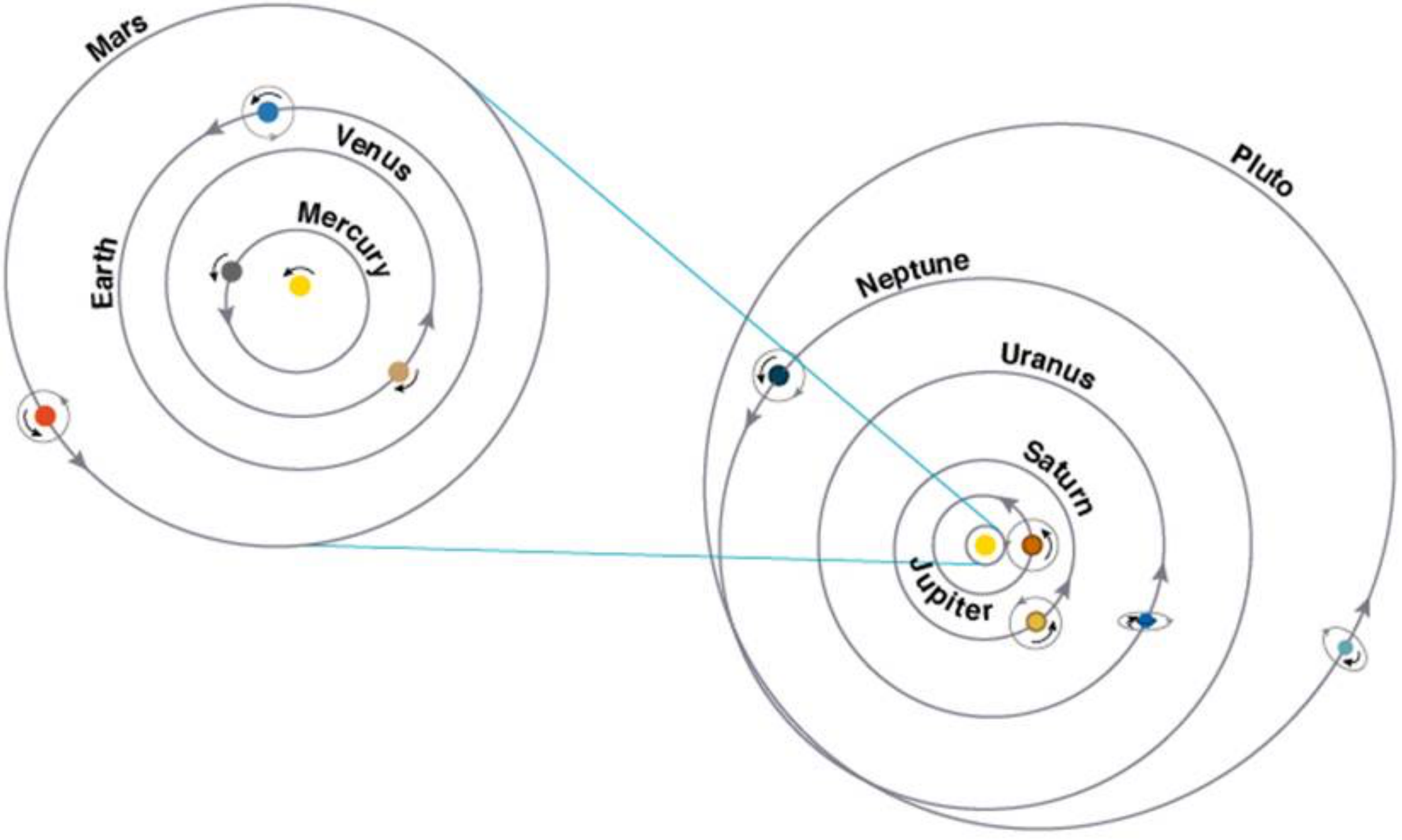
Contents of the Solar System

- The Sun
- Major Planets
  - Terrestrial: Mercury, Venus, Earth, Mars
  - Jovian planets: Jupiter, Saturn
  - Ice Giants: Uranus, Neptune

  } Gas Giants
- Moons
- Dwarf Planets
  - KBOs/TNOs: Pluto, Quaoar, Eris, Sedna...
- Asteroids

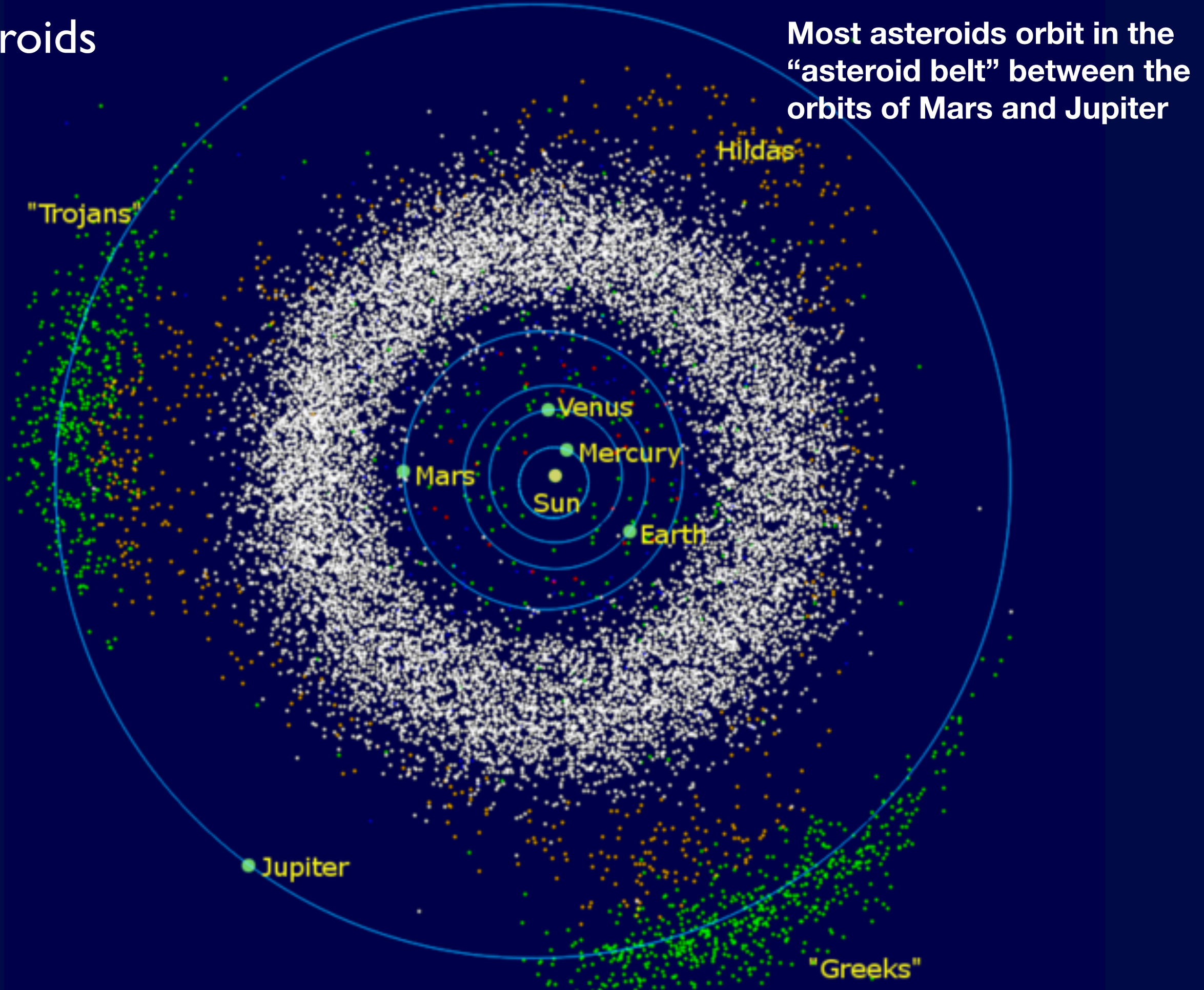
  KBO: Kuiper Belt Object
  TNO: Trans-Neptunian Object
  } same thing
- Comets
  - misc. dust, meteoroids, solar wind particles...

Layout of the Solar System

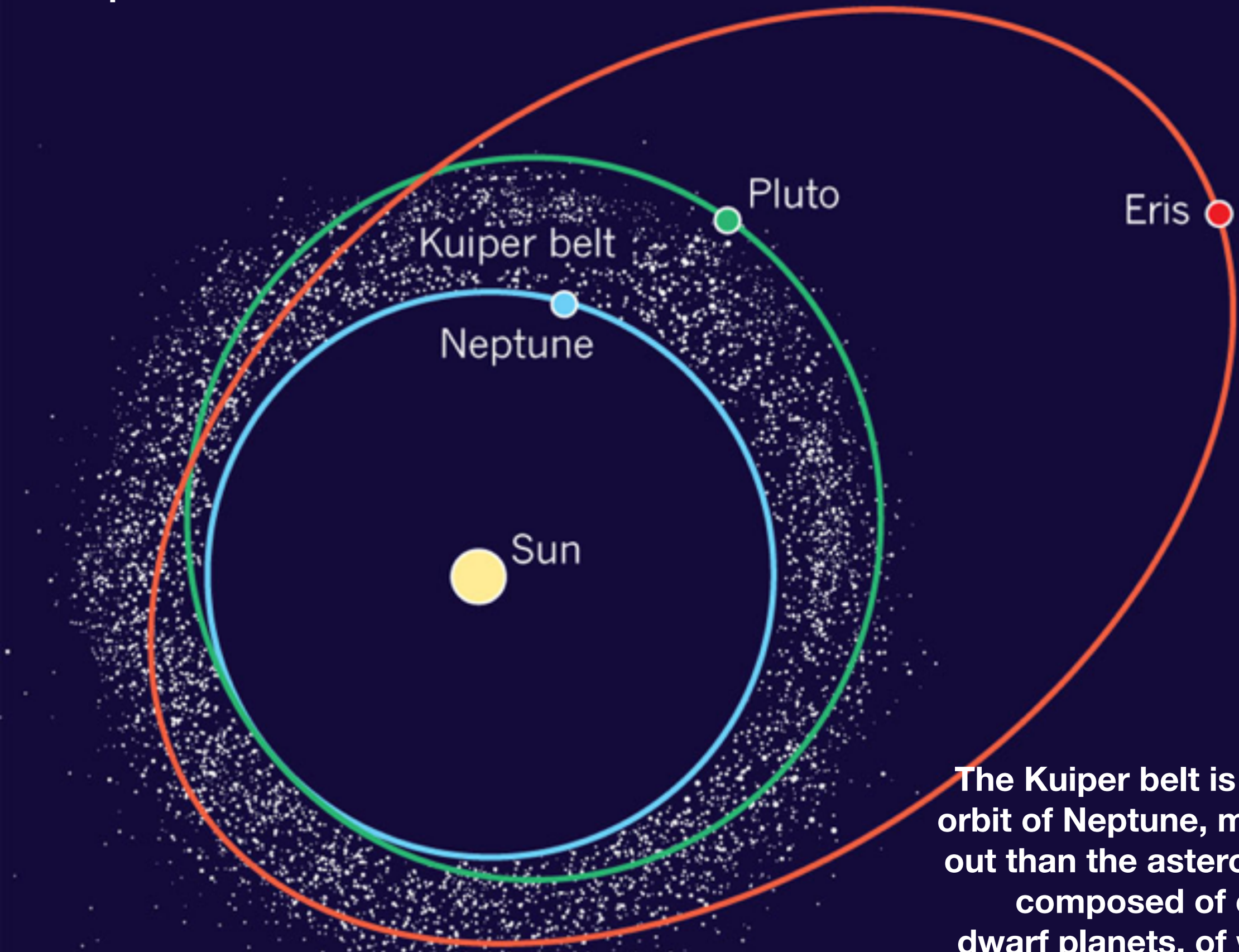


Asteroids

Most asteroids orbit in the "asteroid belt" between the orbits of Mars and Jupiter

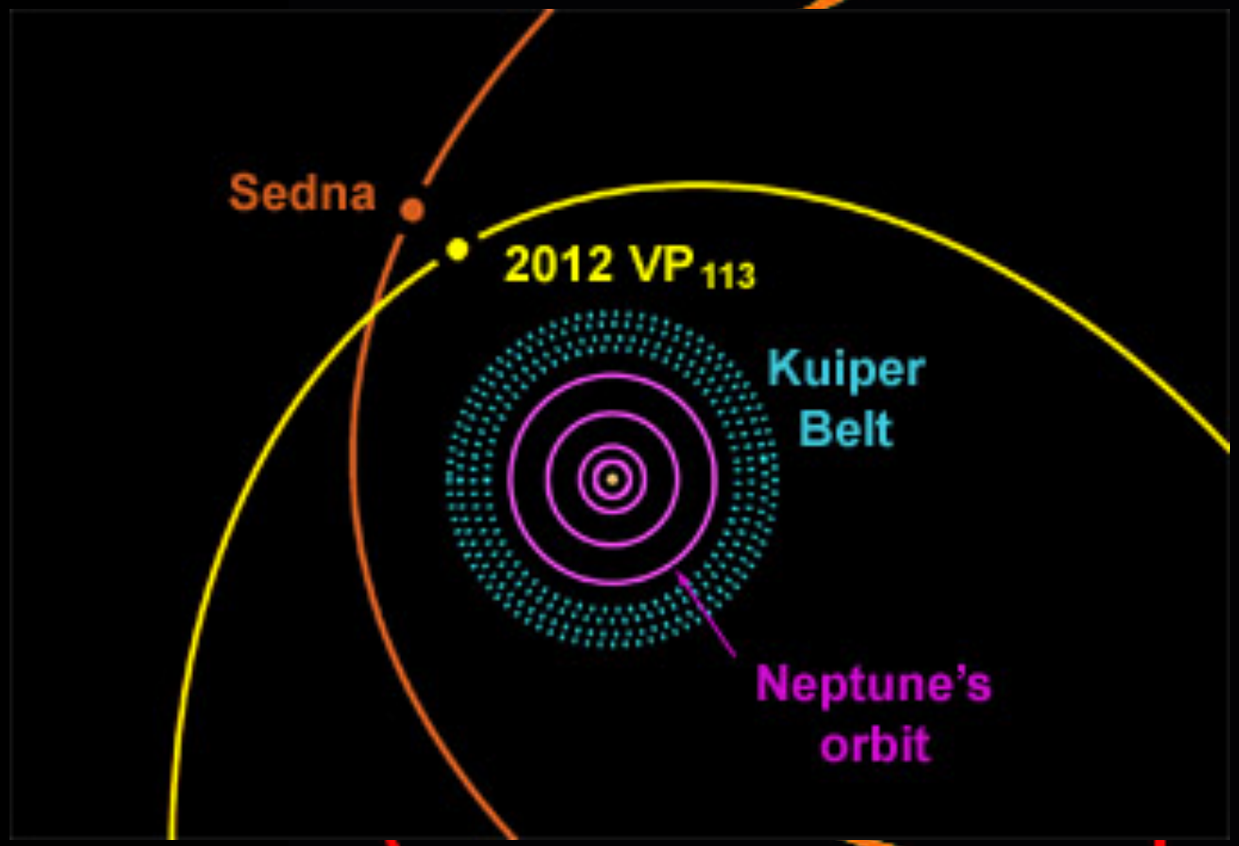


Kuiper belt



The Kuiper belt is beyond the orbit of Neptune, much farther out than the asteroid belt. It is composed of comets and dwarf planets, of which Pluto was the first known example.

A few dwarf planets are known to exist beyond the Kuiper belt



Both currently near perihelion

what're the odds?
Think about Kepler's Laws

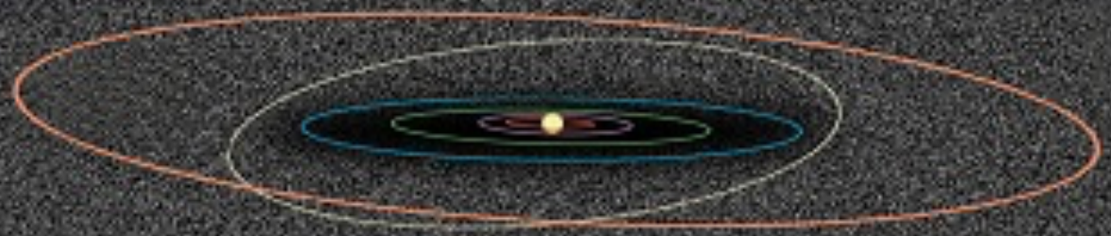
Sedna

P = 11,400 yr
discovered 2003

2012 VP113

discovered 2012 (nicknamed "Biden")

Kuiper Belt



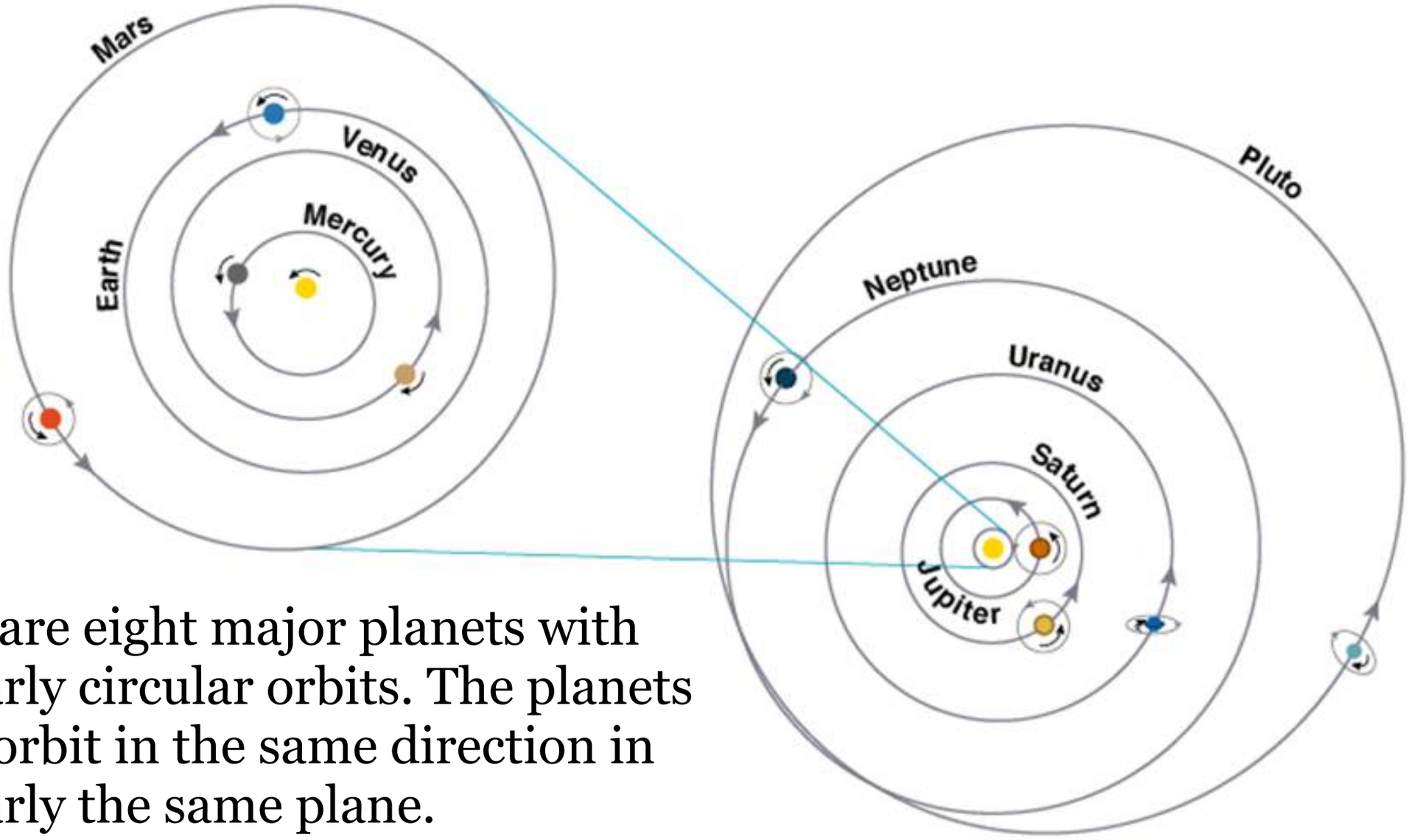
The orange track represents a typical KBO orbit. Pluto's orbit is represented by the yellow ring.

Farther out still… the

Oort Cloud

populated by comets

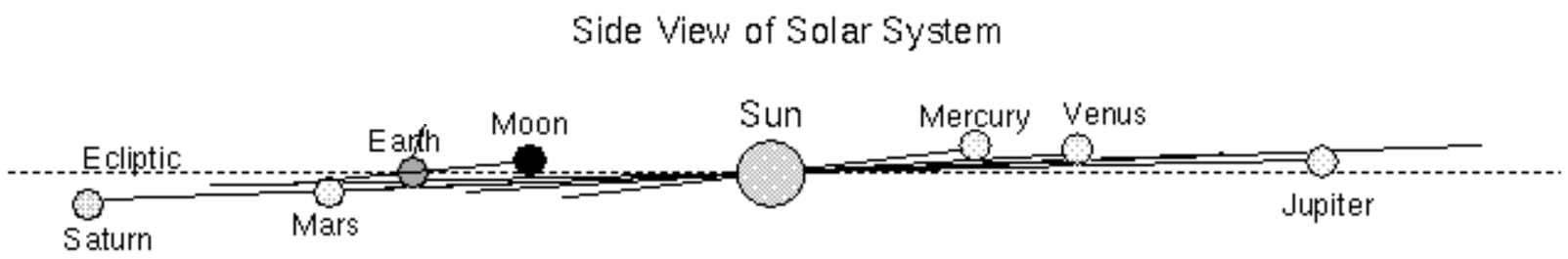
top view:

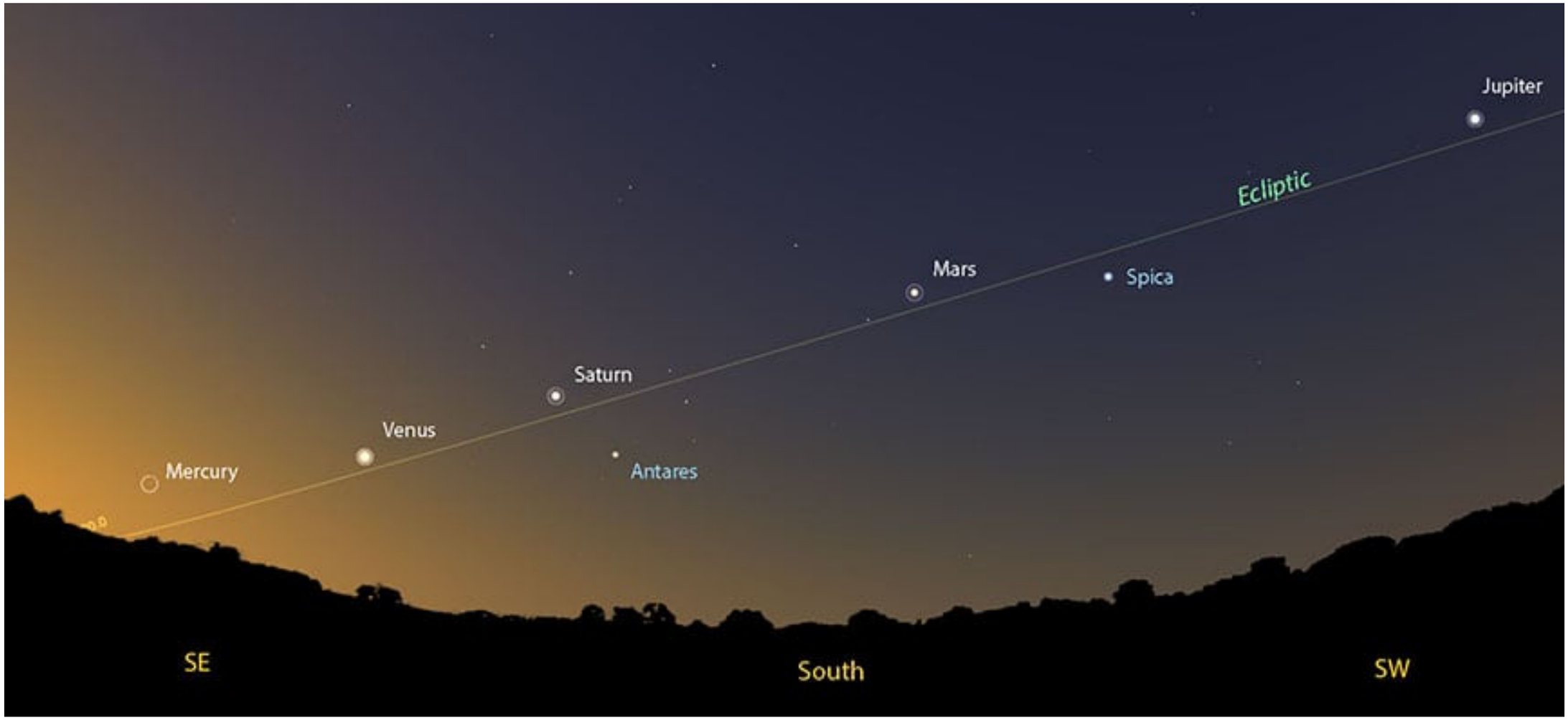


There are eight major planets with nearly circular orbits. The planets all orbit in the same direction in nearly the same plane.

<u>Consequently, they appear along the ecliptic plane in the sky.</u>

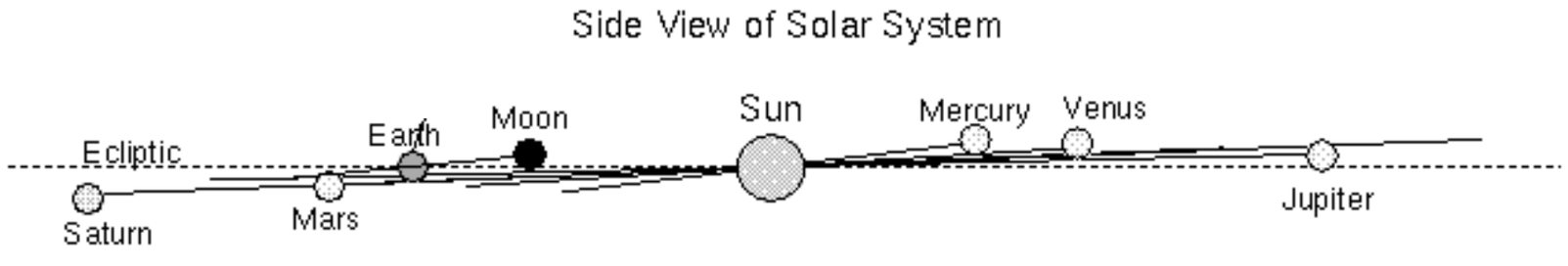
side view:



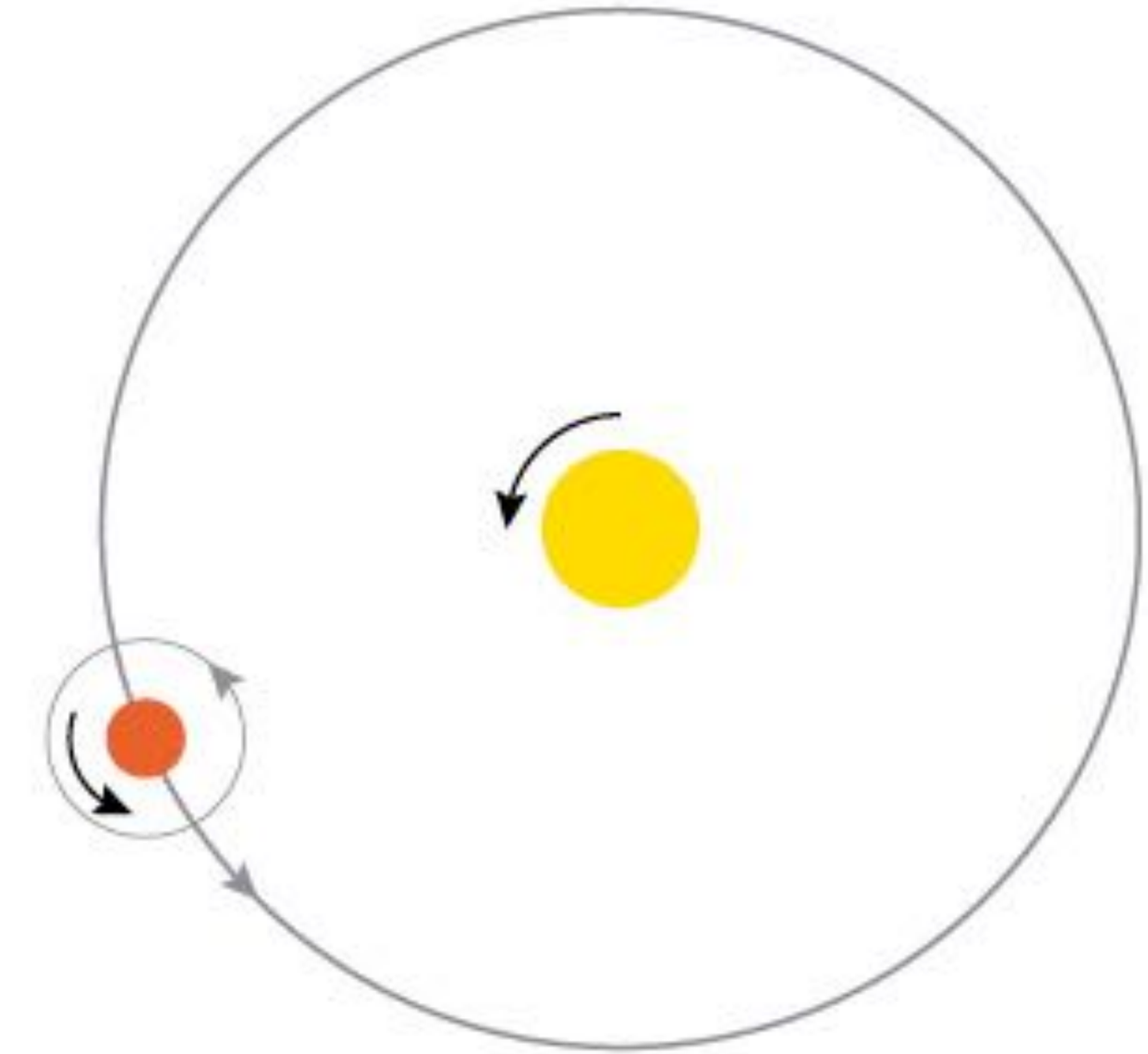


The planets all orbit in nearly the same plane.
Consequently, they appear along the ecliptic plane in the sky.

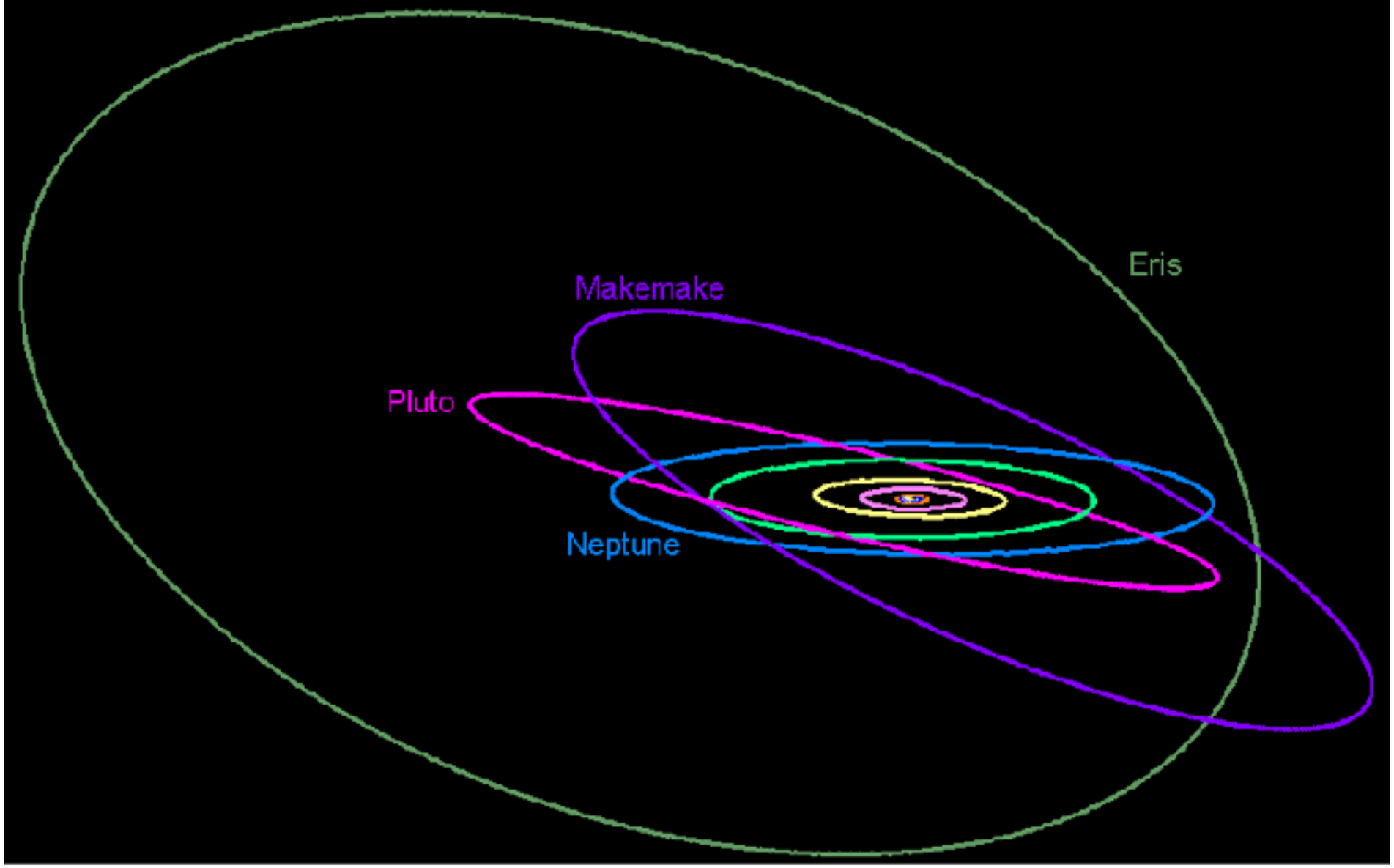
side view:



Motion of Large Bodies



- All large bodies in the solar system orbit in the same direction and in nearly the same plane.
- Most also rotate in that direction.
  – "***prograde***"

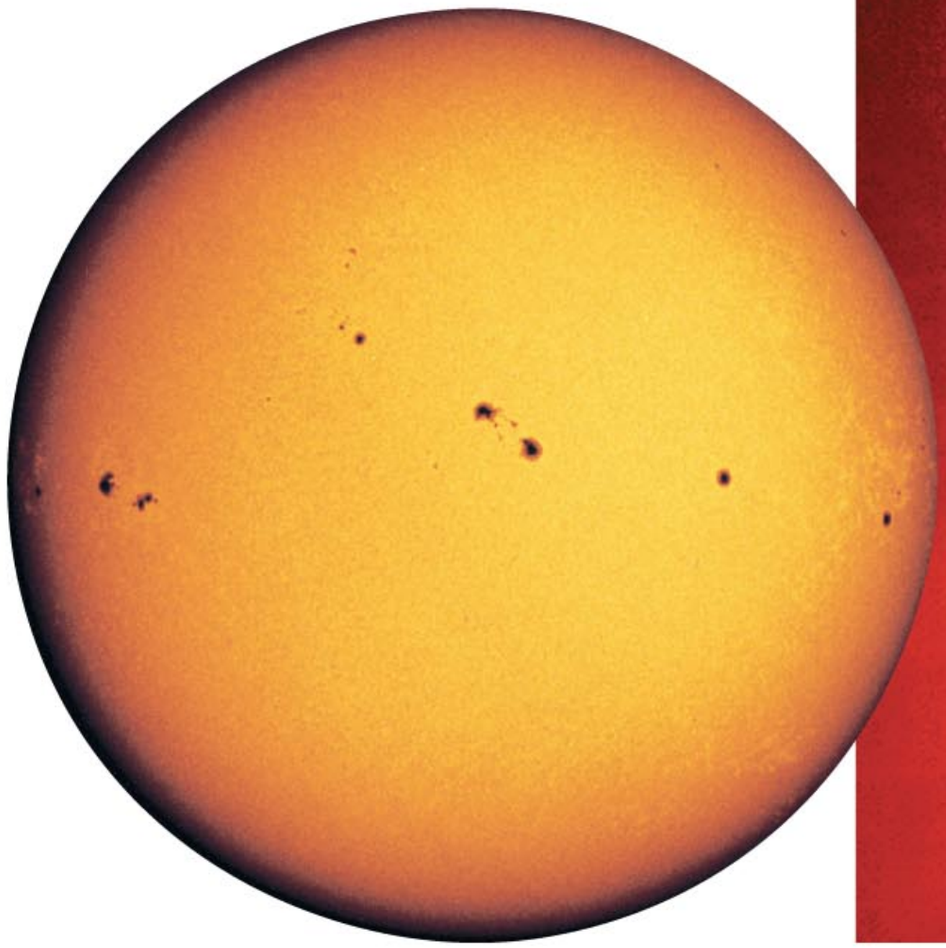


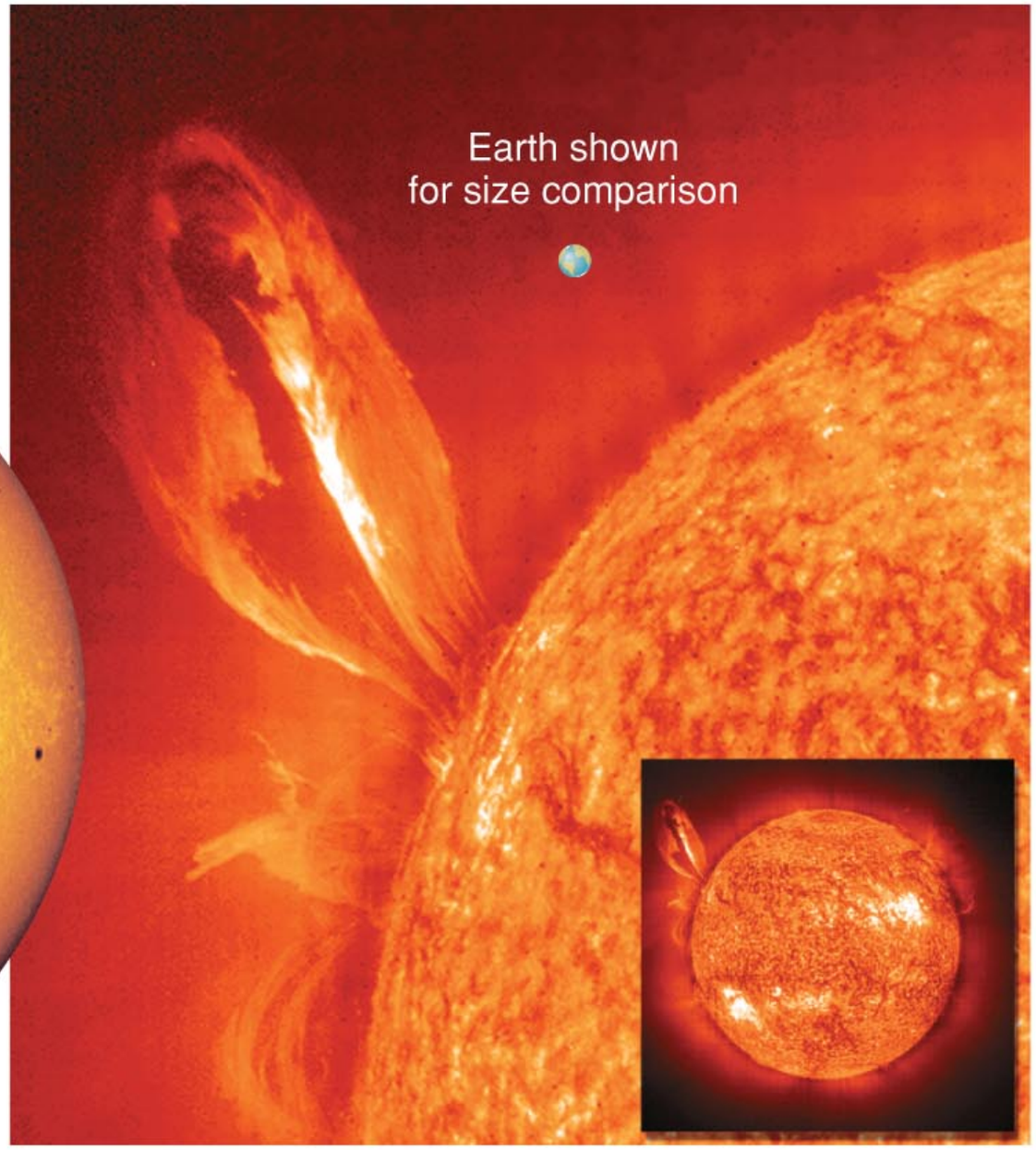
Dwarf planets are smaller than the major planets and some have quite elliptical orbits.

Most dwarf planets & asteroids also revolve prograde.

Comets have highly elliptical orbits; often highly inclined from the planetary plane; sometimes retrograde.

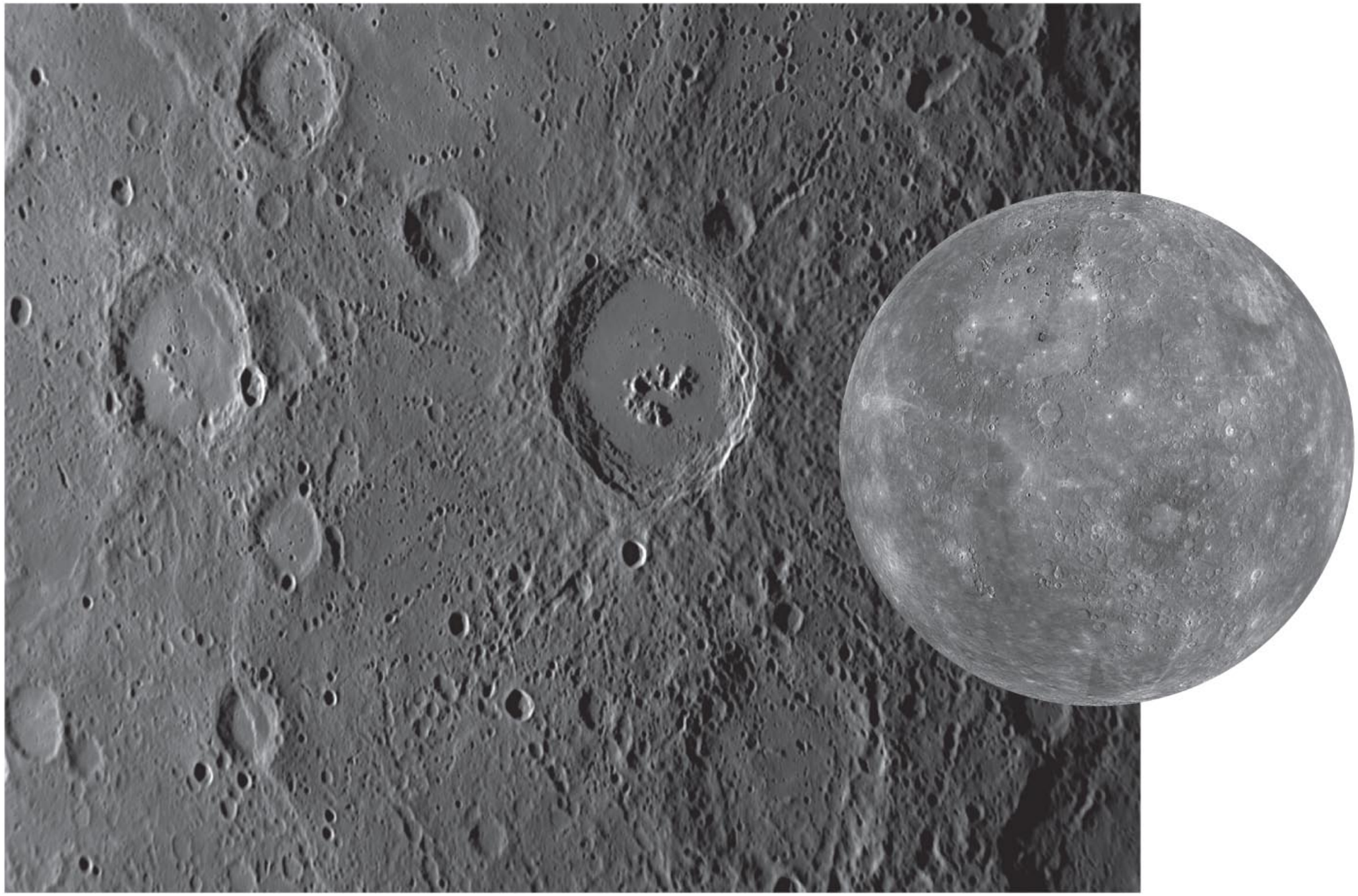
- The Sun





- 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

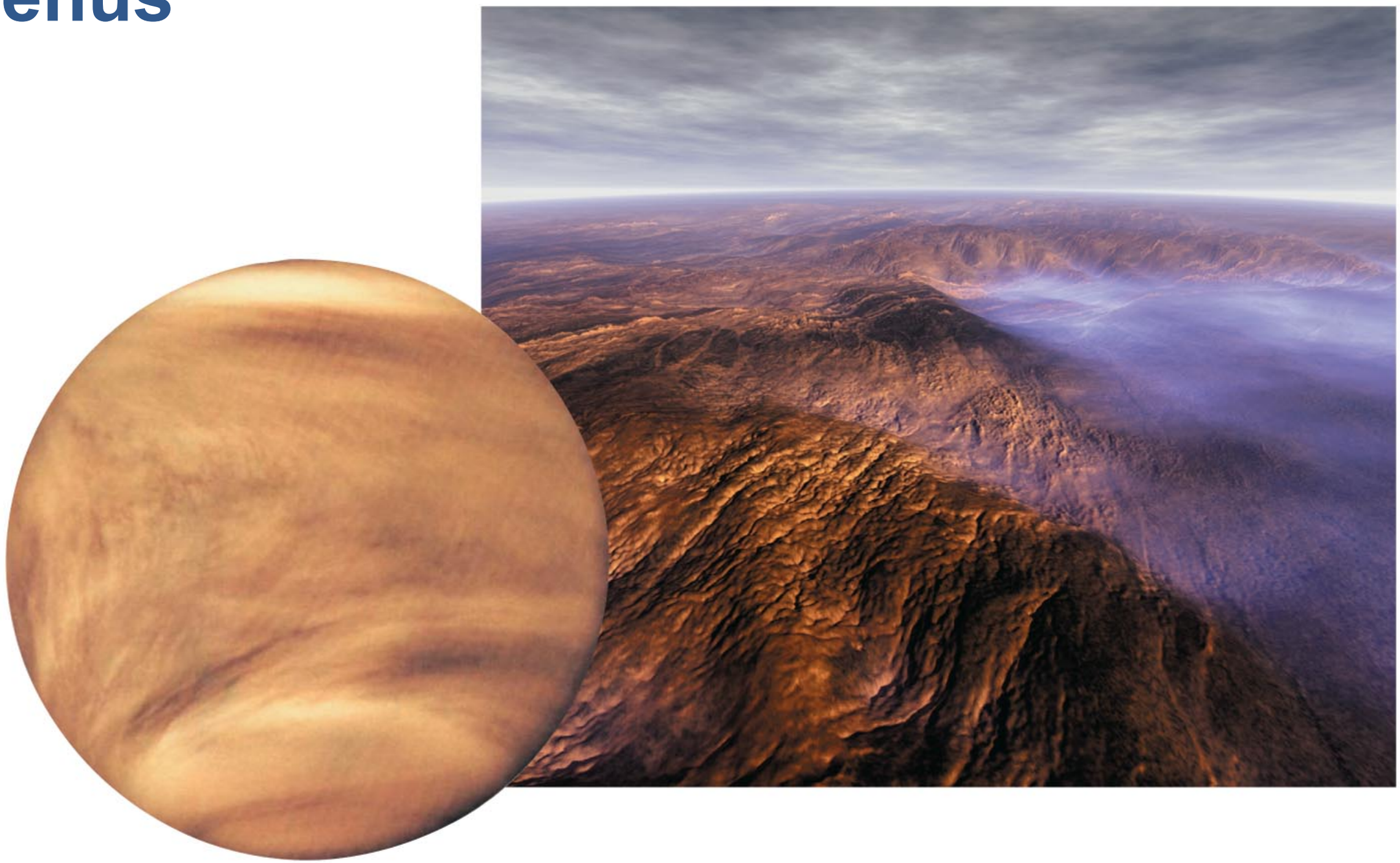
Mercury



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

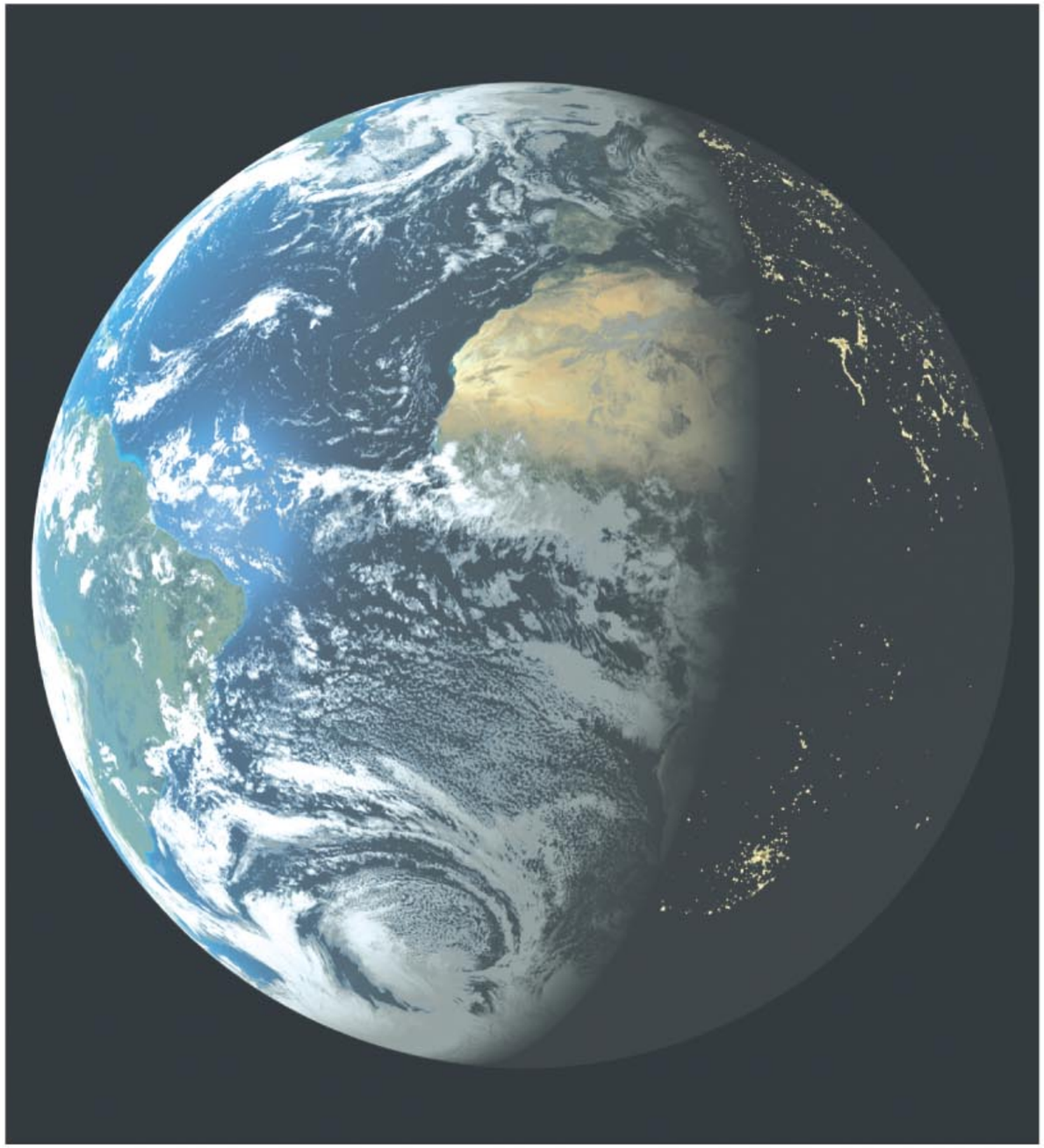
3:2 spin-orbit coupling

Venus



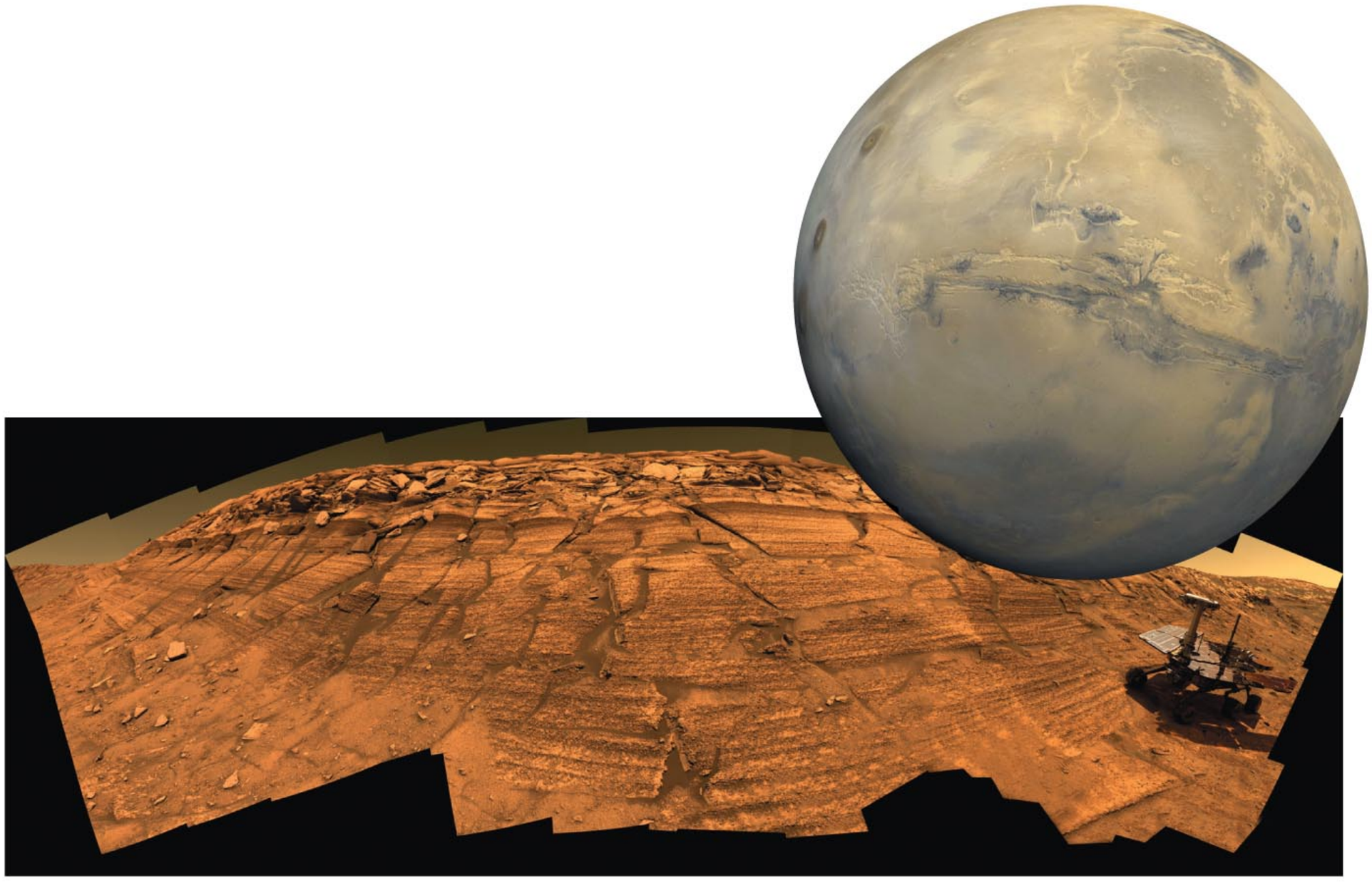
- Nearly identical in size to Earth; surface hidden by clouds
- Hellish conditions due to an extreme **greenhouse effect**
- Even hotter than Mercury: 470°C, day and night

Earth



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

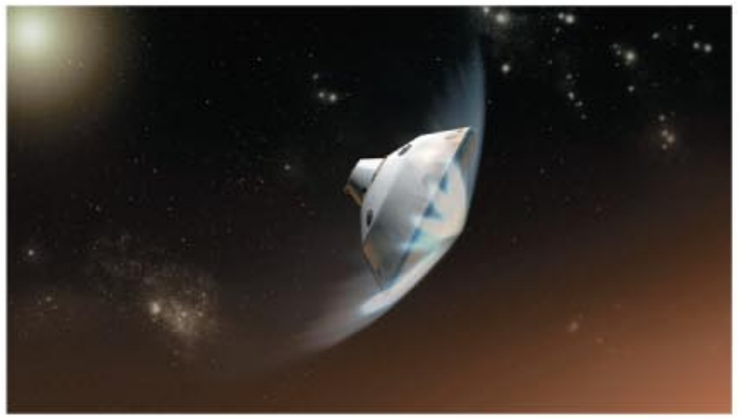
Mars



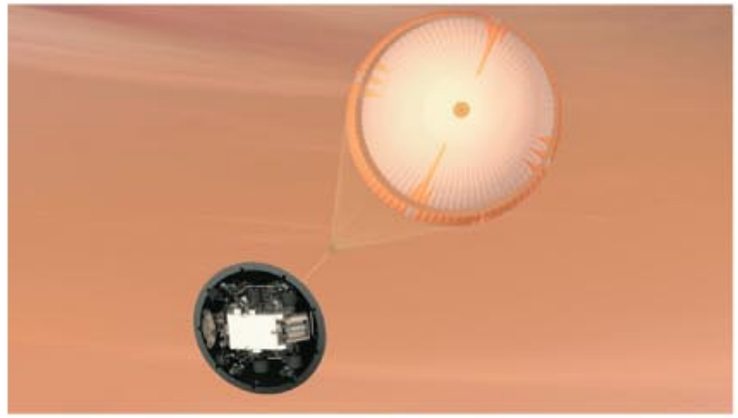
- Looks almost Earth-like, but don't go without a spacesuit!
- Giant volcanoes, a huge canyon, polar caps, more
- Water flowed in distant past; could there have been life?

Mars

- *Curiosity* rover landed in August 2012.



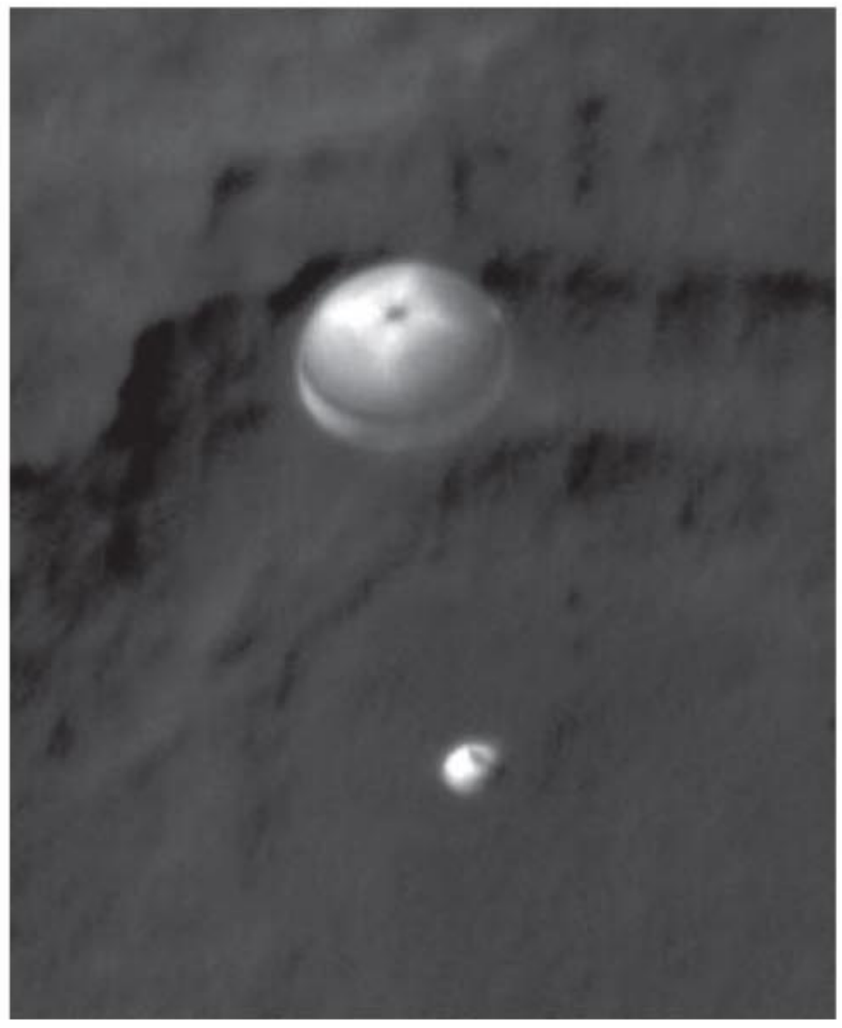
1 Friction slows spacecraft as it enters Mars atmosphere.



2 Parachute slows spacecraft to about 350 km/hr.

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

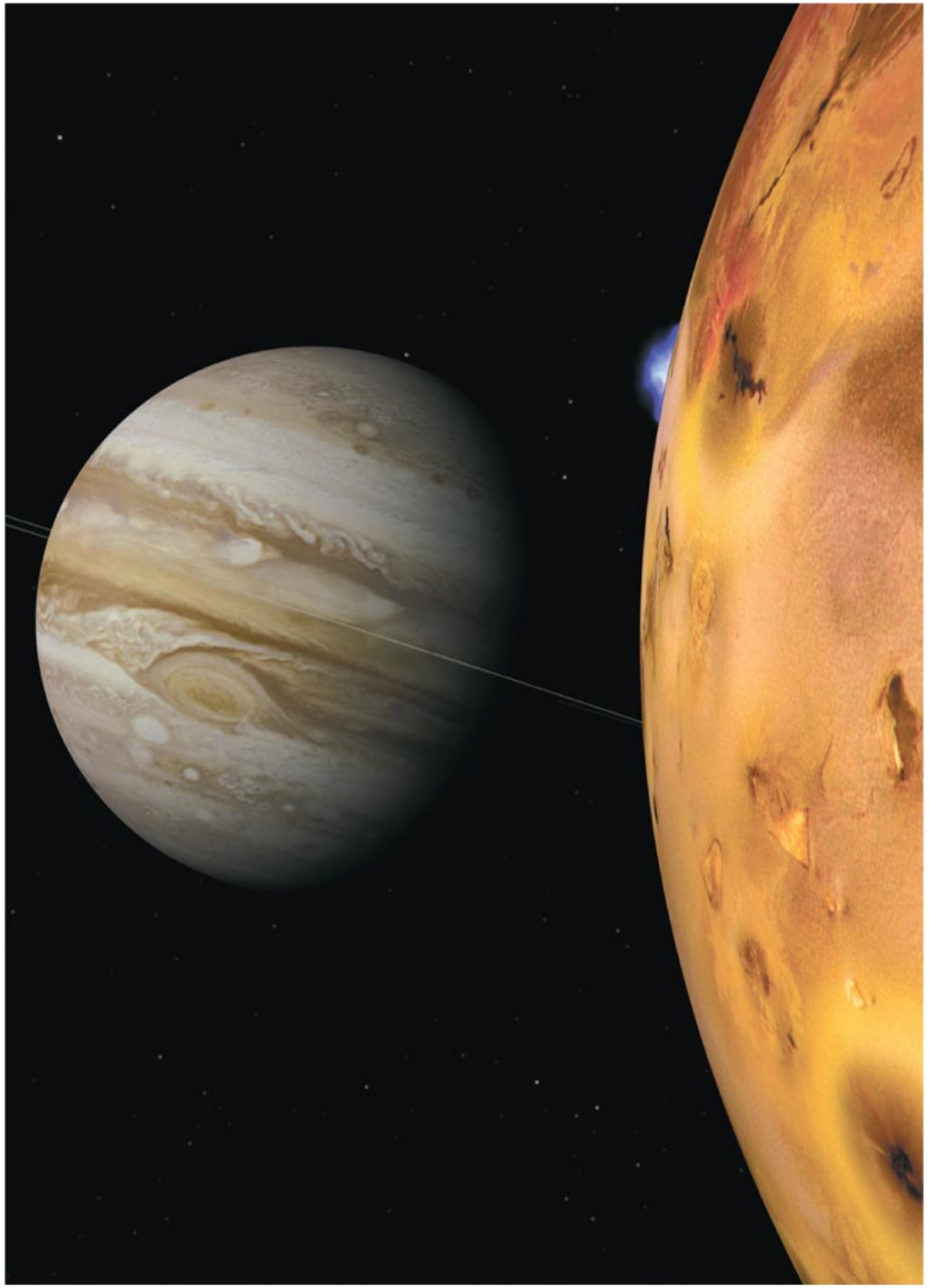
4 Tether released, the rocket heads off to crash a safe distance away.



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

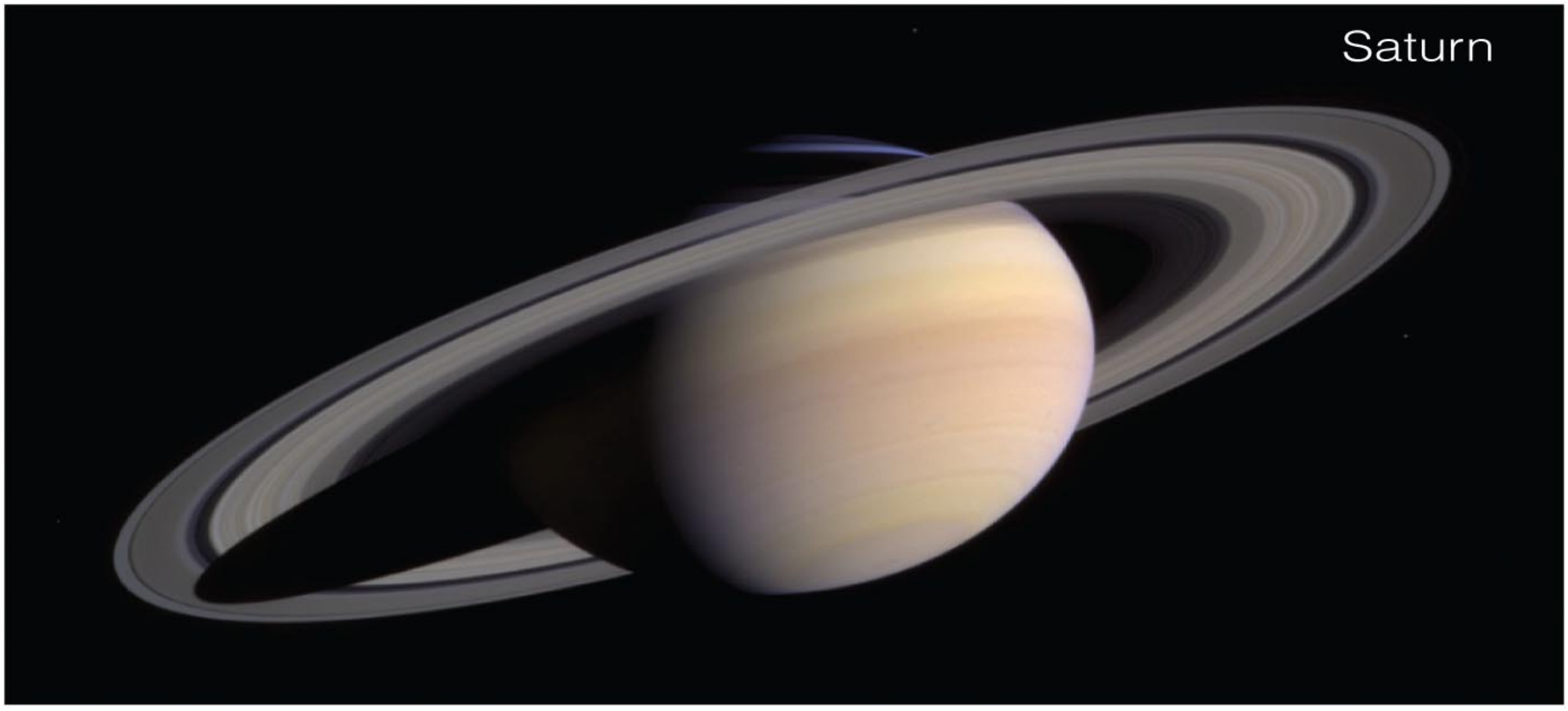
http://www.jpl.nasa.gov/video/details.php?id=1001 1:00 mark

Jupiter



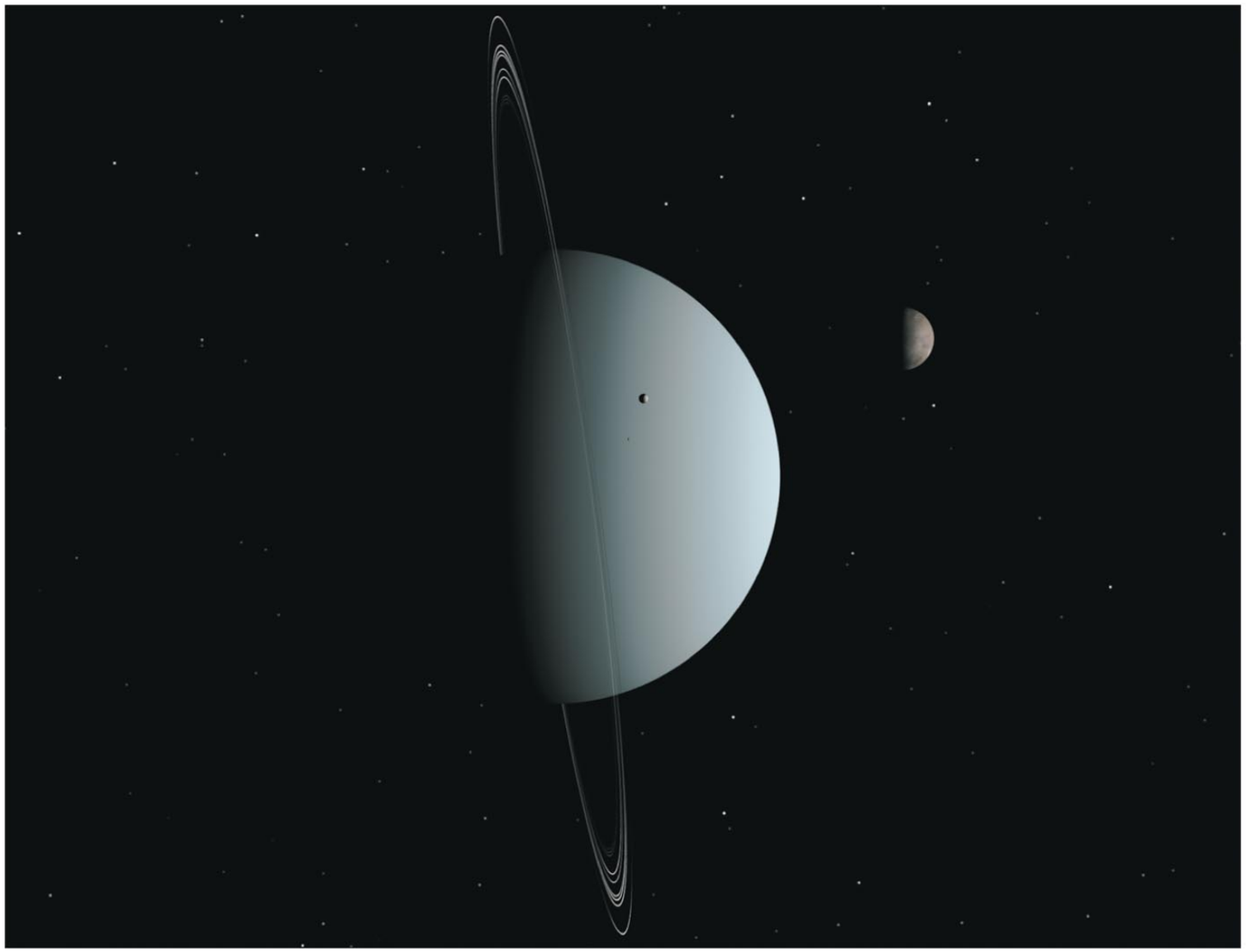
- Much farther from Sun than inner planets
- Mostly H/He; no solid surface
- 300 times more massive than Earth
- Many moons, rings

Saturn



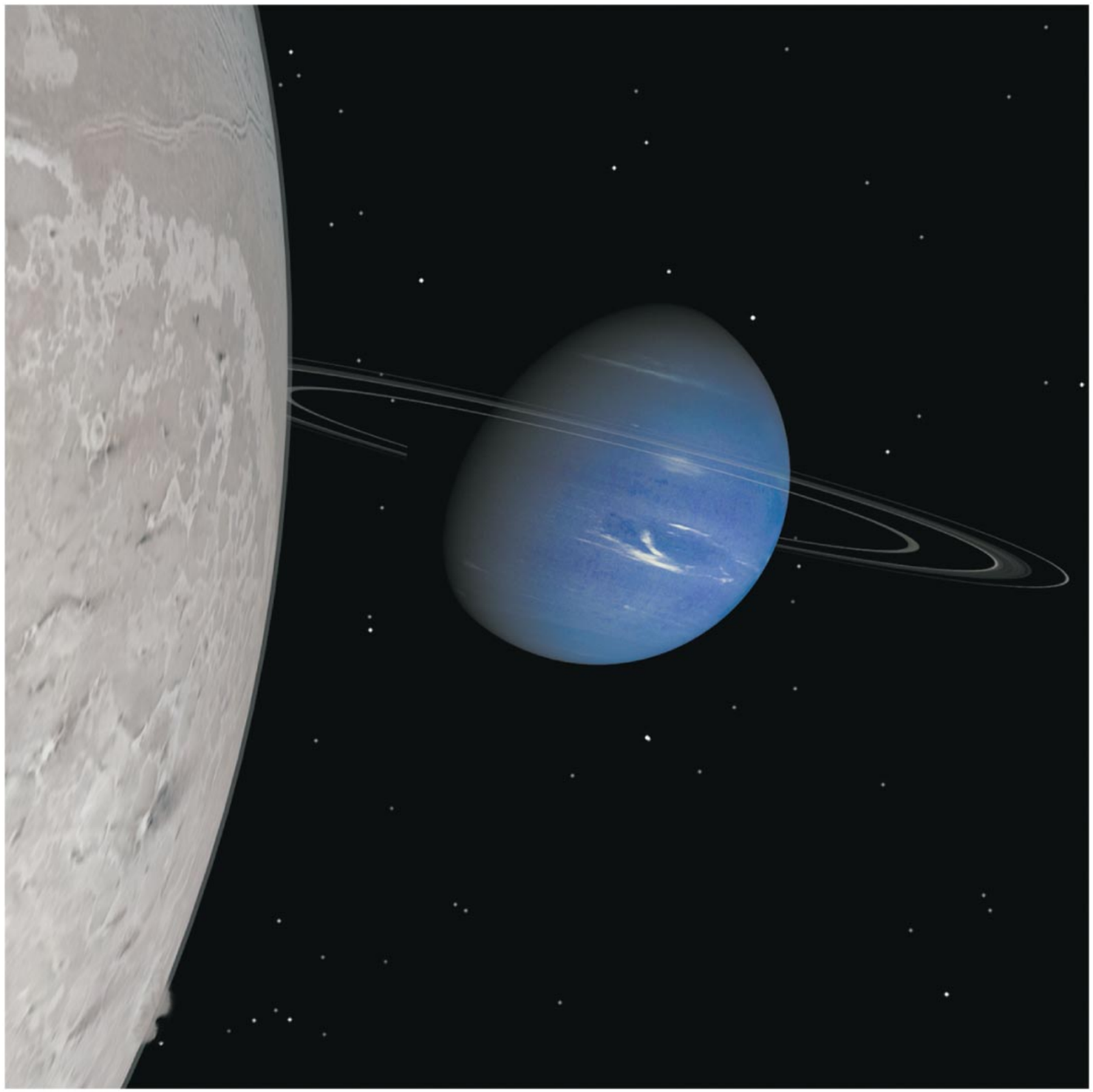
- Giant and gaseous like Jupiter
- Spectacular rings
- Many moons, including cloudy Titan

Uranus



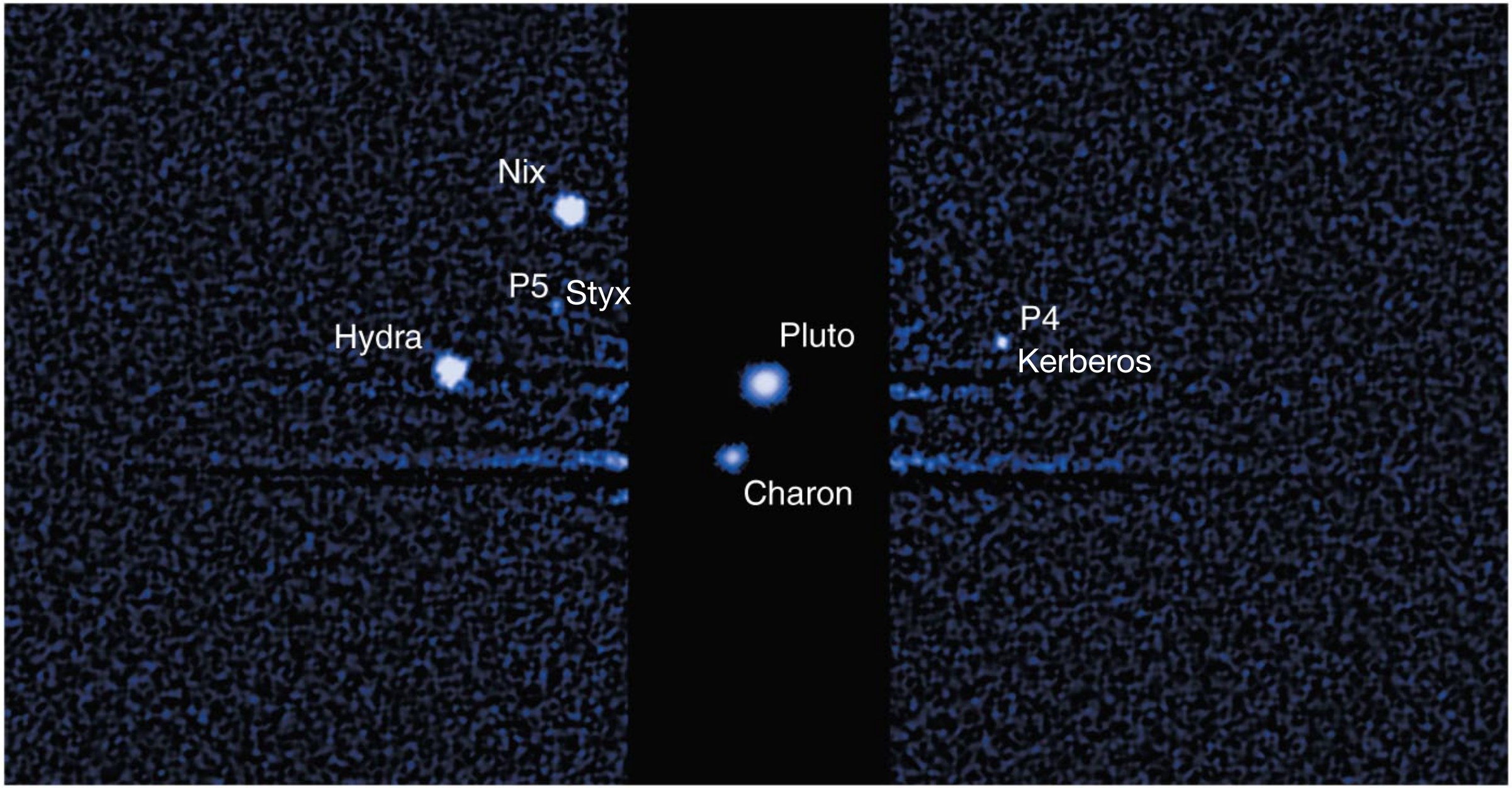
- Smaller than Jupiter/Saturn; much larger than Earth
- Made of H/He gas and **hydrogen compounds** (H_2O, NH_3, CH_4)
- Extreme axis tilt
- Moons and rings

Neptune



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

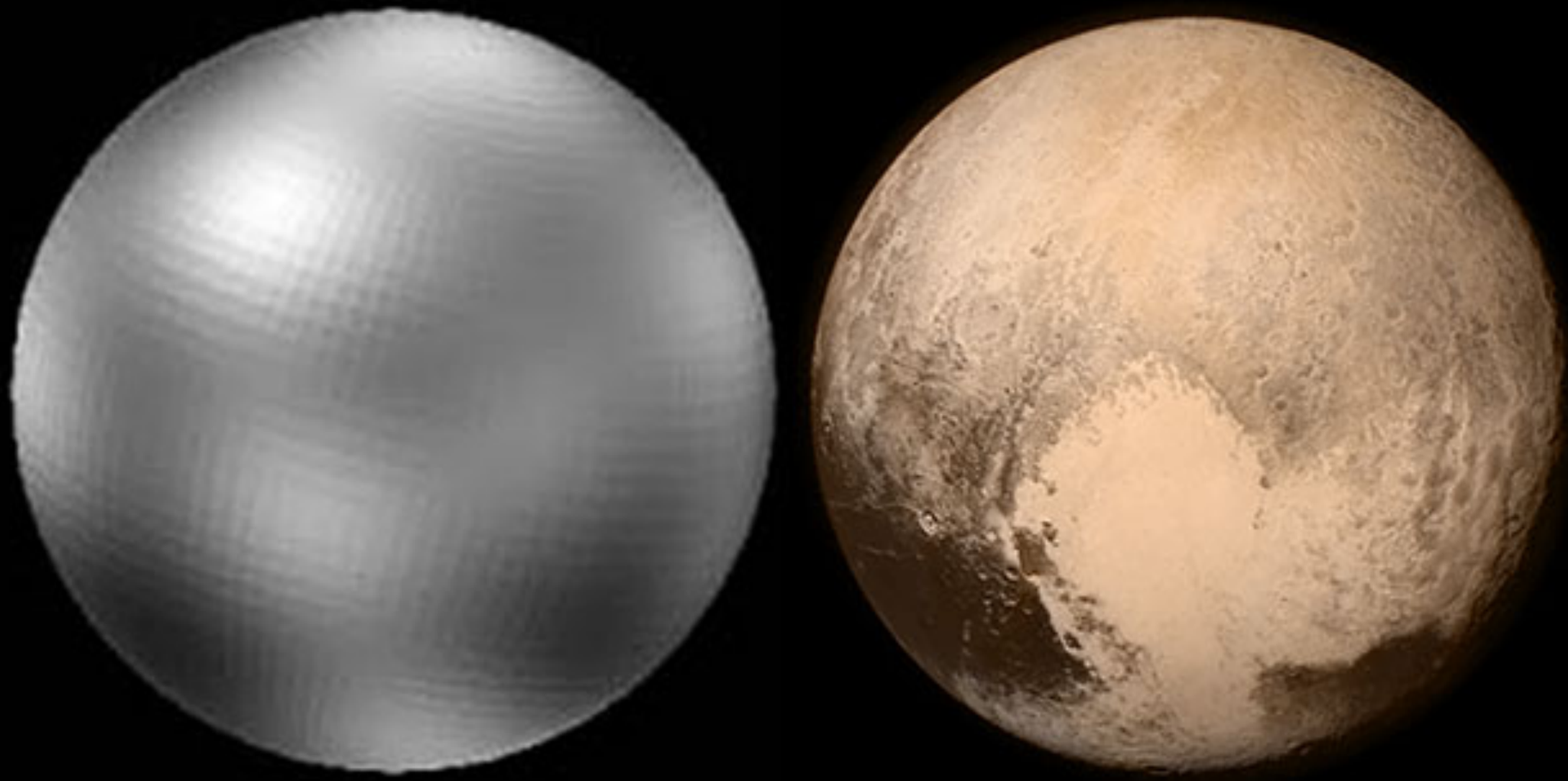
Dwarf Planets: Pluto, Eris, and more



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

Hubble

New Horizons



1996

2015

Charon

Pluto

Selected Moons of the Solar System, with Earth for Scale

Earth

Moon

Mars

Phobos

Deimos

Asteroid Ida

Dactyl

Jupiter

Io

Europa

Ganymede

Callisto

Saturn

Mimas

Enceladus

Tethys

Dione

Rhea

Titan

Hyperion

Iapetus

Phoebe

Uranus

Puck

Miranda

Ariel

Umbriel

Titania

Oberon

Neptune

Proteus

Triton

Nereid

Pluto

Charon

Eris

Dysnomia

Scale: 1 pixel = 25 km

Earth

Asteroids

243 Ida - 58.8 × 25.4 × 18.6 km
Galileo, 1993

253 Mathilde - 66 × 48 × 44 km
NEAR, 1997

433 Eros - 33 × 13 km
NEAR, 2000

951 Gaspra
18.2 × 10.5 × 8.9 km
Galileo, 1991

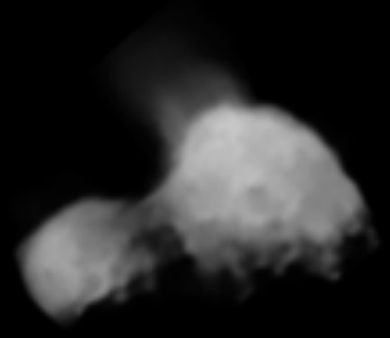
Dactyl
[(243) Ida I]
1.6 × 1.2 km
Galileo, 1993

5535 Annefrank
6.6 × 5.0 × 3.4 km
Stardust, 2002

2867 Steins
5.9 × 4.0 km
Rosetta, 2008

25143 Itokawa
0.5 × 0.3 × 0.2 km
Hayabusa, 2005

9969 Braille
2.1 × 1 × 1 km
Deep Space 1, 1999



1P/Halley - 16 × 8 × 8 km
Vega 2, 1986

9P/Tempel 1
7.6 × 4.9 km
Deep Impact, 2005

19P/Borrelly
8 × 4 km
Deep Space 1, 2001

81P/Wild 2
5.5 × 4.0 × 3.3 km
Stardust, 2004

small
irregular
rocky bodies

Comets icy bodies