Today

- Solar System Overview
- Solar System Formation

Events

- Homework Due Thu Oct 13 (next time)

But first, a few words about space telescopes

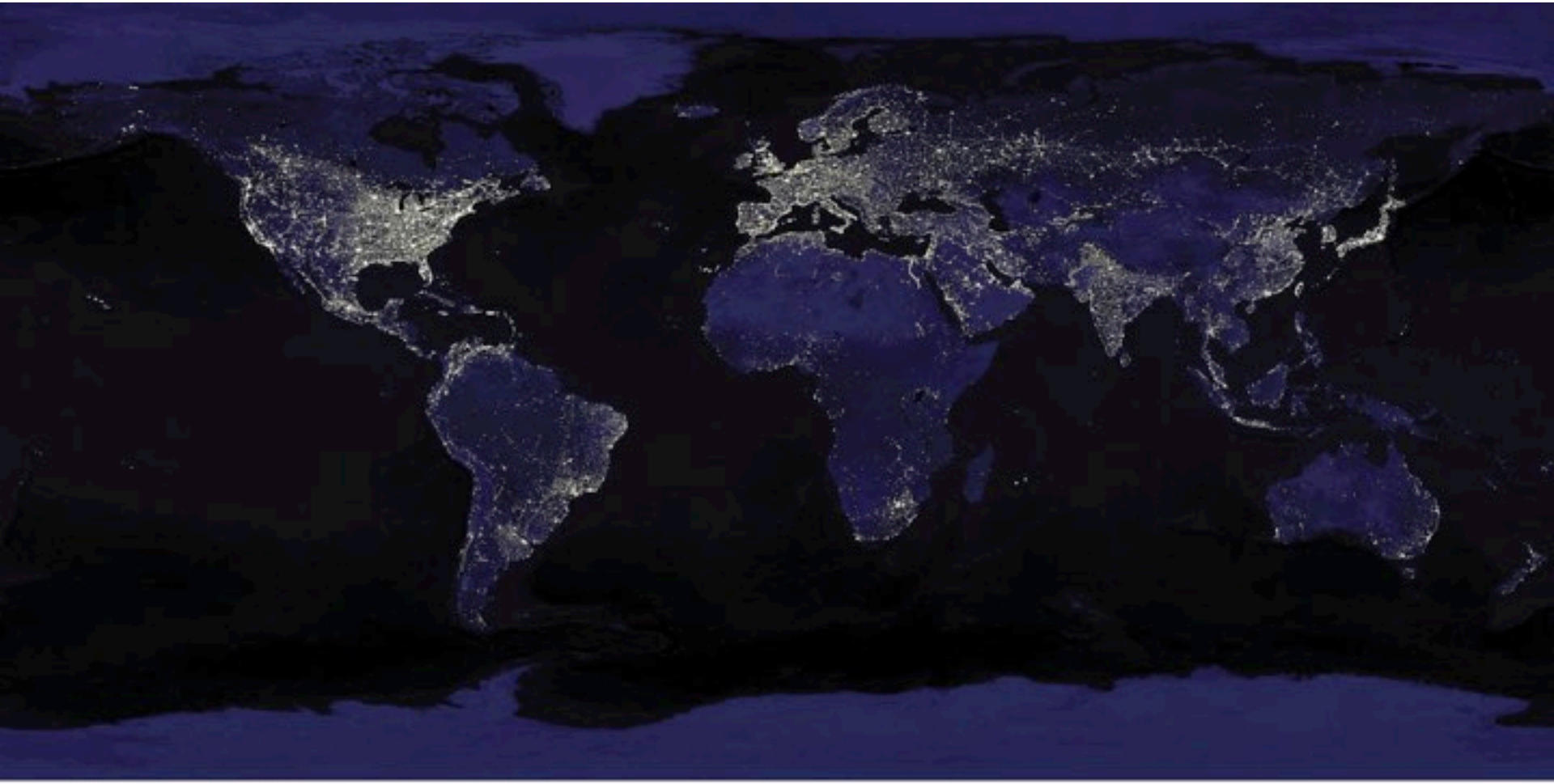
Advantages of telescopes in space

Hubble

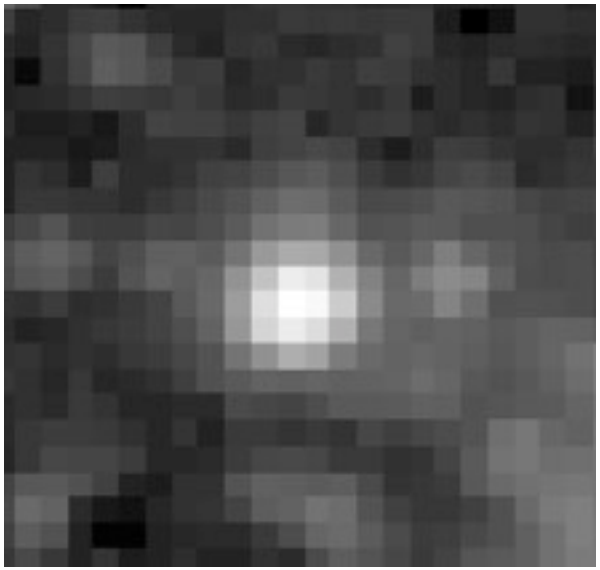
Chandra

Observing problems due to Earth's atmosphere

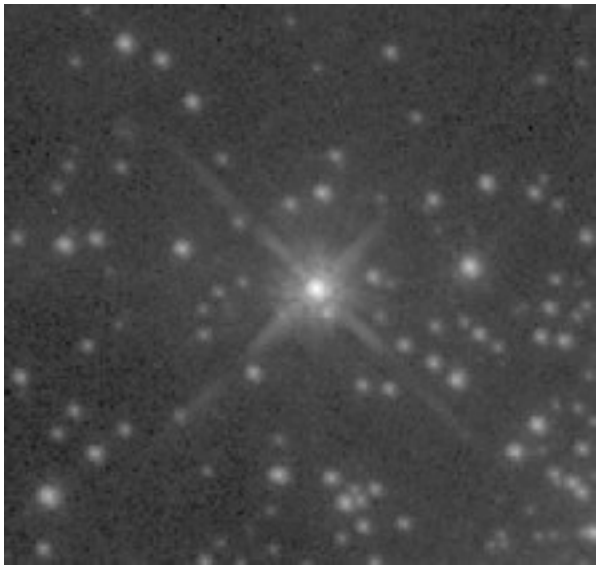
1. Light Pollution



2. Atmospheric Turbulence causes *twinkling* ⇒ blurs images (called "seeing" by astronomers).



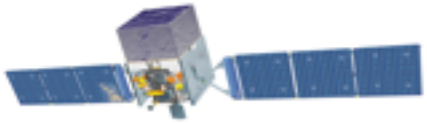
Star viewed with ground-based telescope



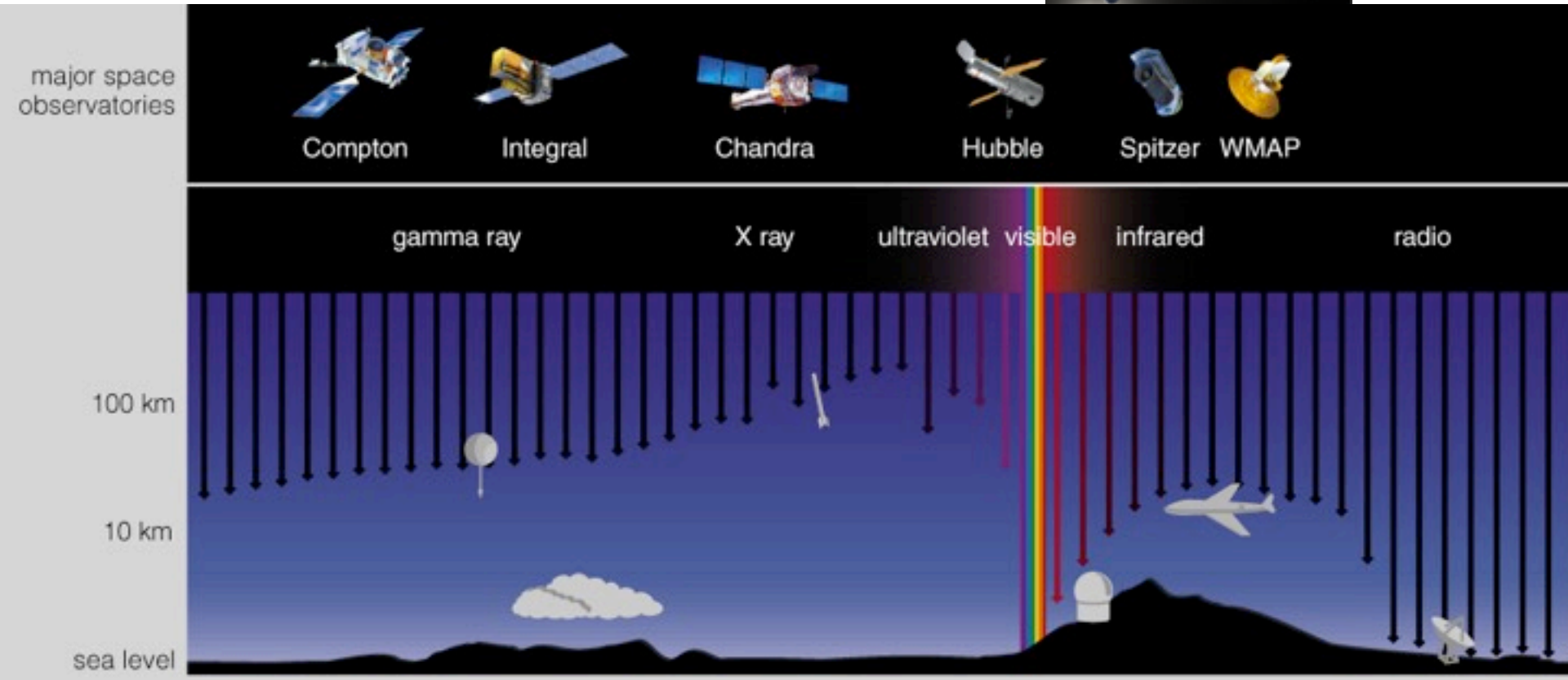
View from Hubble Space Telescope

Atmospheric seeing is usually the limit on the resolution of ground based telescopes, not their diameter.

3. Atmosphere absorbs most of EM spectrum, including all UV and X ray and most infrared.

Fermi 


Herschel



Telescopes in space solve all 3 problems.

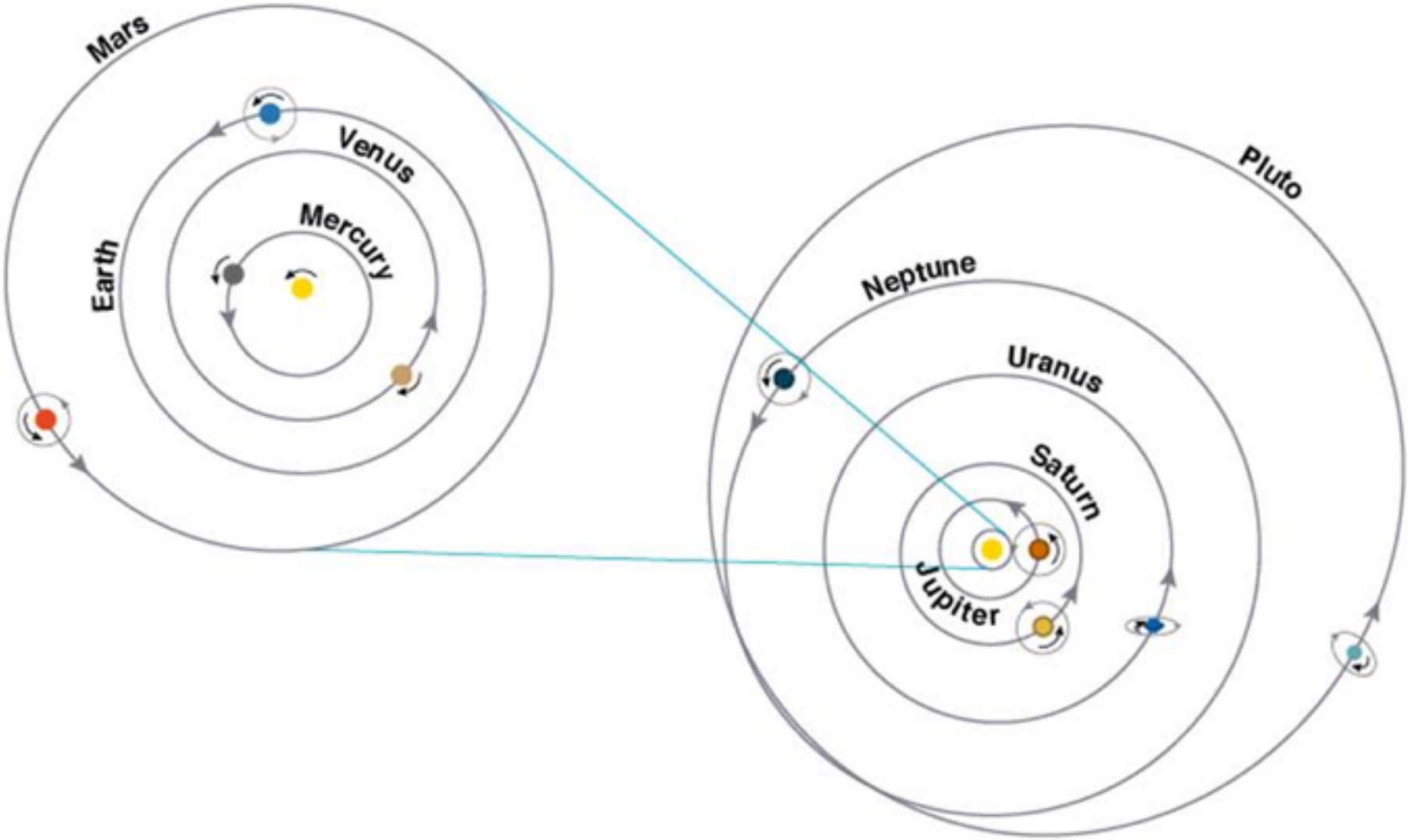
Chandra X-ray Observatory

Contents of the Solar System

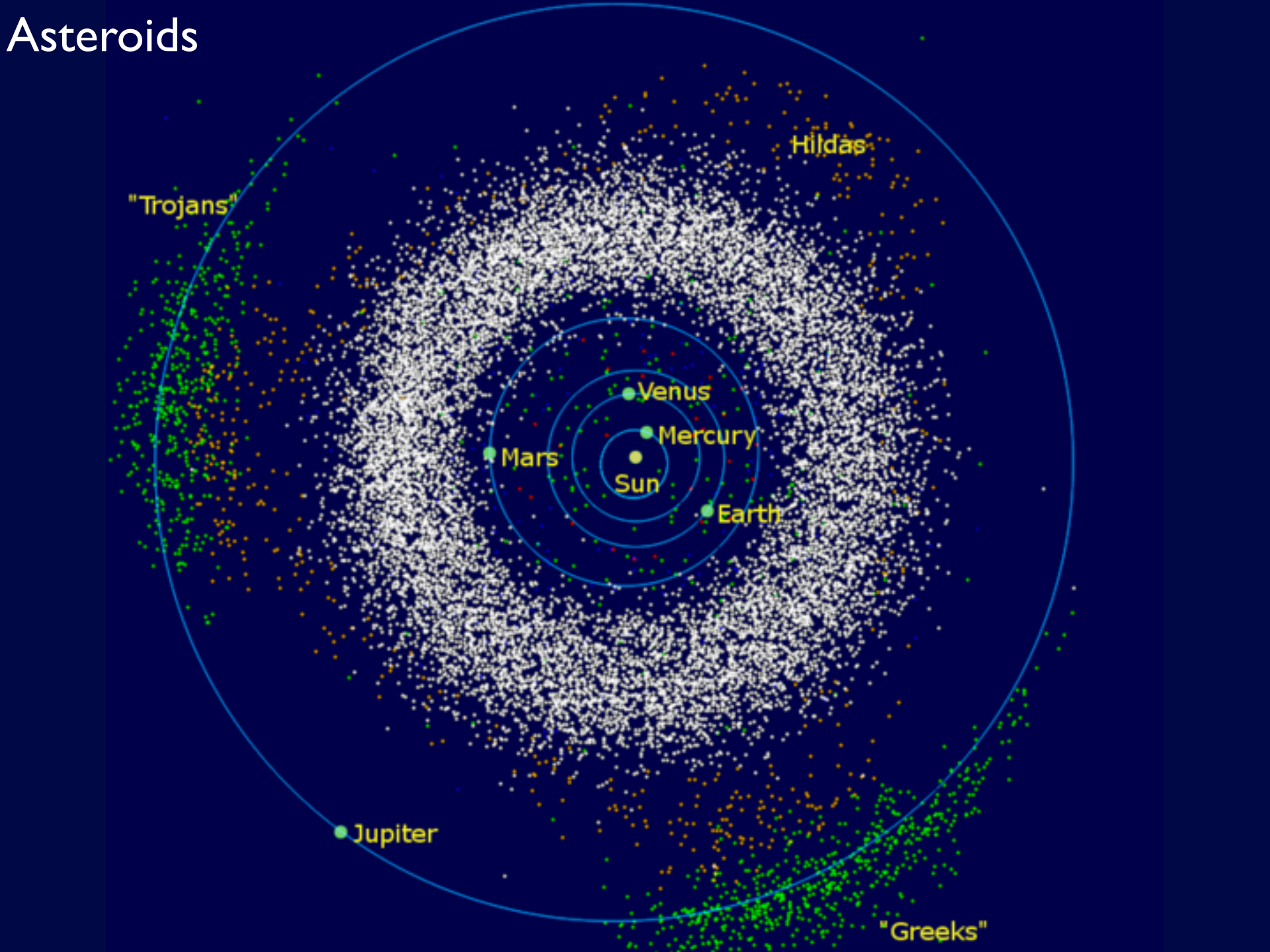
- The Sun
- Major Planets
  - Terrestrial: Mercury, Venus, Earth, Mars
  - Jovian planets: Jupiter, Saturn
  - Ice Giants: Uranus, Neptune

  } Gas Giants
- Moons
- Dwarf Planet
  - KBOs: Pluto, Quaoar, Eris, Sedna...
- Asteroids
- Comets
  - misc. dust, meteoroids, solar wind particles...

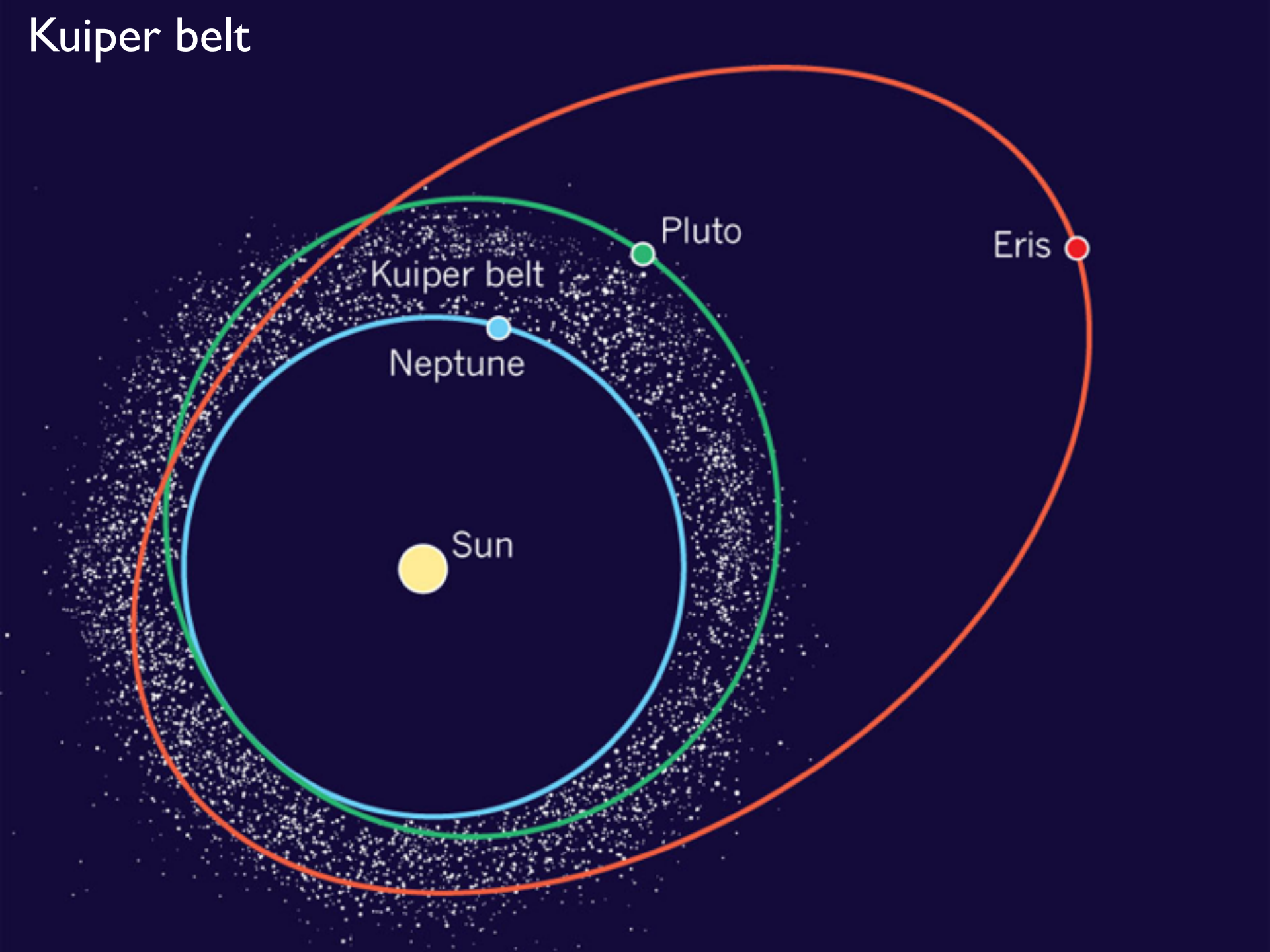
Layout of the Solar System

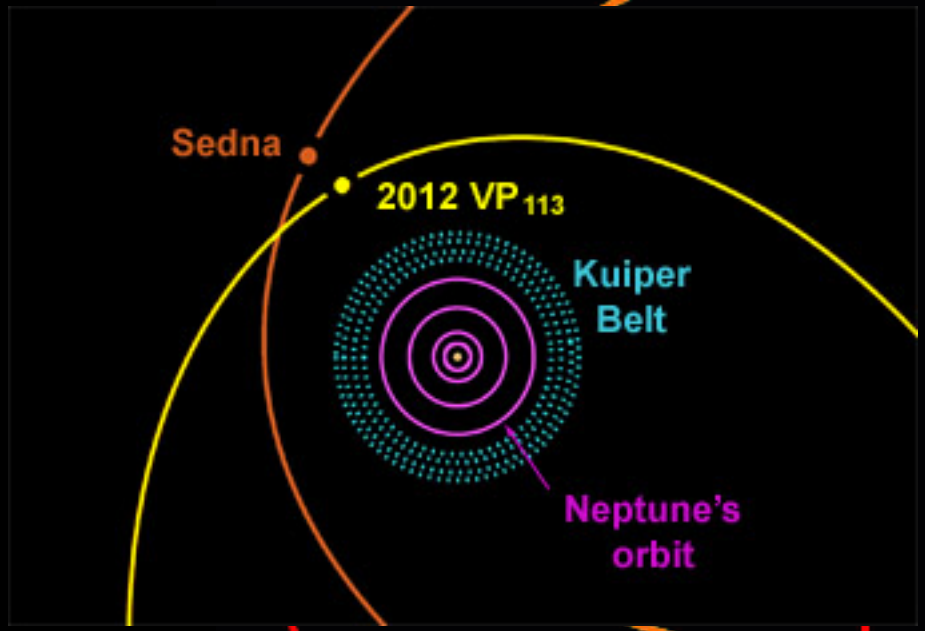


Asteroids


Hildas
"Trojans"
Venus
Mercury
Mars
Sun
Earth
Jupiter
"Greeks"

Kuiper belt





Both currently near perihelion

Sedna

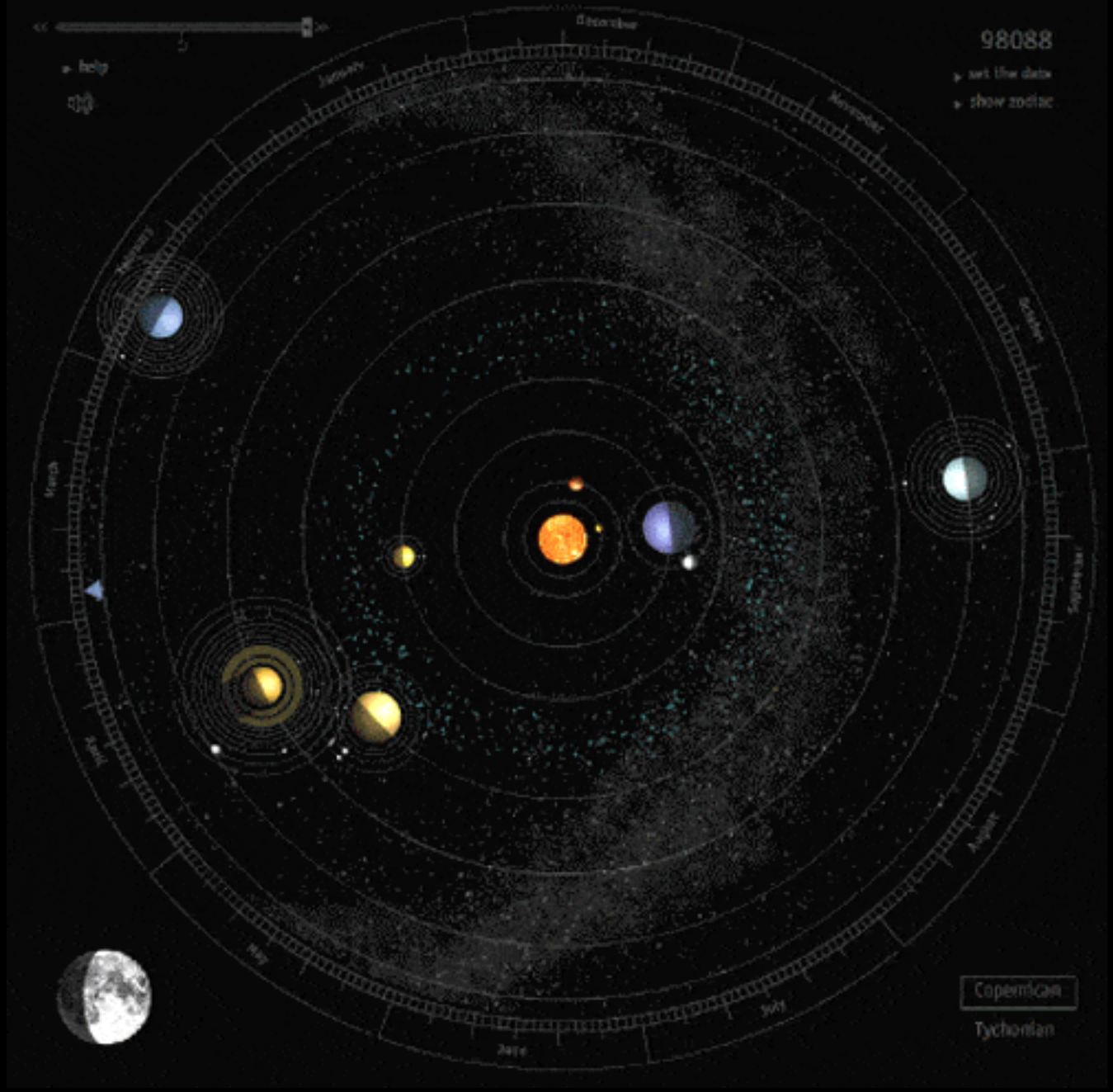
P = 11,400 yr
discovered 2003

2012 VP113

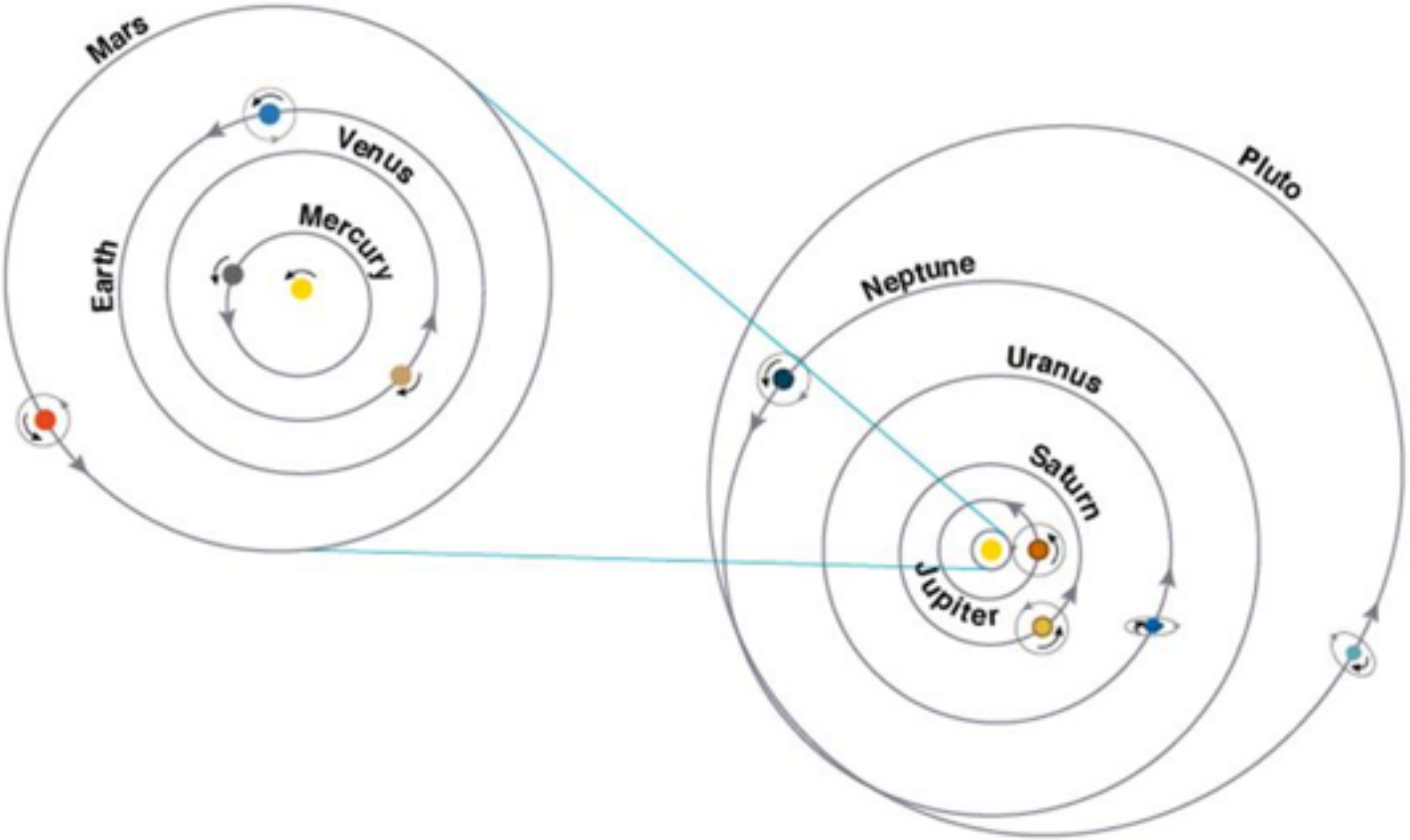
discovered 2012

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

Oort Cloud



http://popperfont.net/2012/11/13/the-ultimate-solar-system-animated-gif/

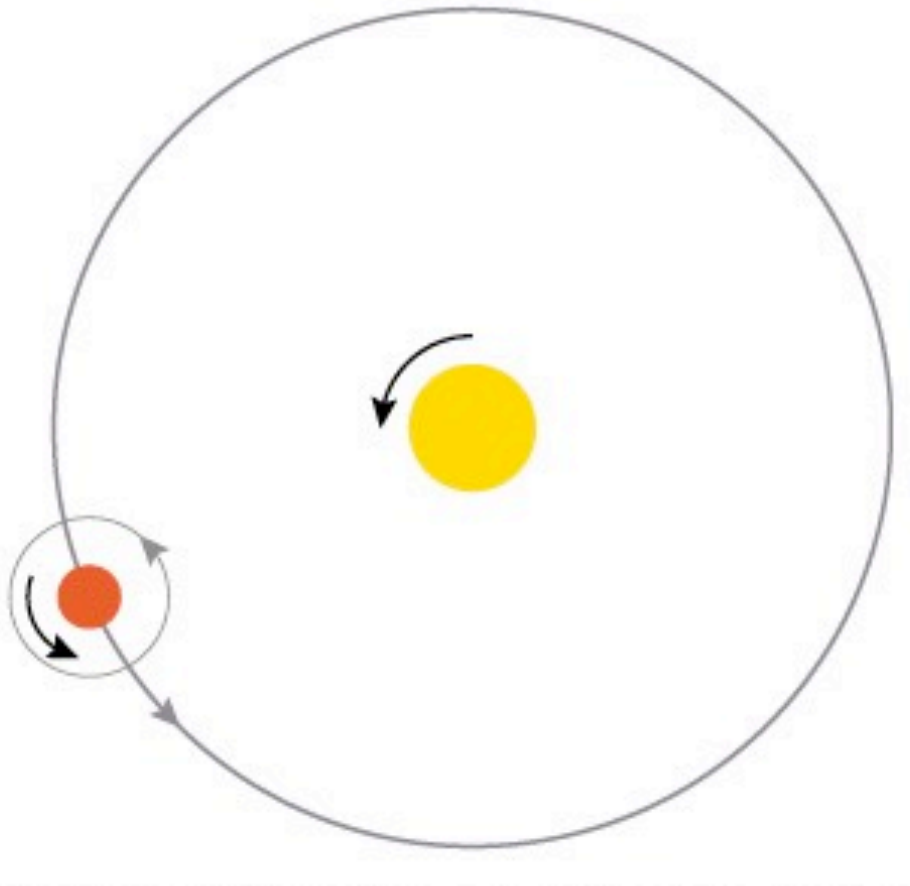


There are eight major planets with nearly circular orbits.

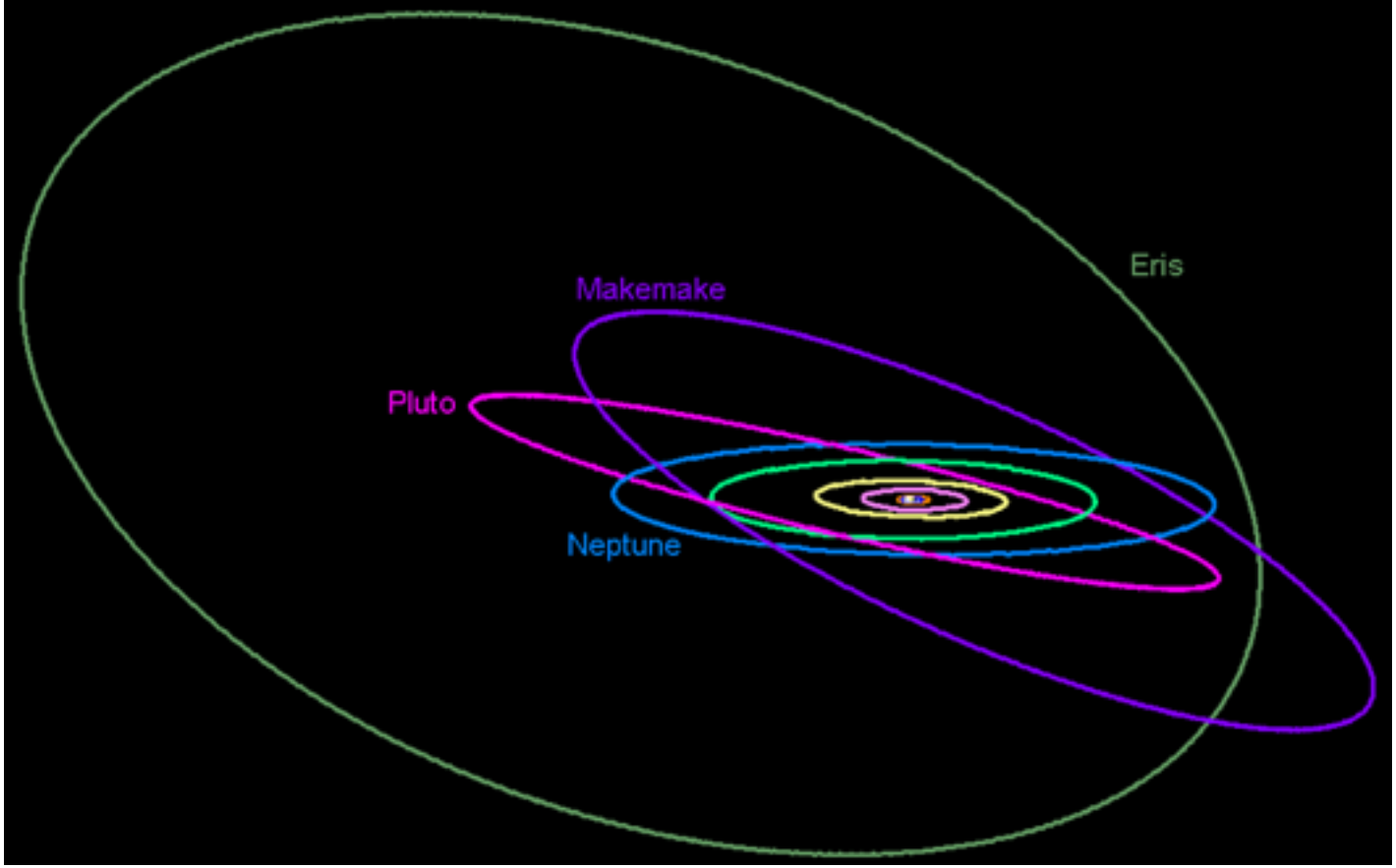
The planets all orbit in the same direction in nearly the same plane.

Consequently, they appear along the ecliptic plane in the sky.

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***"

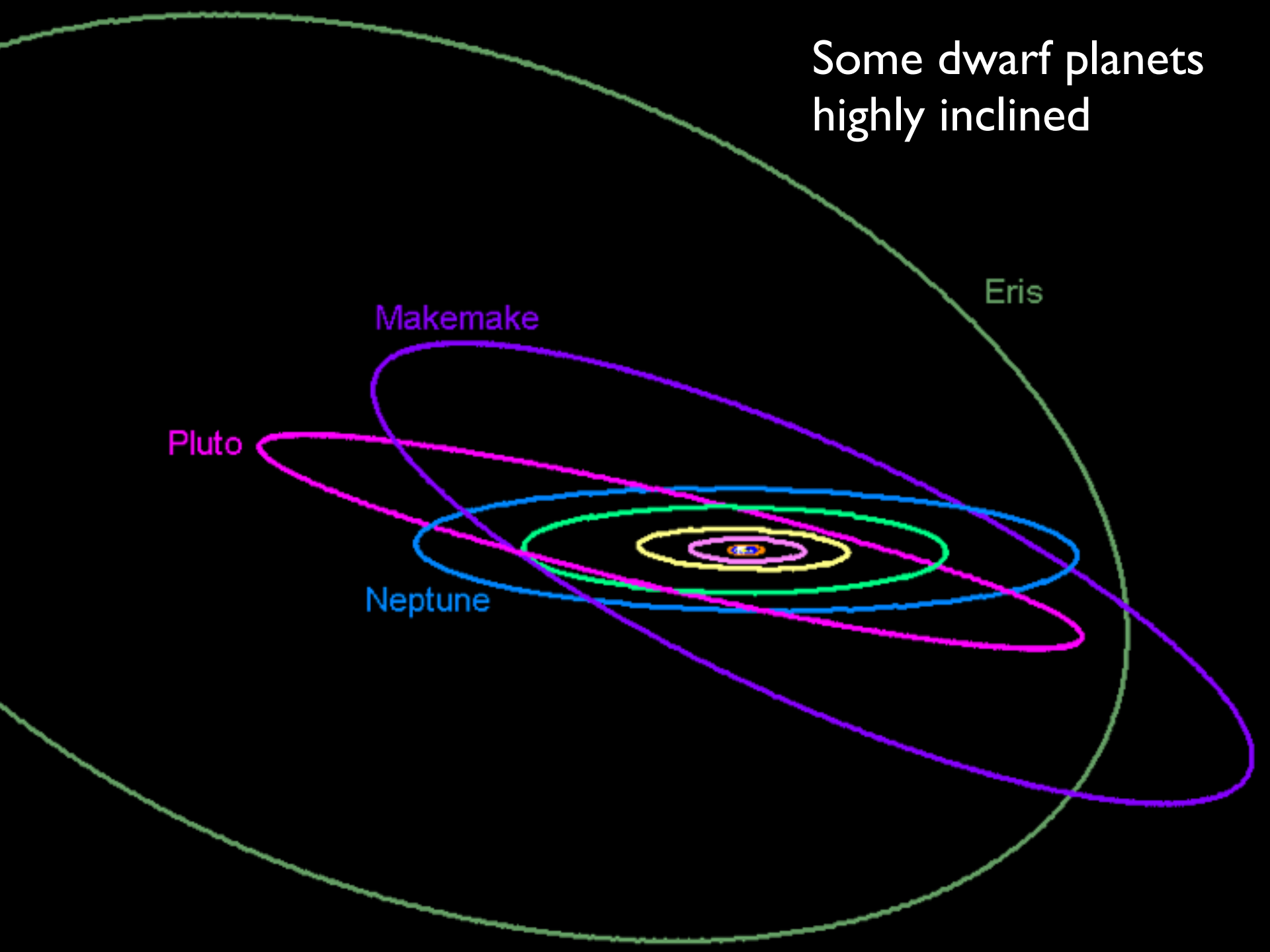


Dwarf planets are smaller than the major planets and some have quite elliptical orbits.

Most dwarf planets & asteroids also revolve prograde.

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

Some dwarf planets highly inclined

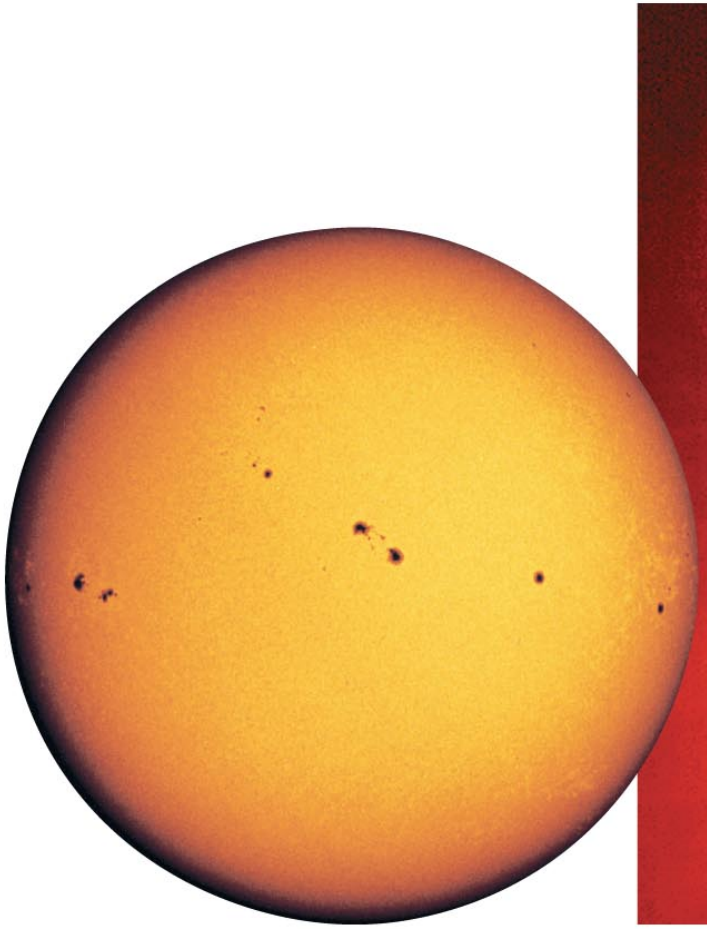


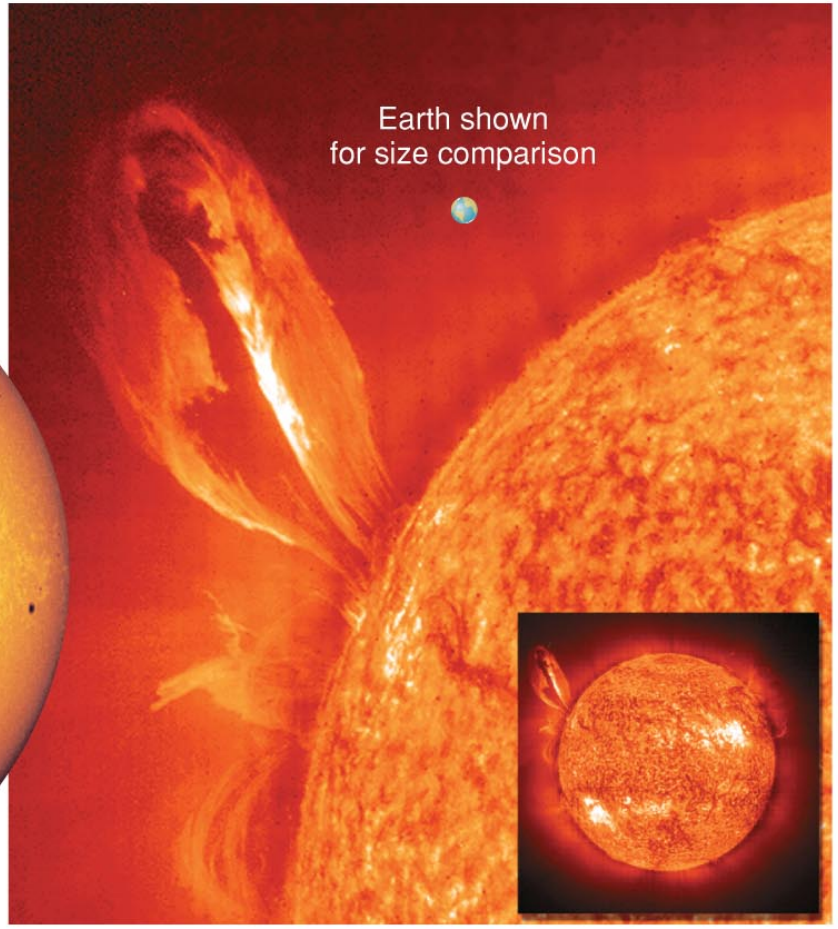
A Closer Look at the Contents

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

  } Gas Giants
- Moons
- Dwarf Planet
  - KBOs: Pluto, Quaoar, Eris, Sedna...
- Asteroids
- Comets
  - misc. dust, meteoroids, solar wind particles...

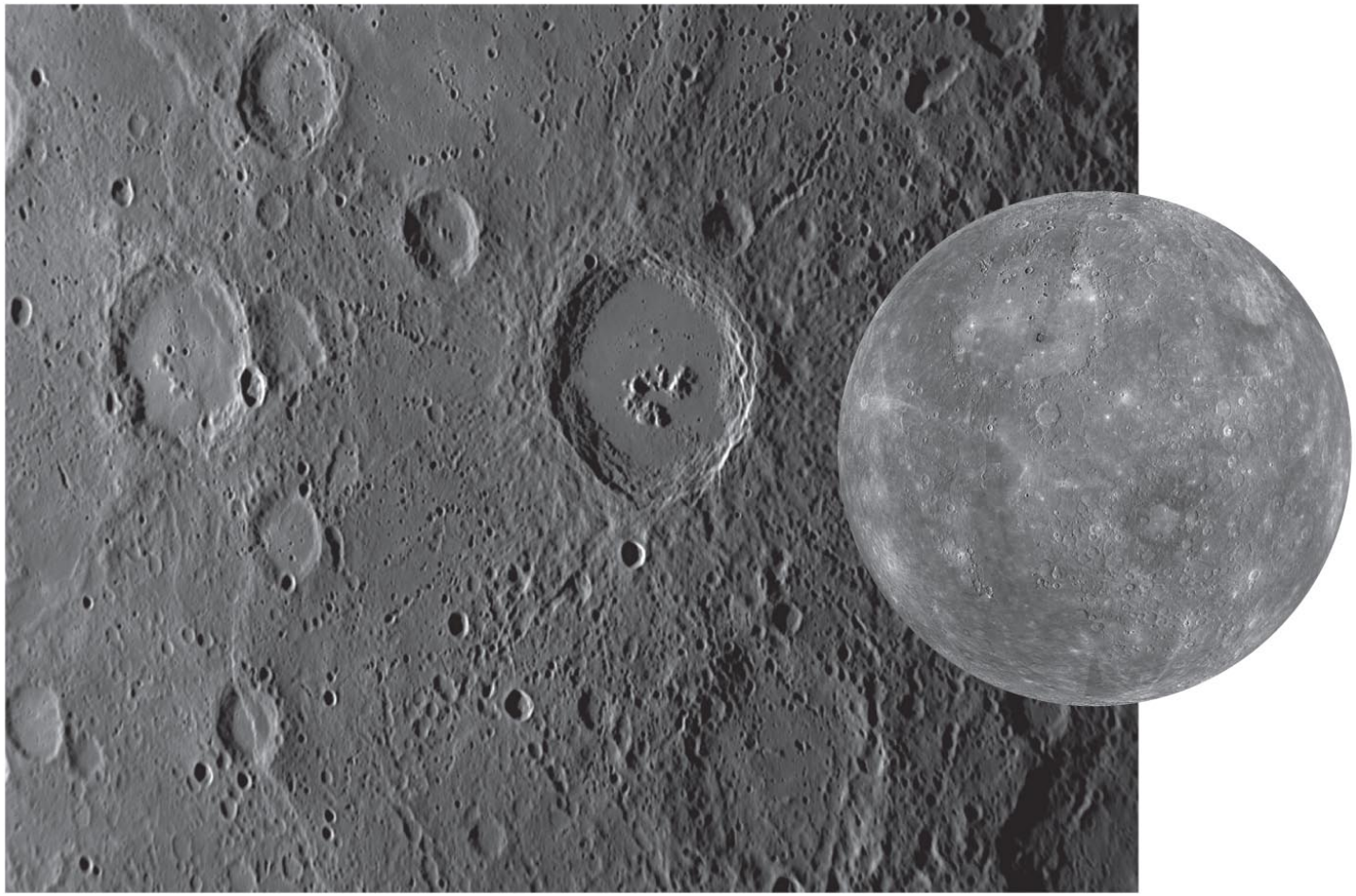
- The Sun





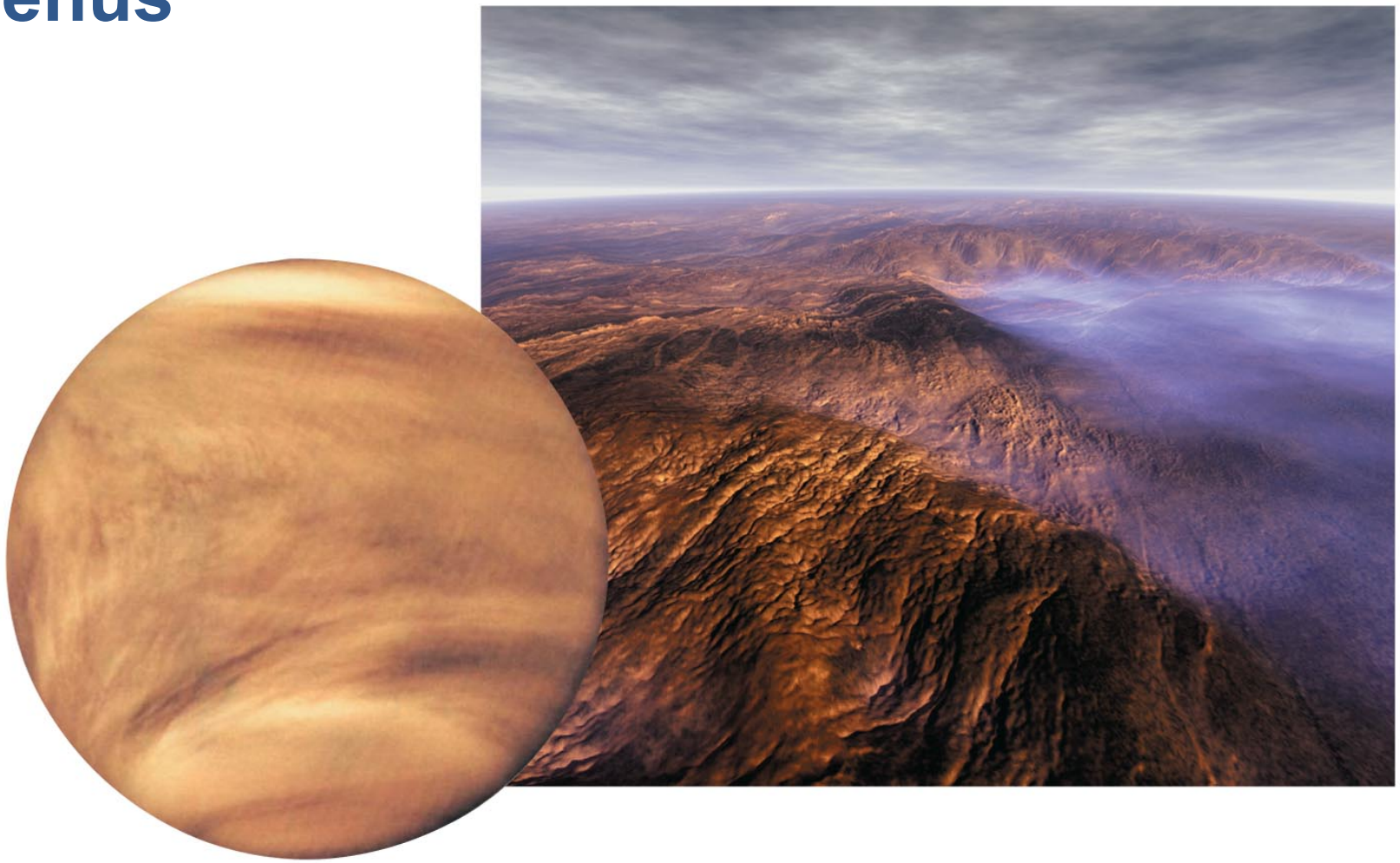
- Over 99.9% of solar system's mass
- Made mostly of H/He gas (plasma)
- Converts 4 million tons of mass into energy each second

Mercury



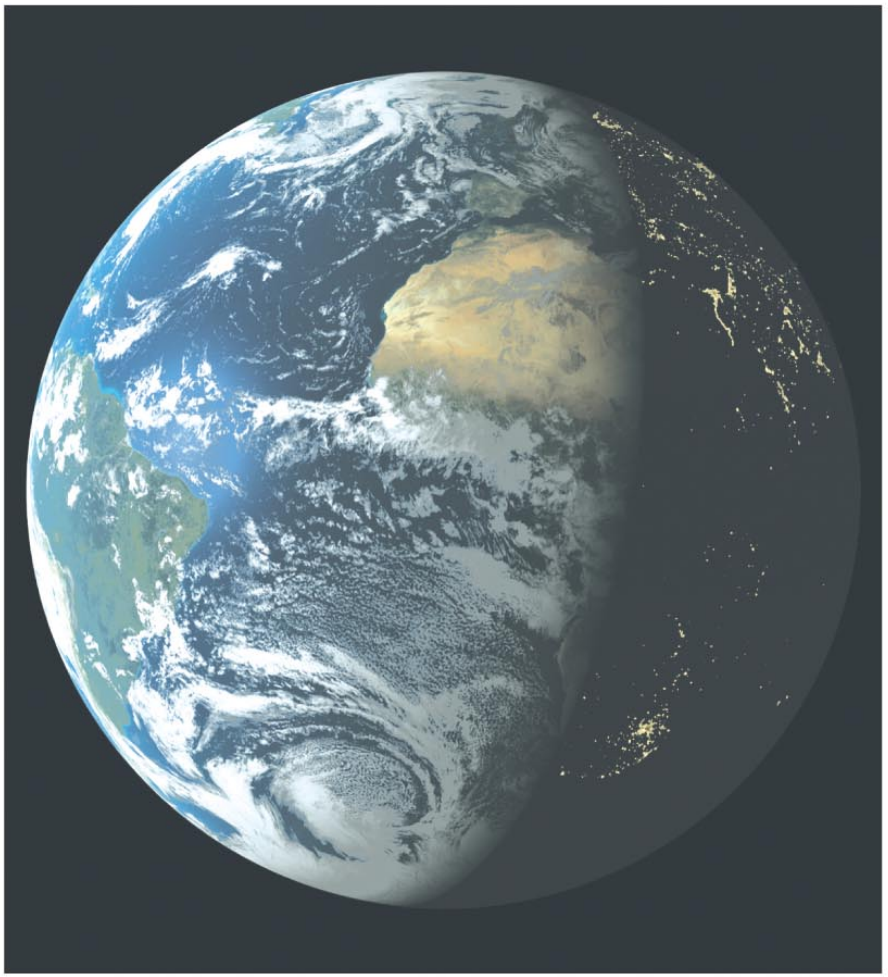
- Made of metal and rock; large iron core
- Desolate, cratered; long, tall, steep cliffs
- Very hot, very cold: 425°C (day), –170°C (night)

Venus



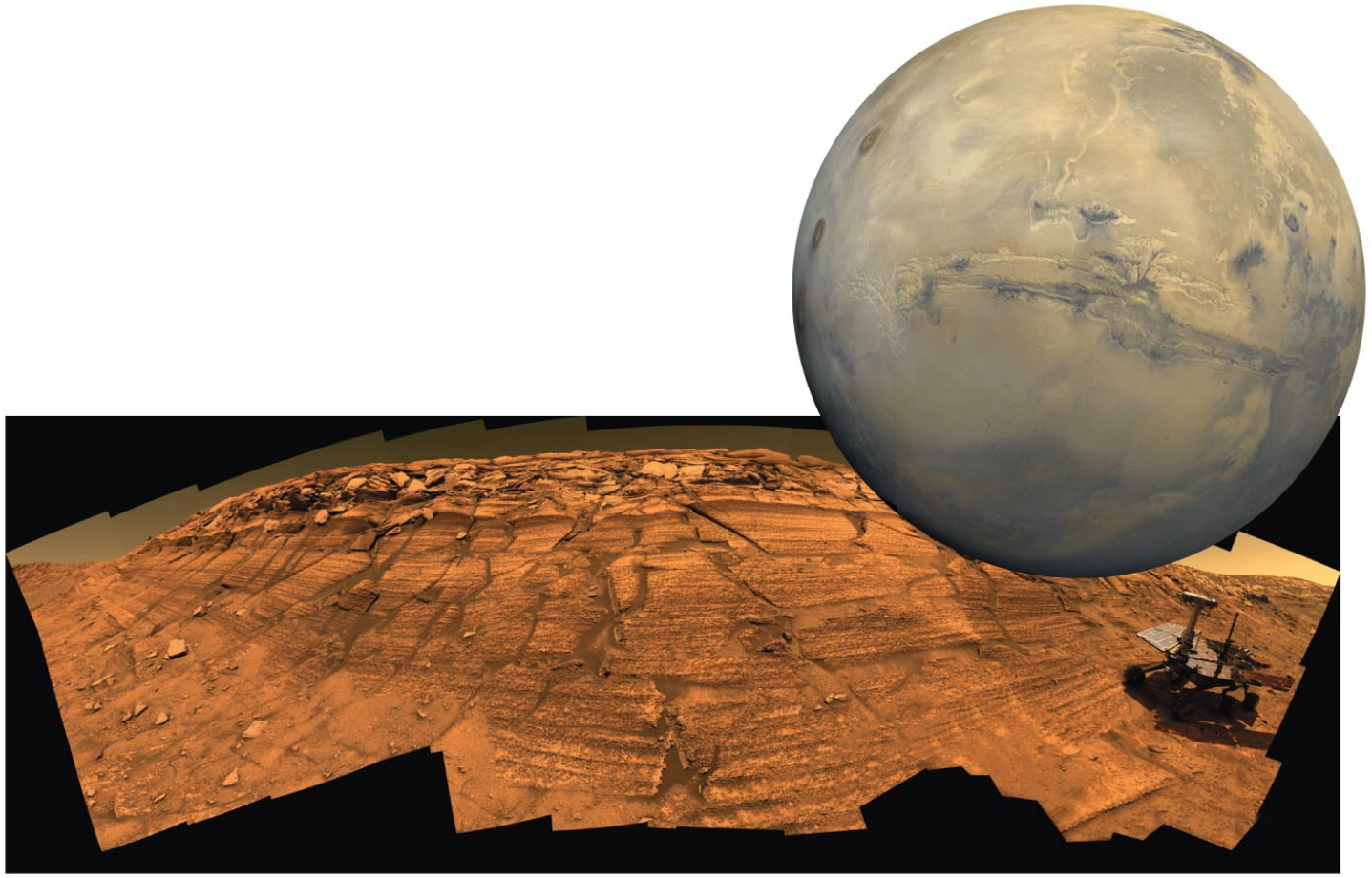
- Nearly identical in size to Earth; surface hidden by clouds
- Hellish conditions due to an extreme **greenhouse effect**
- Even hotter than Mercury: 470°C, day and night

Earth



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

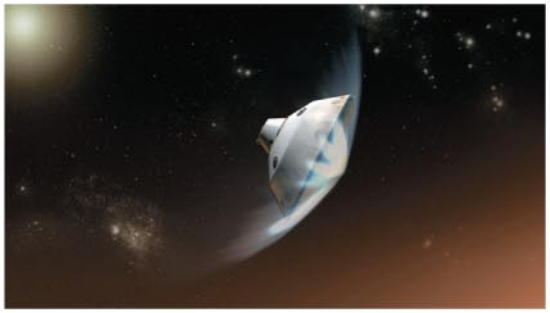
Mars



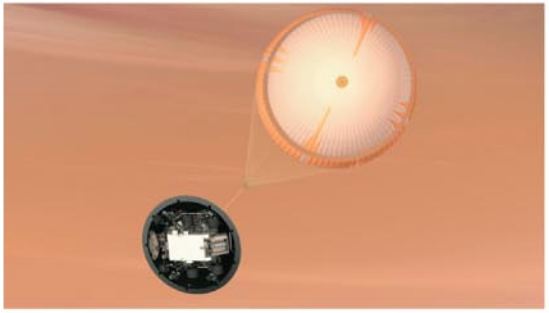
- Looks almost Earth-like, but don't go without a spacesuit!
- Giant volcanoes, a huge canyon, polar caps, more
- Water flowed in distant past; could there have been life?

Mars

- *Curiosity* rover landed in August 2012.

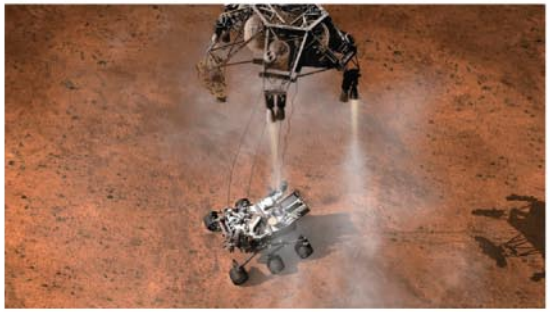


1 Friction slows spacecraft as it enters Mars atmosphere.

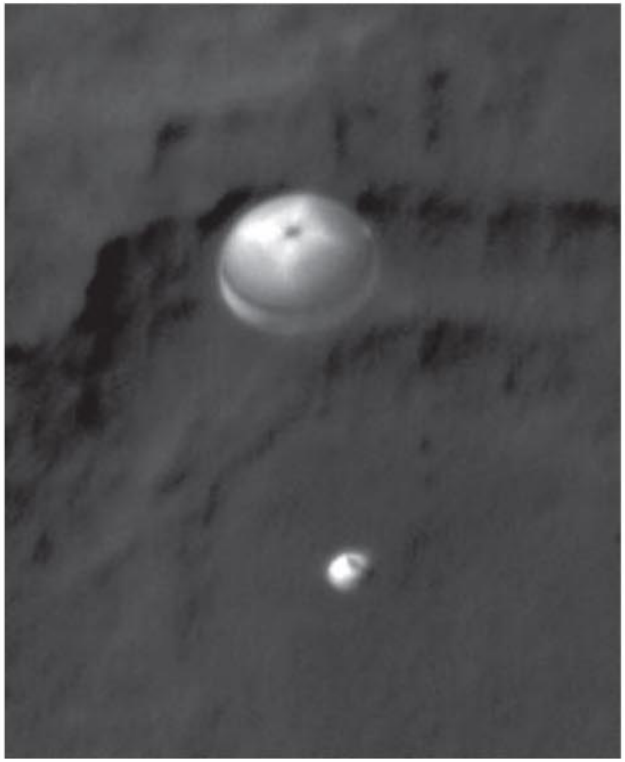


2 Parachute slows spacecraft to about 350 km/hr.

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



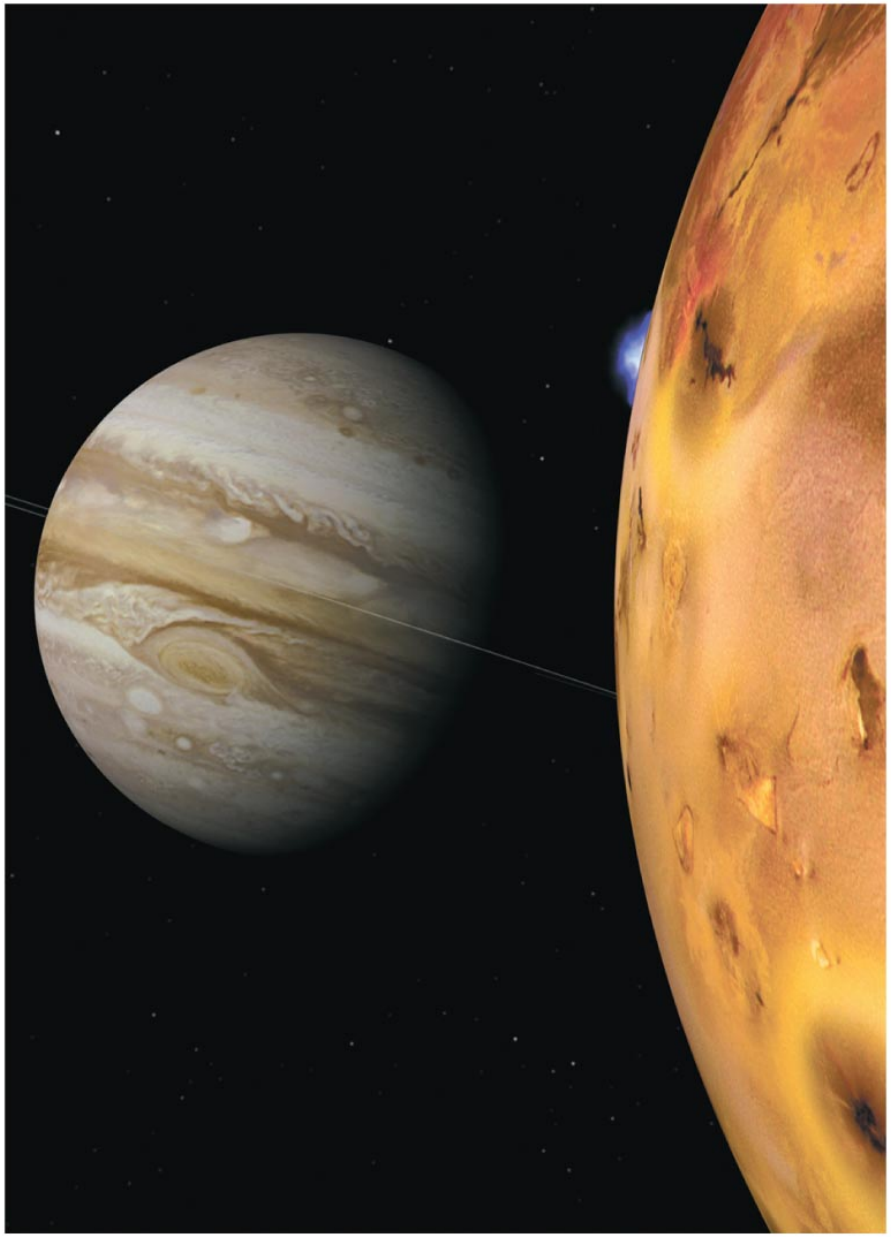
4 Tether released, the rocket heads off to crash a safe distance away.



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

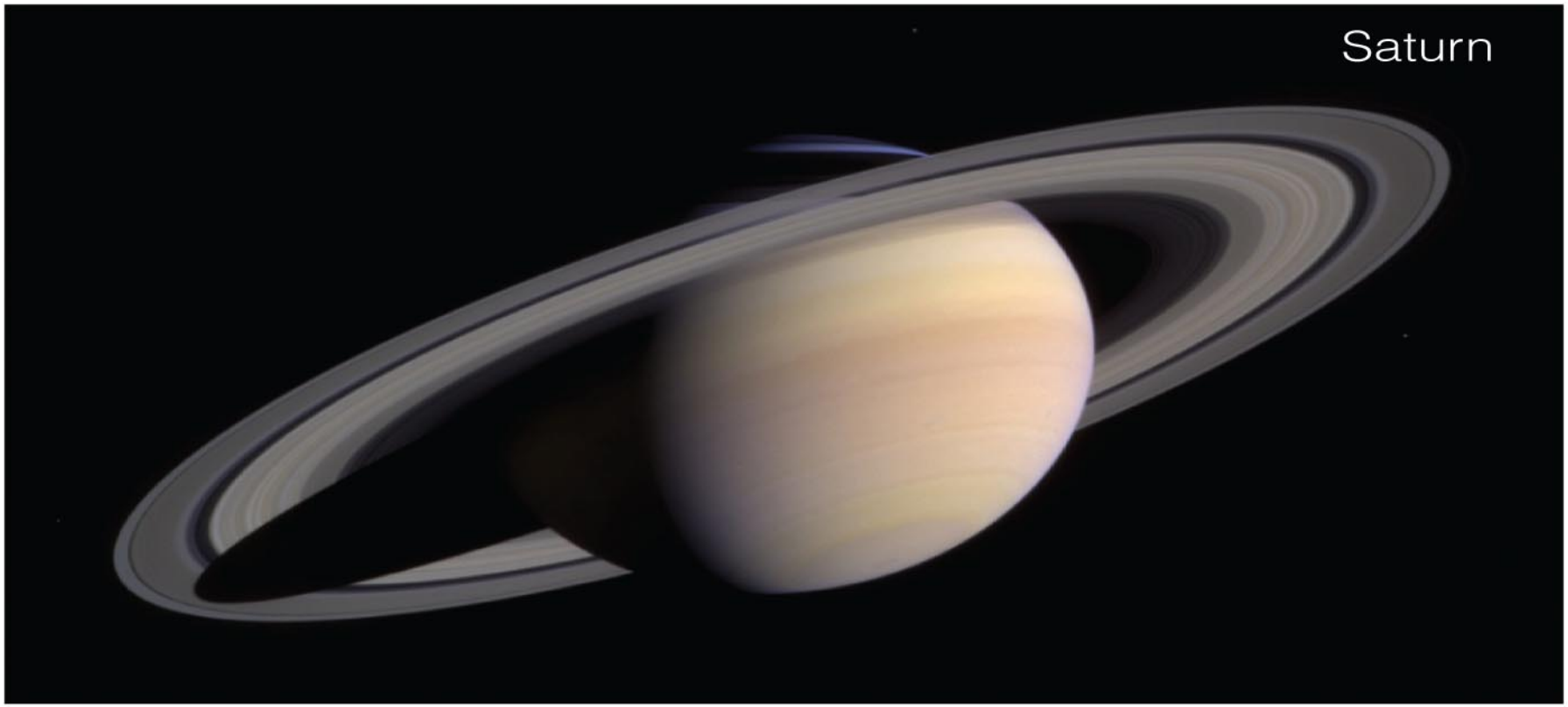
http://www.jpl.nasa.gov/video/details.php?id=1001 1:00 mark

Jupiter



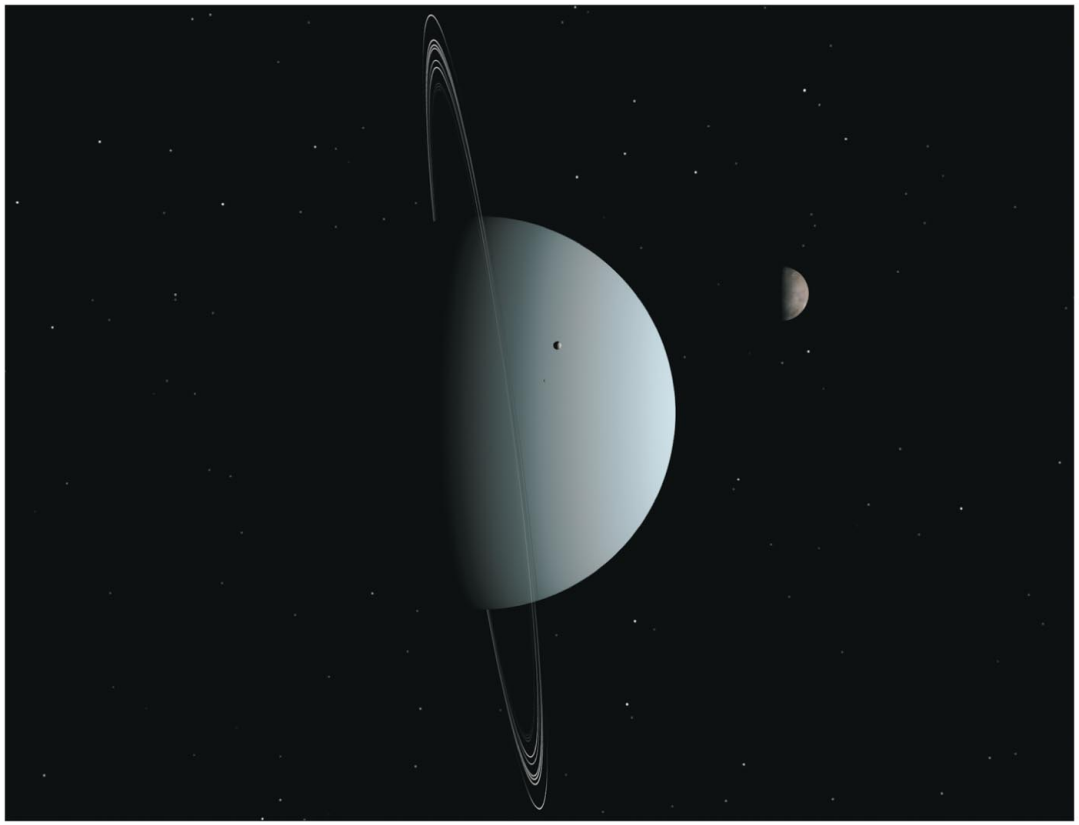
- Much farther from Sun than inner planets
- Mostly H/He; no solid surface
- 300 times more massive than Earth
- Many moons, rings

Saturn



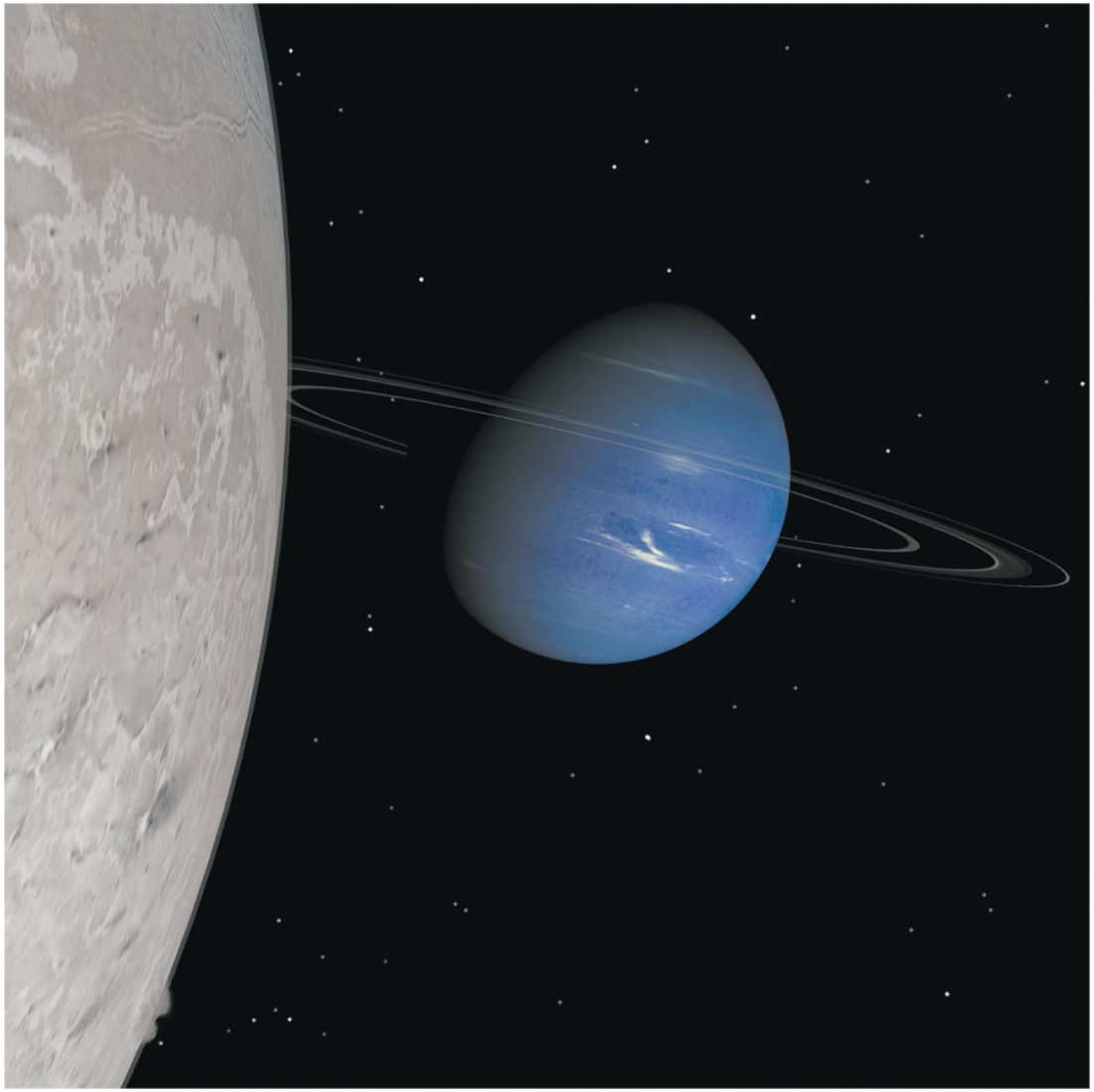
- Giant and gaseous like Jupiter
- Spectacular rings
- Many moons, including cloudy Titan

Uranus



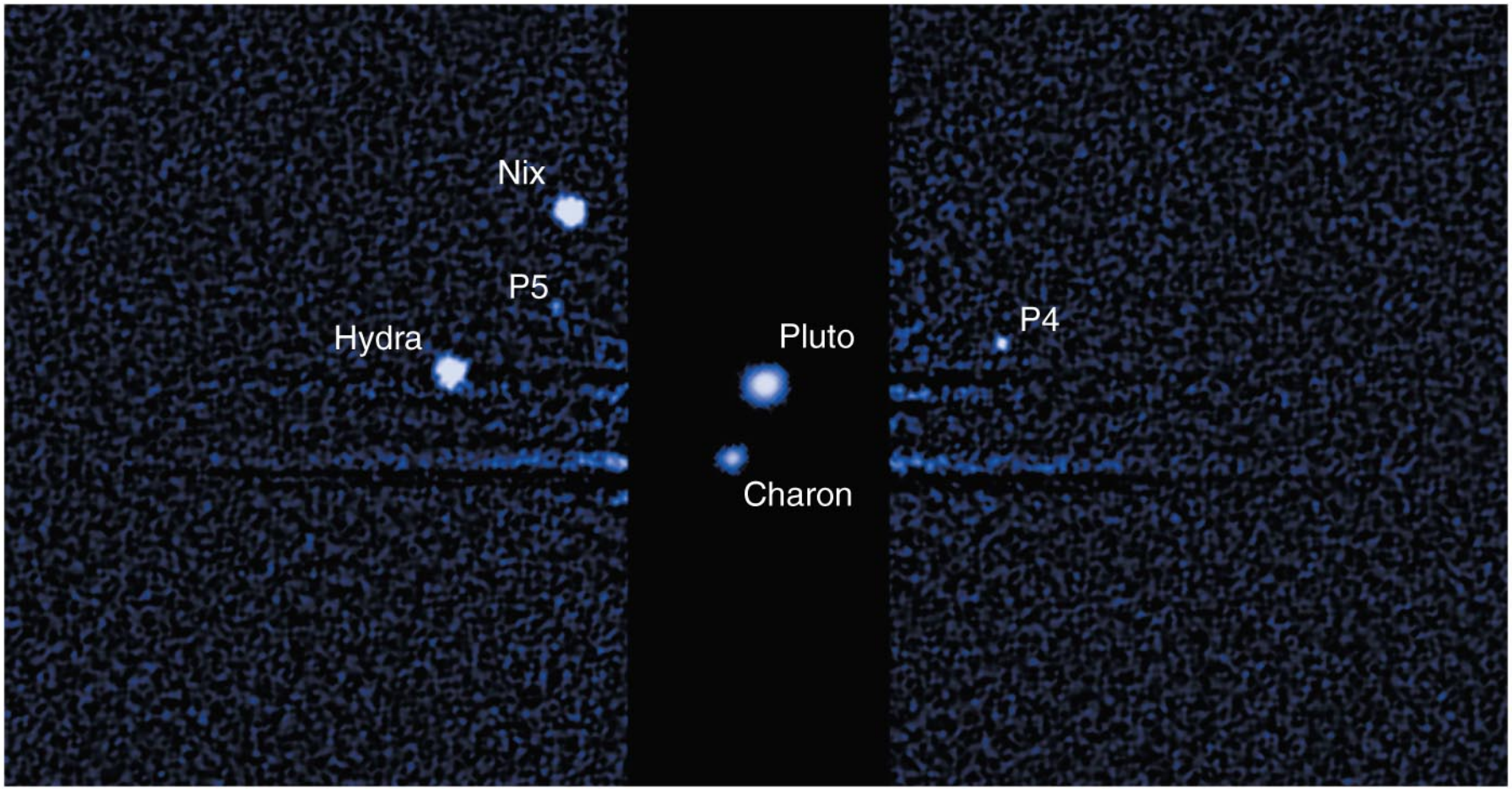
- Smaller than Jupiter/Saturn; much larger than Earth
- Made of H/He gas and **hydrogen compounds** (H_2O, NH_3, CH_4)
- Extreme axis tilt
- Moons and rings

Neptune



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

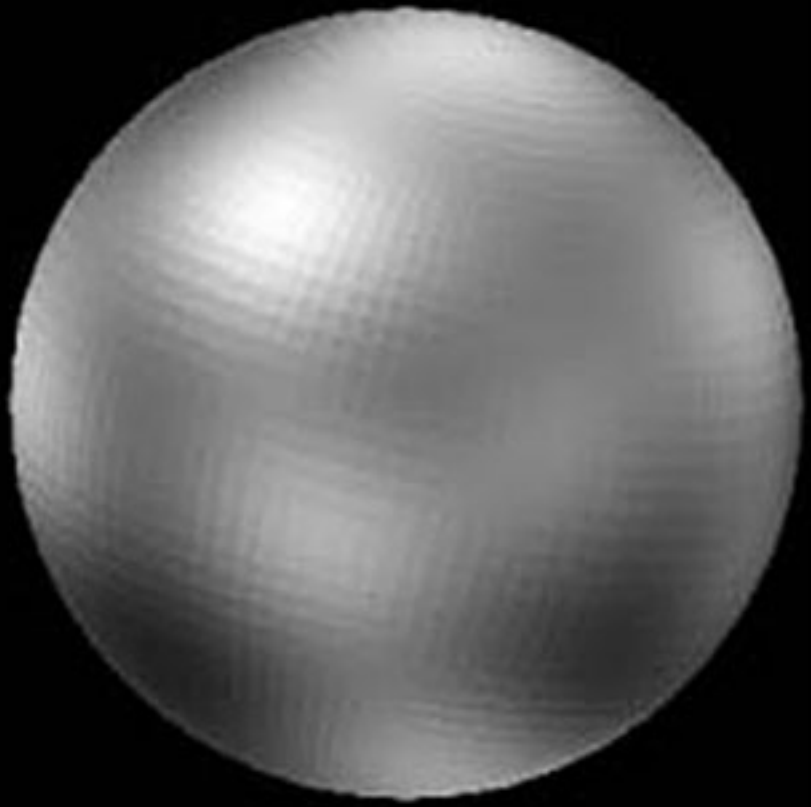
Dwarf Planets: Pluto, Eris, and more



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

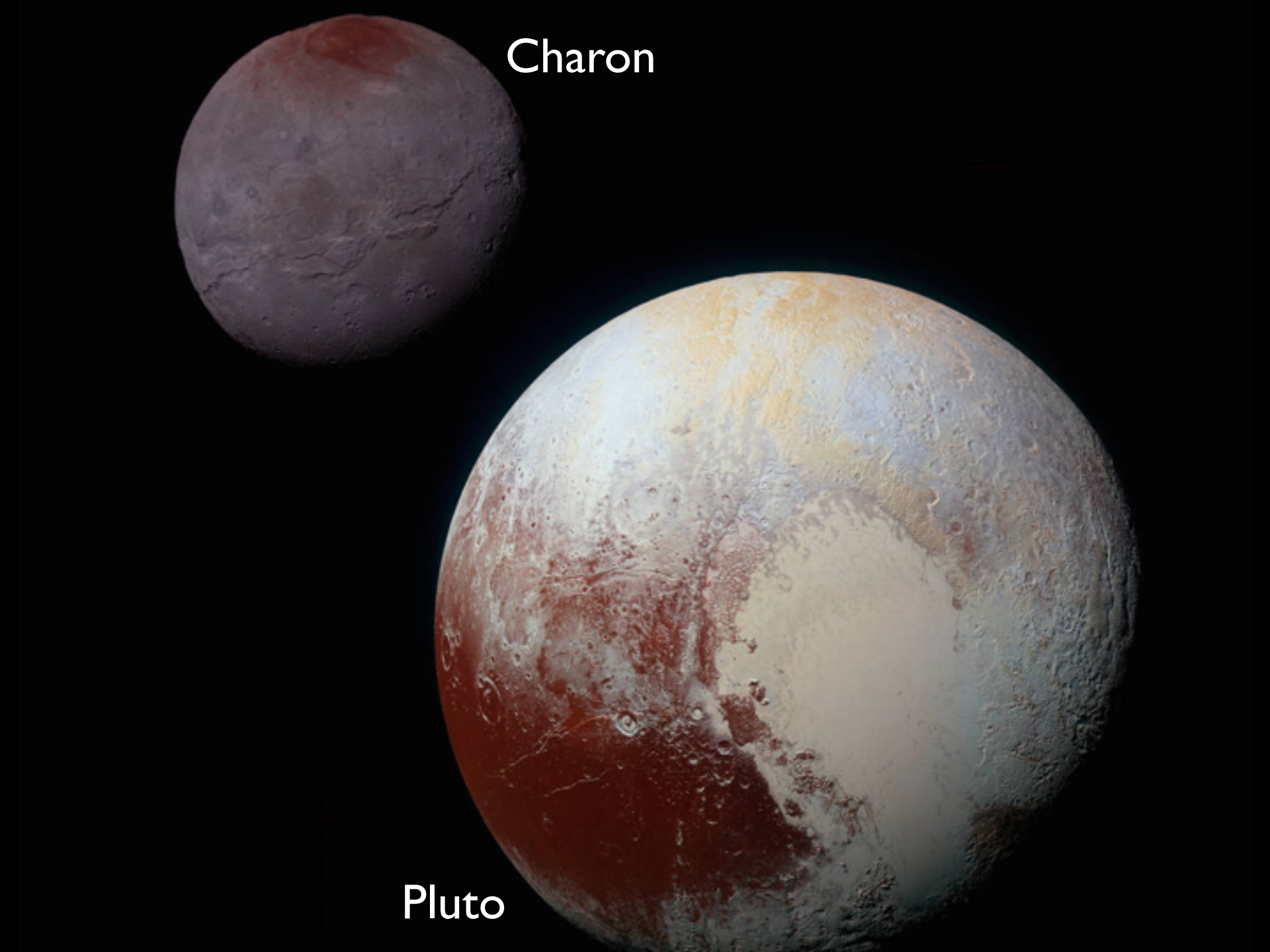
Hubble

New Horizons

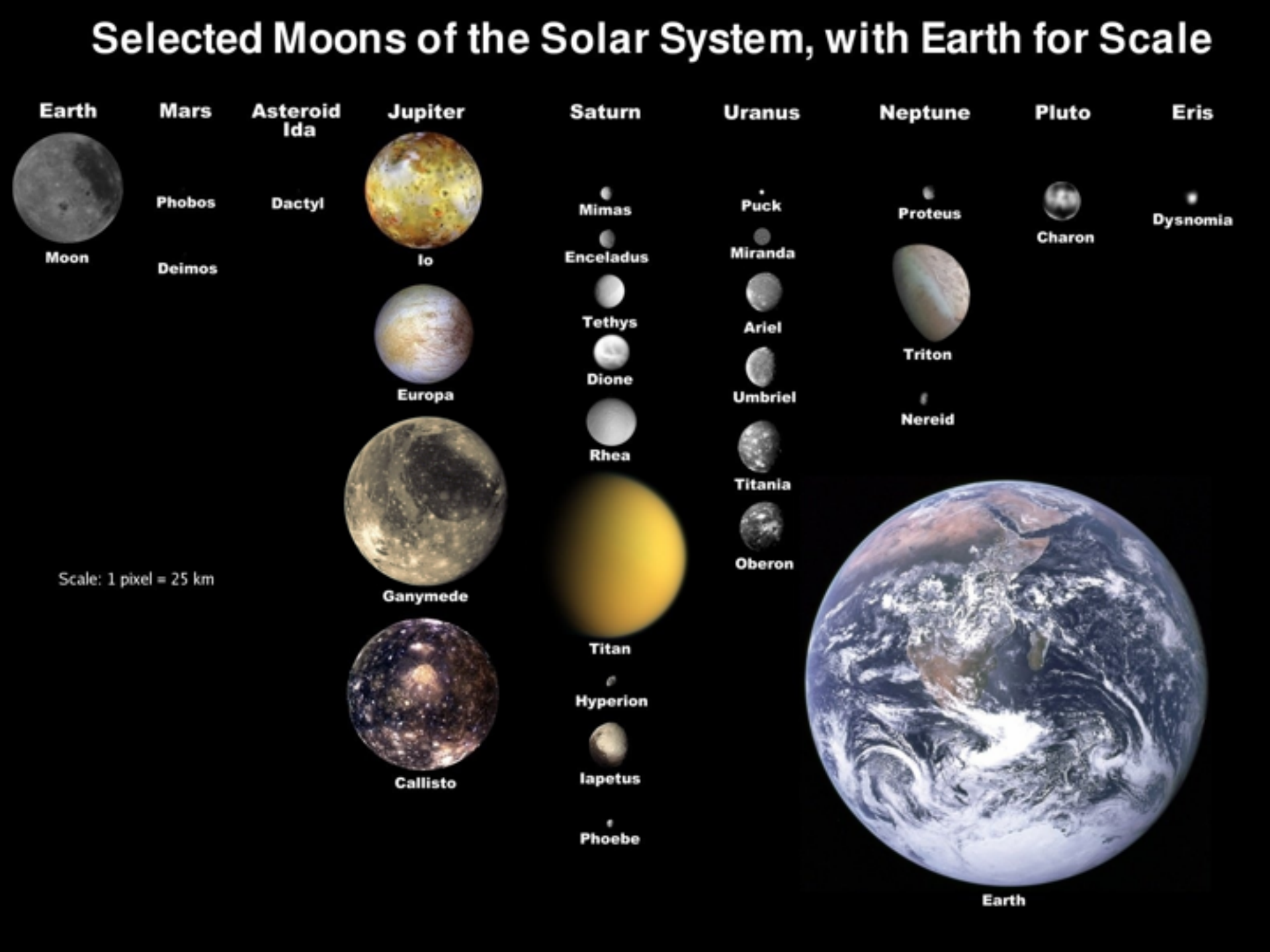


1996

2015


Charon
Pluto

Selected Moons of the Solar System, with Earth for Scale



Asteroids

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

5535 Annefrank
6.6 × 5.0 × 3.4 km
Stardust, 2002

2867 Steins
5.9 × 4.0 km
Rosetta, 2008

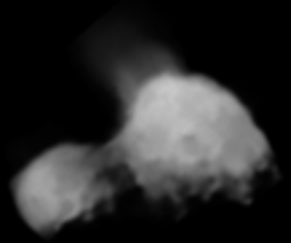
25143 Itokawa
0.5 × 0.3 × 0.2 km
Hayabusa, 2005

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

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

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

small
irregular
rocky bodies



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

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

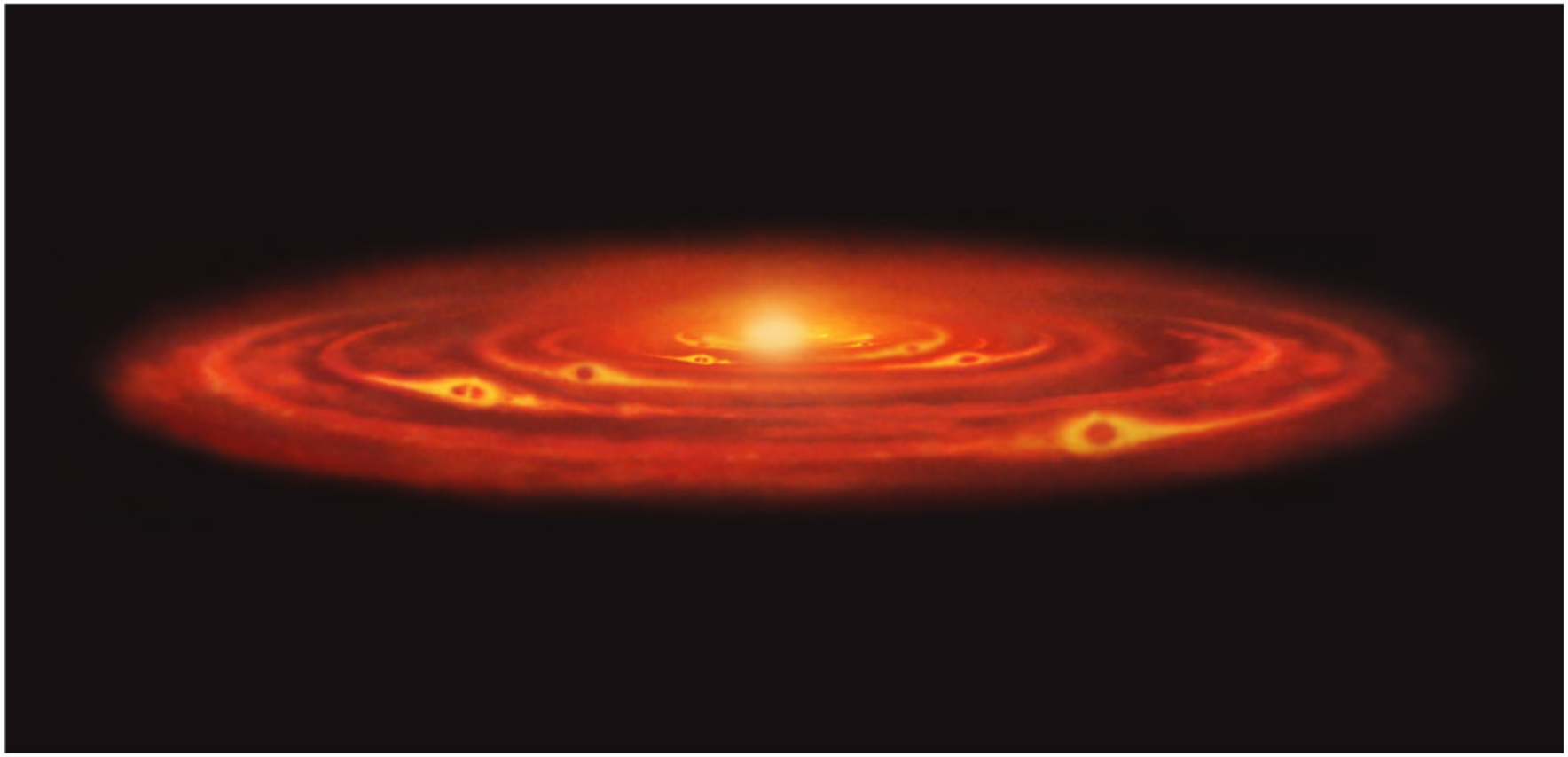
19P/Borrelly
8 × 4 km
Deep Space 1, 2001

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

Comets icy bodies

Formation of the Solar System

How did these things come to be?



What features of our solar system provide clues to how it formed?