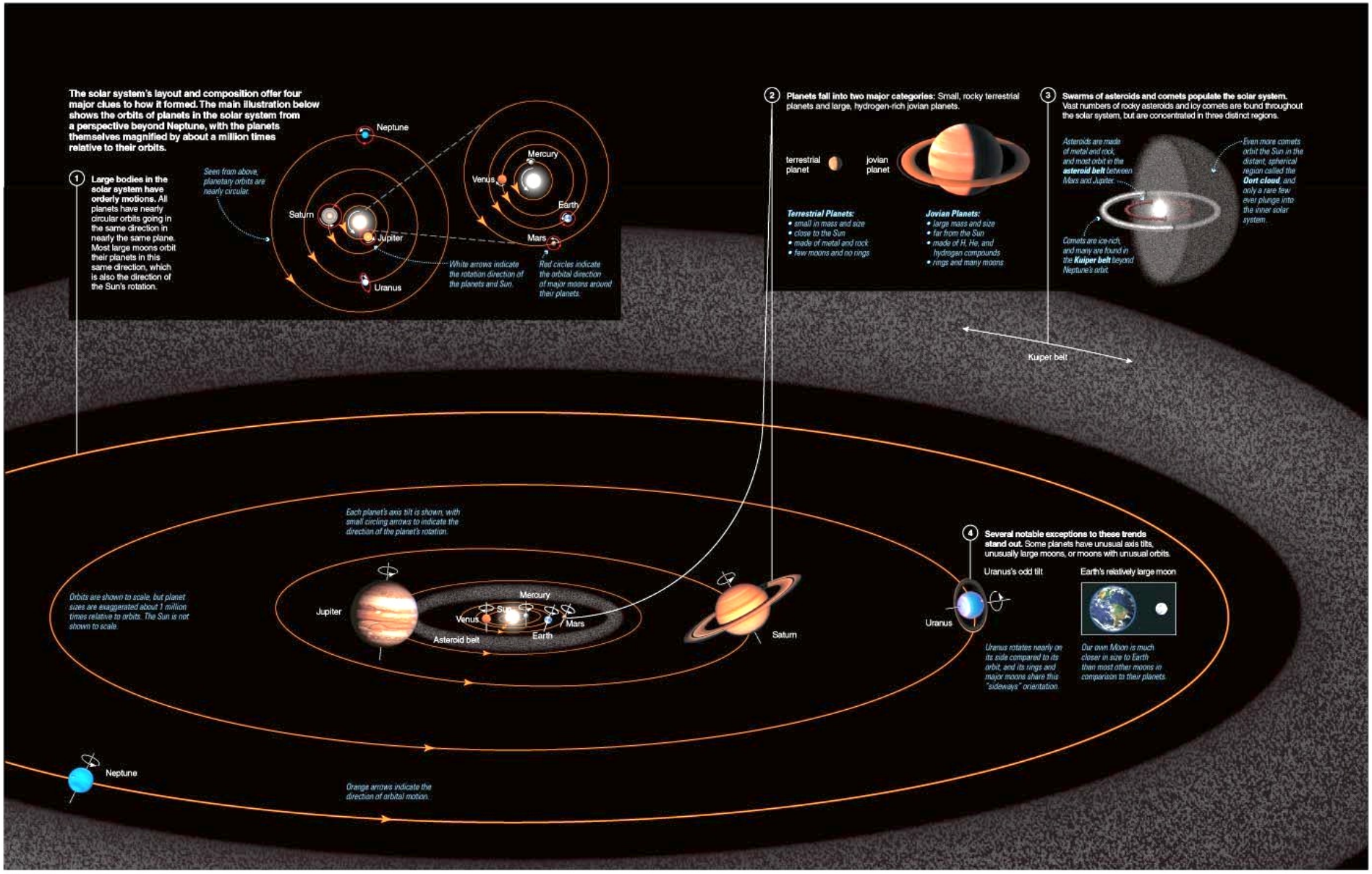
7.1 Studying the Solar System

- Our goals for learning:
  - **What does the solar system look like?**
  - **What can we learn by comparing the planets to one another?**

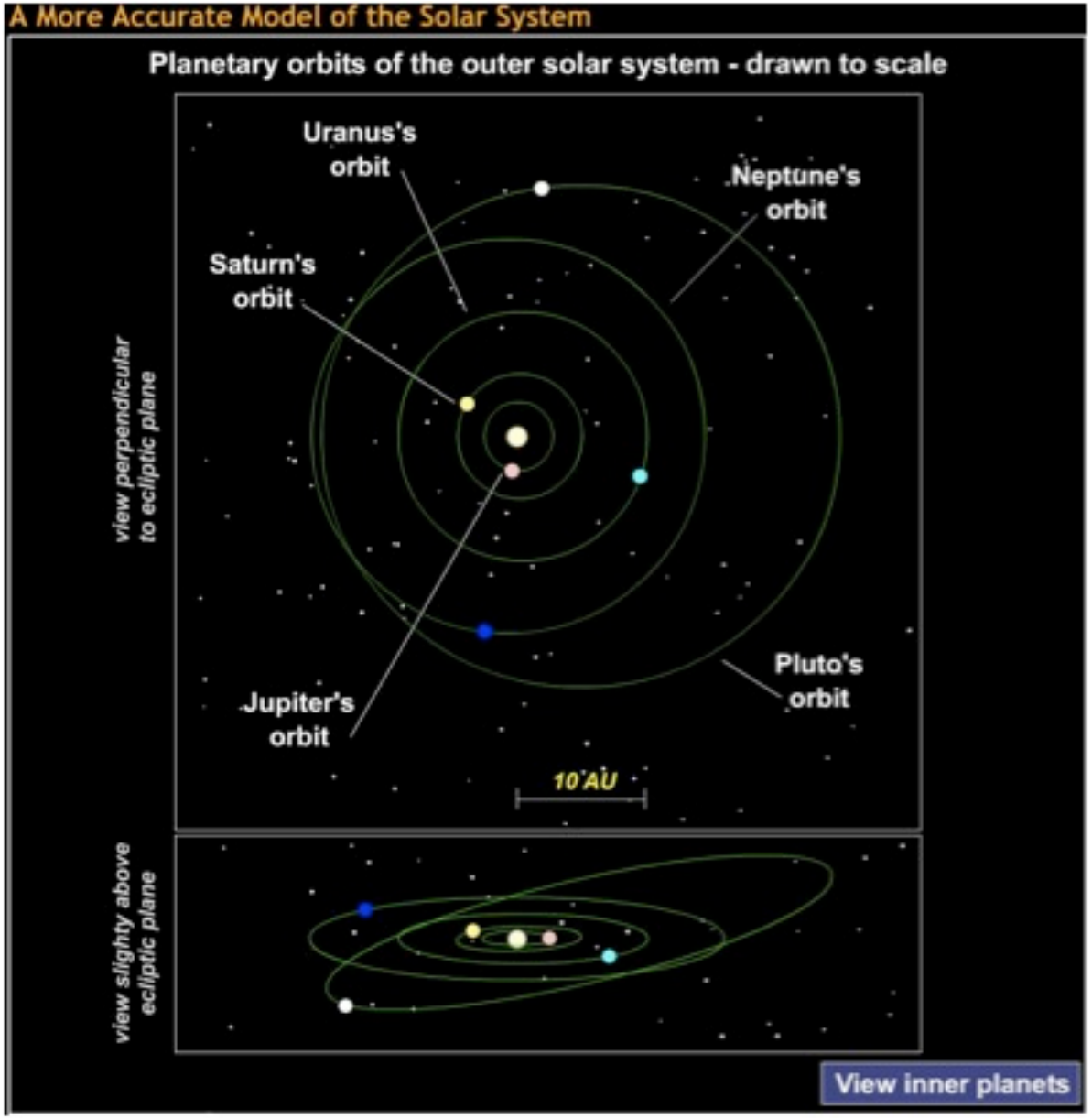
What does the solar system look like?



What does the solar system look like?

- The Sun lives at the center, and has most of the mass.
- There are eight major planets *(sorry, Pluto!)* with nearly circular orbits.
- Dwarf planets are smaller than the major planets and some have quite elliptical orbits.
- Asteroids (rocky, inner solar system) and comets (icy, outer solar system) abound.
- Many planets have moons big and small.

What does the solar system look like?

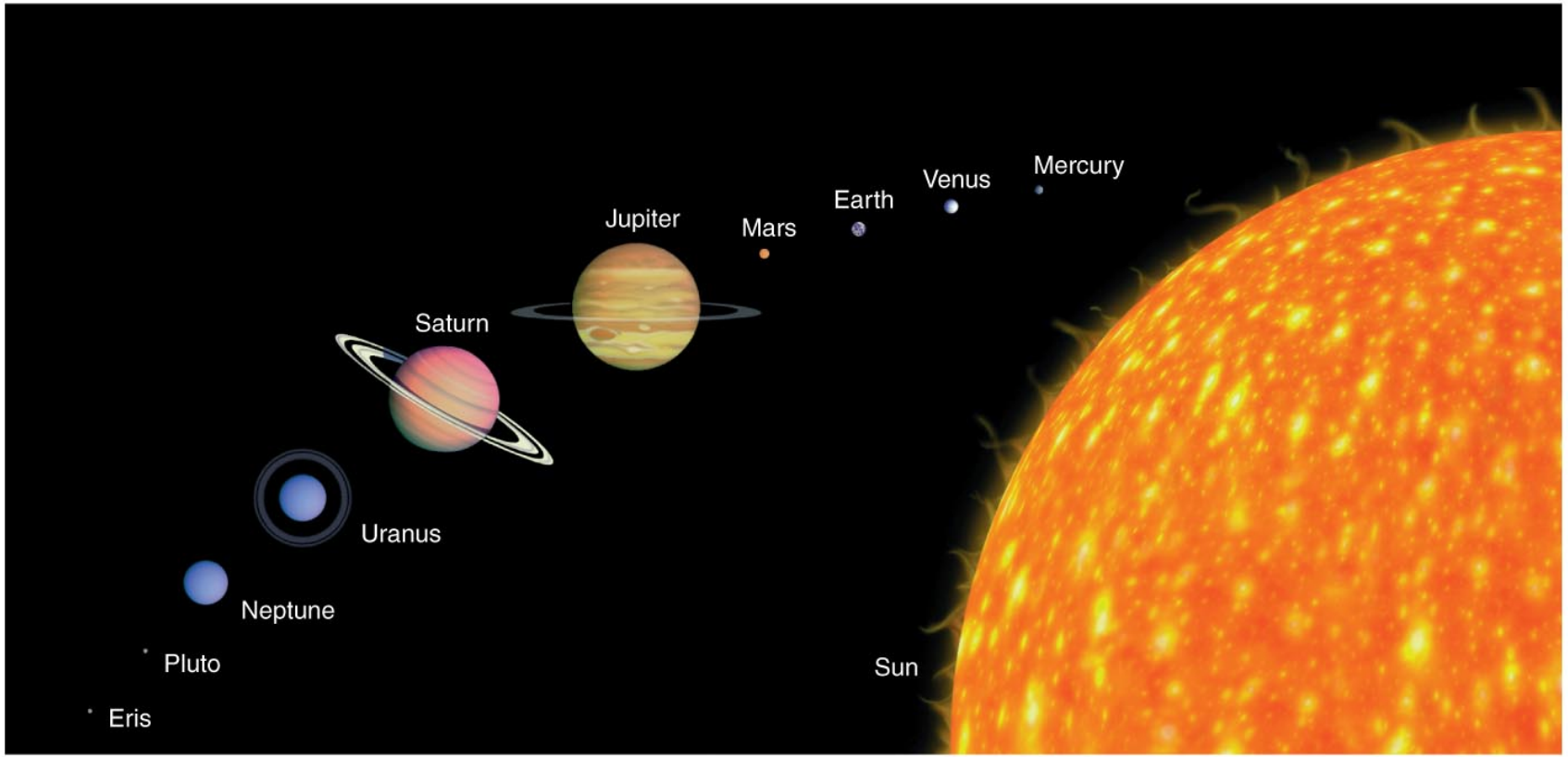


- 4 inner planets
- 4 outer planets
- Planets all orbit in same direction and nearly in same plane.

Comparative Planetology

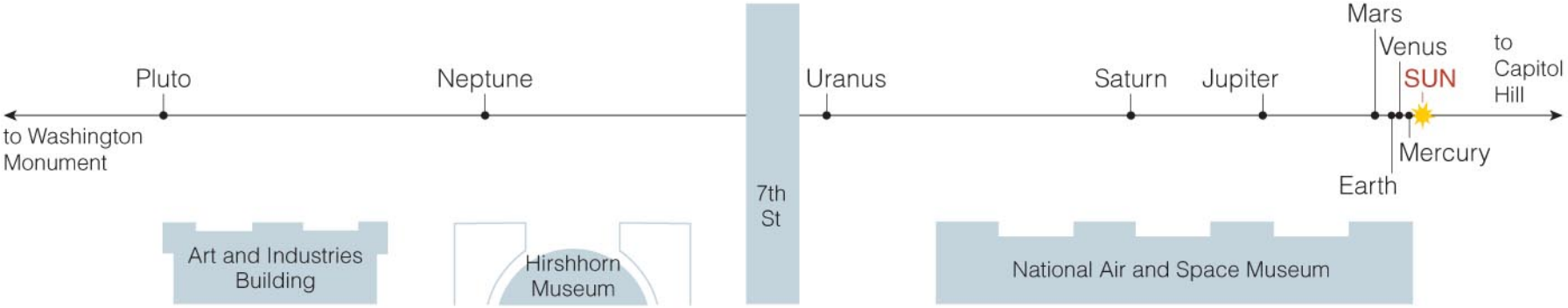
- We can learn more about a world like our Earth by studying it in context with other worlds in the solar system.
- Comparing the planets reveals patterns among them.
- Stay focused on *processes* common to multiple worlds instead of individual facts specific to a particular world.

What are the major features of the Sun and planets?



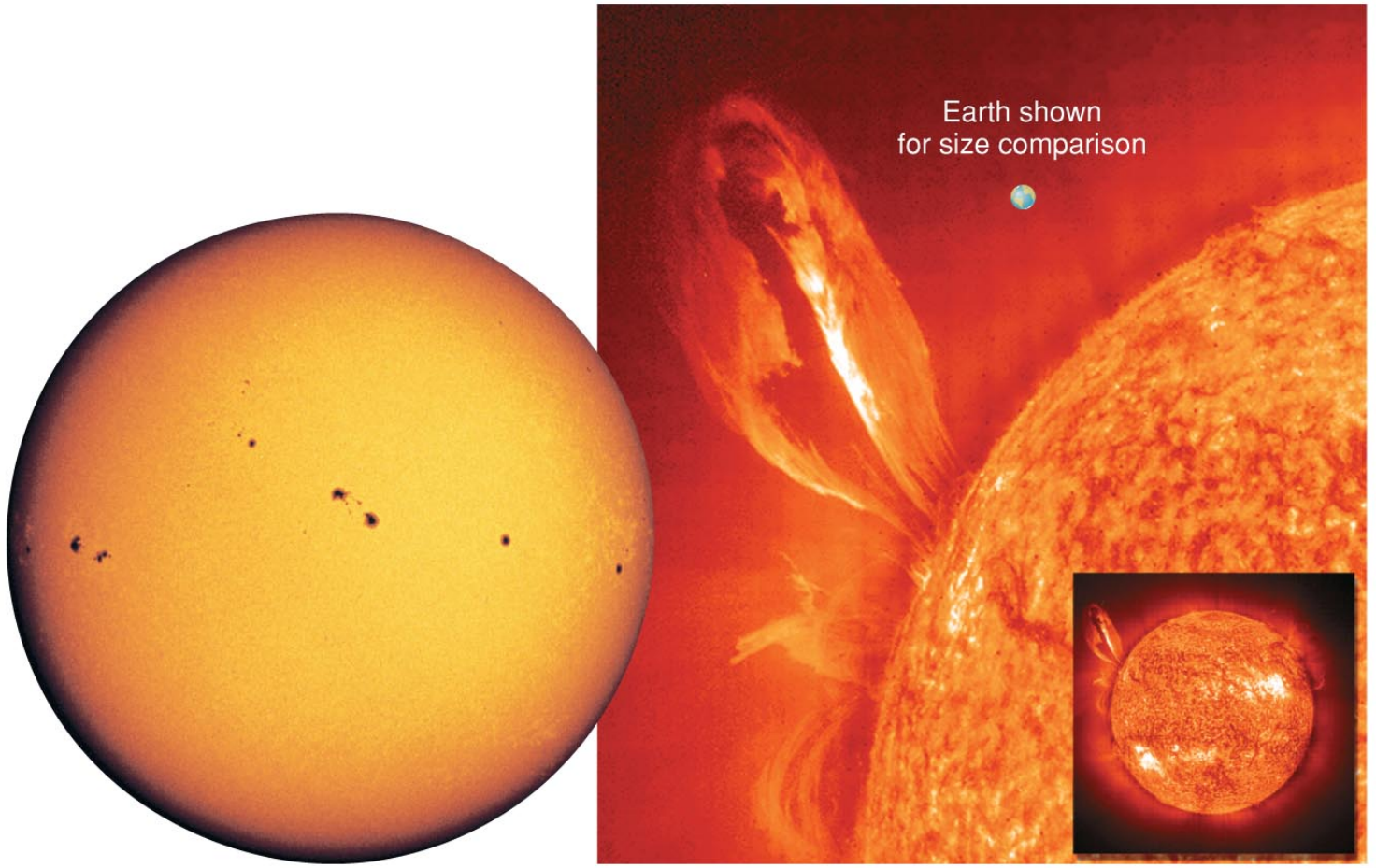
- Sun and planets to scale

Planets are very tiny compared to distances between them.



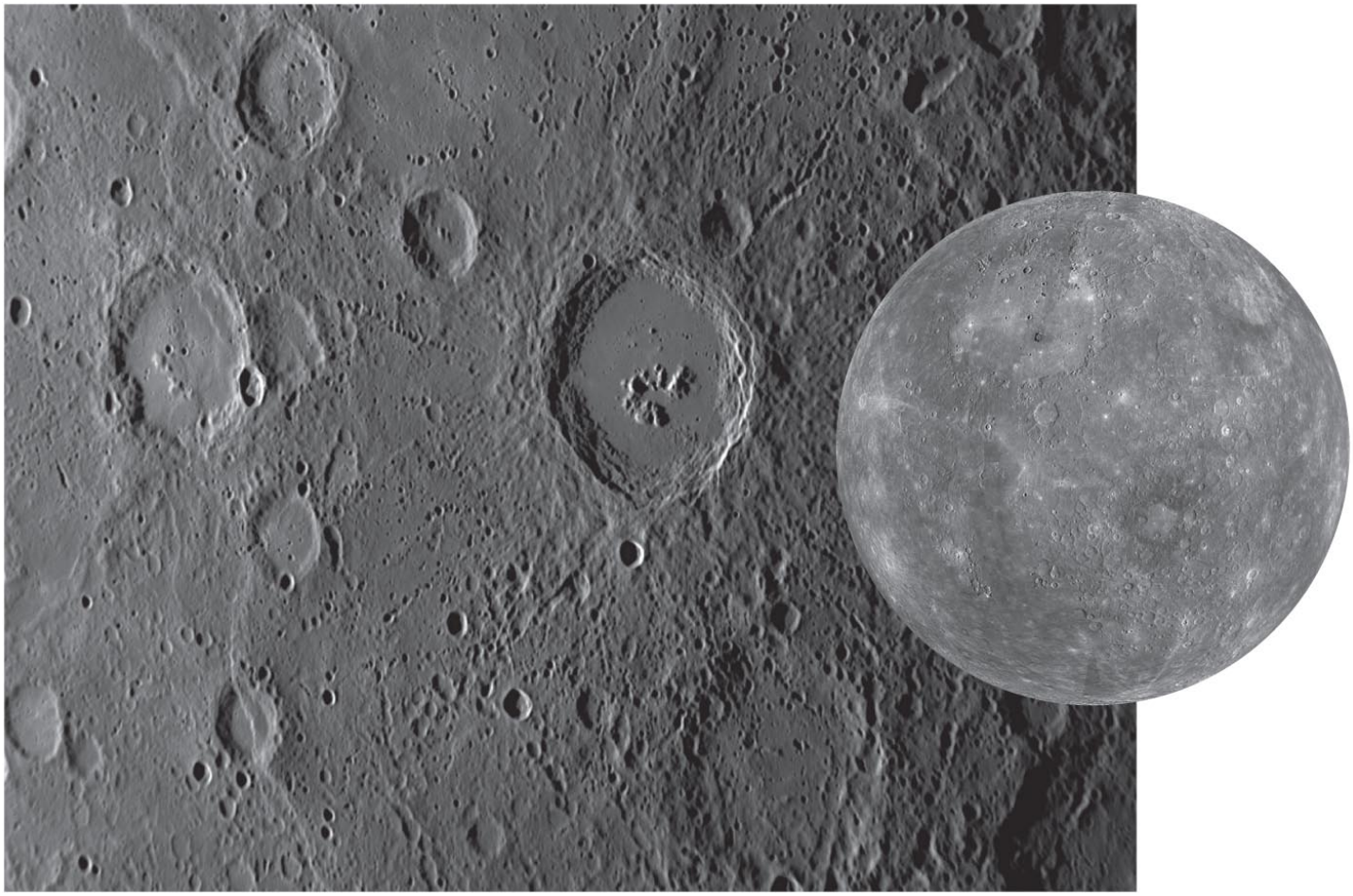
The Voyage scale model solar system represents sizes and distances in our solar system at one ten-billionth of their actual values (see Figure 1.6). The strip along the side of the page shows the sizes of the Sun and planets on this scale, and the map above shows their locations in the Voyage model on the National Mall in Washington, D.C. The Sun is about the size of a large grapefruit on this scale.

Sun



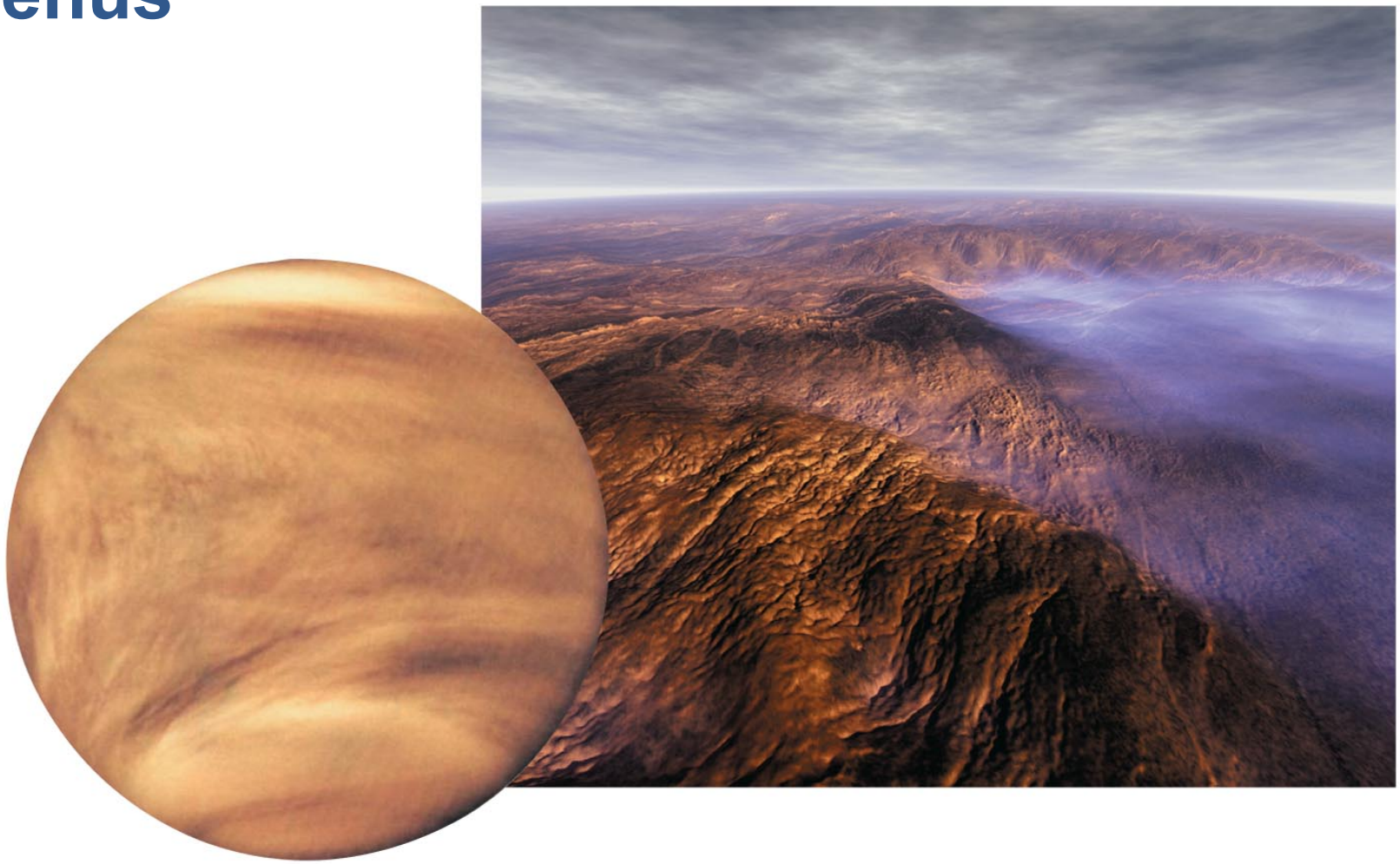
- Over 99.9% of solar system's mass
- Made mostly of H/He gas (plasma)
- Converts 4 million tons of mass into energy each second

Mercury



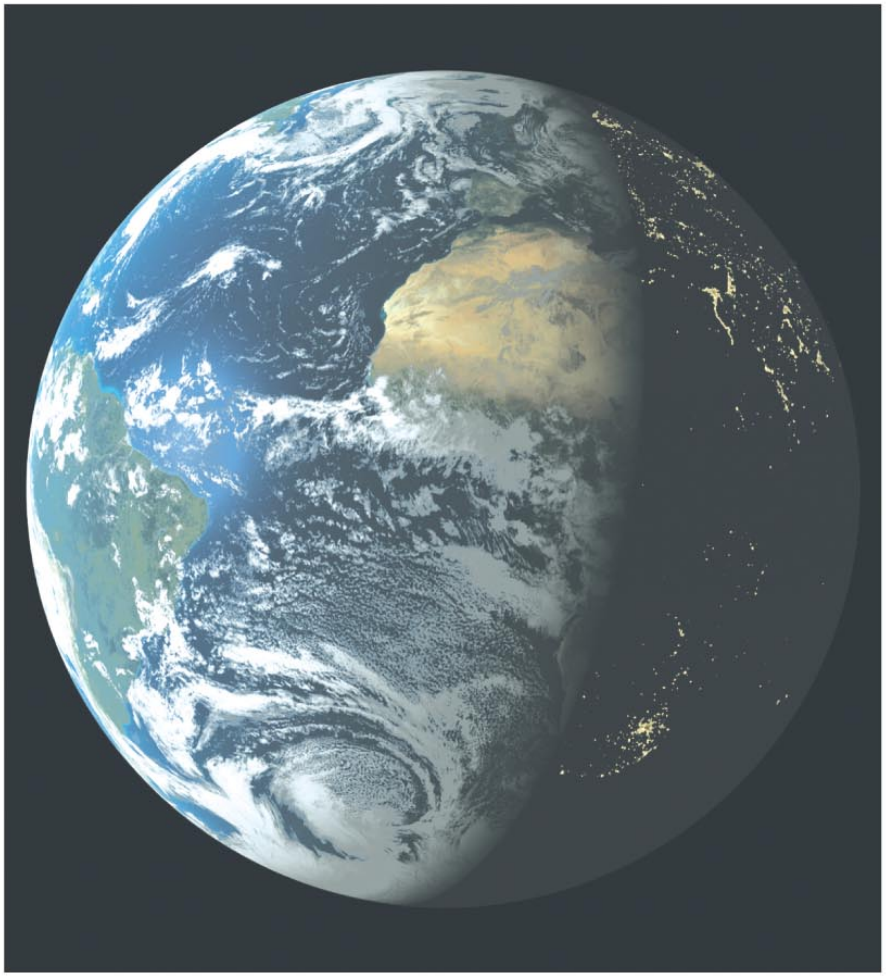
- Made of metal and rock; large iron core
- Desolate, cratered; long, tall, steep cliffs
- Very hot, very cold: 425°C (day), –170°C (night)

Venus



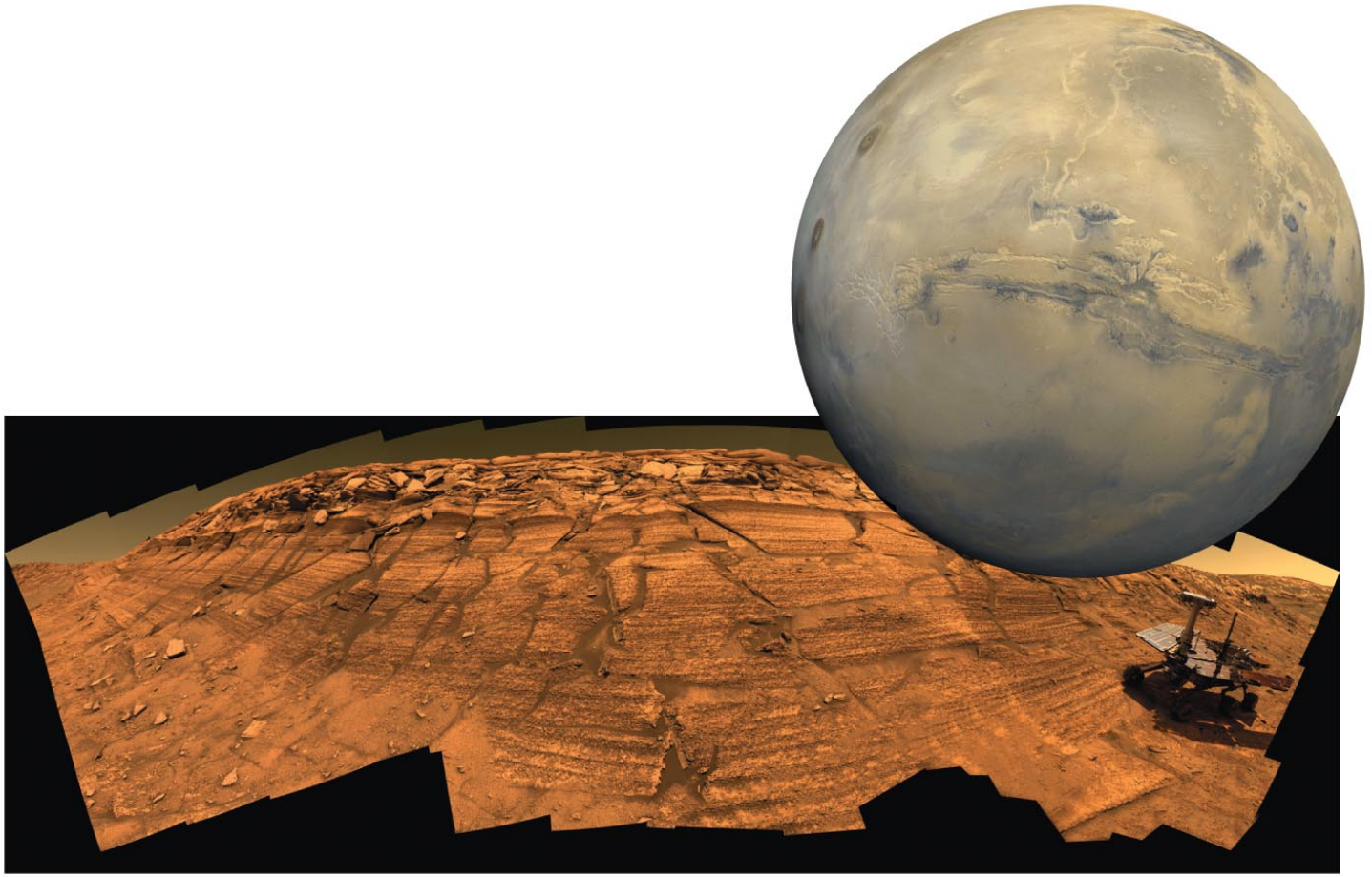
- Nearly identical in size to Earth; surface hidden by clouds
- Hellish conditions due to an extreme **greenhouse effect**
- Even hotter than Mercury: 470°C, day and night

Earth



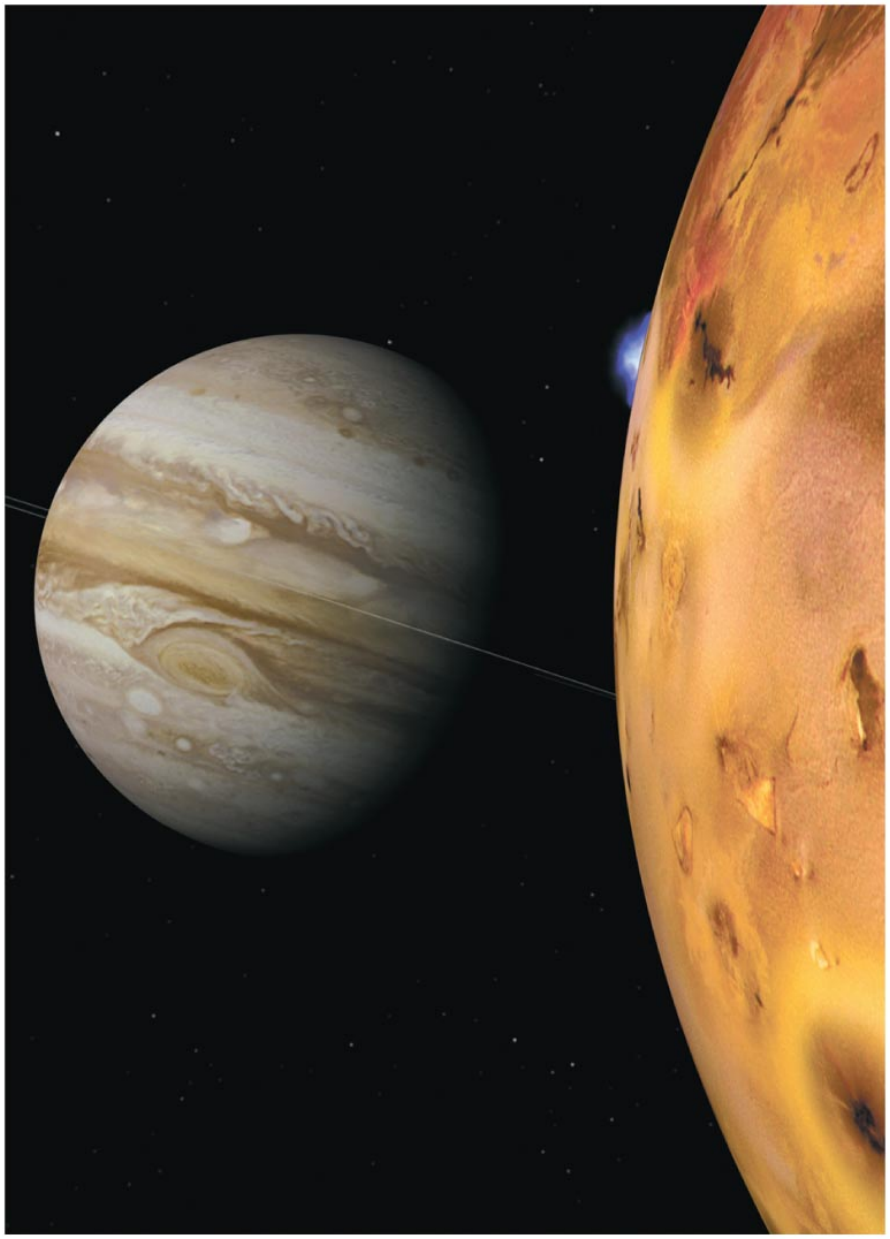
- An oasis of life
- The only surface liquid water in the solar system
- A surprisingly large moon

Mars



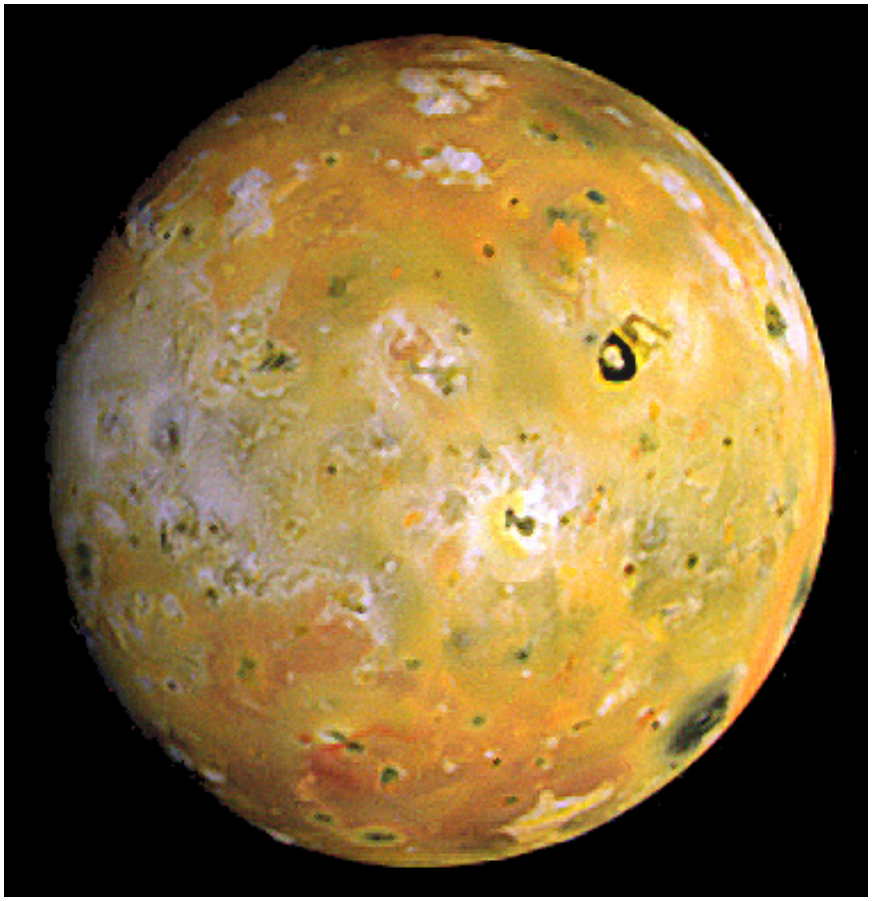
- Looks almost Earth-like, but don't go without a spacesuit!
- Giant volcanoes, a huge canyon, polar caps, more
- Water flowed in distant past; could there have been life?

Jupiter



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

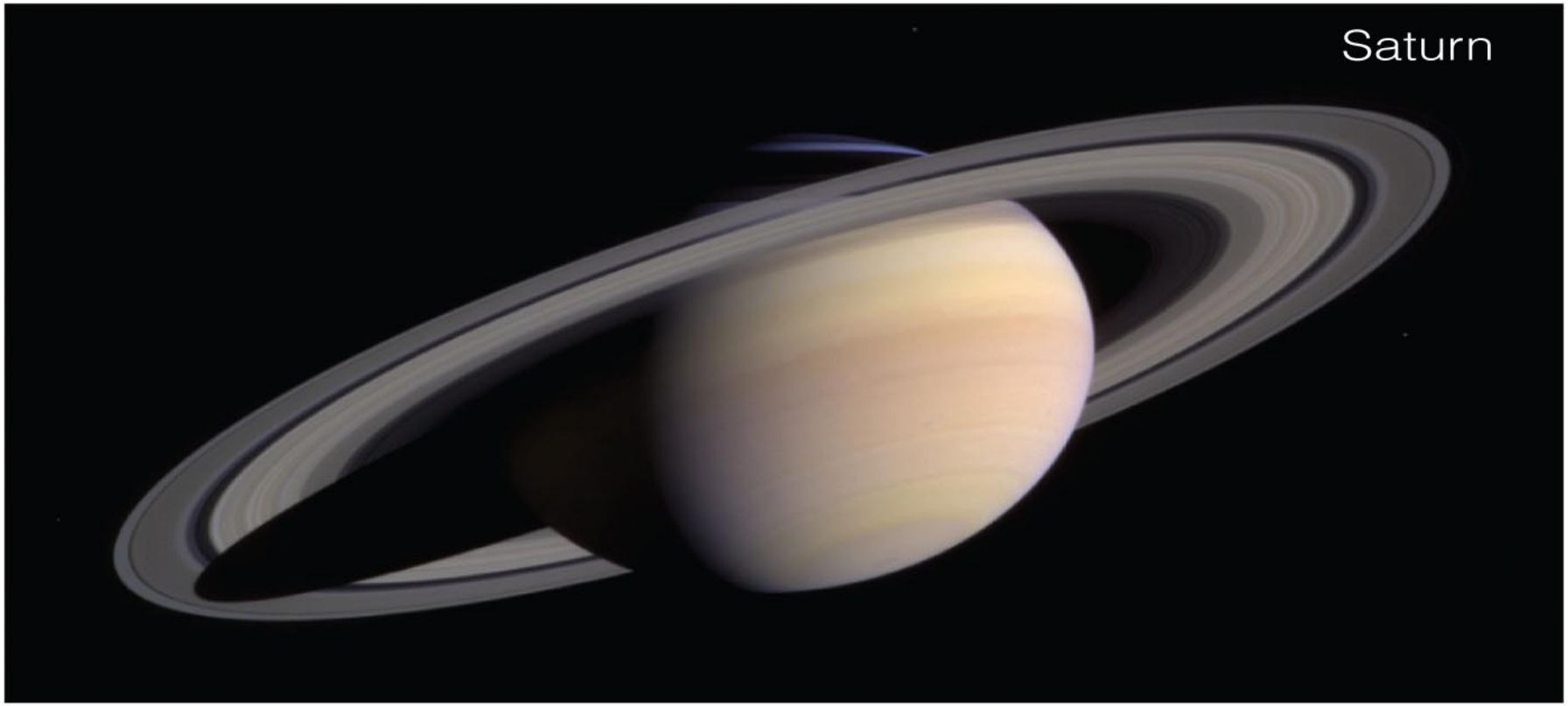
Jupiter



Jupiter's moons can be as interesting as planets themselves, especially Jupiter's four *Galilean moons*.

- Io (shown here): active volcanoes all over
- Europa: possible subsurface ocean
- Ganymede: largest moon in solar system
- Callisto: a large, cratered "ice ball"

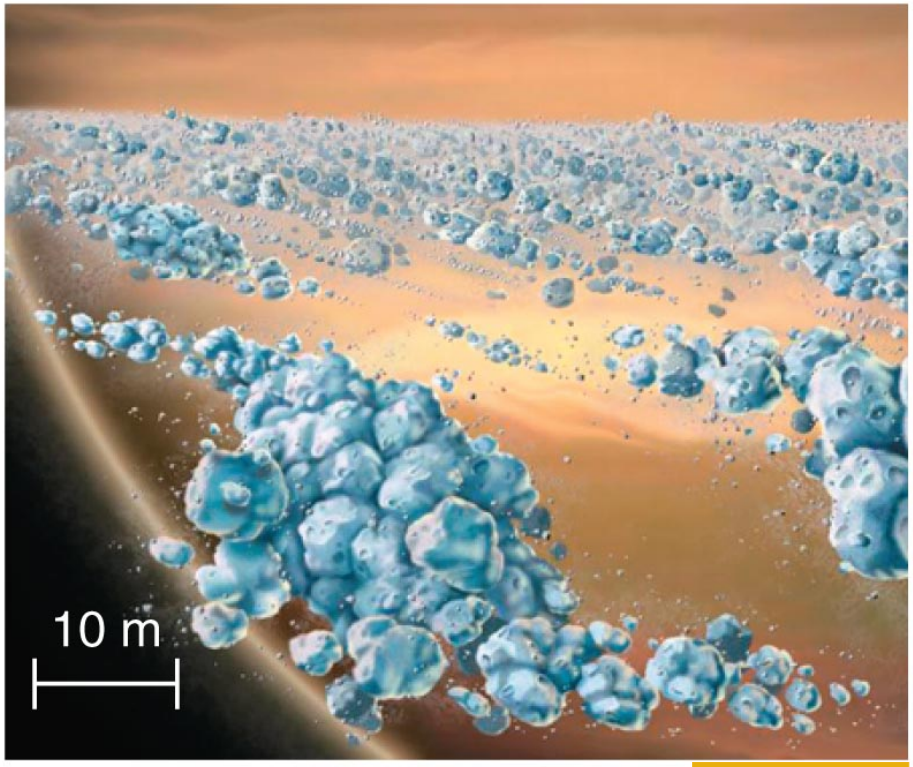
Saturn



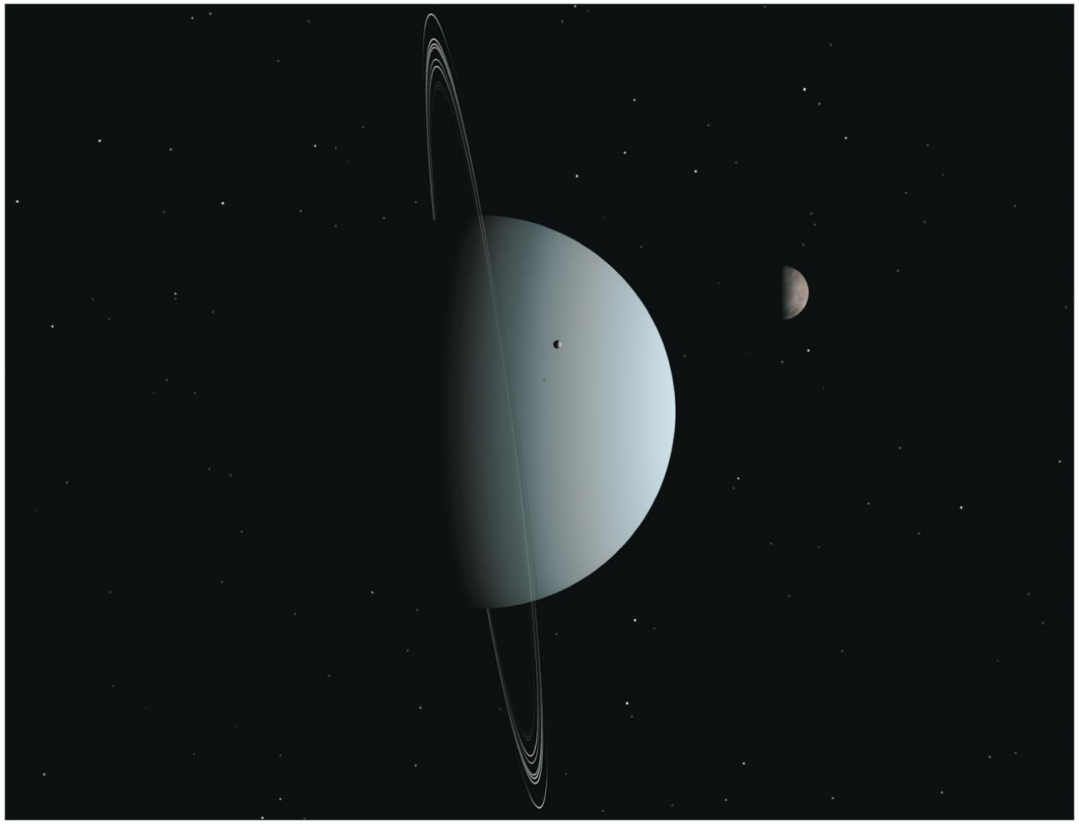
- Giant and gaseous like Jupiter
- Spectacular rings
- Many moons, including cloudy Titan

Saturn

- Rings are NOT solid; they are made of countless small chunks of ice and rock, each orbiting like a tiny moon.

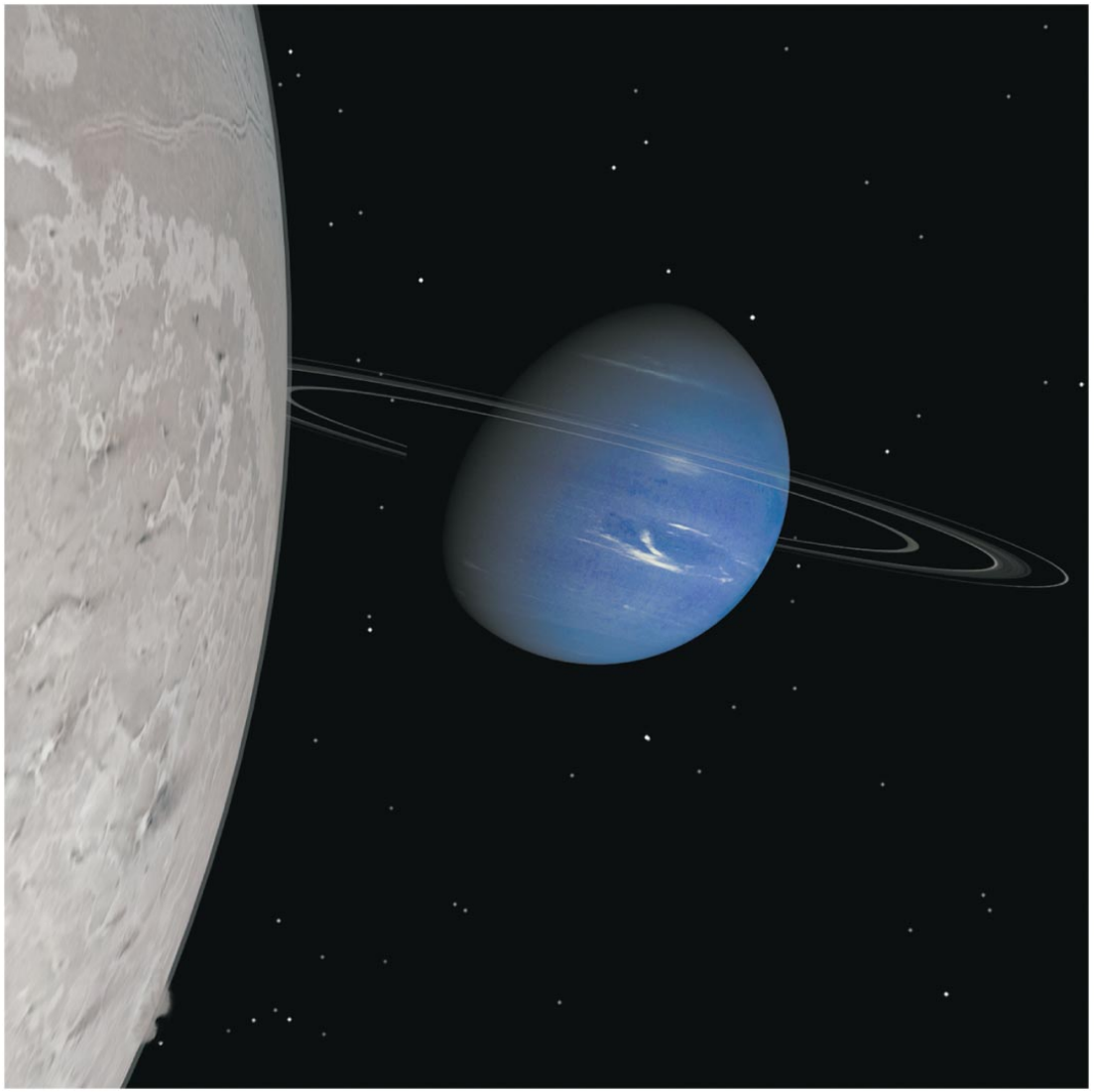


Uranus



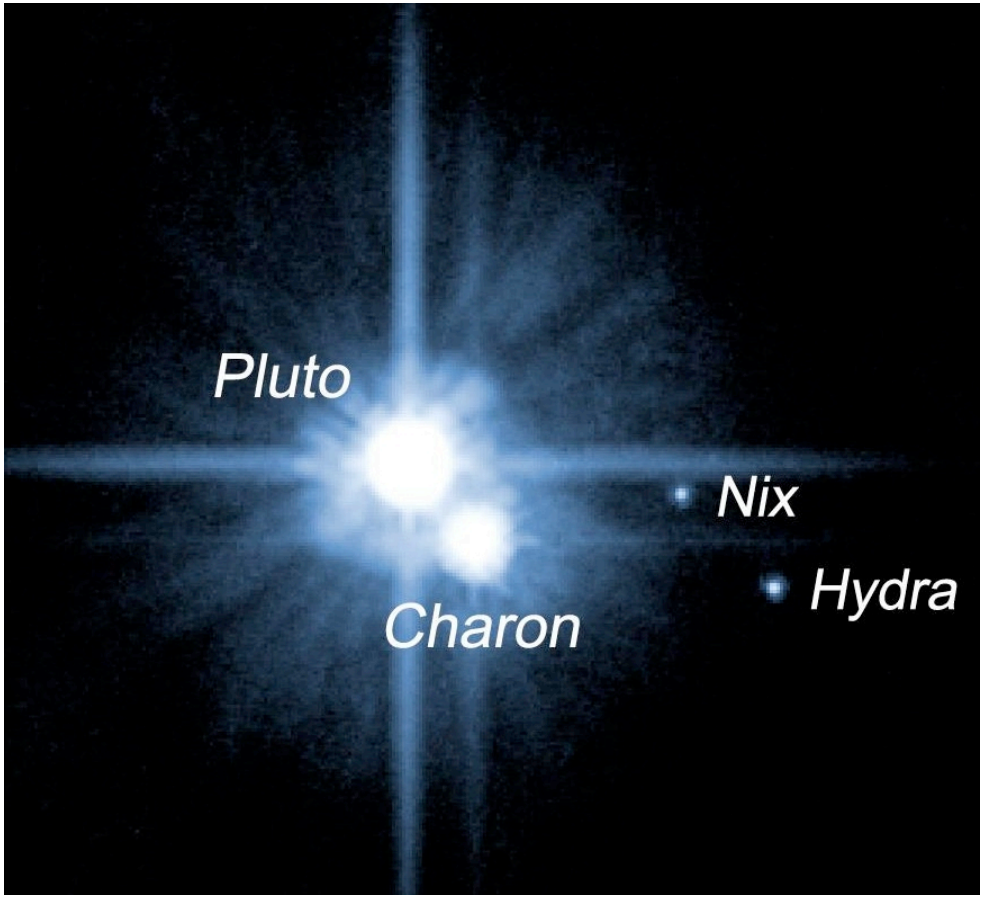
- Smaller than Jupiter/Saturn; much larger than Earth
- Made of H/He gas and **hydrogen compounds** (H_2O, NH_3, CH_4)
- Extreme axis tilt
- Moons and rings

Neptune



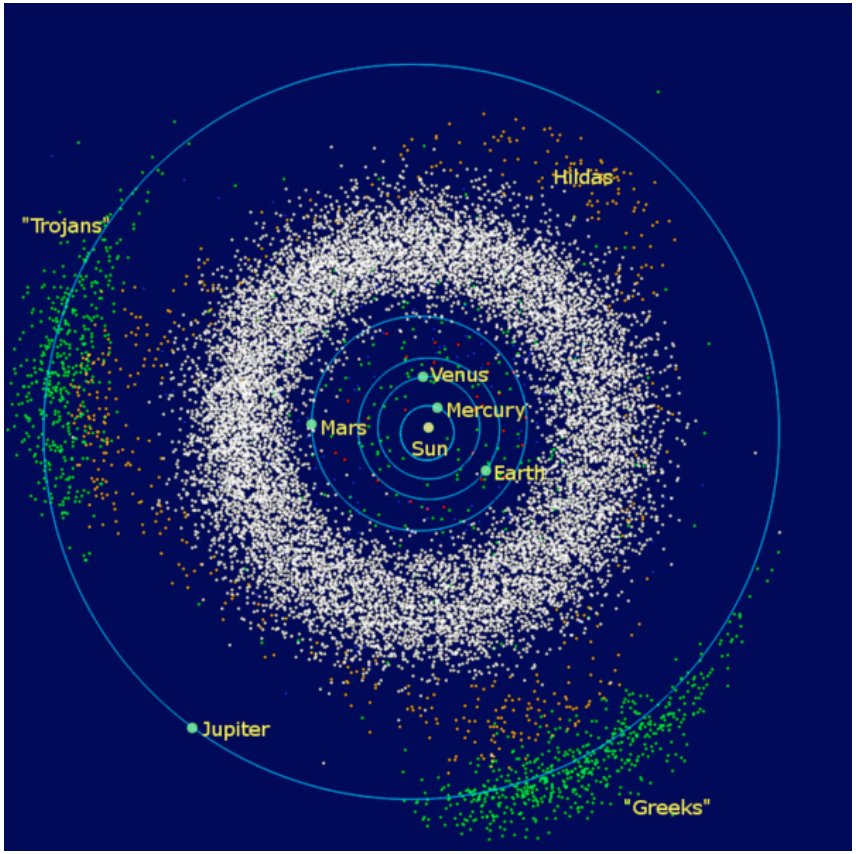
- Similar to Uranus (except for axis tilt)
- Many moons (including Triton)

Dwarf Planets: Pluto, Eris, and more



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

Asteroids and Comets



Most asteroids live in the asteroid belt, between Mars and Jupiter.

Comets generally come from the flattened Kuiper Belt or the much more distant spherical Oort Cloud.

Table 7.1

TABLE 7.1 The Planetary Data[a]

Photo	Planet	Relative Size	Average Distance from Sun (AU)	Average Equatorial Radius (km)	Mass (Earth = 1)	Average Density (g/cm^3)	Orbital Period	Rotation Period	Axis Tilt	Average Surface (or Cloud-Top) Temperature[b]	Composition	Known Moons (2012)	Rings?
	Mercury	·	0.387	2440	0.055	5.43	87.9 days	58.6 days	0.0°	700 K (day) 100 K (night)	Rocks, metals	0	No
	Venus	•	0.723	6051	0.82	5.24	225 days	243 days	177.3°	740 K	Rocks, metals	0	No
	Earth	•	1.00	6378	1.00	5.52	1.00 year	23.93 hours	23.5°	290 K	Rocks, metals	1	No
	Mars	·	1.52	3397	0.11	3.93	1.88 years	24.6 hours	25.2°	220 K	Rocks, metals	2	No
	Jupiter	●	5.20	71,492	318	1.33	11.9 years	9.93 hours	3.1°	125 K	H, He, hydrogen compounds[c]	67	Yes
	Saturn	●	9.54	60,268	95.2	0.70	29.5 years	10.6 hours	26.7°	95 K	H, He, hydrogen compounds[c]	62	Yes
	Uranus	●	19.2	25,559	14.5	1.32	83.8 years	17.2 hours	97.9°	60 K	H, He, hydrogen compounds[c]	27	Yes
	Neptune	●	30.1	24,764	17.1	1.64	165 years	16.1 hours	29.6°	60 K	H, He, hydrogen compounds[c]	13	Yes
	Pluto	·	39.5	1160	0.0022	2.0	248 years	6.39 days	112.5°	44 K	Ices, rock	5	No
	Eris	·	67.7	1200	0.0028	2.3	557 years	1.08 days	78°	43 K	Ices, rock	1	No

[a]Including the dwarf planets Pluto and Eris; Appendix E gives a more complete list of planetary properties.
[b]Surface temperatures for all objects except Jupiter, Saturn, Uranus, and Neptune, for which cloud-top temperatures are listed.
[c]Include water (H_2O), methane (CH_4), and ammonia (NH_3).

What have we learned?

- **What does the solar system look like?**
  - Planets orbit Sun in the same direction and in nearly the same plane.
- **What can we learn by comparing the planets to one another?**
  - Comparative planetology looks for patterns among the planets.
  - Those patterns give us insight into the general processes that govern planets.
  - Studying other worlds in this way tells us about our own planet.