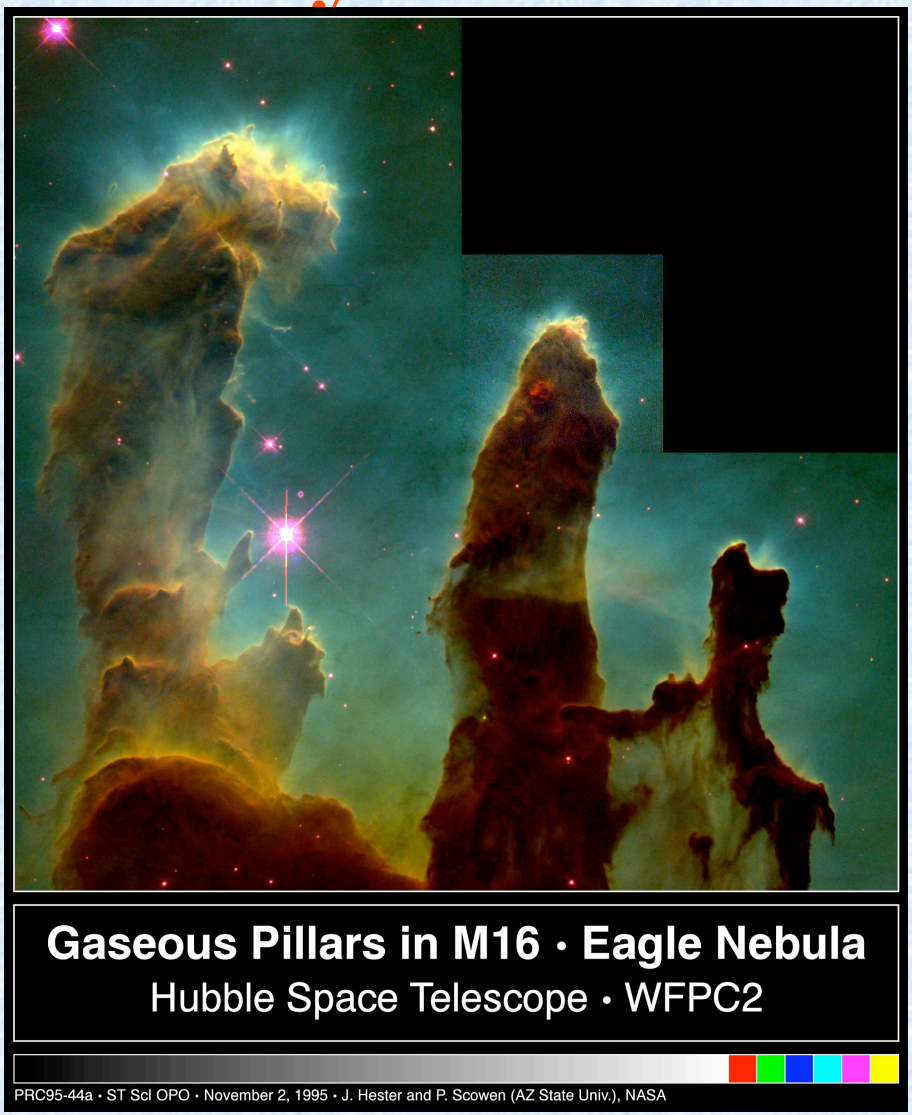
Astronomy 1 – Winter 2011



Lecture 15; February 9 2011

Previously on Astro-1

- **Mercury, Venus, Mars (and Earth)**
  - **Size and composition**
  - **Crusts and cores**
  - **Volcanism and internal activity**

Stargazing Events

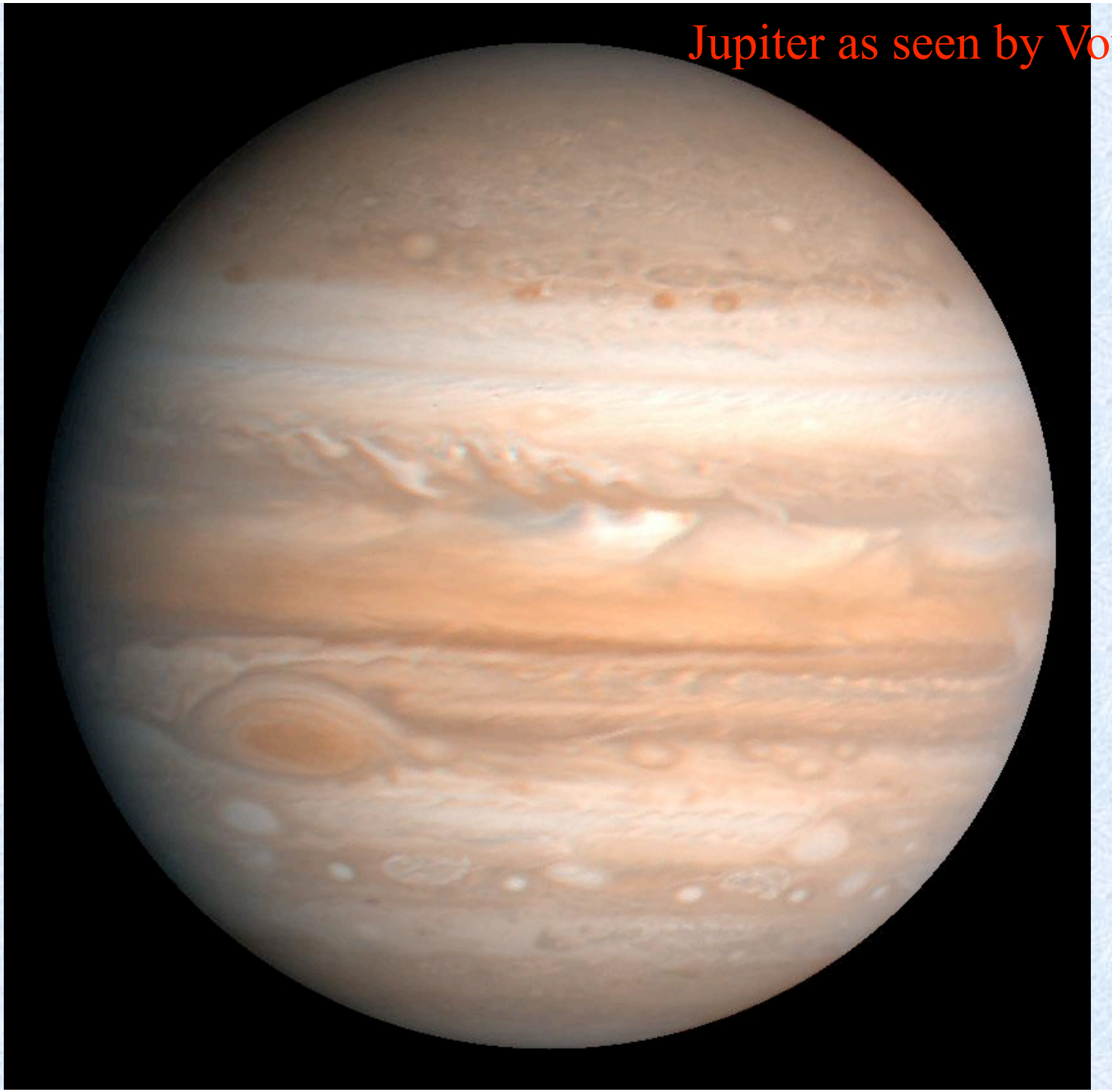
- Santa Barbara Museum of Natural History
  - Feb 12, this Saturday. 7PM
  - March 12. 7PM
  - Ticket is $2
  - 2% credit if you sign your name at the museum
- Broida Hall
  - March 7/8
  - 2% credit, first come first served basis, register with TA. Instructions to be given later (-2% if you register and don't show up!)
- YOU CAN ONLY GET CREDIT FOR ONE EVENT

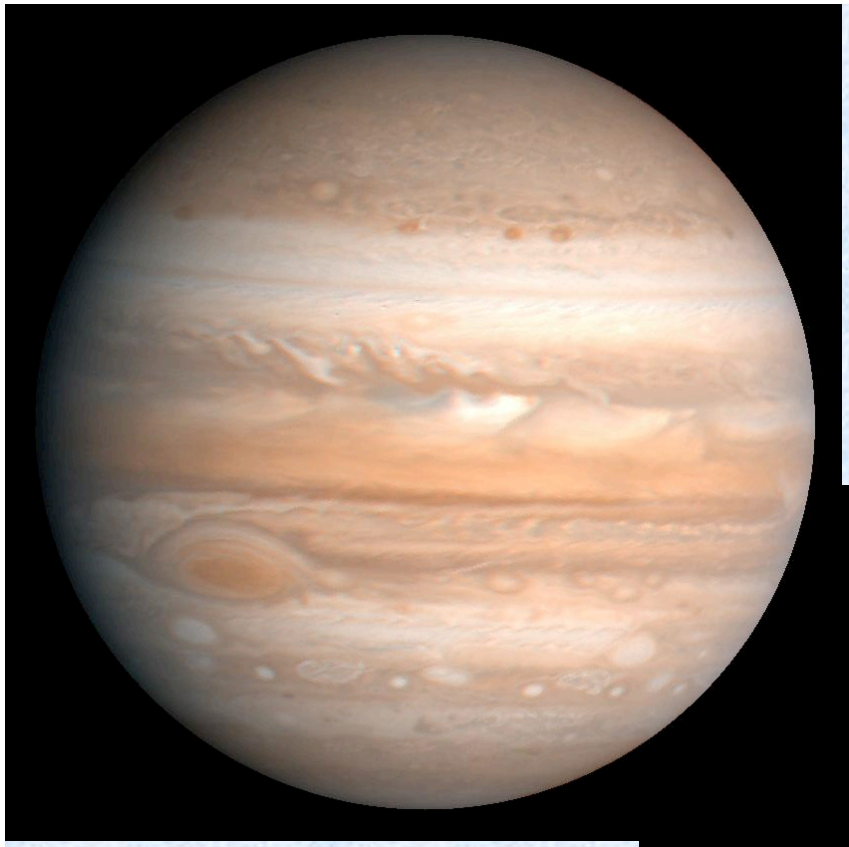
Today on Astro-1

- **Jupiter and Saturn**
  - **Size and composition; Atmosphere & interior**
  - **The rings of Saturn**

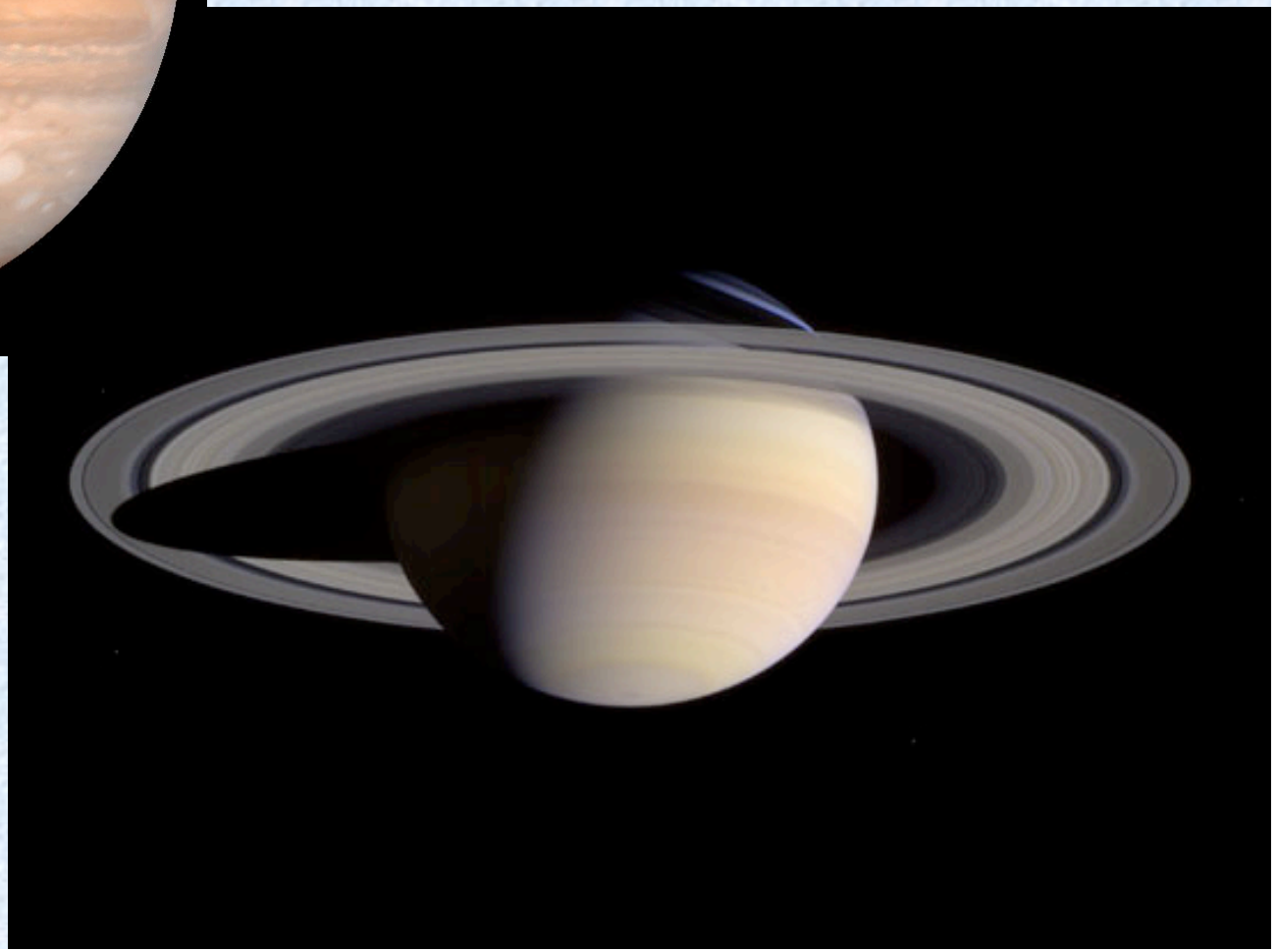
Homework – Due 02/16/10

- On your own: answer all the review questions in chapters 12, 13, 14
- To TAs: answer questions 12.43 12.51 13.44 13.46 14.35 14.40


Jupiter as seen by Voyager 1



Much larger than Earth. Each is composed of 71% hydrogen, 24% helium, and 5% all other elements by mass. Higher percentage of heavy elements than the Sun.



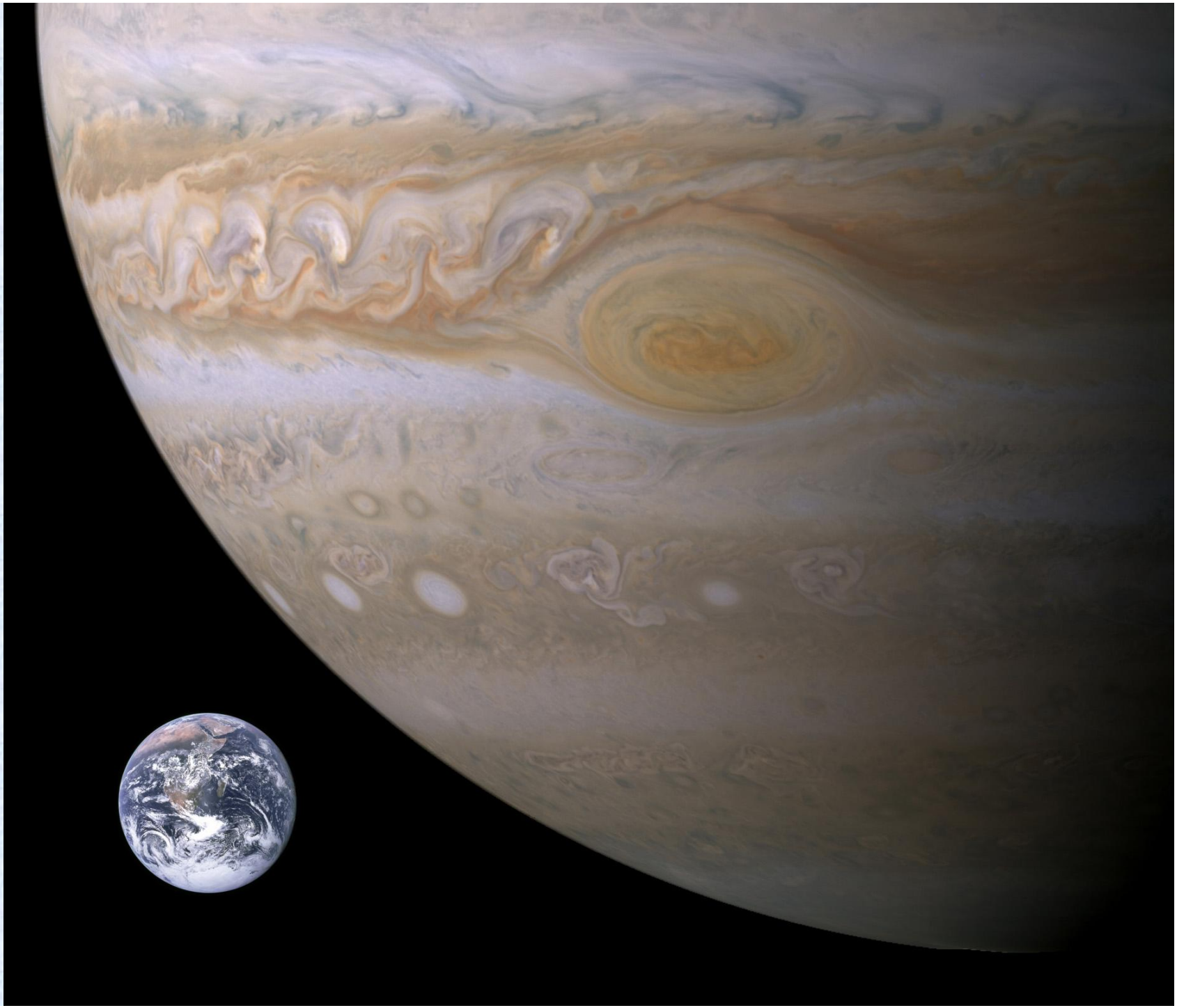
Question 15.1 (iclickers!)

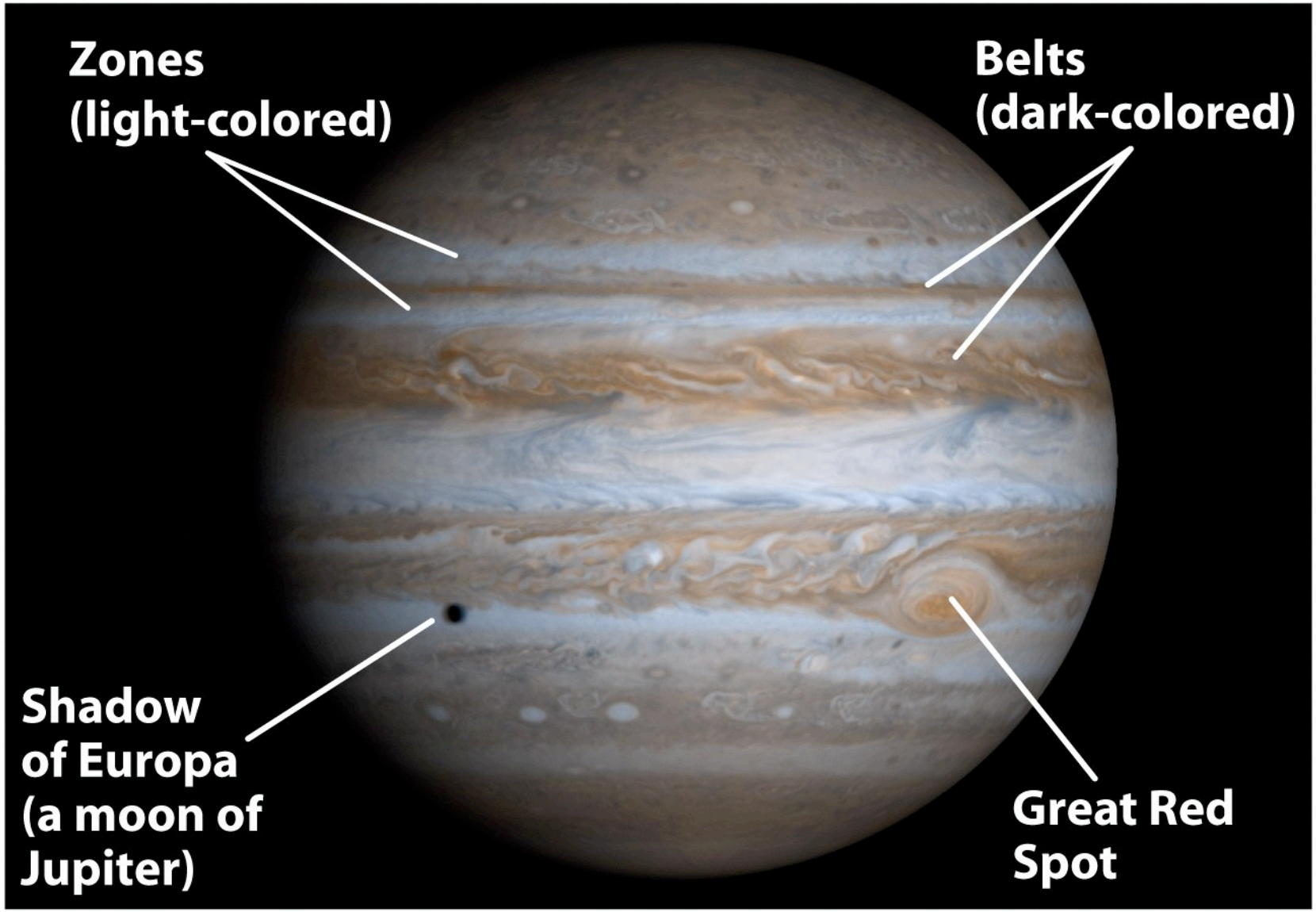
•The mass of Jupiter is 11.25 times that of Earth. What would be the force of gravity exerted by Jupiter on a spacecraft at a distance of 1 AU from Jupiter compared to that exerted on the same spacecraft by Earth at 1AU from Earth?

- A)11.25^2
- B) 1/11.25
- C) 11.25
- D) The same

Why are Jupiter (and Saturn) planets and not stars?

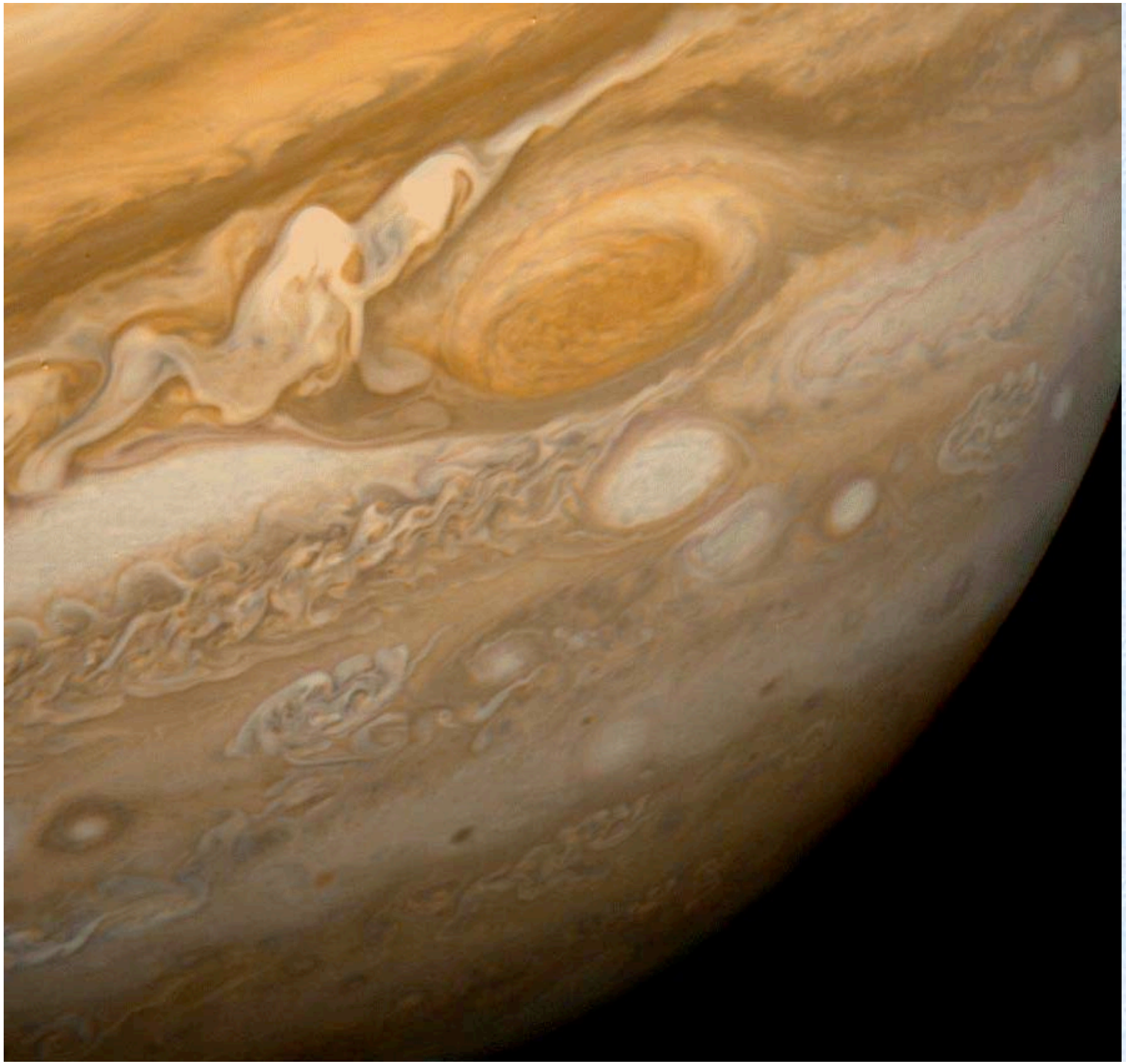
- Temperature of giant planets is due to gravitational heating, like in a protostar
- However, their mass is not sufficient to reach high enough temperatures to ignite nuclear fusion

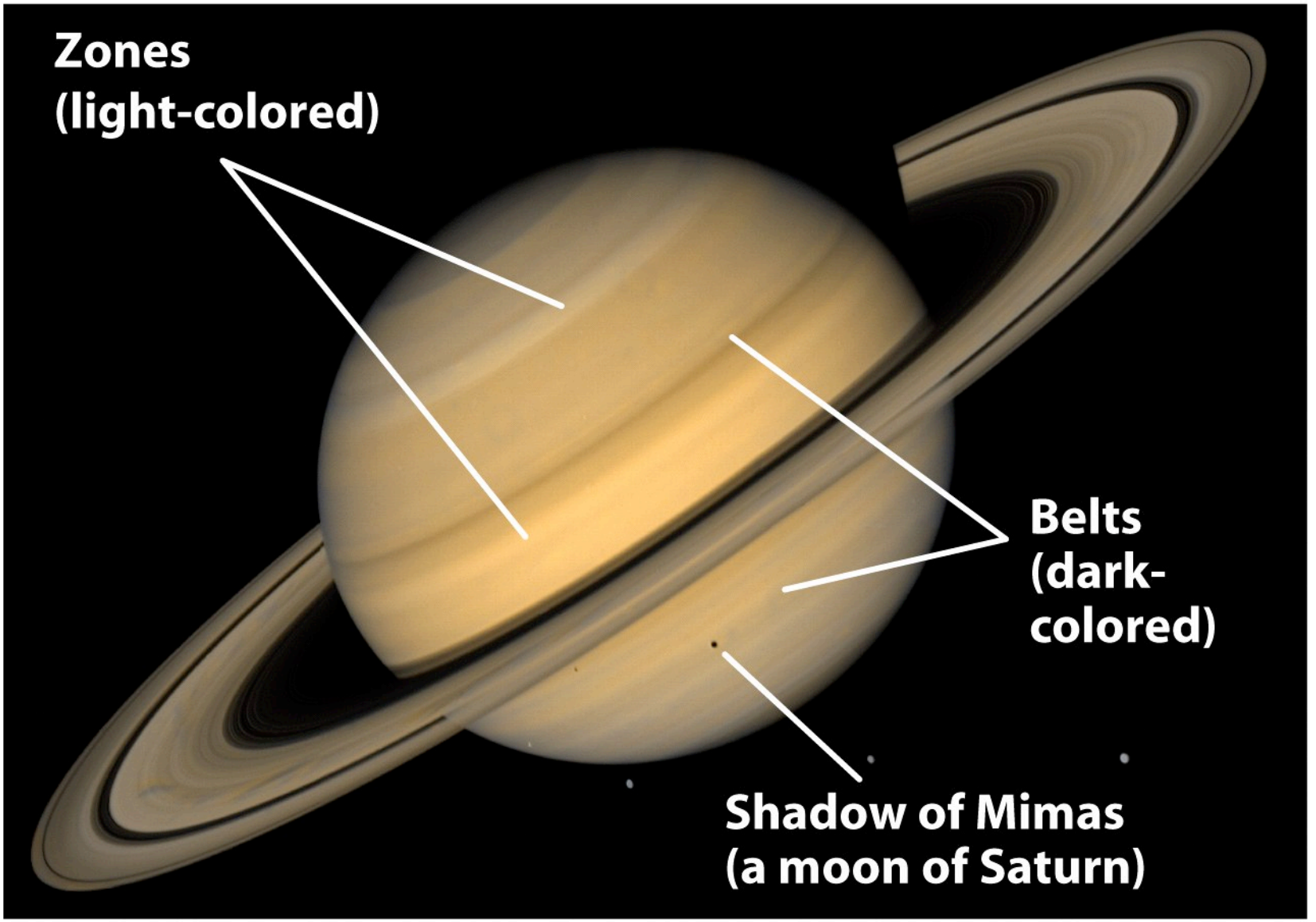




Jupiter

Figure 12-2a
Universe, Eighth Edition





Saturn

Figure 12-2b
Universe, Eighth Edition

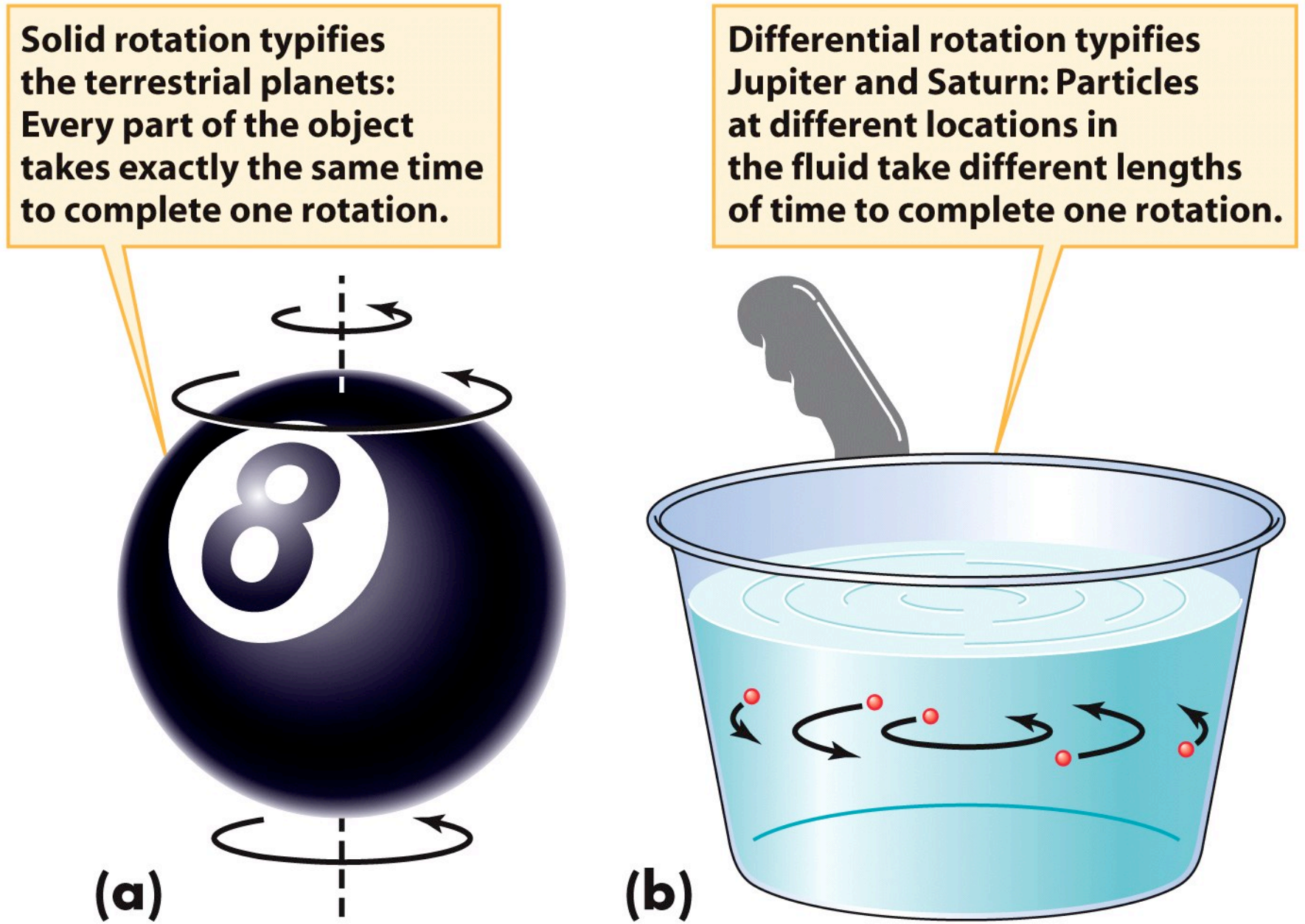
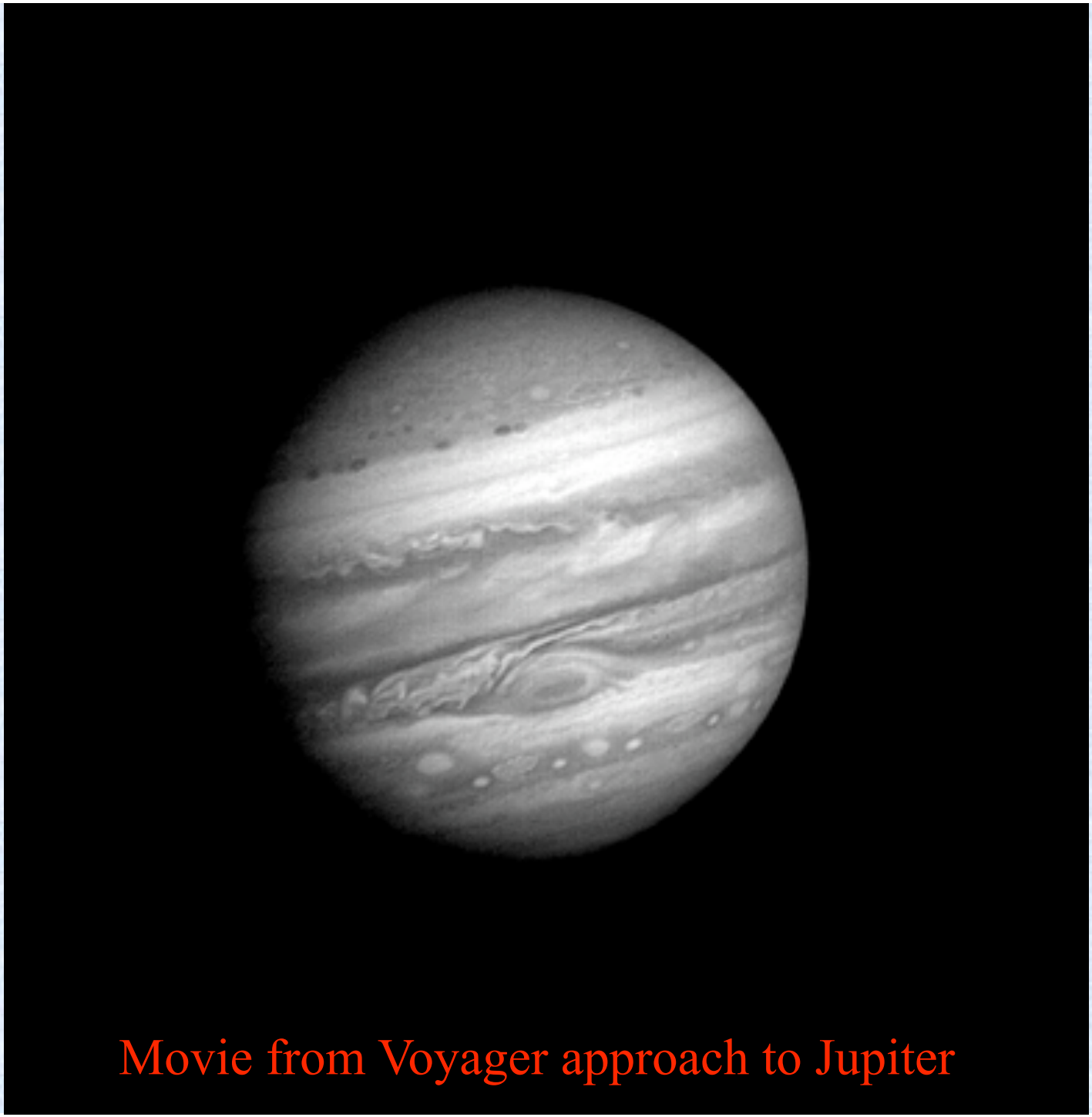


Figure 12-3
Universe, Eighth Edition



Movie from Voyager approach to Jupiter

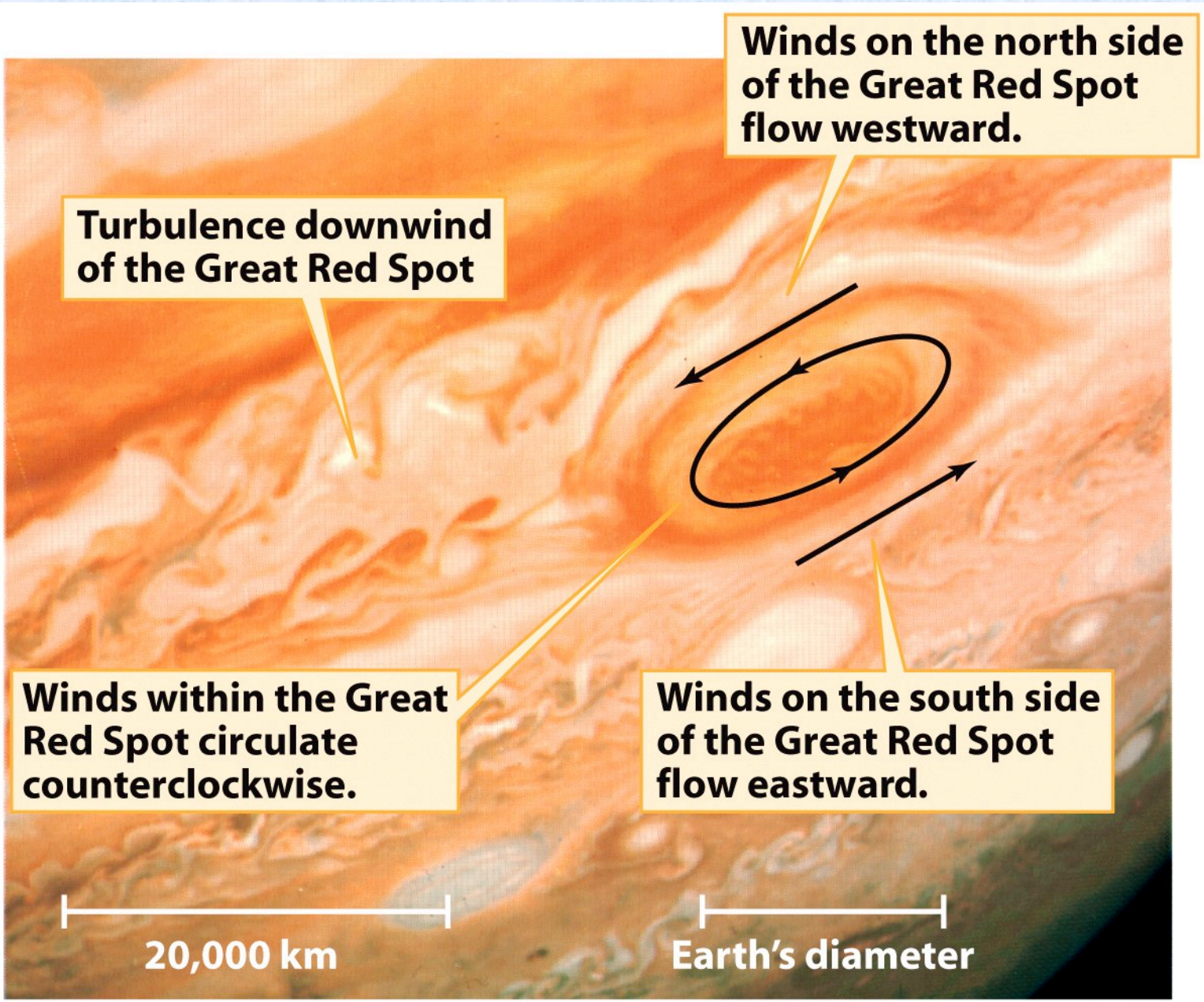
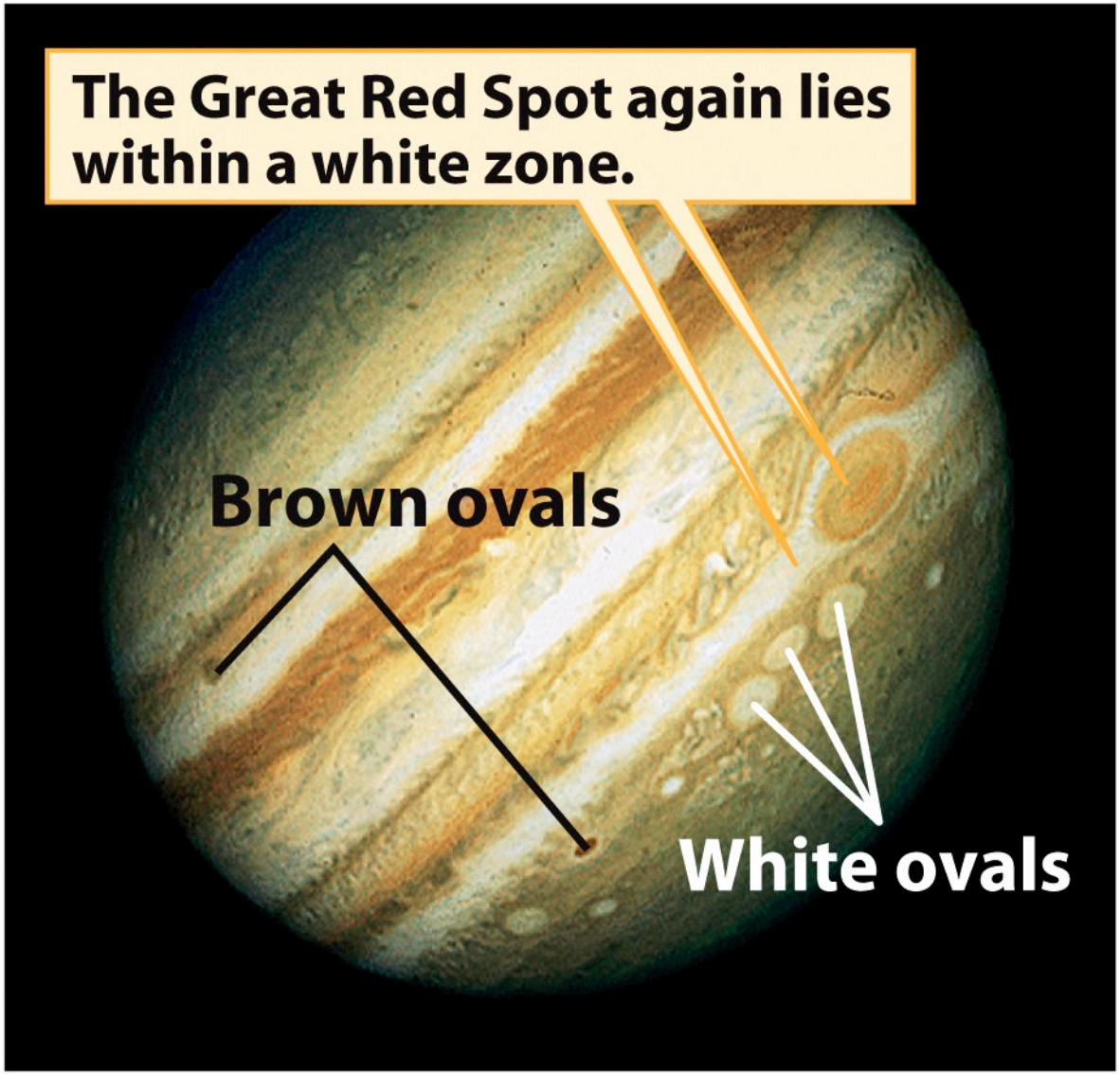


Figure 12-5
Universe, Eighth Edition

(a) *Pioneer 11*, December 1974 (b) *Voyager 2*, July 1979 (c) HST, February 1995

Figure 12-4
Universe, Eighth Edition

Figure 12-4
Universe, Eighth Edition



HST, February 1995

Figure 12-4c
Universe, Eighth Edition

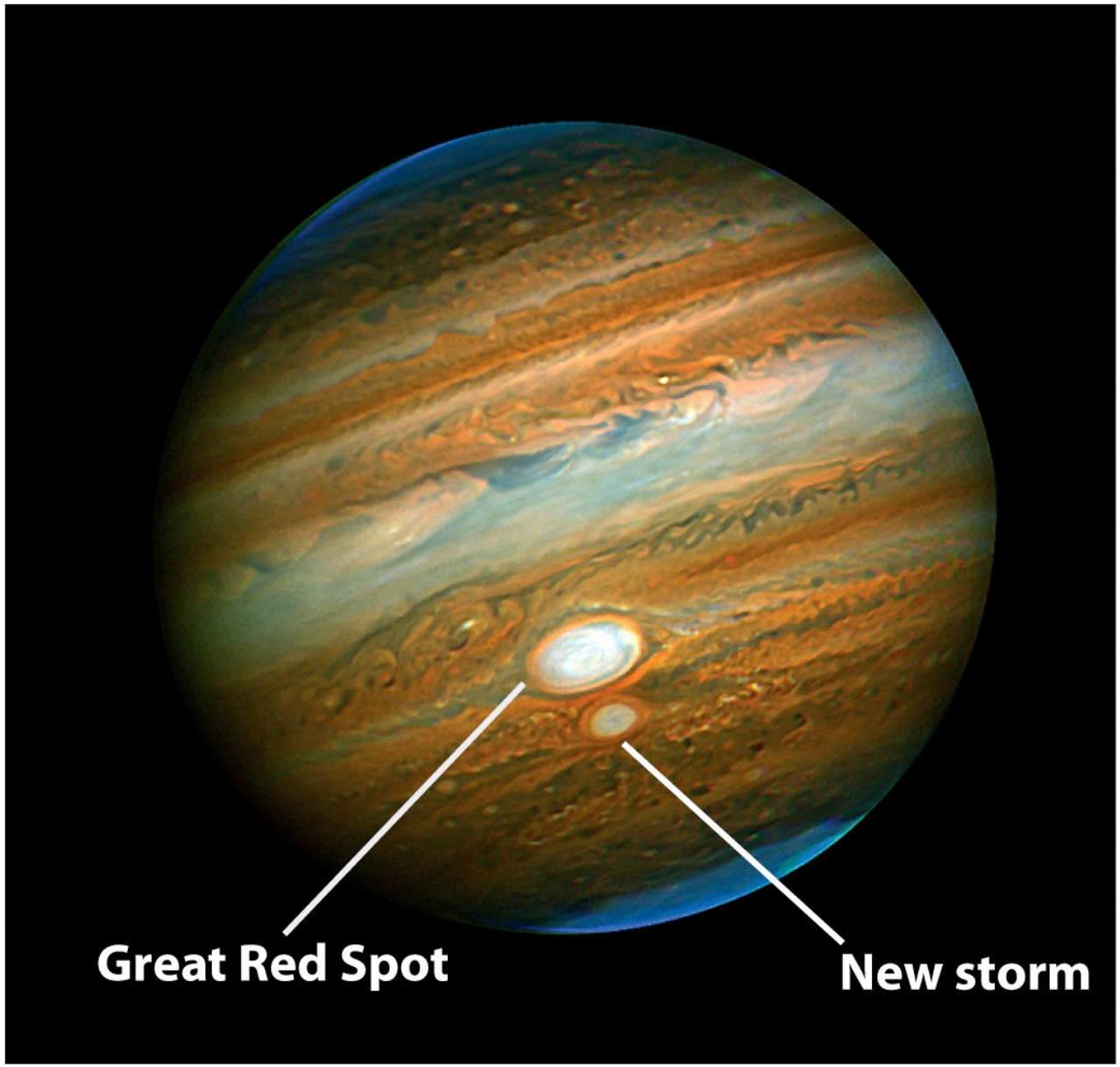


Figure 12-6
Universe, Eighth Edition

Jupiter's "Red Spot Jr."

This 2006 image of Jupiter and a new storm that formed between 1998 and 2000 was made using adaptive optics on the Gemini North telescope in Hawaii. Because Jupiter displays differential rotation, the two storms travel around Jupiter at different rates; they are not always side-by-side as shown

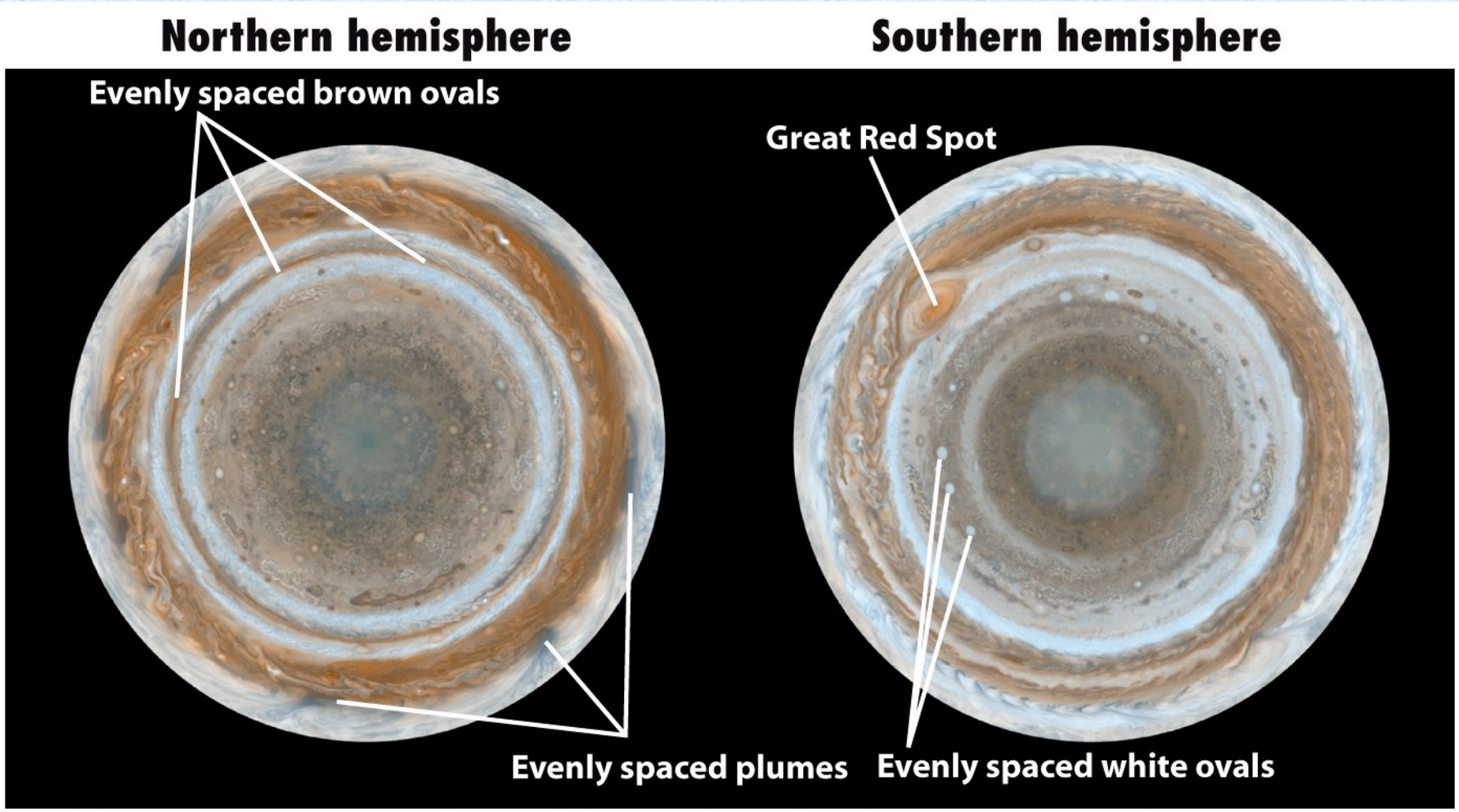


Figure 12-7
Universe, Eighth Edition

Jupiter's Northern and Southern Hemispheres
Cassini images were combined and computer processed to construct these views that look straight down onto Jupiter's north and south poles. Various cloud features are evenly spaced in longitude.

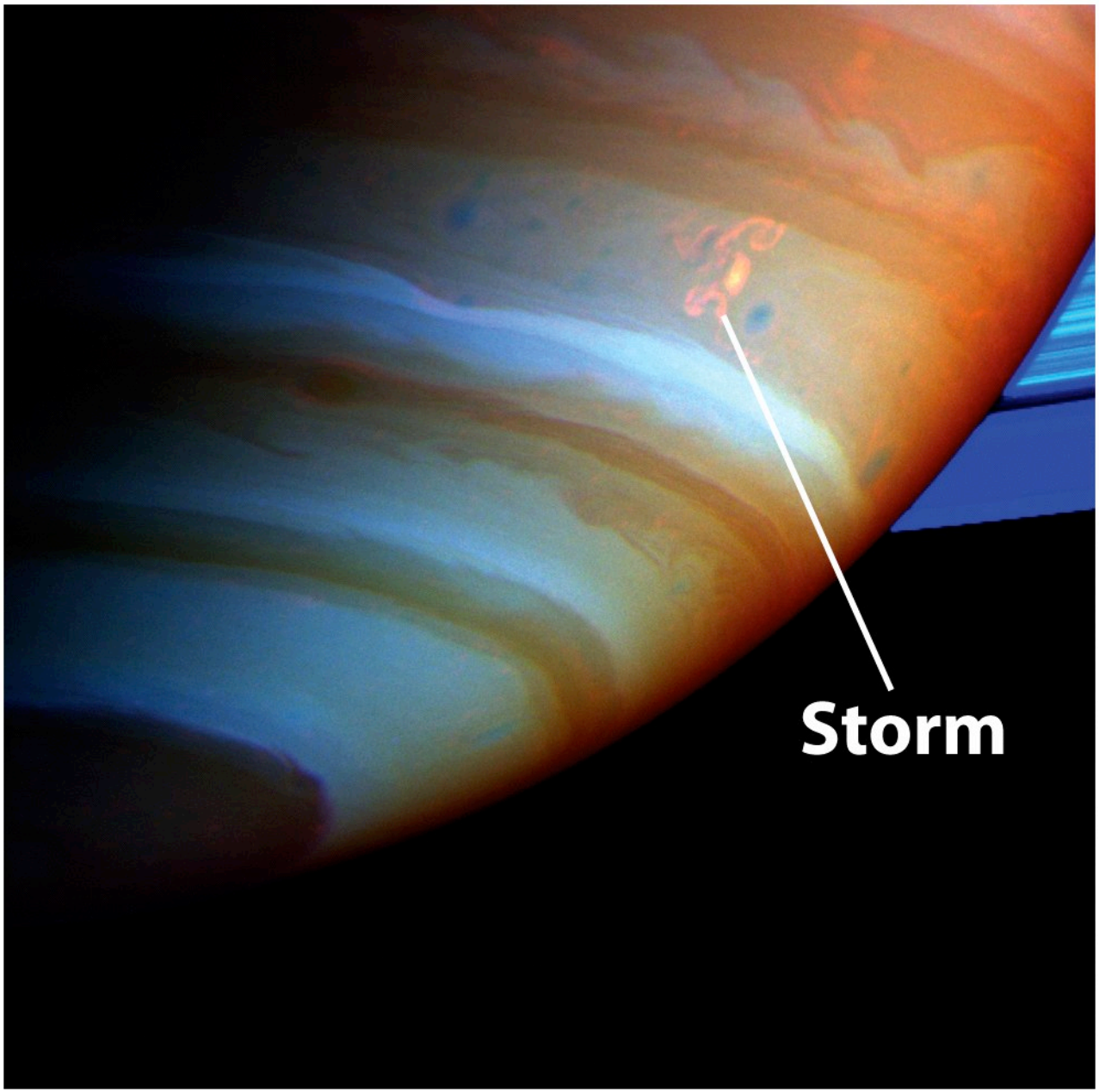


Figure 12-8
Universe, Eighth Edition

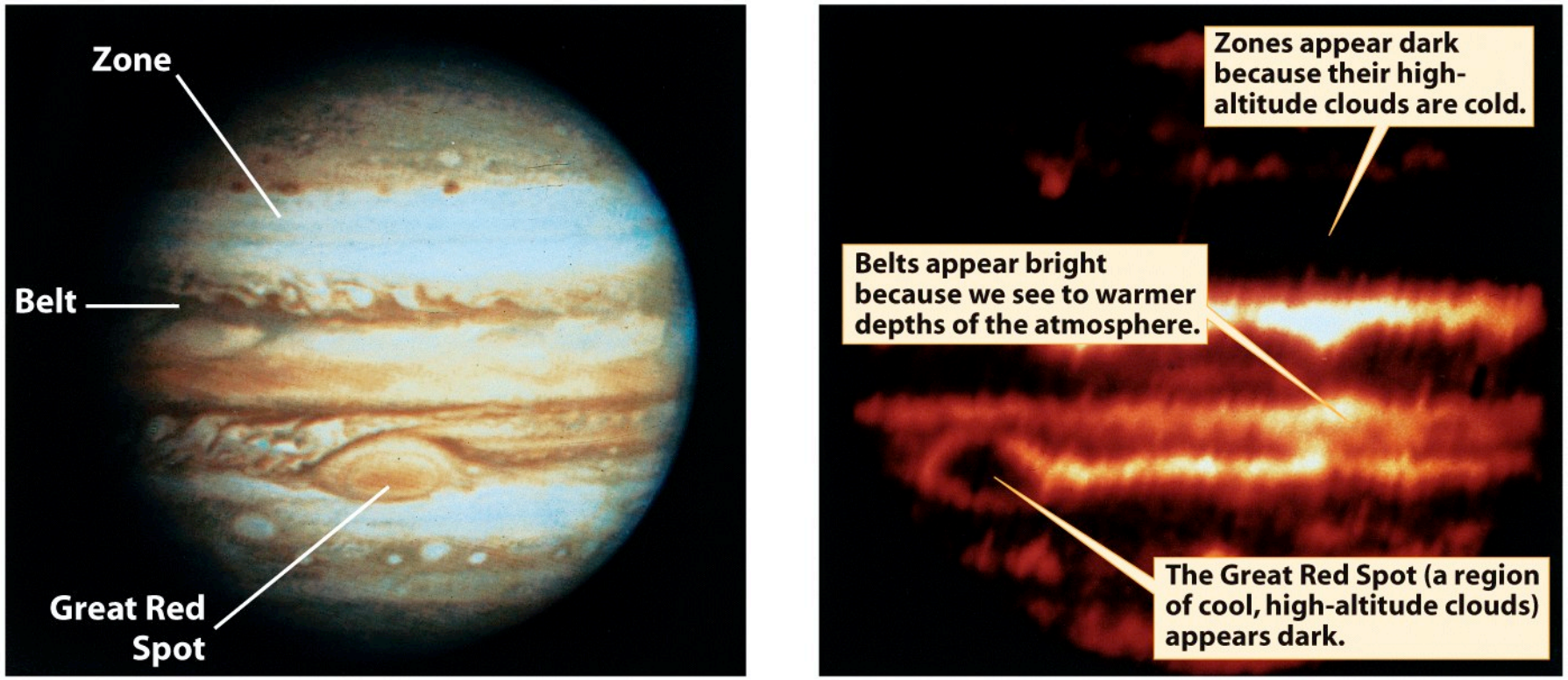


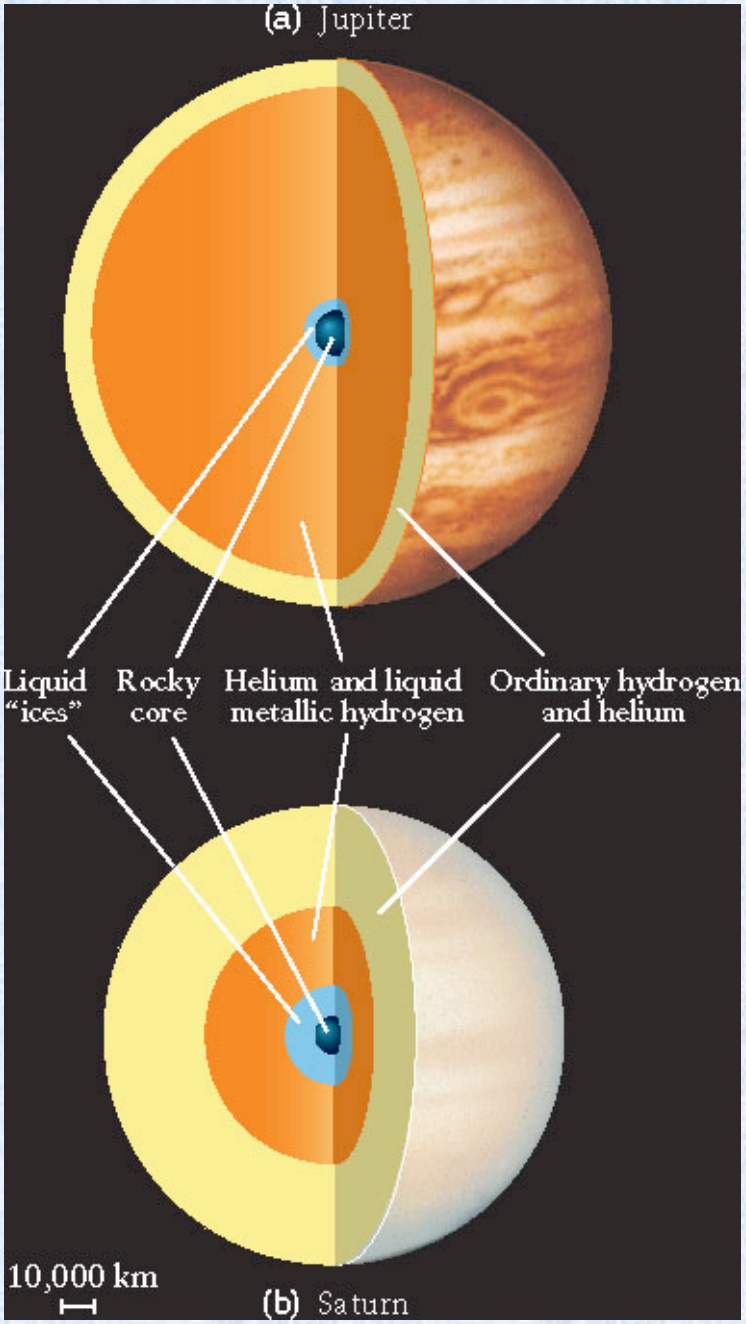
Figure 12-10
Universe, Eighth Edition

Jupiter's Warm Belts and Cool Zones
(a) Visible-light image of Jupiter was made by the *Voyager 1* spacecraft. (b) Bright and dark areas in this Earth-based infrared image, taken at the same time as the image in (a), correspond to high and low temperatures, respectively.

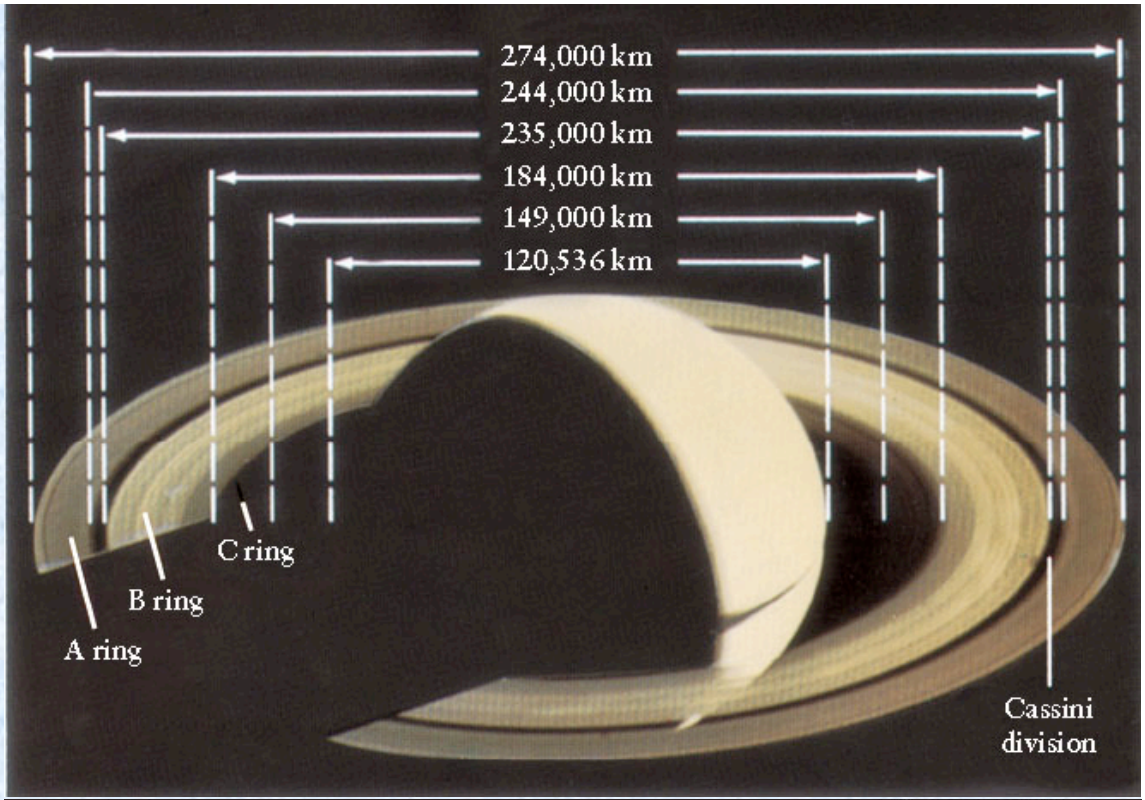
Question 15.2 (iclickers!)

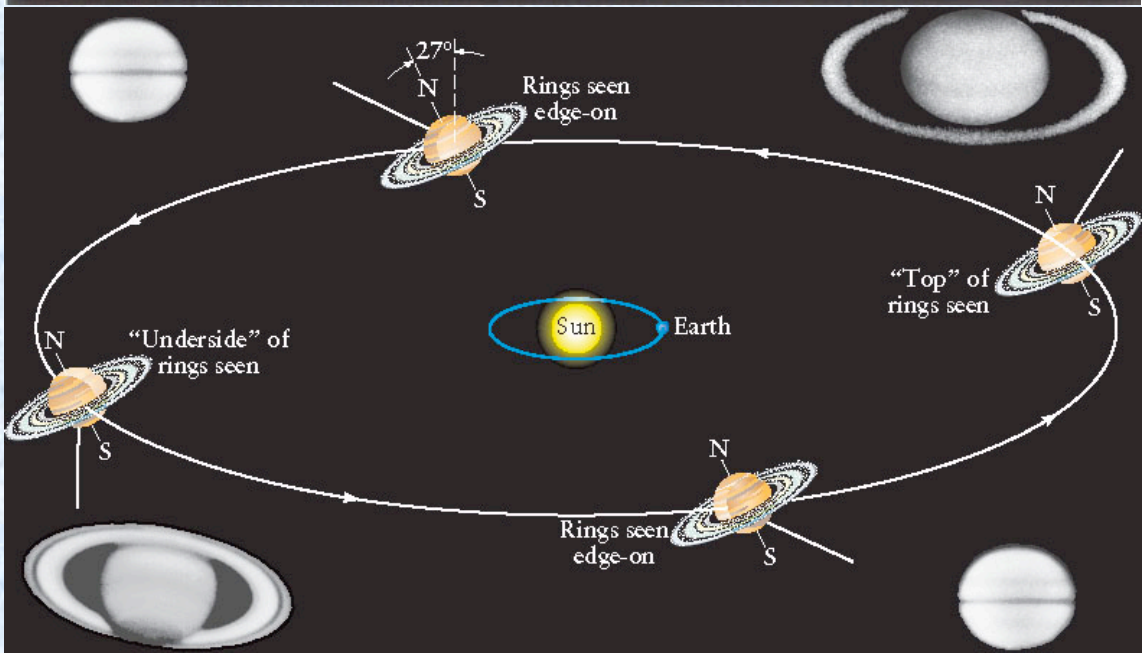
- One observational fact that is common to both Jupiter and Saturn is that
  - A) Both planets appear cooler than is expected on the basis of received solar energy and emit less radiant energy than expected
  - B) The temperature appears to fall continuously as depth into these planets increases
  - C) Co2 in their atmospheres appears to produce an intense greenhouse effect with very enhanced temperatures of greater than 200C in their outer layers
  - D) Both planets emit more energy than they receive from the sun

- Jupiter and Saturn are oblate.
  - Oblateness indicates presence of solid core
- Jupiter and Saturn have strong magnetic fields
  - Liquid inner part. Made of metallic hydrogen!



Saturn's system of rings
Is inclined relative to the ecliptic so that visibility changes

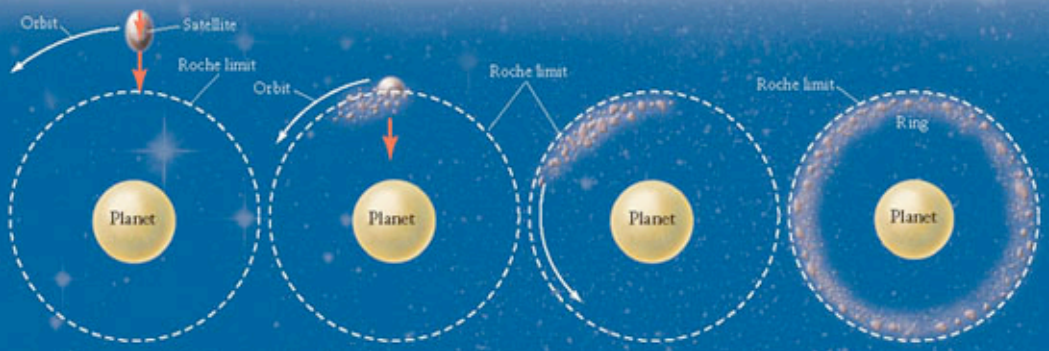




COSMIC CONNECTIONS

Planetary Rings and the Roche Limit

If a small moon wanders too close to a planet, tidal forces tear the moon into smaller particles. These particles form a ring around the planet. The critical distance from the planet at which this happens is called the Roche limit. This helps us understand why the rings of Jupiter and Saturn are made of small particles, as are the rings of Uranus and Neptune (discussed in Chapter 14).



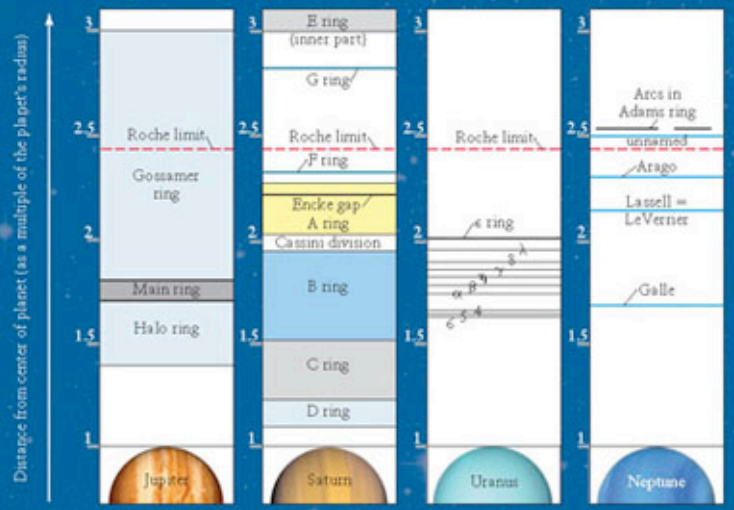
If a satellite is outside the planet's Roche limit, the tidal forces exerted by the planet may deform the satellite but will not tear it apart.

If the satellite crosses the planet's Roche limit, the tidal forces overwhelm the gravitational forces that hold the satellite together and the satellite fragments.

Fragments that are closer to the planet orbit faster (in accordance with Kepler's third law). This spreads the fragments around the planet...

...and the result is a ring.

Jupiter, Saturn, Uranus, and Neptune all have systems of rings that lie mostly within the Roche limit. This diagram shows each of the four ring systems scaled to the radius of the planet.



A planet's Roche limit is about 2.4 times the radius of the planet, provided the material orbiting the planet has the same density as the planet itself. For denser material the Roche limit is closer to the planet.

Summary

- **Composition and Structure:**
  - much larger than Earth. Each is composed of 71% hydrogen, 24% helium, and 5% all other elements by mass. higher percentage of heavy elements than the Sun.
  - The interior of the planet consists of a solid core, a region of liquid metallic H and He and out gaseous layers
- **Atmospheres:**
  - The rapid rotation of the planets twists the clouds into dark belts and light zones that run parallel to the equator. Strong zonal winds run along the belts and zones.
  - The outer layers of both planets' atmospheres show differential rotation:
  - The colored ovals visible in the Jovian atmosphere represent gigantic storms. Some, such as the Great Red Spot, are quite stable and persist for many years. Storms in Saturn's atmosphere seem to be shorter-lived.
- **Rings**
  - Are believed to have formed by the same debris that form satellites, inside the Roche limit

The End

See you on friday!