Astronomy 301 - Mon. Oct. 4

Guest lectures, today and Wednesday:

Prof. Harriet Dinerstein

Last Friday: Overview of the Solar System, surfaces of terrestrial planets

Today: processes affecting surfaces of the terrestrial planets, general properties of Jovian planets, and moons that are nearly planets

Terrestrial vs. Jovian Planets

How do terrestrial planets differ from Jovian ones?

Are there properties that only terrestrial planets have?

Are there properties that only Jovian ones have?

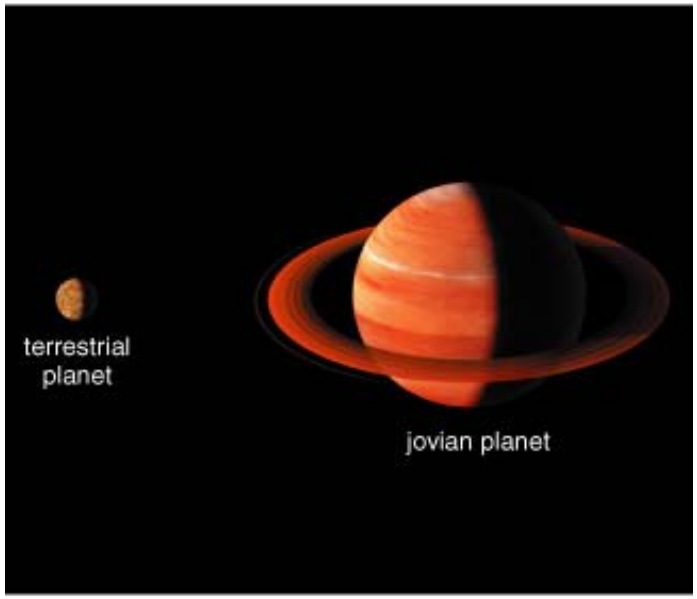

Table 7-3 Comparing Terrestrial and Jovian Planets

	Terrestrial Planets	Jovian Planets
Distance from the Sun	Less than 2 AU	More than 5 AU
Size	Small	Large
Composition	Mostly rocky materials containing iron, oxygen, silicon, magnesium, nickel, and sulfur	Mostly light elements such as hydrogen and helium
Density	High	Low

Table 7-3
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Properties of Terrestrial Planets

Surfaces: features, processes that cause change

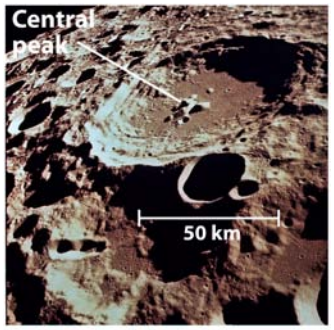
Atmospheres: gases present, thickness (will be discussed in much more detail next week, ch. 10)

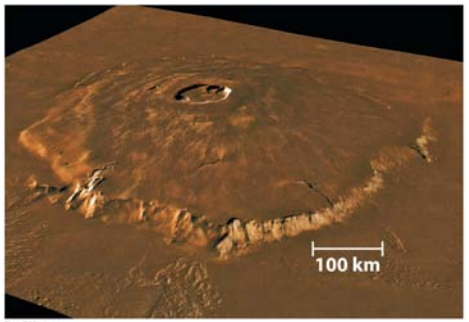
Interiors: what they're made of, conditions there

How do we learn about these, for remote planets?

Processes on Planetary Surfaces

- Impact craters: caused when objects from space crash; craters with central peak, crater walls, “rays”.





  - Vulcanism: the upwelling of lava (hot molten rock), produces conical volcanos, or broad flows that repave the surface. They also “erase” previous impact craters.
  - Erosion: the slow wearing-down of surface features.

  What agents can you think of, that cause erosion on the Earth? What about on the Moon?

Planetary Interiors

- How do we know what planets are made of, inside?

Major clue: average density

What do we need to know, in order to get the density?

Volume of a sphere: $$Vol = \frac{4\pi R^3}{3}$$

Averaged density: $$\langle \rho \rangle = \frac{Mass}{Vol} = \frac{Mass}{\left(4/3\right)\pi R^3}$$

Average Densities of Planets

The Inner (Terrestrial) Planets **Close to the Sun - Small diameter, small mass - High density**

	Mercury	Venus	Earth	Mars
Average distance from Sun (AU)	0.387	0.723	1.000	1.524
Equatorial diameter (Earth = 1)	0.383	0.949	1.000	0.533
Mass (Earth = 1)	0.0553	0.8150	1.0000	0.1074
Average density (kg/m^3)	5430	5243	5515	3934

water	1000 kg m^{-3}
concrete	2000 kg m^{-3}
Earth's crust	3000 kg m^{-3}
Earth's interior	~ 5000 kg m^{-3}

The Outer (Jovian) Planets **Far from the Sun - Large diameter, large mass - Low density**

	Jupiter	Saturn	Uranus	Neptune
Average distance from Sun (AU)	5.203	9.554	19.194	30.066
Equatorial diameter (Earth = 1)	11.209	9.449	4.007	3.883
Mass (Earth = 1)	317.8	95.16	14.53	17.15
Average density (kg/m^3)	1326	687	1318	1638

Planetary Magnetic Fields

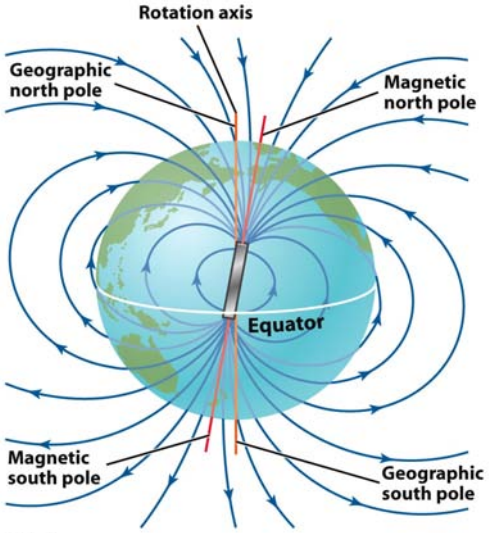


Figure 7-13b
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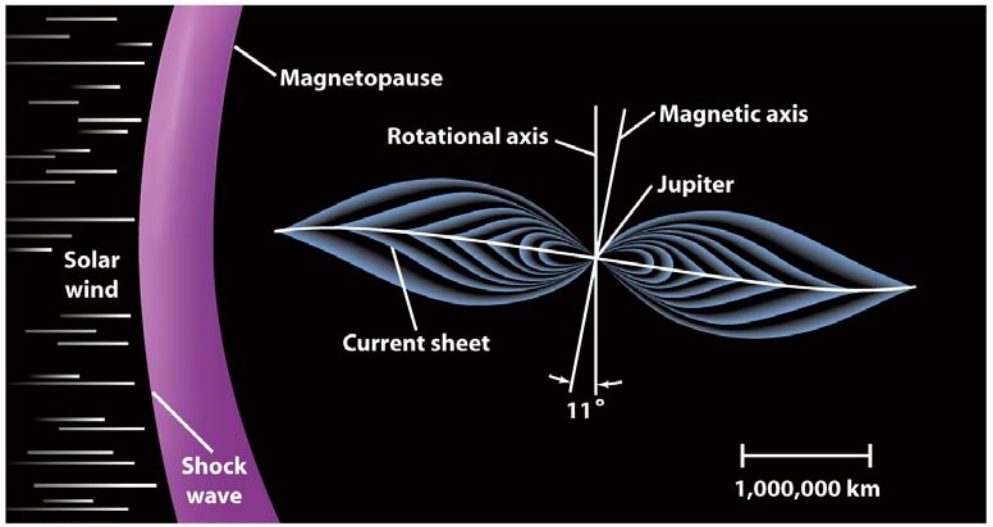

Figure 12-13
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Global magnetic fields arise from moving electrical charges that produce a magnetic field; need a rotating liquid core.

(This is another clue about the interior composition!)

Properties of Jovian Planets

Surfaces: cloud layers, bands, “spots”

Interiors: what they’re made of, conditions

Companions: satellite systems, rings

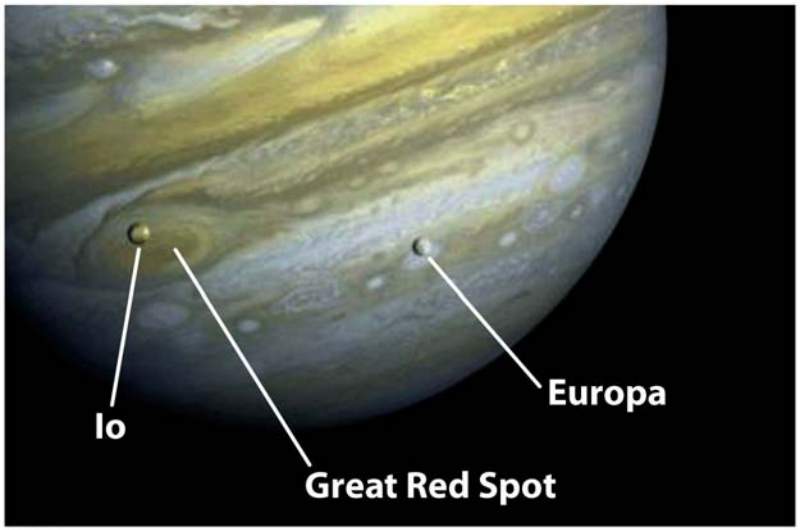

Figure 13-2
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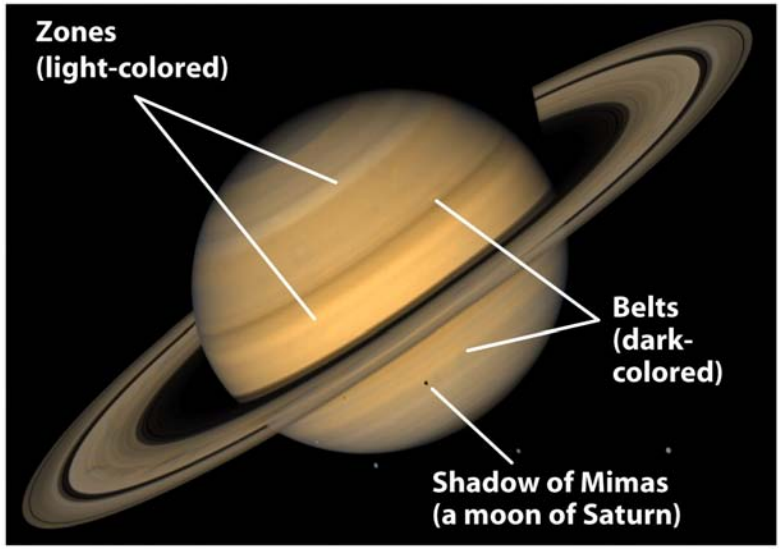

Saturn

Figure 12-2b
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Cloud layers create the visible “surface”

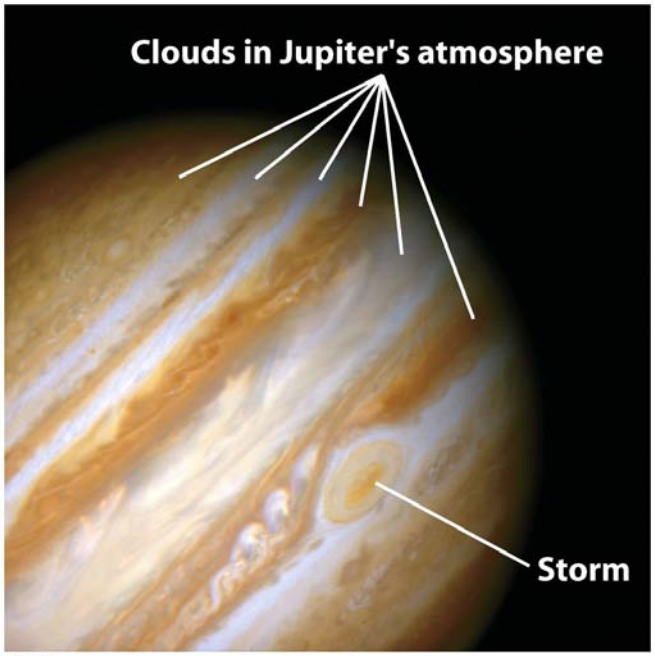

Figure 7-5
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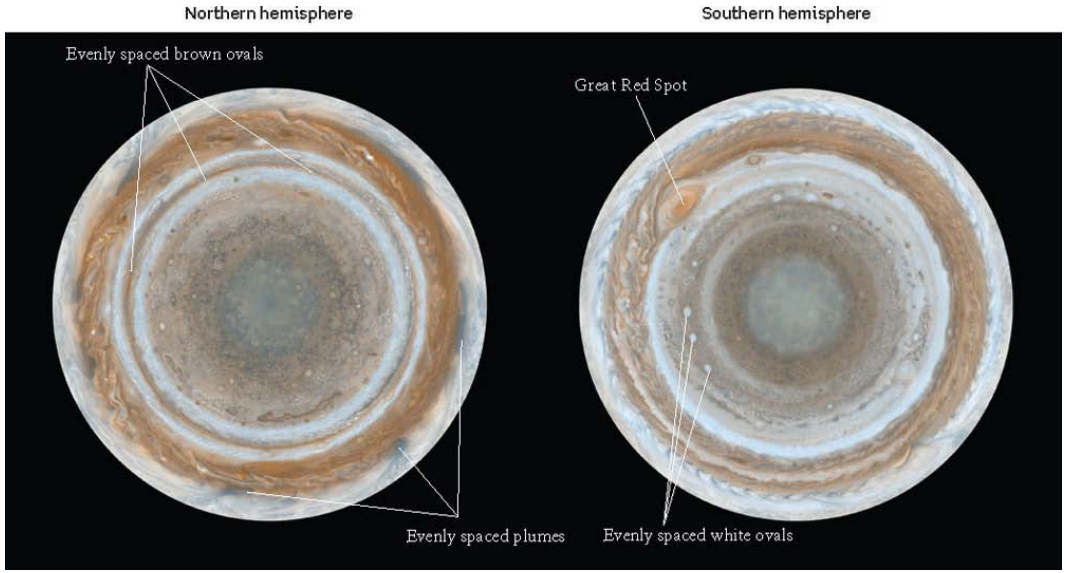
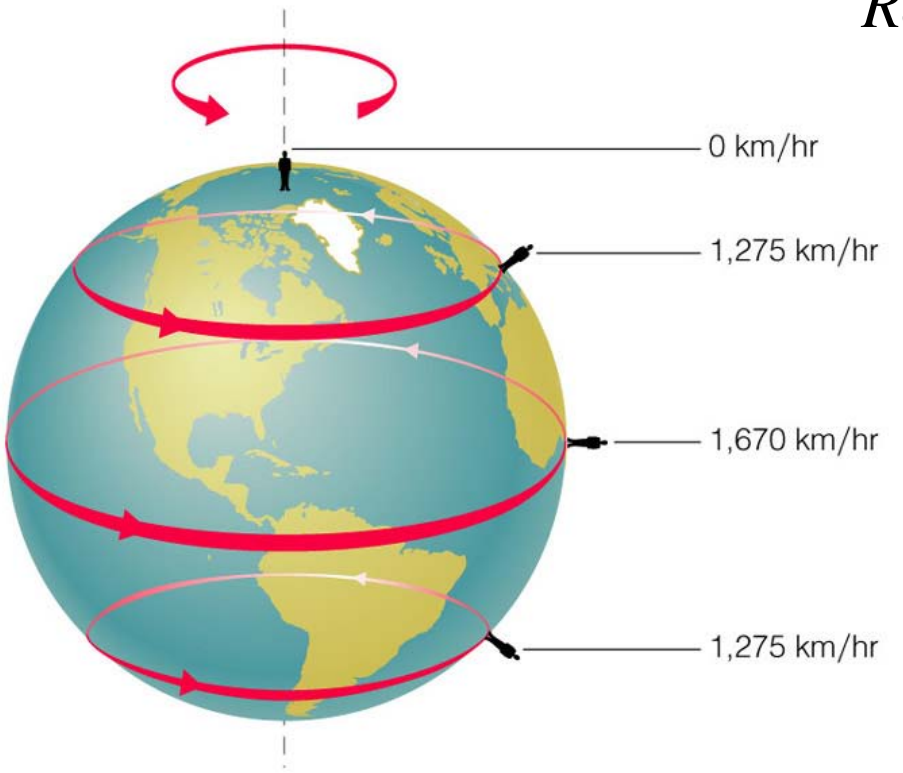
Rapid rotation stretches atmospheric structures into bands.

Because they are gaseous, they can show “differential rotation,” which means the rotation period is different for different latitudes



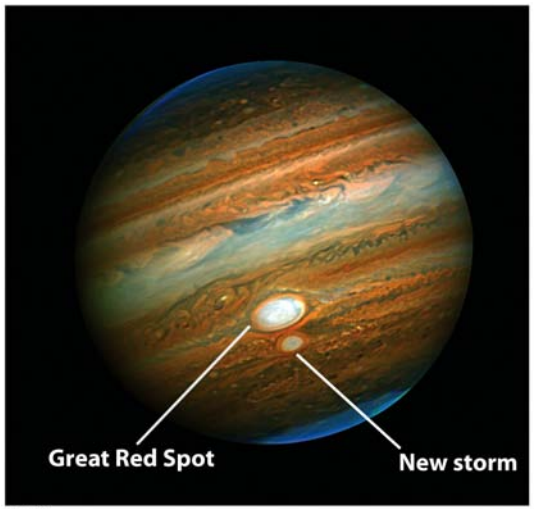
Solid-Body Rotation (e.g. the Earth)

$$Rotational\ Velocity = \frac{2\pi R}{Period}$$



Period is the same for all locations (latitudes), but the value of *R* changes with latitude! Locations at higher latitudes don't travel as far, so their speed is slower.

The “Great Red Spot” - long lived cyclone



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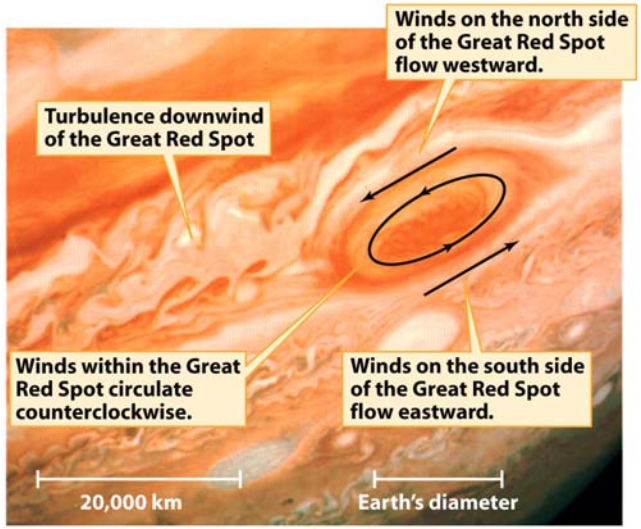

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(a) *Pioneer 11*, December 1974 (b) *Voyager 2*, July 1979 (c) HST, February 1995

Figure 12-4
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Planetary Rings: Rings of Saturn

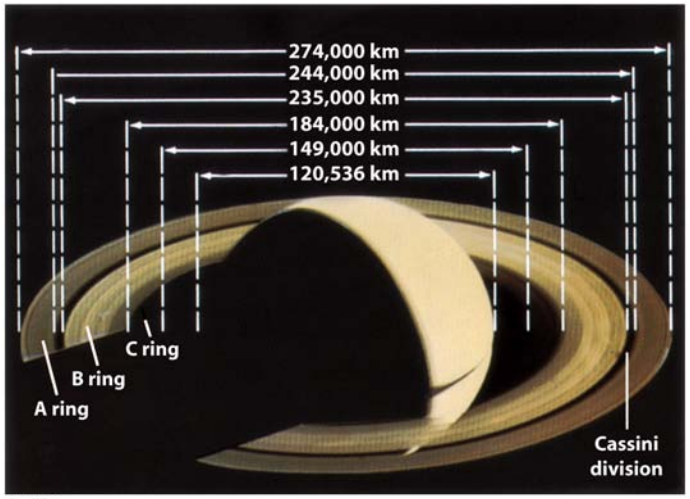

Figure 12-16
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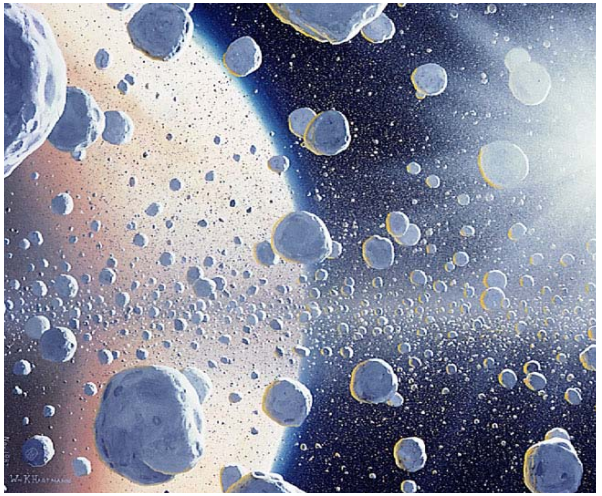

The rings are not solid, but made of small. icy bodies.

How do we know this?

differential rotation;

changing view of the rings

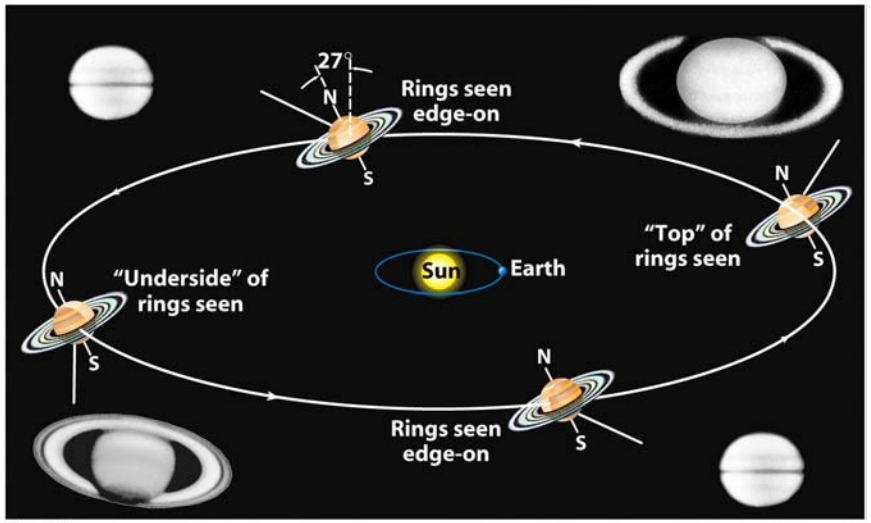

Figure 12-17
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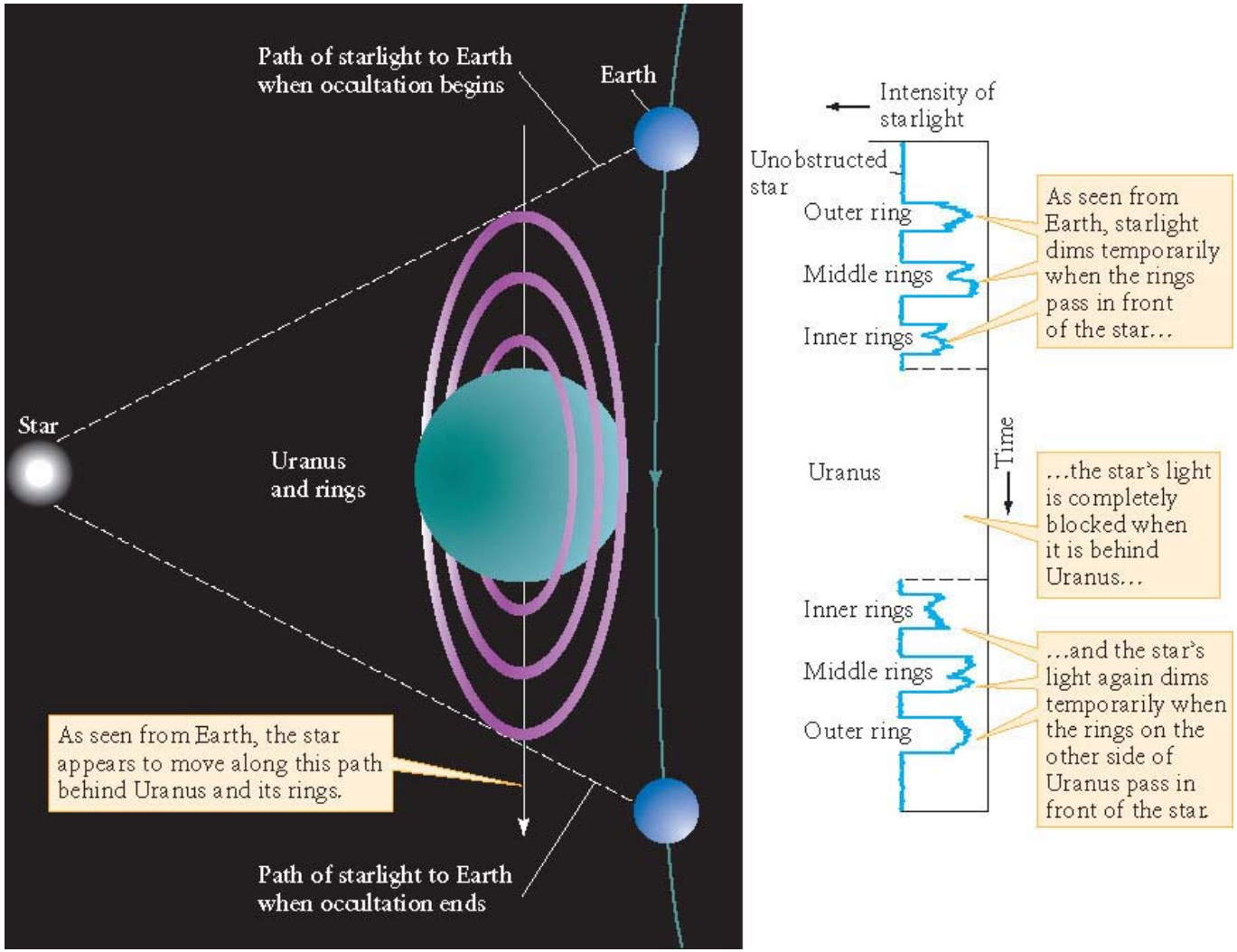
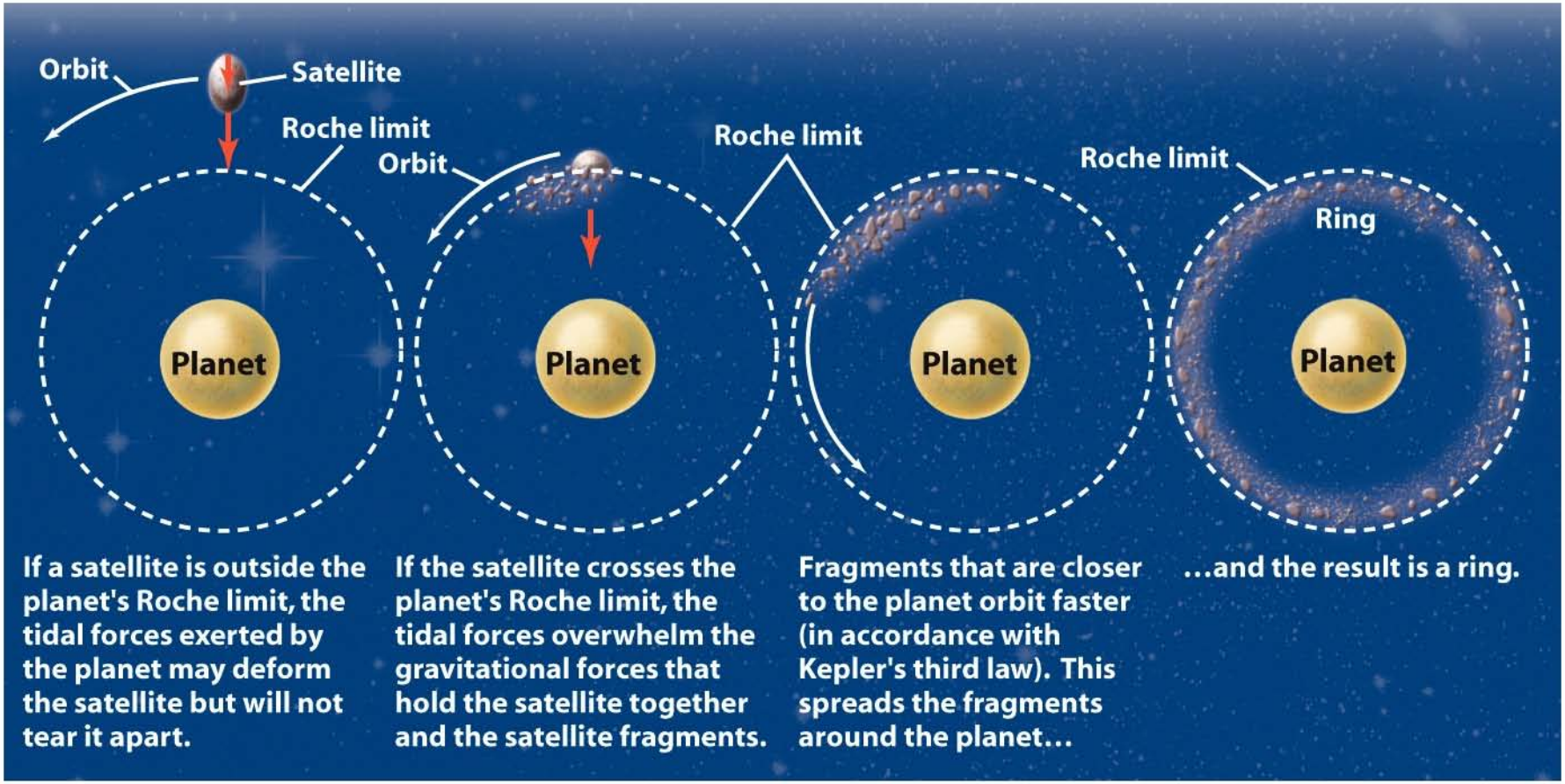
Uranus' Rings were discovered when they "eclipsed" background stars



…of rings and Roche Limits: the location where tidal forces shred bodies



Cosmic Connections 12a
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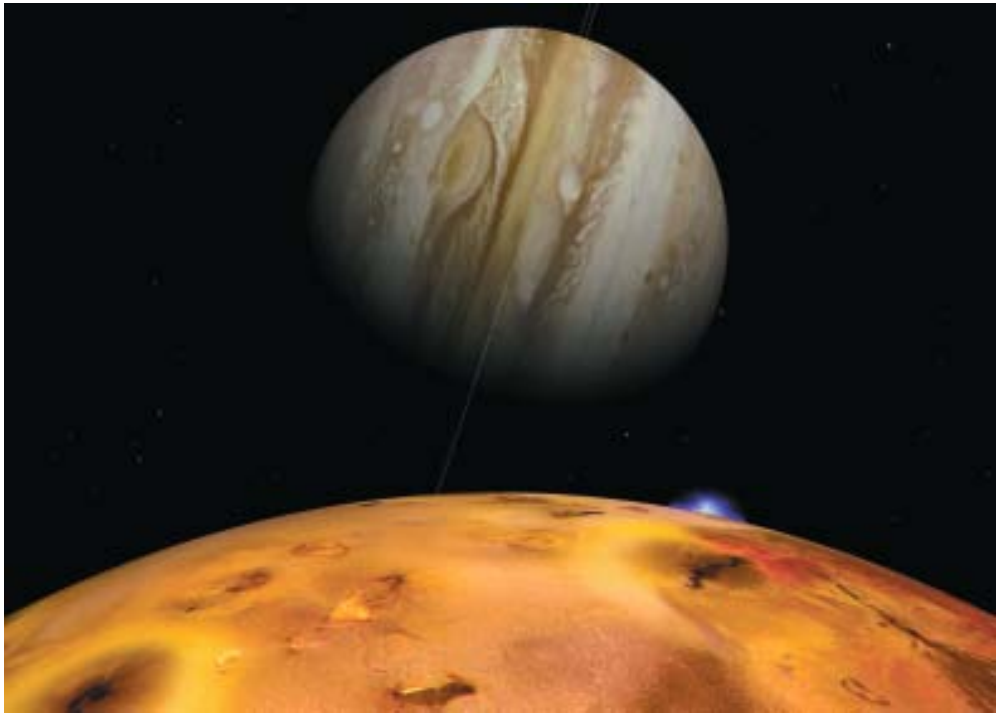
Yet More Worlds: Jovian moons



Jupiter's moons can be thought of as "worlds" in themselves, especially the *Galilean satellites* of Jupiter.

- Io: Active volcanoes (the "pizza" moon)
- Europa: Possible subsurface water ocean
- Ganymede: Largest moon in solar system
- Callisto: A large, cratered "ice ball"

Major Satellites of the Solar System

Table 7-2 The Seven Giant Satellites

	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

R I V U X G

(NASA/JPL/Space Science Institute)

Table 7-2
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