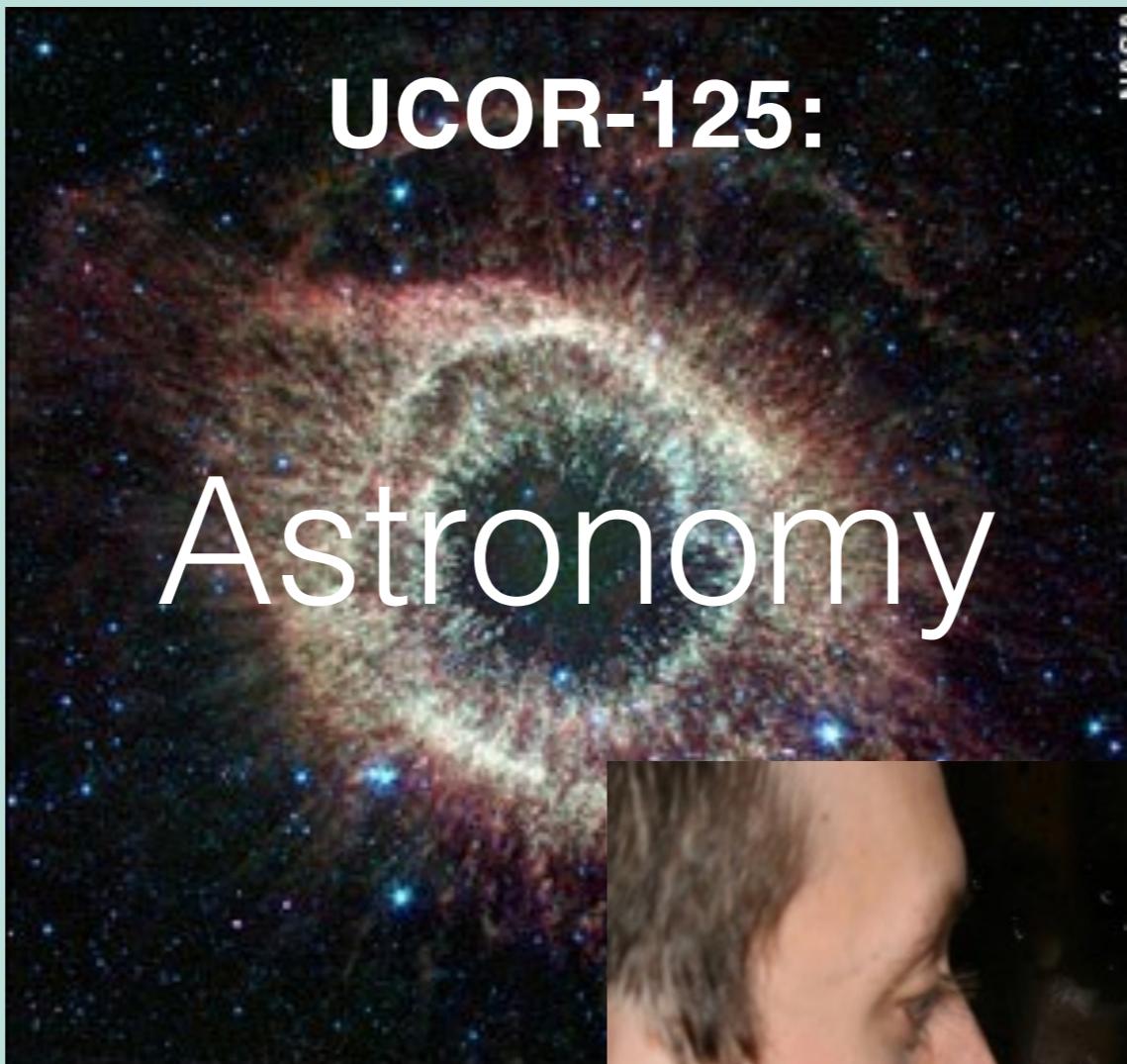
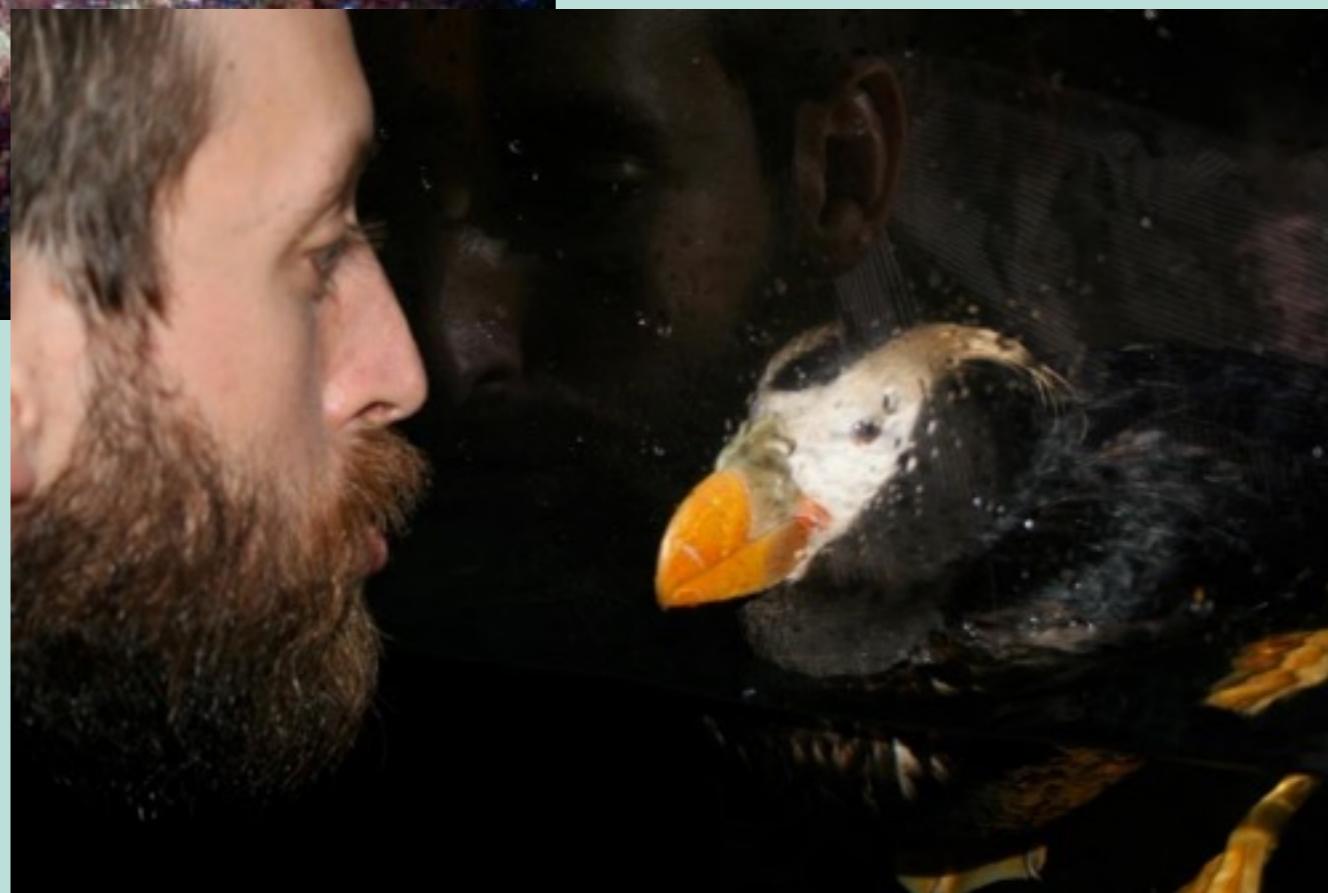




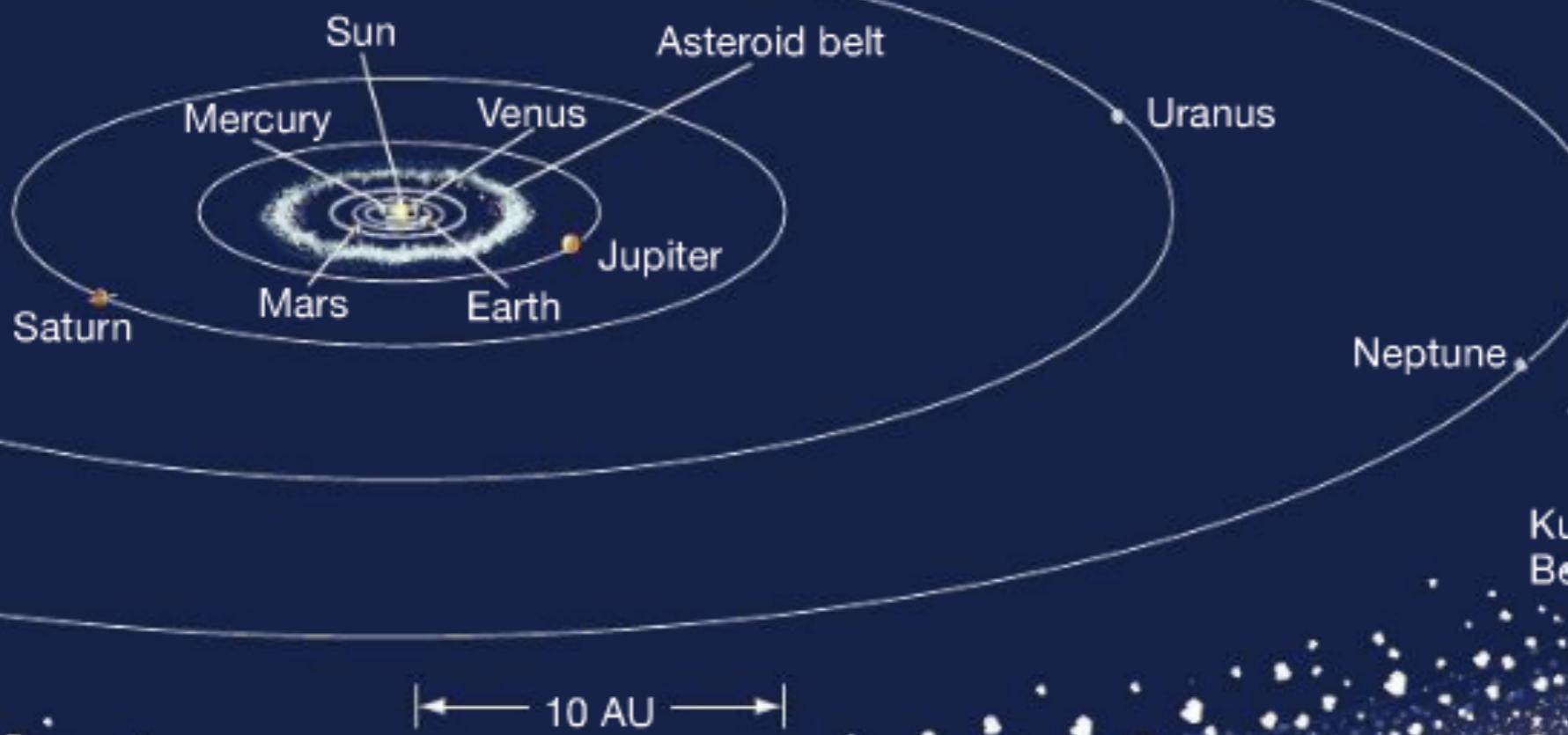
Lecture 10: Jupiter



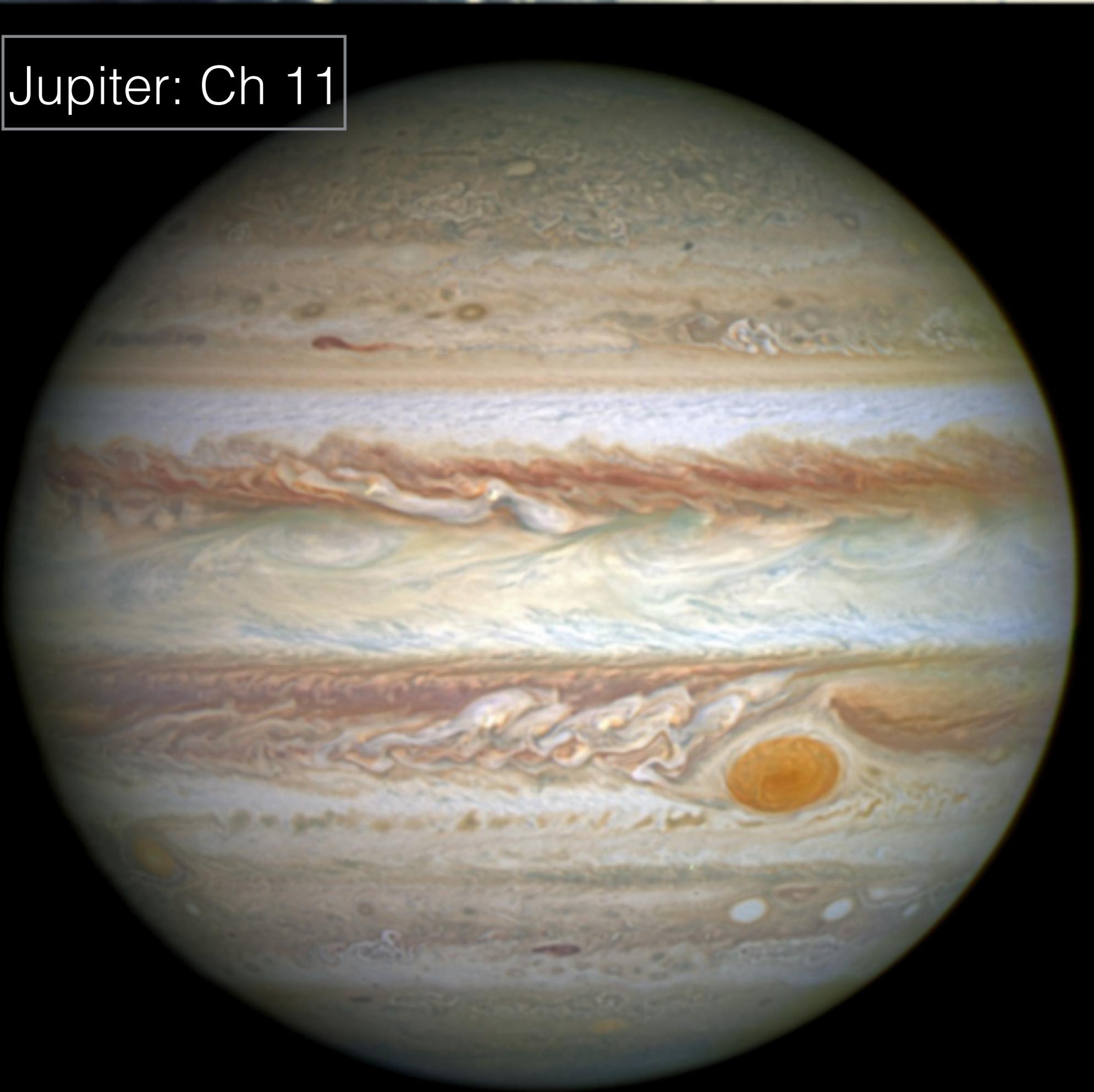
with your host:



Coop



Jupiter: Ch 11



$m \sim 2 \text{ e}27 \text{ kg}$
 $\sim 318 m_e$

$r \sim 6.7 \text{ e}4 \text{ km}$
 $\sim 11 r_e$

$d \sim 5.2 \text{ AU}$
 $\sim 43 \text{ minutes}$

$T \sim 12 \text{ yr}$

density~
1326 kg/m³

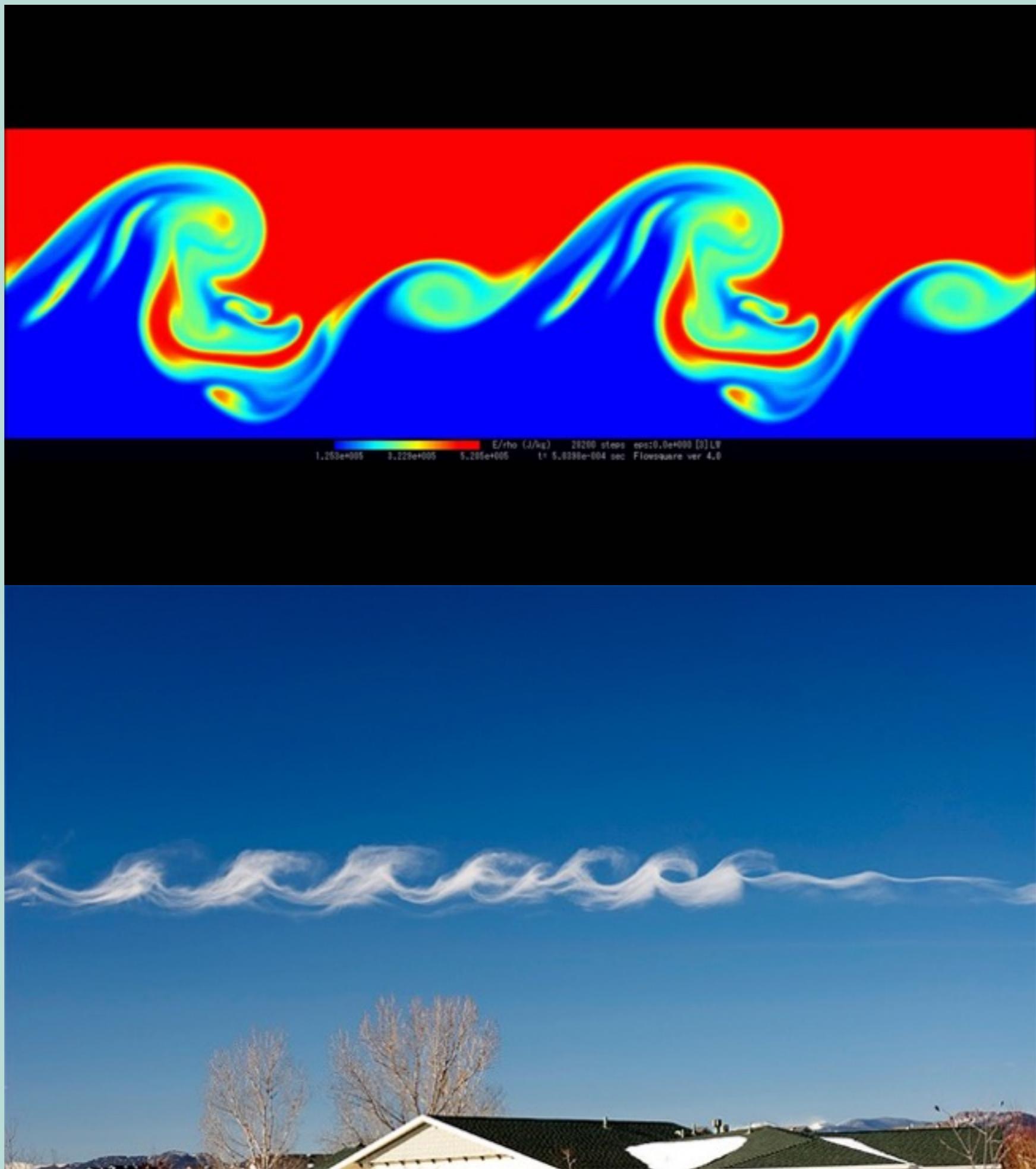
Jupiter: Ch 11

Cassini Fly-by



Jupiter: Ch 11

Kelvin-
Helmholtz

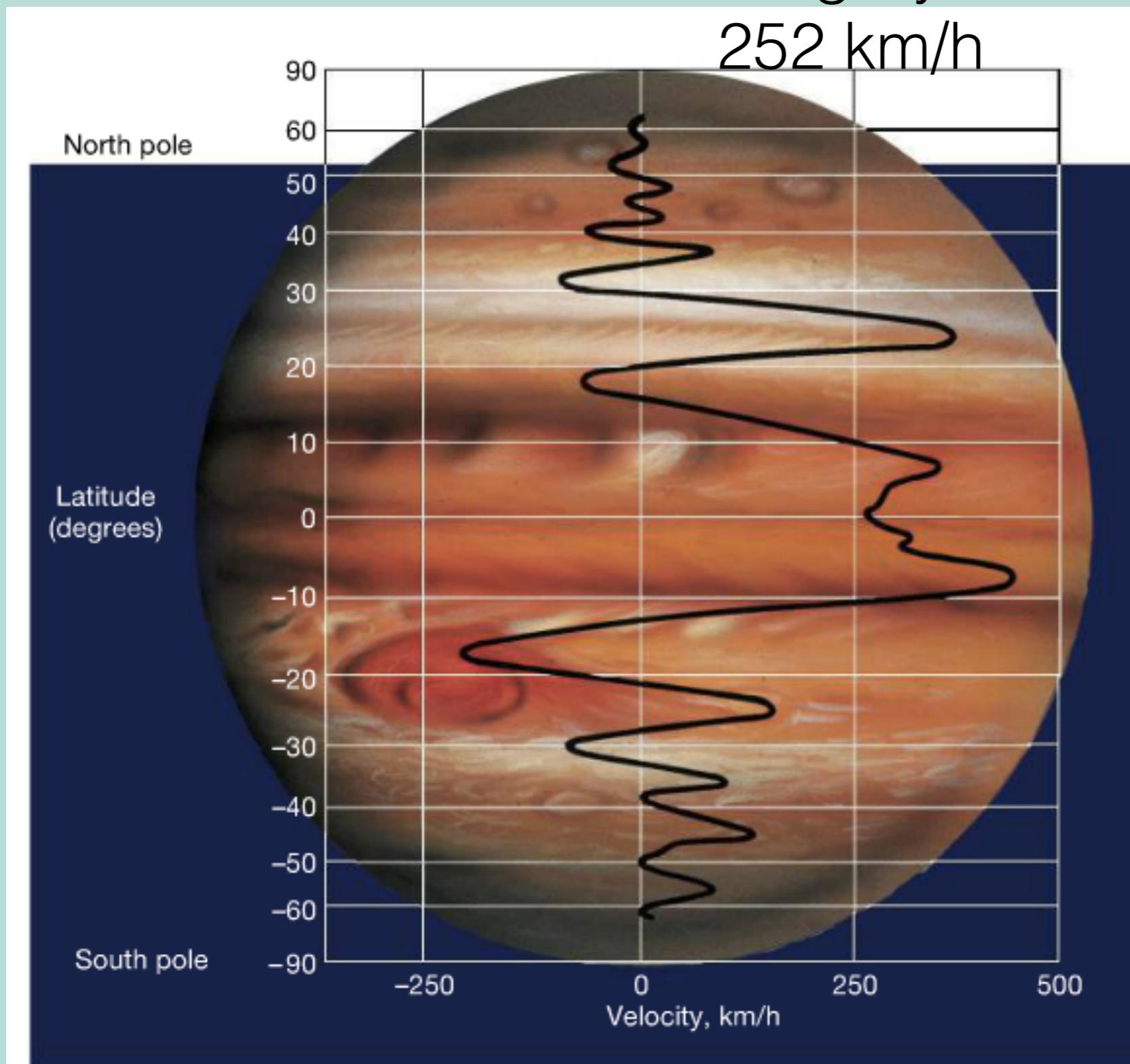


Jupiter: Ch 11

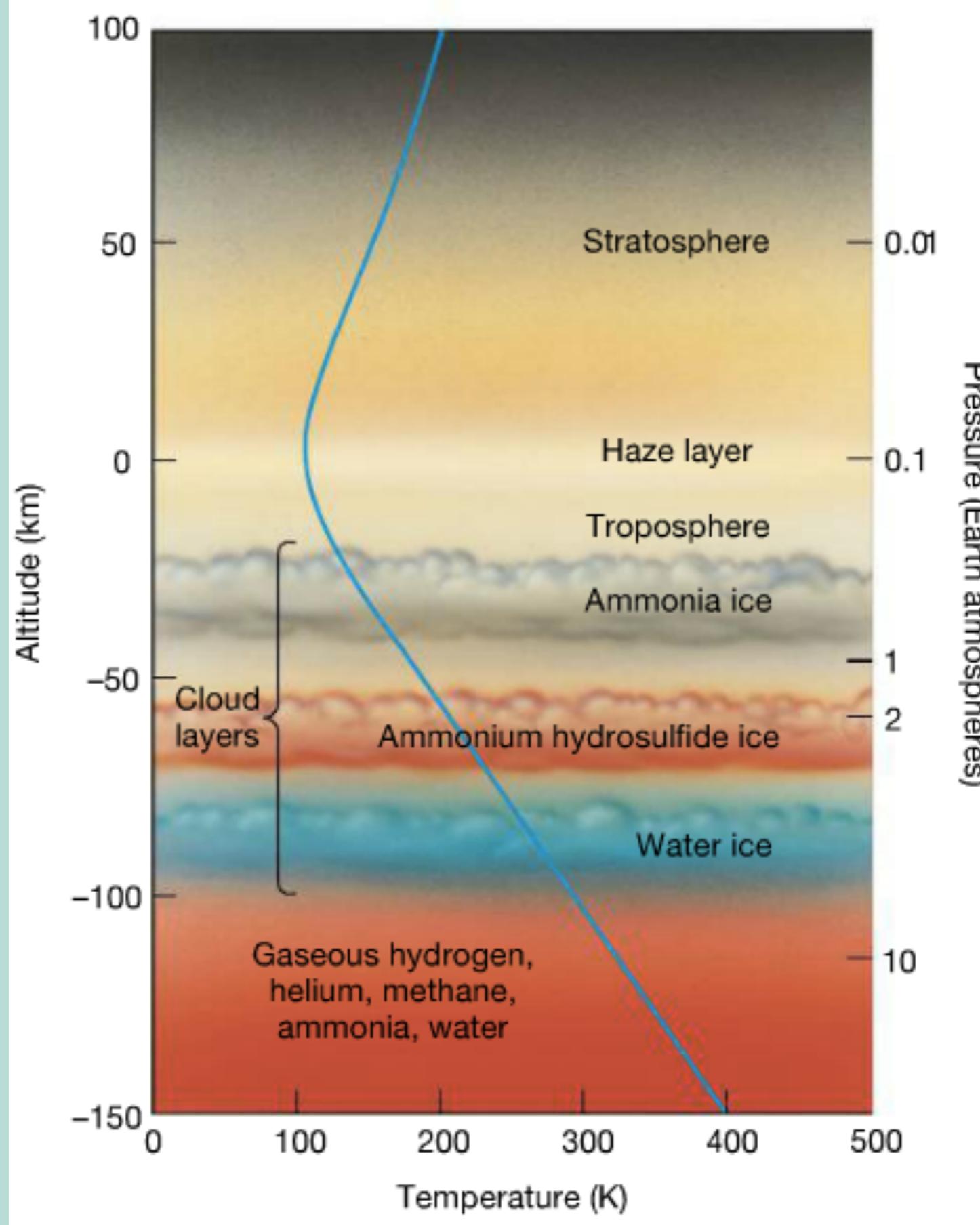
- 50" across closest to earth.
- Doppler shift studies show differential rotation
- Better rotation measurements come from radio wave burst periodicity in the magnetosphere (9hr 55min)

Rotational Velocities

category 5:
252 km/h



Jupiter: Ch 11



Jovian Atmosphere

Jupiter: Ch 11

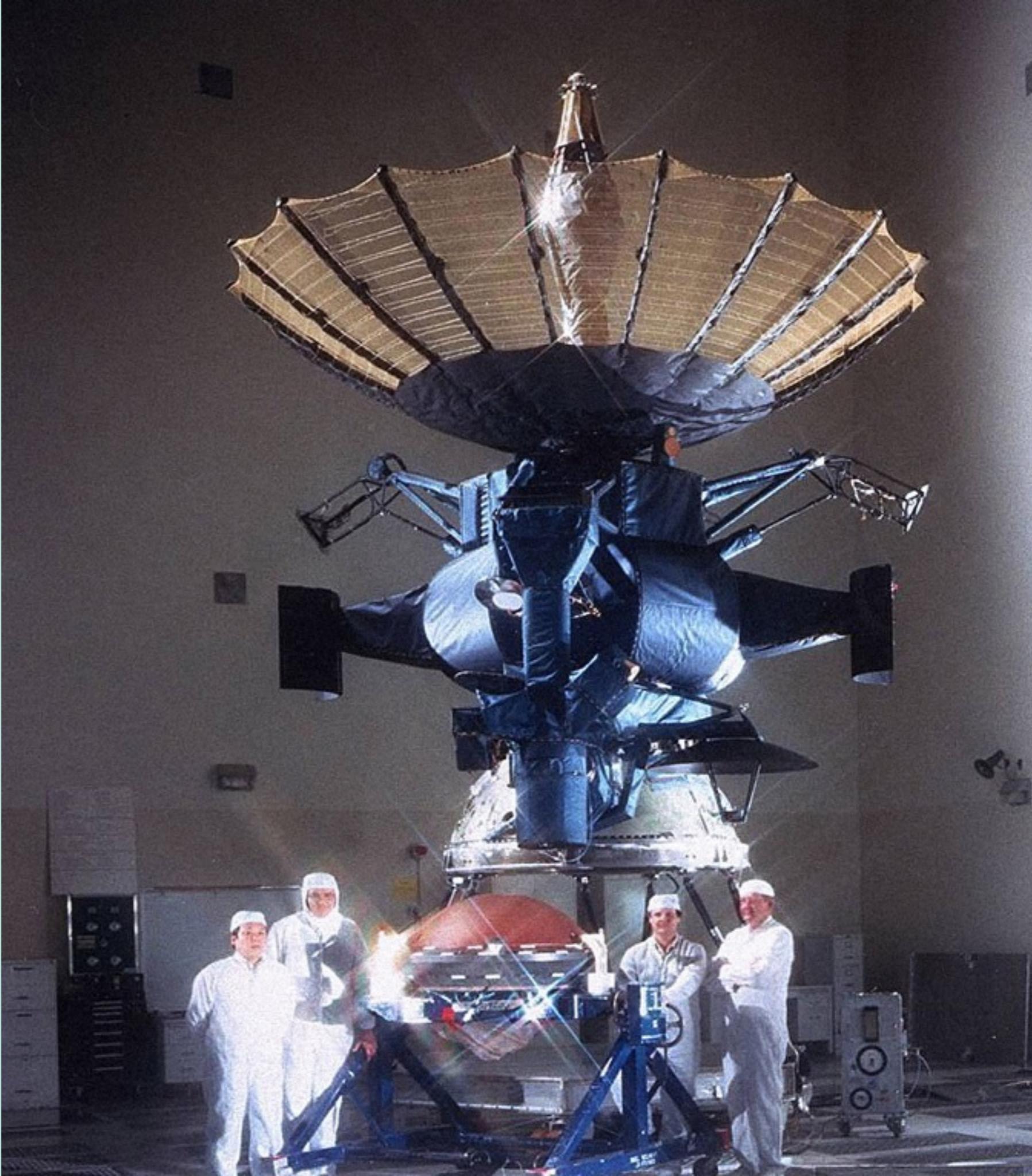
Composition: 86.1% Hydrogen, 13.8% Helium

Trace Methane (CH₄) Ammonia (NH₃) and water vapor

? What's the escape velocity ?

Jupiter: Ch 11

Galileo
(1989-
2003)

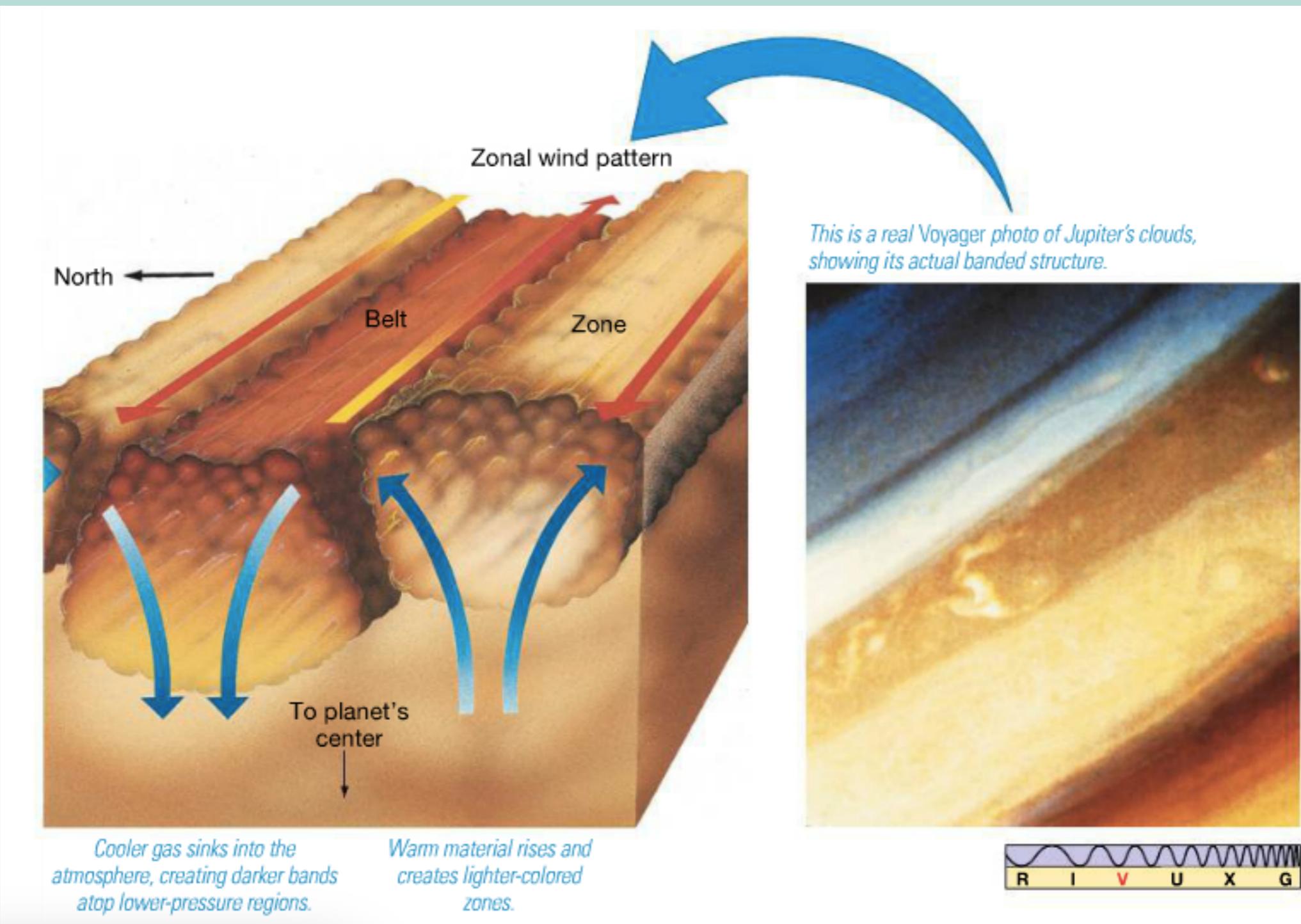


Jupiter: Ch 11

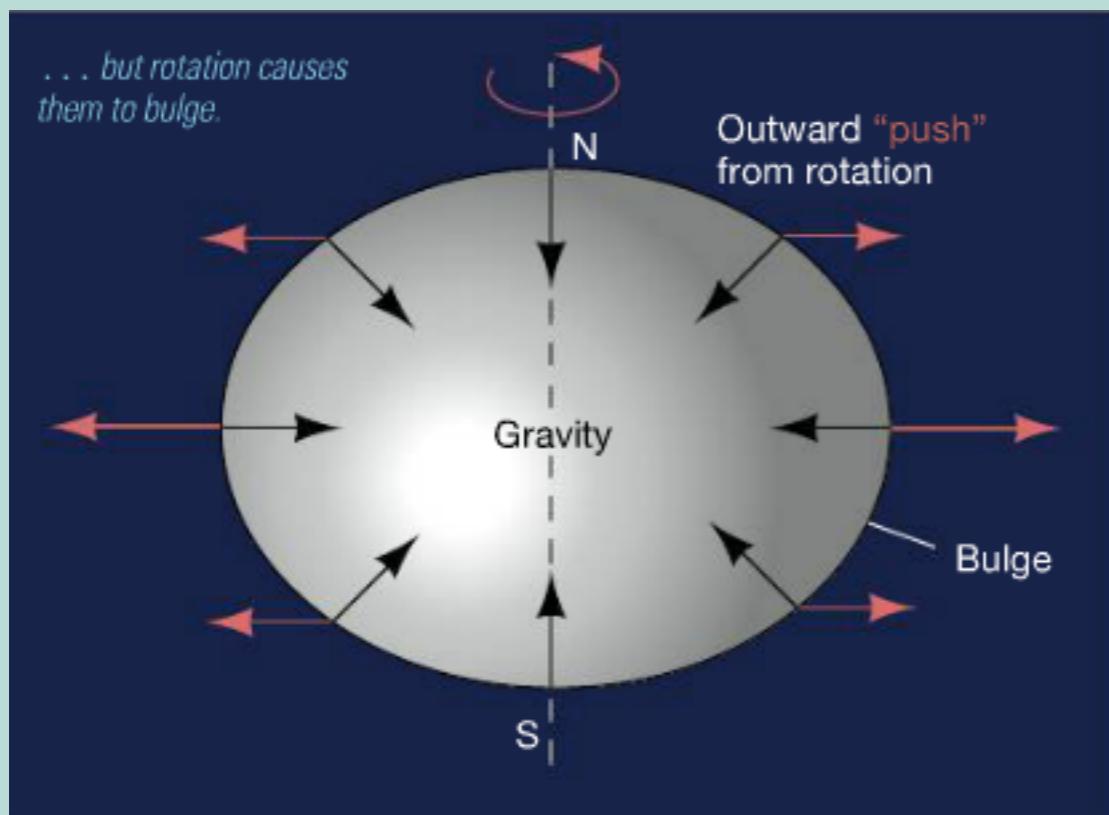
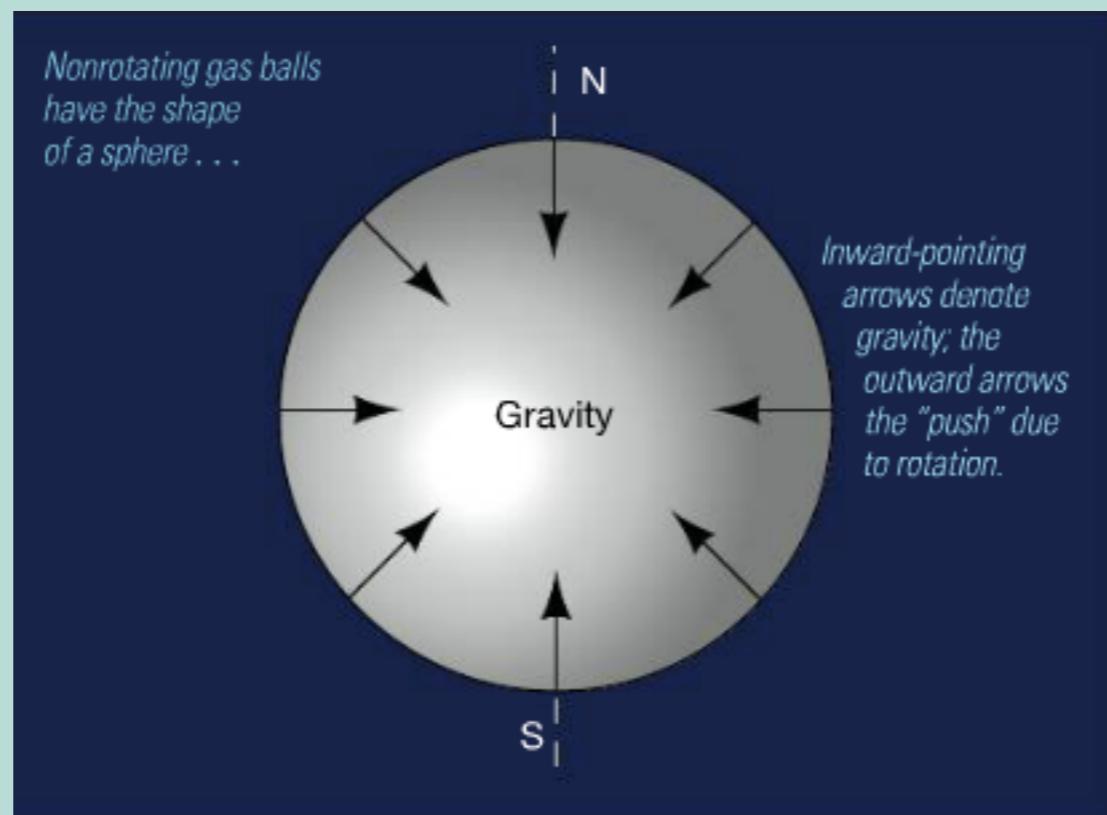
Galileo's Entry Point



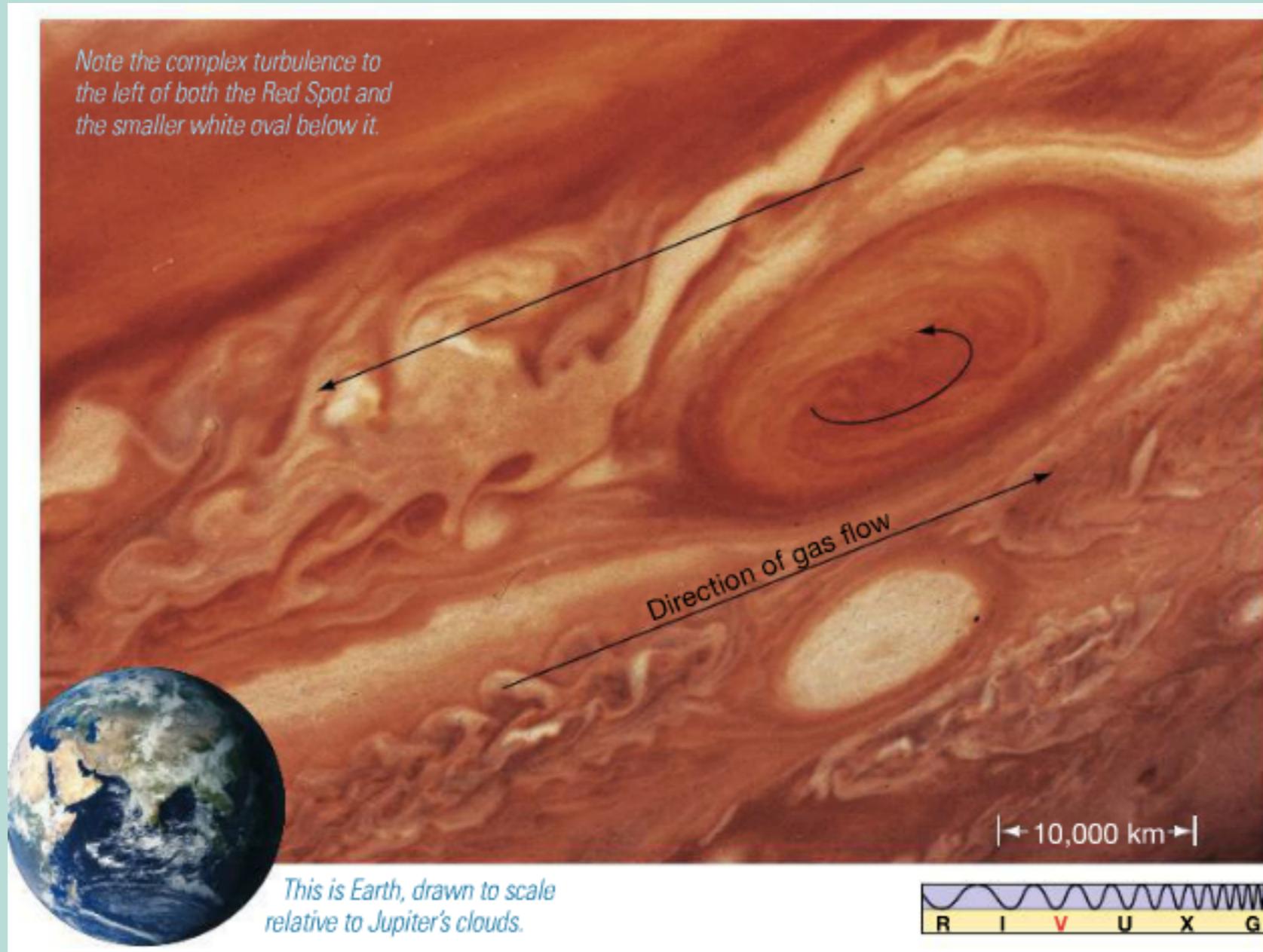
Zonal Flow



Jupiter: Ch 11



The Great Red Spot

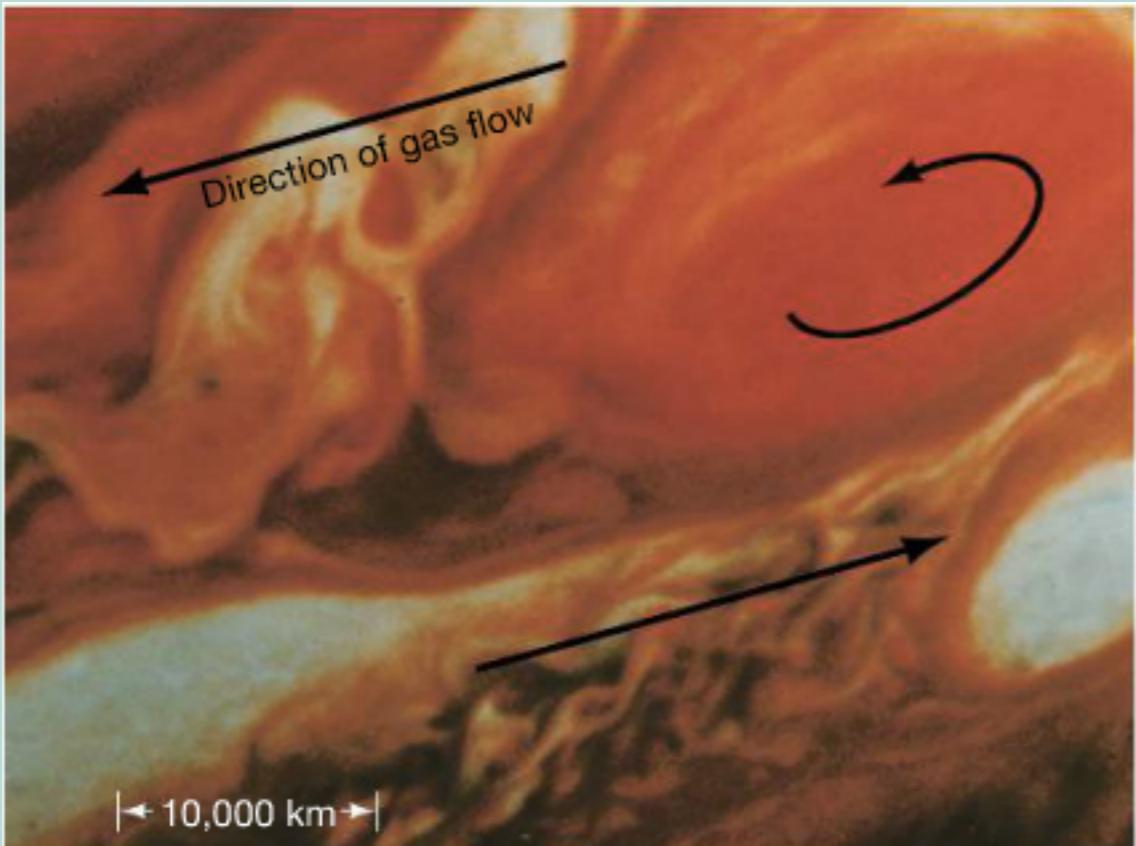


Jupiter: Ch 11

- First noticed by Robert Hooke (~350 years ago!)
 - Twice the size of the Earth
 - 430 km/h

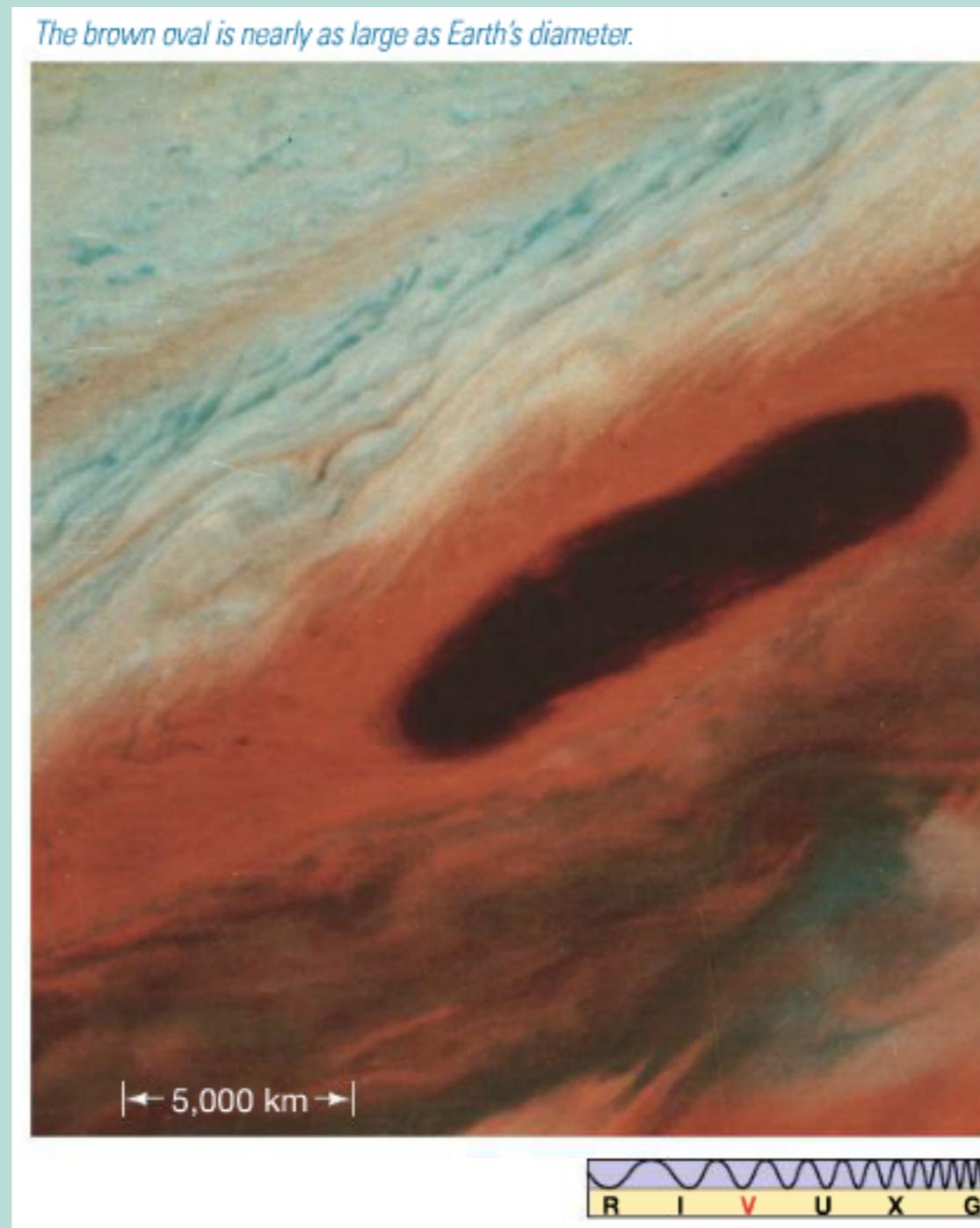


Red Spot Turbulence



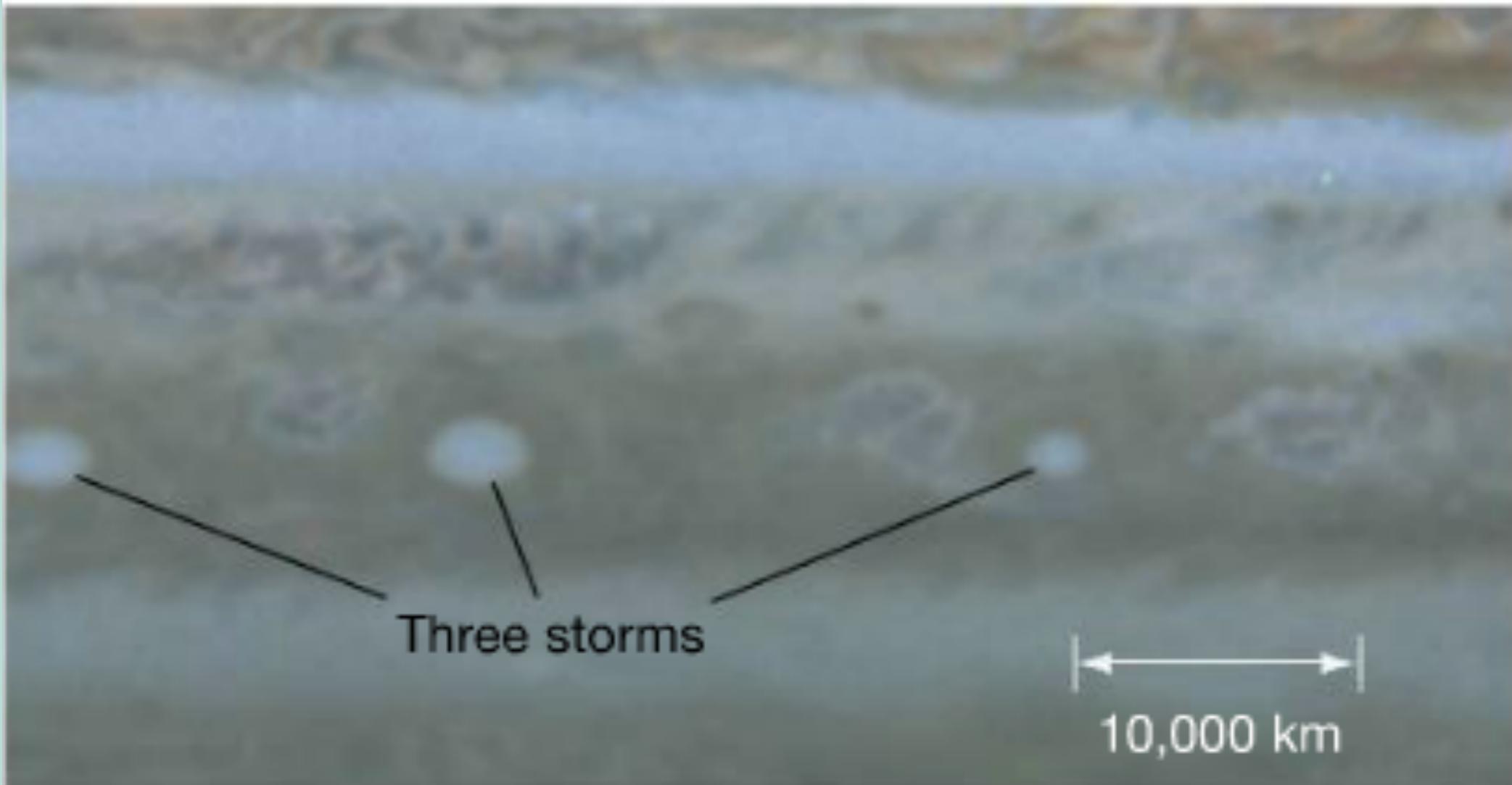
Jupiter: Ch 11

Brown Oval

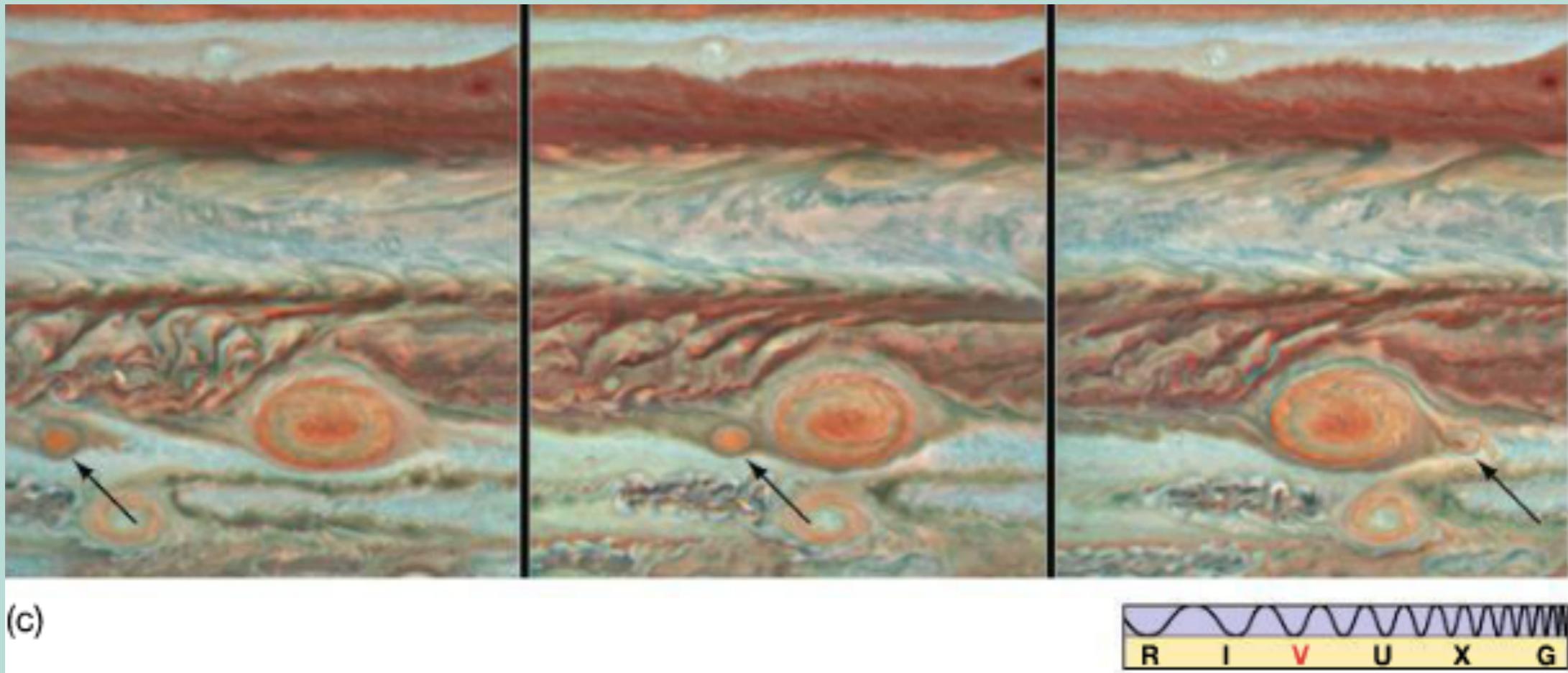


Appear only around 20 degrees north

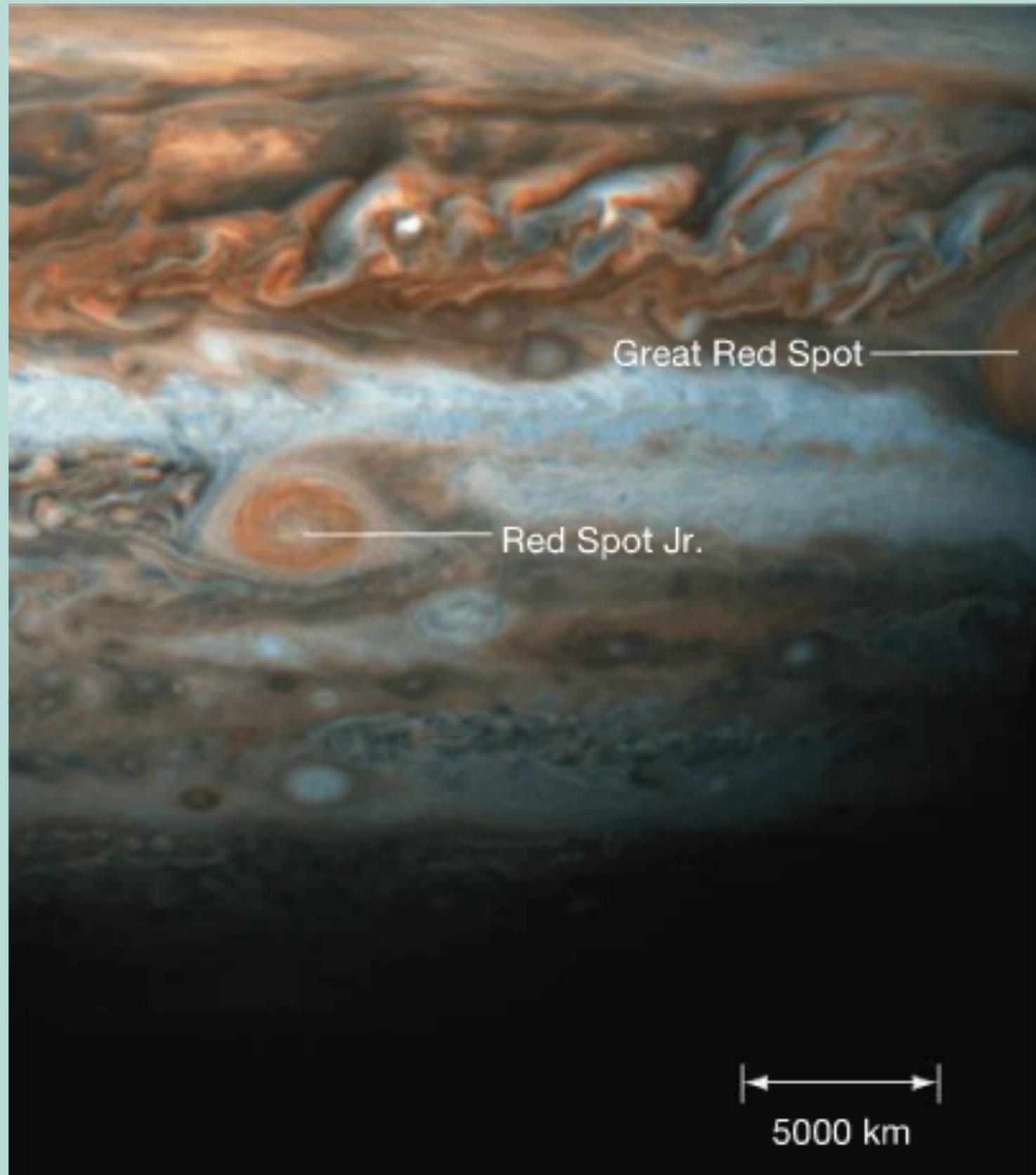
White Ovals



Jovian Storm Coalescence

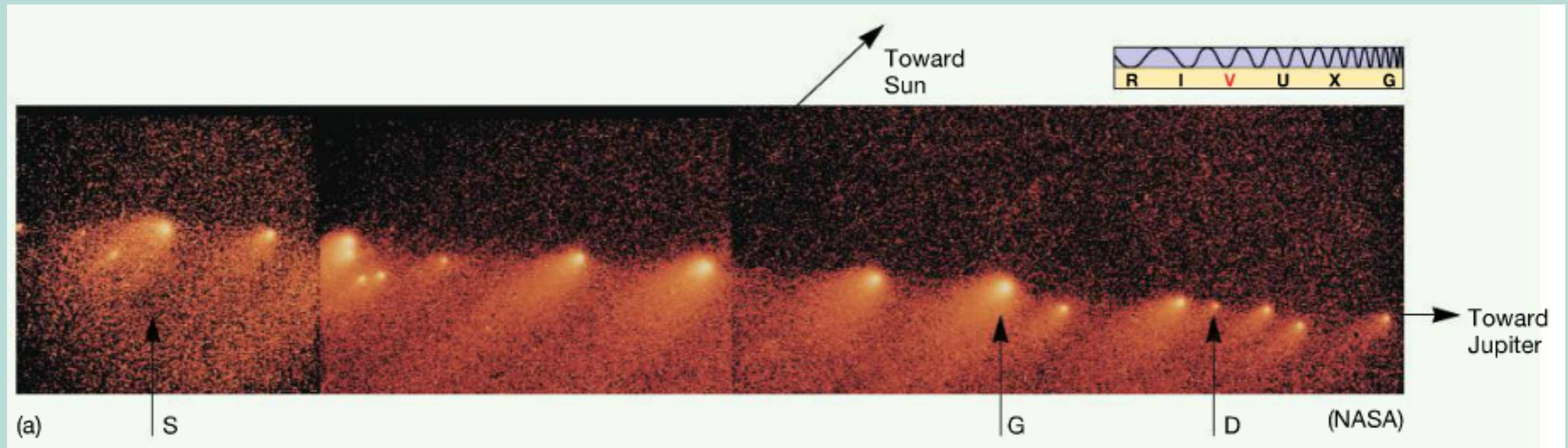


Jupiter: Ch 11



Red coloration may be due to storm intensity

Tidally Disrupted Comet



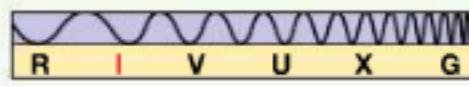
Each pearl is like a billion nukes.

Jupiter: Ch 11

Comet Collision



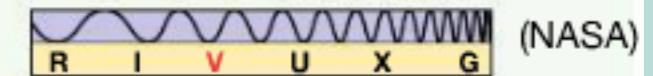
(b)



(Palomar) (c)

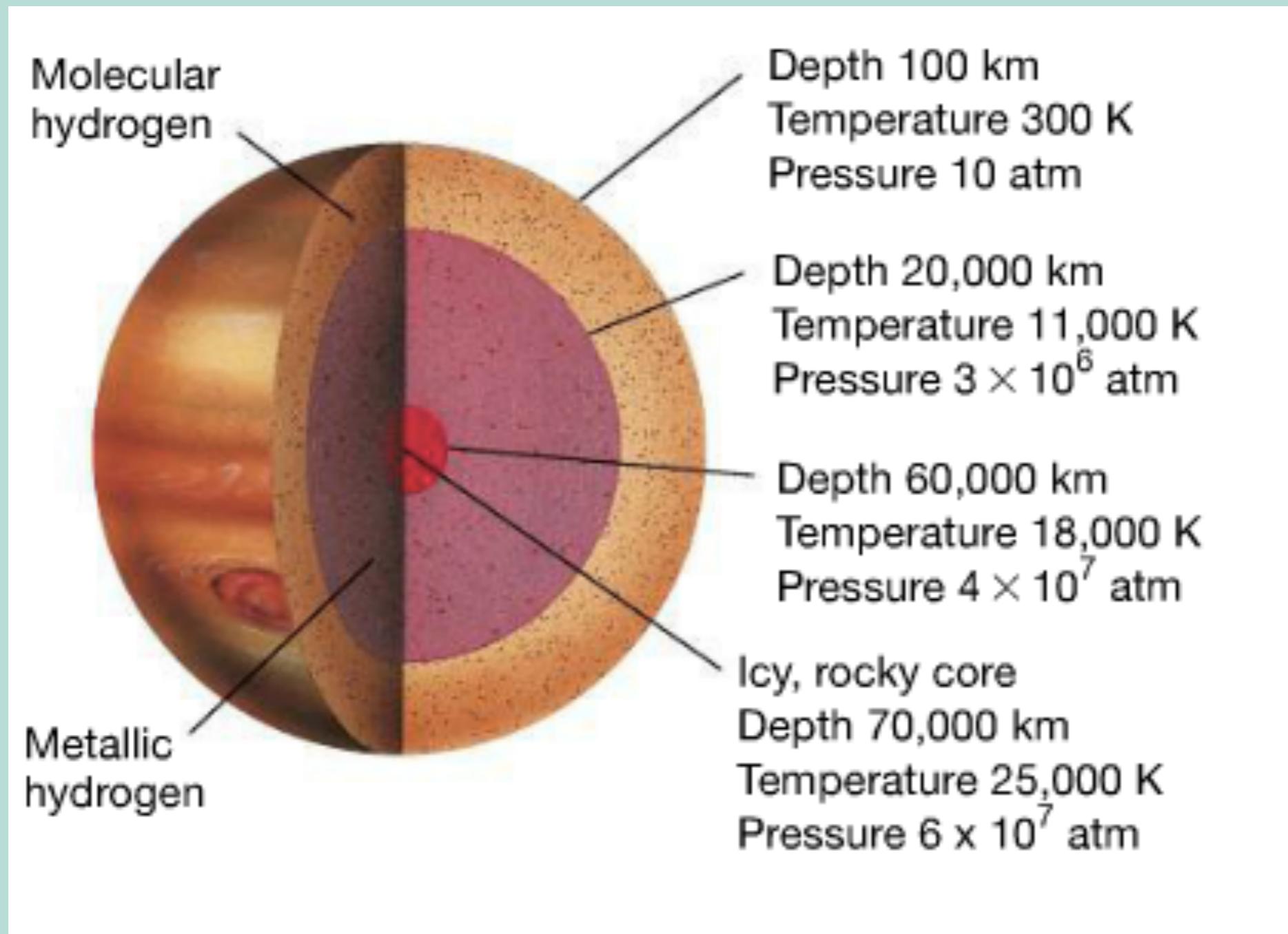


(d)

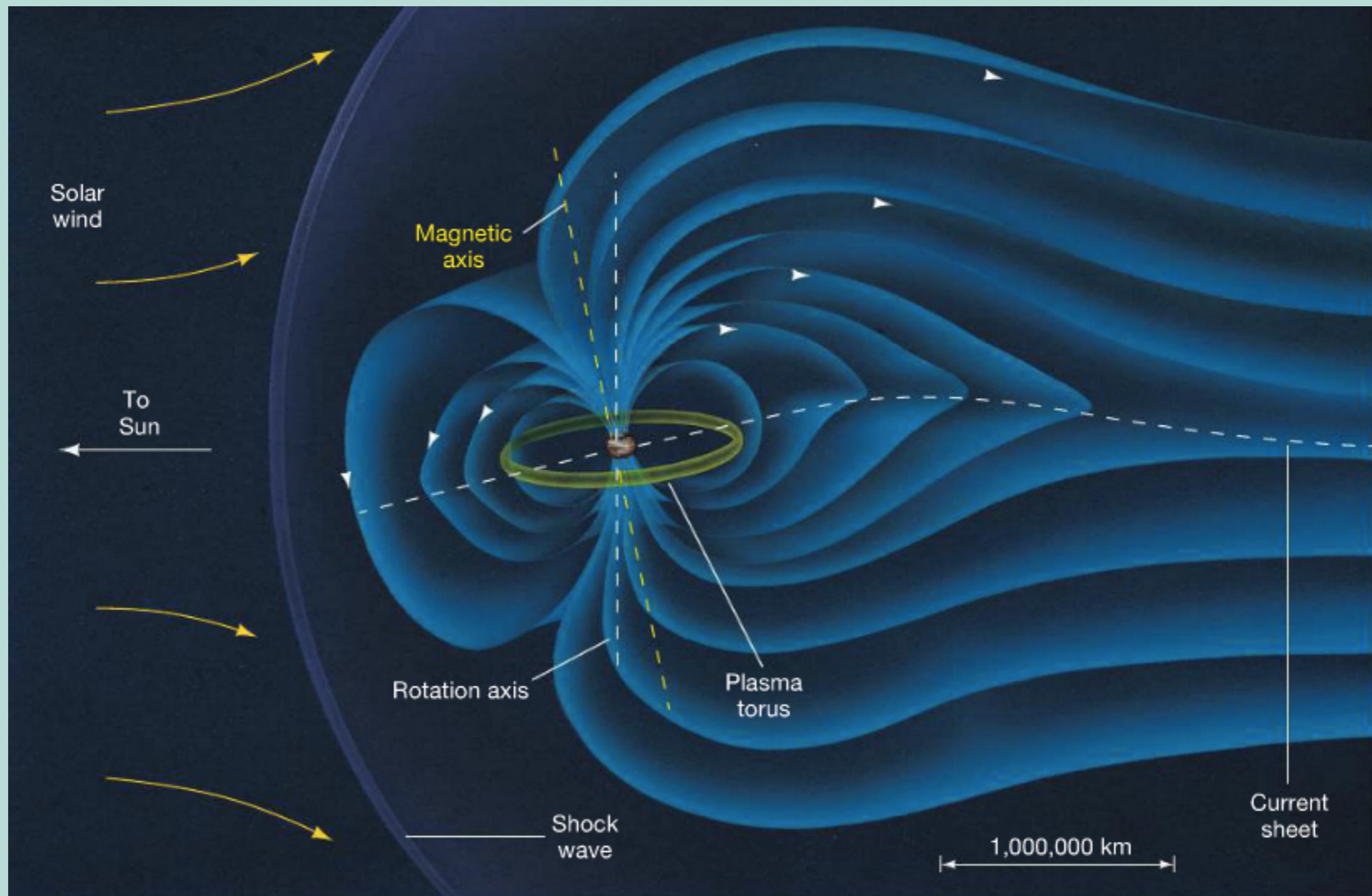


|—————|
30,000 km

Jupiter's Core



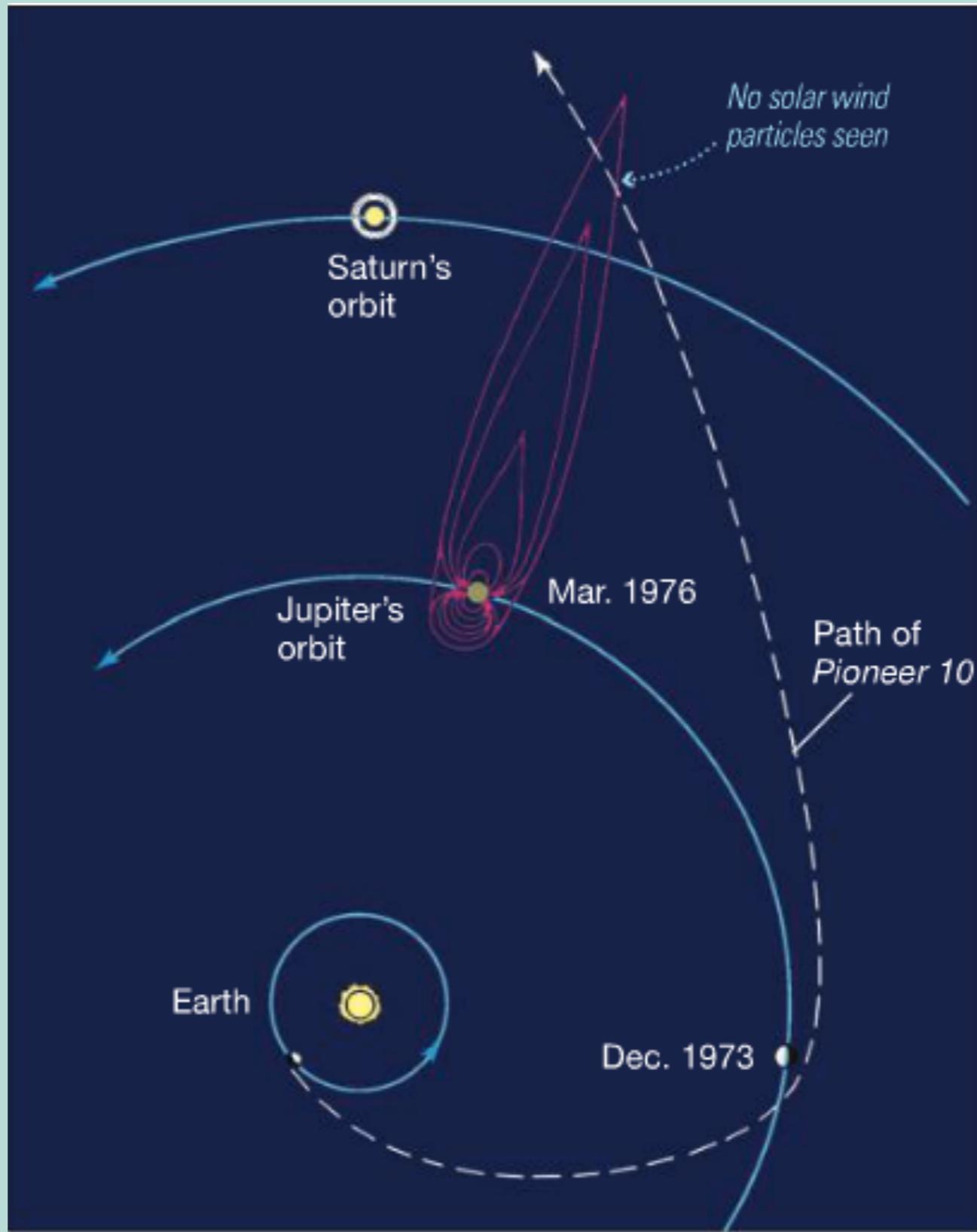
More heat leaves jupiter than it receives from sun!



Jupiter: Ch 11

- ~10 times stronger field than earth
- ~18000 times stronger magnetic moment (careful!)
- volume larger than 1000000 earths (that's larger than the sun!)

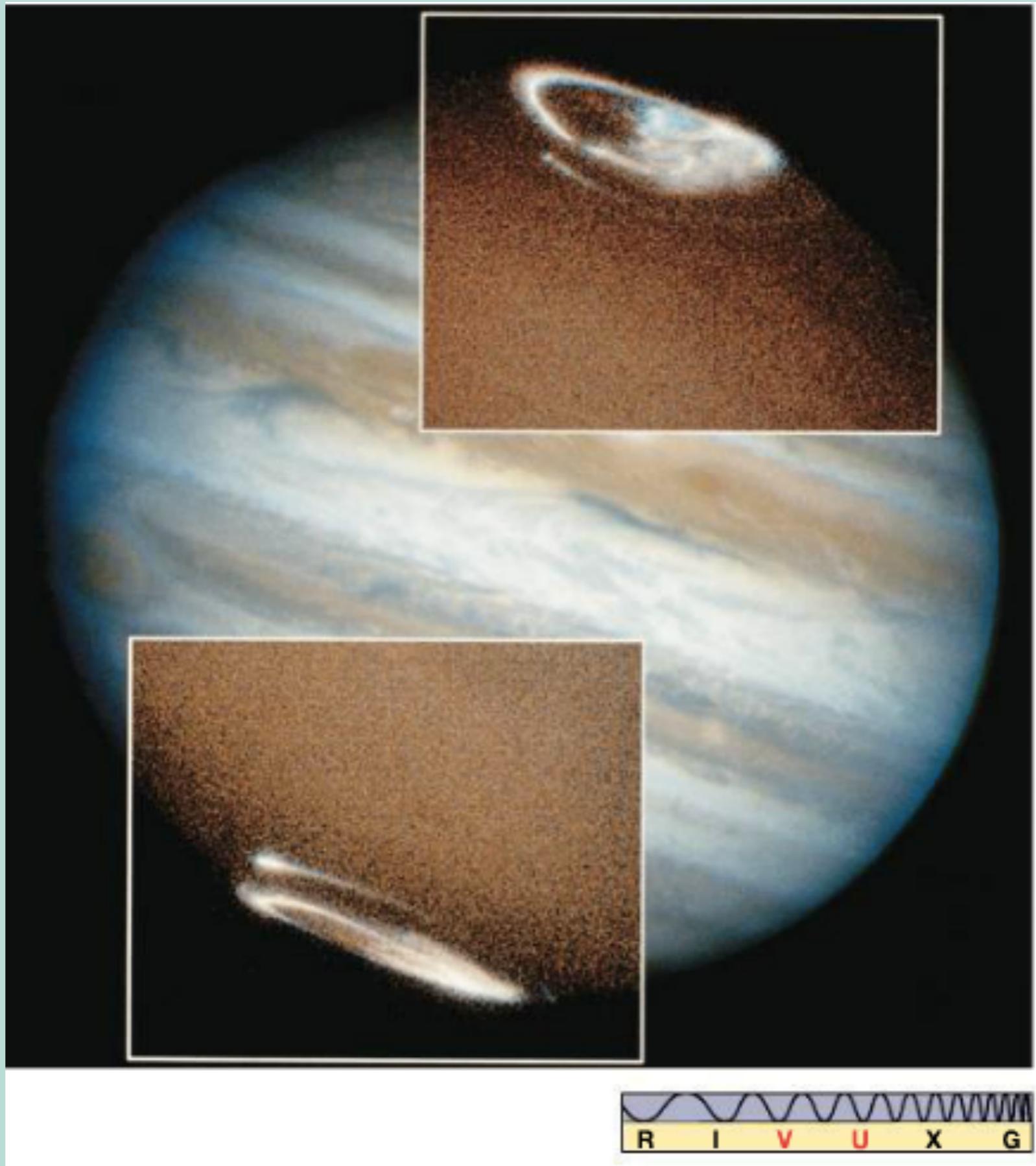
Jupiter: Ch 11



Don't forget Saturn's Orbit is almost 5 AU away from Jupiter!

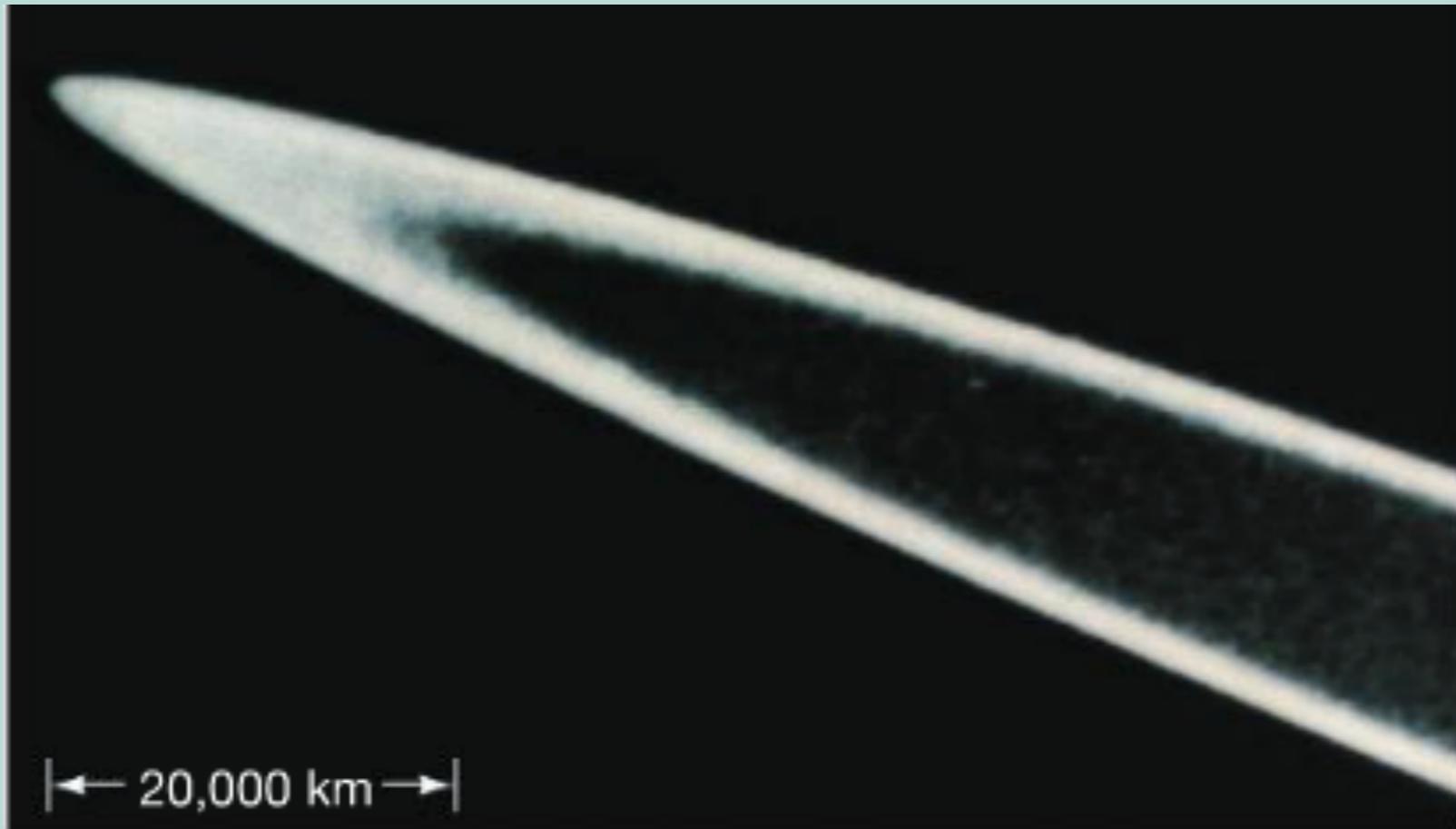
Jupiter: Ch 11

Aurorae



Jupiter: Ch 11

Jupiter has rings!



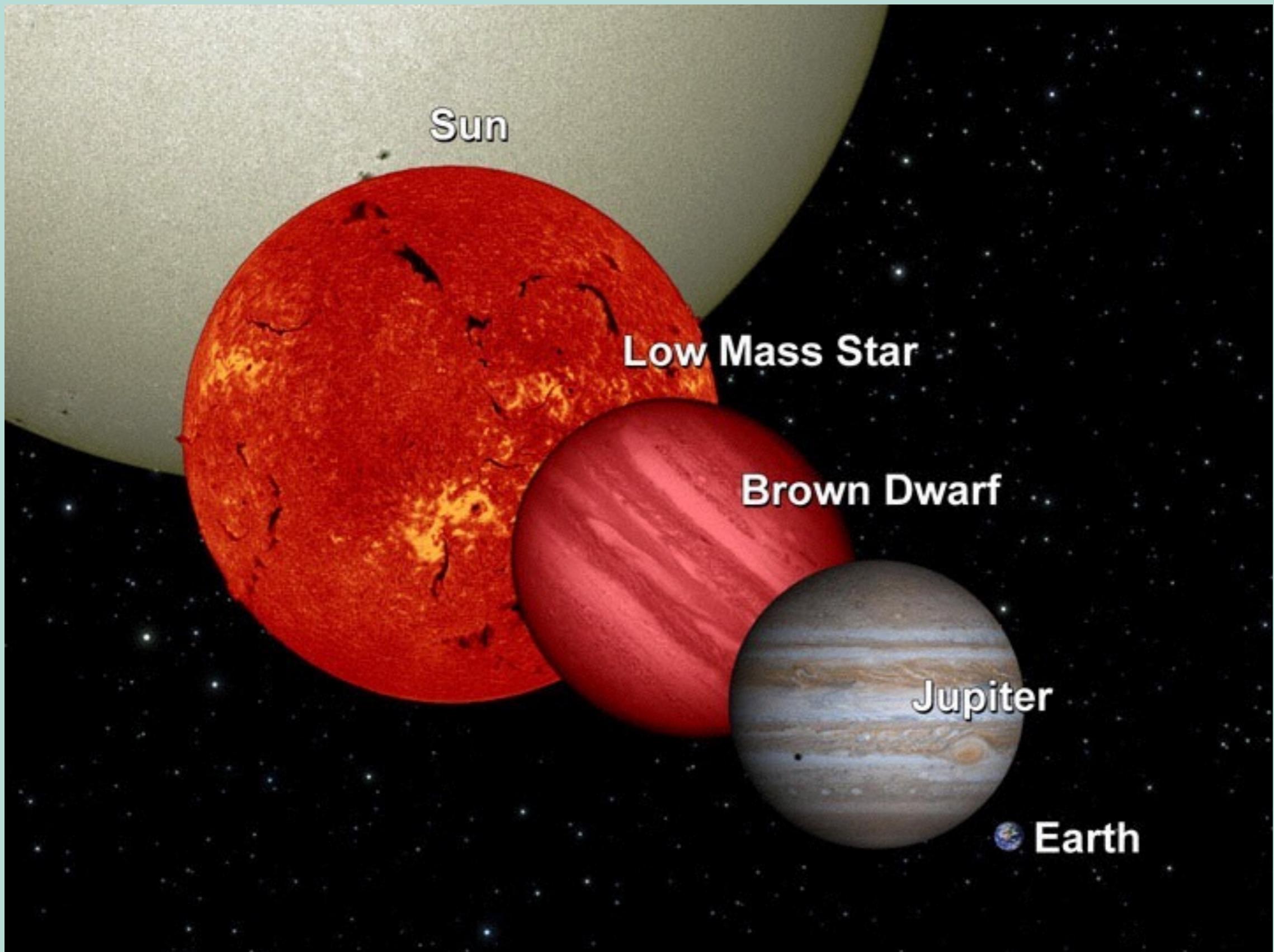
Almost a Star?

Jupiter just doesn't have enough mass to make it hot enough to create the conditions for nuclear fusion in its core (25,000 K not 10,000,000 K)

In the past, it was much hotter and thus much brighter, perhaps 100 times brighter than the moon!

The limit for fusing deuterium (brown dwarf) however is about $13 M_J$, so it was close!

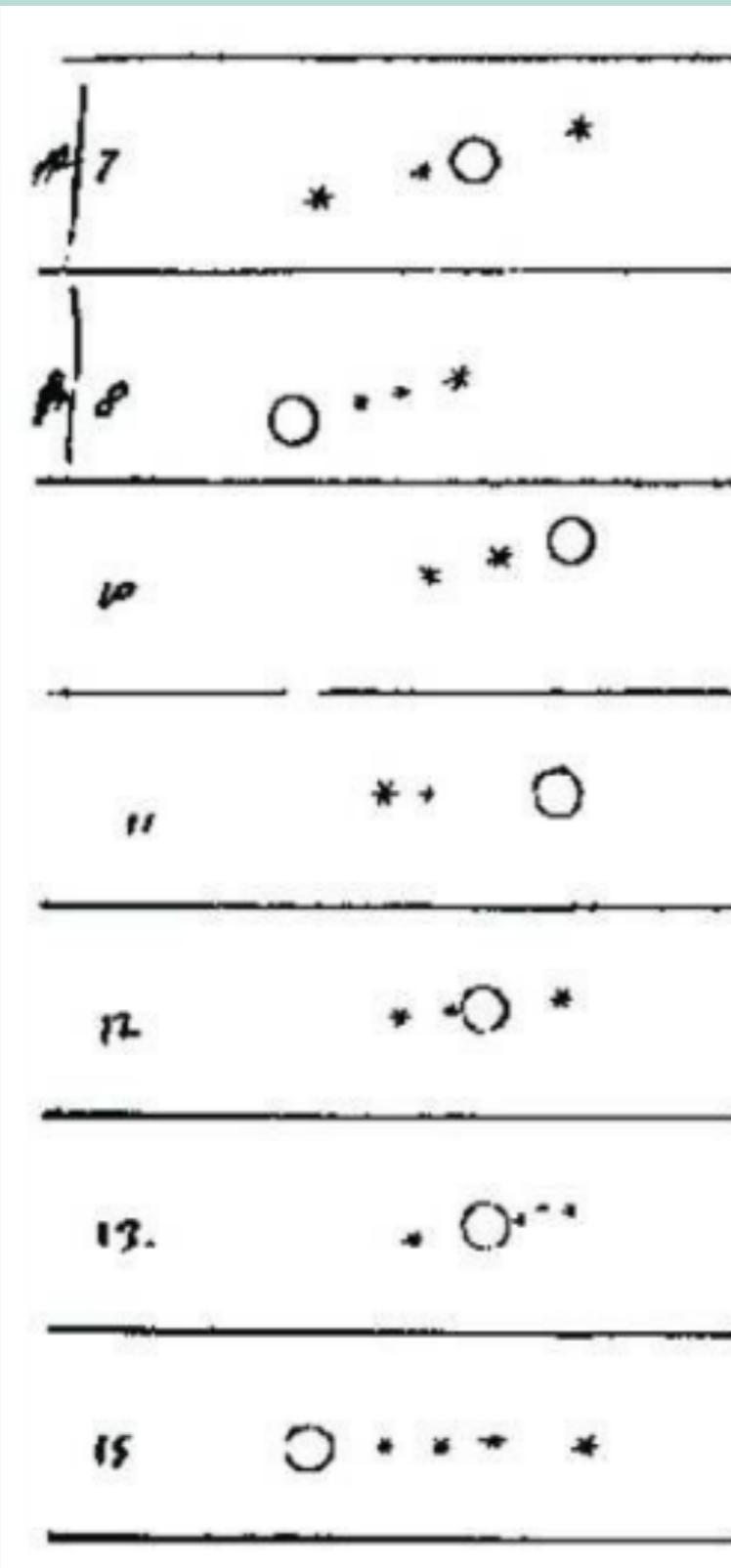
Jupiter: Ch 11





DISCUSSION

Jupiter: Ch 11

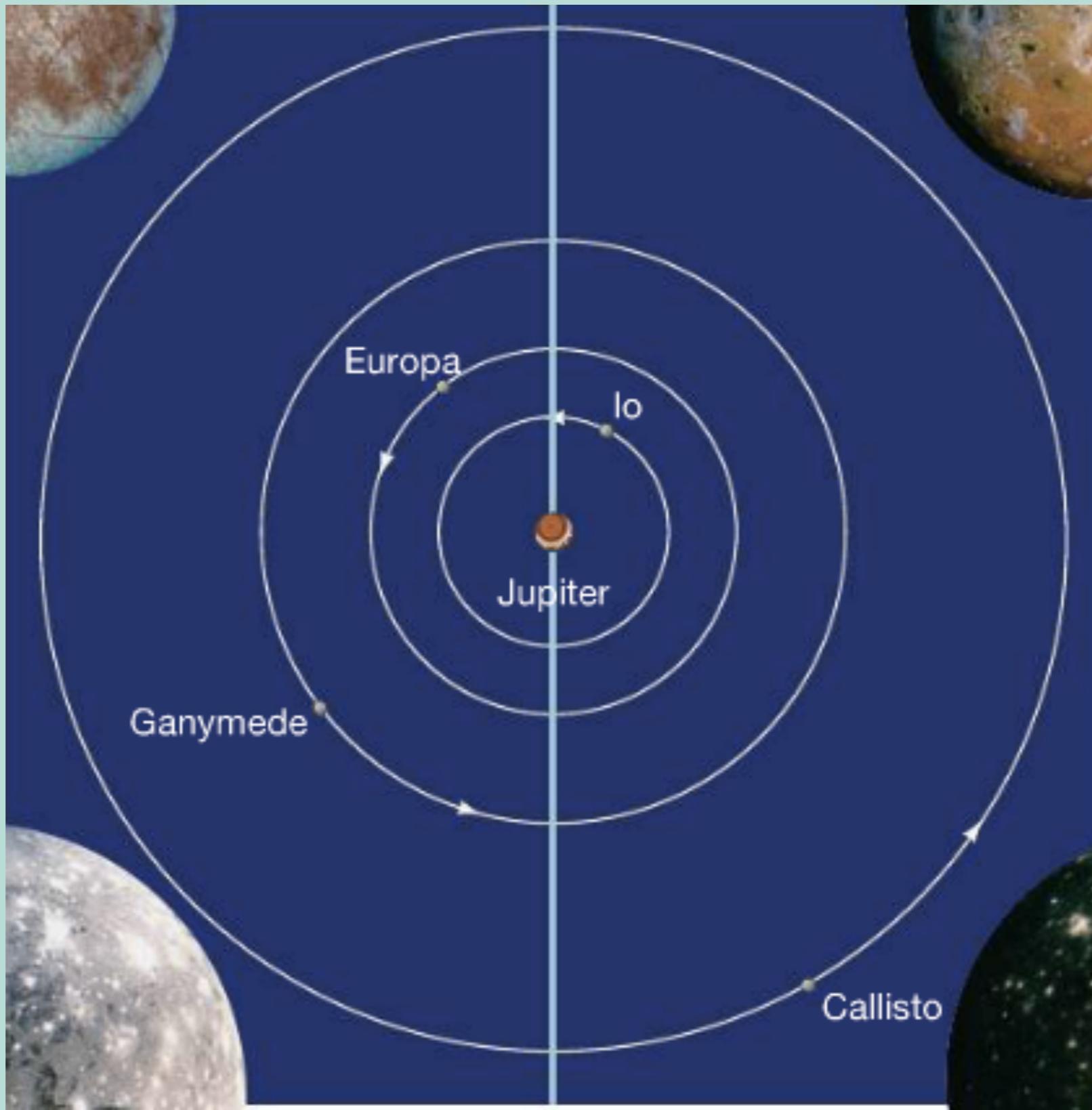


...remember these guys?



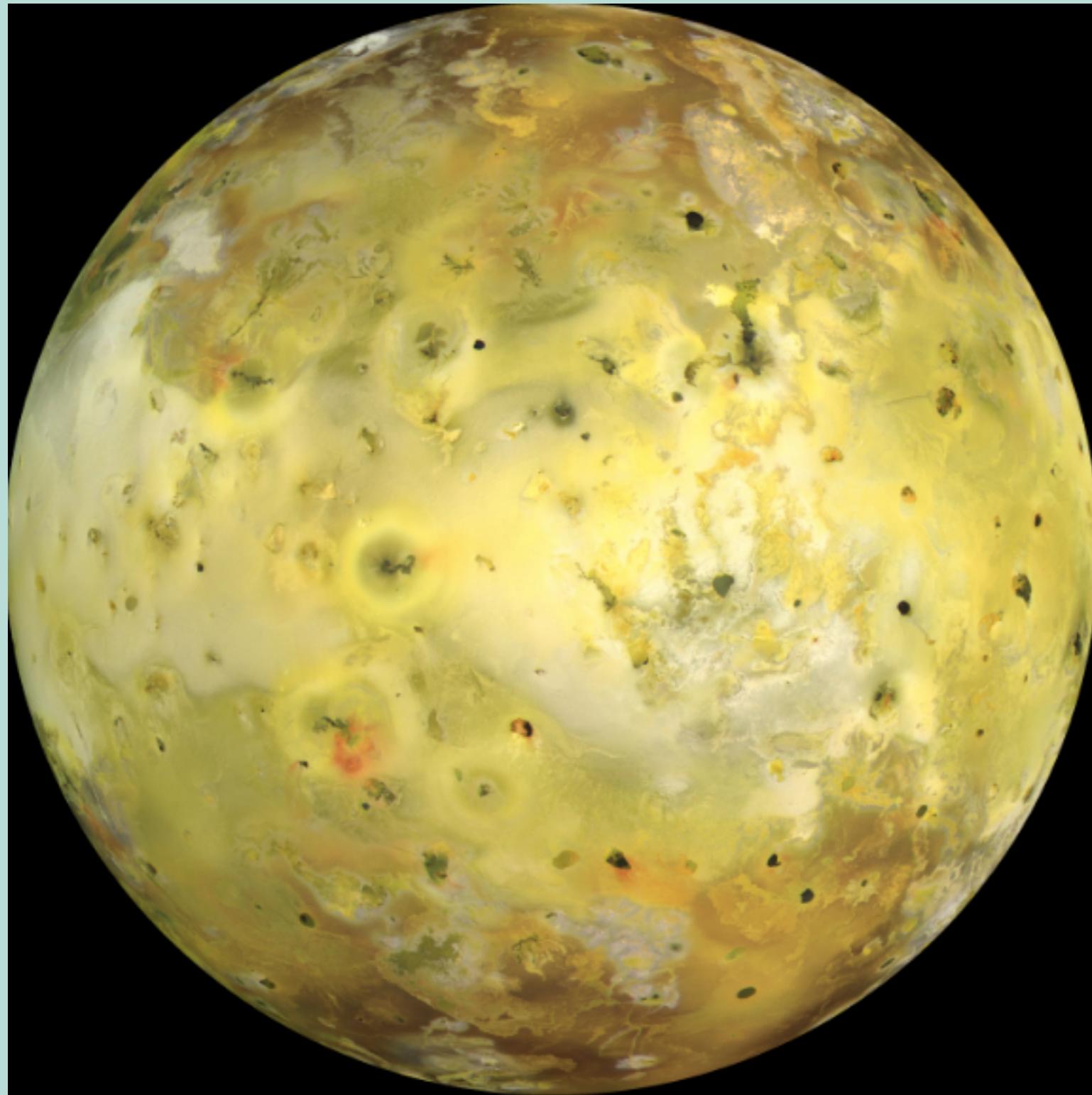
from a better ground
based telescope

Galilean Moons



+63 smaller
guys

Jupiter: Ch 11



Io

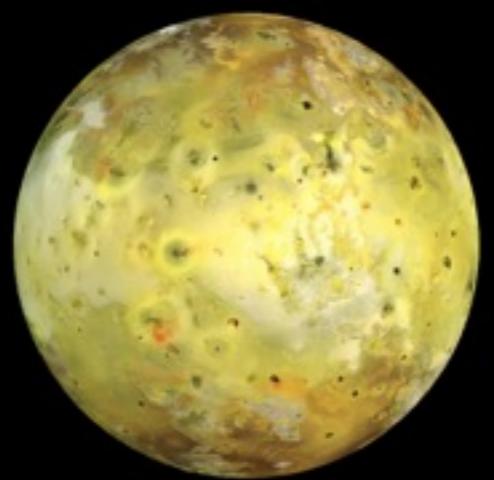
$m \sim 9 \text{ e}22 \text{ kg}$
 $\sim 1.2 m_m$

$r \sim 1.8 \text{ e}3 \text{ km}$
 $\sim 1.05 r_m$

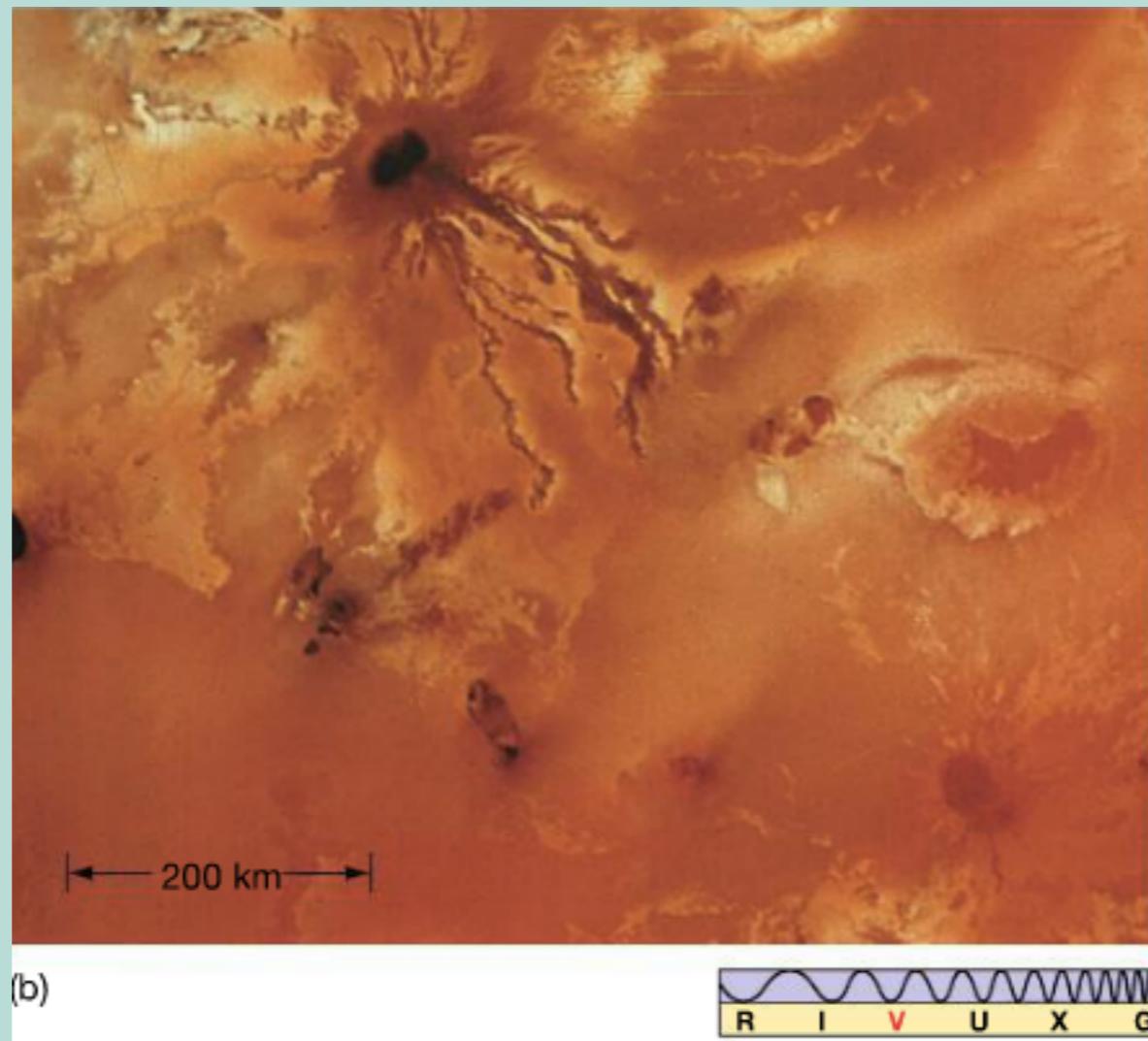
$d \sim 4.2 \text{ e}5 \text{ km}$
 $\sim 6.1 R_J$

density~
 3500 kg/m^3

Jupiter: Ch 11

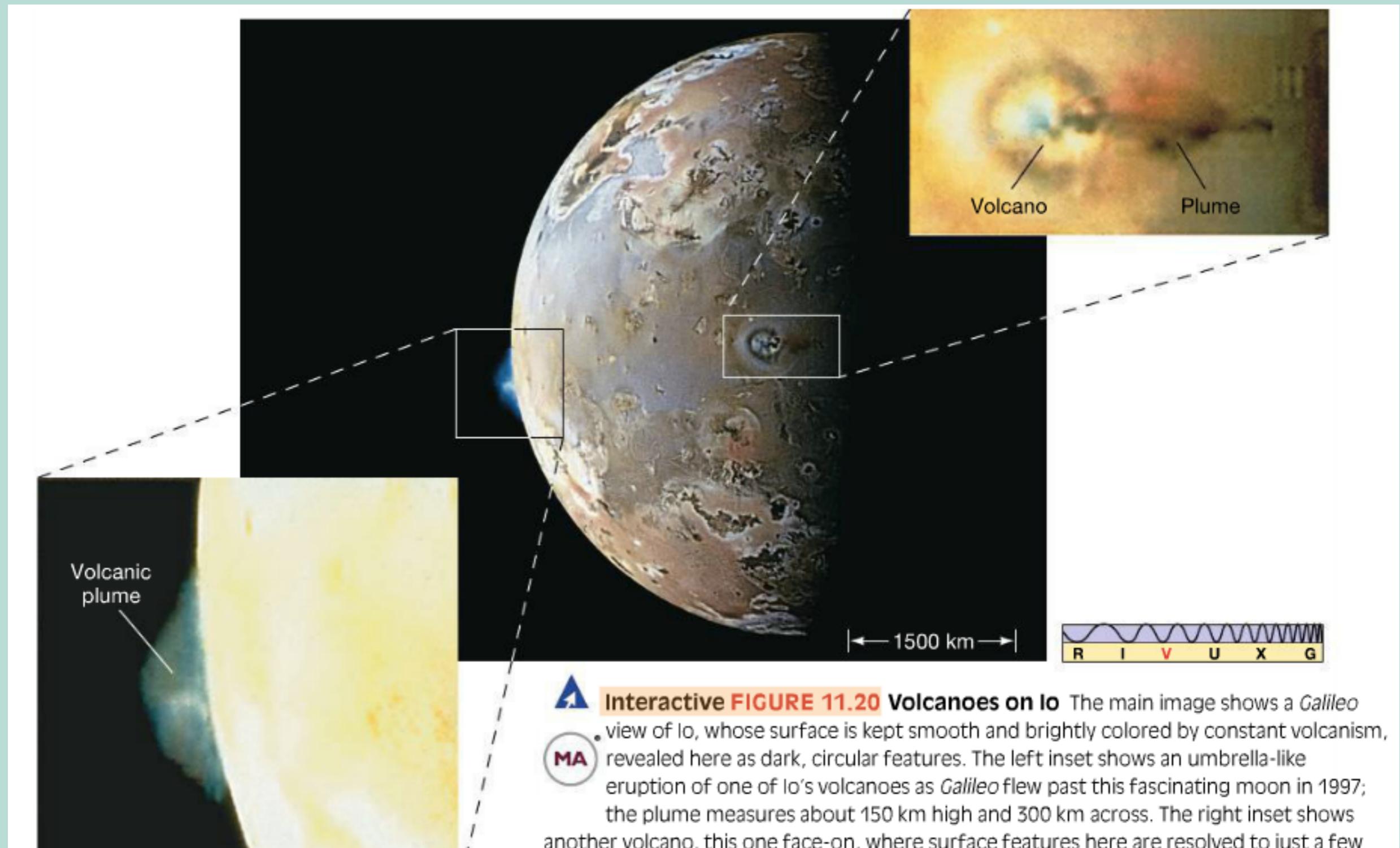


Close up on Io

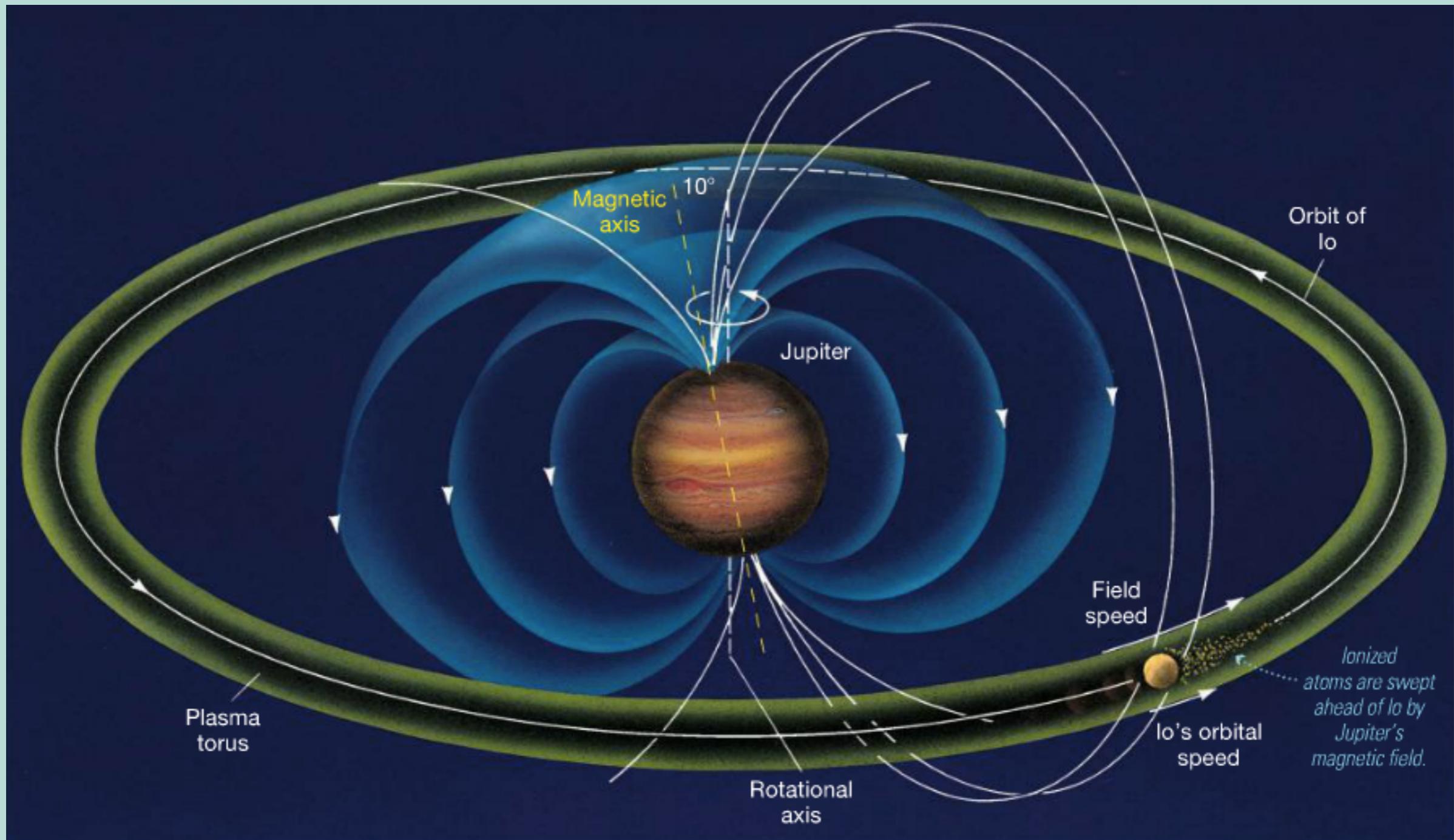


Where does the heat come from?

Loki and Prometheus



Io Plasma Torus



Jupiter: Ch 11

Europa



$m \sim 4.8 \text{ e}22 \text{ kg}$
 $\sim .65 m_m$

$r \sim 1.6 \text{ e}3 \text{ km}$
 $\sim .9 r_m$

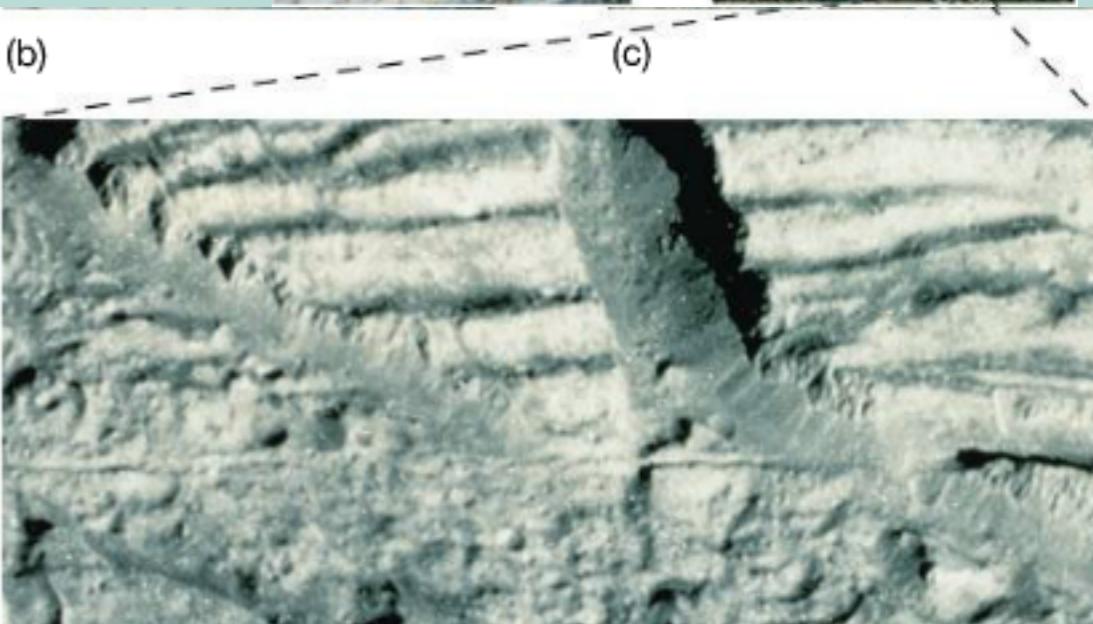
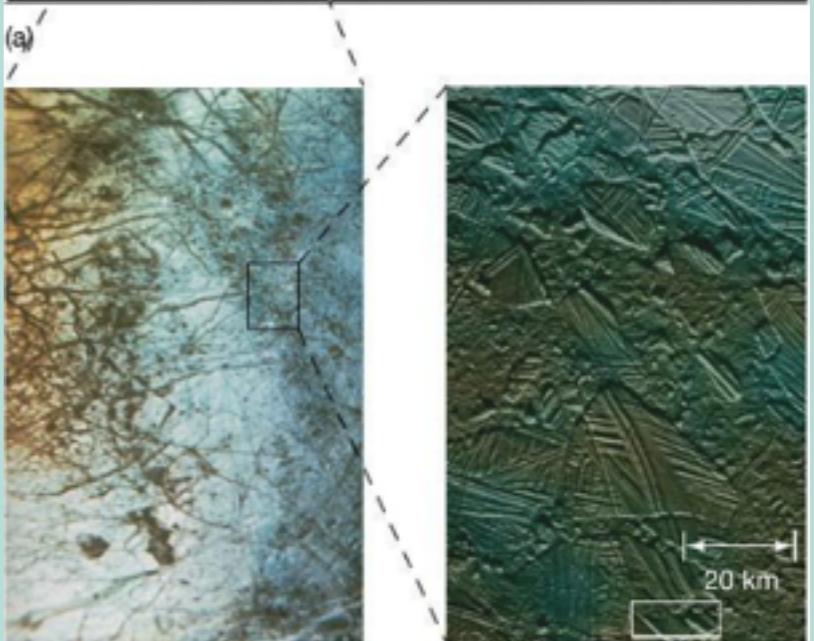
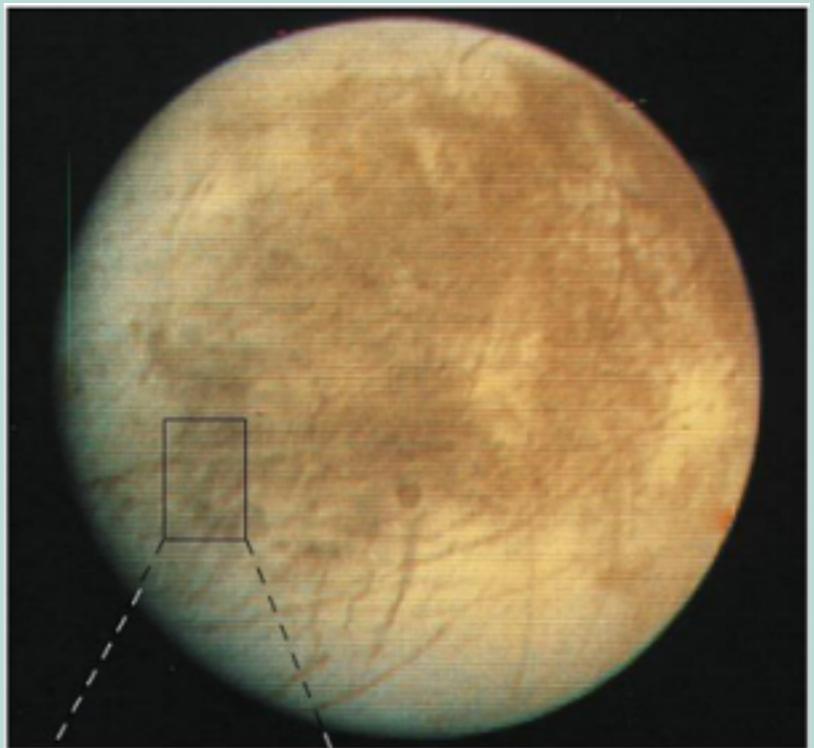
$d \sim 6.7 \text{ e}5 \text{ km}$
 $\sim 10 R_J$

density~
 3000 kg/m^3

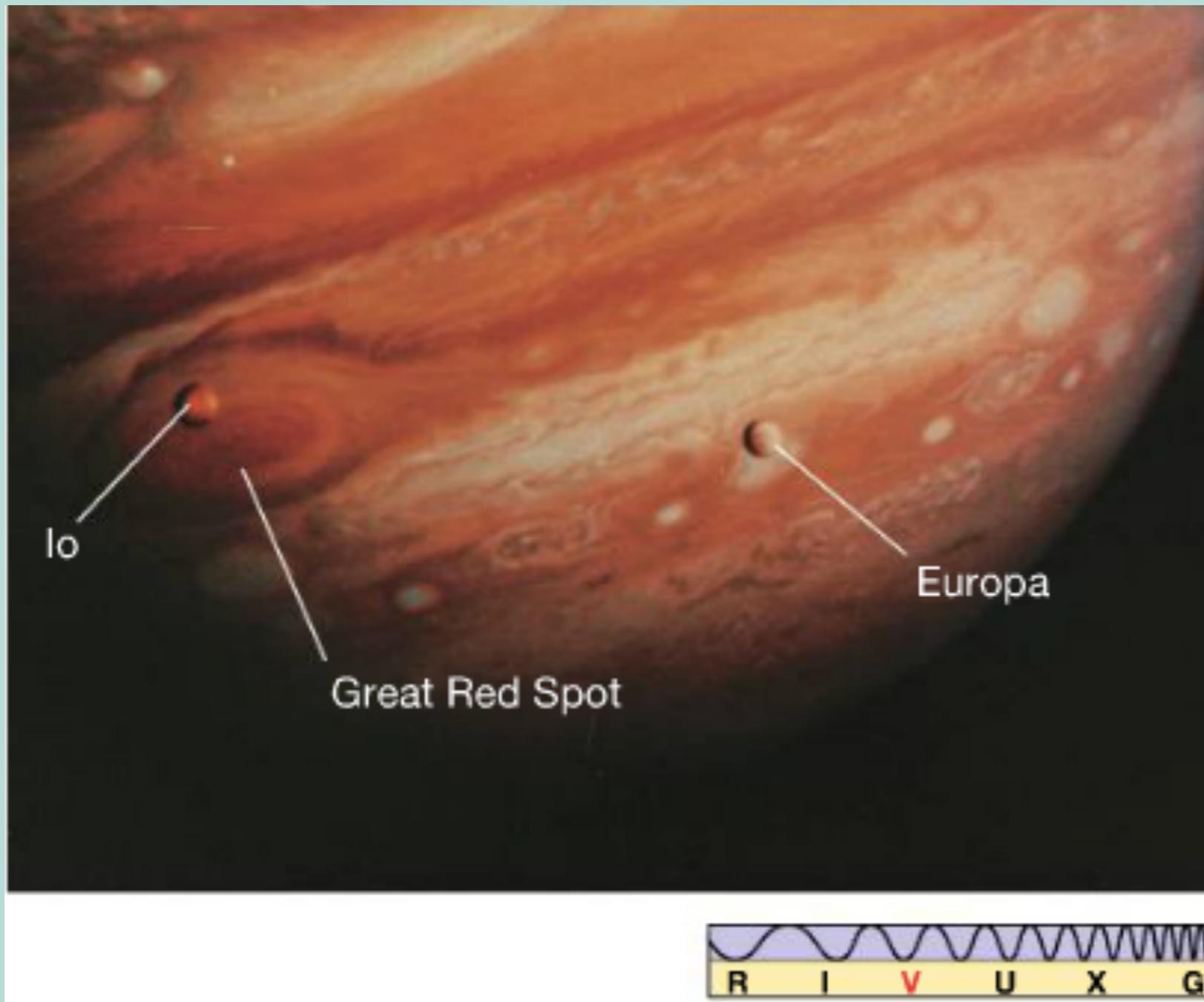
Jupiter: Ch 11

Ice Cracks On Europa

Conjectured to contain MOST of the water in the solar system!



Jupiter: Ch 11



Jupiter: Ch 11



Ganymede

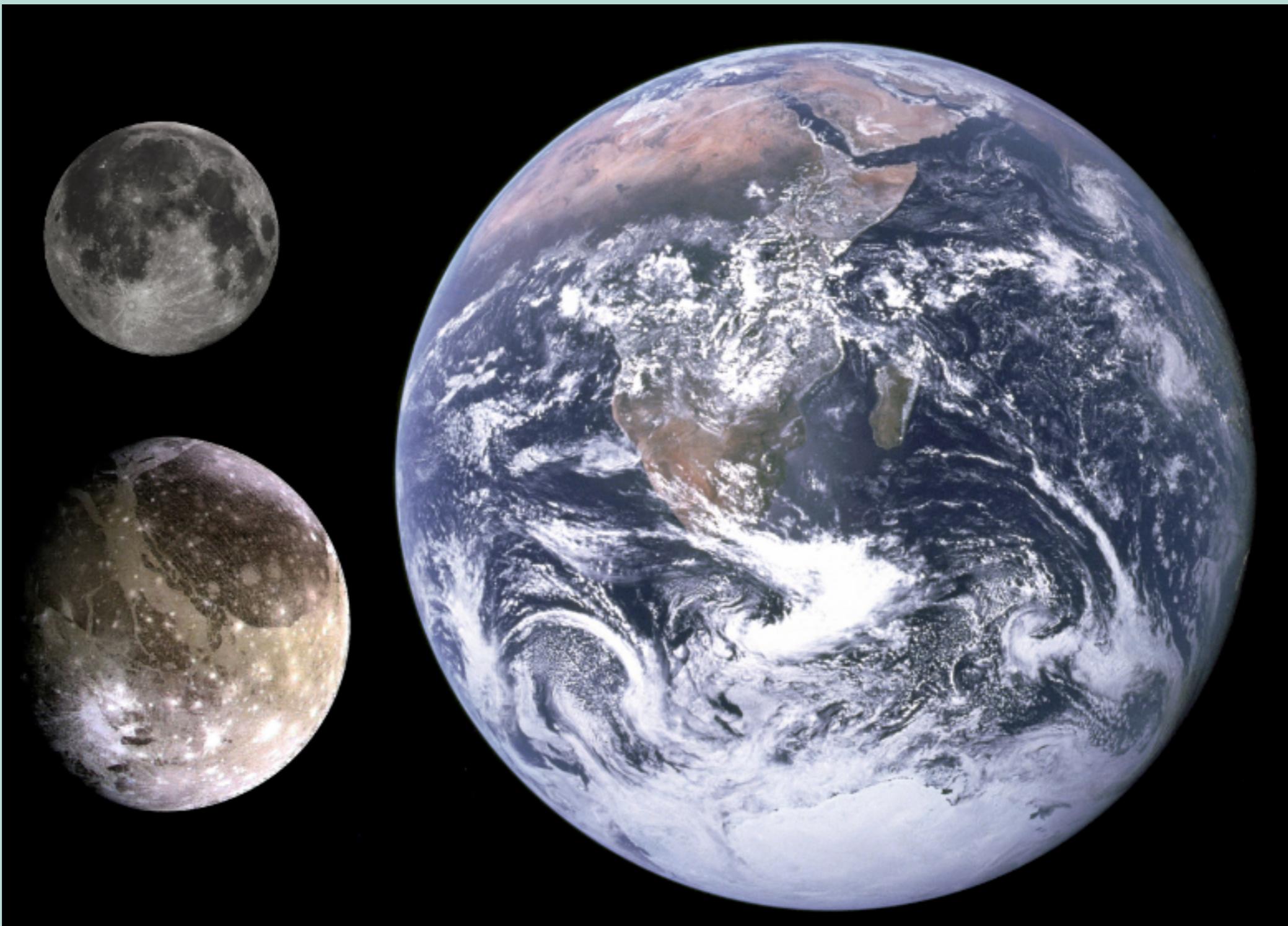
$m \sim 1.5 \text{ e}23 \text{ kg}$
 $\sim 2 m_m$

$r \sim 2.6 \text{ e}3 \text{ km}$
 $\sim 1.5 r_m$

$d \sim 1 \text{ e}6 \text{ km}$
 $\sim 15.4 R_J$

density~
 2000 kg/m^3

Jupiter: Ch 11

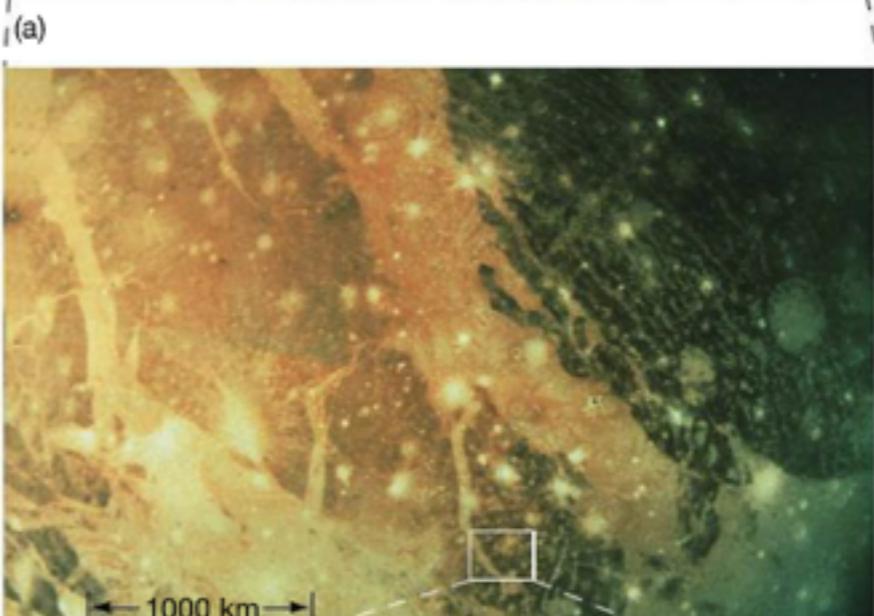
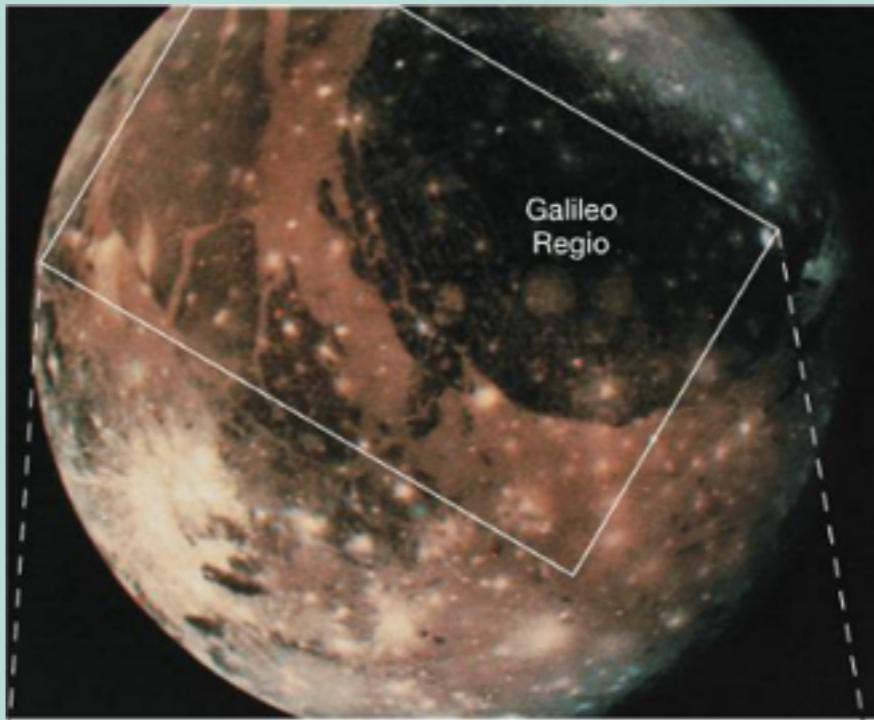


To scale comparison

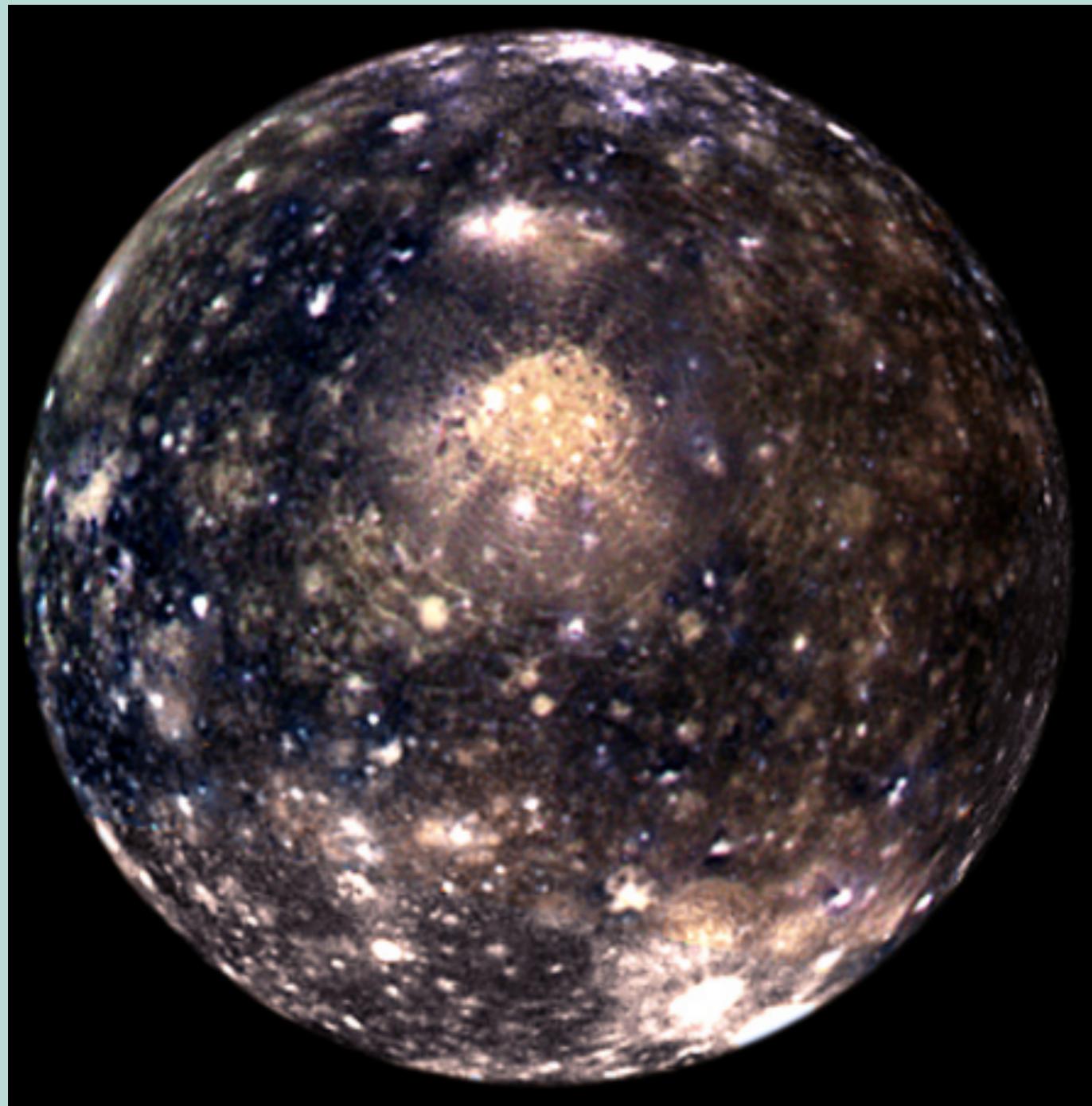
Jupiter: Ch 11

Crustal Cracks on Ganymede

Ganymede cooled somewhat recently. The mechanism for keeping it hot for so long is unknown...



Jupiter: Ch 11



Callisto

$m \sim 1 \text{ e}23 \text{ kg}$
 $\sim 1.5 m_m$

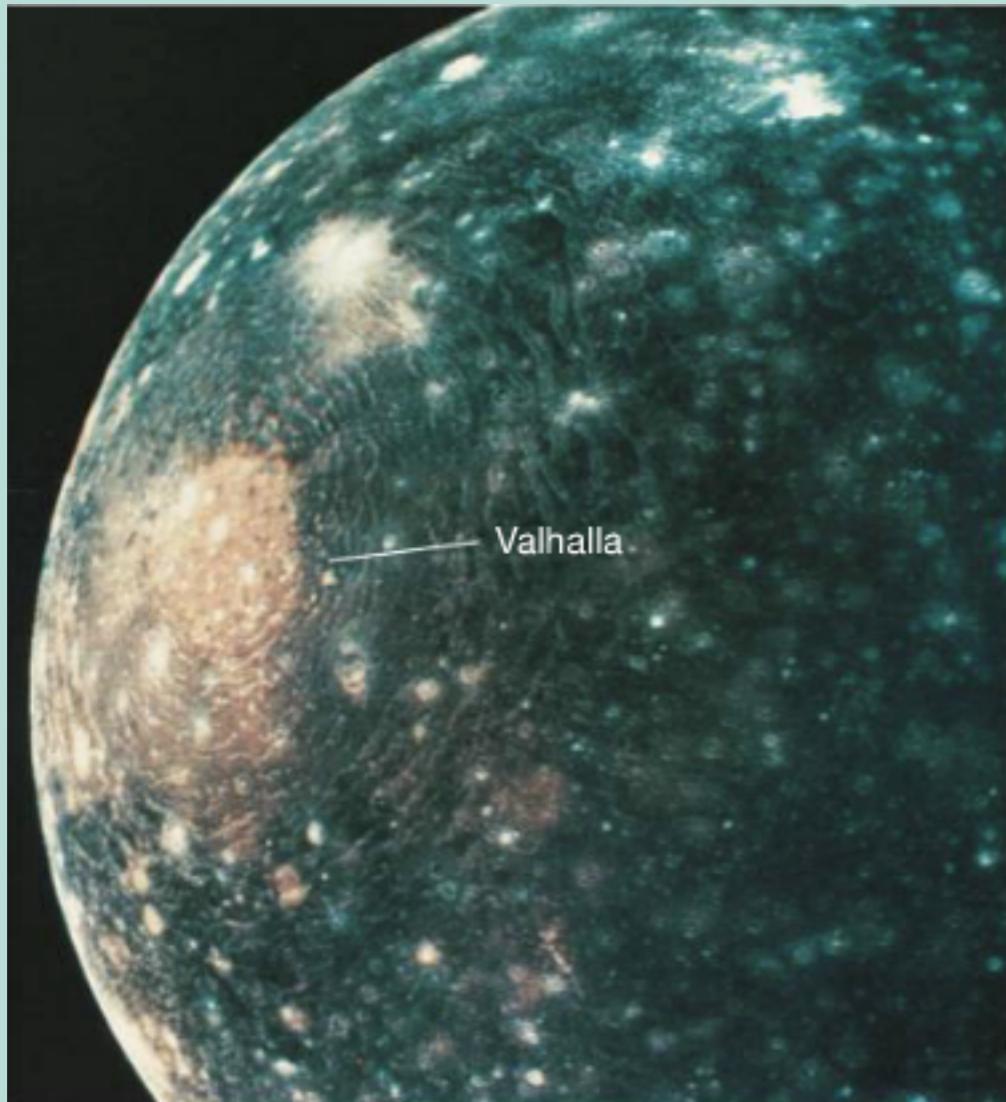
$r \sim 2.4 \text{ e}3 \text{ km}$
 $\sim 1.38 r_m$

$d \sim 1.8 \text{ e}6 \text{ km}$
 $\sim 26 R_J$

density~
1800 kg/m³

Jupiter: Ch 11

Valhalla



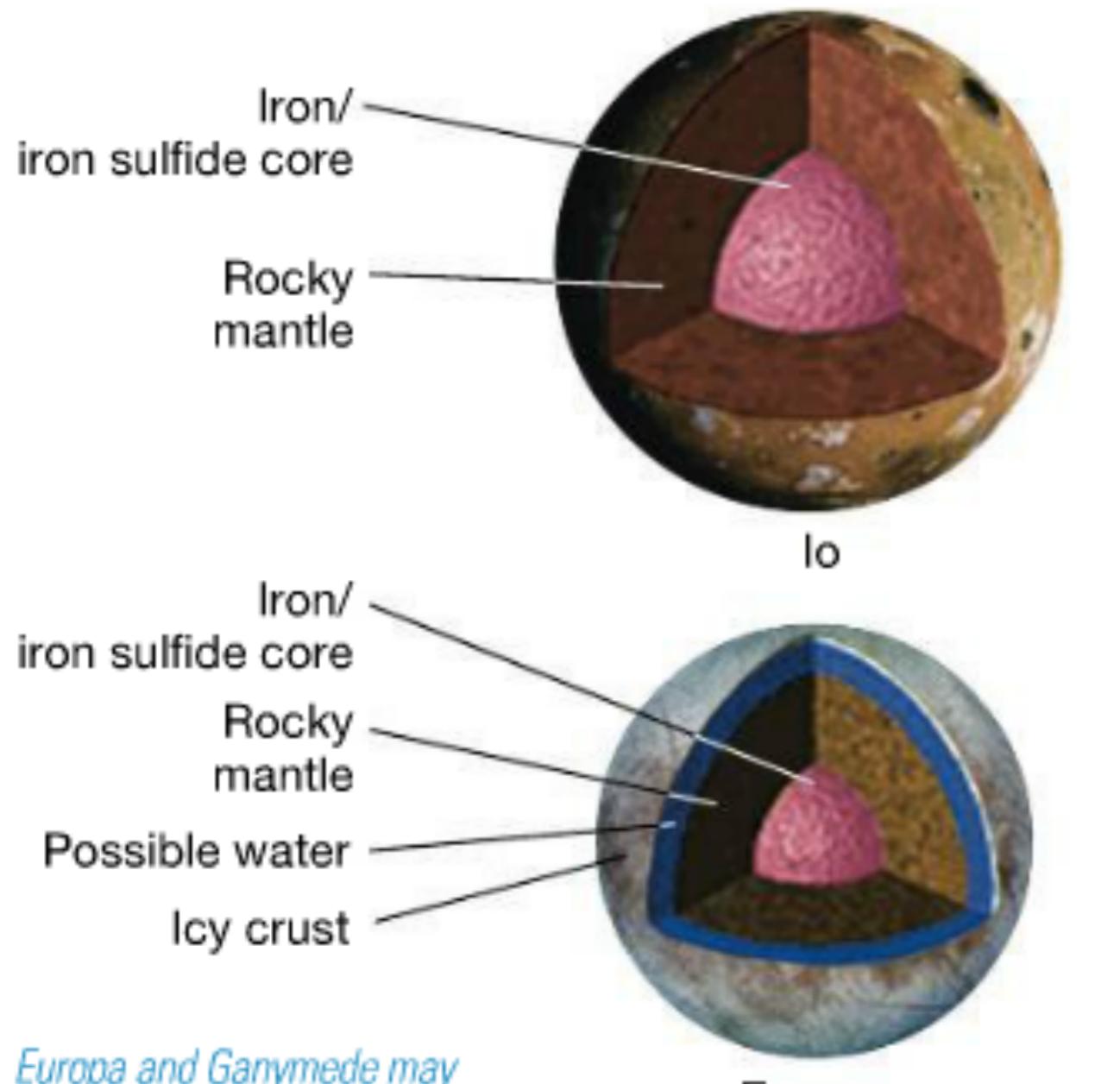
Moon Comparison

TABLE 11.1 The Major Moons of Jupiter*

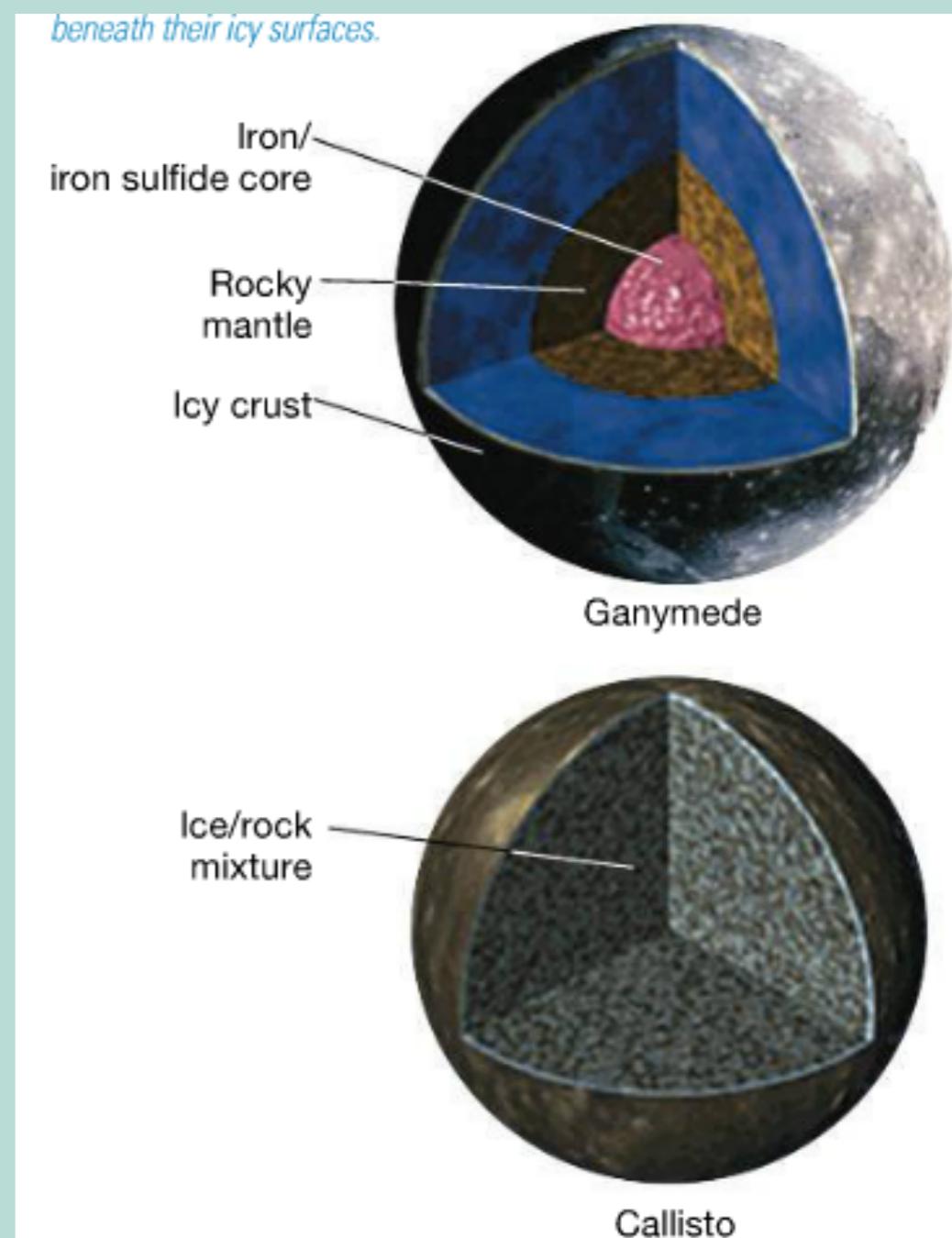
Name	Distance from Jupiter (km)	Distance from Jupiter (planetary radii)	Orbital Period (days)	Size (longest diameter, km)	Mass** (Earth Moon masses)	Density (kg/m ³)	Density (g/cm ³)
Io	422,000	5.90	1.77	3640	1.22	3500	3.5
Europa	671,000	9.38	3.55	3130	0.65	3000	3.0
Ganymede	1,070,000	15.0	7.15	5270	2.02	1900	1.9
Callisto	1,880,000	26.3	16.7	4800	1.46	1900	1.9

Jupiter: Ch 11

Inner Moons



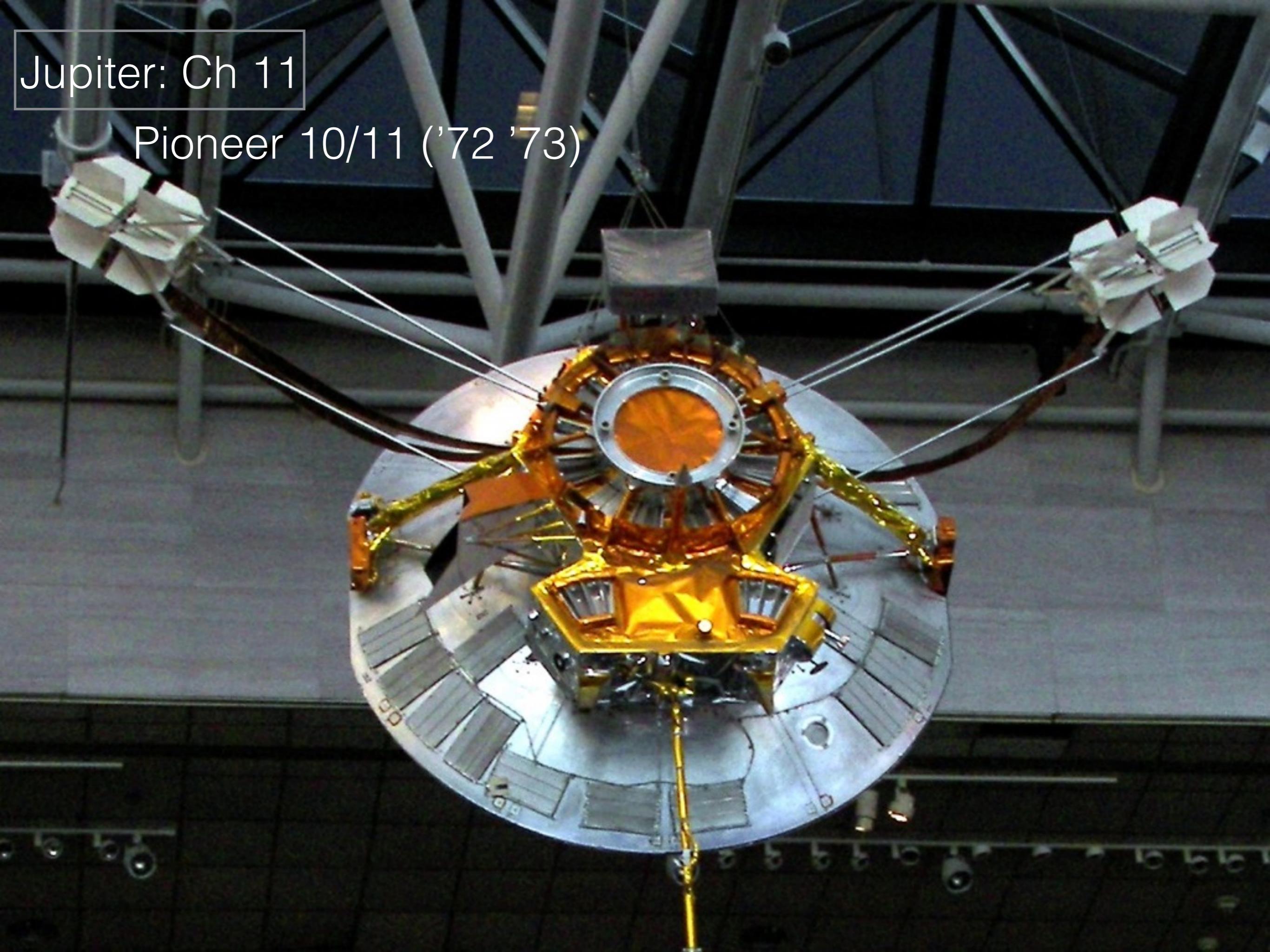
Outer Moons



Europa and Ganymede may have layers of liquid water

Jupiter: Ch 11

Pioneer 10/11 ('72 '73)

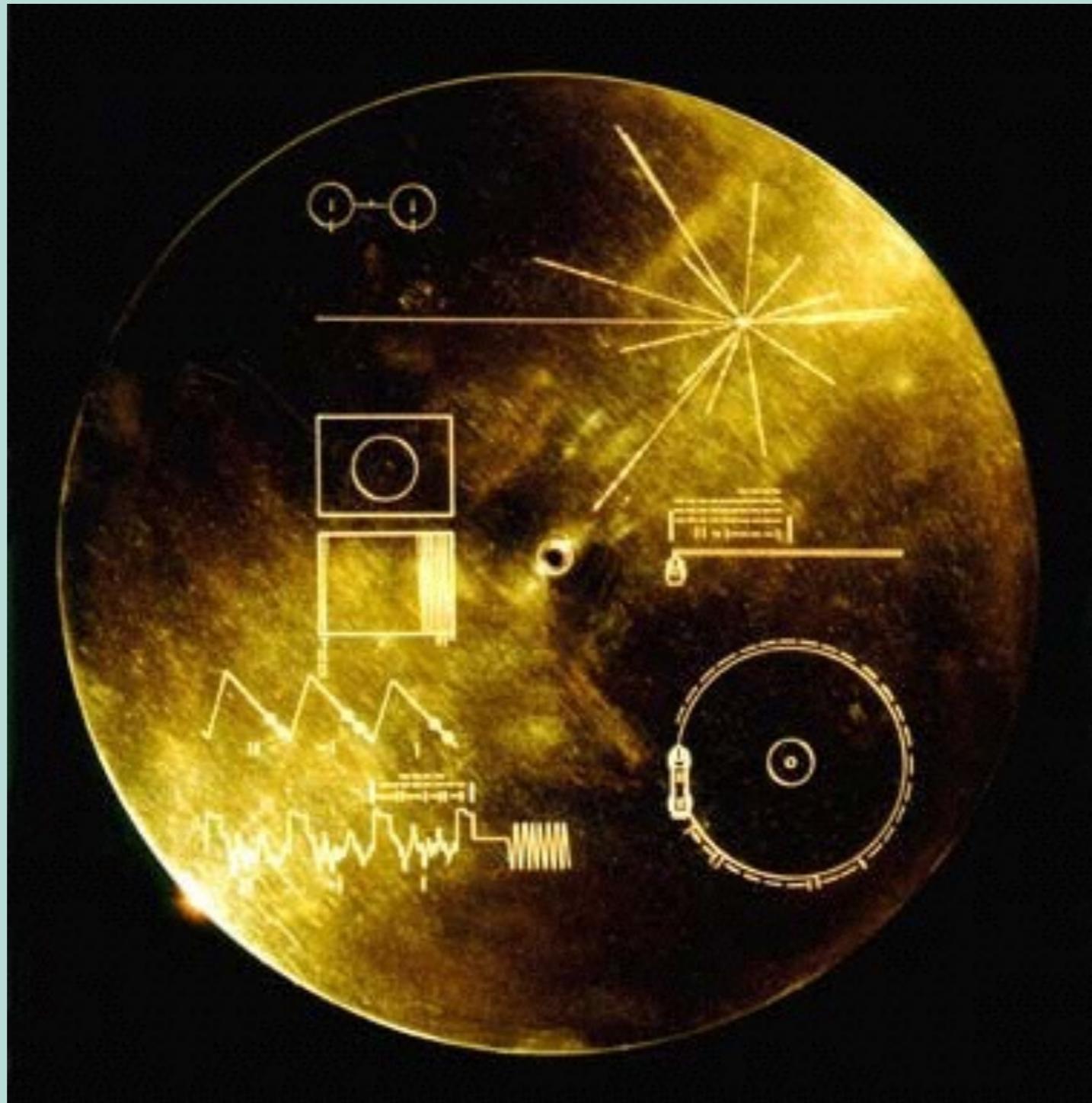


Jupiter: Ch 11

Voyager (1977)

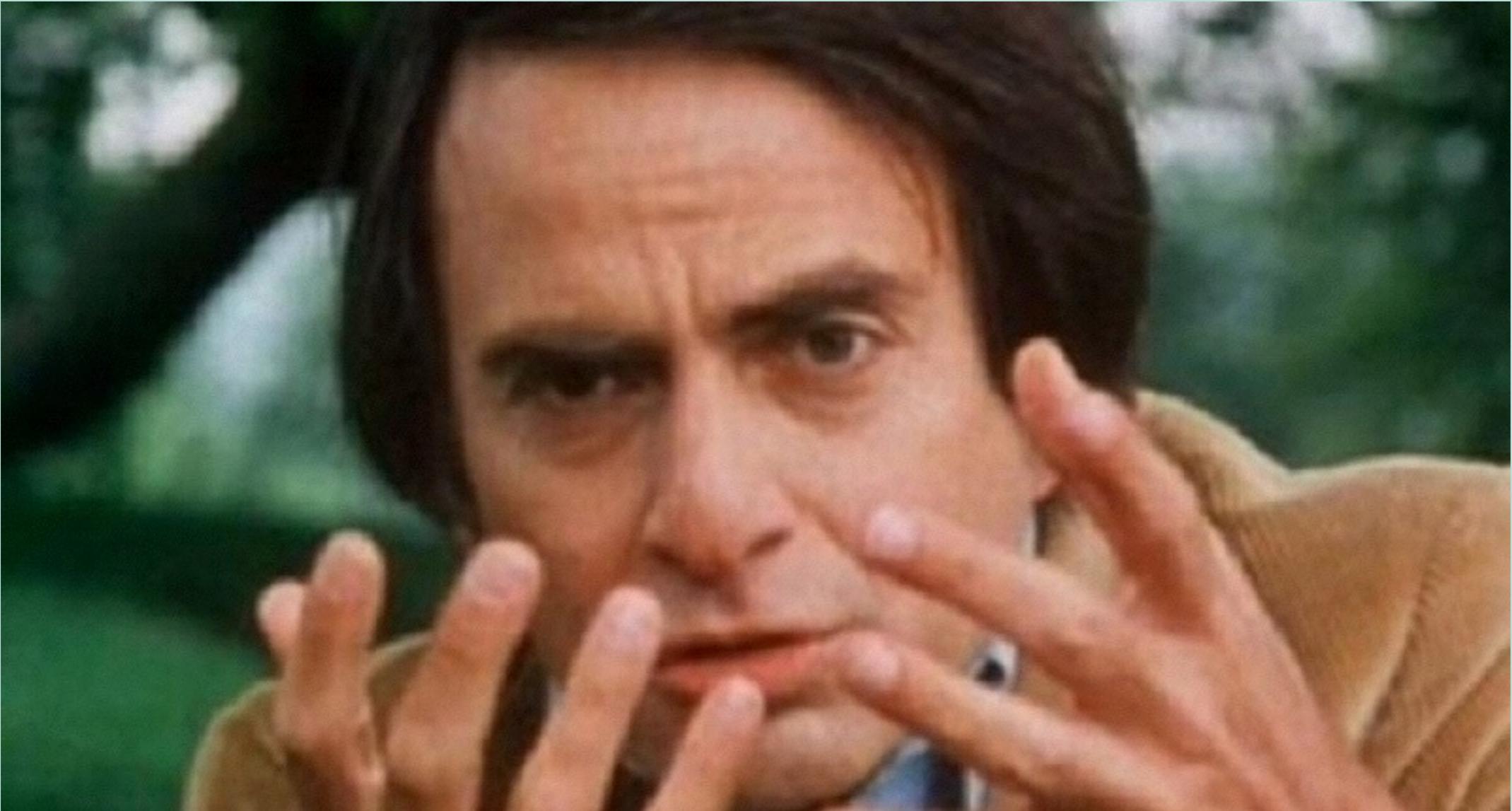


Jupiter: Ch 11



Golden Record

Jupiter: Ch 11



Jupiter: Ch 11

- Included 116 images of humans, nature, things about the earth and our solar system.
- Included numerous recordings of natural sounds from birds and whales, wind and surf.
- Included sounds of Mozart, Bach, Rock and roll (not the Beatles though)
- Included a recording of brain waves while the person thought about what it's like to be a human and fall in love.