



Astronomy

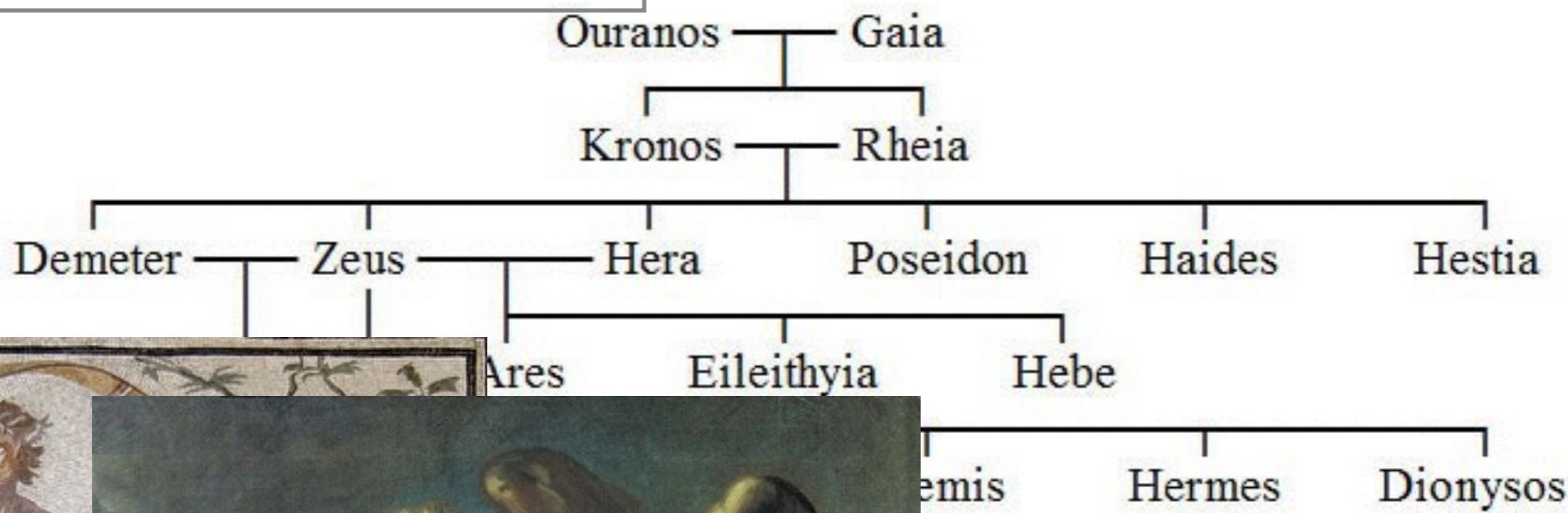
with your host:



**Lecture 12:
Uranus/Neptune**

Coop

Uranus and Neptune: Ch 13



Uranus and Neptune: Ch 13



Uranus

$$r \sim 4 r_E$$

$$m \sim 14.5 m_E$$

$$\text{density} \sim 1300 \text{ kg/m}^3$$

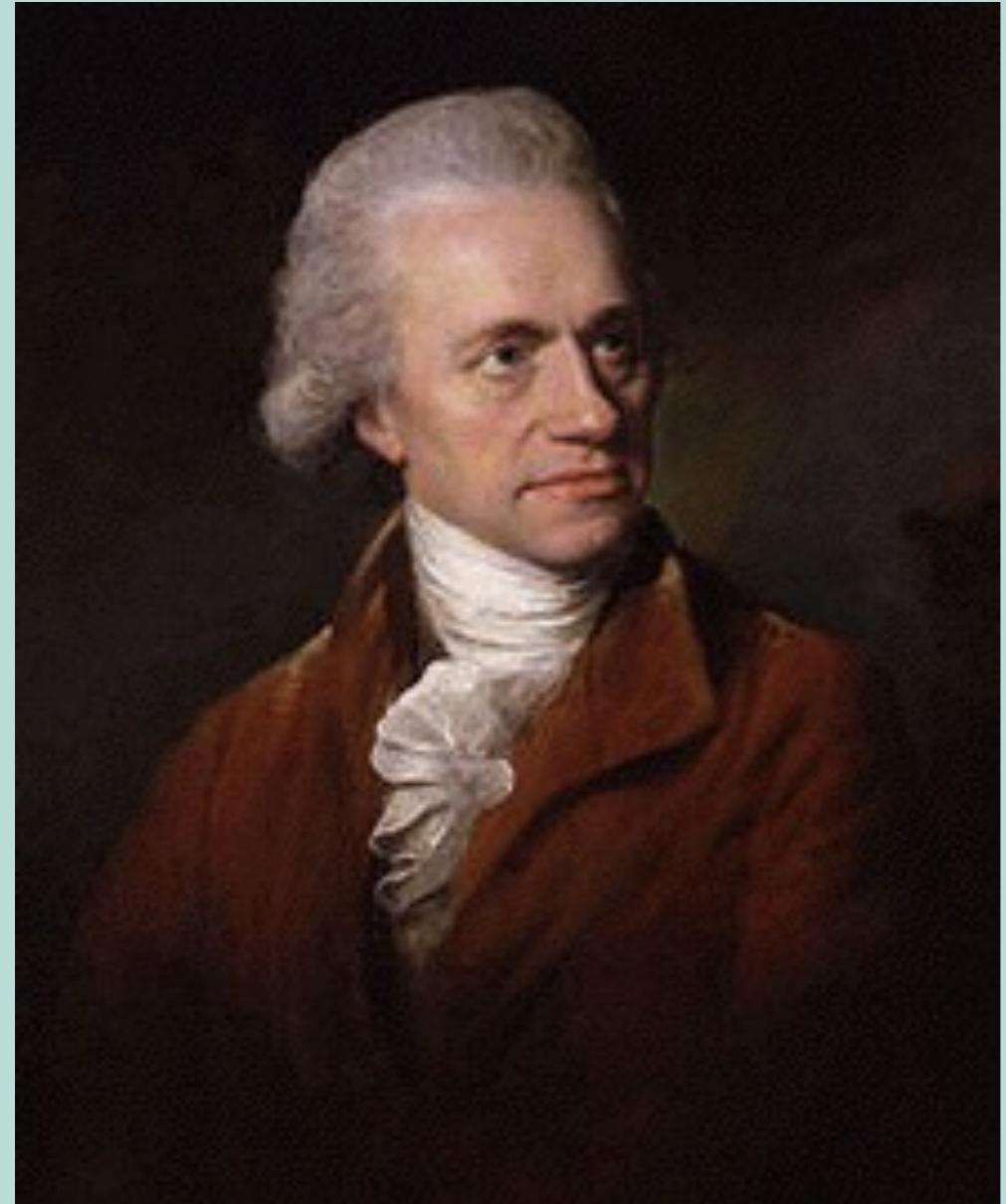
$$d \sim 19.2 \text{ AU}$$

Uranus and Neptune: Ch 13

Uranus and some of its moons



Uranus and Neptune: Ch 13



William Herschel

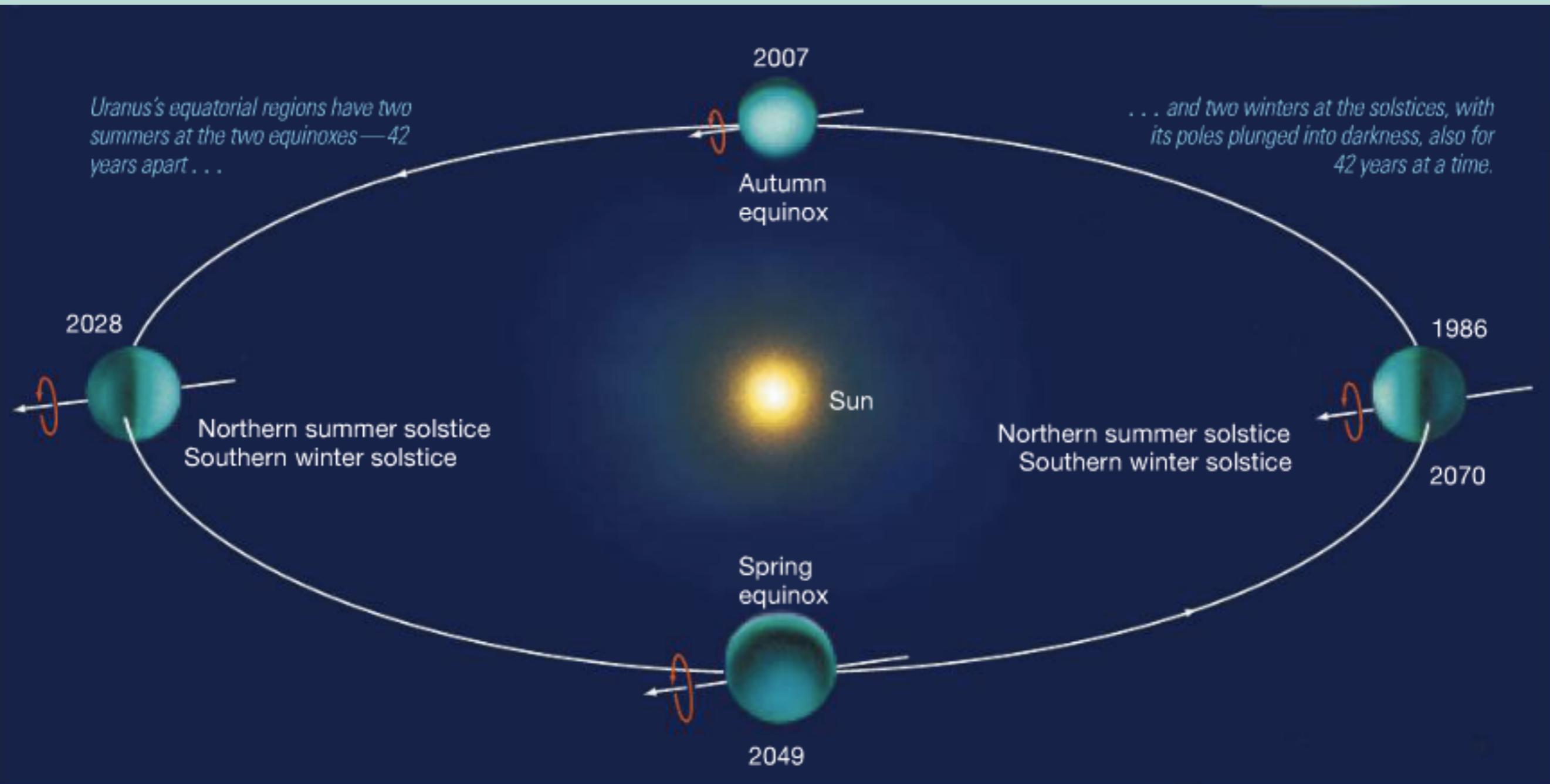
b. Hanover 1738
d. Slough, UK 1822

- Discovered Uranus (1781)
- Discovered Oberon (Uranus), Enceladus (Saturn), Titania (Uranus) and Mimas (Saturn)
- Discovered Infrared Radiation!

Uranus and Neptune: Ch 13

- Was found the good old fashion way. Looking around.
- Originally wanted to name Uranus “George’s Star”
 - First planet discovered in over 2000 years!

Uranus and Neptune: Ch 13



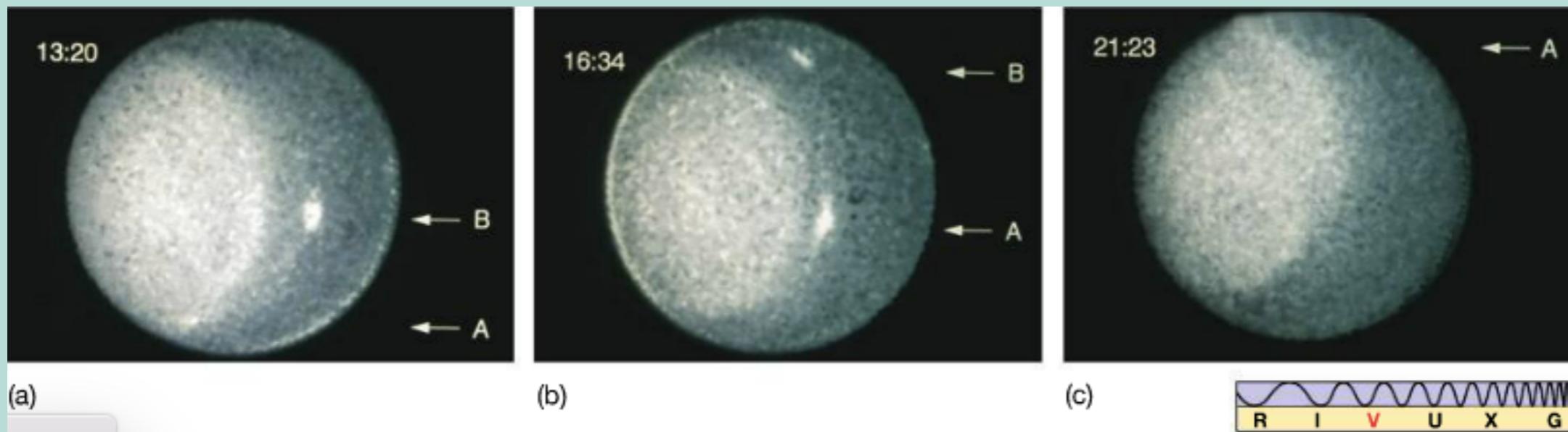
Rotation axis tilted 98 degrees!

Uranus and Neptune: Ch 13

- Origin of tilt: unknown!
- One day ~17.2 hours
- Atmospheric differential rotation, but this time faster at the poles!

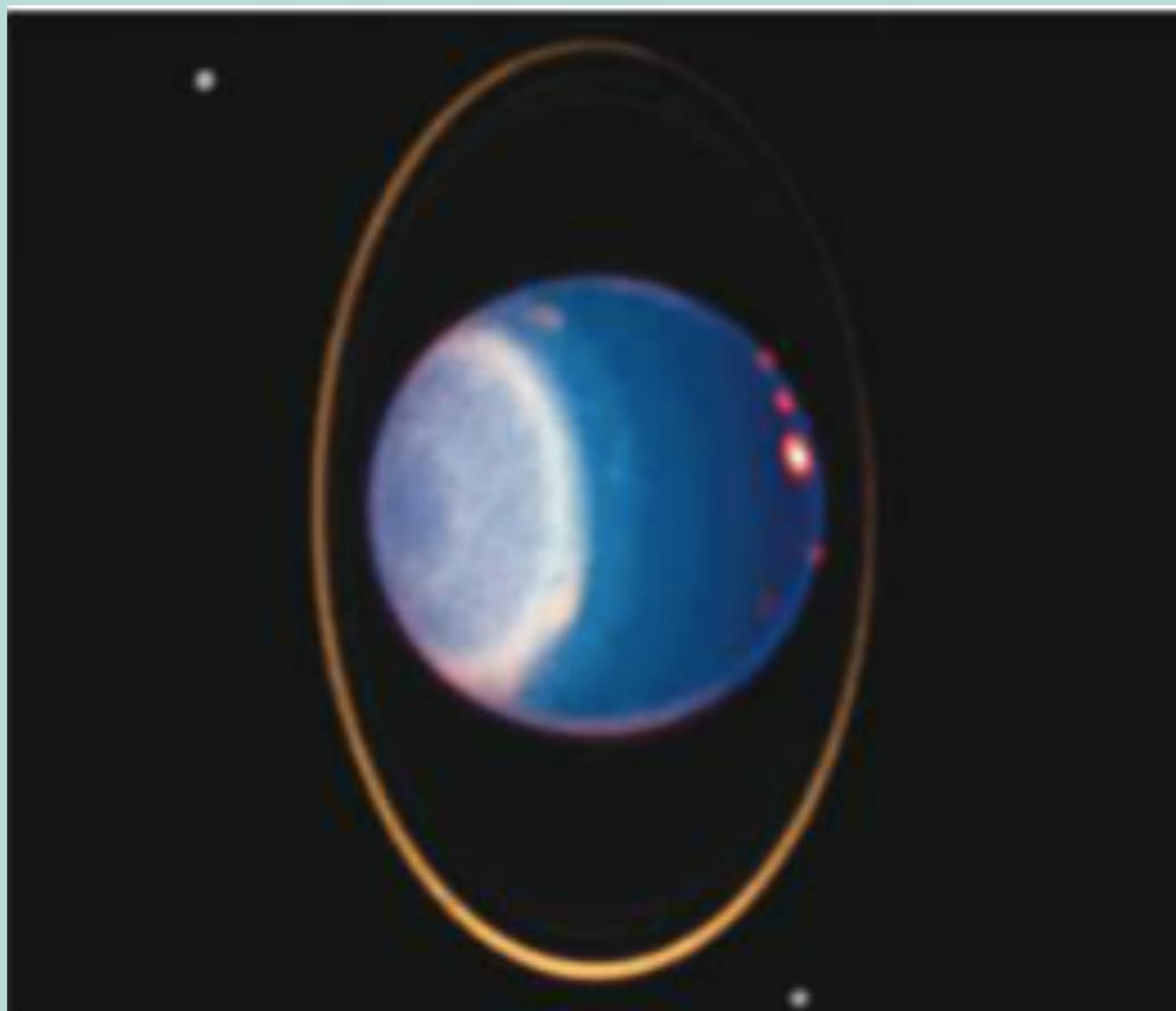
Uranus and Neptune: Ch 13

Turbulent Cloud Structure

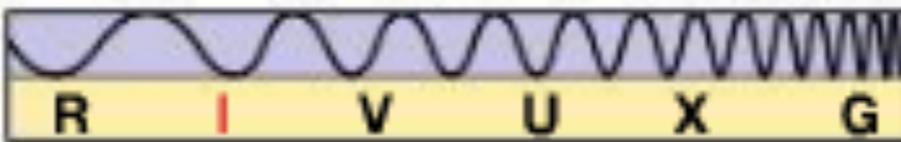


Uranus and Neptune: Ch 13

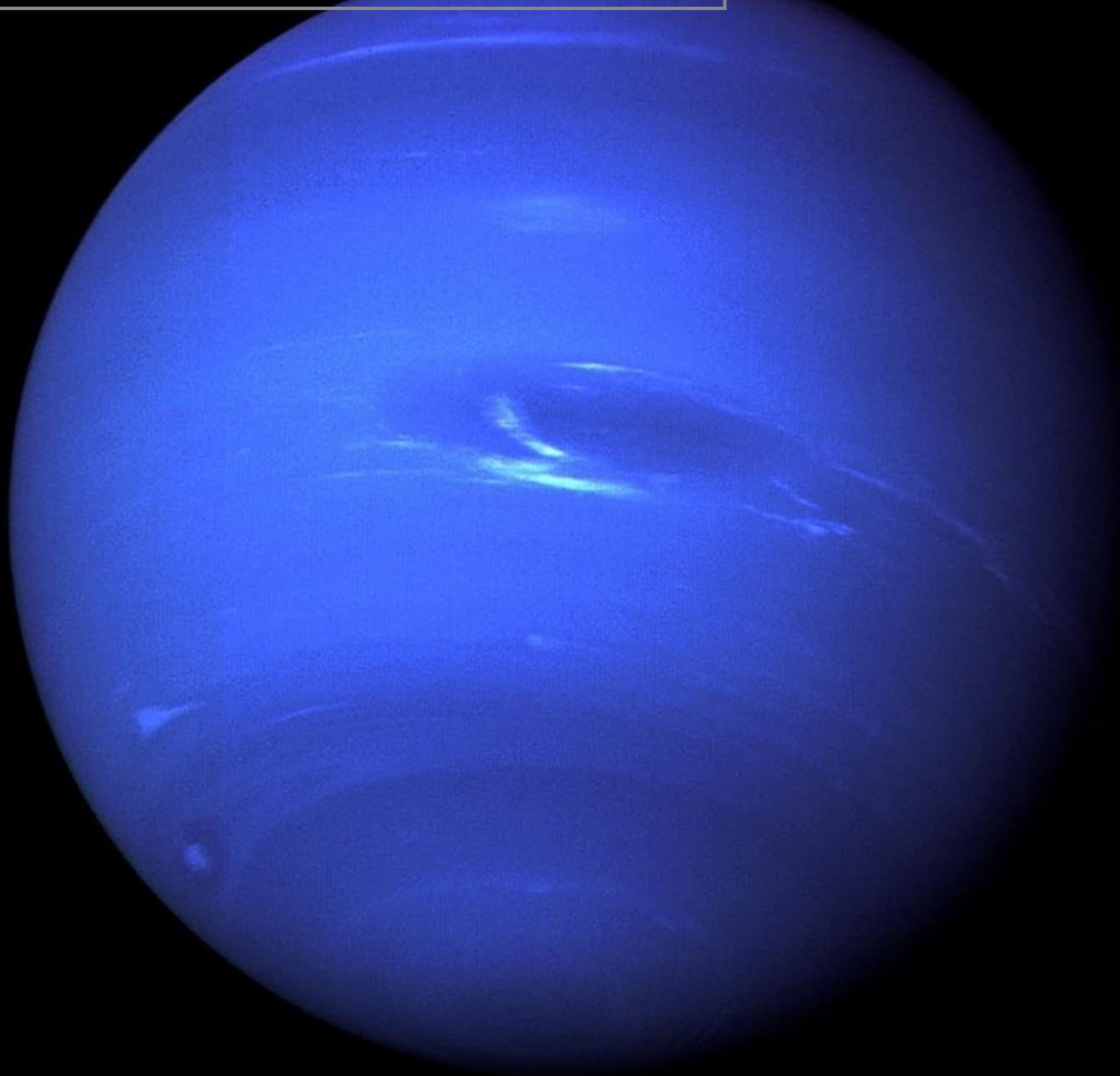
Uranus in the IR



(d)



Uranus and Neptune: Ch 13



Neptune

$r \sim 3.9 r_E$

$m \sim 17.1 m_E$

density ~
1600

$d \sim 30.1 \text{ AU}$

Uranus and Neptune: Ch 13

- The presence of Neptune was inferred from its gravitational perturbation of Uranus's orbit: Dark Matter!
- The planet was “Discovered” mathematically by John Adams and Urbain Leverrier (1845) and eventually found by Johan Galle
- Orbital period of 163.7 years! (about how long we've known about Neptune)

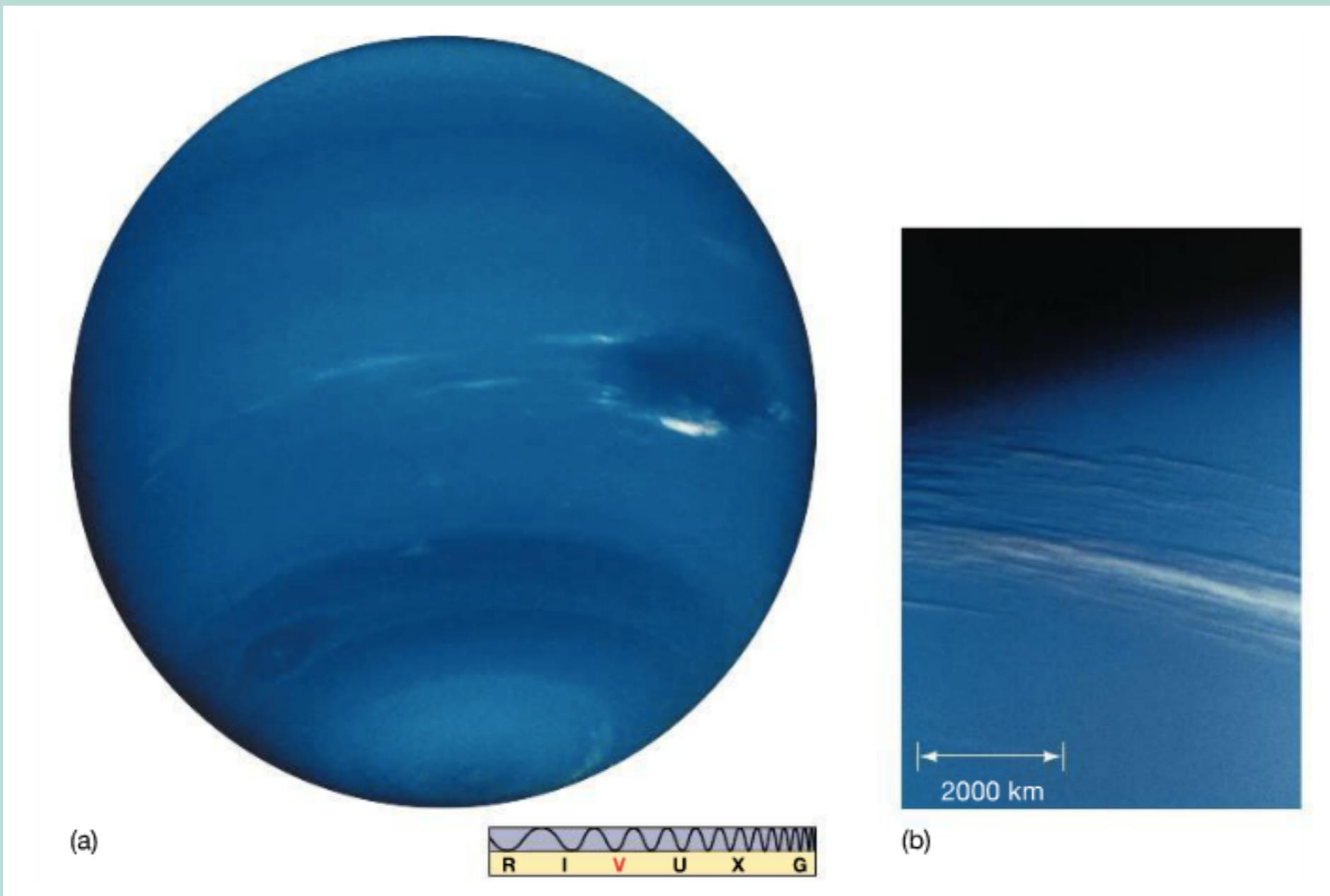
Uranus and Neptune: Ch 13

Neptune and its Moons



Uranus and Neptune: Ch 13

Cloud Streaks

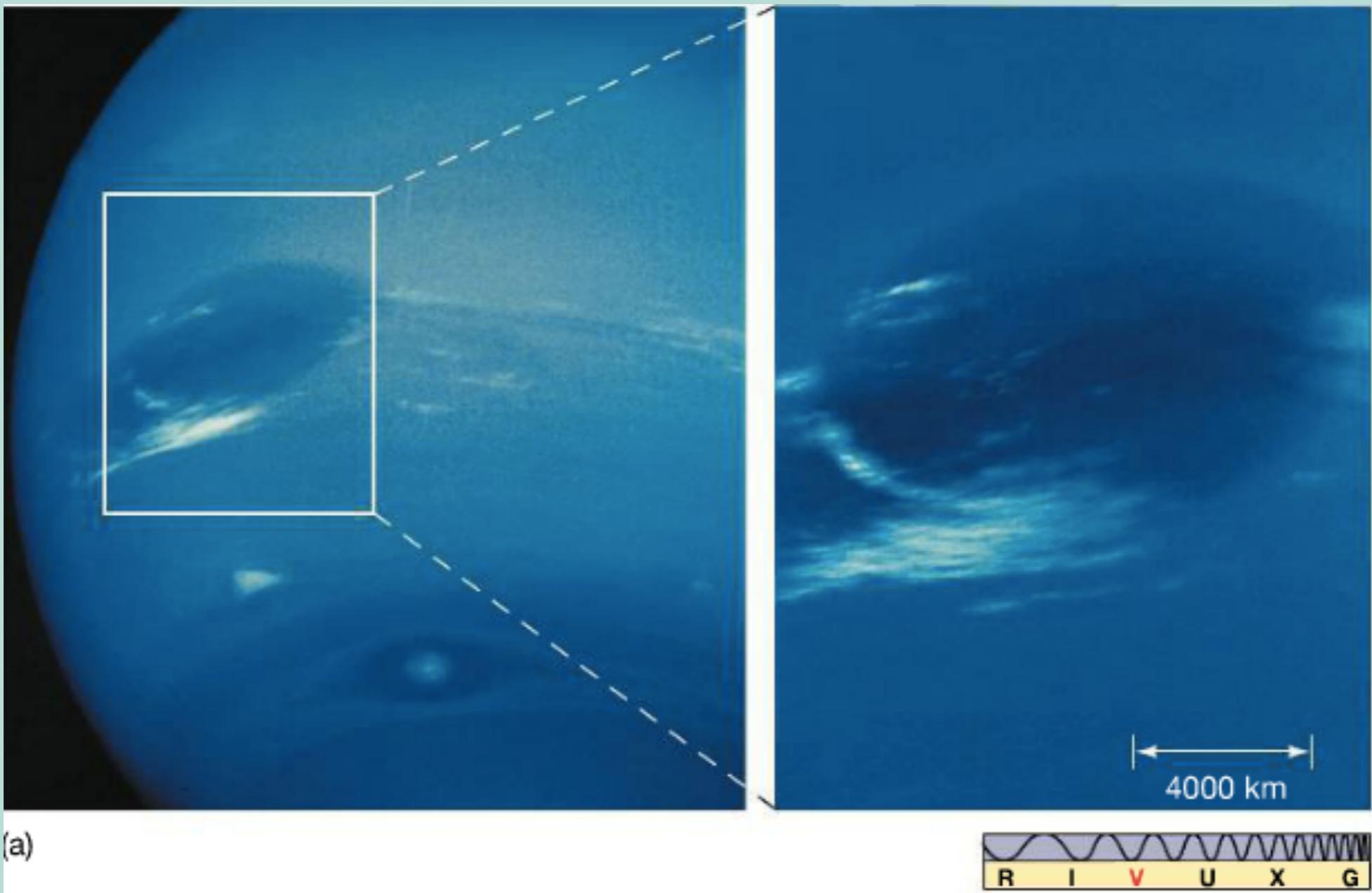


Uranus and Neptune: Ch 13

- The interior rotates once every 16.1 hours, but the rotation period of the atmosphere is 17.3 hours. Neptune is unique among Jovian planets in this regard ($T_{\text{atmos}} > T_{\text{interior}}$)
- Axis of rotation inclined 29.6 degrees (similar to 27 degrees for Saturn)

Uranus and Neptune: Ch 13

The Great Dark Spot

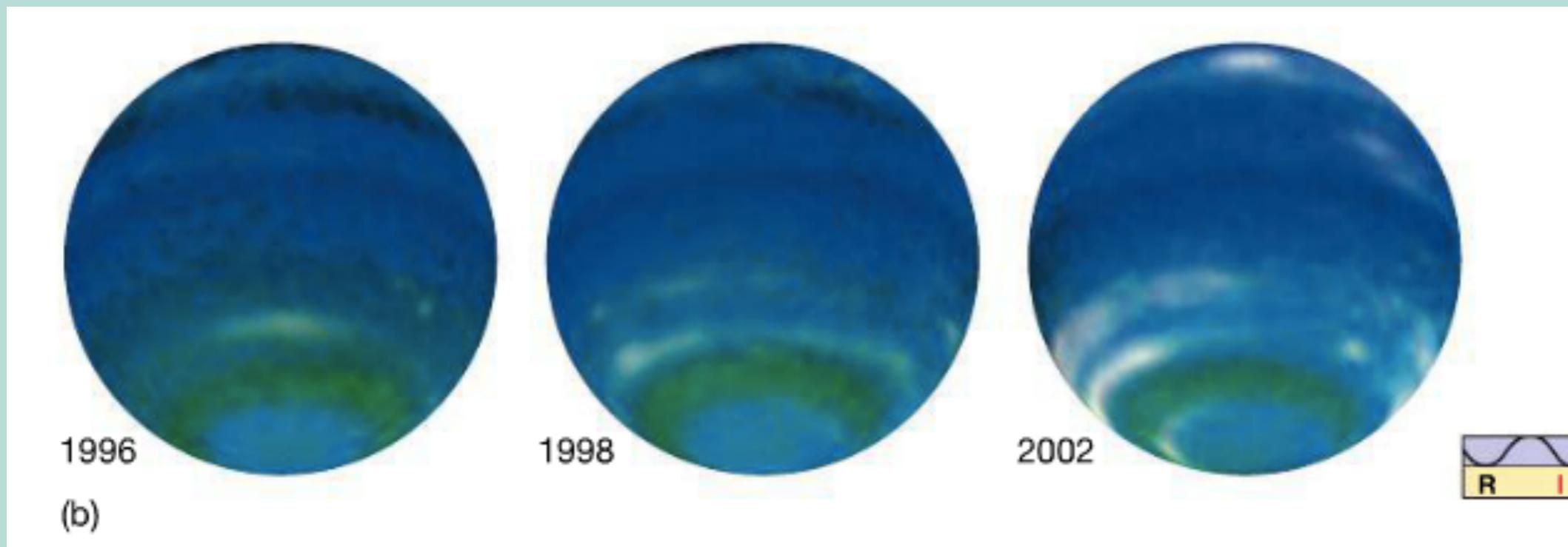


Uranus and Neptune: Ch 13

Neptune is crazy violent.

- Earth sized storms are the ‘rule’ more than the ‘exception’.
- Wind speeds have been clocked up to 1500 km/h!!
(Mach .5)

Neptunian Weather



No Spot!

Uranian and Neptunian Atmospheres

- ~84% molecular hydrogen, ~14% Helium for both
- Methane ~3% for Neptune and ~2% for Uranus (methane responsible for bluish hue)
- Ammonia freezes at 70K (between the cloud tops of Saturn/Jupiter and Uranus/Neptune) So very little in outer planets' atmospheres

Uranus and Neptune: Ch 13

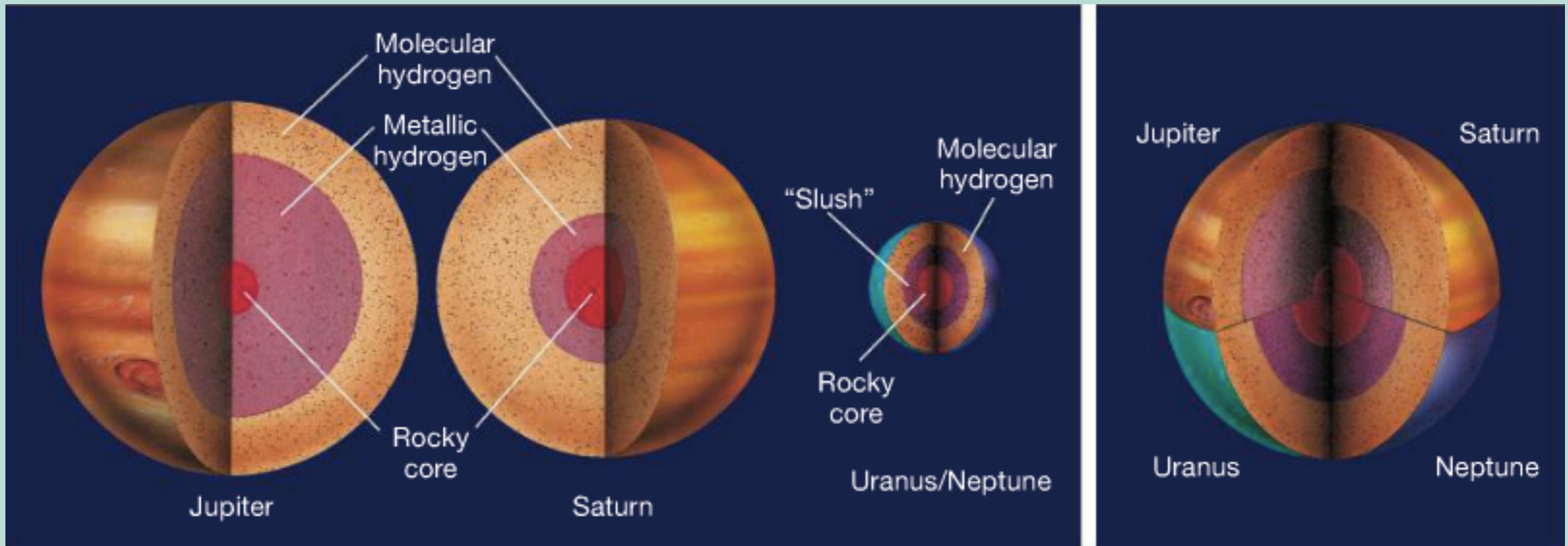
- Uranus has no internal heat source but Neptune does! The source is likely the same as Jupiter: left over heat from formation.
- Recall, Neptune is more massive and has more methane to keep it insulated

Uranus and Neptune: Ch 13

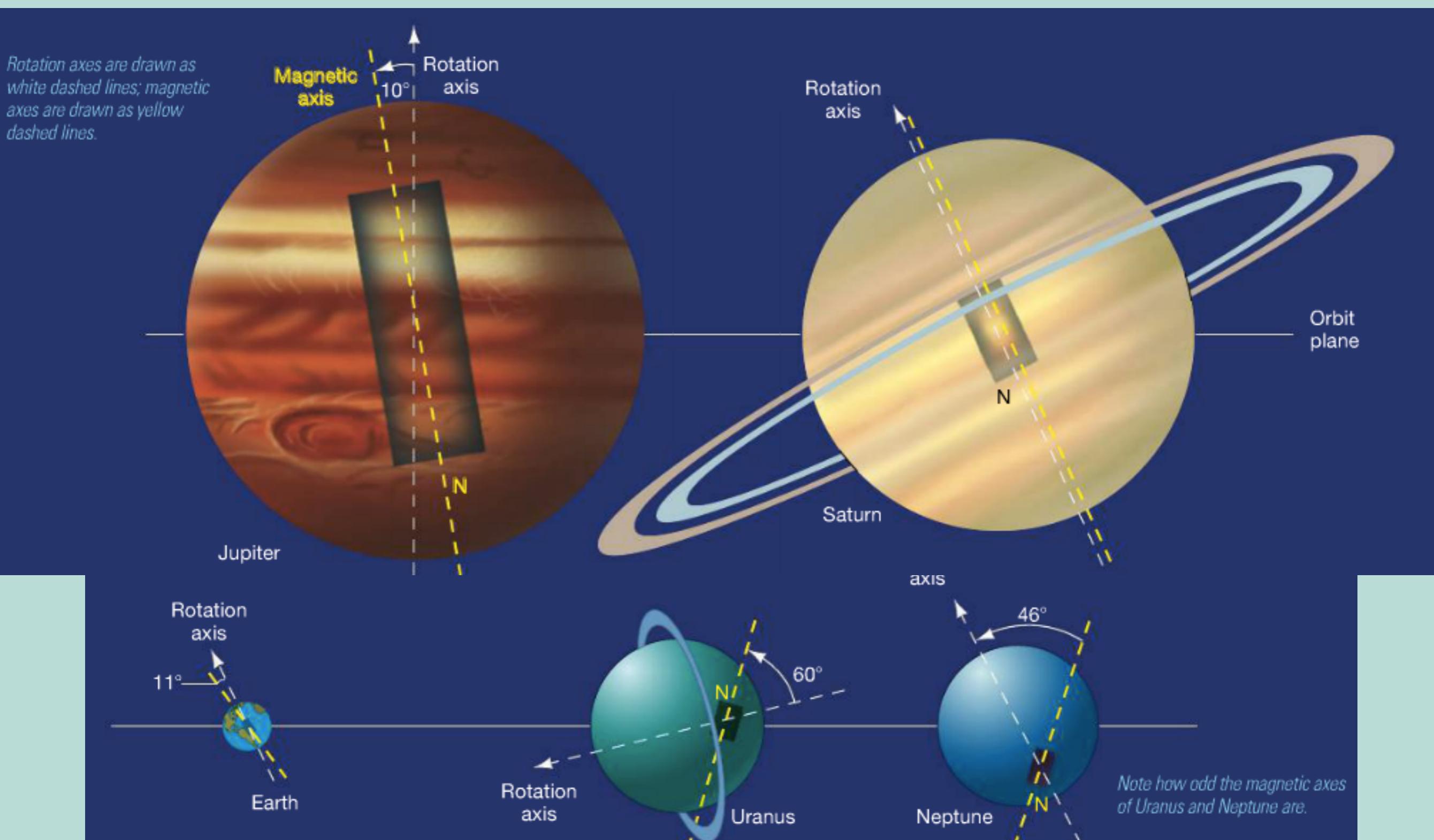


Uranus and Neptune: Ch 13

Interior Comparison



Uranus and Neptune: Ch 13



Magnetic and Rotational Axes

Uranus and Neptune: Ch 13

- The axes are misaligned in Neptune and Uranus with respect to the rotation axis and also its center isn't centered on the planet, uncommon in typical "dynamo" theories of a conductive liquid core.
- Nothing is certain, but this could be due to the fact that at the temperature and pressures of these outer jovian cores, hydrogen doesn't transition into its metallic state.
- What creates the magnetosphere instead could be a "slush" of water and ammonia (frozen and sunk out of the atmosphere) which would create a much more complicated field.

Uranus and Neptune: Ch 13



DISCUSSION

Uranus and Neptune: Ch 13

Uranus: 27 moons
Neptune: 13 moons

TABLE 13.1 The Major Moons of Uranus and Neptune*

Name	Distance from Planet (km)	Distance from Planet (planetary radii)	Orbital Period (days)	Size (longest diameter, km)	Mass** (Earth Moon masses)	Density (kg/m ³)	Density (g/cm ³)
Miranda (U)	130,000	5.08	1.41	480	0.00090	1100	1.1
Ariel (U)	191,000	7.48	2.52	1160	0.018	1600	1.6
Umbriel (U)	266,000	10.4	4.14	1170	0.016	1400	1.4
Titania (U)	436,000	17.1	8.71	1580	0.048	1700	1.7
Oberon (U)	583,000	22.8	13.5	1520	0.041	1600	1.6
Proteus (N)	118,000	4.75	1.12	440			
Triton (N)	355,000	14.3	-5.88 [†]	2710	0.292	2100	2.1
Nereid (N)	5,510,000	223	360	340	0.0000034	1200	1.2

(> 300 km)

Uranus and Neptune: Ch 13

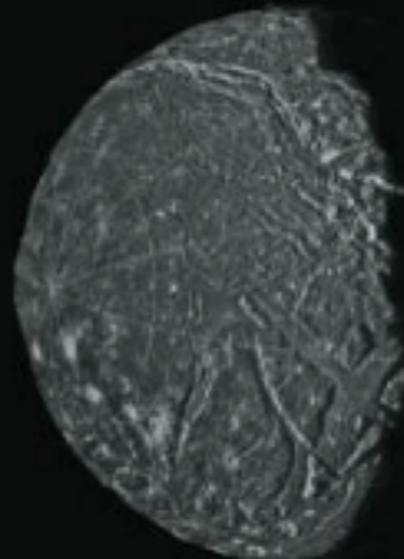
The appearance, structure, and history of Titania and Oberon seem similar to those of Saturn's moon Rhea.



Oberon



Miranda



Ariel



Proteus



Umbriel



Titania

Ariel might have some signs of past geological activity.

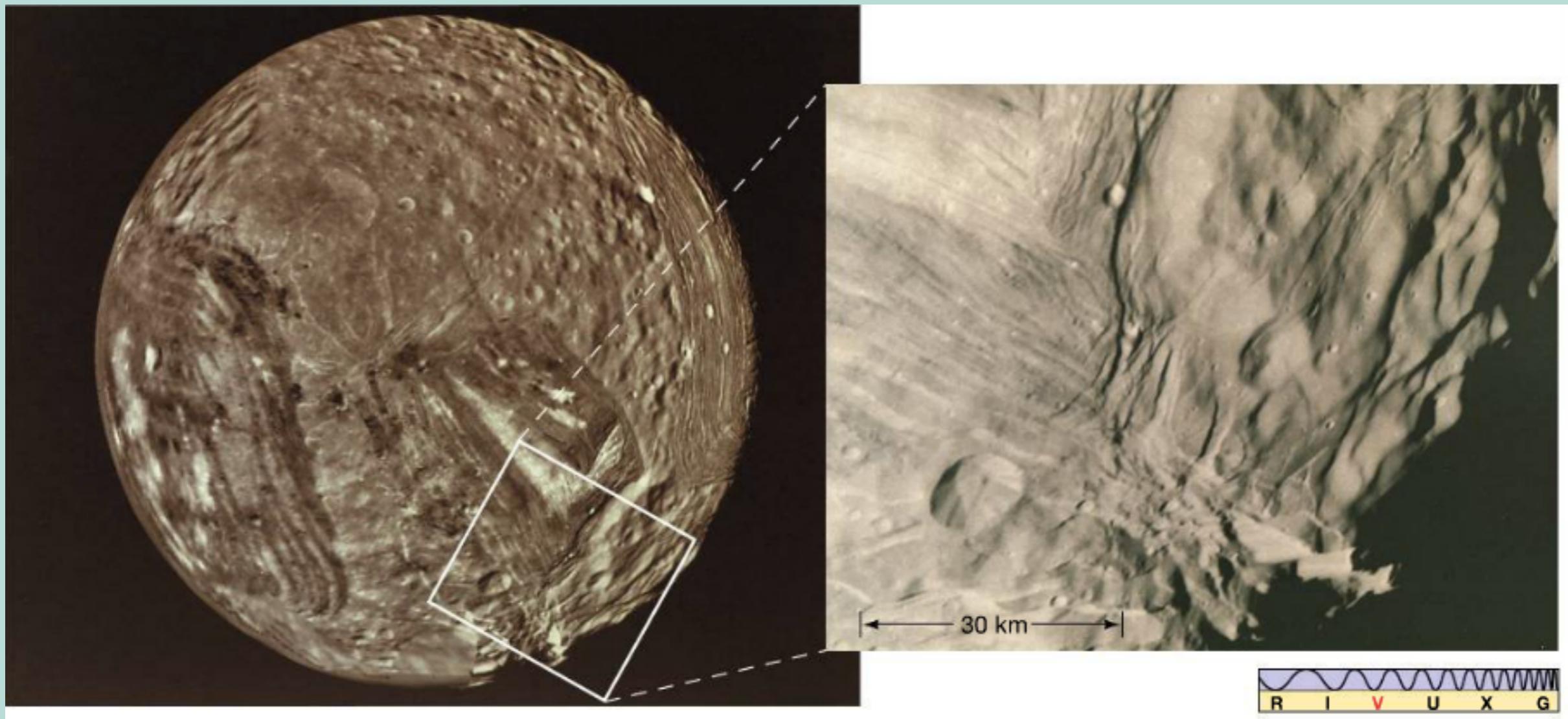
Umbriel is one of the darkest bodies in the solar system.

Uranus and Neptune: Ch 13

- Bodies in the outer solar system tend to be sootier than the inner (radiation darkening, possible reason)

Uranus and Neptune: Ch 13

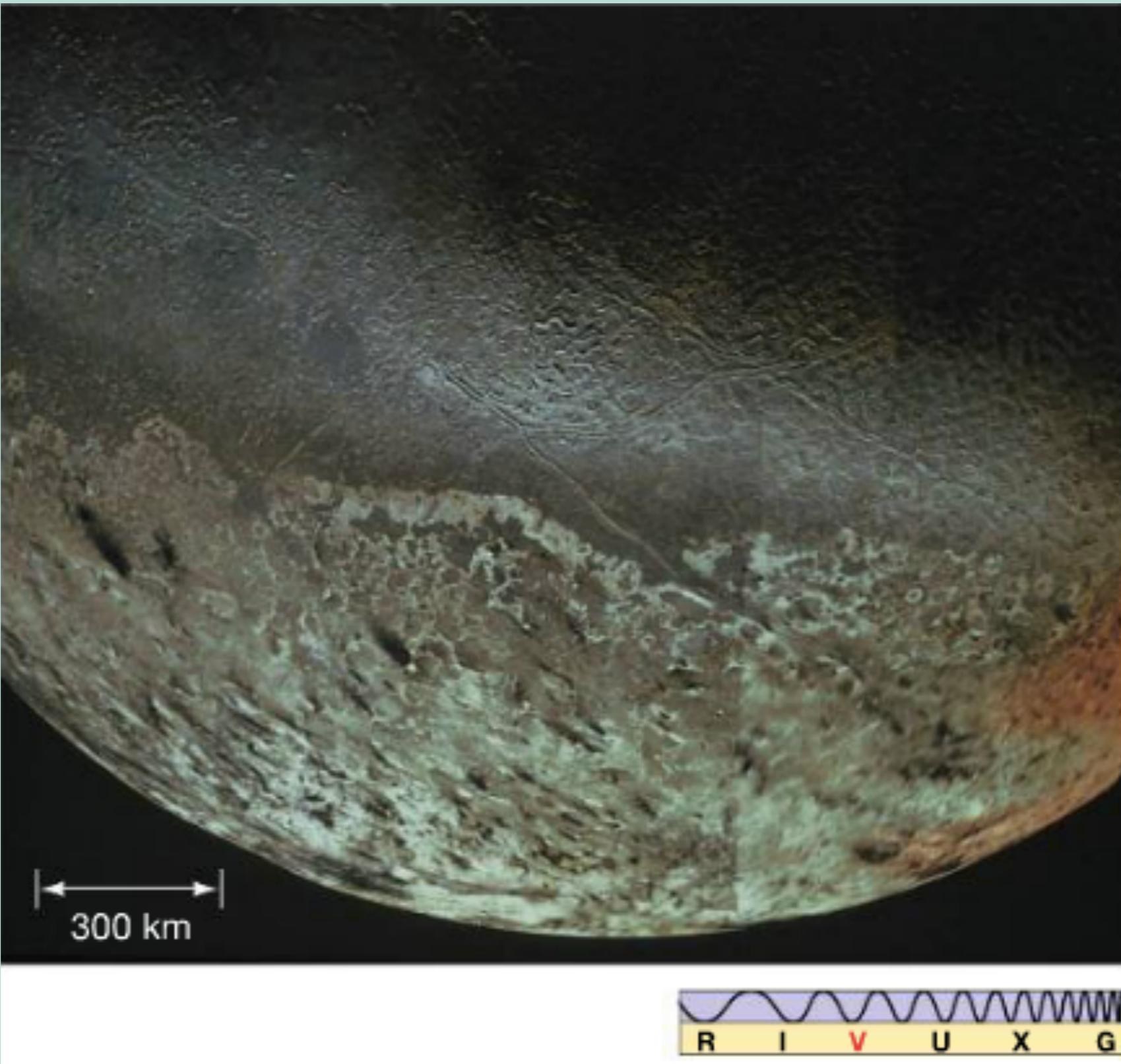
Miranda: A glitch in the Matrix



Smashed apart and reformed?

Uranus and Neptune: Ch 13

Triton

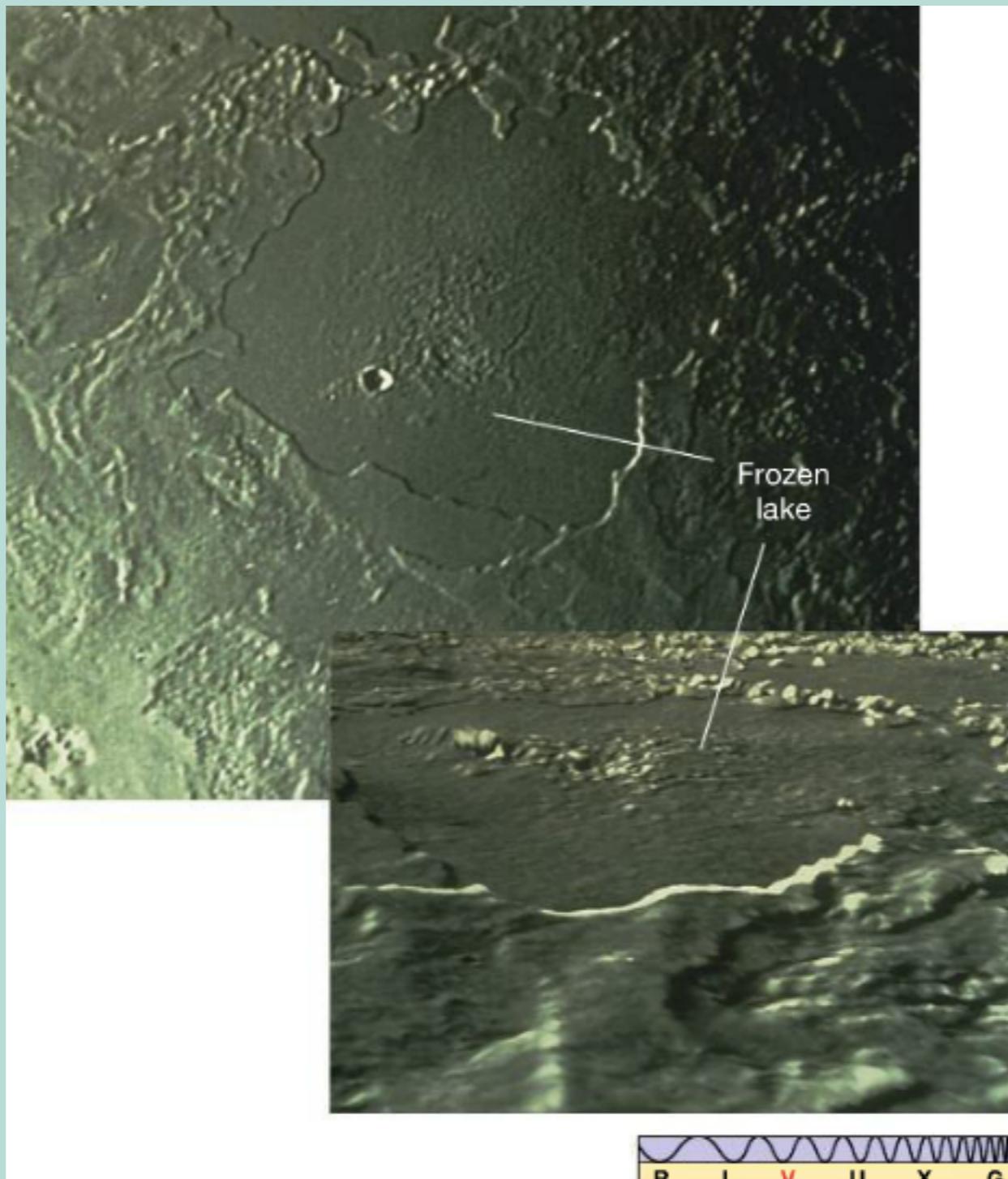


Uranus and Neptune: Ch 13

- Only large moon in a retrograde orbit
- 16th largest thing in the solar system! (half Europa-ish)
- Nitrogen Frost caps (37 K)
- Captured?

Uranus and Neptune: Ch 13

Water Lakes on Triton



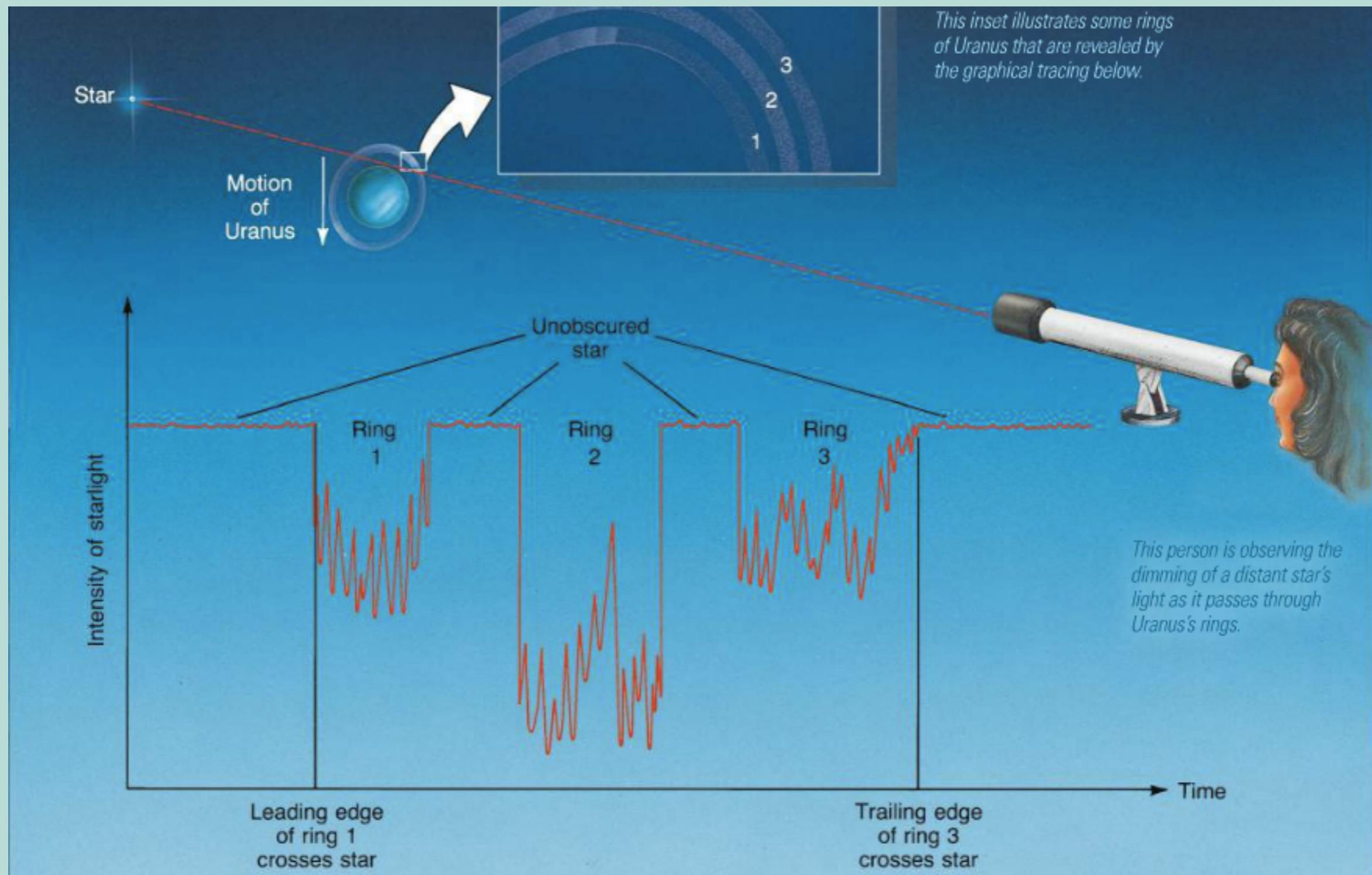
... and nitrogen geysers!

Uranus and Neptune: Ch 13

Triton's Spiral of Death. (~100 million years)

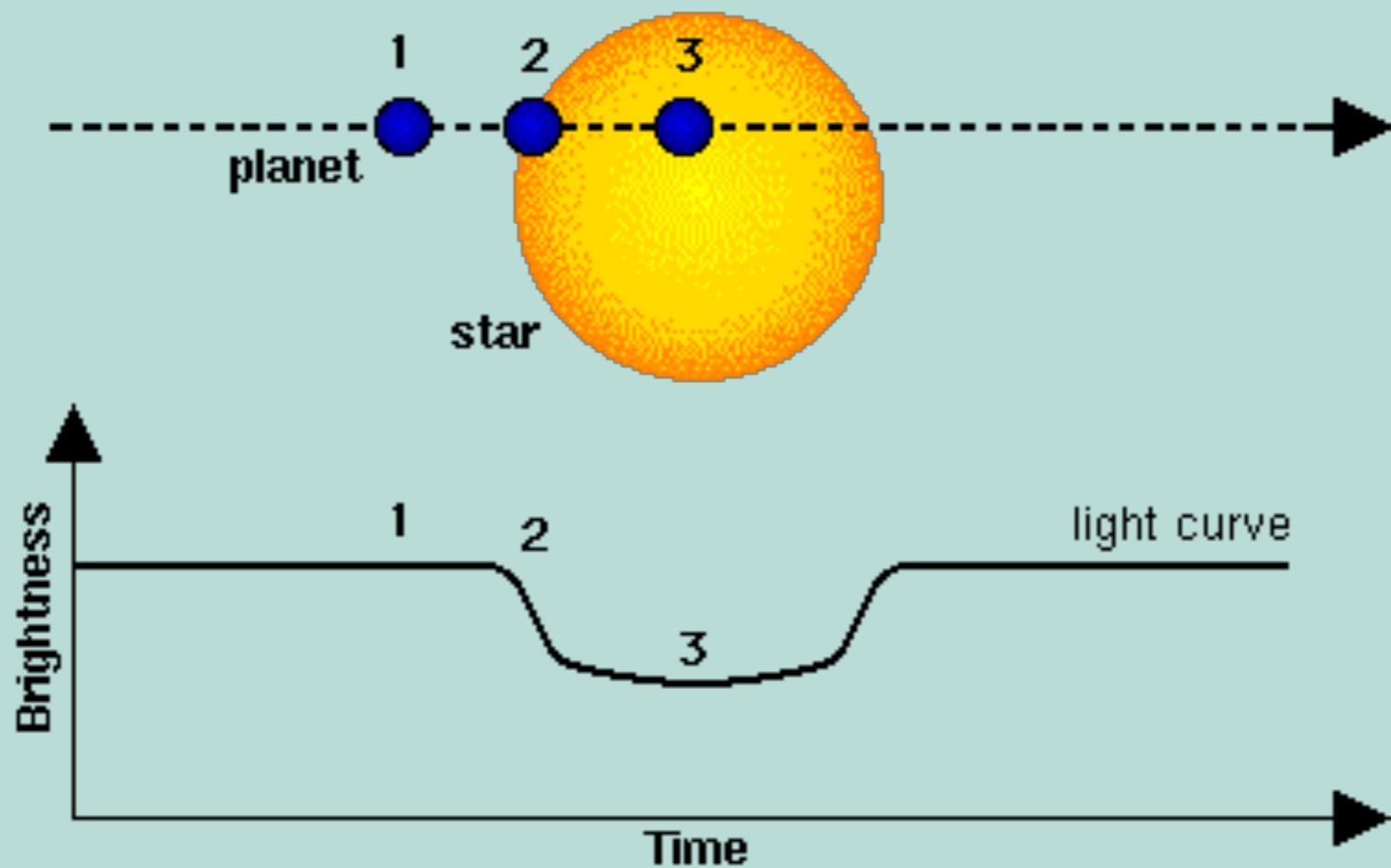


Uranus and Neptune: Ch 13

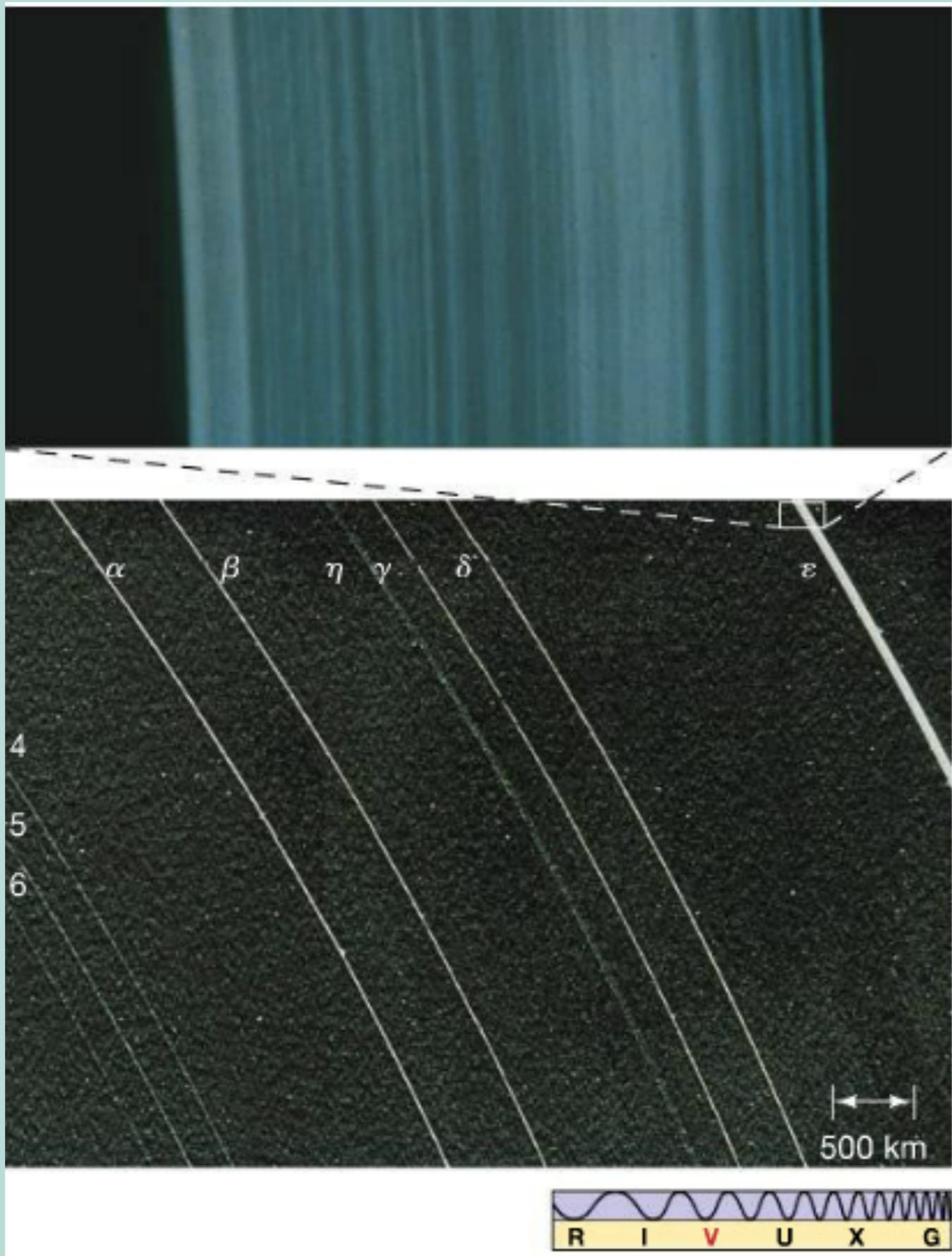


Uranus and Neptune: Ch 13

Same technique used to find Exoplanets!

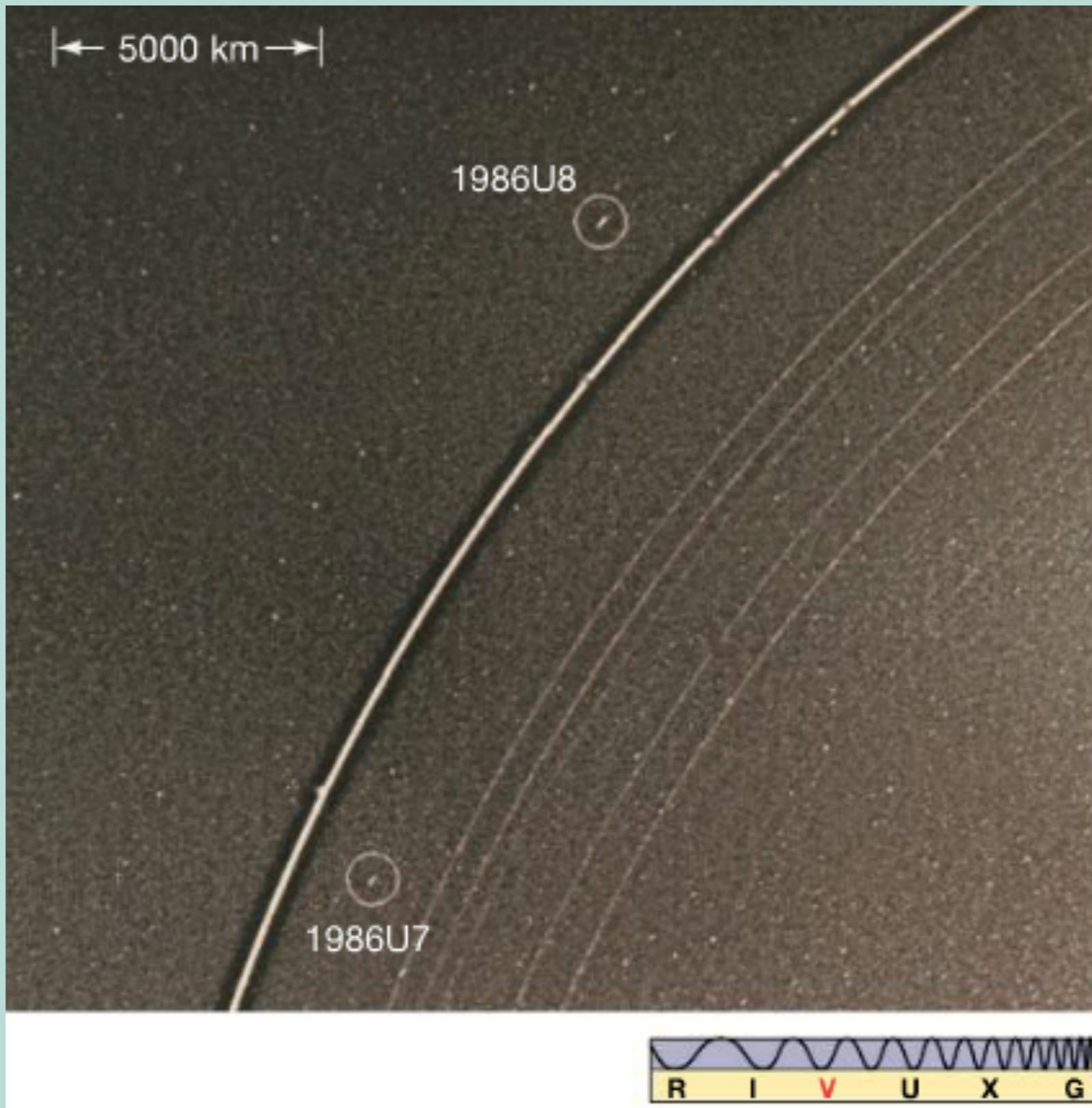


Uranus and Neptune: Ch 13



'skinny'

Uranus and Neptune: Ch 13



Uranus Shepard Moons (the origin of the theory)

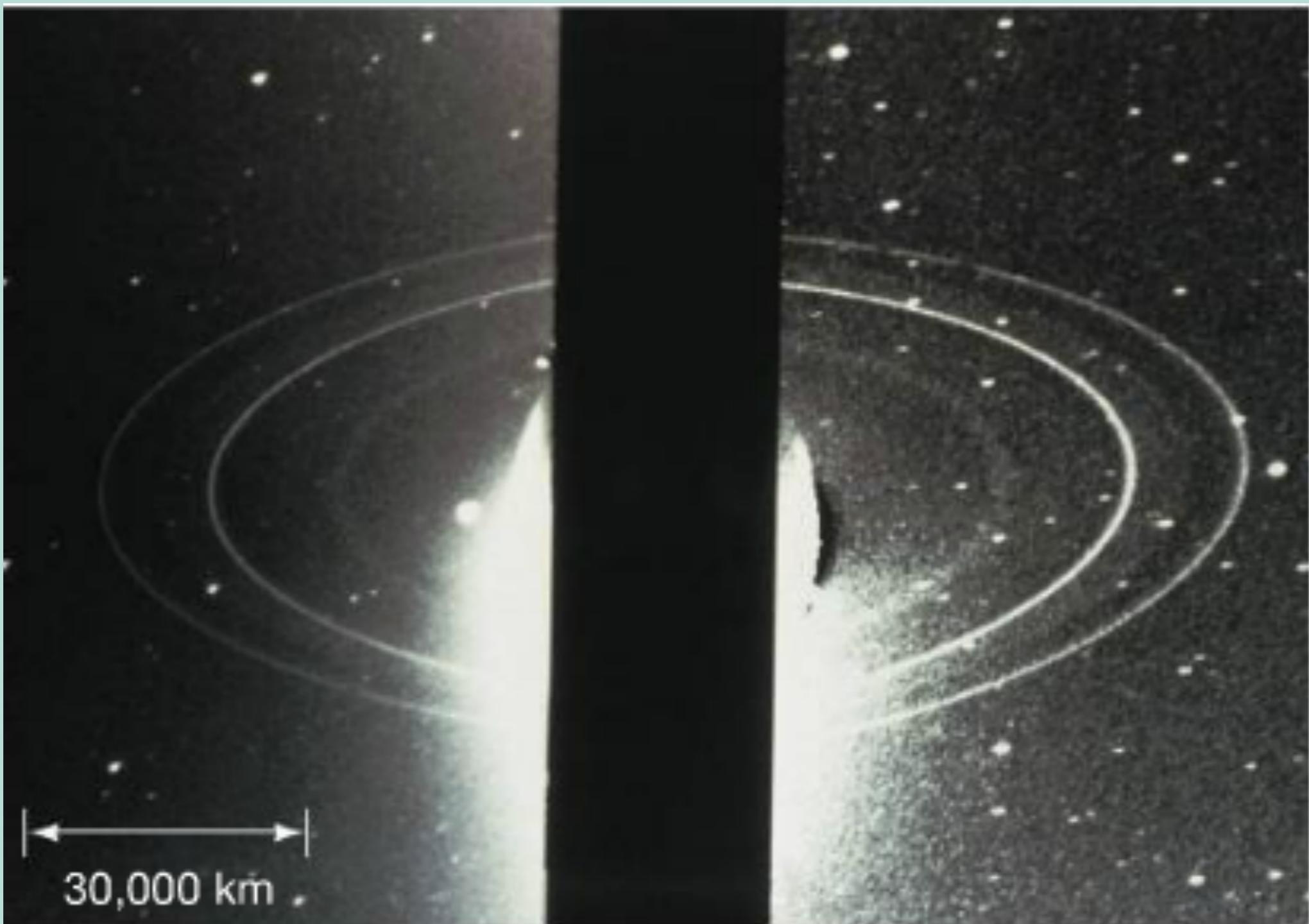
Uranus and Neptune: Ch 13

TABLE 13.2 The Rings of Uranus

Ring	Inner Radius (km) (planetary radii)	Outer Radius* (km) (planetary radii)	Width (km)
1986U2R	37,000	1.45	39,500
6	41,800	1.64	2
5	42,200	1.65	2
4	42,600	1.67	3
Alpha	44,700	1.75	4–10
Beta	45,700	1.79	5–11
Eta	47,200	1.83	2
Gamma	47,600	1.86	1–4
Delta	48,300	1.90	3–7
1986U1R	50,000	1.96	2
Epsilon	51,200	2.00	20–100

Uranus and Neptune: Ch 13

Neptune's Rings (long exposure)



Neptune Ring Data

TABLE 13.3 The Rings of Neptune

Ring	Inner Radius (km)	Outer Radius* (km)	Width (km)
	(planetary radii)	(planetary radii)	
Galle (1989N3R)	40,900	1.65	42,900
Leverrier (1989N2R)	53,200	2.15	100
Lassell (1989N4R) ^{**}	53,200	2.15	57,200
Arago (1989N4R) ^{**}	57,200	2.31	100
Adams (1989N1R)	62,900	2.54	50