



Lecture Outlines

Chapter 13

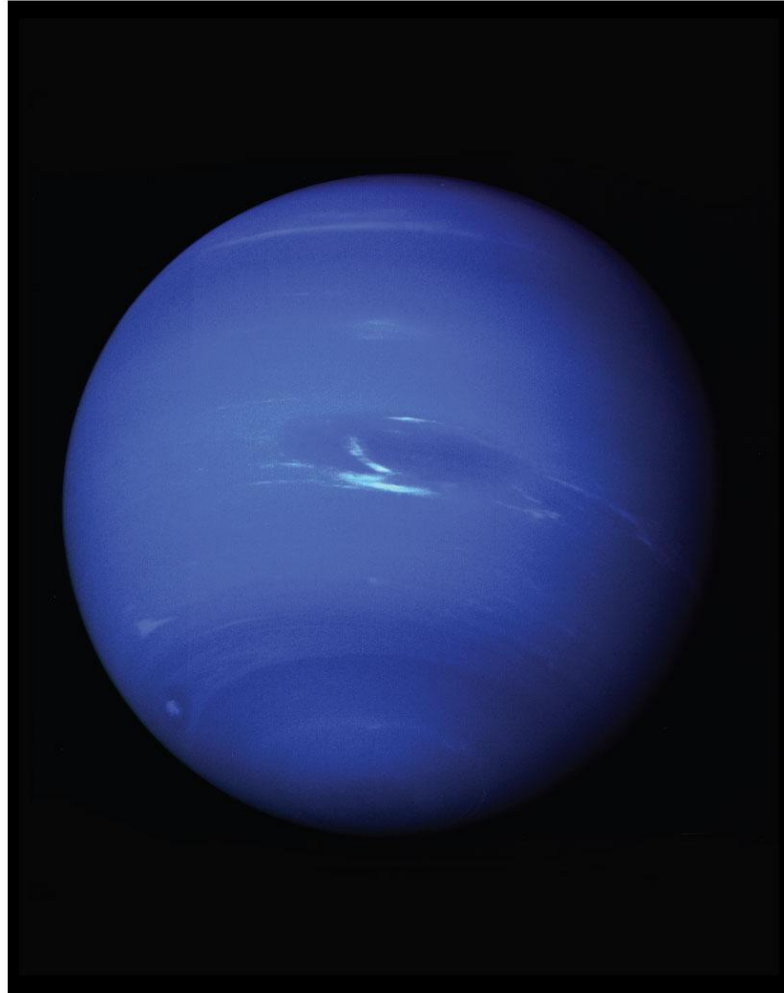
Astronomy Today

7th Edition

Chaisson/McMillan

Chapter 13

Uranus and Neptune



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Units of Chapter 13

13.1 The Discoveries of Uranus and Neptune

13.2 Orbital and Physical Properties

13.3 The Atmospheres of Uranus and Neptune

13.4 Magnetospheres and Internal Structure

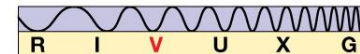
13.5 The Moon Systems of Uranus and Neptune

13.6 The Rings of the Outermost Jovian Planets

13.1 The Discoveries of Uranus and Neptune

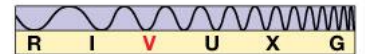
Uranus was discovered in 1781 by Herschel; first planet to be discovered in more than 2000 years

Little detail can be seen from Earth; arrows point to three of Uranus's moons



13.1 The Discoveries of Uranus and Neptune

Slightly more detail can be seen in this image taken by *Voyager 2* at a distance of 1 million km



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13.1 The Discoveries of Uranus and Neptune

Neptune was discovered in 1846, after analysis of Uranus's orbit indicated its presence

Details of Neptune cannot be made out from Earth either; arrows again point to moons



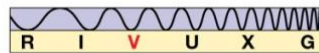
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13.1 The Discoveries of Uranus and Neptune

More detail is visible in these *Voyager 2* images, also taken from a distance of 1 million km



(a)



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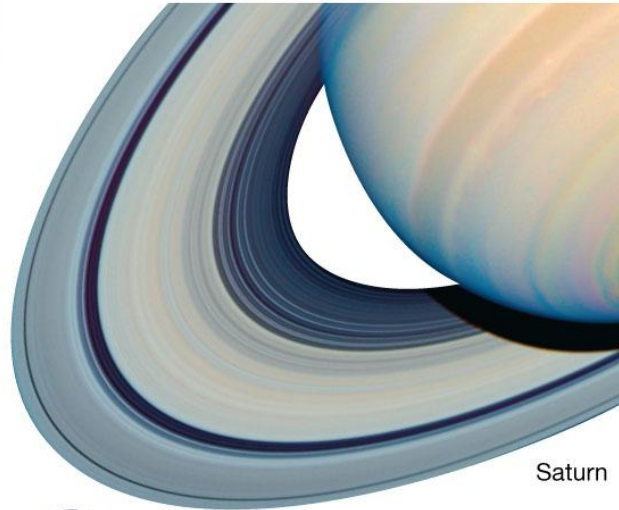
(b)

13.2 Orbital and Physical Properties

Uranus and Neptune are very similar



Jupiter



Saturn



Uranus



Earth



Neptune

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13.2 Orbital and Physical Properties

Uranus

Neptune

Mass

14.5 x Earth

17.1 x Earth

Radius

4.0 x Earth

3.9 x Earth

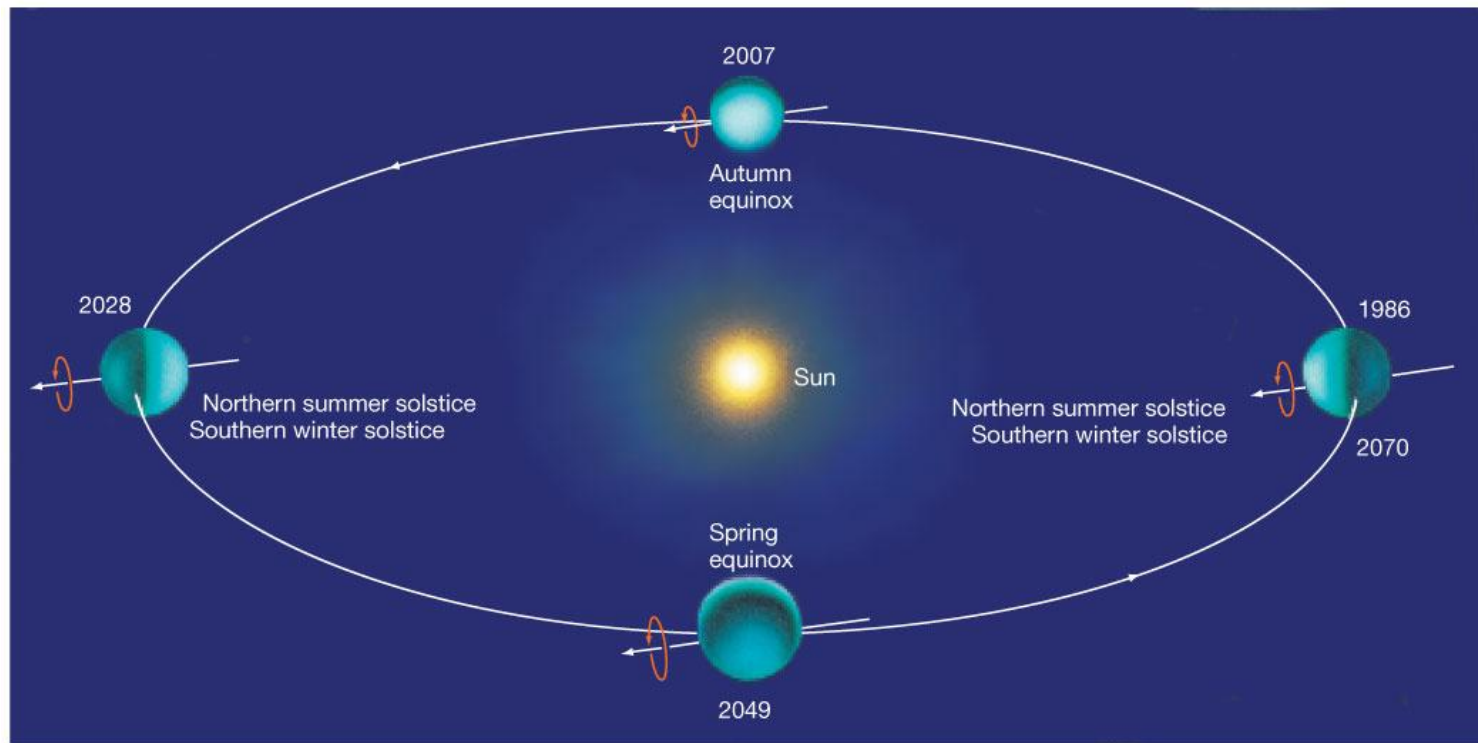
Density

1300 kg/m³

1600 kg/m³

13.2 Orbital and Physical Properties

Peculiarity of Uranus: Axis of rotation lies almost in the plane of its orbit. Seasonal variations are extreme.

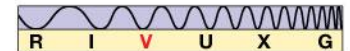


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13.3 The Atmospheres of Uranus and Neptune

Outer atmospheres of Uranus and Neptune are similar to those of Jupiter and Saturn

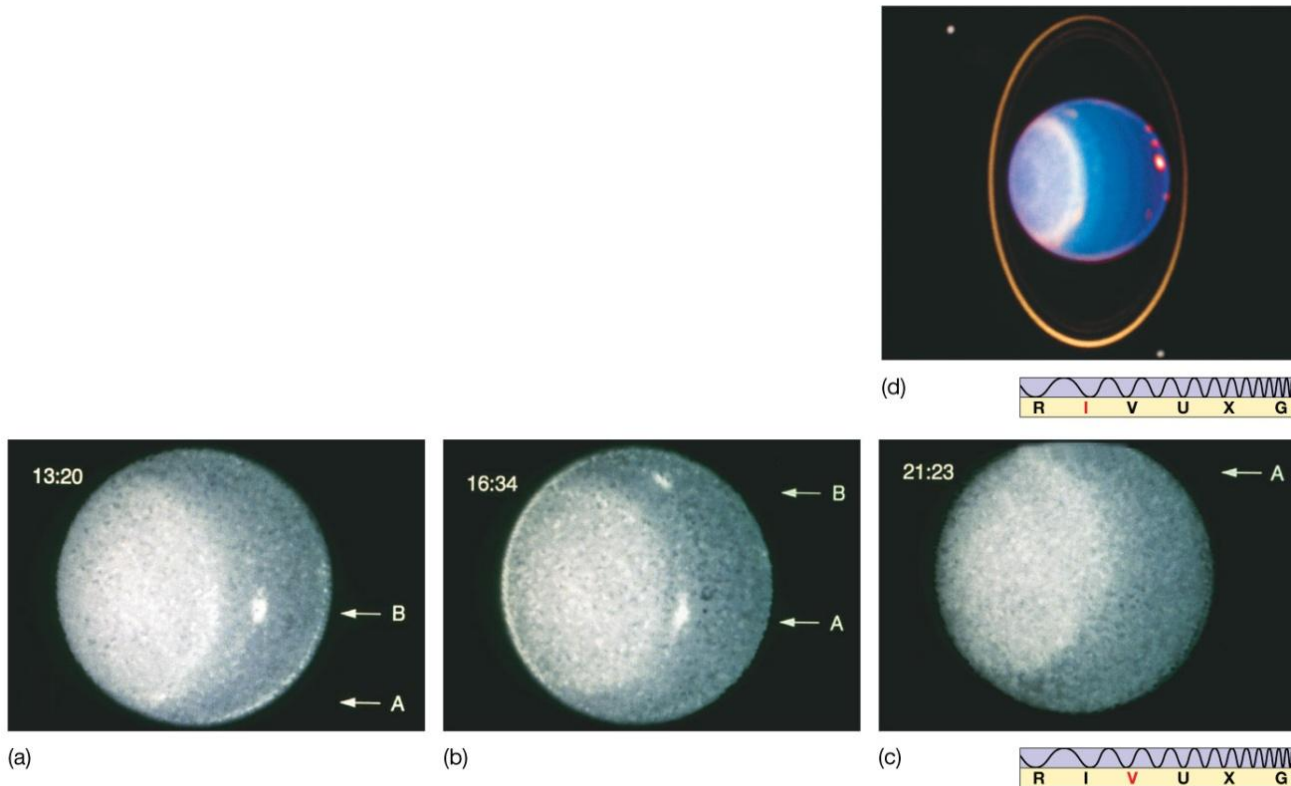
Uranus and Neptune are cold enough that ammonia freezes; methane dominates and gives the characteristic blue color



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13.3 The Atmospheres of Uranus and Neptune

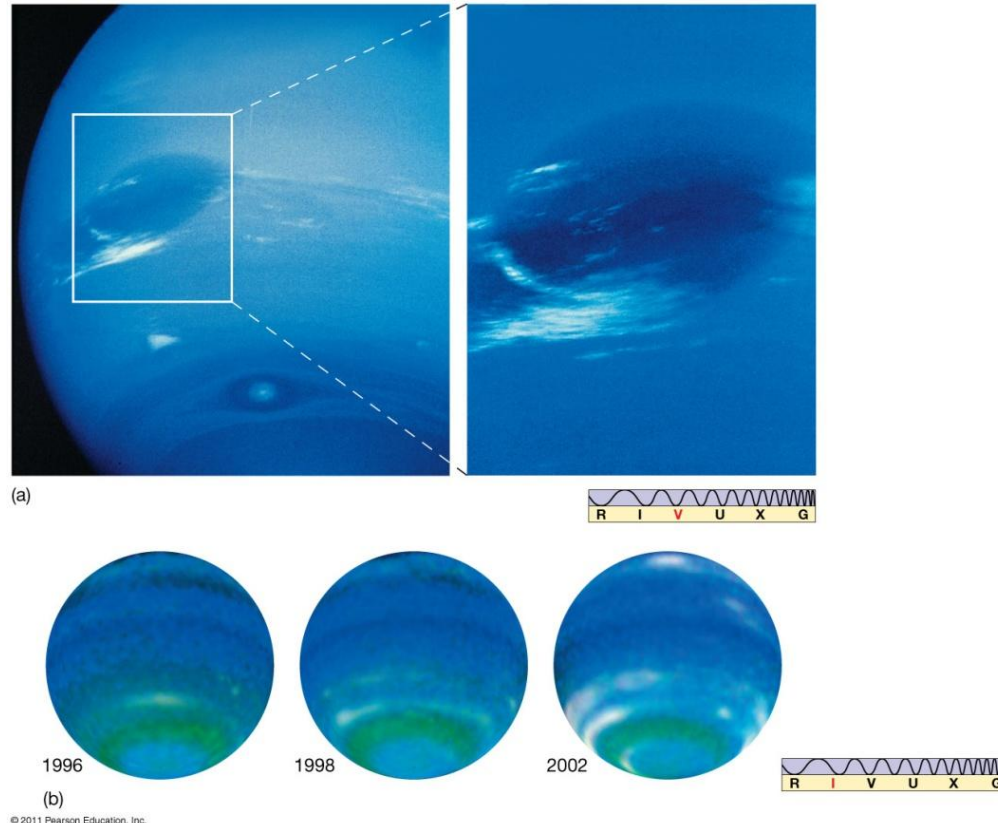
Uranus is very cold; clouds only in lower, warmer layers
These images show Uranus rotating (a–c), and its ring (d)



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13.3 The Atmospheres of Uranus and Neptune

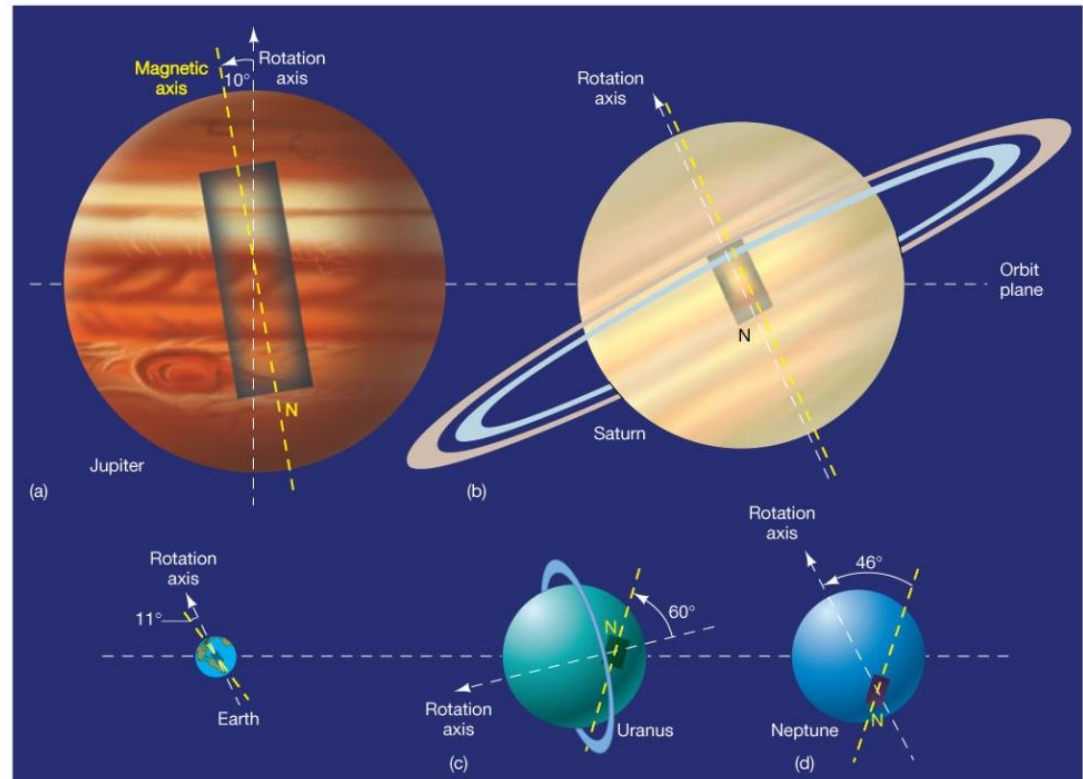
Band structure of Neptune is more visible; it had a “Dark Spot” similar to Jupiter’s storms (now vanished)



13.4 Magnetospheres and Internal Structure

Uranus and Neptune both have substantial magnetic fields, but at a large angle to their rotation axes.

The rectangle within each planet shows a bar magnet that would produce a similar field. Note that both Uranus's and Neptune's are significantly off center.

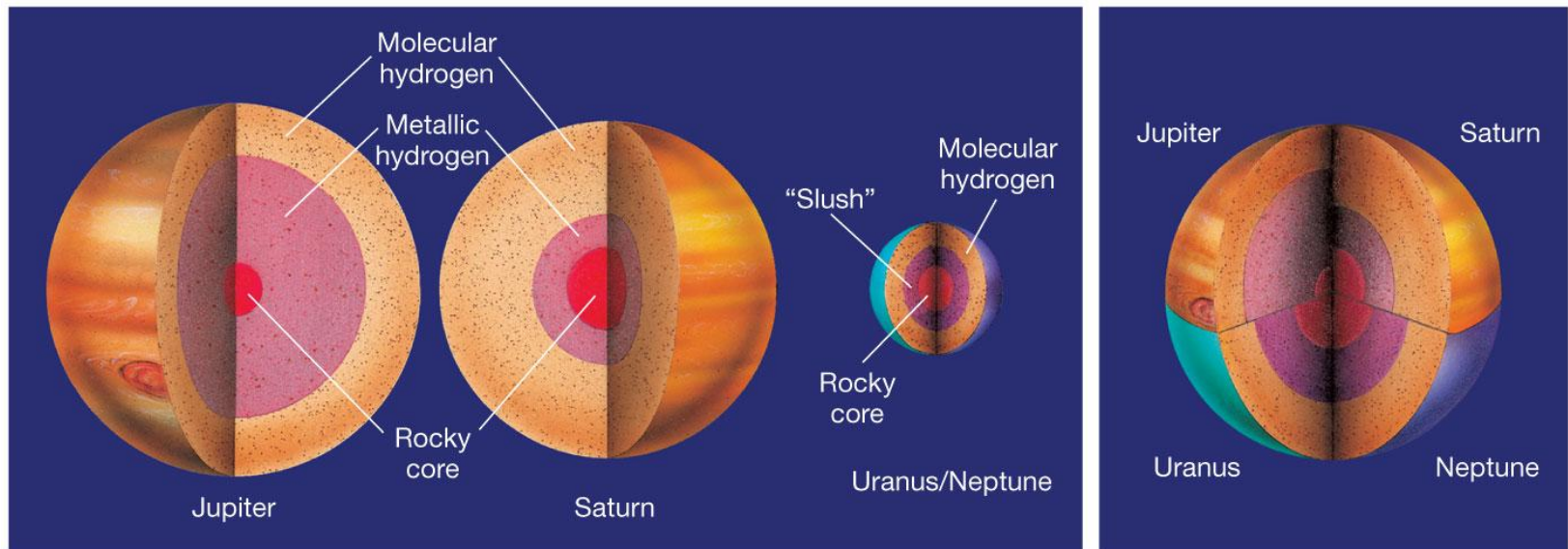


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13.4 Magnetospheres and Internal Structure

Magnetic fields of Uranus and Neptune must not be produced by dynamos, as the other planets' fields are

Interior structure of Uranus and Neptune, compared to that of Jupiter and Saturn



(a)

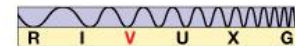
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13.5 The Moon Systems of Uranus and Neptune



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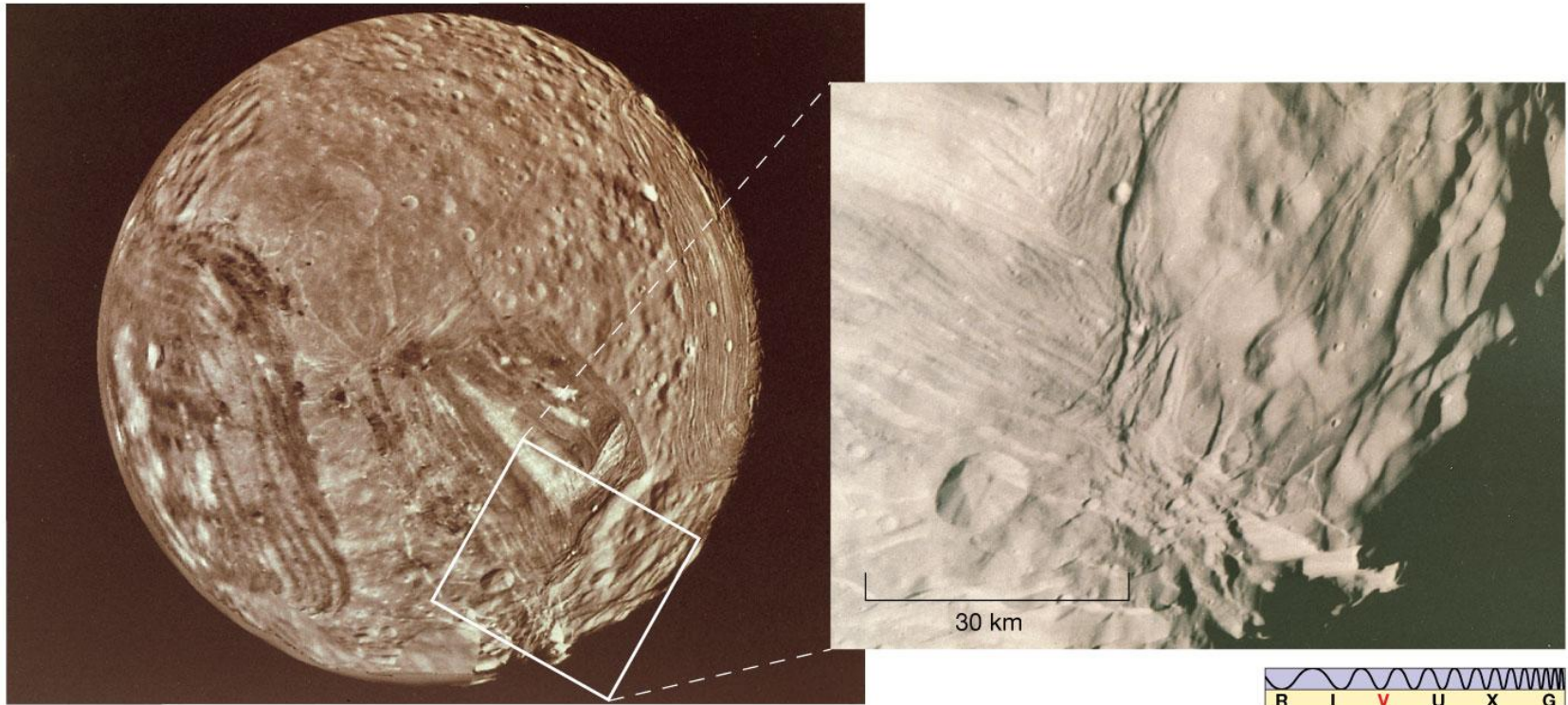


13.5 The Moon Systems of Uranus and Neptune

- Uranus has 27 moons, five of which are major: Miranda, Ariel, Umbriel, Titania, and Oberon
- Similar to Saturn's medium-sized moons, except that all are much less reflective
- Umbriel is the darkest

13.5 The Moon Systems of Uranus and Neptune

Miranda is the most unusual moon of Uranus; origin of the cracks and grooves is unknown



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13.5 The Moon Systems of Uranus and Neptune

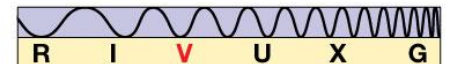
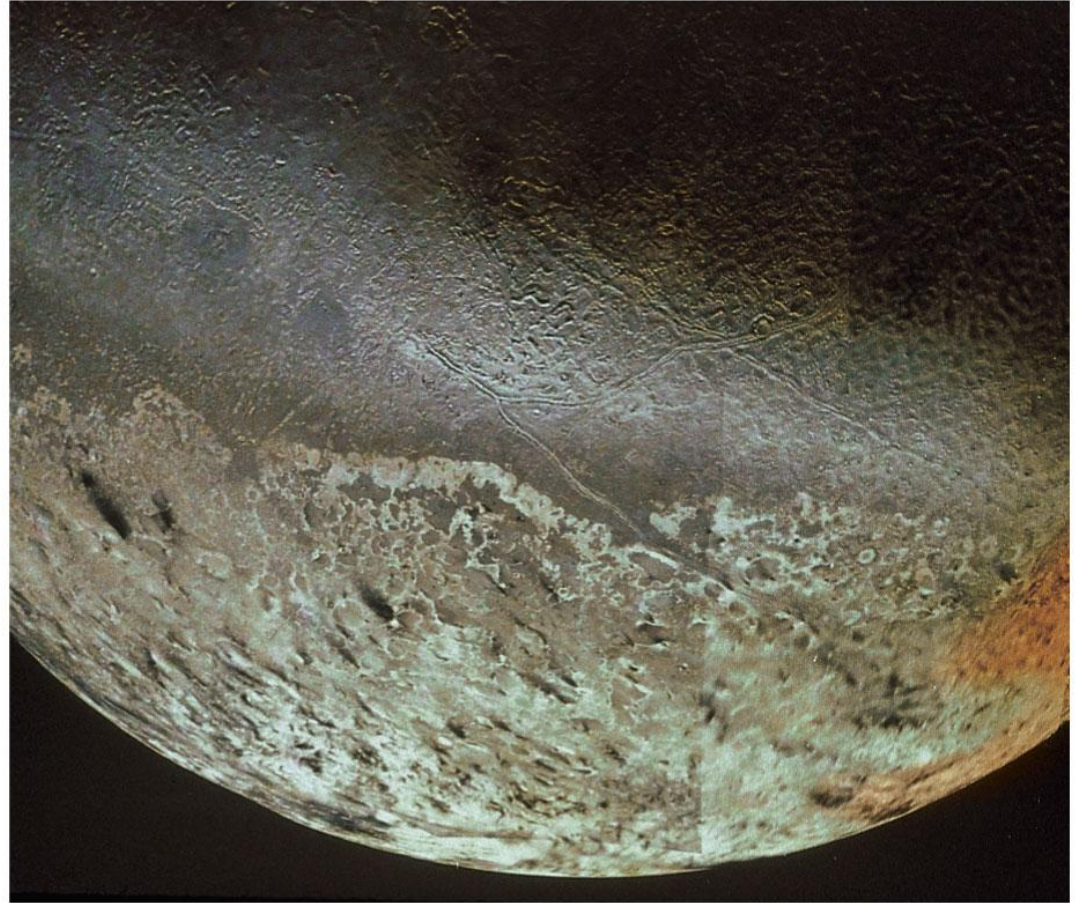
Neptune has 13 moons, but only two can be seen from Earth: Triton and Nereid

Triton is in a retrograde orbit; Nereid's orbit is highly eccentric

Triton's surface has few craters, indicating an active surface

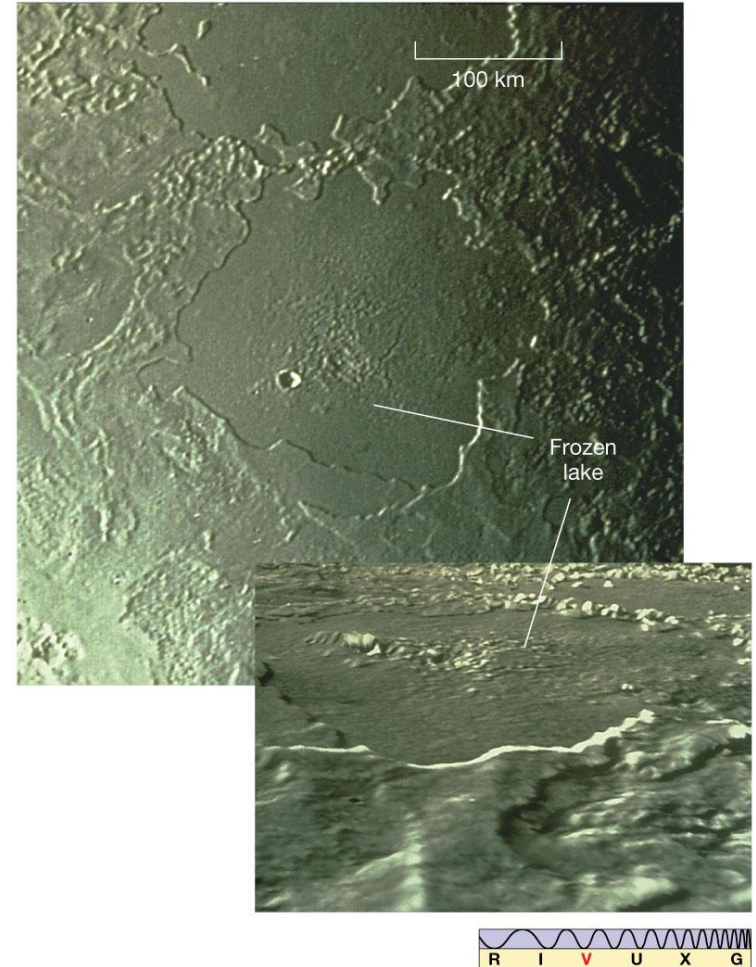
13.5 The Moon Systems of Uranus and Neptune

Nitrogen geysers
have been observed
on Triton, contributing
to the surface
features



13.5 The Moon Systems of Uranus and Neptune

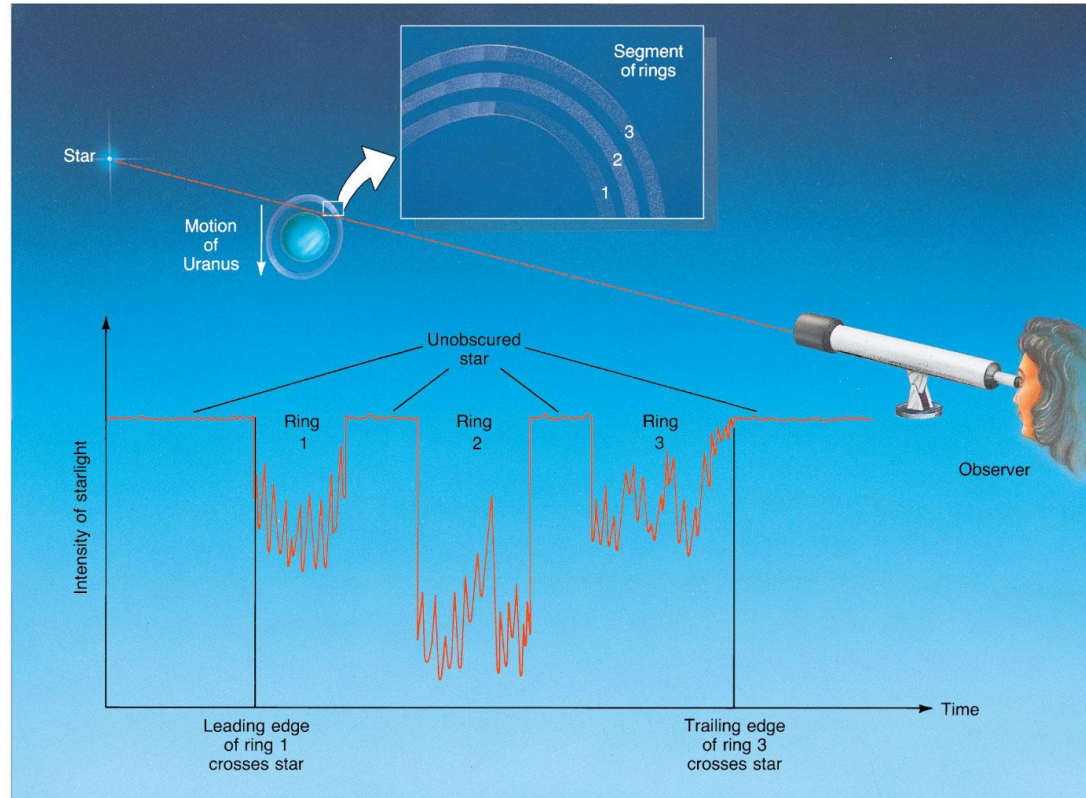
Also, there appear to be ice volcanoes



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13.6 The Rings of the Outermost Jovian Planets

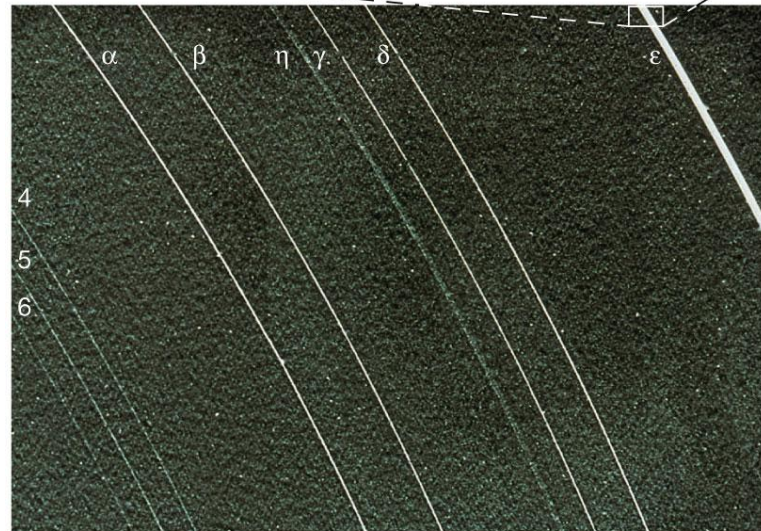
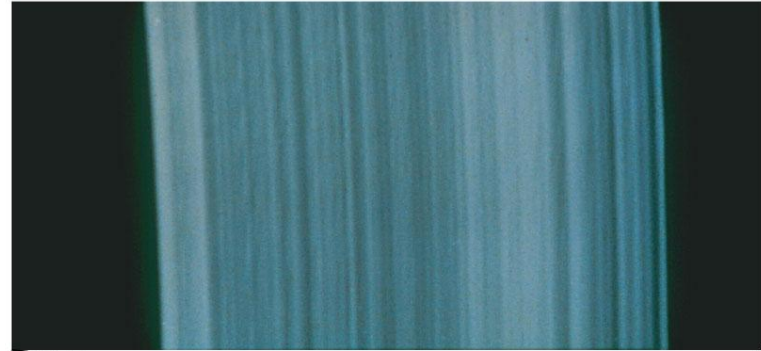
Uranus and Neptune have faint ring systems, recently detected via stellar occultation



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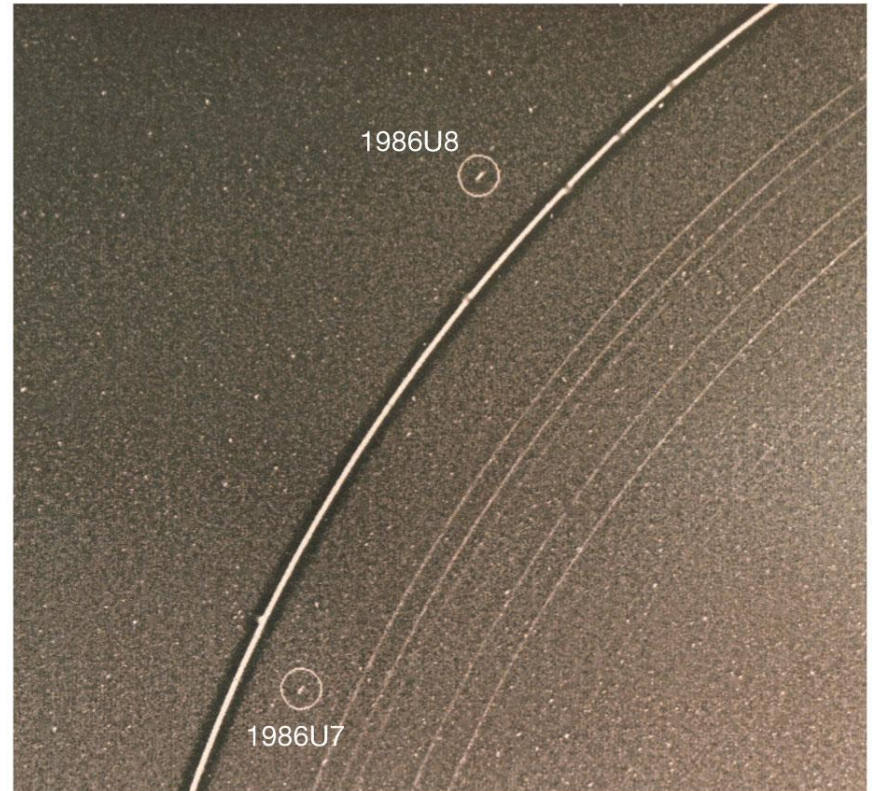
13.6 The Rings of the Outermost Jovian Planets

Uranus's rings are narrow



13.6 The Rings of the Outermost Jovian Planets

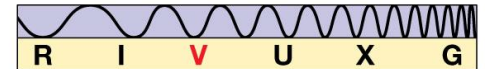
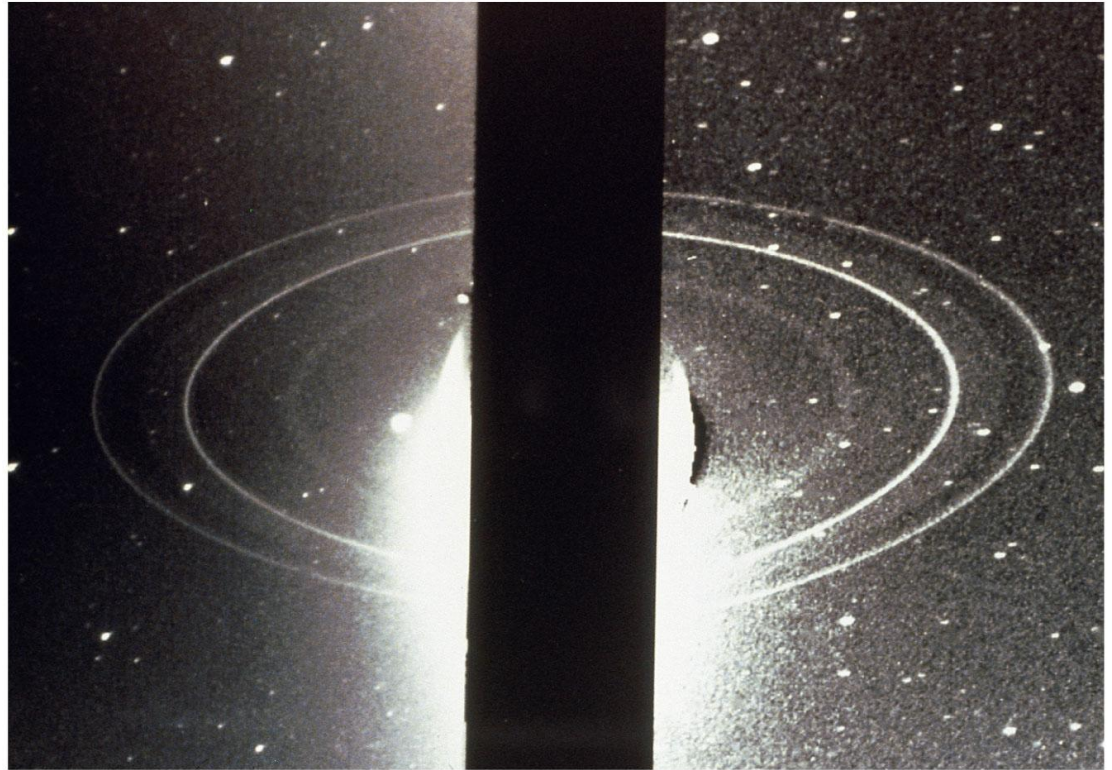
Two shepherd moons keep
the epsilon ring from diffusing



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13.6 The Rings of the Outermost Jovian Planets

Neptune has five rings:
three narrow and two
wide



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Summary of Chapter 13

- Uranus and Neptune were discovered in the last 350 years
- Uranus and Neptune are similar: gaseous and cold
- Uranus's spin axis is almost in the plane of its orbit
- Surface features are hard to discern on Uranus but are more obvious on Neptune
- Uranus has no excess heat emission, but Neptune does

Summary of Chapter 13 (cont.)

- Uranus's midsize moons are similar to those of Saturn
- Neptune's moon Triton has a retrograde orbit
- Uranus and Neptune both have faint ring systems