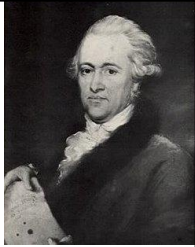


# Uranus



William Herschel - 1781  
Visible to the naked eye (barely)



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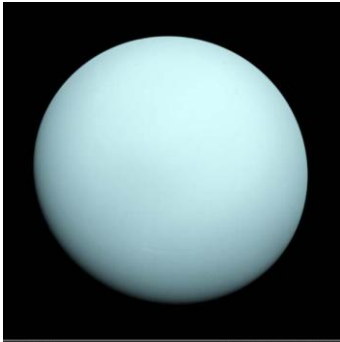
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Uranus visited by Voyager 2 in 1986



Uranus

© Copyright Calvin J. Hamilton

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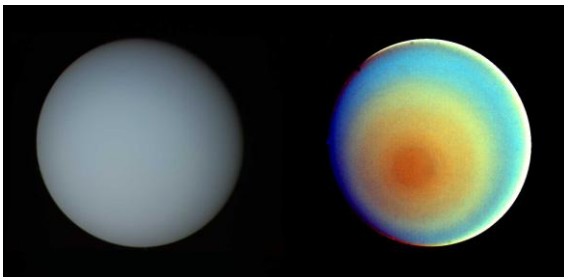
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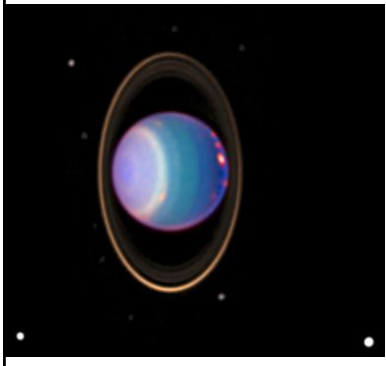
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Wait a minute!  
Clouds on Uranus!  
What's happening?  
Seasonal variations!

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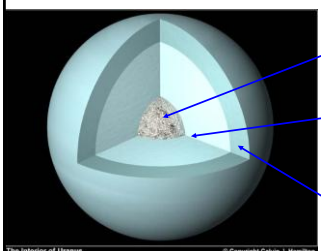
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Rock  
Compressed water, methane, ammonia ocean  
Liquid H, He

The Interior of Uranus © Copyright Cahoon J. Neillman

Magnetic field is tilted and off axis



MAGNETIC FIELD OF URANUS

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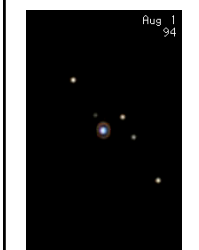
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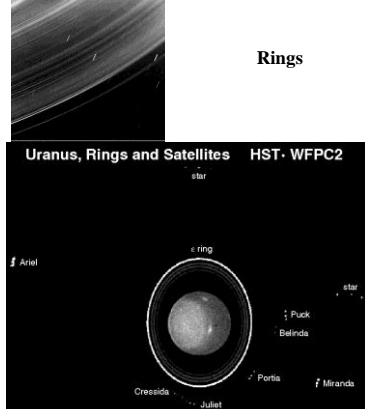
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Aug 1 94

Rings



Uranus, Rings and Satellites HST-WFPC2

star

Ariel

ε ring

star

Puck Belinda

Portia

Miranda

Cressida Juliet

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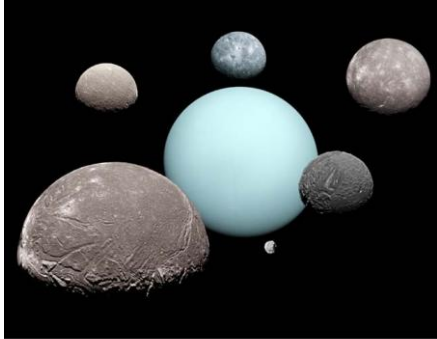
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### Uranus' Satellites - 27



Uranian System

© Copyright Calvin J. Hamilton

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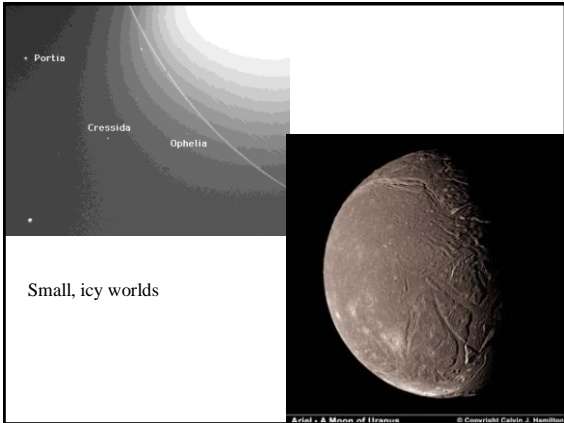
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Small, icy worlds

Ariel - A Moon of Uranus

© Copyright Calvin J. Hamilton

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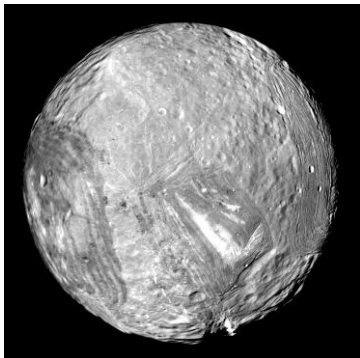
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### Miranda - The Fractured Moon



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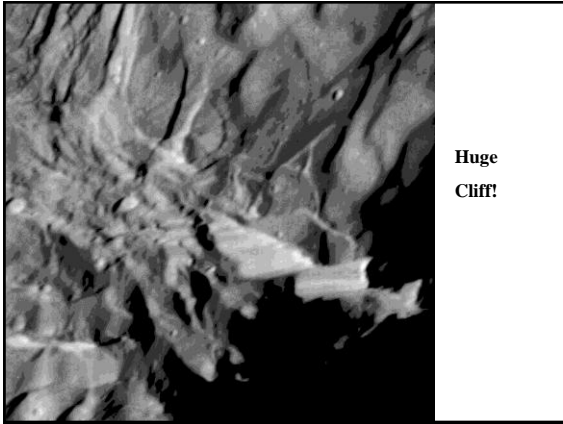
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Huge  
Cliff!

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Strange  
patterns  
Discoloration  
Why?

Miranda • 'Chevron' Grooves © Copyright Calvin J. Hamilton

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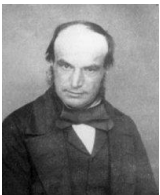
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## Neptune ♃

1846 - An Englishman, a Frenchman and a German walked into a bar and...



John Couch Adams



Urbain Le Verrier



Johann Galle

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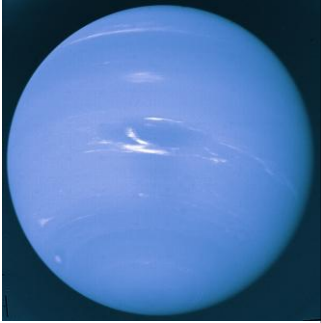
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Similar to Uranus  
Composition  
Mass, radius  
Cloud structures  
Magnetic fields  
More active atmosphere



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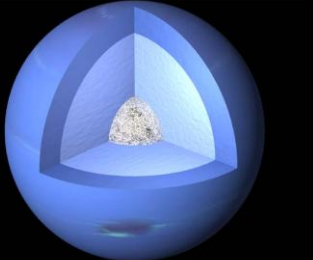
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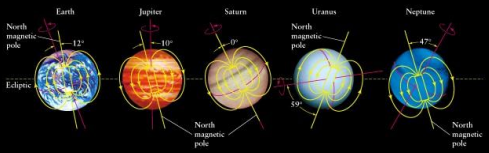
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The Interior of N



Planet	North magnetic pole tilt
Earth	12°
Jupiter	10°
Saturn	9°
Uranus	59°
Neptune	47°

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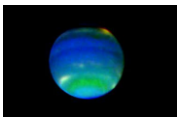
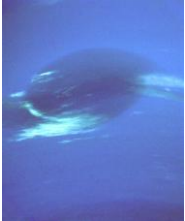
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Great Dark Spot  
Analogous to the  
Great Red Spot



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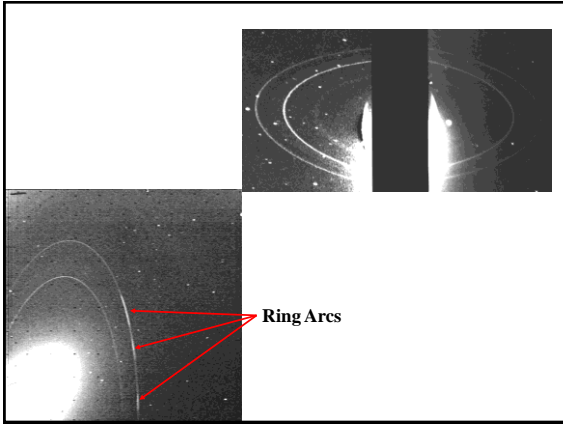
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**Neptune's Moons**

13 known satellites  
Small icy worlds  
Heavily cratered

Proteus © Calvin J. Hamilton

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**Triton - The Geyser World**

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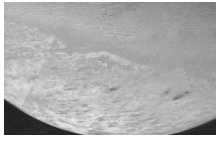
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**Geysers erupt gas (nitrogen and methane) and methane ice  
Triton's unusual orbit - tidal heated**

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## Beyond Neptune...

1930 - Pluto Discovered

1951 - Kuiper Belt proposed

1992 - Discovery of another object beyond Neptune

### **Kuiper Belt Objects**

#### **Trans-Neptunian Objects**

1,000 known (so far),

100,000 may exist

30 - few hundred AU

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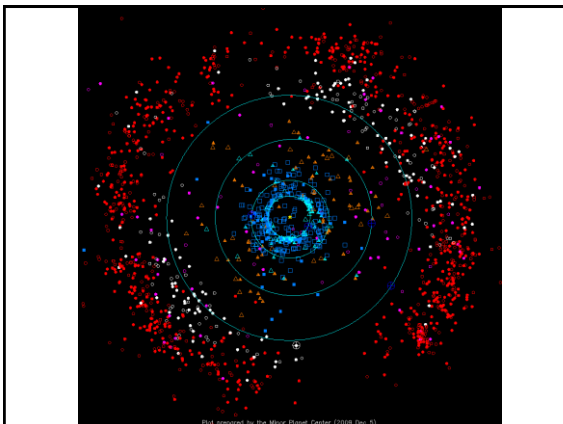
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Plot prepared by the Minor Planet Center (2008 Dec 01)

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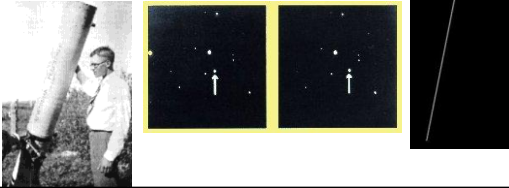
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# Pluto

Discovered in 1930 by Clyde Tombaugh  
Moon (Charon) discovered in 1978 by Robert Christy  
2 more satellites recently discovered (2005)



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## Observations of Pluto

Small, icy  
Has an atmosphere sometimes



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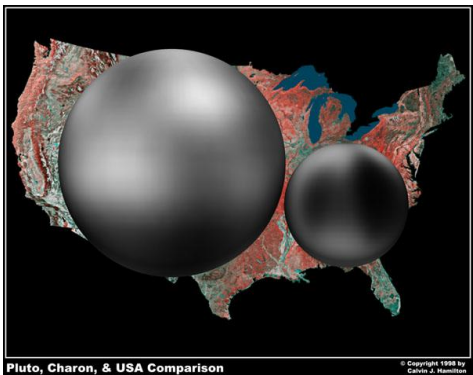
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Pluto, Charon, & USA Comparison

© Copyright 1998 by  
Curtis Z. Hamilton

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Is it a planet?

Pluto System

Hubble Space Telescope ACS

Pluto

Charon

Candidate Satellites

May 15, 2005

Charon

Pluto

Candidate Satellites

May 18, 2005

NASA, ESA, H. Weaver (JHU/APL), A. Stern (SwRI), and the HST Pluto Companion Search Team.

STScI-PRC05-19a

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### Eris & Sedna

Bigger than Pluto!  
Has a satellite  
Is this a planet?  
What about Sedna?

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What about the other KBOs? Are they planets

#### Largest known trans-Neptunian objects (TNOs)

Dysnomia

Nix

Charon

Hydra

Namaka

Hi'iaka

Eris

Pluto

Makemake

Haumea

Sedna

Orcus

2007 OR<sub>10</sub>

Weywot

Quaoar

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