Lecture

Uranus, Neptune and Pluto

Objectives

• Overview of features of Uranus, Neptune, and Pluto

References: http://pds.jpl.nasa.gov/planets/

Notes

Uranus

• Profile

Distance from the Sun (location): 20 AU
Mean radius (size): about 4 Earth radius (slightly more than Neptune)
Mass: about 14 Earth mass (slightly less than Neptune)
Orbital period: about 84 Earth years
Orbital inclination: 0.8 degrees (low)
Orbital eccentricity: 0.047 (low)
Axial inclination (season): 97.9 degrees (rotate on its back, no sunrise or sunset)
Axial rotational period (related to length of day): 0.718 Earth day

• Overview of geological features

— Atmosphere: The cloud top is made of methane. Uranus gets its blue-green color from methane gas above the deep cloud layer (methane absorbs red light and reflects blue light).

— Internal structure: The outermost layer is made of gaseous hydrogen and helium. Because of much lower internal pressure, hydrogen cannot turn into metallic inside Uranus. The bulk (80% or more) of the mass of Uranus is contained in an extended liquid layer consisting primarily of icy material. There may be a denser core made of rocky/icy material.

— Satellites: Miranda is the innermost of the five large Uranian satellites. Its surface is composed mostly of rolling cratered plains. The bright V-shaped feature in the grooved area has been nicknamed the “Chevron”. Half of Miranda’s surface is younger and consists of complex sets of parallel and intersecting scarps and ridges. Coronae, large oval racetrack-like regions, are thought to have been formed by a combination of tectonic and volcanic activities.

Ariel is the second largest satellite. Its surface shows craters, global fracturing, and eruption of icy volcanic fluid.

Umbriel is darker than other Uranian satellites. How its ancient cratered surface was darkened remains a mystery.

Titania is the largest satellite of Uranus. It is covered by small craters, none of them appears to be larger than 50 km across. There are also extensive series of chasms (valleys), some 5 km deep.

Oberon is the outermost moon. It shows several large impact craters surrounded by bright rays, and a large mountain about 6 km high.

Uranus’ ring system appears very faint because the rings are composed mainly of rocks or organic carbon. They are much less reflective than icy particles that make Saturnian rings.

• Outstanding features

— spin on its back
— appear like a blue ping pong ball
— magnetic filed displaced from the center; dipole axis significantly tilted from rotational axis
Neptune

• Profile
Distance from the Sun (location): 30 AU
Mean radius (size): nearly 4 Earth radius (slightly less than Uranus)
Mass: nearly 17 Earth mass (slightly more than Uranus)
Orbital period: about 164 Earth years
Orbital inclination: 1.8 degrees (low)
Orbital eccentricity: 0.009 (nearly circular)
Axial inclination (season): 29.6 degrees
Axial rotational period (related to length of day): 0.671 Earth day

• Overview of features
— Atmosphere: The cloud top is made of methane and hydrocarbon. It shows a lot more structure than that of Uranus. The Great Dark Spot is a major cyclone like the Great Red Spot of Jupiter. The white patches are believed to be methane ice.

— Internal Structure: Very similar to that of Uranus, with a gaseous layer of hydrogen and helium at the top, an icy layer in the middle, and possibly a rocky/icy layer at the center.

— Satellite: Its satellites are expected to be covered with a layer of ice. Triton is the largest satellite of Neptune. It is a bit smaller than our Moon. Geologically, its surface is quite complex, covered by craters, fractures (chasms), and flood plains (lake-like features). One peculiar feature of Triton is that it has retrograde orbit. This led to the suggestion that Triton may be a captured moon.

Proteus is a strangely shaped, tiny, dark body. Nereid is similar to Proteus in size.

There are three narrow rings made of dark particles like the rings of Uranus.

• Outstanding features
— Great Dark Spot
— magnetic field displaced from the center; dipole axis significantly tilted from rotational axis
— Triton has a retrograde orbit, and is the coldest body found in the Solar System.
**Pluto**

- **Profile**
  - Distance from the Sun (location): 40 AU
  - Mean radius (size): nearly 1/6 Earth radius
  - Mass: nearly 0.2% Earth mass
  - Orbital period: about 248 Earth years
  - Orbital inclination: 17.1 degrees (high)
  - Orbital eccentricity: 0.249 (high)
  - Axial inclination (season): 119.6 degrees (retrograde, spins on its back like Uranus)
  - Axial rotational period (related to length of day): 6.39 Earth day

- **Overview of features**
  - Atmosphere: Its surface is probably covered with frozen nitrogen (~97%), methane and carbon dioxide ices (~2%) and water ice (the rest).
  - Internal Structure: By analogy with Ganymede and based on its mean density, it probably has a layer of water ice about 400 km thick and a silicate core about 800 km in radius.
  - Satellite: Charon is the only satellite that has been discovered so far. Pluto and Charon are comparable in size. They are locked into an orbit such that both objects show the same hemisphere to each other at all times. Some scientists suggested that they may represent a binary planet system.

- **Outstanding features**
  - Highly eccentric and inclined orbit; its status as the 9th planet is questionable
  - Pluto and Charon may be a binary system