

NEPTUNE

Voyager 2 completed its 12-year tour of the solar system with an investigation of Neptune and the planet's moons. On August 25, 1989, the spacecraft swept to within 4,850 kilometers (3,010 miles) of Neptune and then flew on to the moon Triton. During the Neptune encounter, it became clear that the planet's atmosphere was more active than Uranus'.

Voyager 2 observed the Great Dark Spot, a circular storm the size of Earth, in Neptune's atmosphere. Resembling Jupiter's Great Red Spot, the storm spins counterclockwise and moves westward at almost 1,200 kilometers (745 miles) per hour. Voyager 2 also noted a smaller dark spot and a fast-moving cloud dubbed the "Scooter," as well as high-altitude clouds over the main hydrogen and helium cloud deck. The highest wind speeds of any planet were observed, up to 2,400 kilometers (1,500 miles) per hour.

Like the other giant planets, Neptune has a gaseous hydrogen and helium upper layer over a liquid interior. The planet's core contains a higher percentage of rock and metal than those of the other gas giants. Neptune's distinctive blue appearance, like Uranus' blue color, is due to atmospheric methane.

Neptune's magnetic field is tilted relative to the planet's spin axis and is not centered at the core. This phenomenon is similar to Uranus' magnetic field and suggests that the fields of the two giants are being generated in an area

above the cores, where the pressure is so great that liquid hydrogen assumes the electrical properties of a metal. Earth's magnetic field, on the other hand, is produced by its spinning metallic core and is only slightly tilted and offset relative to its center.

Voyager 2 also shed light on the mystery of Neptune's rings. Observations from Earth indicated that there were arcs of material in orbit around the giant planet. It was not clear how Neptune could have arcs and how these could be kept from spreading out into even, unclumped rings. Voyager 2 detected these arcs, but they were in fact part of thin, complete rings. A number of small moons could explain the arcs, but such bodies were not spotted.

Astronomers had identified the Neptunian moons Triton in 1846 and Nereid in 1949. Voyager 2 found six more. One of the new moons, Proteus, is actually larger than Nereid, but since Proteus orbits close to Neptune, it was lost in the planet's glare for observers on Earth.

Triton circles Neptune in a retrograde orbit in under six days. Tidal forces on Triton are causing it to spiral slowly towards the planet. In 10 to 100 million years (a short time in astronomical terms), the moon will be so close that Neptunian gravity will tear it apart, forming a spectacular ring to accompany the planet's modest current rings.

Triton's landscape is as strange and unexpected as those of Io and Miranda. The moon has more rock than its counterparts at Saturn and Uranus. Triton's mantle is probably composed of water-ice, but its crust is a thin veneer of nitrogen and methane. The moon shows two dramatically different types of terrain: the so-called "Icantaloupe" terrain and a receding ice cap.

Dark streaks appear on the ice cap. These streaks are the fallout from geyser-like volcanic vents that shoot nitrogen gas and dark, fine-grained particles to heights of 2-8 kilometers (1-5 miles). Triton's thin atmosphere, only 1/70,000th as thick as Earth's, has winds that carry the dark particles and deposit them as streaks on the ice cap, the coldest surface yet discovered in the solar system (-235 degrees Celsius, -391 degrees Fahrenheit). Triton might be more like Pluto than any other object spacecraft have so far visited.

* Cloud patterns were detected in the atmosphere of Neptune by ground-based observations in 1978.

* Uranus and Neptune are often thought of as a pair, because of their great distance from the Sun and their similarities in size and color. But already scientists expect that Neptune will be vastly different from any of the other planets yet studied. * Although Neptune is the fourth largest planet, it is invisible to the naked eye because it orbits in the outer regions of the solar system, 4 1/2 billion kilometers (nearly 3 billion miles) from the Sun. (In fact, Neptune is currently the farthest planet from the Sun since the early 1970s, Pluto has been closer to the Sun than Neptune has, and it will remain so until the end of this century.)

* At this distance, Neptune receives nearly 1,000 times less sunlight than Earth, and about two and one-half times less than Uranus, but its overall temperature is about the same as that of Uranus. Therefore, scientists believe that Neptune must have some internal heat of its own, as do Jupiter and Saturn.

* Neptune's seasons last more than 40 years. Its rotational axis is tilted about

30 degrees to the plane of its orbit around the Sun (Earth's axis tilts 23.5 degrees). At this phase in Neptune's sojourn around the Sun, it is summer in the southern hemisphere and there is continuous daylight at the south pole, while the north pole is cloaked in darkness.

* Both planets rotate at about the same rate (Uranus' internal rotation rate is 17 hours 14 minutes, while Neptune's atmospheric rotation rate is between 17 and 18 hours. Rotation rates of planets can be measured in two ways: by tracking cloud features in the atmosphere or by monitoring the radio emissions generated by electrons spiraling into the planet's magnetic field. Radio emissions give the rotation rate of the bulk of the planet because the magnetic field is generated in the planet's interior.

* Measurements obtained by tracking cloud features include the additional effects of atmospheric winds. As Voyager 2 nears Neptune, the planetary radio astronomy experiment will determine the rotation rate of the planet's interior.

* With an equatorial diameter of about 49,400 kilometers (30,700 miles), Neptune is only slightly smaller than Uranus. But Neptune is denser, indicating that it must contain a larger quantity of heavier materials than does Uranus.

* Like Uranus, Neptune is believed to be composed primarily of rock and melted ice, mixed with hydrogen and helium. The combination of infrared and radio observations will provide a measurement of the relative amounts of helium and hydrogen in Neptune as compared with the amounts in the other gaseous outer planets and the Sun.

* Despite Neptune's remoteness, astronomers have been able to learn a few

things about the planet's atmosphere. (Light emitted and reflected from an atmosphere contains information about the atmosphere's chemistry and composition.) At times, high-resolution images taken from Earth-based telescopes indicate the existence of thin atmospheric hazes over major portions of the planet. The haze, which comes and goes in a matter of days or weeks, may consist of methane ice crystals.

* If there are methane clouds on Neptune, they probably condense at a pressure of about 2 bars (twice the atmospheric pressure at sea level on Earth) and a temperature of about 85 kelvins (-305° F). Voyager 2's radio signals can probe to a pressure level of 3 to 5 bars, so there is a good chance of detecting the base of the methane clouds, which will indicate the amount of methane in Neptune's atmosphere. Although other cloud layers, including water-ice clouds, are expected deeper in the atmosphere, Voyager 2 will not be able to detect them. While the spacecraft is in Neptune's shadow, it will maneuver to precisely track the outer edge of the planet to enable Voyager's radio signal to probe Neptune's atmosphere.

* There is evidence that Neptune has a magnetic field, as do Mercury, Earth, Jupiter, Saturn, and Uranus. Voyager 2 is not likely to penetrate the planet's magnetosphere until the last day before the spacecraft's closest approach to the planet.

RING ARCS

* Jupiter, Saturn, and Uranus are encircled by ring systems, but Neptune's rings may be a series of ring arcs.

* A classic technique in identifying ring systems is to monitor the brightness of a star as a planet's ring region passes in front of (occults) the star as seen by the observer. Rings may be deduced if the starlight blinks off and on in a regular pattern on both sides of the planet. However, the effects that may be due to ring material near Neptune have been seen in only about 7 percent of the occultation studies to date, and never has the same ring been seen on both sides of the planet. Pieces of rings, or ring arcs, could explain these results.

* Currently, scientists believe that there may be three narrow (8- to 20-kilometer or 5- to 12-mile) near-circular sets of arcs in or near Neptune's equatorial plane at distances of 17,000 to 42,000 kilometers (10,500 to 26,100 miles) from the planet's cloud tops. The size of particles comprising these rings could range from tiny dust particles to pebbles.

* Voyager 2's flight path carried the spacecraft close to the outermost set of possible ring arcs. As at Uranus, there is likely to be diffuse material that could fill much of the space within the ring arc region. Although such a diffuse sheet of material is not expected outside the area of the possible ring arcs, the flight path can be adjusted as late as 10 days before the closest approach to Neptune, should more-distant ring arcs be discovered. Several ring observations will be retargeted if individual ring arcs are located in images taken as the spacecraft approaches the planet. Retargeting to these ring arcs can take place as late as a day or two before closest approach.

* As the spacecraft passes behind the rings, changes in the radio signal will be analyzed to determine the sizes of the particles and the structure of the rings.

- * Neptune is named for the Roman god of the sea. Neptune's symbol is the fishing spear.
- * This is the eighth planet from the Sun.
- * Neptune is the smallest of the gas planets.
- * Neptune circles the Sun every 164.1 Earth years.
- * One day on Neptune is 16 hours and 7 minutes.
- * The gravity on Neptune is 1.15 of Earth's gravity.
- * The diameter of the Neptune is 30,780 miles.
- * Neptune was discovered in 1846; this was the first time a planet was found by mathematical calculations.
- * Neptune is a twin planet to Uranus.
- * Neptune's bluish-green color is caused by methane gas (natural gas).
- * Neptune's atmosphere is made up of hydrogen, helium, and methane.
- * Neptune has three rings.
- * Neptune has eight moons (Triton, Nereid and six others).
- * Neptune's moon Triton is slowly spiralling in toward the planet.
- * Triton is the only large satellite with retrograde orbital motion (east to west), and with the same face toward the planet (synchronous rotation).
- * Neptune receives 900 times less sunlight than Earth, less than half of Uranus,

but Neptune's temperature is the same as Uranus.

- * Voyager 2 will fly-by the planet on August 25, 1989.

- * Neptune's Great Dark Spot is reminiscent of Jupiter's hurricane-like storms and is large enough to contain the entire Earth.

- * Neptune's moon Triton shows evidence of a remarkable geological history, and Voyager 2 images show active geyser-like eruptions spewing invisible nitrogen gas and dark dust particles several kilometers into space.

- * Triton has a minimal atmosphere (1/70,000 of surface pressure on Earth).

Source: NASA