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News

Neptune begins to give up its secrets

Scientists have discovered how fast the Solar System's outermost planet rotates, but it still holds many mysteries.

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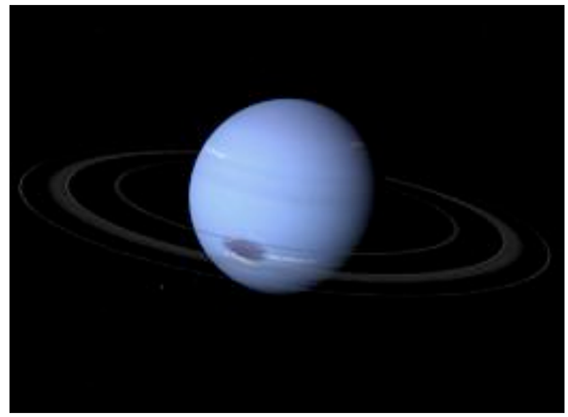

Neptune's hidden surface made determining the length of its day difficult.

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Next week, Neptune will complete its first full orbit of the Sun since it was discovered in 1846.

The blue planet, the farthest out in the Solar System, remains one of Earth's most mysterious neighbours, but scientists now know one thing that they hadn't for the past 165 years: the precise length of its day.

Earlier estimates had set that figure at about 16 hours and 6 minutes. But, in a paper in *Icarus*[1], Erich Karkoschka, a planetary scientist at the University of Arizona in Tucson, now pegs it at 15 hours, 57 minutes and 59 seconds.

Determining the day length of rocky bodies such as Mars or Mercury is easy, because scientists can look at their surfaces, in photos or radar images, and track the motion of easily identifiable features.

But Neptune is made mostly of thick clouds of gas, so it has no visible surface. The only visible features are storms, the apparent motion of which results from a mixture of the planet's rotation and shifting weather fronts. Until now, the best estimate of the planet's day length came from radio signals measured during a 1989 flyby by the NASA spacecraft Voyager 2. But studies of Saturn have since indicated that such signals are not as clearly tied to the planet's rotation as was once thought.

Karkoschka went back to basics. Poring over archived images from the Hubble Space Telescope, he found that Neptune has two cloud disturbances, dubbed the South Polar Feature and the South Polar Wave, that seem to be linked to surface features deep beneath the clouds, probably a hot spot on the planet's solid core.

"The best analogue is clouds moving over a mountain," says Karkoschka. "Each cloud moves, so if you track them you don't get the rotation. But the feature as a whole remains stable."

By painstakingly plotting the positions of the two features in 500 images taken by the Hubble Space Telescope over the course of two decades, Karkoschka was able to pin down the planet's day length to an accuracy of 0.0002 of an hour. To put this into perspective, even with the Cassini probe in orbit around Saturn, the planet's day length is known only with an order of magnitude less certainty, he says.

Knowing a planet's rotation rate to such high precision isn't just interesting information — it has practical applications, too. "It constrains models of Neptune's interior," says Karkoschka. "If you know how fast the planet rotates, you can determine the mass distribution inside."

It is also intriguing that Neptune has atmospheric features so strongly linked to its solid interior. "Nothing similar has been seen before on any of the four giant planets," says Karkoschka.

Planetary puzzles

Neptune still holds many mysteries. In fact, Karkoschka's finding itself raises a new one: the source of the heat that produces the recurring cloud disturbances.

Another, says Sushil Atreya, a planetary scientist at the University of Michigan, Ann Arbor, is the source of Neptune's magnetic field. Such fields on Jupiter and Saturn are believed to result from the movement of metallic hydrogen, produced inside the gassy planets at pressures of several million times that of Earth's atmosphere. But Neptune is smaller than Jupiter or Saturn, with lower internal pressures. "Metallic-hydrogen formation in Neptune is unlikely," says Atreya.

There is also the question of why Neptune exists at all.

The planet is 30 times further from the Sun than is Earth. That far out, planet-formation models suggest that the solar nebula, from which planets condensed during the formation of the Solar System, should have been very diffuse, says Francis Nimmo, a planetary scientist at the University of California, Santa Cruz. So scientists believe that Neptune formed closer to the Sun, where the nebula was denser, then moved outwards. But many Neptune-mass planets in other planetary systems seem to have migrated inwards, rather than outwards, says Nimmo.

Atreya says that understanding these "hot Neptunes" elsewhere in the Universe requires a better understanding of why our own large planets have ended up so far from the Sun.

"The mystery of Neptune transfers to hundreds of exoplanets that superficially seem similar to Neptune," says Geoffrey Marcy, an astronomer at the University of California, Berkeley, who hunts for planets outside the Solar System.

Atreya adds that the solution to these mysteries will be best obtained by sending entry probes and orbiters to Neptune at some point in the future.

Preferably before the planet makes another full orbit of the Sun.

References

1. Karkoschka, E. *Icarus* **doi:10.1016/j.icarus.2011.05.013** (2011).

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It will be Monday evening (11th July), at around 22:00 U.T.

Calculations & reasoning here: http://bit.ly/neptuneorbit

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