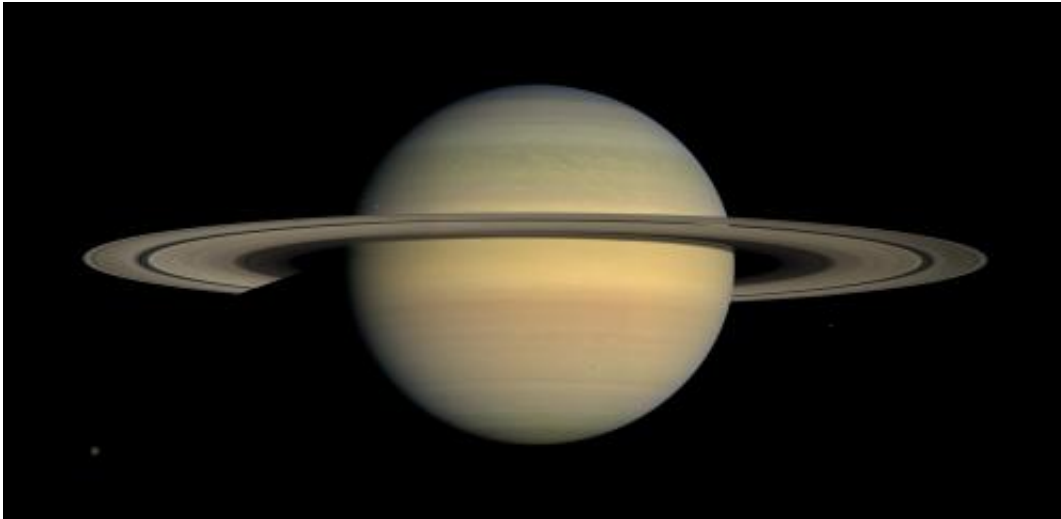


A new spin on Saturn's peculiar rotation

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Saturn as seen by the Cassini spacecraft. Credit: NASA/JPL/Space Science Institute

Tracking the rotation speed of solid planets, like the Earth and Mars, is a relatively simple task: Just measure the time it takes for a surface feature to roll into view again. But giant gas planets Jupiter and Saturn are more problematic for planetary scientists, as they both lack measureable solid surfaces and are covered by thick layers of clouds, foiling direct visual measurements by space probes. Saturn has presented an even greater challenge to scientists, as different parts of this sweltering ball of hydrogen and helium are known to rotate at different speeds, whereas its rotation axis and magnetic pole are aligned.

A new method devised by Tel Aviv University researcher Dr. Ravit

Helled, published recently in *Nature*, proposes a new determination of Saturn's rotation period and offers insight into the internal structure of the planet, its weather patterns, and the way it formed. The method, by Dr. Helled of the Department of Geosciences at TAU's Raymond and Beverly Sackler Faculty of Exact Sciences and Drs. Eli Galanti and Yohai Kaspi of the Department of Earth and Planetary Sciences at the Weizmann Institute of Science, is based on Saturn's measured [gravitational field](#) and the unique fact that its east-west axis is shorter than its north-south axis.

According to the new method, Saturn's day is 10 hours, 32 minutes and 44 seconds long. When the researchers applied their method to Jupiter, whose rotation period is already well known, the results were identical to the conventional measurement, reflecting the consistency and accuracy of the method.

Between sunup and sundown on Saturn

For years, scientists have had difficulty coming up with a precise measurement of Saturn's rotation. "In the last two decades, the standard rotation period of Saturn was accepted as that measured by Voyager 2 in the 1980s: 10 hours, 39 minutes, and 22 seconds," said Dr. Helled. "But when the Cassini spacecraft arrived at Saturn 30 years later, the rotation period was measured as eight minutes longer. It was then understood that Saturn's rotation period could not be inferred from the fluctuations in radio radiation measurements linked to Saturn's magnetic field, and was in fact still unknown." The Cassini spacecraft had measured a signal linked to Saturn's magnetic field with a periodicity of 10 hours, 47 minutes and 6 seconds long—slower than previous recordings.

"Since then, there has been this big open question concerning Saturn's rotation period," said Dr. Helled. "In the last few years, there have been different theoretical attempts to pin down an answer. We came up with

an answer based on the shape and gravitational field of the planet. We were able to look at the big picture, and harness the physical properties of the planet to determine its rotational period."

Helled's method is based on a statistical optimization method that involved several solutions. First, the solutions had to reproduce Saturn's observed properties (within their uncertainties): its mass and gravitational field. Then the researchers harnessed this information to search for the rotation period on which the most solutions converged.

Narrowing the margin of error

The derived mass of the planet's core and the mass of the heavy elements that make up its composition, such as rocks and water, are affected by the rotation period of the planet.

"We cannot fully understand Saturn's internal structure without an accurate determination of its rotation period," said Dr. Helled. Knowledge of Saturn's composition provides information on giant planet formation in general and on the physical and chemical properties of the solar nebula from which the solar system was formed.

"The rotation period of a giant planet is a fundamental physical property, and its value affects many aspects of the physics of these planets, including their interior structure and atmospheric dynamics," said Dr. Helled. "We were determined to make as few assumptions as possible to get the rotational period. If you improve your measurement of Saturn's gravitational field, you narrow the error margin."

The researchers hope to apply their method to other gaseous planets in the solar system such as Uranus and Neptune. Their new technique could also be applied in the future to study gaseous planets orbiting other stars.

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