Saturn's bulging core implies moons younger than thought

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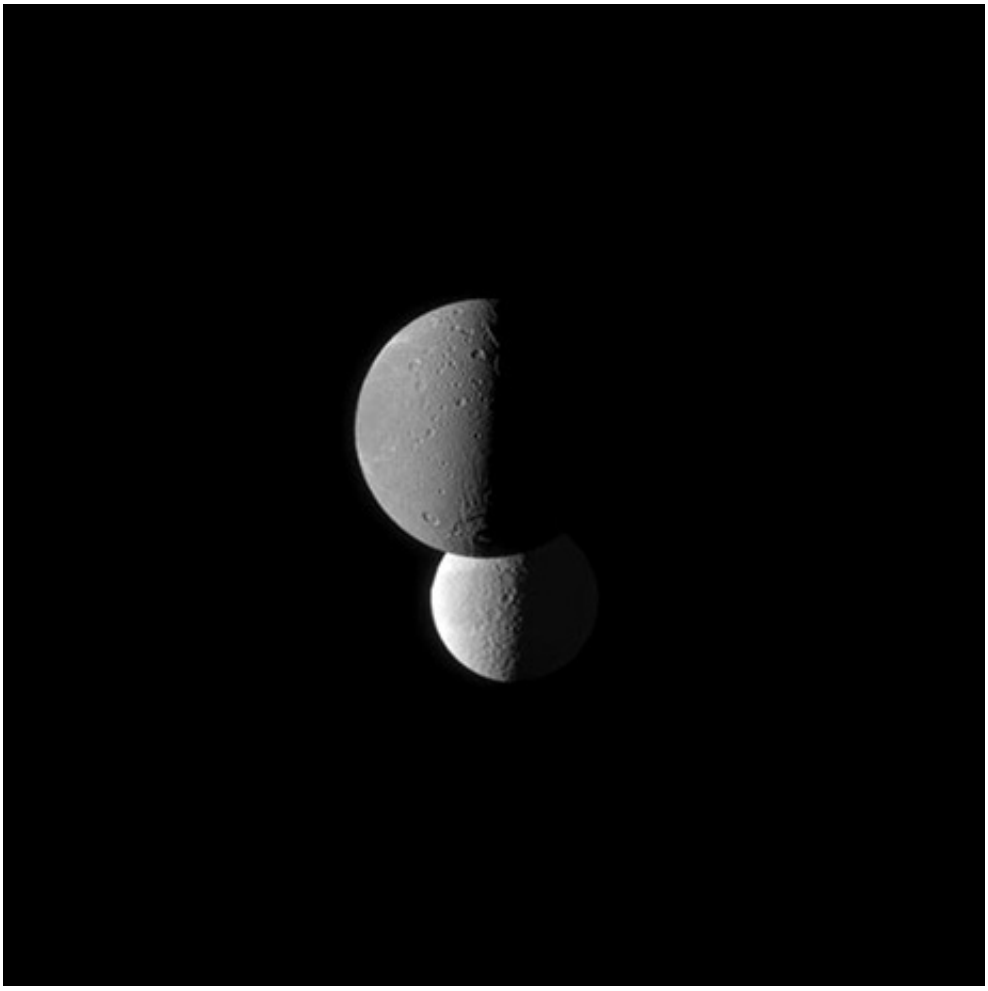

Saturn's moon Dione, foreground, appears darker than the moon Tethys because it has a lower surface albedo, as shown in a photograph taken from the Cassini spacecraft on March 23, 2010. At the time, Cassini was about 746,000 miles from Dione and about 1.1 million miles from Tethys. Credit: NASA/Jet Propulsion Lab

Freshly harvested data from NASA's Cassini mission reveals that Saturn's bulging core and twisting gravitational forces offer clues to the ages of the planet's moons. Astronomers now believe that the ringed planet's moons are younger than previously thought.

"All of these Cassini mission measurements are changing our view of the Saturnian system, as it turns our old theories upside down. It takes one good spacecraft to tell us how wrong we were in the past," said Radwan Tajeddine, Cornell research associate in astronomy and a member of the European-based Encelade (pronounced en-CELL-ad) scientific team that pored over the Cassini data and published a paper in the astronomy journal *Icarus* (January 2017).

The Encelade team – lead by Valéry Lainey of the Paris Observatory – provided two key measurements in the research, "New Constraints on Saturn's Interior From Cassini Astrometric Data." The scientists measured Saturn's Love number (the rigidity of a planet) for the first time and confirmed Saturnian moons move away from the planet at a faster rate than expected. (Most moons, including Earth's moon, move away from their parent planet.)

Using photographic images taken from century-old glass negatives and Cassini spacecraft observations, the group measured the Love number – named for Augustus E.H. Love, a famed British mathematician who studied elasticity – that describes the rigidity of the tidal bulge and the dissipation factor, which controls the speed at which moons move away.

While Saturn is mostly a gigantic shroud of liquid hydrogen and liquid helium, it contains a rocky core – about 18 times the size of Earth, which responds to tidal forces from all of Saturn's major moons by bulging. The forces of the bulging core, in turn, push the moons slightly away.

"Those two parameters – the Love number and dissipation factor – are

difficult to separate," Tajeddine said.

So the team detected and examined the orbits of four tiny moons associated with the larger moons Tethys (Telesto and Calypso) and Dione (Helene and Polydeuces). While these tiny moons do not affect the tidal forces on Saturn, their orbits are disturbed by Saturn's core tidal bulges.

"By monitoring these disturbances, we managed to obtain the first measurement of Saturn's Love number and distinguish it from the planet's dissipation factor," Tajeddine said. "The moons are migrating away much faster than expected."

Tajeddine explains that if Saturn moons actually formed 4.5 billion years ago, their current distances from the home planet should be greater. Thus, this new research suggests, the moons are younger than 4.5 billion years, favoring a theory that the moons formed from Saturn's rings.

The team also found that Saturn moon Rhea is moving away 10 times faster than the other moons, which is the first evidence that a planet's dissipation factor can vary with its distance in relation to the moon. The scientists have no definitive explanation.

After 13 years of cruising around Saturn, to explore its rings and moons, NASA will program Cassini's grand finale – a flight through the planet's rings and a dive into its atmosphere – for September 2017. "What we believe about Saturn's moons history might still change in the coming years with the finale of the Cassini mission," said Lainey, who suggested, "The more we learn about Saturn, the more we learn about exoplanets."

More information: Valéry Lainey et al, New constraints on Saturn's interior from Cassini astrometric data, *Icarus* (2017). DOI: 10.1016/j.icarus.2016.07.014

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