A new spin on planet formation mysteries

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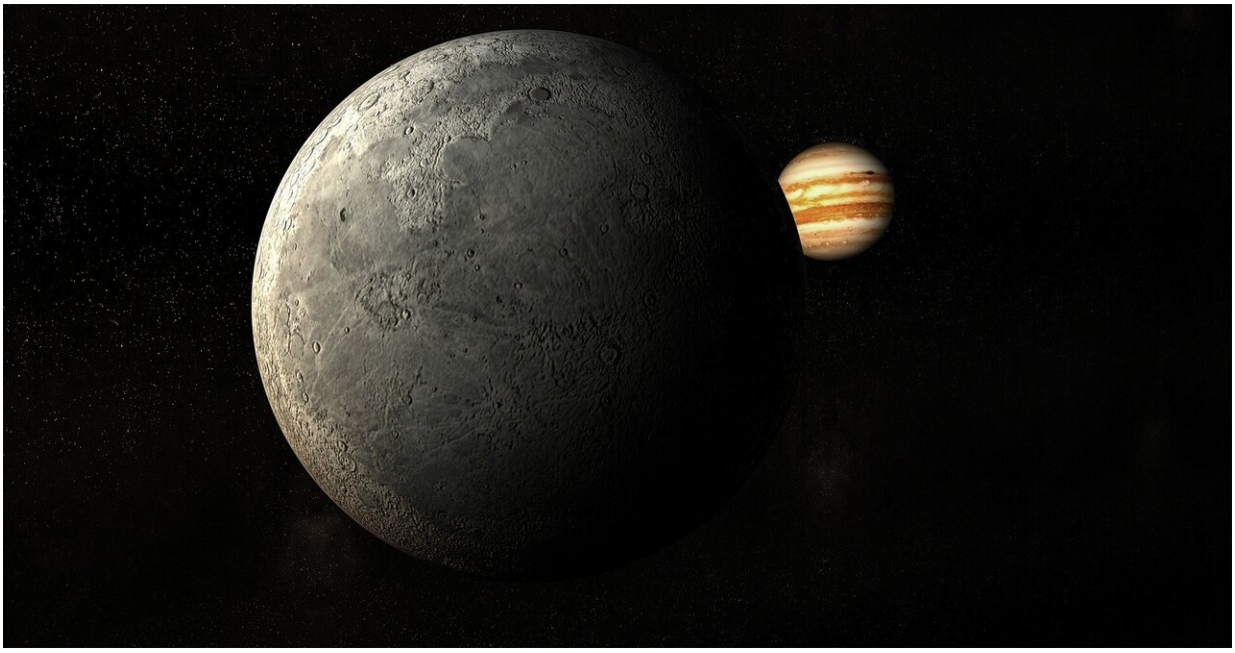

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Astronomers have captured the first-ever spin measurements of planets making up the HR 8799 star system.

Discovered in 2008 by the W. M. Keck Observatory and Gemini Observatory, which are both located in Hawaii, the HR 8799 star system is located 129 light-years away and has four so-called super-Jupiter planets, each more massive than Jupiter. HR 8799 is one of the first planetary systems to have its picture directly taken by a telescope.

However, none of the HR 8799 planets' rotation periods, or spin rates, had been measured—and in fact, the spin rate (which translates into the length of a day on the planet) has been measured for only a handful of the thousands of exoplanets so far discovered.

The breakthrough was made possible by a Caltech and Keck Observatory-led science and engineering team that developed an instrument called the Keck Planet Imager and Characterizer (KPIC). Commissioned between 2018 and 2020, the instrument can observe, with extremely high spectral resolution, exoplanets that were previously imaged. KPIC provides a resolution that is high enough to decipher how fast the planets are spinning.

A study about the findings has been accepted for publication in *The Astronomical Journal*; the work represents the first science results from KPIC.

The study showed that the minimum rotation speeds of two of the HR 8799 planets, known as HR 8799 d and HR 8799 e, are 10.1 kilometers per second (km/s) and 15 km/s, respectively. This translates to a length of day that could be as short as three hours or could be as long as 24 hours, as on Earth, depending on the tilts of the planets, which are currently undetermined. For context, Jupiter has a rotation speed of about 12.7 km/s, and one day on Jupiter lasts nearly 10 hours.

The team was also able to constrain the spin of a third planet, HR 8799 c, to an upper limit of less than 14 km/s. The rotation rate of the fourth planet, HR 8799 b, could not be conclusively determined.

Knowing the spin rates of planets provides important clues as to how they formed.

"With KPIC, we were able to obtain the highest spectral resolution

observations ever conducted of the HR 8799 exoplanets," says Jason Wang, the 51 Pegasi b Postdoctoral Scholar Research Associate in Astronomy at Caltech and lead author of the study. "This allows us to study them with finer granularity than ever before and unlocks the key to gaining a deeper understanding of not just how these four planets formed but how gas giants in general develop throughout the universe."

More information: Detection and Bulk Properties of the HR 8799 Planets with High Resolution Spectroscopy, arXiv:2107.06949v1 [astro-ph] arxiv.org/abs/2107.06949v1

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