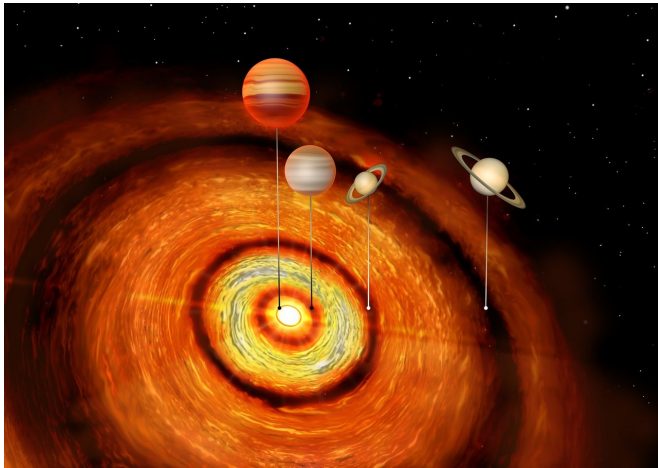


# Giant planets around young star raise questions about how planets form

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Credit: University of Cambridge

Researchers have identified a young star with four Jupiter and Saturn-sized planets in orbit around it, the first time that so many massive planets have been detected in such a young system. The system has also set a new record for the most extreme range of orbits yet observed: the outermost planet is more than a thousand times further from the star than the innermost one, which raises interesting questions about how such a system might have formed.

The star is just two million years old – a 'toddler' in astronomical terms – and is surrounded by a huge disc of dust and ice. This disc, known as a [protoplanetary disc](#), is where the planets, moons, asteroids and other astronomical objects in stellar systems form.

The star was already known to be remarkable because it contains the first so-called hot Jupiter—a massive planet orbiting very close to its parent star – to have been discovered around such a young star. Although hot Jupiters were the first type of exoplanet to be discovered, their existence has

long puzzled astronomers because they are often thought to be too close to their parent stars to have formed in situ.

Now, a team of researchers led by the University of Cambridge have used the Atacama Large Millimeter/submillimeter Array (ALMA) to search for planetary 'siblings' to this infant hot Jupiter. Their image revealed three distinct gaps in the disc, which, according to their theoretical modelling, were most likely caused by three additional [gas giant planets](#) also orbiting the young star. Their results are reported in the *Astrophysical Journal Letters*.

The star, CI Tau, is located about 500 light years away in a highly-productive stellar 'nursery' region of the galaxy. Its four planets differ greatly in their orbits: the closest (the hot Jupiter) is within the equivalent of the orbit of Mercury, while the farthest orbits at a distance more than three times greater than that of Neptune. The two outer planets are about the mass of Saturn, while the two inner planets are respectively around one and 10 times the mass of Jupiter.

The discovery raises many questions for astronomers. Around 1% of stars host hot Jupiters, but most of the known hot Jupiters are hundreds of times older than CI Tau. "It is currently impossible to say whether the extreme planetary architecture seen in CI Tau is common in hot Jupiter systems because the way that these sibling planets were detected—through their effect on the protoplanetary disc – would not work in older systems which no longer have a protoplanetary disc," said Professor Cathie Clarke from Cambridge's Institute of Astronomy, the study's first author.

According to the researchers, it is also unclear whether the sibling planets played a role in driving the innermost planet into its ultra-close [orbit](#), and whether this is a mechanism that works in making hot Jupiters in general. And a further mystery is

how the outer two planets formed at all.

"Planet formation models tend to focus on being able to make the types of planets that have been observed already, so new discoveries don't necessarily fit the models," said Clarke. "Saturn mass planets are supposed to form by first accumulating a solid core and then pulling in a layer of gas on top, but these processes are supposed to be very slow at large distances from the star. Most models will struggle to make planets of this mass at this distance."

The task ahead will be to study this puzzling system at multiple wavelengths to get more clues about the properties of the disc and its planets. In the meantime, ALMA – the first telescope with the capability of imaging [planets](#) in the making – will likely throw out further surprises in other systems, re-shaping our picture of how planetary systems form.

**More information:** C. J. Clarke et al. High-resolution Millimeter Imaging of the CI Tau Protoplanetary Disk: A Massive Ensemble of Protoplanets from 0.1 to 100 au, *The Astrophysical Journal* (2018). [DOI: 10.3847/2041-8213/aae36b](https://doi.org/10.3847/2041-8213/aae36b)

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