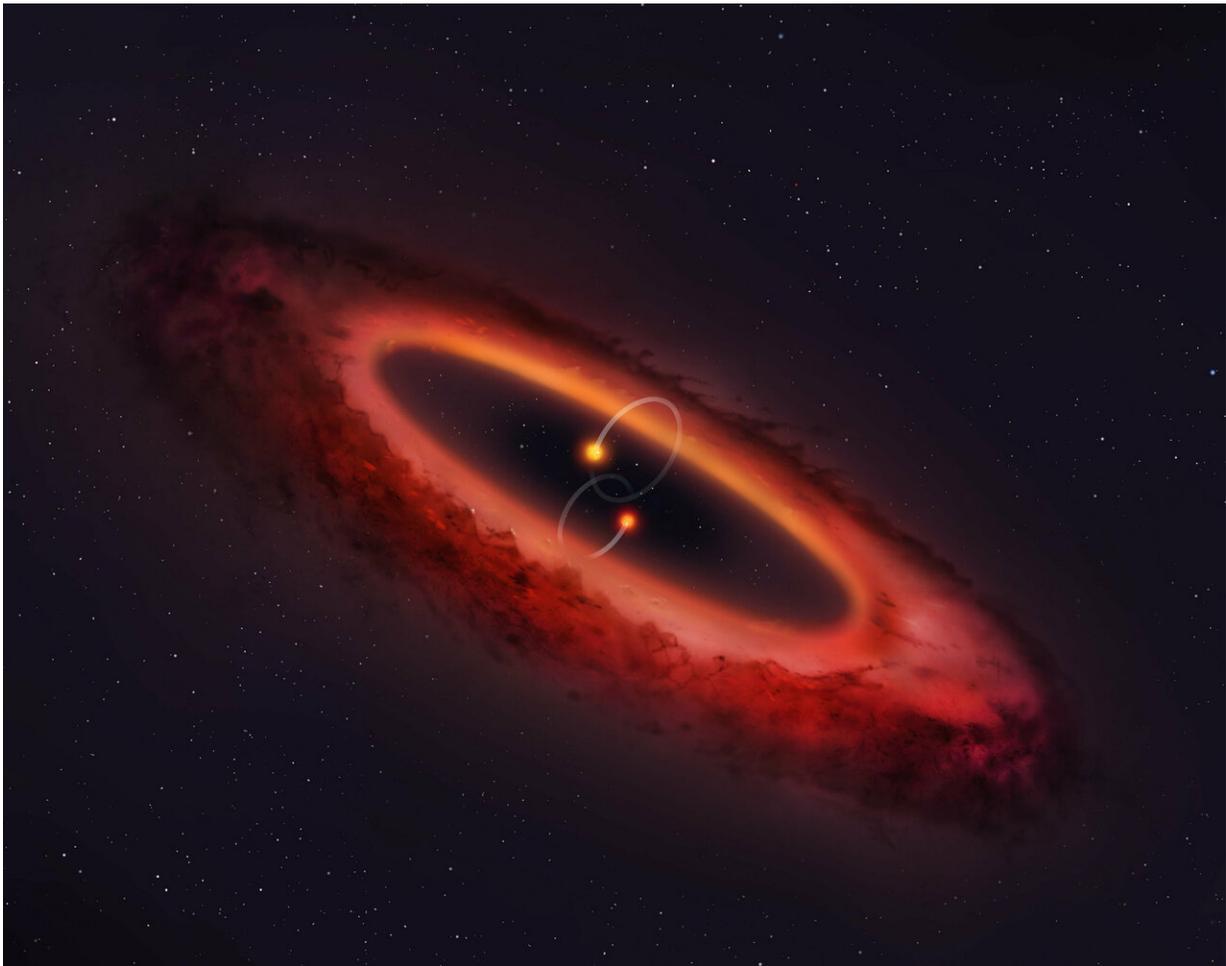


Double star system flips planet-forming disk into pole position

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Artist's impression of a view of the double star system and surrounding disc.
Credit: University of Warwick/Mark Garlick

New research led by an astronomer at the University of Warwick has found the first confirmed example of a double star system that has flipped its surrounding disc to a position that leaps over the orbital plane of those stars. The international team of astronomers used the Atacama Large Millimeter/sub-millimeter Array (ALMA) to obtain high-resolution images of the Asteroid belt-sized disc.

The overall system presents the unusual sight of a thick hoop of gas and dust circling at right angles to the binary star [orbit](#). Until now this setup only existed in theorists' minds, but the ALMA observation proves that polar discs of this type exist, and may even be relatively common.

The new research is published today (14 January) by Royal Society University Research Fellow Dr. Grant M. Kennedy of the University of Warwick's Department of Physics and Centre for Exoplanets and Habitability in *Nature Astronomy* in a paper entitled "A circumbinary protoplanetary disc in a polar configuration".

Dr. Grant M. Kennedy of the University of Warwick said:

"Discs rich in gas and dust are seen around nearly all young [stars](#), and we know that at least a third of the ones orbiting single stars form [planets](#). Some of these planets end up being misaligned with the spin of the star, so we've been wondering whether a similar thing might be possible for circumbinary planets. A quirk of the dynamics means that a so-called polar misalignment should be possible, but until now we had no evidence of misaligned discs in which these planets might form."

Dr. Kennedy and his fellow researchers used ALMA to pin down the orientation of the ring of gas and dust in the system. The orbit of the binary was previously known, from observations that quantified how the stars move in relation to each other. By combining these two pieces of information they were able to establish that the dust ring was consistent

with a perfectly polar orbit. This means that while the stellar orbits orbit each other in one plane, like two horses going around on a carousel, the disc surrounds these stars at right angles to their orbits, like a giant ferris wheel with the carousel at the centre.

Dr. Grant M. Kennedy of the University of Warwick added:



Artist's impression of the view from an orbiting planet. Credit: University of Warwick/Mark Garlick

"Perhaps the most exciting thing about this discovery is that the disc shows some of the same signatures that we attribute to dust growth in discs around single stars. We take this to mean planet formation can at least get started in these polar circumbinary discs. If the rest of the planet formation process can happen, there might be a whole population of misaligned [circumbinary planets](#) that we have yet to discover, and things like weird seasonal variations to consider."

If there were a planet or planetoid present at the inner edge of the dust ring, the ring itself would appear from the surface as a broad band rising almost perpendicularly from the horizon. The polar configuration means that the stars would appear to move in and out of the disc plane, giving objects two shadows at times. Seasons on planets in such systems would also be different. On Earth they vary throughout the year as we orbit the Sun. A polar circumbinary planet would have seasons that also vary as different latitudes receive more or less illumination throughout the binary orbit.

Co-author Dr. Daniel Price of Monash University's Centre for Astrophysics (MoCA) and School of Physics and Astronomy added:

"We used to think other solar systems would form just like ours, with the planets all orbiting in the same direction around a single sun. But with the new images we see a swirling disc of gas and dust orbiting around two stars. It was quite surprising to also find that that disc orbits at right angles to the orbit of the two stars.

"Incredibly, two more stars were seen orbiting that disc. So if planets were born here there would be four suns in the sky!

"ALMA is just a fantastic telescope, it is teaching us so much about how planets in other solar systems are born."

The research is supported by the Monash Warwick Alliance, established by the University of Warwick and Monash University in 2012 as a bold and innovative project to develop an Alliance with a breadth, scale and impact beyond standard practice in the sector.

More information: Grant M. Kennedy et al, A circumbinary protoplanetary disk in a polar configuration, *Nature Astronomy* (2019).
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