Concentric rings found in the debris disk of a young nearby star

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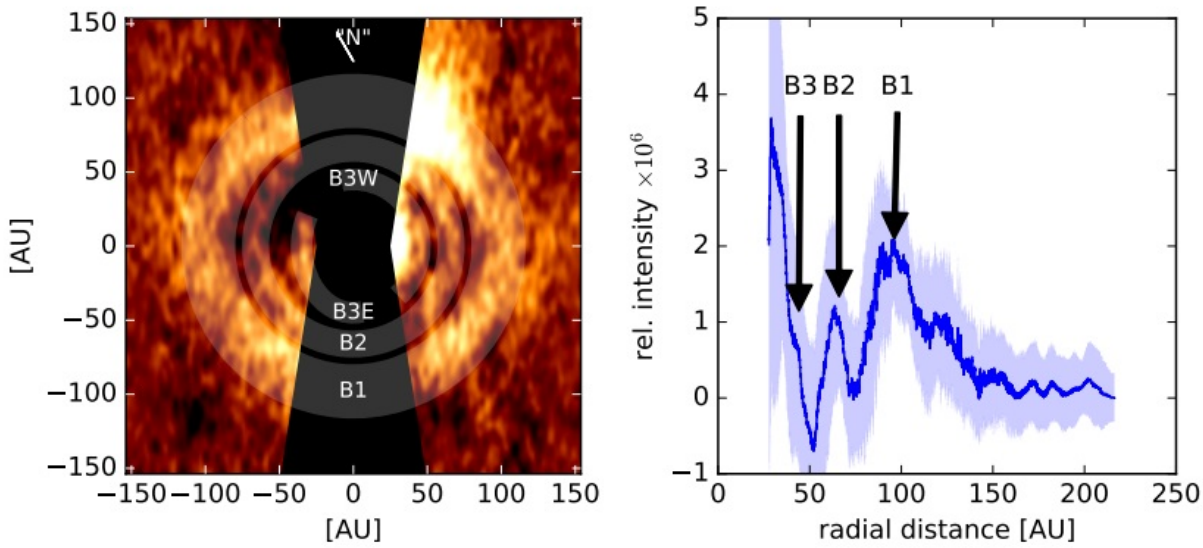

Structures detected in the disk of HIP 73145. Left: The features under discussion are denoted with semi-transparent rings and labeled B1, B2, B3E, and B3W. The black mask covers the area that is too close to the coronagraph and the large negative ADI artifacts. Right: Intensity of all pixels in the image to the left plotted versus their radial separation from the center. The dark blue line is formed by applying a 100 point wide running mean to all pixel intensities after sorting according to their distance to the center. The light-blue shaded area represents the standard deviation across 100 neighboring points at each separation. The two major features B1 and B2 are easily identified. The B3 feature is less obvious, as it is close to the inner edge of the usable area and not circular. Credit: Feldt et al., 2016.

(Phys.org)—An international team of researchers reports the discovery of a series of concentric rings in the debris disk around a young nearby star known as HIP 73145. These unusual substructures could provide new details about the evolution of circumstellar disks around young stars. The findings were presented in a paper published Dec. 22 on arXiv.org.

Located some 400 light years away, HIP 73145 (also known as HD 131835) is a 15-million-year-old star with a spectral type of A2IV. It belongs to the Upper Centaurus Lupus (UCL) moving group, which is part of the Scorpius–Centaurus association. The star is about 70 percent more massive than the sun and has a radius of 1.38 solar radii. Importantly, HIP 73145 is known to host a debris disk with a radius of approximately 96 AU.

HIP 73145's disk was first detected in scattered light in the near-infrared, and at far-infrared wavelengths in 2015. However, no substructures were spotted during these observations. This year also, a team of astronomers led by Markus Feldt of the Max Planck Institute for Astronomy in Heidelberg, Germany, has conducted a multi-wavelength observational campaign which allowed them to distinguish concentric rings in the star's debris disk.

These observations were carried out in May 2015 using the European Southern Observatory's extreme adaptive optics coronagraphic instrument, known as the Spectro-Polarimetric High-contrast Exoplanet REsearch (SPHERE). They were part of the SpHere INfrared survey for Exoplanets (SHINE) campaign aimed at the detection and characterization of extrasolar planets.

The researchers found a substructure of concentric rings around the star. They detected one ring inside the disk with a radius of 66 AU. Moreover, the team also spotted structures further in at 35 AU and 45

AU from the star.

"We report the results of an observation with SPHERE in non-polarized scattered light in the H band. (...) We detect a bright ring of scattered light plus some secondary structures inside, at least one of them forming a secondary, concentric ring with the first. This is the first detection of this disk in total-intensity scattered light," the authors write.

According to the paper, these ring-like structures are most likely caused by planets or by dust-gas interactions. In the search for the most probable explanation, the researchers noted that the dust composition of the disk seems to be dominated by carbon and that the star retained a large amount of gas and dust despite of its age.

The team emphasized that the newly detected ring-like structures present questions regarding the nature of the object as a pure debris disk, since the gas and dust content would presumably offer sufficient explanations for such structures to form. However, it is still too soon to confirm which hypothesis is the most plausible.

"Whether the substructures in the HIP 73145 disk are caused by dynamical interactions with planets or by dust-gas interactions cannot be clarified in this paper," the team concluded.

More information: SPHERE/SHINE reveals concentric rings in the debris disk of HIP 73145, arXiv:1612.07621 [astro-ph.SR] arxiv.org/abs/1612.07621

Abstract
The debris disk of HIP73145 has been detected in scattered light in the near-IR, and at far-IR wavelengths before, but no substructure has been seen so far. Detection of such substructures in combination with detailed modeling can hint at the presence of perturbing planetary bodies, or

reveal other mechanisms acting to replenish gas and dust reservoirs and forming structures such as spirals or rings. We obtained multiwavelength images with SPHERE in the near-IR in the H2 and H3 bands with the IRDIS camera and a 0.95-1.35 micron spectral cube with the IFS. Data were acquired in pupil-tracking mode, thus allowing for angular differential imaging. The SPHERE standard suite of angular differential imaging algorithms was applied. ALMA Band 6 observations complement the SPHERE data. We detect a bright ring of scattered light plus more structures inside, at least one of them forming a secondary, concentric ring with the first. This is the first detection of this disk in total-intensity scattered light. A second object is detected in the field at high contrast but concluded to be a background star. Forward modeling yields information on the primary parameters of the disk and confirms that the detected substructures are not due to the data analysis approach, which sometimes leads to spurious structures. We detect a series of concentric rings in the disk around HIP73145. This is one of the rare cases where multiple components are necessary to fit the SED and are also detected in scattered light. The presence of such ring structures somewhat questions the nature of the object as a pure debris disk, but the gas and dust content would presumably offer sufficient explanations for such structures to form.