Astronomers detect a circumbinary disk around the system Oph-IRS67AB

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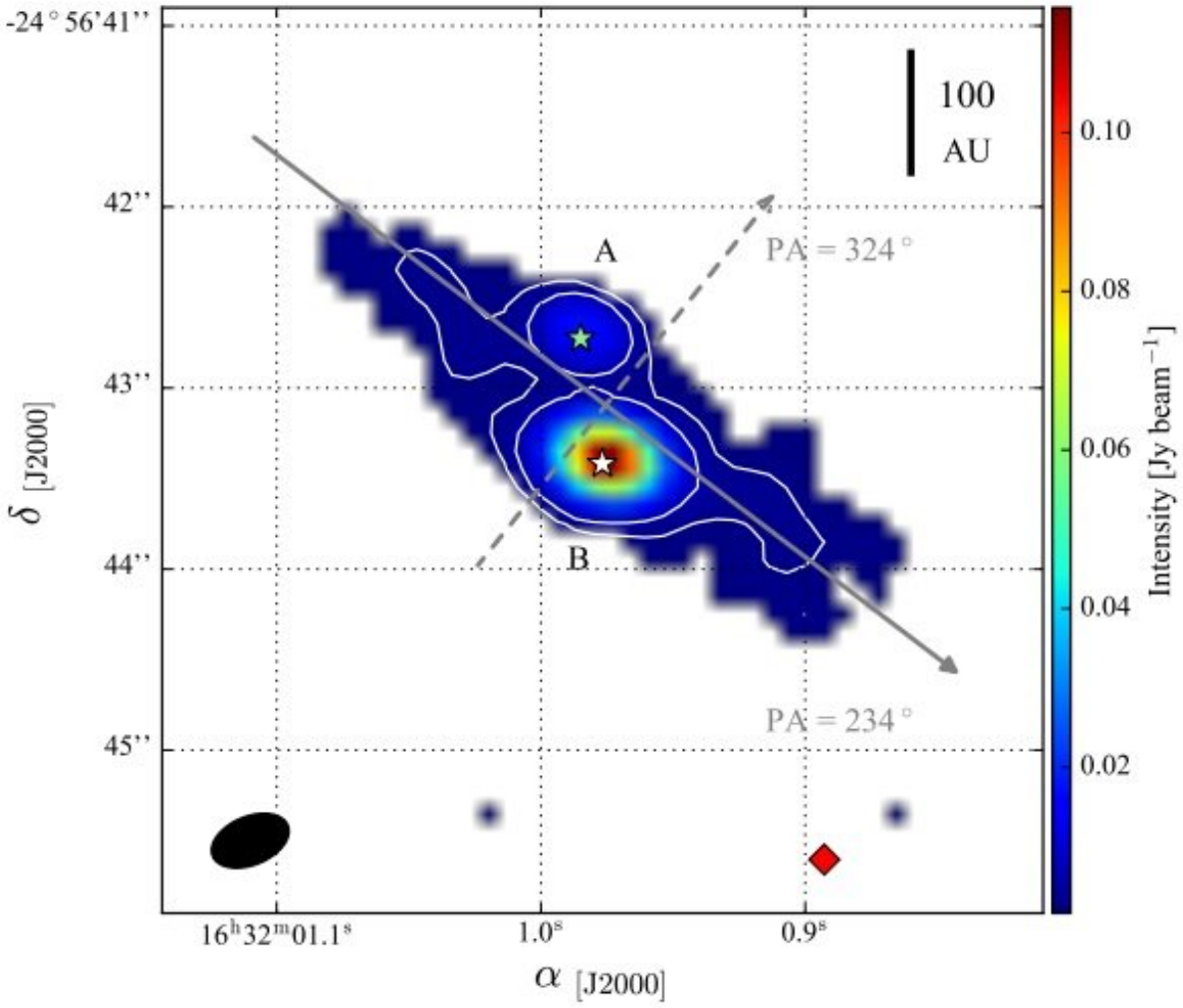

Continuum emission above 4σ in color scale and specific values of 7 and 15σ in white contours. The synthesised beam is represented by the black filled ellipse. The grey solid and dashed arrows cross at the geometric centre and they represent the direction of and perpendicular to the disk-like structure,

respectively. The green and white stars show the positions of Oph-IRS67A and OphIRS67B, respectively. The red diamond denotes the location of the offset region. Credit: De la Villarmois et al., 2018.

An international team of astronomers has discovered a circumbinary disk around the system Oph-IRS67AB and analyzed its chemistry as well as physical properties. The finding is detailed in a paper published February 26 on the arXiv pre-print repository.

Circumbinary disks are accretions of matter composed mainly of gas, dust, planetesimals and asteroids that orbit both the primary and secondary stars in binary systems. Given that astronomers have recently started detecting extrasolar worlds around binary systems, finding and studying such disks could improve the understanding of planetary formation scenarios.

Now, a group of researchers led by Elizabeth Artur de la Villarmois of the University of Copenhagen, Denmark, reports the finding of a circumbinary disk around the binary named Oph-IRS67AB. The system, located some 500 light years away in the Ophiuchus constellation, is composed of Oph-IRS67A and Oph-IRS67B, separated from each other by about 90 AU.

Using the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile, the team observed Oph-IRS67AB in mid-2015. The observations allowed the astronomers to detect the presence of a circumbinary disk around this system and to reveal its properties.

"The purpose of this paper is to present the detection of a circumbinary disk around the system Oph-IRS67 and analyze its chemical and physical structure. (…) The continuum emission agrees with the position of Oph-

IRS67 A and B, and reveals the presence of a circumbinary disk around the two sources," the researchers write in the paper.

The study reveals that the disk has a size of 620 by 124 AU, an inclination of about 80 degrees and an estimated mass of most likely 2.2 solar masses. The derived parameters indicate that this disk is about three times larger than typical circumbinary disks.

The researchers found that the system's high-density region, spatially offset from the two stars, shows strong emission from carbon chain molecules (C_2H and $c–C_3H_2$). They assume that this emission could be related to the inner envelope material, for instance outflow cavity, spiral-arm structures or infalling material from the envelope to the circumbinary disk.

"The high-density region shows a different chemistry than the disk, being enriched in carbon chain molecules," the paper reads.

Furthermore, the astronomers found that there is no methanol emission in the system, which may be caused by the presence of the disk. They also revealed that sulfur dioxide transition is optically thick, shows compact emission, and is detected only around Oph-IRS67B.

In concluding remarks, the authors of the paper noted that observation of other molecules and more transition from carbon chain molecules in the binary are required to uncover more details about the high-density region. Moreover, higher-angular-resolution observations could reveal further insights into the nature of the circumstellar disks around each source and explain the chemical differences seen between them. According to the researchers, the Oph-IRS67AB system is also an ideal candidate for proper motion studies and planet formation.

More information: Chemistry of a newly detected circumbinary disk

in Ophiuchus, arXiv:1802.09286 [astro-ph.SR]
arxiv.org/abs/1802.09286

Abstract
Astronomers recently started discovering exoplanets around binary systems. Therefore, understanding the formation and evolution of circumbinary disks is crucial for a complete scenario of planet formation. The aim of this paper is to present the detection of a circumbinary disk around Oph-IRS67 and analyse its structure. We present high-angular-resolution (0.4", 60 AU) observations of C17O, H13CO+ , C34S, SO2, C2H and c-C3H2 molecular transitions with ALMA at 0.8 mm. The spectrally and spatially resolved maps reveal the kinematics of the circumbinary disk as well as its chemistry. Molecular abundances are estimated using RADEX. The continuum emission reveals the presence of a circumbinary disk around the two sources. This disk has a diameter of ~620 AU and is well traced by C17O and H13CO+ emission. C2H and c-C3H2 trace a higher-density region which is spatially offset from the sources (~430 AU). Finally, SO2 shows compact emission around one of the sources, Oph-IRS67 B. The molecular transitions which trace the circumbinary disk are consistent with a Keplerian profile on disk scales (200 AU). The Keplerian fit leads to a mass of 2.2 Msun. Inferred CO abundances w.r.t. H2 are comparable to the canonical ISM value of 2.7e-4. This study proves the first detection of the circumbinary disk associated with Oph-IRS67. The disk is chemically differentiated from the nearby high-density region. The lack of methanol emission suggests the extended disk dominates the mass budget in the inner- most regions of the protostellar envelope, generating a flat density profile where less material is exposed to high temperatures. Thus, complex organic molecules would be associated with lower column densities. Finally, Oph-IRS67 is a promising candidate for the detection of both circumstellar disks with higher-angular-resolution observations.