Astronomers discover new brown dwarf with quasi-spherical mass loss

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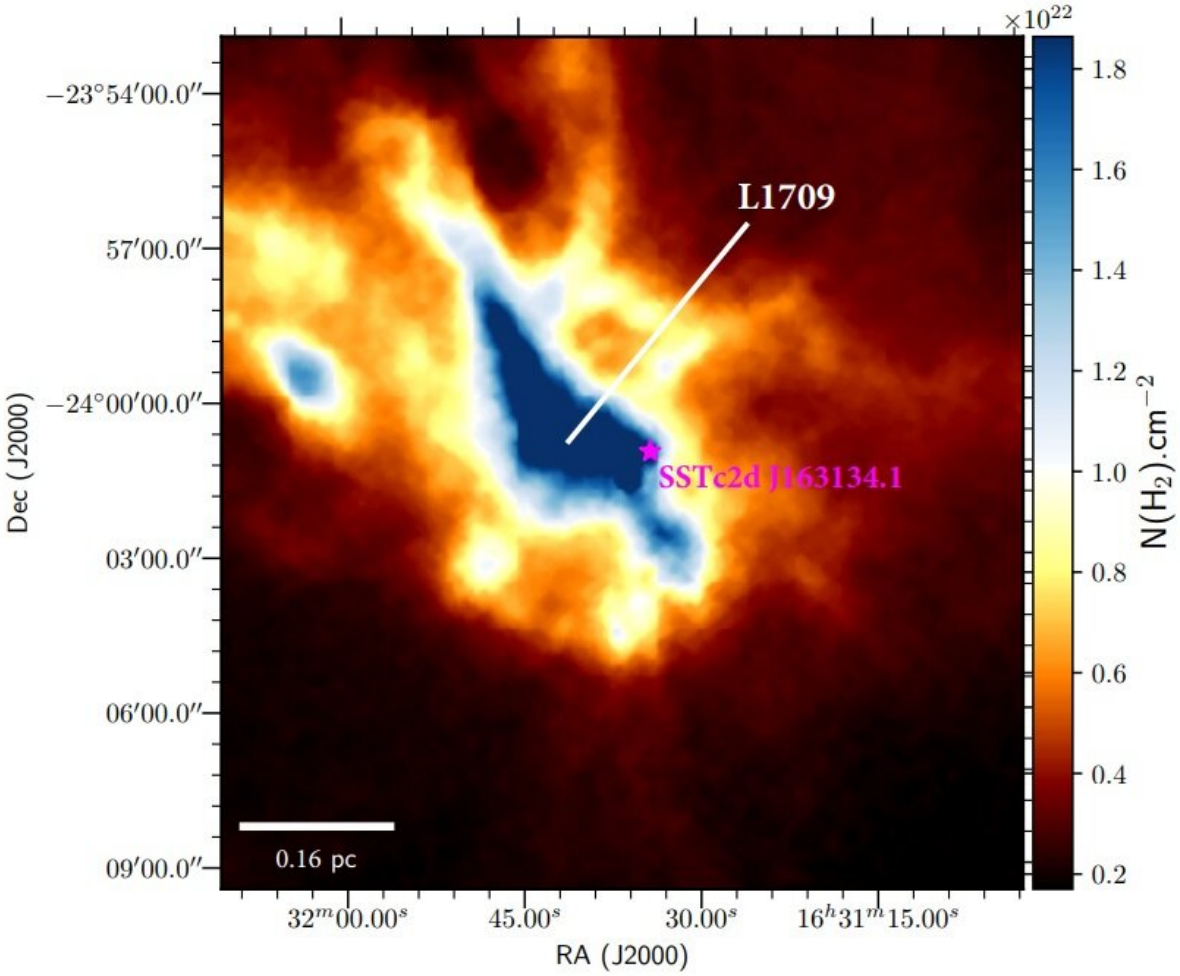

Herschel column-density map of the Ophiuchus molecular cloud. The magenta star indicates the location of SSTc2d J163134.1. The Lynds L1709 dark cloud in the region is indicated. Credit: Ruiz-Rodriguez et al., 2022.

Astronomers report the detection of a new brown dwarf as part of the Ophiuchus Disk Survey Employing ALMA (ODISEA) program. The newfound object, designated SSTc2d J163134.1-24006, appears to be experiencing a quasi-spherical mass loss. The discovery was detailed in a paper published September 2 on the arXiv pre-print repository.

Brown dwarfs are intermediate objects between planets and stars, occupying the mass range between 13 and 80 Jupiter masses (0.012 and 0.076 solar masses). They can burn deuterium but are unable to burn regular hydrogen, which requires a minimum mass of at least 80 Jupiter masses and a core temperature of about 3 million K.

A team of astronomers led by Dary Ruiz-Rodriguez of the National Radio Astronomy Observatory (NRAO) in Charlottesville, Virginia, have investigated SSTc2d J163134.1-24006, initially identified as a faint stellar object, under the ODISEA project, which is dedicated to study the entire population of protoplanetary disks in the Ophiuchus Molecular Cloud. They found that SSTc2d J163134.1-24006 is most likely a brown dwarf with a mass of about 0.05 solar masses, and an elliptical shell of carbon monoxide (CO).

"SSTc2d J163134.1 was observed as part of the 'Ophiuchus Disk Survey Employing ALMA' (ODISEA) program (Project ID: 2016.1.00545.S PI: L. Cieza). ALMA Band 6 (1.3 mm) observations were performed on April 27 and August 22, 2018, during Cycle 5 using the C43-3 configuration (15–500 m baselines)," the researchers wrote in the paper.

First of all, the team serendipitously discovered an expanding shell of carbon monoxide ejected from an object, with a temperature below 3,000 K, located in the direction of the Ophiuchus Molecular Cloud. Further observations revealed that this shell is associated with SSTc2d J163134.1.

In order to explain the nature of SSTc2d J163134.1 and its expanding shell, Ruiz-Rodriguez's team considered various scenarios, including the inside-out collapse of a dense molecular core in the Ophiuchus cloud, the mass loss of a giant star in the distant background, or a shell of gas expelled from a young brown dwarf. According to the researchers, the most plausible one is the brown dwarf hypothesis.

"We conclude that the source is not a giant star in the distant background (>5–10 kpc) and is most likely to be a young brown dwarf in the Ophiuchus cloud, at a distance of just ~139 pc," the astronomers explained.

Given that emission of carbon monoxide from SSTc2d J163134.1 has an elliptical shape, it was noted that this makes it the first brown dwarf known to exhibit a quasi-spherical mass loss. The authors of the paper assume that a deuterium flash could be responsible for this phenomenon, but more detailed theoretical work is required in order to verify this explanation.

More information: Dary A. Ruíz-Rodríguez et al, Discovery of a brown dwarf with quasi-spherical mass-loss. arXiv:2209.00759v1 [astro-ph.SR], arxiv.org/abs/2209.00759

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