Researchers study complex morphology of the protoplanetary disc around star MWC 758

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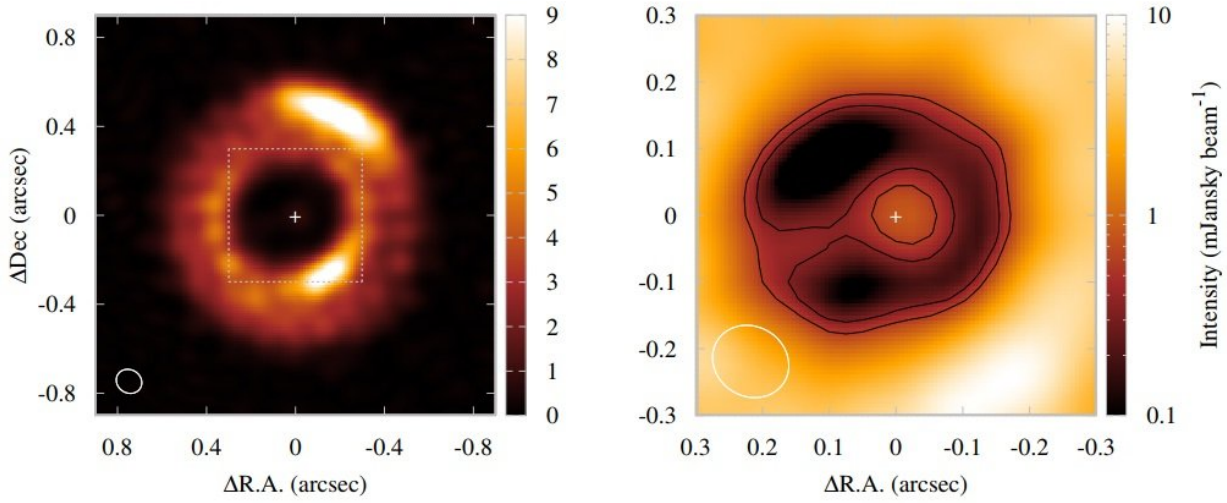

ALMA images of MWC 758. Left: Map of the dust continuum emission obtained using super-uniform weighting. Right: Map of the disk cavity in logarithmic scale. Credit: Boehler et al., 2017.

Using the Atacama Large Millimeter Array (ALMA) in Chile, an international team of researchers has studied the disc surrounding the star MWC 758. The new observations reveal further insights into the

complex morphology of this disc. The study was presented in a paper published December 23 on arXiv.org.

Located some 500 light years away from the Earth, MWC 758 (also known as HD 36112) is a young Herbig Ae star, known to have a circumstellar disc around it. The disc is about 3.5 million years old and has an accretion rate of approximately 100 millionth of a solar mass per year.

What is so special about MWC 758's disc is its complex morphology. It has a large cavity of a few tens of AU in radius, asymmetries in the dust continuum emission and two spiral arms seen in near-infrared scattered light that might be spiral density waves launched by planets of a few Jupiter masses.

Now, a team of astronomers led by Yann Boehler of the Rice University in Houston, Texas, presents the results of ALMA observations conducted in order to obtain more detailed information about the morphology of MWC 758's disc. The observations were carried out in September 2015 in an angular resolution of 0.1″ to 0.2″, what provided new insights into the disc morphology.

"Our new observations image the MWC 758 system in both the dust continuum emission, at a wavelength of about 0.88 millimeter, and in the 13CO and C18O J = 3-2 emission lines. The observations achieve a resolution of 0.1″-0.2″, or 15-30 AU according to the distance of the system, which corresponds to a factor 4 of improvement with respect to previous millimeter-wave observations, and reveal unprecedented details of the disc morphology," the researchers wrote in the paper.

According to the study, the disc's cavity, which might contain a mildly inner warped disc, has a radius of roughly 40 AU. The scientists detected dust emission at millimeter wavelengths what suggests the presence of

the inner disc. They also found a twist in the velocity curves in the cavity, as well as indications of a shadow projected toward the west outer region, what indicates that this inner disc could be mildly warped.

Beyond this cavity, the outer disc features two large dust clumps at 47 and 82 AU that form a double-ring structure. The clumps are associated with elongated structures which are tracing the double-ring structure.

Furthermore, ALMA observations revealed the two spirals previously detected in near-infrared and two arc-like features, which were also found by previous near-infrared studies.

The researchers concluded that the complex morphology of MWC 758's disc could be explained by the existence of two massive planets orbiting the star.

"Our observations are consistent with the existence of two massive planets. A planet in the inner region of the disc which carves the cavity, and another planet in the outer regions to produce the spirals and the dark ring between the two dust clumps," the authors of the paper concluded.

More information: The complex morphology of the young disk MWC 758: Spirals and dust clumps around a large cavity, arXiv:1712.08845 [astro-ph.EP] arxiv.org/abs/1712.08845

Abstract
We present Atacama Large Millimeter Array (ALMA) observations at an angular resolution of 0.1-0.2" of the disk surrounding the young Herbig Ae star MWC 758. The data consist of images of the dust continuum emission recorded at 0.88 millimeter, as well as images of the 13CO and C18O J = 3-2 emission lines. The dust continuum emission is characterized by a large cavity of roughly 40 au in radius which might

contain a mildly inner warped disk. The outer disk features two bright emission clumps at radii of about 47 and 82 au that present azimuthal extensions and form a double-ring structure. The comparison with radiative transfer models indicates that these two maxima of emission correspond to local increases in the dust surface density of about a factor 2.5 and 6.5 for the south and north clump, respectively. The optically thick 13CO peak emission, which traces the temperature, and the dust continuum emission, which probes the disk midplane, additionally reveal two spirals previously detected in near-IR at the disk surface. The spirals seen in the dust continuum emission present, however, a slight shift of a few au towards larger radii and one of the spirals crosses the south dust clump. Finally, we present different scenarios in order to explain the complex structure of the disk.