Circumbinary Molecular Rings around Young Stars in Orion‡‡

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Abstract

We present high angular resolution 1.3 mm continuum, methyl cyanide molecular line, and 7 mm continuum observations made with the Submillimeter Array and the Very Large Array toward the most highly obscured and southern part of the OMC1S or Orion-S region. OMC1S is located behind the Orion Nebula. We find two flattened and rotating molecular structures with sizes of a few hundred astronomical units suggestive of circumbinary molecular rings produced by the presence of two stars with very compact circumstellar disks with sizes and separations of about 50 AU associated with the young stellar objects 139-409 and 134-411. Furthermore, these two circumbinary rotating rings are related to two compact and bright hot molecular cores. The dynamic mass of the binary systems obtained from our data are ~1.3 M̄ for 139-409 and 0.5 M̄ for 134-411. This result supports the idea that intermediate-mass stars will form through circumstellar disks and jets/outflows, as the low mass stars do. Furthermore, when intermediate-mass stars are in multiple systems they seem to form a circumbinary ring similar to those seen in young, multiple low-mass systems (e.g., SS 29 and UY Aur).

Introduction

The OMC1S or Orion-S is the “twin” dusty massive molecular core of the Orion BN-KL core. It is located almost at the same angular distance from the “Trapezium” as Orion BN-KL (+1°) but to the southwest of the former. The OMC1S region has a mass of about 100 M[☉] similar to that reported for BN-KL, but with a bolometric luminosity of ~10^6 L[☉] which is a factor of 10 less. This difference in luminosity might be attributed to OMC1S being less evolved than Orion BN-KL, as inferred if one compares the molecular line emission from both. While the massive stars forming in OMC1S might reach their final masses and shine with much larger luminosity than now, this possible evolutionary scheme has been also suggested to be taking place in the NGC2024 region.

In this paper we present the possible presence of two circumbinary molecular rotating rings located in the OMC1S region with sizes of a few hundred Astronomical Units (AU) around two very compact circumstellar disks and that are associated with intermediate-mass (proto)stars.

Observations

The observations were made with the Submillimeter Array (SMA: The Submillimeter Array is a joint project between the Smithsonian Astrophysical Observatory and the Academia Sinica Institute of Astronomy and Astrophysics, and is funded by the Smithsonian Institution and the Academia Sinica) and The Very Large Array of the NRAO (The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.), centered at 1.3 mm and in the molecular line CH3CN, and 7 mm, respectively.

Results

The SMA 1.3 mm continuum observations revealed a group of dusty and highly obscured objects in southernmost region of OMC1S, while the molecular observations (CH3CN) revealed two flattened and rotating molecular objects associated with the sources 139-409 and 134-411, and that in addition are associated with groups of water masers (see Figures 1, 2 and 4). These sources are related with two strong hot molecular cores (Zapata et al. in prep.). The physical parameters of these structures are given in Table 1.

In conclusion, we interpret the flattened molecular structures associated with the sources 139-409 and 134-411 as two circumbinary molecular rings around two very massive stars. The very compact structures located on the center of the hot cores 139-409 and 134-411. These sources tentatively support the idea that intermediate-mass stars are in multiple systems. The physical parameters of these circumstellar disks and jets/outflows, as the low mass stars do.