Substellar-Mass Condensations in Prestellar Cores

NAKAMURA, Fumitaka
(NAOJ)

TAKAKURA, Shigehisa
(ASIAA)

KAWABE, Ryohei
(NAOJ/Joint-ALMA Observatory)

We present combined Submillimeter-Array (SMA) + single-dish images of the (sub)millimeter dust continuum emission toward two prestellar cores SM1 and B2-N5 in the nearest star cluster forming region, ρ Ophiuchus. Our combined images indicate that SM1 and B2–N5 consist of three and four condensations, respectively, with masses of 10^{-2}–10^{-1} $M_\odot$ and sizes of a few hundred AU. The individual condensations have mean densities of 10^8–10^9 cm^{-3} and the masses are comparable to or larger than the critical Bonner-Ebert mass, indicating that the self-gravity plays an important role in the dynamical evolution of the condensations. The coalescence timescale of these condensations is estimated to be about 10^4 yr, which is comparable to the local gravitational collapse timescale, suggesting that merging of the condensations, instead of accretion, plays an essential role in the star formation process.

These results challenge the standard theory of star formation, where a single, rather featureless prestellar core collapses to form at most a couple of condensations, each of which potentially evolves into a protostar that is surrounded by a rotating disk where planets are created.
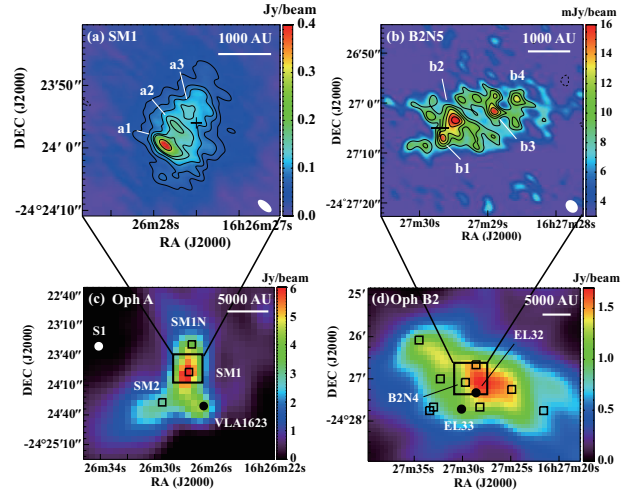

Figure 1: (a) Combined SCUBA and SMA image toward SM1. The contour levels are −20, 60, 80, 100, 130, 160, and 320 mJy/beam. The cross is the position of SM1 identified by Motte et al. (1998). The alphabets designate the identified condensations. (b) Combined AzTEC/ASTE and SMA image toward B2–N5. The contour levels are −3, 8, 10, 12, 14, and 16 mJy/beam. The cross is the position of B2-N5 identified by Friesen et al. (2010). (c) the SCUBA 850 μm continuum image toward the Oph A region (Johnstone 2000). The white and black filled circles are the B star, S1, and the prototypical Class 0 YSO, VLA 1623, respectively. The positions of some submillimeter continuum sources are indicated by the squares (Motte et al. 1998). (d) the AzTEC/ASTE 1.1 mm continuum image toward the Oph B2 region. The black filled circles are the positions of Class I YSOs, EL32 and EL33. In panels (a) and (b), the synthesised beams are shown in the lower right of the panels.

Reference

[1] Nakamura, F., Takakuwa, S., Kawabe, R.: 2012, *ApJ*, **758**, 25.