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Multiple star formation of a starless core in the Orion A cloud

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Abstract. We have investigated a starless dense core (TUKH122) with ALMA 3 mm continuum. This core is a part of a filament in the Orion A cloud and is suggested to be on the verge of star formation because the turbulence is almost completely dissipated and this core is the most chemically evolved core among starless cores in the Orion A cloud. By combining ALMA and ACA data, we recovered the extended emission with high angular resolution of $\sim 5''$. We found that ALMA+ACA data can only recover 30% of the total flux by comparing with the *Herschel* 250 μm observations. The single dish observations will be important for nearby clouds. Interestingly, we found column density variations along the filament, which are fitted by sinusoidal motions with a interval of 0.035 pc. This separation is consistent with the OMC-3, one of the active star forming region in the Orion A cloud. We suggest that the filamentary structure and its gravitational instability are important to form stars simultaneously.

1. Introduction

We have investigated the chemical evolutionary stages of dense cores in the Orion A cloud using carbon chains of CCS and HC_3N and N-bearing molecules of N_2H^+ and NH_3. We suggest that the column density ratios of carbon chain molecules to N-bearing molecules are indicators of the chemical evolution (e.g., Ohashi et al. 2014, 2016). TUKH122 is the most chemically evolved core among starless cores in the Orion A cloud. This is located in southern part of the Orion A and a part of a filament revealed by Herschel 250 μm dust observations. We found no association with protostars and/or star formation activities toward this core referred to Megeath et al. (2012) and Da Rio et al. (2016). Furthermore, VLA NH_3 observations shows a linewidth of ~ 0.2 km s^{-1} toward the core indicating the turbulence is almost dissipated.

2. Observation

TUKH122 was observed with the ALMA 12-m Array on 2016 March 10-12 in the C36-2/3 configuration with a total of 38 antennas and with the 7-m Array of the Atacama Compact

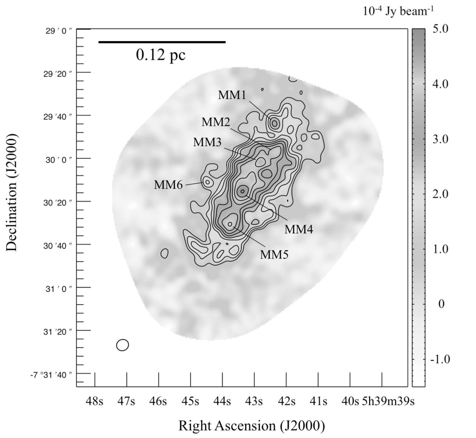

Fig. 1. The ALMA-ACA combined 3 mm dust continuum image without the primary beam correction.

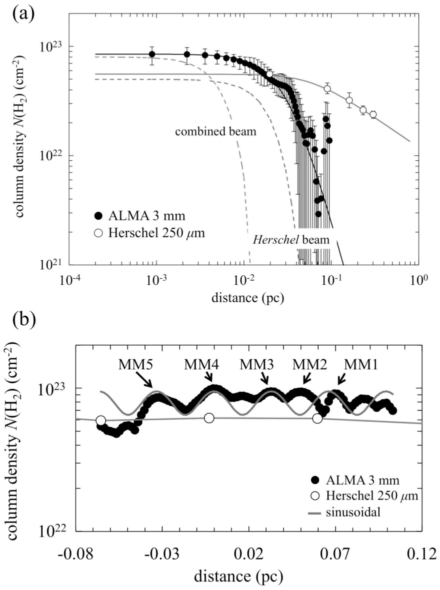

Fig. 2. (a) The column density profile perpendicular to the filament direction taken by ALMA-ACA observations and *Herschel* 250 μm observations. Error bars show the maximum and minimum distributions of the profiles in each region. The lines represent the Plumber like function with the power laws of 4.0 and 1.6, respectively. (b) The maximum column density profile along the filament taken by ALMA-ACA observations and the *Herschel* 250 μm observations.

Array. All images were reconstructed with the CASA task CLEAN using natural weighting.

3. Results and discussion

We combine the ALMA 12-m and ACA in the uv plane (Figure 1). The contours start at 3σ with intervals of 1σ. The 1σ noise level is 0.4 μJy beam^{-1} and the beamsize is $5''.7\times5''.2$ (PA= $-66°$).

Figure 2 (a) shows the column density profiles perpendicular to the filament. The profile is calculated by averaging the column densities at a distance from the peak position with $15''$ width to the south-westen direction. The *Herschel* observations recover extended emission at a distance larger than 0.1 pc, while ALMA-ACA observations only detect dense gas within 0.1 pc.

Figure 2 (b) shows the column density profiles taken from the maximum position along the filament direction. The reference position here is the MM4 condensation corresponding to the peak flux in the ALMA-ACA observations. The *Herschel* single dish observations indicate almost flat density structure due to the large beamsize.

On the other hand, the ALMA-ACA observations show column density variations. The line represents a sinusoidal column-density variation with an interval of 0.035 pc to visually match the observed variations. The southern part (MM3, 4, and 5) seems to be nicely fitted by this sinusoidal variation.

References

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