Testing Dust-Surface Formation Model of Prebiotic Molecule CH_3NCO in Star-Forming Cores Sagittarius B2 (M) and (N)

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Origin of organic molecules on Earth is discussed to be interstellar clouds, because comets carried molecules produced in clouds. Methyl isocyanate CH_3NCO is presumably one of the delivered organic molecules at the primitive earth. This molecule was firstly detected in the the (N) core of the Galactic Center star-forming region Sagittarius (Sgr) B2 [1]. Recently, the theoretical studies have suggested that this molecule is formed on dust surface in molecular cloud [2]. If that is the case, CH_3NCO abundantly desorbs from dust surface as hot gas in a central region of a star-forming core and slightly exists in an outer region as cold gas.

To examine an outer region of a star-forming core, we observed the (M) core in Sgr B2 with the 45-m telescope of Nobeyama Radio Observatory. Rotational transitions of CH_3NCO were firstly detected in this region. The abundance ratio and the rotational temperature are derived to be $[CH_3NCO]/[HNCO] = 0.03 \pm 0.01$ and $T_{rot} = 28 \pm 6$ K, respectively.

To examine temperature and distribution of CH_3NCO, the archival data toward the (N1) core of Sgr B2 observed by ALMA were investigated in the 94–113 GHz region. Considering intensity maps and velocity structures, a compact distribution having a clumpy toroidal structure was firstly imaged by CH_3NCO showing high temperature of ~60 K, as shown in Fig. 1. These results suggest a hot and abundant condition of this molecule in the central region of the core. Hence, CH_3NCO and/or its precursors are likely to be produced on dust surface.

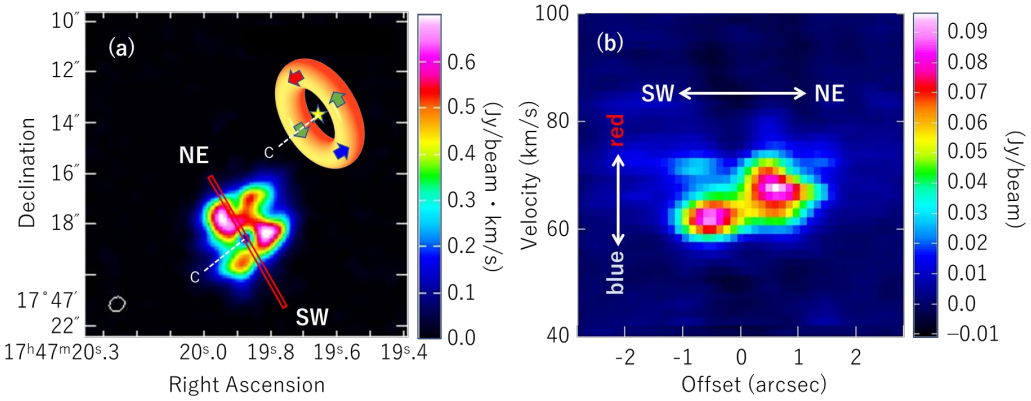

Figure 1: The integrated intensity map of the $J_{Ka,Kc} = 11_{1,10}–10_{1,9}$ line of CH_3NCO (a) and its position velocity map (b). The illustration in (a) shows an expected toroidal structure. The map (b) is sampled in the red square of (a).

References

[1] Halfen et al., 2015, ApJL, 812, L5. [2] e.g., Majumdar et al., 2018, MNRAS, 473, L59.