Innermost Envelope Structure of B335 Traced by Complex Organic Molecules

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B335 is an isolated low-mass protostellar source (Class 0) without influences of other star-forming regions. We have been studying the chemical characteristics of this source as a testbed of chemical evolution of a protostellar core. With ALMA, we found a hot corino in the closest vicinity (r~10 au) of the protostar by detecting various complex organic molecules (COMs) such as $HCOOCH_3$ and CH_3OCH_3. B335 also shows an association of abundant carbon-chain molecules at a larger (r~1000 au) scale, which is a typical feature of warm carbon-chain chemistry (WCCC). Thus B335 has a hybrid (hot corino chemistry and WCCC) chemical character[1].

Recently, we explored the structure of the innermost envelope of this source, where hot corino chemistry is seen, at an angular resolution of 0.1" (10 au) with ALMA. Using the emission lines of COMs, a very tiny rotation structure is resolved in this source for the first time. The radius of the centrifugal barrier is estimated to be 3 au, which is smaller by more than an order of magnitude than those of other protostellar sources. This result shows that the COM lines can be used as a powerful tracer of the closest vicinity of the protostar without influences of surrounding gas. Interestingly, the direction of the velocity gradient is different among molecular species (Figure 1). This feature is explained as rotating motion with infall motion rather than the Keplerian motion. The different velocity gradient may reflect the different distribution of COMs at a few au scale.

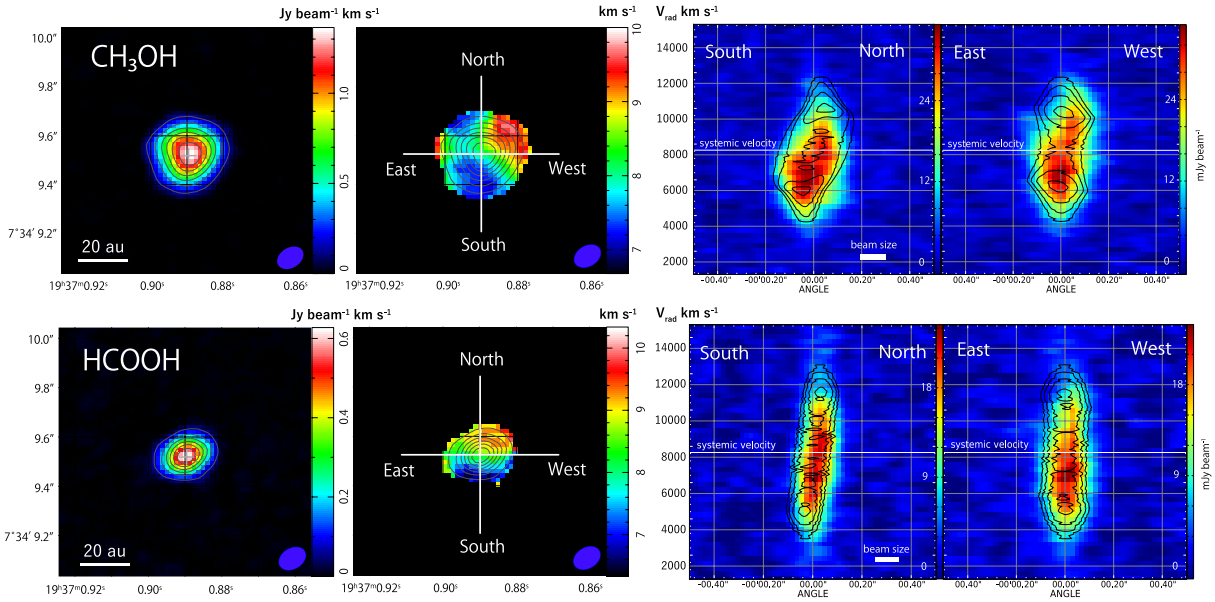

Figure 1: (*left two panels*) The moment 0 maps (left) and the moment 1 maps (right) of the CH_3OH and HCOOH emission. (*right two panels*) PV diagrams along the south-north (disk) and east-west directions, where the results of the infalling and rotating envelope model are overlaid in contours.

References

[1] M. Imai, N. Sakai, Y. Oya, et al. 2016, ApJ, 830, L37