Compact Distributions of N-bearing species and HCOOH in the Protostellar Source B335

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Molecular-line distributions around newly born protostars provide us an important clue to understanding chemical processes as well as physical structures such as a disk/envelope or an outflow. B335 is a Bok globule harboring the Class 0 protostellar source (T_{bol}=37 K), IRAS 19347+0727, whose distance is reported to be 90-120 pc. A number of Complex Organic Molecule (COM) lines were detected in the vicinity of the protostar with ALMA (Atacama Large Millimeter/submillimeter Array), and hence, this source contains a hot corino at a few 10 au scale [1].

We have conducted ALMA observations toward this source at a high spatial resolution of ~3 au. The CH_3OH and CH_2DOH line emission have an extended distribution with the radius of ~10 au around the protostar. In contrast, the N-bearing molecular lines, NH_2CHO and HNCO, show a more compact distribution within a radius of ~6 au or less. These characteristic features have been reported for other sources [2][3]. Interestingly, the HCOOH lines show a similar distribution to the N-bearing molecular lines, despite being an O-bearing species. This trend has also been seen in a high-mass source [4]. We derive the rotation temperature around the protostar under the assumption of the LTE condition using multiple lines each for CH_3OH, CH_2DOH, NH_2CHO, and HCOOH. Figure 1 shows the temperature distribution along the disk/envelope system. The temperature is derived to be ~250 K at the continuum peak, and decreases with increasing the distance from it. The derived temperatures in the vicinity of the protostar within 3 au are all similar. However, it depends on molecules at 6 au. This may suggest the complex structure of the disk/envelope system. Further works are in progress.

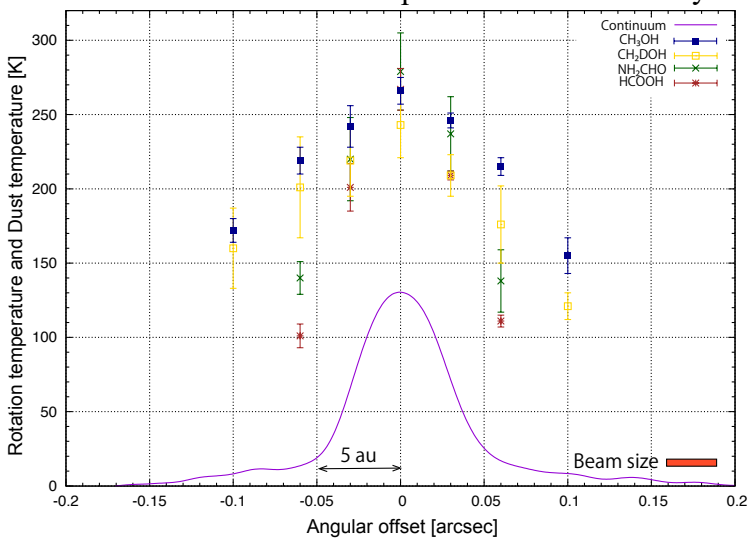

Figure 1: The blue, yellow, green, and orange marks represent the rotation temperatures derived from the CH_3OH, CH_2DOH, NH_2CHO, and HCOOH lines, respectively, along the disk/envelope system. The vertical bars indicate the error bars. The purple line represents the dust continuum distribution.

References

[1] Imai, M., Sakai, N., Oya, Y., et al. 2016, ApJL, 830, L37
[2] Colzi, L., Rivilla, V.~M., Beltrán, M.~T., et al. 2021, AAP, 653, A129
[3] Okoda, Y., Oya, Y., Abe, S., Komaki, A., et al. 2021, arXiv:2110.00150
[4] Csengeri, T., Belloche, A., Bontemps, S., et al. 2019, AAP, 632, A57