Infalling-Rotaing Motion and Associated Chemical Change in the Envelope of IRAS 16293-2422 Source A Studied with ALMA

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We have analyzed rotational spectral line emission of OCS, CH_3OH, $HCOOCH_3$, and H_2CS observed toward the low-mass Class 0 protostellar source IRAS 16293-2422 Source A at a sub-arcsecond resolution (~0".6x0".5) with ALMA[1]. Significant chemical differentiation is found at a 50 au scale. The OCS line is found to well trace the infalling-rotating envelope in this source. On the other hand, the CH_3OH and $HCOOCH_3$ distributions are found to be concentrated around the inner part of the infalling-rotating envelope. The kinematic structure of the infalling-rotating envelope is well explained with a simple ballistic model, as in the case of L1527 [2,3]. With this model, the radius of the centrifugal barrier (a half of the centrifugal radius) and the protostellar mass are evaluated from the OCS data to be from 40 to 60 au and from 0.5 to 1.0 $M_\odot$, respectively, assuming the inclination angle of the envelope/disk structure to be 60º (90º for the edge-on configuration). Although the protostellar mass is correlated with the inclination angle, the radius of the centrifugal barrier is not. This is the first indication of the centrifugal barrier of the infalling-rotating envelope in a hot corino source. CH_3OH and $HCOOCH_3$ may be liberated from ice mantles due to weak accretion shocks around the centrifugal barrier, and/or due to protostellar heating. H_2CS emission seems to come from the disk component inside the centrifugal barrier in addition to the envelope component. This study has further revealed that the centrifugal barrier plays a central role not only in the formation of a rotationally-supported disk but also in the chemical evolution from the envelope to the protoplanetary disk.

References

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