Mono-deuterated methanol in prestellar cores

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Mono-deuterated methanol is thought to form during the prestellar core stage of star formation. Variations in the CH_2DOH/CH_3OD ratio suggest that its formation is strongly dependent on the surrounding cloud conditions. Thus it is a potential tracer of the physical conditions before the onset of star formation.

A single-point physical model descriptive of a prestellar core is coupled to chemical models to investigate potential formation pathways towards deuterated methanol at the prestellar stage and discussed in context with observational findings [1]. The implementation of an abstraction scheme [2] leads to the efficient formation of methyl-deuterated methanol, but lacks sufficient formation of hydroxyl-deuterated methanol.

This leads to the conclusion that CH_3OD is most likely formed at a later evolutionary stage, potentially from H/D exchange in warm ices between D_2O (or HDO) and CH_3OH.
Our results suggest that the ratio of CH_2DOH/CH_3OD is therefore not an appropriate tracer of the physical conditions during the prestellar stage, but might be better suited as a tracer of ice heating.

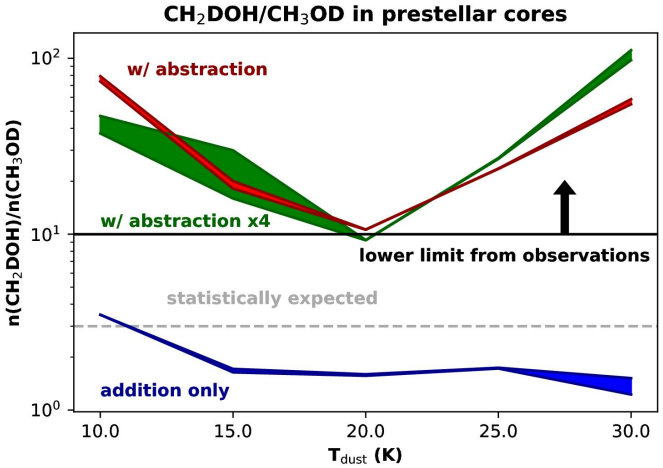

Figure 1: Ratio of CH_2DOH/CH_3OD over a grid of core ages and dust temperatures descriptive of the prestellar phase as obtained with three different chemical networks [1]. The gray, dashed line indicates the statistically expected value of 3, the solid, black line indicates the lower limit derived from observations [3].

References

[1] B. M. Kulterer et al., 2021, submitted to: ACS Earth and Space Chemistry
[2] H. Hidaka et al., 2009, ApJ, 702, 291
[3] L. Bizzocchi et al., 2014, A&A, 569, 27