Formaldehyde deuteration from protostars to comets: results from IRAM-30m and follow-up studies with ALMA

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Understanding how molecular complexity evolves in Sun-like star forming regions is mandatory to comprehend whether the chemical composition of the protostellar stages is inherited by protoplanetary disks and planets. [1]. An illustrative example of this is molecular deuterium enrichment. Indeed, such an enrichment occurs in cold environments, such as prestellar cores. Therefore, high D/H values in comets are believed to be a "fossil" record of the early phases of our Sun.

We studied the deuteration of formaldehyde (H_2CO) and methanol in a sample of Class I sources with the IRAM-30m antenna and found typical values of between 10^{-2} and 1 [2]. Our analysis shows that the D/H values set in the prestellar stage have been inherited by the later stages of the star forming process, i.e. Class 0 and I protostars. The follow-up work is to test this scenario with interferometric data, since we need high angular resolution to measure deuteration on Solar System scales in the different components, i.e. the outflow, the envelope, and the disk. In this context, we present H_2CO, HDCO, and D_2CO observations at 50 au resolution towards the prototypical star-forming region VLA1623-2417 in Ophiuchus A [3], obtained in the framework of the FAUST ALMA Large Program [4]. VLA1623-2417 is an embedded protostellar cluster, which consists of three sources with the present data: Source A (Class 0), Source B (Class 0), and Source W (Class I).

The FAUST observations reveal emission from one H_2CO (Eu=21 K), two HDCO (38 K and 63 K), and one D_2CO (28 K) lines at ALMA Band 6. H_2CO and its deuterated and doubly deuterated forms probe several components of the protostellar cluster: the extended envelope (traced by low-velocity H_2CO and HDCO emission), an X-shaped outflow cavity associated with the binary A1+A2 (detected also in D_2CO), and the rotating disk/inner envelope (seen at high-velocities towards both source A1+A2 and source B). We will be able to compare the deuteration of the inner disk to the deuteration of the extended cavity. The detected lines will allow us to estimate for the first time the deuterium fractionation in the Class 0 and I sources of the protostellar cluster at the disk scale (~50 au) and to compare the obtained D/H with estimates at earlier prestellar phases as well as in comets.

References

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