CONTROL ID: 2252947

TITLE: Probing the water and CO snow lines in the young protostar NGC 1333-IRAS4B

ABSTRACT BODY:

Abstract Body: Today, we believe that the onset of life requires free energy, water, and complex, probably carbon-based chemistry. In the interstellar medium, complex organic molecules seem to mostly form in reactions happening on the icy surface of dust grains, such that they are released into the gas phase when the dust is heated. The resulting "snow lines", marking regions where ices start to sublimate, play an important role for planet growth and bulk composition in protoplanetary disks. However, they can already be observed in the envelopes of the much younger, low-mass Class 0 protostars that are still in their early phase of heavy accretion. The information on the sublimation regions of different kinds of ices can be used to understand the chemistry of the envelope, its temperature and density structure, and may even hint at the history of the accretion process. Accordingly, it is a crucial piece of information in order to get the full picture of how organic chemistry evolves already at the earliest stages of the formation of sun-like stars. As part of the CALYPSO Large Program (http://irfu.cea.fr/Projets/Calypso/), we have obtained observations of $C^{18}O$, N_2H^+ and CH_3OH towards the Class 0 protostar NGC 1333-IRAS4B with the IRAM Plateau de Bure interferometer at sub-arcsecond resolution. Of these we use the methanol observations as a proxy for the water snow line, assuming methanol is trapped in water ice. The observed anti-correlation of $C^{18}O$ and N_2H^+, with N_2H^+ forming a ring around the centrally peaked $C^{18}O$ emission, reveals for the first time the CO snow line in this protostellar envelope, with a radius of ~300 AU. The methanol emission is much more compact than that of $C^{18}O$, and traces the water snow line with a radius of ~40 AU. We have modeled the emission using a chemical model coupled with a radiative transfer module. We find that the CO snow line appears further inwards than expected from the binding energy of pure CO ices. This may hint at CO being frozen out in H_2O or CO_2 dominated ices. Our observations can thereby yield clues on the widely unknown composition of interstellar ices, being the initial seeds of complex organic chemistry.

CONTACT (NAME ONLY): Sibylle Anderl

CONTACT (E-MAIL ONLY): sibylle.anderl@obs.ujf-grenoble.fr

AUTHORS/INSTITUTIONS: S. Anderl, S. Maret, B. Lefloch, CNRS, Institut de Planétologie et d'Astrophysique de Grenoble, F-38000 Grenoble, FRANCE|S. Anderl, S. Maret, B. Lefloch, Univ. Grenoble Alpes, IPAG, F-38000 Grenoble, FRANCE|P. André, A. Maury, DSM/IRFU Service d'Astrophysique, CEA Saclay, Gif/Yvette, FRANCE|A. Belloche, Max-Planck-Institut für Radioastronomie, Bonn, GERMANY|C. Codella, INAF, Osservatorio Astrofisico di Arcetri, Firenze, ITALY|S. Cabrit, LERMA, UMR 8112 du CNRS, Observatoire de Paris, Paris, FRANCE|

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