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Interstellar methanol: the challenge of reactivity in astrophysical conditions

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The presence of clouds of methanol in the interstellar medium (ISM) has been evidenced recently by the ALMA (Atacama Large Millimeter Array) radiotelescope. The high abundance of such organic molecule shows its remarkable persistence despite being exposed to the energetic radiation in interstellar space. Indeed, radiation impact can lead to dissociation of the molecule but can also open opportunities for the formation of more complex organic molecules (COMs). The very high abundance of protons in the ISM facilitates the formation of small protonated methanol clusters $H^+(CH_3OH)_n$ via weak bonding of the protonated form $H^+(CH_3OH)$ with other neutral molecules. The Molecular-Cluster Irradiation Device (DIAM) set-up at the Institut de Physique des 2 Infinis de Lyon is devoted to perform experiments under conditions that reproduce some aspects of interstellar, circumstellar or planetary atmospheric environments. We performed single collision experiments of 8-keV mass-selected protonated methanol clusters on argon atom in order to investigate the competition of the various fragmentation processes: evaporation, dissociation or formation of other COMs. The protonated dimethyl ether observed in interstellar clouds of methanol is evidenced to be formed in our laboratory experiment via a water loss reaction in a protonated methanol cluster.

Auteur principal: COMTE, Denis (IP2I Lyon)

Orateur: COMTE, Denis (IP2I Lyon)

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