

Chemical pathways of Methyl Mercaptan (CH₃SH) with Hydrogen atoms on Interstellar Ice

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There have been about 30 sulfur (S)-bearing species identified in the interstellar medium (ISM). Since the observed abundance of S-bearing species in the gas phase is lower than the cosmic abundance of S¹, it is often considered that there might be a source of “missing S” on interstellar grains. Based on an assumption that physico-chemical processes of S-bearing species on interstellar grains would be a key to constrain their presence in the ISM, several laboratory studies have been performed and our understanding has been significantly improved on the surface processes of S-bearing species at low temperatures^{2,3}. In the present study, we shed light on the behavior of other S-bearing species, methyl-mercaptan (CH₃SH), via chemical reactions of CH₃SH and H atoms without external energies on interstellar ices at low temperatures (typically 10 K) using experimental and computational methods.

We found that chemical reactions of CH₃SH with H atoms proceeded via multiple channels: CH₃SH + H → CH₃ + H₂S, CH₃S + H₂, or CH₂SH + H₂. The major channel was the dissociation of C-S bond in CH₃SH with the activation barrier of 0.05 eV on amorphous solid water, eventually resulting in the formation of methane (CH₄) by further hydrogenation to CH₃⁴. The hydrogen abstraction channels lead to the formation of CH₃S and CH₂SH radicals, and further hydrogenation to these radicals would result in the formation of CH₃SH again. Chemical desorption of CH₃SH was not positively identified via these processes, implying the presence of other processes for the desorption of CH₃SH from interstellar grains at low temperatures.

References

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