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Low-temperature surface reactions of carbon atoms

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The method to study surface chemical reactions at ultra-low-temperatures and to measure the amount of energy release has been developed. The method was used to investigate surface reactions of carbon atoms leading to the formation of complex organic molecules (COMs). We found that that the key surface reaction $C + H_2 \rightarrow HCH$ is barrierless in contrast with the previously considered energy barrier of 2500 K. The corresponding modification of the value of the energy barrier of this reaction in the chemical network simulations provides a huge impact on the abundancies of many molecules inside dark molecular clouds.
This is also in line with our experiments, where the carbon atoms together with the most abundant interstellar molecules (H_2, H_2O, and CO) were used to dope superfluid helium nanodroplets. These experiments suggest that in the denser regions of the ISM, the condensation of carbon atoms leads to the formation of complex organic molecules (COMs) and their polymers. Water molecules were found not to be involved directly in the reaction network leading to the formation of COMs. It was proposed that COMs are formed via addition of carbon atoms to H_2 and CO molecules ($C + H_2 \rightarrow HCH, HCH + CO \rightarrow OCCH_2, \cdots$). Due to the involvement of molecular hydrogen, the formation of COMs by carbon addition reactions is expected to be more efficient at high extinctions compared with the previously proposed reaction scheme with atomic hydrogen.

Consider for a poster?

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