

A Summary of Experimental Results on Molecular Hydrogen Formation on Dust Grain Analogues

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Abstract. The problem of the formation of molecular hydrogen is a fundamental issue in astrophysics/astrochemistry because of the great importance that molecular hydrogen has for the structure and evolution of our Universe. Even if great advances have taken place in the last decade from both the experimental and theoretical standpoint, this problem is not yet fully understood.

In this talk, we present the most important laboratory results on molecular hydrogen formation that have been obtained on the three most relevant classes of surfaces exposed to gases in interstellar diffuse and dense clouds: silicates, carbonaceous materials and amorphous water ice. Our experimental investigations range from the evaluation of the catalytic efficiency of the studied surfaces to the energetics of the reaction, i.e. the partition of the formation energy between the grain and the nascent molecule. Such measurements have been done by changing various parameters such as: the temperature of the interstellar dust analogue, the kinetic temperature of the atoms, the morphology of the surface and, to be completed soon, the composition of the solid.

To simulate as closely as possible the physical conditions of extremely low pressure and temperature encountered in the ISM, we have employed state-of-the-art surface science and low temperatures techniques in combination with the use of atomic beams of hydrogen isotopes at very low flux. The choice of a low-flux beam is very important in order to make the results of the laboratory simulation meaningful for astrophysical applications, since some of the mechanisms that are responsible for the formation of molecular hydrogen may become relevant at a coverage (i.e., surface density of adsorbed atoms) that is just a fraction of a single layer.

Today we may say that, following the experimental and theoretical studies in the last few years, we have a much better understanding of how molecular hydrogen forms on dust grains in the interstellar medium; yet, we also recognize that still much has to be learned about the influence of mechanisms of reaction, the quantification of the role of morphology, and the partition of the energy released in the reaction among the different degrees of freedom of the molecule and the solid.

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