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Molecular hydrogen formation experiments in astrophysical conditions

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Abstract:

Our goal is to understand the formation of molecular hydrogen in the interstellar medium (ISM). To this end we use a solid state model where we investigate the effects of the cosmic dust (modeled by an amorphous silicate surface) and the surrounding ISM gas (modeled as a beam of deuterium atoms) on D_2 formation. Furthermore, these experiments are performed in ultra-high vacuum conditions. We use a QMS[a] to monitor the dynamical coverage and sticking of D atoms and D_2 molecules on dust, while a REMPI-TOF[b] spectrometer monitors the newly formed D_2 molecules, assuming a formation rovibrational distribution peaking at v" = 4, J" = 2. These experiments reveal a macroscopic view of the most favorable thermal conditions for H_2 formation on silicates at astrophysical ranges: $5K < T_{dust} < 90K$ and $50K < T_{gas} < 300K$. We discuss the astrophysical implications of this research.

Key words: astrochemistry – ISM: atoms – ISM: molecules – methods: laboratory – molecular processes

Notes: [a] QMS: Quadrupole Mass Spectrometer.
[b] REMPI-TOF: Resonantly Enhanced Multiphoton Ionization – Time of Flight.