MONTE CARLO SIMULATIONS OF H_2 FORMATION ON GRAINS OF VARYING SURFACE ROUGHNESS

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Although the formation of molecular hydrogen in diffuse and dense regions of the neutral interstellar medium occurs by the recombination of hydrogen atoms on the surfaces of dust particles, the detailed mechanisms by which this process occurs are still in doubt. Experimental studies using a technique known as temperature-programmed desorption (TPD) indicate that for olivine and amorphous carbon, H_2 is formed by the so-called Langmuir-Hinshelwood mechanism, which involves the diffusion of one or both H atoms to find one another on a given granular surface[a]. Based on these measurements and a flux of H atoms relevant for diffuse interstellar clouds, it was deduced that the surface temperature range over which efficient H_2 formation occurs is very small for olivine (6-10 K) and for amorphous carbon (13-17 K)[b]. Considering that the surface temperature for interstellar grains in unshielded regions is probably closer to 20 K[c], it appears that if the experimental results and inferences are correct, then olivine and amorphous carbon are not realistic candidates for granular surfaces in diffuse clouds, where H_2 formation is known to be efficient. These models, however, all assume flat surfaces characterised by single values of the energy parameters for hydrogen-atom adsorbates. We performed continuous-time random-walk Monte Carlo simulations of H_2 formation on a variety of grain surfaces of varying roughness based on olivine and amorphous carbon. With these inhomogeneous surfaces, we find that the temperature range over which efficient H_2 formation occurs in the ISM is much larger than it is for flat surfaces. Our results show, in particular, that the formation of H_2 on all but the smoothest interstellar grains occurs efficiently at typical surface temperatures in diffuse interstellar clouds.

[a] V. Pirronello *et. al. Astrophys. J.* **483**(L131), 1997, V. Pirronello *et. al. Astrophys. J.* **475**(L69), 1997, V. Pirronello *et. al. Astron. Astrophys.* **344**(681), 1999

[b] N. Katz *et. al. Astrophys. J.* **522**(305), 1999

[c] A. Li and B. Draine *Astrophys. J.* **554**(778), 2001