Surface reactions in interstellar clouds: Rate constants of hydrogenation reactions and diffusion constants of hydrogen atoms

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The observations of interstellar ices or comets detected formaldehyde (H2CO) and methanol (CH3OH) (Crovisier & Bockelee-Morvan 1999, Space Sci Rev. 90, 19; Keane et al. 2001, A&A 376, 254). Several kinds of reactions to form H2CO and CH3OH have been proposed such as gas-phase reactions (Shalabiea & Greenberg 1994, A&A 290, 266), UV photolysis on H2O+CO ices (Schutte et al. 1996, A&A 309, 633), proton bombardment on H2O+CO ices (Hudson & Moore 1999, Icarus 140, 451), and hydrogenation on H2O+CO ices (Tielens & Whittet 1997, in Molecules in Astrophysics: Probe and Processes, 45).

Hydrogenation is proposed to be the one of the most effective reactions (Tielens & Whittet 1997, in Molecules in Astrophysics: Probe and Processes, 45), and laboratory experiment has been carried out recently (Hiraoka et al. 2002, ApJ 577, 265; Watanabe & Kouchi 2002, ApJ 571, L173).

We analyze the data of the quantitative hydrogenation experiment of CO by Watanabe & Kouchi (2002, ApJ 571, L173), Watanabe et al. (2002, ApJ 588, L121), and Hidaka et al. (2003, Proc. 36th ISAS LPS, 250), and derive the rate constants of hydrogenation of CO and H2CO and the diffusion constant of H atoms in the ice.