Formation processes of deuterated formaldehyde on interstellar ice surface

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Recently the high gas-phase abundance of deuterated molecules have observed in Orion (KL)[1], IRAS 16293-2422[2-4], TMC-1[5], and comet C/1995 O1(Hale-Bopp)[6]. Although the cosmic D/H ratio is quite low (10^{-5}), the observed abundances of deuterated molecules (e.g. formaldehyde, H_2CO-d_{1-2} and methanol, CH_3OH-d_{1-3}) are three or four orders larger than cosmic D/H ratio. There have been several studies on the enhancement of deuterated molecules mainly in the scheme of gas phase. However, the approach of gas phase cannot explain a formation of multiply deuterated molecules such as D_2CO and CH_3OH-d_{2-3}. The origin of the enhancement is still open question.

Since H_2CO and CH_3OH are produced by CO hydrogenation on interstellar ice, we deduce that the surface reaction on interstellar ice is a key process also for the formation of H_2CO-d_{1-2} and CH3OH-d_{1-3}.

We investigated the formation of deuterated formaldehyde on cold ice surface, experimentally. Below 20K, solid H_2CO and D_2CO were exposed to cold (30K) H and D atoms, respectively. The variations of IR absorption spectra for the each solid target are measured by a Fourier transform infrared spectrometer during the exposure of atoms. Reaction of H-D substitution in those molecules was measured. H_2CO was efficiently converted to HDCO and D_2CO by D-atom. On the other hand, in exposure of D_2CO to hydrogen atom, the conversion rate to HDCO and D_2CO is less than that of D-atom exposure of H_2CO. Comparing the obtained rates with those for deuteration of CO, we discuss the possible formation route for the deuterated formaldehyde on ice surface.

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