Deuterium to Hydrogen Ratios in Cometary Methane: Deep Search for CH_3D in Comets

Hideyo KAWAKITA
(Koyama Astronomical Observatory, Kyoto Sangyo Univ., Kyoto, Japan)

Cometary volatiles are expected to be more enriched in deuterated species (e.g., HDO for water) and their D/H ratios are larger than that of proto-solar H_2 gas (~2 x 10^{-5}). The D/H ratios of water found in comets are in the range from ~1.5x10^{-4} to ~6x10^{-4}. In case of hydrogen cyanide (HCN) in comet, its isotopologue (DCN) is also enriched (~2.3x10^{-3}) but different from those of water. Thus, different species exhibit different D/H ratios, probably depending on how these molecules formed in the early Solar System.

Here we report the upper limits of D/H ratios in methane, deduced from the CH_3D/CH_4 ratio for several bright comets observed by Keck II with NIRSPEC. The much lower sublimation temperature of methane (~30 K) compared to water (~150 K) means that methane molecules processed in the solar nebula might not re-condense efficiently in the inner warmer part of comet-forming regions. We discuss our results in the context of the formation conditions of cometary ices and the contribution of interstellar ices based on comparisons with astrochemical models.