X-ray photodesorption of realistic ice mantle: circumstellar ice analogue

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Abstract

We have investigated soft X-ray processing two-layer ices which consist of H_2O+CH_4+NH_3 covered by CO+CH_3OH. The structure is considered the cooling process of circumstellar dust grains. Water, the most abundant molecule observed in the ice mantle, has higher sublimation temperature and condensed with hydrogenation products of abundant atoms, such as CH_4 (C atom) and NH_3 (N atom) on grains, formed a water-rich ice mantle with the decreasing temperature in circumstellar regions. The temperature could be finally down to ~10 K at the mid-plane of a protoplanetary disk. Since the temperature is lower than condensing temperature of most molecules, CO molecules form relative pure ice mantle at the outermost. However, hydrogenation is continuing. Methanol, the production of CO hydrogenation, is embedded in CO-rich ice.

The two-layer ices are irradiated by soft X-ray provided by BL08B with a spectrum range of 250-1250 eV. The photon energy is covering the emission spectrum of T Tauri star which is a young solar-type protostar and brighter thousands of times than our sun. The ices which mimic the realistic circumstellar ice mantle are used to explore how the chemical products formed under CO-rich ice layer are introduced into gas phase and how complex organic molecules form in a protoplanetary disk which is believed where planet formed.

Keywords – Protoplanetary disks, X-rays, photodesorption, and astrochemistry