SESSION 1

Ice and Organics under Irradiation in Space

DAY 1 – Feb.13, 2017
8:30 am – 11:20 am
4:30 pm – 4:55 pm

Nitrogen Isotopic Evolution of Organic Molecules in Interstellar Ice Analogues by UV Irradiation

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Nitrogen isotopic composition ($\delta^{15}N$, relative to terrestrial air) of pristine solar system materials (e.g., comets and chondrites) show elevated $\delta^{15}N$ values such as +1500‰ as bulk [e.g., 2], compared to the Sun (–407±7‰) [1]. They also have extream ^{15}N-enrichment up to +5000‰ in microscale domains [3]. The formation mechanisms of the ^{15}N-enrichment have not been fully understood, whereas photodissociation of N_2 in cold interstellar medium (ISM) is considered to be a plausible candidate [4]. Previous studies focused mostly on simple, gaseous N-containing molecules, but complex organic molecules in interstellar grains have not been investigated from the aspect of nitrogen isotopic composition.

We conducted laboratory experiments to examine nitrogen isotopic fractionation caused by UV irradiation to interstellar ice analogues. The experiments were designed to focus on the effects of UV irradiation during the formation of interstellar ice analogues at 12 K (Run-1) and of the further UV irradiation in a warm environment (room temperature) after ice evaporation (Run-2). An apparatus called PICACHU (Photochemistry in Interstellar Cloud for Astro-Chronicle in Hokkaido Univ.) was used for the experiments. The typical ISM gas (H_2O:CH_3OH:NH_3 = 2:1:1) was introduced into the highly vacuumed chamber and deposited onto the surface of sapphire substrates at ~12 K. During the experiments, UV photons (~10^{14} photons cm^{-2} s^{-1}) were simultaneously irradiated for 71 h. For the Run-2, UV photons were further irradiated for 232.5 h after warmed up to room temperature.

The nitrogen isotopic composition of organic residue was analyzed as bulk sample by nano-EA/IRMS technique [5] and also in individual amino acids: a representative of N-containing complex organic molecule by GC/C/IRMS [6]. A significant nitrogen isotopic fractionation observed for Run-2 suggests that the UV photodissociation of organic matter is important for the isotopic fractionation. In addition, the degree of the isotopic fractionation was large in bulk sample, but it was small in amino acids .

References: [1] Marty B. et al. (2011) *Science* 332, 1533. [2] Manfroid J. *et al*. (2009) *A&A* 503, 613. [3] Briani G. et al. (2009) *PNAS* 106, 105222. [4] Chakraborty S. et al. (2014) *PNAS* 111, 14704 [5] Ogawa N. O. et al. (2010) in *Earth, Life, and Isotopes*. pp.339. [6] Chikaraishi Y. *et al*. (2010) in *Earth, Life, and Isotopes*. pp.367.