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Nitrogen Isotopic Ratios in Cometary NH_2: Implication for ^{15}N-fractionation in Ammonia

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Abstract (2,250 Maximum Characters): Isotopic ratios in cometary molecules are diagnostic for the physico-chemical conditions where molecules formed and are processed, from the interstellar medium to the solar nebula. Usually temperatures at the molecular formation control the fractionation of the heavier element in molecular species, e.g., D-fractionation in water.

In cometary volatiles, the $^{14}N/^{15}N$ ratios in CN have been well observed (Manfroid et al. 2009, A&A, 503, 613, and reference therein) and is consistent with the ratio in HCN (a most probable parent of CN) measured in few comets (Bockelée-Morvan et al. 2008, ApJ, 679, L49). Those ratios are enriched compared to the proto-solar value by a factor of ~3. In contrast to those Nitriles, there are only few reports on $^{14}N/^{15}N$ ratios in Ammonia (as Amine) (Rousselot et al. 2014, ApJ, 780, L17; Shinnaka et al. 2014, ApJ, 782, L16). Ammonia (NH_3) is usually the most abundant and HCN is the second most abundant N-bearing volatiles in cometary ice. Especially, recent observations of $^{15}NH_2$ revealed the $^{14}N/^{15}N$ ratios in NH_3 are comparable to those of CN. However, from the viewpoint of theoretical work, the enrichment of ^{15}N in cometary NH_3 cannot be reproduced by current chemical network models. Information about the diversity of the $^{14}N/^{15}N$ ratios in NH_3 of individual comets is needed to understand the formation mechanisms/environments of NH_3 in the early solar system.

To clarify the diversity of the $^{14}N/^{15}N$ ratios in cometary NH_3, we determine the $^{14}N/^{15}N$ ratios in NH_3 for more than ten comets individually which include not only Oort cloud comets but also short period comets by using the high-resolution optical spectra of NH_2. These spectra were obtained with both the UVES mounted on the VLT in Chile and the HDS on the Subaru Telescope in Hawaii.

The derived $^{14}N/^{15}N$ ratios in NH_3 for more than ten comets show high ^{15}N-enrichment compared with the elemental abundances of nitrogen in the Sun by about factor of ~3 and has no large diversity depending on these dynamical properties. We discuss about the origin of the formation conditions of cometary NH_3 and its physico-chemical evolution in the solar nebula based on our and other results.

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