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

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Comets are remnants of icy planetesimals formed in the solar nebula 4.6 Gyr ago. In general, the icy materials in comets are definitely one of the keys for us to understand the origin and evolution of our Solar system. The isotopic ratios are diagnostics for the physico-chemical conditions governing molecular formation. In comets, $^{14}N/^{15}N$ ratios have been measured from HCN in three comets and from CN in more than 20 comets [1,2,3]. Those ratios are enriched in ^{15}N compared to the elemental abundances of the Sun by a factor of ~3, have a small diversity and do not depend on the dynamical types of the comets. The origin of this high ^{15}N-fractionation is still in debate because CN probably comes not only from HCN, but also from other materials in the coma. Consequently, an interpretation of the isotopic ratios in cometary CN is quite complicated due to the multiple possible parents of CN. In contrast with CN, the isotopic ratios of nitrogen in NH_3 give us a much clearer interpretation than in CN because NH_3 is directly incorporated in the nuclear ices.

To estimate the $^{14}N/^{15}N$ ratios in NH_3, $^{14}N/^{15}N$ ratios have been determined from high-resolution spectra of NH_2 in the optical wavelength region. NH_2 is indeed a dominant photodissociation product of NH_3. These high-S/N ratio high-resolution spectra were taken by the High Dispersion Spectrograph (HDS) mounted on the Subaru Telescope summit of Mauna Kea, Hawaii, USA and the Ultraviolet and Visible Echelle Spectrograph (UVES) mounted on the UT2 of the Very Large Telescopes (VLT) at European Southern Observatory (ESO)'s Paranal Obsrvatory, Chile.

Those ratios were also found to be enriched in ^{15}N compared to the Sun by a factor of ~3 [4]. In this paper, we present $^{14}N/^{15}N$ ratios in NH_2 for 20 comets as total. Our sample includes short-period comets as well as long-period comets. We found that the $^{14}N/^{15}N$ ratios in cometary NH_2 also show a small dispersion and do not depend on the dynamical origin of the comets (Fig. 1).

Interpretation of $^{14}N/^{15}N$ ratio in cometary volatiles is still in debate. In order to reduce the measurement uncertainty for each comet, we should develop the emission model of $^{15}NH_2$ considering the Swings effect as well as need more high-S/N spectra by next-generation large telescopes such as the TMT and E-ELT. We can truly discuss the variation of $^{14}N/^{15}N$ ratios in comets if $^{14}N/^{15}N$ ratios with smaller uncertainties will be obtained for each comet.

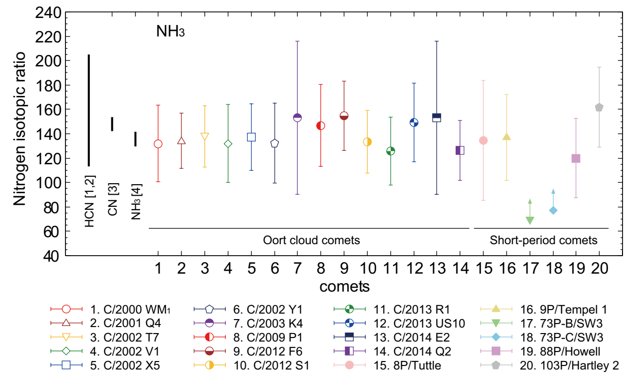

Figure 1: $^{14}N/^{15}N$ ratio in comets. Three black bars indicate the range of $^{14}N/^{15}N$ ratios in HCN and the weighted means of $^{14}N/^{15}N$ ratios in CN and NH_3.

References

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