SESSION 1

Light Elements and Organic Matter from ISM to Small Bodies

DAY 1 – Feb.17, 2016
8:30 am – 11:25 am

INTERSTELLAR HERITAGE BY THE SOLAR SYSTEM CHALLENGED BY COMETARY NITROGEN ISOTOPIC FRACTIONATION? L. Bonal*, P. Hily-Blant, E. Quirico, A. Faure - IPAG (Grenoble-France); *lydie.bonal@obs.ujf-grenoble.fr

As recently reviewed by Füri and Marty (2015), large nitrogen (N) isotope variations are observed in the Solar System. As they are unlikely to be explained by the remnants of nucleosynthetic heterogeneities, these variations are attributed to isotope fractionation. The environment (pre-natal molecular cloud, protoplanetary disk, Solar System) and the fractionating process (ion-molecule reactions, isotope selective photo-dissociation, self-shielding) are highly debated (ref. in [1]).

Based on a compilation of astronomical observations in prestellar cores, we showed that molecules carrying the nitrile functional group appear to be systematically ^{15}N-enriched ($^{14}N/^{15}N$ up to 140; $\delta^{15}N$ up to ~ 1000 ‰) compared to those carrying the amine functional group ($^{14}N/^{15}N > 400$; $\delta^{15}N < -100$ ‰) [2]. This differential fractionation allowed us to propose that the large N isotopic variations in the Solar System could be explained by the sampling of distinct interstellar N reservoirs [2]. Recent determinations of the N isotopic composition of cometary NH_3 [e.g., 3, 4], similar to that of CN and HCN ($^{14}N/^{15}N \sim 127$; $\delta^{15}N > 1000$ ‰), challenge our scenario. However, instead of directly discarding the idea of a potential interstellar heritage within the solar system, our objective here is to understand what these new cometary data could be teaching us.

First, based on its N isotopic composition, NH_3 in cometary coma has not been directly inherited from the gas phase of the pre-natal dense molecular cloud. Nevertheless, a genetic link with interstellar matter could still be envisaged as NH_3 ices could be ^{15}N-enriched ($\delta^{15}N$ up to 3000 ‰) depending on CO depletion and on the temperature [5]. Second, neither cometary HCN, CN, nor NH_3 have an isotopic composition representative of the bulk solar nebula ($^{14}N/^{15}N_{comet} \sim 140$ vs. $^{14}N/^{15}N_{PSN} = 441$). Another N-carrying molecule (e.g., N_2, N) might then represent the main cometary reservoir. However, recent results by the Rosetta mission show that in the coma of 67P/CG $(N_2/CO)_{67P} \ll (N_2/CO)_{PSN}$ [6]. Whether the coma composition reflects that of the nucleus should be discussed. It should also be questioned whether comets accreted and/or trapped, without chemical fractionation, the matter initially present in the solar nebula [e.g., 7]. Last, as shown by Roueff et al. (2015) our current theoretical understanding of the N isotopic fractionation is far from complete. Spin-state dependence [9] and non-equilibrium effects [e.g., 10] might be more important than previously anticipated. For the coming workshop, we propose to confront observations from diverse astronomical setups (clouds, comets, cosmomaterials) to fractionation models, with a special emphasis on chemical carriers and relative abundances. Robust constraints may still be lacking to close the debate on the origin of N isotopic fractionation in the Solar System.

[1] Füri and Marty (2015) *Nature Geoscience*, **8**, 515. [2] Hily-Blant et al. (2013) *Icarus* **223**, 582. [3] Rousselot et al. (2014) *ApJL* **780**, L17. [4] Shinnaka et al. (2014) *ApJL* **782**, L16. [5] Rodgers and Charnley (2008) *MNRAS* **385**, L48. [6] Rubin et al. (2015) *Science* **348**, 232. [7] Yokochi et al. (2012) *Icarus* **218** 760. [8] Roueff et al. (2015) *A&A* **576**, A99. [9] Wirstrom et al. (2012) *ApJL* **757**, L11. [10] Herbst et al. (2003) *SSR* **106**, 293.