# $^{15}$N fractionation traces isotope-selective photodissociation in a pre-stellar core

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Isotopologue abundance ratios are the key to understand the evolution of astrophysical objects and ultimately the origins of a planetary system like our own. Being nitrogen a fundamental ingredient of pre-biotic material, understanding its chemistry and inheritance is of fundamental importance to understand the formation of the building blocks of life.

We studied the $^{14}$N/$^{15}$N fractionation ratio across a pre-stellar core through IRAM 30m observations of HCN, HNC and CN. Our results show for the first time that the fractionation of nitrogen presents significant variations across a pre-stellar core. The fractionation maps that we derived for HCN and HNC present a very clear decrease of the $^{14}$N/$^{15}$N ratio towards the southern edge of L1544, the region of L1544 that corresponds to a steeper drop in $H_2$ column density and is consequently more efficiently illuminated by the ISRF (Spezzano et al. 2016). The same trend is tentatively observed also for CN.

Our results strongly suggest that the main fractionation path for nitrogen in L1544 is the isotope-selective photodissociation. This fractionation mechanisms has so far not been considered for the fractionation of nitrogen towards dense core.

$^{14}$N$^{15}$N photodissociate more efficiently than $^{14}N_2$ because it is not abundant enough to self-shield. The photodissociation of $^{14}$N$^{15}$N is expected to be more efficient towards the more illuminated part of the core, the southern part, where more atomic $^{15}$N will be available to form cyanides like HCN, HNC and CN. The effect of isotope-selective photodissociation in nitrogen fractionation has already been observed towards a protoplanetary disk where the irradiation from UV photons in the inner part of the disk translates into a lower $^{14}$N/$^{15}$N ratio in HCN (Hily-Blant et al. 2019).

With our work we show that not only the irradiation of UV photons, but also the uneven illumination from the ISRF onto a pre-stellar core has an effect on the $^{14}$N/$^{15}$N ratio through the isotope-selective photodissociation. We also show that the scatter in the $^{14}$N/$^{15}$N ratio of HCN, HNC and CN observed in dense cores so far might be a consequence of the different illumination on the individual cores, as well as their environment.

Pre-stellar cores provide the budget of material that will finally be inherited by forming planets. In order to assess what is the $^{14}$N/$^{15}$N budget that will be inherited from pre-stellar cores, it is important to consider the illumination-induced variations across the core.

**References**

[1] Hily-Blant, P.; Magalhaes de Souza, V.; Kastner, J., Forveille, T., 2019, A&A, 632, L12

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