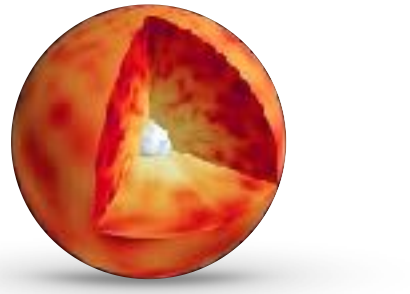

Carbon isotopic ratio in giant stars : the missing puzzle of stellar evolution

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Deciphering the evolution of stars requires acquiring the best knowledge on transport processes occurring in their interiors. Surface chemical properties allow to decrypt the signature of these mixing processes. Therefore it is very important to have precise constraints on these mechanisms at all stages of the evolution of stars. When put together, the chemical abundances derived by spectroscopic surveys and the stellar structure properties revealed by asteroseismic surveys for a large number of stars help us to understand the impact of hydrodynamical processes as a function of stellar masses or metallicity and at different evolutionary stages (e.g., Lagarde et al. 2019). This leads to a deeper understanding of stellar structure and evolution.

In the classical theory of stellar evolution, the only expected mixing episode between the main sequence and the tip of the red giant branch (RGB) is the first dredge-up. In low- and intermediate-mass stars, it leads to an increase of the photospheric abundances of ^{13}C and ^{14}N and a decrease of that of Li and ^{12}C in proportions which vary as a function of the initial stellar mass and metallicity. However observational data show a different reality. Indeed, in addition to the first dredge-up, low- and intermediate-mass stars show a further increase in N and decrease in C and $^{12}C/^{13}C$ just after the luminosity RGB-bump (Charbonnel et al. 1998). This results from an extra-mixing phenomenon which is currently attributed to the **double diffusive thermohaline instability** (Charbonnel & Zahn 2007). Charbonnel & Lagarde (2010) showed that this mechanism can simultaneously account for the observed behaviour of $^{12}C/^{13}C$, [N/C], and Li in low-mass red-giant stars located between the RGB bump and the clump in open clusters (e.g. Tautvaišiene et al. 2016; Drazdauskas et al. 2016; Smiljanic et al. 2009) as well as in 3 CoRoT targets (Lagarde et al. 2015).

Although current large spectroscopic surveys provide chemical properties of heavier elements, the C ratios are determined for a small sample of evolved field stars (e.g., Gratton et al. 2000, Tautvaišiene et al. 2010, 2013), with unclear evolutionary states, and much less accurate stellar masses than may be determined from asteroseismology (Chaplin & Miglio 2013).

We proposed here **to interpret very recent observations done by Takeda et al. (2019)** where they derived the [N/Fe] and $^{12}C/^{13}C$ ratios for 239 late-G/early-K giant stars. This is the larger sample of giant field stars published up to now for which we have the determination of $^{12}C/^{13}C$ ratio. We proposed to :

- Find in the literature more stellar properties of these stars, **crossing this catalog with other kind of surveys such as asteroseismology** (e.g., Kepler survey) **or astrometry** (e.g., Gaia survey).

- **Compare these observations with stellar evolution model predictions** including the effects of thermohaline mixing or/and rotation. We could use for this point directly stellar evolution models computed with STAREVOL code, or simulations done with the Besançon stellar population synthesis model. These kinds of models are developed in our research team.
- If we have time, we propose **to develop a small code (like MCMC code) to derive from stellar evolution models the stellar properties** (such as age or mass) **from the observed properties** (such as luminosity, effective temperature or distance).