

## Origin of the light elements: Lithium and Beryllium

Lithium is a key astronomical element with multiple and sometimes controversial origins which plays an important role in cosmology, cosmic rays, chemical evolution and stellar structure. It is a primordial element but is also made by spallation reactions of cosmic rays with the atoms in the interstellar medium and is produced in significant amounts by a still unknown Galactic source (s). The two main conundrums are:

- 1) the Cosmological Lithium problem,
- 2) the Galactic Li problem.

In the last years, we have proposed a stellar fix for the former and made a discovery that could explain the latter, i.e. the first detection of  ${}^7\text{Li}$  and  ${}^7\text{Be}$  in the outburst of Novae. These observations confirm theoretical speculation made in the '70s, but which was never supported by observations before. The measured  ${}^7\text{Be}$  (and  ${}^7\text{Li}$ ) in Novae show overabundances of 4 to 5 orders of magnitude over the  ${}^7\text{Li}$  meteoritic-solar value. Using a detailed chemical evolution model, we showed that indeed Novae could be the missing Galactic source for  ${}^7\text{Li}$ . We have also explained the different behaviour of the Thick Disk Li abundances. Following these seminal observations, we have initiated a ToO at the VLT-ESO since 2017 (P100) and ongoing to observe the relatively bright Novae to detect  ${}^7\text{Be}$  to characterize frequency/abundances/ Nova type. In parallel, we triggered a ToO at the INTEGRAL satellite to detect the 478 keV line produced by the  ${}^7\text{Be}$  decay into  ${}^7\text{Li}$  for the first time.

${}^9\text{Be}$  can be formed only by spallation processes in the interstellar medium. Recently we have succeeded to trace the evolution of this element in the accreted dwarf galaxy Gaia Enceladus.

The PhD student is expected to work either on one or several of the related problems connected to the origin of these two elements. The project can be carried out from an observational perspective with analysis of Li and Be either in novae, stars (galactic or extragalactic) or in the interstellar and intergalactic medium; it may be also in the theoretical side addressing the Cosmological and Galactic problems or the evolution of the light elements in the Galaxy and in external galaxies, such as Gaia Enceladus galaxy.

### References:

- Cescutti & Molaro 2019 MNRAS 482, 4372  
Molaro et al. 2020 MNRAS 492, 4975  
Olive Fields Molaro PDG review.  
Molaro, Cescutti Fu 2020 MNRAS, 496, 2902