Laboratoire d'Études Spatiales et d'Instrumentation en Astrophysique

AFE 2018: The fine structure of the red clump

Benoît Mosser, Kévin Belkacem, Charlotte Géhan, Réza Samadi, LESIA, Pôle Étoile
David Katz, Misha Haywood, GEPI, Carine Babusiaux (IPAG et GEPI), Léo Girardi (U. Padova), A. Miglio (U. Birmingham), M. Takata (U. Tokyo)

This project focusses on the core-helium burning stars in the red clump, which play a peculiar role for stellar physics, distance measurement and Galactic archaeology. The detailed morphology of the red clump has just become accessible to detailed analysis thanks to asteroseismic constraints (see, e.g., Girardi et al. 2016 ARAA). The luminosity and effective temperature of core-Helium burning stars depend primarily on the Helium-core mass at ignition and on the envelope mass. Now, with seismology, we aim to: 1) probe second-order effects such as initial helium abundance, metallicity and dependence on the physical conditions that determine the Helium-core mass and the thermal and chemical stratification in the core (e.g. radiative and conductive opacities, convection, diffusion, rotation); 2) infer the initial helium abundance by combining Gaia's parallaxes, masses from asteroseismology, and photospheric metallicity, with the ambitious aim of determining a chemical enrichment relation; 3) possibly compare with estimates of the helium abundance in the envelope from acoustic glitches; 4) stress-test stellar models by analyzing and interpreting seismic signatures of sharp-structure variations near the core (including various prescriptions for mixing); provide an improved map of the red-clump luminosity as a function of the underlying stellar populations, which can be used when inferring properties of stellar populations in resolved and integrated stellar populations studies in other galaxies. Quantifying systematic uncertainties related to our limited knowledge of physics will be key.

The project started last year and is expected to last about 3 years, with a long-term schedule fixed by both the schedule of the Gaia deliveries and the amount of work. During the first year, we have made large progress in the precise characterization of second-order seismic effects that may perturb the use of red clump stars as distance candles. This is good news for the program of the 2nd year, where we shall start to mix seismic + astrometric constraints, as explained above

Program for the 2nd year= 2018
- continuation of the seismic effort
- implementation of the up-to-date seismic analysis
- implementation of DR2 and further releases of Gaia

Budget for 2018 (total = 6 k€)

- mission for Masao Takata (2-month stay payed as PTV by the CS)	2 k€
- 2 x 3-day missions for 2 European colleagues invested in seismology	1 k€
- Participation of Charlotte Gehan to the KASC meeting	1 k€
- 3 x 3-day missions for 2 European colleagues invested in Galactic archaeology	1.5 k€
- Mission between Grenoble and Meudon for Carine Babusiaux	0.5 k€