Laboratoire d'Études Spatiales et d'Instrumentation en Astrophysique

AFE 2017: The fine structure of the red clump

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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 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. Priorities for the 1st year are
-1- to consider second-order seismic effects. This step requires the participation of Masao Takata, who recently proposed an approximation-free asymptotic development of the dipole mixed-mode (Takata 2016a,b, PASJ 68, 91 & 109). In addition to this, during the first year we will develop interactions between the seismic and astrometric programs. This work involves the contribution of two PhD students, Charlotte Géhan (start in 2015) and Saniya Khan (start in 2017). The PhD subject of Saniya is specifically devoted to the subject of the AFE project.
-2- to cross DR1 data and APOKASC data, paying attention to all possible biases on both seismic and astrometric data.

Program for the 2nd and 3rd years: implementation of the up-to-date seismic analysis; implementation of DR2 and further releases of Gaia

Budget for 2017:
We intend to have a meeting in Paris with all participants + a long-duration stay for Masao Takata. So the budget is 6000 € for a 1-month mission for Masao Takata (Japan) and 2 short missions for 2 European colleagues invested in Galactic archaeology