

Project for “Action Fédératrice Etoiles”

Title: Laboratory astrophysics and analysis of stellar spectra

PI: Lydia Tchang-Brillet (LERMA)

Members of the project:

1. Nicole Feautrier (LERMA), Elisabetta Caffau (GEPI)
2. Lydia Tchang-Brillet, C. Balança, N. Champion (LERMA), Coralie Neiner, Richard Monier (LESIA),

Expected duration: 2 years

Description of the project: As described in our 2017 application, this project proposes an interdisciplinary strategy, combining new developments in experimental or theoretical laboratory works aiming to the best interpretation of the observed stellar spectra. All our data are intended to feed atomic and molecular databases. This projects includes two parts:

1) **Modeling of stellar atmospheres at the area of GAIA:** Our models are now able to take into account at the same time non-LTE and granulation effects of the stellar atmospheres using radiative transfer and 3D hydrodynamical simulations. However, a problem on non-LTE calculations comes from uncertainties in atomic data, of which the inelastic neutral hydrogen collisional rates are the most significant source. Our project combines new developments in quantum chemistry and theory of collisions. The current work is focusing on H-collisions with CaI, CaII, OI species, with perspectives for iron. It also includes the development of new theoretical models giving good estimates of rate coefficients for a large number of species. The impact of the data for non-LTE modeling of stellar atmospheres will be investigated. Collaborations: M. Guitou, A. K Mitrushenkov (Paris-Est University).

2) **Laboratory spectroscopic data for space observations :** In LESIA, C. Neiner is one of the two French PI's for the construction of a high-resolution spectropolarimeter POLLUX involved in the LUVUOIR space mission. R. Monier is studying HST spectra of chemically peculiar stars. The LERMA team has expertise in UV and FUV spectroscopy of heavy atomic ions and will contribute by their laboratory work (wavelengths, intensities, Landé factors) to these projects. In complement of existing light sources (vacuum spark, Penning discharge, hollow cathode), the team plans to use an EBIT (Electron Beam Ion Trap) ion source in front of the high-resolution spectrograph of Meudon, in collaboration with Fudan University in Shanghai. The experiment aims to study emission of ions of higher charges in low-density conditions, like Fe X for a start. Collaborations: A. Meftah (Tizi Ouzou University, affilié LERMA), J. F. Wyart (Aimé Cotton laboratory).

Requested budget 2018: AFE 4500 € HT

For 2018, our first priority is to invite Pr R. Hutton and Y. Yang of the Shanghai EBIT laboratory (Fudan University) for one month to perform the experiment with a rented EBIT source from DREEBIT (the rental has supports from Plas@Par and Fudan). A contribution of **2500€** to their expenses from the AFE is requested. An application has been submitted to an exchange program XuGuangqi, to possibly complete the present one.

The second priority is an exchange visit between Pr. A. Belyaev (St Petersburg University) and N. Feautrier (2-3 weeks), in order to develop a realistic H-collision model, which is highly expected for OI and Fe spectra analysis. A contribution of **2000 €** for living expenses is requested.

Programme Blanc du Conseil Scientifique 5500 HT ou 6300 TTC

One of us should attend the ICAMDATA conference to be held in Cambridge, MA, USA in September 2018, to present our work at this data producers-users meeting. A contribution of **1500€** is desirable. On the experimental side, two highly reflective concave mirrors are necessary for building an imaging system for the entrance slit of the 10-m spectrograph to ensure a uniform illumination of the grating by different weak sources (EBIT, Penning discharge, hollow cathode) in intensity measurements and also to increase the signal level. The quotation amounts to **3454 € (HT)**. We also need to buy some chemicals for cleaning the light sources (**500€ HT**).

In case the AFE does not accept the corresponding funding, we wish to have its support for an application to the "**Programme blanc du Conseil Scientifique**".