Thesis subject

Name of the laboratory: Laboratoire d'Astrophysique de Marseille

Thesis advisor: Cecile Gry
Email and address: cecile.gry@lam.fr
Tel: +33 4 91 05 59 21

Subject's title: **Physics of the diffuse interstellar medium via spectroscopy of the local clouds.**

Subject description:

Studies of ultraviolet absorption features appearing in the spectra of hot stars have yielded fundamental insights into the compositions and physical characters of different phases of the interstellar medium (ISM) (Savage & Sembach 1996), along with the processes that influence them.
Nearby stars present simple lines of sight through the local ISM, free of the clutter resulting from many different media accumulated along longer lines of sight, and offer the rare opportunity to explore individual clouds and interactions.
In broadest terms, the Sun is located in a specially rarefied region of the Galaxy. It is situated in a small, diffuse ($n(HI) \sim 0.2\ cm^{-3}$), warm medium, which itself is embedded in an irregularly shaped cavity of about 100~pc radius (Welsh et al 2010) called the Local Bubble. It is almost devoid of neutral gas and is filled mostly with a hot ($T \sim 10^6$ to $10^7 K$) tenuous, collisionally ionized gas that emits soft X-rays (Snowden et al 2014).
Many previous spectroscopic studies have shed light on its dynamics (Redfield & Linsky 2008, Gry & Jenkins 2014), gas-phase composition (Lehner et al 2003, Redfield & Linsky 2004a), ionization state (Jenkins et al 2000), temperature and turbulent velocities (Redfield & Linsky 2004b) and the presence of a very hot medium in some nearby locations. A review of many findings on the local medium has been presented by Frisch, Redfield, & Slavin (2011).
The recent (cycle21) HST Treasury Program ASTRAL produced high-resolution, complete UV spectra of a few nearby hot stars. The detailed analysis of one of them, alpha Leo (Gry & Jenkins 2017) revealed important details on the conditions in the local cloud. Together with a preliminary analysis of other ASTRAL spectra it brought up important questions on 1) the role of the magnetic field and non-equilibrium conditions in the physics of the interfaces between the local cloud and the surrounding hot gas, 2) its relation with the Local Leo Cold Cloud, a dense, unusually cold cloud in the Local Bubble which seems to be kinematically related, and 3) the nature of some of the secondary velocity components tentatively interpreted as shock waves progressing inside the cloud. New observations to be performed with the Hubble Space Telescope in March 2018 will bring bring the opportunity to study in depth the physics of thermal interfaces between warm and hot gas.
The thesis will address these questions and their implications to the broader subject of the general ISM. There will be a data analysis aspect with profile fitting of absorption lines in UV spectra from the ASTRAL program, the new HST observations to come, as well as from the HST archive. The interpretation of the data will tackle the physics of thermal interfaces between warm and hot gas, the effects of shock wave progression in diffuse partly ionized gas, and/or the formation of clumps of dense gas within diffuse clouds. Finally, the thesis will involve or lead to a possible implication in future UV spectroscopic instruments on-board space missions like LUVOIR (NASA).

Bibliography:

Frisch, P. C., Redfield, S. & Slavin, J. D. 2011, ARA &A, 49, 237
Gry, C. & Jenkins, E. B. 2014, A&A, 567, A58
Gry, C. & Jenkins, E. B. 2017, A&A, 598, A31
Jenkins, E. B., Oegerle, W. R., Gry, C., et al. 2000, ApJ, 538, L81
Lehner, N., Jenkins, E. B., Gry, C., et al. 2003, ApJ, 595, 858
Redfield, S. & Linsky, J. L. 2004a, ApJ, 602, 776
Redfield, S. & Linsky, J. L. 2004b, ApJ, 613, 1004
Redfield, S. & Linsky, J. L. 2008, ApJ, 673, 283
Savage, B. D. & Sembach, K. R. 1996, ARA&A, 34, 279
Welsh, B. Y., Lallement, R., Vergely, J. L. & Raimond, S. 2010, A&A, 510, A54