LERMA-CY
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From Interstellar Clouds to Planetary Systems: Investigating the Formation and Evolution of Molecules in Space

Funded 3-year Ph.D. project, starting October 1st, 2023

Keywords : experimental astrochemistry – surface science – IR spectroscopy – interstellar molecules – cosmic dust grains – interstellar ices - prebiotic molecules – *complex organic molecules – desorption/diffusion on cosmic dust grain analogues*

Context: The detection of nearly 200 different molecular species in space over the last 50 years demonstrates that the interstellar medium (ISM) is home to a rich chemistry. In the last decade our laboratory has contributed greatly to the understanding of ***how molecular complexity develops in space***, by synthesizing new molecules under interstellar cloud conditions, by publishing a couple of papers about the sticking properties of hydrogen on dust grains, by exploring the **thermal and non-thermal mechanisms** of the return of molecules to the gas phase, and by impacting the scientific scene with papers concerning the ***diffusion at low temperatures*** of key atoms (H, O, and N) on surfaces of astrophysical interest.

Thesis work: Given the variety of laboratory techniques used at LERMA-CY, that is 1) **Surface science mechanisms** in astrophysics, 2) **Mass spectrometry**, temperature-controlled desorption (**TPD**) and temperature-controlled during exposure desorption (**TP-DED**), 3) Fourier Transform Infrared (**FTIR**) spectroscopy, and the various ongoing research topics (see https://cylerma.cyu.fr/), an example of thesis work could be to expand the experimental study of the **mobility of species to selected molecules and radicals** (CO, NO, OH, ...) adsorbed on ice mantles. In fact, one of the important parameters that sparks chemistry in very cold cosmic environments is the **diffusion capability of adsorbed species**, which can lead to the formation of more *complex organic molecules*, especially if atoms are locked-up in heavy and almost immobile radicals (HCO, NH_2). Depending on the background and specific skills of the successful candidate, however, the thesis work may equally unfold on the **infrared spectroscopy of pure, mixed, and processed interstellar ices**. In fact, a robust and a fairly reliable identification of the chemical species in the ISM can only be based on the comparison of laboratory experiments and telescopic observations. As a further alternative, the project could address the **reactivity** of selected species leading to **complex organic molecules** in the interstellar medium, protoplanetary disks, and comets.

Skills: Master degree in chemistry, physics, astrophysics, or similar fields; prior experience with laboratory experiments and/or astrochemical modelling would be an asset, but is not required. Coding skills are a plus (e.g., Python), as well as a good written and oral level of English.

Procedure: Informal inquires are welcome (francois.dulieu@cyu.fr, emanuele.congiu@cyu.fr). Applicants should submit a detailed CV, letter of motivation, letter of intent, and arrange for at least one recommendation letter, **to be sent by June 1st 2023**.

Each application will receive full consideration and applicants will be interviewed.

The successful Ph.D. student will be hosted at the LERMA-CY Lab (5, mail Gay-Lussac, 95000 Neuville sur Oise – CERGY-PONTOISE).