The role of charges in the evolution of astrophysical ices

Funded 3-year Ph.D. project, starting October 1st, 2025

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

Astrophysical 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. Interstellar chemistry develops at extremely cold temperatures (10-100K). Intriguingly, even in these extreme environments, matter spontaneously evolves towards prebiotic molecules (e.g. peptides, sugars, etc.) which we are studying experimentally in the laboratory. At these temperatures and pressures, there is no liquid, but salts can still form, and the electrical conductivity of ice has been demonstrated. The role of charges in this chemistry at very low temperatures needs to be redefined.

Thesis work: The thesis work will involve carrying out laboratory experiments to reveal the role of charges in the evolution of molecular films under astrophysical conditions. To do this, the student will use the VENUS UHV set-up (Congiu et al 2020), which consists of a series of atomic or molecular beams directed at a cold surface. The molecules can be detected by infrared or mass spectroscopies. Charges can be induced in situ (e.g. formation of salts) or deposited using a low-energy electron gun (a few eV). Currents can be collected on a cold electrode.

Skills: Master degree in chemistry, physics, astrophysics, or similar fields; prior experience with laboratory experiments and/or astrochemical modelling and/or quantum chemistry 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 inquiries 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 2025**.

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

The successful Ph.D. student will be hosted at the LIRA-CY Lab (5, mail Gay-Lussac, 95000 Neuville sur Oise – CERGY-PONTOISE). https://cylira.cyu.fr/

The employment contract will be that of a standard 36-month French PhD Studentship ‘contrat doctoral’. If the student wishes, he or she may be offered a doctoral assignment, such as outreach or teaching.