Diffusion of reactants on highly porous cosmic dust analogues

Funded 3-year Ph.D. project, starting February 1st , 2026

Keywords: experimental astrochemistry – ultrahigh vacuum experiments – interstellar medium – interstellar ices – cosmic dust grains – surface chemistry – porous dust analogues – diffusion barriers – diffusion on porous dust grains – surface reactions

Astrophysical Context: In space, molecular complexity arises from a subtle interplay between gas-phase and surface chemistry on interstellar dust grains. These grains are coated or mixed with amorphous ices and act as catalytic platforms where atoms and molecules meet, diffuse, and react to form more complex species. While decades of experiments have revealed how ices form and desorb, the microscopic diffusion mechanisms of reactants on porous, fractal dust surfaces remain poorly constrained — even though they control most of the chemistry in cold interstellar environments. The ANR–DFG project DIFFUSIONSPACE unites the LIRA-CY laboratory (CY Cergy Paris Université, France) and FSU Jena (Germany) to investigate how molecular diffusion and desorption occur on realistic, porous analogues of cosmic dust.

Objectives: The Ph.D. student will perform laboratory experiments under ultrahigh vacuum and cryogenic conditions to quantify the diffusion of reactive species (H, O, OH, CO_2, NH_3, H_2CO, H_2O) on porous amorphous carbon and silicate grains. Experiments will use temperature-programmed desorption (TPD), infrared spectroscopy (FTIR), and atomic/molecular beam techniques to derive diffusion and desorption barriers, and to study how porosity and morphology affect reactivity.

In close collaboration with the German team, the candidate will also participate in sample characterization and exchange missions (Jena ↔ Cergy), and use modelling tools to interpret data in terms of diffusion coefficients and activation energies. The combined results will yield the first quantitative framework for porosity-driven diffusion in astrophysical environments, with implications for the formation of complex organics.

Skills: Applicants should hold a Master's degree in physics, chemistry, astrophysics, or related fields. Experience with vacuum systems, cryogenics, spectroscopy, or laboratory astrochemistry will be appreciated but not mandatory. Programming or data analysis skills (Python, Matlab, etc.) are a plus, as is an interest in modelling microscopic kinetics. Strong proficiency in English (spoken and written) is required.

Procedure: Informal inquiries are welcome and encouraged (emanuele.congiu@cyu.fr, francois.dulieu@cyu.fr). Applicants should submit a CV, a motivation letter, Master's transcripts, and at least one recommendation letter.

Applications will be accepted on a **rolling basis** ("au fil de l'eau") starting from December 15th, 2025, until the position is filled.

The successful Ph.D. student will be hosted at LIRA-Cergy laboratory https://cylira.cyu.fr/ (CY Cergy Paris Université, 5 mail Gay-Lussac, 95000 Neuville-sur-Oise, France) and will benefit from collaborative exchanges with Friedrich Schiller University Jena, Germany.

This position is **fully funded** by the ANR PRCI DIFFUSIONSPACE project for **36 months**.