



LABEX
LIO
UNIVERSITÉ DE LYON

Offre d'emploi :

Contrat postdoctoral en Physique Subatomique (H/F) à l'IP2I Lyon, Labex LIO "Cross section measurements for the p-process nucleosynthesis"

Postdoctoral position - CDD	Job: catégorie: A+	Qualifications: PhD
Period 24 month / 2 years	Remuneration: Selon expérience, sur la base de la grille de rémunération en vigueur à l'Université de Lyon¹	Starting date: between September 1, 2022 and November 1, 2022

The Université de Lyon is a world-class academic site of excellence. It is located at the heart of the Auvergne-Rhône-Alpes region, in Lyon & Saint-Étienne.

The Université de Lyon, which is structured around 12 member institutions and 25 associated institutions, has three major objectives:

- To be a major, attractive and responsible university
- To provide outstanding training and research opportunities
- To develop and promote the dynamics of the Lyon Saint-Etienne site

Description of LabEx LIO

In 2011, The Lyon Institute of Origins LabEx was selected following the first "Laboratory of Excellence" call for projects, part of the "Investissement d'Avenir" program for forward-looking research. It is one of 12 LabExes supported by the University of Lyon community of universities and establishments (COMUE). LIO brings together more than 200 elite researchers recruited throughout the world and forming 18 research teams from four laboratories in the Rhône-Alps region, all leaders in their fields, under the auspices of the University Claude Bernard Lyon 1 (UCBL), the Ecole Normale Supérieure de Lyon, and the CNRS. LIO's goal is to explore questions about our origins, operating in a broad field of study that ranges from particle physics to geophysics, and includes cosmology, astrophysics, planetology and life.

¹ Exclusivement pour les contractuels

JOB DESCRIPTION

Supervisor:

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Job location:

Most of the work is performed in the [IP2I Laboratory](#)

Domaine scientifique de la Doua

Bâtiment Paul Dirac
4, rue Enrico Fermi
69622 Villeurbanne CEDEX

Research project:

In the Universe chemical composition, several elements beyond iron are observed to have stable isotopes situated on the proton-rich side of the stability valley: these isotopes are called **p-nuclei**. Their specificity is that they cannot have been produced by neutron-capture processes, contrary to the majority of nuclei heavier than iron. The nucleosynthesis mechanism that leads to the formation of p-nuclei is called the **p-process**. According to the dominant astrophysical scenario, it takes place during core-collapse supernovae, and mainly involves the photodisintegration of a seed population of nuclei originating from the neutron rich side of the stability valley. First, several neutrons are expelled by (γ, n) reactions, but the final abundance of the different p-nuclei crucially depends on (γ, p) and (γ, α) reactions that occur in the end. They are an essential input for the nucleosynthesis calculations that aim to test different astrophysical models to reproduce the observed abundance of p-nuclei.

Globally, the p-process involves a network around 2000 nuclei and 20000 reactions, most of which cannot be measured experimentally. **Nucleosynthesis calculations have to rely on theoretical calculations** of cross sections based on the Hauser-Feshbach statistical model. The nuclear statistical parameters that allow to perform such calculations are the optical

model potentials, the level density and the gamma strength, which are themselves described by different models. **Experimental data are much needed to better constrain these models.** Especially, it is repeatedly mentioned in the literature that the lack of experimental knowledge on the alpha-nucleus optical potential at energy of astrophysical interest (namely far below the Coulomb barrier) hinders the progress in the nucleosynthesis modeling. Our project is focused on the measurement of cross sections that are crucial to improve the knowledge of astrophysical reaction rates.

We have selected several key reactions for this purpose. The main objective of our project is to perform **alpha and proton capture experiments at the NFS-SPiRAL2 facility**, whose high-intensity alpha and proton beams in the relevant energy range offers a unique opportunity to access the very low cross sections that are needed in the astrophysical context. These measurements will involve two types of techniques: if the lifetime of the reaction product allows, the well-known **activation** technique can be used ; else, **in-beam** techniques have to be employed to count the gamma rays produced instantaneously after the reaction. We plan to perform such experiments around 2023. Meanwhile, **preparatory experiments** should be performed at medium-scale facilities, to better control the classical experimental issues before facing the new challenges associated with very high intensity. Furthermore, the knowledge of alpha-nucleus optical potentials also need to be increased by **complementary alpha-scattering measurements**: the exploration of isotopic and deformation effects should be particularly enlightening, and several such measurements will take place in the next years, for instance at the Orsay Split-Pole facility.

QUALIFICATIONS / SKILLS

Qualifications:

The candidate must hold a PhD in experimental nuclear physics/astrophysics.

Skill:

The ideal candidate should have facilities in conducting an experimental program involving large collaborations and international facilities. Skills in running complex codes, nuclear reaction codes (Ex: TALYS) and simulation codes (Ex: GEANT4), and in programming (C++,python) are very welcome. Experience in experimental gamma-ray spectroscopy (with very high resolution Germanium detectors or gamma-ray calorimeters) is an advantage.

Research requirements:

Most of the work is performed in the [IP2I Laboratory](#) and consists in conducting an experimental research program using international infrastructures: it thus required to travel on a regular basis. The recruited candidate will have the charge to develop our p-process program and thus she/he will have to manage the experiments already accepted and the ones to be proposed. It requires also to perform data analysis and simulations in close collaboration with a PhD student. As well, the candidate will have the charge to strengthen our collaboration with the [“Laboratoire de Géologie de Lyon – Terre, Planètes, Environnement”](#) which is working also on the p-process though measurements of compositions of micrometeorites.

Most of the experimental work is performed using international facilities such as [ALTO](#) at Orsay or [NFS-SPIRAL2 at GANIL/Caen](#) using existing (split-pole, gamma-ray) detectors.

SELECTION PROCESS

Information about the job:

C.Ducoin Institut de Physique des 2 Infinis de Lyon Campus LyonTech la Doua, bâtiment Dirac 4 rue Enrico Fermi, 69622 Villeurbanne France TEL: +33 (0)4 72 43 13 41 c.ducoin@ipnl.in2p3.fr	O.Stézowski Institut de Physique des 2 Infinis de Lyon Campus LyonTech la Doua, bâtiment Dirac 4 rue Enrico Fermi, 69622 Villeurbanne France TEL: +33 (0)4 72 43 13 46 o.stezowski@ip2i.in2p3.fr
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Request candidature:

Applicants must email a **CV, a statement of interest, a letter of recommendation and contact details for 2-3 references** at c.ducoin@ipnl.in2p3.fr and o.stezowski@ip2i.in2p3.fr before April the 1st, 2022.