GIANT INTERNATIONAL INTERNSHIP PROGRAMME

PROPOSED INTERNSHIP PROJECTS

2023

Research projects proposed to students from Universidade Federal da Paraiba (UFPB)

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HOW TO APPLY?

GIANT INTERNATIONAL INTERNSHIP PROGRAMME – 2023

The GIANT International Internship Programme (GIIP) is a unique opportunity for non-European students to gain first-hand experience of scientific research and innovation in state-of-the-art facilities in Grenoble, France.

The GIIP provides placement in the GIANT Campus laboratories and companies as well as tailored welcome services, such as housing and administrative assistance.

You can find more information on GIANT and the GIIP on the following websites:

- www.giant-grenoble.org
- www.internships.giant-grenoble.org

There are on intake:

- Spring intake from January/February to May/June

Dates can be flexible and will be discussed and decided between the supervisor and the student.

If you are interested in this program, please send your application at giant.internship@cea.fr.
***Email subject**: GIIP 2023: application – project [number of project to mention]*
Please attach to your email:

- the attach application form filled exhaustively
- a CV /resume
- a personalised cover letter (please, make sure you tailor the cover letter to the research project. If you're interested in several projects, please send a cover letter per application)
- your latest report card and transcript (even non official)

There are no French language requirements, but applicants must be fluent enough in English to work in a laboratory and interact with their colleagues.

DEADLINE FOR APPLICATION

Applications to the GIIP will be opened until **Monday 2 January 2023 at the latest.**

The sooner you send in your application, the better it will be considered.

PROJECT 1 – CATALYTIC HYDROTHERMAL GASIFICATION OF SEWAGE SLUDGE UNDER MILD OPERATING CONDITIONS

Supervisors' name

- Supervisor 1: Hary DEMEY CEDENO
- Supervisor 2: Alban CHAPPAZ (in case of absence)

GIIP Intake: Spring intake from January/February to May/June

Institute: CEA Grenoble

Laboratory: CEA-LITEN/DTCH, Reactors and processes laboratory (LRP)

Keywords: Supercritical water gasification, catalysts, waste valorisation, hydrogen, methane, sewage sludge

Description of the project:

Hydrogen and methane production from wastes is a hot topic that has attracted great interest in the energy transition in the recent years. Different thermochemical conversion processes of biomasses and wastes implemented at the LRP laboratory (such as hydrothermal gasification), contribute to produce gaseous molecules with a high heating value (HHV). Hydrothermal gasification (HTG) process employs the supercritical conditions of water (T > 374 °C, P > 221 bar) for converting the organic carbon contained in the wet feedstock into a gaseous phase (which contains CH_4, H_2 and CO_2 species). This process is endothermic and requires severe operating conditions of temperature and pressure (T~600 °C and P~300 bar) for obtaining the best conversion yield. Thus, the utilization of catalyst-materials has been studied recently, to improve the efficiency of carbon conversion into gas at mild temperatures (400 °C-500 °C) and also to increase the gas selectivity towards methane and/or hydrogen [1, 2]. However, the reaction pathways, which represent the key for understanding the biomass conversion in supercritical conditions, are poorly studied in the literature. The internship aims to study the impact of several commercial catalysts and their interaction with inorganic species present in the sewage sludge at different operating conditions. This study will lead to improve the understanding of the influence of the inorganic species on: i) the catalytic conversion of sewage sludge in supercritical conditions, and ii) the process selectivity towards a gas richer in hydrogen or methane.

The selected candidate will work with the HTG reactors (under supervision of the laboratory technical staff), and will be implicated with several analytical techniques for biomass and gas characterization (such as elemental and calorimetric analyses, gas analyses by micro-GC equipment, aqueous phase analyses by ion-chromatography, etc.).

Student profile

The work requires high level of experimental skills to operate sophisticated equipment and analytical mind-set for interpreting measured data

Recommended background:

- Chemical engineering and/or process engineering
- Knowledge of thermal-conversion processes and catalysis science
- Comfortable with experimental lab-work
- Excellent communication skills (oral and writing)
- Good organization and self-management skills
- Ability to work in a collaborative team towards a common goal

References

- [1] Chen, Y., Lei, Y., Sha, L., Jiarong, Y., Hui, J., Catalytic gasification of sewage sludge in near and supercritical water with different catalysts, Chemical Engineering Journal 388 (2020) 124292
- [2] Q. Guan, Z. Kong, Z. Xie, Y. Chen, S. Chen, S. Tian, P. Ning, Catalytic gasification of phenol in supercritical water over bimetallic Co–Ni/AC catalyst, Environmental Technology 16 (2019) 2182-2190

PROJECT 2 – NEUTRON SPECTROSCOPY DATA ANALYSIS AND RHEOLOGY OF PROTEINS IN CROWDED SOLUTIONS

Supervisor's name

- Supervisor 1: Tilo SEYDEL

GIIP Intake: Spring intake from January/February to May/June

Institute: Institut Laue Langevin

Keywords: neutron spectroscopy, biophysics, data analysis

Description of the project

Depending on the protein type and concentration, salt type and concentration, as well as on the temperature, aqueous solutions of proteins can display complex phase diagrams. These phases comprise fully dissolved regimes, so-called re-entrant dissolution regimes, as well as turbid and precipitate regimes and a liquid-liquid phase separation (LLPS). When transiting between different regimes, the protein dynamics is strongly affected by transient or static cluster formation and the possible entry into gel-like arrested states. The turbid and re-entrant regimes are assumed to be caused by an increasing charge-screening and ultimately inversion of the protein surface charge by the ions in the solution. The complex phase diagrams are being investigated since recently using neutron spectroscopy, and protein cluster formation has been observed as well as quantitatively modeled, depending on both the added salt [M. Grimdaldo et al., J.Phys.Chem.Lett. 6, 2577 (2015); M. Grimdaldo et al., Quart.Rev.Biophys. 52, e7 (2019)] as well as on the crowding [M.K. Braun et al., J.Phys.Chem.Lett. 8, 2590 (2017) ; C.Beck et al., J.Phys.Chem. B 122, 8343 (2018) and C.Beck et al., Soft Matter 17, 8506 (2021)]. The new project will continue these studies by exploring the entry into dynamically arrested states. Neutron spectroscopy data accessing this regime are already available, and it is planned to carry out complementary rheology experiments. Depending on availability of neutron beam time, new neutron spectroscopy experiments will also be performed. The project involves the use of commercially available proteins such as bovine serum albumin or caseins from bovine milk.

Student profile (recommended background, required competences & knowledge, soft skills…):
The trainee will analyse existing neutron scattering data on concentrated protein solutions and carry out complementary rheology experiments in the PSCM.

Level required:
4th year university studies in physics

Language skills:
As an international research centre, we are particularly keen to ensure that we also attract applicants from outside France. You must be able to communicate in English or in French.

PROJECT 3 – NETWORKING ASSISTANT FOR THE FOSTERING SCIENCE PROGRAM

Supervisor's name

- Supervisor 1: Eric Gouré
- Supervisor 2 : An Phung

GIIP Intake: Spring 2023 (from January/February to May/June)

Institute: Grenoble Alps University – Fostering Science Programme

Keywords: community creation, events, interviews

Description of the project

Fostering Science is a support program under the supervision of Grenoble Institutions (universities and research organizations). Its goal is to inform and help researchers who wish to apply for competitive calls to carry out their innovative research projects in a Grenoble-based institution. Fostering Science specializes in European fundings such as the ERC program and the Marie Sklodowska Curie program (notably the MSCA Postdoctoral Fellowship) where the selection is very competitive and at a high international level. That is the reason why this program offers researchers an awareness of the potentialities of those fundings. It also gives the opportunity to evaluate their own eligibility conditions, but also documented information and strong support for their applications to ensure maximum chances of success. For more than 10 years, Fostering Science has been consolidating its know-how through a proven process. Its ambition is to optimize researchers' chances of success because their success is the one of the region and the reputation of Grenoble is growing.

In order to make the program better known in Grenoble and to improve our support to the researchers and thus the competitivity of the Grenoble site, we have launch a series of actions notably a communication strategy. In the framework of this evolution, we are looking for an intern who will be in charge of the creation of community networkings by following our new media plan with the following missions:

- Creation of two communities for Grenoble area:
  - A community of MSCA fellows (10-20 fellows max)
  - A community of ERC fellows (50-100 fellows)
- Creation of associated events, for instance :
  - A formal, official event (annual? monthly?…)
  - Informal events (like Pint of Science,…)
- Propose guidelines to manage and animate the networks
- Spread those new actions to the targeted audience by managing the digital communication channels: LinkedIn, mails, new web site updates

Co organization and interviews of laureates (testimony)

NB: the last two actions will be conducted in close collaboration with the other internship (communication assistant)

Student profile (recommended background, required competences & knowledge, soft skills…):

- Interpersonal skills
- Organisation skills
- Interest in science

Level required:

At least Bachelor's Degree

Language skills:

Fluent in English, both written and spoken.

PROJECT 4 – COMMUNICATION ASSISTANT FOR THE FOSTERING SCIENCE PROGRAM

Supervisor's name

- Supervisor 1: Eric Gouré
- Supervisor 2 : An Phung

GIIP Intake: Spring 2023 (from January/February to May/June)

Institute: Grenoble Alps University – Fostering Science

Keywords: Communication

Description of the project

Fostering Science is a support program under the supervision of Grenoble Institutions (universities and research organizations). Its goal is to inform and help researchers who wish to apply for competitive calls to carry out their innovative research projects in a Grenoble-based institution. Fostering Science specializes in European fundings such as the ERC program and the Marie Sklodowska Curie program *(notably the* MSCA *Postdoctoral Fellowship*) where the selection is very competitive and at a high international level. That is the reason why this program offers researchers an awareness of the potentialities of those fundings. It also gives the opportunity to evaluate their own eligibility conditions, but also documented information and strong support for their applications to ensure maximum chances of success. For more than 10 years, Fostering Science has been consolidating its know-how through a proven process. Its ambition is to optimize researchers' chances of success because their success is the one of the region and the reputation of Grenoble is growing.

In order to make the program better known in Grenoble, Fostering Science is currently redesigning the logo and the website as a part of our communication strategy. For this reason, we are looking for a Communication & Journalism Intern who will be in charge of the following missions by initiating our new media plan:

- Create communication media based on existing materials presentation, poster, flyer…by using the Canva Pro web platform.
- Spread those media to the targeted audience.
- Write scenario for the audition of laureates (ERC, MSCA) and conduct interviews which will be published on the new website - NB : action will be conducted in close collaboration with the other internship (community networking assistant)
- Manage any updates for the new Fostering Science website through continual communication
- Management of digital communication channels: social media (LinkedIn), mails and of public relations: events, invitations, information…

Student profile (recommended background, required competences & knowledge, soft skills…):

- Interpersonal skills
- Organisation skills
- Interest in science.

Level required:

At least Bachelor's Degree

Language skills:

Fluent in English, both written and spoken.

PROJECT 5 – MANIPULATION OF MAGNETIC SKYRMIONS FOR NEUROMORPHIC COMPUTING

Supervisor's name

- Supervisor 1: Olivier BOULLE

GIIP Intake: Summer 2023 (May to July/August)

Institute: CEA IRIG, SPINTEC

Keywords: magnetic skyrmions, neuromorphic computing, spintronic devices

Description of the project

Context

Magnetic skyrmions are texture composed of spins that whirl closely to form a topologically stable, chiral structure (see Fig.1 (a-b)). Their size can be as small as a few nanometers. Skyrmions can also be manipulated by electric currents, which has led to novel concepts of non-volatile magnetic memories and logical devices where skyrmions in nanotracks encode the information. The nanometer size of skyrmions, combined with the low current density required to induce their motion, opens a path for devices that combine high storage density, high speed execution and low energy consumption.

A first step toward application was made in Spintec with the first direct observation of magnetic skyrmions at room temperature in ultra-thin Pt/Co(1nm)/MgO multilayer nanostructures [1] and the demonstration of their fast (>100 m/s) manipulation using electrical currents [2].

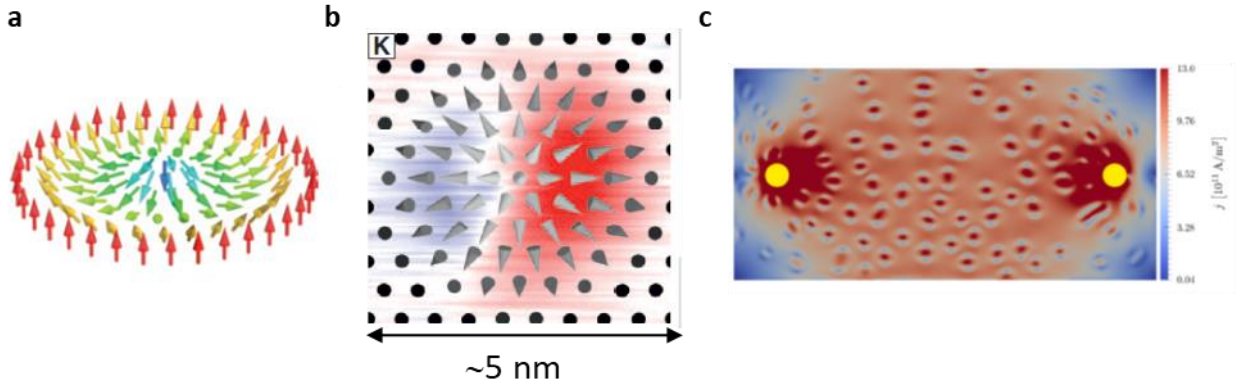

Figure 1a Schematic representatioin of the spin texure of a magnetic skyrmion b. Spin polarized scanning tunneling microscopy (SP-STM) of a magnetic skyrmion in FePd(2ML) on Ir(111) at 4.2 K [3]. c Proposal of skyrmion reservoir computing device: the current injected in the magnetic film at the position of the yellow dots, leads to oscillation of the skyrmion texture. The resulting changes in the device resistance can be used to recognize temporal pattern for speech recognition. [4]

Recently, unconventional computing schemes, such as neuromorphic or reservoir computing, have been proposed where skyrmions are used to solve standard complex machine learning problems (classification, prediction) with very low energy consumption [4]. The nanometer size of magnetic skyrmions and their

non-volatility would allow gains of several orders of magnitude in computing speed and delay compared to current neuromorphic computing devices based on standard CMOS architectures.

In this internship, we propose to demonstrate the potential of magnetic skyrmions for neuromorphic computing by showing the basic functionalities of logic devices based on the manipulation of magnetic skyrmions for non-conventional computing. The first step will be to fabricate neuromorphic devices based on the manipulation of skyrmions and demonstrate their basic functionalities. The final objective will be the demonstration of the resolution of standard learning problems.

Work program & Skills acquired during internship

The internship will be based on all the methods and experimental techniques used for the development and characterization of spintronic devices: sputtering deposition of ultra-thin multilayers and the characterization of their magnetic properties by magnetometry methods, then nanofabrication of nanostructures by electron beam lithography and ion etching. The nanofabrication will be performed at the PTA nanofabrication platform located in the same building as the Spintec laboratory. The manipulation of the skyrmions in the nanostructures will then be characterized by Kerr effect optical magnetic microscopy (MOKE). The data will then be analyzed using neural network algorithms in order to achieve pattern recognition tasks.

Reference

[1] O. Boulle *et al.*, Nat Nano 11, 449 (2016).
[2] R. Juge *et al.*, Phys. Rev. Applied 12, 044007 (2019).
[3] N. Romming *et al.*, Science 341, 636 (2013).
[4] D. Pinna *et al.*, Phys. Rev. Applied 14, 054020 (2020).

Student profile (recommended background, required competences & knowledge, soft skills…):

- **Studies**: Master 2 in nanophysics or equivalent
- **Background**: Solid state physics, magnetism
- **Required skills**: curiosity, interest in fundamental and applied science, motivation
- **Language**: fluent in English

PROJECT 6 – EVALUATING THE IMPACT OF EXPERIMENTAL CONDITIONS ON SIGNAL DRIFTS IN NANO-RESONATOR MASS SPECTROMETRY DATA.

Supervisor's name

- Supervisor 1: Thomas FORTIN
- Supervisor 2: Christophe MASSELON

GIIP Intake: Summer 2023 (May to July/August) or Autumn 2023 (September to December)

Institute: CEA IRIG, Large Scale Biology Laboratory

Keywords: nanoresonator mass spectrometry, experimental data analysis.

Description of the project (context of the project, missions, aims, experimental techniques,):
In cooperation with the CEA LETI, our group developed a novel approach to determine the mass of viruses using nanoresonators mass spectrometry (See Dominguez-Medina et al. Science 2018, 362 (6417), 918–922). In this context, our spectrometer produces noisy discontinuous nanoresonator frequency traces where each discontinuity is interpreted as a virus detection. Once all discontinuities have been identified, a simple mathematical equation is used to retrieve an estimate of the virus mass distribution from the set of all discontinuities amplitudes. In order to better resolve this estimated mass distribution, we have designed a denoising software where the spectrometer signals are modelled as discontinuous linear piecewise functions: the linear parts in our model are indeed meant to represent unexplained trends in the collected experimental data between signal discontinuities. These trends are believed to depend on experimental conditions and could represent flags for identifying if our device is operating under control or could be related to novel relevant experimental information. Therefore, we would like to better understand the correlation between our processing parameters, which regulate the linear part of our model, and experimental conditions, seen as a set of records of simple physical variables (e.g. temperature, pressure, etc.).

Student profile (recommended background, required competences & knowledge, soft skills…):
We would welcome a student with a background in analytical chemistry or physics, who is familiar with statistical analysis.

A knowledge of programming would be advantageous. He/she would be working in an interdisciplinary team and perform some denoising computations as well as data analysis.

PROJECT 7 – MAGNETIC MOMENTS AND SUPERCONDUCTIVITY IN NOVEL NICKELATE SUPERCONDUCTORS

Supervisor's name:

- Supervisor 1: Andrés Cano
- Supervisor 2: Quintin Meier (in case of absence)

GIIP Intake: Spring 2023 (February-April) – Summer 2023 (May-July/August)

Institute: CNRS, Grenoble Alpes University

Laboratory: Institut Néel, théorie de la Matière condensée

Keywords: Superconductivity, magnetism, density functional theory, computational physics

Description of the project:

In 2019, superconductivity was observed in Sr-doped $NdNiO_2$ [1]. This special nickelate has similar crystal and electronic structure as the high-T_c cuprates and has sparked a lot of interest in finding new high-temperature unconventional superconductors within this material class [2].

Up to this day, the exact mechanism leading to superconductivity in both the cuprates and the nickelates remains a conceptual challenge. Local magnetic correlations have recently been observed in a superconducting nickelate [3], which is intriguing for two antagonistic reasons: (i) fluctuating magnetic moments have been hypothesized to induce the superconductivity in both the cuprates although (ii) magnetic order is usually destructive to the superconducting state.

In this project, we will use state-of-the-art ab-initio electronic structure calculations in order to study theoretically the interplay between magnetic moments and crystal and electronic structure with a focus on the nickelate superconductors.

[1] Li, D. et al. Superconductivity in an infinite-layer nickelate. Nature 572, 624–627 (2019).
[2] A. S. Botana, F. Bernardini, and A. Cano, Nickelate superconductors: an ongoing dialog between theory and experiments, JETP 159, 711 (2021) arXiv:2012.02764
[3] Fowlie, J. et al, Nat. Phys. 18, 1043–1047 (2022)

Student profile
We look for a student with a background in physics, materials science or chemistry, who has a flair for theoretical condensed matter physics and computational methods. Basic programming skills a required.

PROJECT 8 – STRUCTURAL BIOLOGY OF RNA MODIFICATIONS

Supervisor's name:

- Supervisor 1: Eva Kowalinski

GIIP Intake: Summer 2023 (May to July/August) – Autumn 2023 (September-December)

Institute: EMBL Grenoble

Keywords: Biochemistry, Structural biology, protein-RNA interactions, RNA modification, x-ray christallography, cryo-EM

Description of the project:

The central dogma of molecular biology described a linear flow of information from genes towards the protein level. However, many regulatory steps between tightly control actual gene expression, also on the level of RNAs. RNA modifications are ubiquitously present on all kinds of RNA molecules (mRNA, tRNA, lncRNA etc.) and in all kingdoms of life. They add a reversible layer of information on top of the coding sequence of the RNA. Modifications can effect RNA structure, stability and localization and the interaction with other cellular players. In humans, RNA editing events are also linked to diseases like amyotrophic lateral sclerosis (ALS), schizophrenia, epilepsy, neuronal disorders and cancers. In the Kowalinski lab at EMBL Grenoble, we study the biochemistry and structural biology of RNA modification mechanisms to understand how these modifications are specifically written, read or erased. Practically in the lab, we purify proteins and RNA and assess the sample quality by different biophysical methods before we proceed to structural analysis by x-ray crystallography or cryo-electron microscopy. Once a structure is solved and the model built, we interpret the models and test our hypotheses, on how a particular interaction could function with biochemical or cellular assays. The internship project will comprise a particular section of this workflow, best matching the applicant's interests and the status of a project.

Student profile
Biochemistry, molecular biology, cell