7 February 2024

Post-doctoral contract offer

To start before end of 2024

Subject : Electrostatic instabilities and transport in magnetized fusion plasmas – theory and simulations

Informations générales

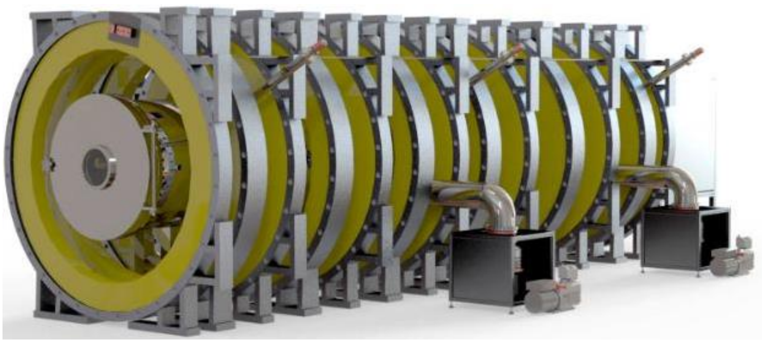
Workplace: Nancy, France (if absolutely necessary, remote work will be allowed for a few months)
Type of contract: Postdoctoral fixed-term contract, full-time
Contract period: 24 months (an extension by one year is possible – funds are available)
Expected date of employment: Between March and December 2024 (ideally: September)
Remuneration : Depending on experience, between 2597€ and 3246€ monthly before taxes
Typical monthly cost of life: About €400-500 for lodging, €300 food & misc.
Desired level of education: PhD **Experience required:** -

Subject description

To ensure the success of magnetic confinement thermonuclear fusion experiments such as ITER, and to design a commercial fusion reactor, we need to overcome a number of remaining scientific challenges. In particular, understanding and controlling instabilities and plasma turbulence is key in the future of fusion energy. The target of current research is a robust predictability of characteristics (linear and non-linear) and the macroscopic impacts of turbulence (mainly transport, or turbulent mixing). Several paths can be explored, depending on the recruited person:

1. Modeling cylindrical plasmas.

Linear devices enable fundamental investigation of edge physics in a cylindrical geometry that facilitates modelisation, instrumentation, measurements, and interpretations. A new linear device, called SPEKTRE, is under construction in our laboratory. It is designed to approach the main conditions encountered in the edge of fusion reactors such as ITER. A 2-minutes video presentation of SPEKTRE is available at http://bit.ly/ijl-spektre. It is a rather large device, the cylindrical vessel being almost 1 meter in diameter, and more than 6 meters in length. The magnetic field will range from 0.1 to possibly 0.9 T.



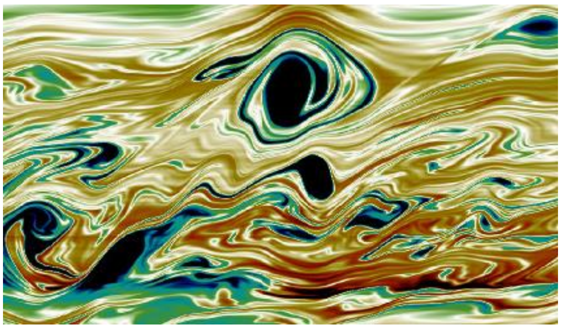
Conceptual drawing of the SPEKTRE device. The main vacuum vessel, 6 m long and 90 cm in diameter, houses a plasma confined by 13 copper coils (in yellow).

Theoretical modelisation of SPEKTRE plasmas is an opportunity to test and improve the predictive capabilities of existing models. It is also essential to prepare a **toolbox of modelisation** to be ready to exploit the future experiments. We will adopt a fluid and/or a gyrokinetic approach :

- Two different **electrostatic fluid codes** can be used, a specific BOUT++ module and/or the Numerical Linear Device (NLD) code. An important objective is to treat adequately boundary conditions (including sinks and sources of particles, energy, and momentum), and equilibrium flows. In addition, it will be interesting to model impurities self-consistently.

- The **gyrokinetic code** GYSELA can be used in a cylindrical limit by taking a very large aspect ratio. In this configuration, preliminary results show the presence of ITG and PVG instabilities. Simulations can be used to explore the nonlinear coupling between these waves.

2. Role of fine-scale structures in both real-space AND velocity-space.



In hot plasmas, collisions are so rare that vortex-like fine scale structures develop in the **phase-space** of the particle distribution: coupling both real space and velocity space. This is illustrated in the figure, which show fluctuations of the distribution function in the (x,v) phase-space. Many PS vortices of various sizes can form and interact, leading to a **new type of turbulence**, which can be explored by gyrokinetic simulations. More precisely, by isolating one type of low-dimensional turbulence (dominated by trapped-electron modes, TEM), as a fundamental prototype of more general turbulence, and taking advantage of the reduced gyrokinetic numerical simulation code TERESA, **phase-space structures can be investigated.**

In summary, the mission for this postdoctoral work is to perform numerical simulations of high-temperature, magnetized plasmas, in cylindrical and/or toroidal geometry, and to analyse the results based on linear, quasi-linear and non-linear theories, existing or to be developed. This work will provide the building blocks towards a more comprehensive turbulence theory, with academic and socioeconomic applications, not only in fusion energy, but in astrophysics, space weather, and space exploration as well.

Work context

The post-doc will work within the “Fusion Plasmas” research group based in Nancy, under the supervision of Dr. Maxime Lesur, in collaboration with the Institute for Magnetic Fusion Research in CEA Cadarache, both LPP and CPHT in Polytechnique near Paris, the LPIIM in Marseille, the Center for Energy Research in UC San Diego, and the RIAM in Kyushu University, Japan. The work program could include short stays in some of these laboratories.

This contract is funded by the Lorraine Université d’Excellence (LUE) initiative, and is part of one of the 200 projects selected by Institut Universitaire de France.

About Institut Jean Lamour

The Institut Jean Lamour (IJL) is a joint research unit (UMR 7198) of CNRS and Université de Lorraine. Focused on materials and processes science and engineering, it covers: materials, metallurgy, plasmas, surfaces, nanomaterials and electronics.

It regroups 183 researchers/lecturers, 91 engineers/technicians/administrative staff, 150 doctoral students and 25 post-doctoral fellows. Partnerships exist with 150 companies and our research groups collaborate with more than 30 countries throughout the world.

Its exceptional instrumental platforms are spread over 4 sites; the main one is a new building located on Artem campus in Nancy.

In this large institute, the employees benefit from efficient administrative and technical services.

Application

Applicants are invited to send a résumé (free format) and cover letter to:
maxime.lesur@univ-lorraine.fr
if possible before March 15th, 2024.