Postdoctoral Research Position for the MANTIS project at LPP

Multi-scale Simulations of Solar Energetic Particle Injection and inner heliopshere propagation

Laboratory of Plasma Physics (LPP), France

Applications are now open
Application deadline: September 30th, 2026
Starting date: Flexible, between November 2026 and March 2027

Contact: Sophie.masson@lpp.polytechnique.fr

The **Laboratory of Plasma Physics (LPP)** invites applications for a postdoctoral research position to investigate one major challenge in heliophysics: how energetic particles are injected from the solar corona into the heliosphere and how their earliest propagation shapes the particle populations eventually detected near Earth and throughout the Solar System.

Solar energetic particles (SEPs) produced during flares and eruptive events can travel across the heliosphere within minutes, posing significant hazards to spacecraft, astronauts, and technological infrastructure. Yet, many fundamental questions remain unanswered. How do particles escape from their acceleration sites? How are they injected onto open magnetic field lines? How does the evolving coronal magnetic field modify their trajectories before they enter the solar wind? To what extent does the dynamic of the large-scale magnetic field during the eruptions influence the timing, intensity, and spatial extent of Solar Energetic Particle events observed near Earth?

To address these questions, we developed and a Particle-in-Cell (PIC) code that is now coupled to the state-of-the art 3D MHD code ARMS dedicated to study solar eruptions. This new multi-scale code has been developed for the MANTIS project which aims Modelling the acceleration and escape of energetic particles during solar flare and eruptive events.

The successful candidate will use this new-generation multi-scale code in order to design solar flare and eruptions models that combine the global evolution of the corona with kinetic descriptions of energetic particles. This unique numerical approach enables the self-consistent study of particle injection and the earliest stages of heliospheric transport in realistic eruptive environments.

This position offers an exciting opportunity to contribute to both the development of advanced computational methods and to our understanding of the physical processes that govern the escape of energetic particles from their acceleration site close to the Sun into the open heliosphere.

Research objectives

This post-doctoral project aims at investigating how energetic particles are released into interplanetary space and how the evolving magnetic environment influences their propagation close to the Sun.

This project is part of the MANTIS project for which we developed a newly multi-scale code designed to bridge the gap between global coronal dynamics and kinetic particle physics. Unlike traditional test-particle approaches that assume prescribed electromagnetic fields, this new multi-scale code relies on the coupling of global MHD models, using the ARMS code (DeVore 1991), describing the evolving magnetic structure of the solar corona and solar wind; and a fully kinetic Particle-in-Cell (PIC) code that resolves particle kinetics. This enables to develop simulations that capture the dynamic interaction between evolving magnetic structures and the particle populations, in a much more realistic description of SEP injection and early transport. The successful candidate will contribute to the development of highly scalable numerical tools capable of modelling coupled fluid-kinetic plasma systems and investigate fundamental questions at the frontier of heliophysics.

The successful candidates will perform state-of-the-art HPC simulations using the newly developed MHD-PIC code. The work will consist of first building new models of solar flares and eruptions that couple the closed corona and the open heliospheric field and that include the full kinetic treatment of particles. The analysis will focus on investigating :

- The particle escape from magnetic reconnection regions and influence of dynamically evolving magnetic fields on particle beam evolution;
- The magnetic connectivity between solar source regions and near-Earth space
- The escape of solar energetic particles onto open magnetic field lines;
- The temporal dispersion of energetic particle populations, evolution of particle pitch-angle distributions, longitudinal and latitudinal spreading of SEP events;
- The comparison with observations from modern heliophysics missions by developing methods to produce synthetic observables from the simulations.

A particular emphasis will be placed on understanding how the dynamic evolution of the coronal magnetic field modifies the timing, anisotropy, and spatial distribution of energetic particle beams during the earliest phases of their propagation, before they enter the large-scale heliosphere. While the multi-scale code is developed by our computational scientist, the successful candidate will develop post-processing routines to create synthetic observables (X-rays and radio signatures) that can be compared with observations.

The post-doctoral researcher will benefit from the team time allocation grant at the French National high-performance computers (e.g. Jean Zay @ IDRIS, ADASTRA @ CINES) in order to carry the numerical simulations that requires require state-of-the-art high-performance computing resources.

Within the MANTIS project, provisions have been made for the acquisition of computers to carry the work, to fund regular travels to international workshops and conferences where we expect the post-doctoral researcher to present his/her research work.

The research work will be published in peer-reviewed scientific journals and presented at national and international conferences.

Research Activities

The main expected activities include:

- Conducting innovative scientific research on solar flare and eruptions and their role in the release of solar energetic particles.
- Performing numerical simulations using HPC facilities
- Developing codes and post-processing tools to analyse the simulations results

- Collaborating with the MANTIS project team and the solar physics team at LPP, in particular to initiate collaboration related to the project.
- Disseminating research activities and results through team and project meetings, seminars, scientific articles, and conference presentations.
- There may be opportunities to supervise master students.

The Laboratory of Plasma Physics

The Laboratory of Plasma Physics is one of Europe's leading laboratories dedicated to plasma physics and space sciences. It brings together researchers studying plasmas across an exceptional diversity of environments, from laboratory experiments to the Sun, planetary magnetospheres, and the heliosphere. Expertise spans observations, numerical simulations, theory, laboratory plasma experiments, and the development of instrumentation for international space missions.

The LPP is implanted within the Paris-Saclay scientific campus (Palaiseau, France), and within Sorbonne University (Paris, France) LPP benefits from one of Europe's most dynamic research ecosystems including internationally renowned universities and research organizations (CNRS, École Polytechnique, Institut Polytechnique de Paris, Institute d'Astrophysique Spatiale (IAS), CEA, and ONERA) It offers a vibrant scientific atmosphere with regular seminars, workshops, international visitors, and extensive interdisciplinary collaborations.

The LPP solar physics team of LPP is based at Sorbonne University (Paris).

The salary depends on the experience of the candidate. French salaries already include employer-funded health insurance contributions so no additional cost should be added on the income.

The Paris area offers an exceptional combination of scientific excellence and quality of life. Beyond its world-famous cultural heritage, museums, music, and gastronomy, the region provides: a vibrant international scientific community; excellent public transportation; extensive parks and natural areas.

Candidate profile

Applications are encouraged from early-career researchers seeking a first postdoctoral appointment (completed his/her PhD after 2025), women and minorities are especially encouraged to apply. Due to requirements of the funding contract, applicants from an EU Member state, Norway, Switzerland or United Kingdom will not need pre-approval by the French government.

The candidate should have:

- A PhD in astronomy, astrophysics, plasma or solar physics and/or a related field. A publication record in peer-reviewed journals is essential.
- Advanced knowledge in solar physics, plasma physics, solar energetic particles, plasma simulations (MHD and/or PIC), magnetic reconnection, high-performance computing. Full expertise in all these fields is not required, but willingness to learn across the project's topics is essential.

- Advanced knowledge in scientific programming (C/C++, Fortran, Python, or similar) is required
- English proficiency at C1 level or higher.
- Strong scientific communication skills (oral and written).
- Proven ability to work collaboratively and as part of a team.

Applicants from both numerical and observational backgrounds interested in connecting simulations with space observations. Enthusiasm, scientific curiosity, and the ability to work collaboratively are valued as highly as prior experience with the specific numerical methods.

Application

Applications are **open now** and will be reviewed starting **September 1st, 2026** until the position is filled.

Applicants should submit by email to Sophie.masson@lpp.polytechnique.fr

- a curriculum vitae;
- a publication list;
- a statement of research interests (1–2 pages);
- contact information for two or three referees.

The anticipated starting date is **flexible between November 2026 and April 2027**, depending on the candidate's availability.

As part of its recruitment process, the École Polytechnique (and LPP) is committed to reviewing all applications without any form of discrimination. École Polytechnique is a diverse institution that is committed to preserving and strengthening this diversity.