Call for applications for a two year Postdoc position

Title of the postdoctoral project:

Strong-Field Quantum Processes in Plasmas in the Context of Extreme Light Laser Facilities

Project description:

This post-doctoral project is at the frontier of relativistic plasma physics and strong-field quantum electrodynamics. It aims at developing the theoretical and numerical framework necessary to tackle two important aspects of future experiments at Multi-PW optical laser facilities able to deliver ultra-short (~few cycles) light pulses of ultra-high intensities (up to 10^{23} W/cm^2). The Apollon laser, who started operating in 2020, and is managed by the LULI laboratory, is in that class of lasers. The postdoc will rely on both theoretical modeling and Particle-In-Cell (PIC) simulation with the open-source code SMILEI [Derouillat et al., Comp. Phys. Comm. **222**, 351 (2018); webpage: https://smileipic.github.io/Smilei/].

The aspects under study are:

(1) the problem of measuring the extremely high laser intensity of a pulse at focus;
(2) the study of the contribution of the electromagnetic Trident process in pair production.

1) Accurate measurement of the laser intensity at focus is today in most cases not possible and the laser intensity is only extrapolated from low intensity measurements. Yet it is a crucial information for studies of QED effects in laser matter/plasma interaction, and in particular for pair production. A promising idea for measuring ultra-high intensities has been recently put forward by Ciappina and co-workers [Ciappina et al., Phys. Rev. A **99**, 043405 (2019)] that may allow the direct and unambiguous measurement of ultrahigh laser intensities exceeding 10^{20}W/cm^2. It relies on the sequential tunnel ionization of heavy atoms with sufficiently high ionization potentials. This process is extremely sensitive to the laser intensity, thus measuring this or that ionization level of atoms after interaction with the strong laser pulse allows assessing the laser intensity experienced by the ionized atoms. The postdoc will work at building on this scheme, and at tuning it for conditions accessible to Multi-PW laser facility.
2) The study of the electromagnetic Trident process under conditions relevant to Multi-PW laser facilities is the second key aspect of the postdoctoral project. Electron-positron pair production will certainly be among the most exotic and exciting processes on extreme light facilities. Various processes for pair production involve ultra-relativistic electrons interacting with strong electromagnetic fields. These strong field can be the Coulomb field at the vicinity of highly charged ions or the laser fields of extremely intense pulses. The postdoc will be focused on the second situation. Two important contributions to the pair production process can exist : a two-step process that consists in the emission of a high-energy γ-photon by an ultra-relativistic electron in the strong laser field (inverse Compton scattering) and subsequently in the decay of this γ-photon through its interaction with the laser field (nonlinear Breit-Wheeler process), or direct conversion of the electron into pair in a strong field via a virtual photon (Trident process). The first on is thought to dominate in particular at large (laser) field amplitude, and is the the most largely studied. The one-step contribution may however prove more important than initially expected, and recent works [see, in particular, Dinu & Torgrimsson, Phys. Rev. D **97**,

036021 (2018) and Mackenroth & Di Piazza, Phys. Rev. E **98**, 116002 (2018)] provide us with tools to implement these corrections in PIC code, and thus to study the importance of the single step process in practical situations, such as forthcoming experiments.

The successful applicant will work with the theory group TIPS (Théorie, Interprétation, Plasma & Simulation) of LULI (Sorbonne University and Ecole Polytechnique), and the group "DYNAMICS OF QUANTUM SYSTEMS IN STRONG FIELDS" of LCPMR (Sorbonne University) on the theory and simulation of laser-plasma interaction at ultra-high and extreme intensities and theory and modelling of quantum processes in strong-fields. The project is two-fold, with a first part aimed at developing theoretical models and new physics modules for SMILEI, and a second part by providing theoretical support to and/or designing of future experiments at Multi-PW

Requirements for the candidate:

The candidate should hold a PhD in Plasma Physics, and have some experience in PIC simulations, laser-plasma interaction and/or strong-field QED. He/she should have a strong interest in theoretical and numerical studies and be motivated by high performance computing. He/she should be autonomous, rigorous, and have good communication skills. Good skills in both written and oral English are required.

Location and starting date:

The location is in LULI in Paris Center (Sorbonne Université, Campus Pierre et Marie Curie).
The position is for 24 months and the expected start will be no later than September 1st 2021.

Application:

The application should include :
-cover letter
-CV specifying past research experience,
-copies of degree diplomas and Master grades,
-publication list
-two reference letters to be sent separately at the address emails below.

The application should be sent by e-mail to:

caterina.riconda@upmc.fr, richard.taieb@upmc.fr and mickael.grech@gmail.com

Applications will be considered until May 30, after that the call will be closed.