Spécialité de Master « Optique, Matière, Plasmas »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 04/10/2013

Responsable du stage / *internship supervisor*:

Nom / *name*: **PRIGENT** Prénom/ *first name* : **Christophe**

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Nom du Laboratoire / *laboratory name*: INSP/GSI dans le cadre du labex **Plas@par**

Code d'identification : UMR75 88 Organisme : UPMC - CNRS

Site Internet / *web site*: http://www.insp.jussieu.fr/-Agregats-et-Surfaces-sous-.html

Adresse / *address:* Tour 22-12, bureau 323, case courrier 840 ; 4, place Jussieu 75005 Paris France

Lieu du stage / *internship place*: mainly at GSI– Germany (***supervisor: R. Grisenti***)

Titre du stage / *internship title*: **Matter under relativistic plasma conditions**

Résumé / *summary*

The dynamics of highly non-linear systems under non-equilibrium conditions is currently the subject of emergent researches at the forefront of Modern Physics. Several teams worldwide are implied, in particular in the field of particles – matter interaction. More specifically, our team seeks to understand how "the matter reacts" when submitted either to intense laser pulses (that induces plasma formation), or under highly charged ion impact (that leads to electron transfer). In many aspects, these two types of interaction present strong similarities like the establishment of an intense electric field generated by the excited matter that reaches values higher than 10^9 V/cm, i.e. corresponding to studies of "matter under extreme condition".

The proposed internship is especially dedicated to the study of matter during the interaction with ultra-intense laser pulses in the relativistic domain. In general, a significant fraction of the laser energy is transferred to the bulk material via the production of "hot" electrons at relativistic energies. Such extreme conditions allow the investigation of a huge variety of exciting phenomena, which range from the demonstration of tabletop-scale ion accelerators to the simulation of astrophysical phenomena in the laboratory. However, the extended transverse dimensions of the targets that are usually employed in such kind of experiments, micrometer-thin solid foils of mm^2 surface area, lead to a substantial lateral spread of the laser-produced hot electrons, reducing the hot electron density and, thus, precluding the heating of the target material to the very high temperatures of interest.

Liquid droplets beams turn out to be extremely attractive target systems with respect to the above applications. A droplet beam is produced by forcing a liquid in a laminar flow through a micrometer-sized orifice into vacuum. Initially, the liquid emerges as a continuous, cylindrical filament, before it spontaneously breaks up into a stream of spherical droplets. Droplets of different target materials can be in principle produced, yet for many of the most exciting applications the use of cryogenic target materials such as argon is mandatory. However, producing micrometer-sized argon droplets proves in general very difficult: Owing to the high vapor pressure of liquid argon, the expanding filament rapidly cools below its normal melting point and freezes well before the droplet formation can take place. During the internship, the student will thus learn how it is experimentally possible to overcome the above challenging issue. She or he will then directly participate at an experiment at the PHELIX laser facility at GSI with the aim to employ microscopic liquid argon droplets to the study of matter under high energy density (HED) plasma conditions, accessing electron densities and temperatures that range from ideal plasma conditions to strongly coupled and high-density Fermi degenerate plasma. High-resolution K-shell spectroscopy will allow providing direct insights into the laser-driven heating mechanisms of the droplet target material. The student will thus have the unique possibility to learn a variety of state-of-the-art experimental techniques in a range of topical research fields. A large part of the internship topics will be developed in Germany (GSI and university of Frankfurt) while it may be continue with a PhD in our group in France.

This internship will be supported by the Labex PLAS@PAR with a grant up to 4500 or 6500 € for 4 or 6 months respectively.

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : YES**

Si oui, financement de thèse envisagé/ *financial support for the PhD***: will be submitted to PLAS@PAR**

Lasers et matière	**X**	Lumière, Matière : Mesures Extrêmes	**X**
Optique de la science à la technologie		Plasmas : de l'espace au laboratoire	**X**

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