Spécialité de Master « Optique, Matière, Paris »

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

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : October 2015

Responsable du stage / *internship supervisor*:

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Nom du Laboratoire / *laboratory name*: physique des interactions ioniques et moléculaires

Code d'identification : umr 7345 Organisme : Aix-Marseille université & CNRS

Site Internet / *web site*: http://piim.univ-amu.fr

Adresse / *address:* service 362, campus Saint-Jérôme, Marseille

Lieu du stage / *internship place*: service 362, campus Saint-Jérôme, Marseille

Titre du stage / *internship title*: HAMILTONIAN DESCRIPTION OF ELECTRONS-WAVES INTERACTION

Résumé / *summary*

Wave-particle interaction is a fundamental process in the physics of warm and natural hot plasmas, of accelerators and of beams ; in particular, it is the basis of electromagnetic radiation amplifiers such as free electron lasers, gyrotrons, travaling wave tubes… Power densities in these devices and their wide frequency spectrum lead to instabilities which are increasingly critical and difficult to simulate nowadays. A microscopic description enables a better understanding of the coupling mechanisms between N particles (x_l, p_l) and M waves (with phases θ_j and intensities I_j) using a so-called **self-consistent** hamiltonian. For $N \to \infty$, the dynamics of this system converges to the one described with vlasovian kinetic equations.

Numerical simulation presently relies on two classes of models. Particle-in-cell (PIC) models rest on a minimal simplification of the physics equations but imply gigantic computing times, due to the very large number of degrees of freedom. Specialized models, on the contrary, permit only the simulation of particular regimes, albeit with incommensurately shorter computing times. The widely used envelope models are frequency-domain models in which the amplified wave is represented by the cold wave (propagating in the absence of a beam) modulated by an envelope function varying with the position along the propagation direction. This approach is not suited to the study of nonlinear regimes, such as instability saturation.

The internship will focus on the development of simple nonlinear systems and their numerical implementation toward application to the traveling wave tubes for the industry (Thales Electron Devices, Vélizy) and for fundamental research in our laboratory (Marseilles). It could be followed with a Ph.D. in collaboration and joint financial support with TED.

- Y. Elskens & D. Escande, ***Microscopic dynamics of plasmas and chaos*** (IoP Publishing, Bristol, 2003).
- F. André, P. Bernardi, N.M. Ryskin, F. Doveil & Y. Elskens, *Hamiltonian description of self-consistent wave-particle dynamics in a periodic structure*, **Europhysics Letters 103** (2013) 28004.
- Marseilles Ph.D.'s : A. Macor (2007), A. Aïssi (2008), P. Bernardi (2011).

Toutes les rubriques ci-dessous doivent obligatoirement être remplies

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***: CNES**

Lumière, Matière, Interactions	**X**	Lasers, Optique, Matière	**X**

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