Spécialité de Master « Optique, Matière, Plasmas »

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

Proposition de stage

Date de la proposition :

Responsable du stage / *internship supervisor*:

Nom / *name*:	CHARRON	Prénom/ *first name* :	ERIC
Tél :	01 69 15 61 14	Fax :	01 69 15 77 50
Courriel / *mail*:	eric.charron@u-psud.fr		

Nom du Laboratoire / *laboratory name*:

Code d'identification : ISMO — Organisme : Université Paris-Sud / CNRS

Site Internet / *web site*: www.ismo.u-psud.fr

Adresse / *address:* Université Paris-Sud, Bâtiment 350, 91405 Orsay cedex

Lieu du stage / *internship place*: Orsay et Hanovre (*voir proposition*)

Titre du stage / *internship title*:

Controlled transport of atom chip-generated quantum gases with minimum perturbations

Résumé / *summary*

Recent proposals in the field of fundamental tests of foundations of physics assume Bose-Einstein condensates (BEC) as sources of atom interferometry sensors. Indeed, thanks to their narrow momentum width and their slow expansion they represent a unique source in terms of coherence and compact size. Degenerate gases experiments were, however, suffering from long evaporation ramps and bulky experimental setups. Those two drawbacks have recently been overcome with the development of transportable BEC machines [1,2] with an atomic flux of 10^5 condensed atoms every second [3]. These developments take advantage of atom chip devices, which can deliver high magnetic field gradients at very modest power consumption. The proximity of the atoms to the chip surface is, however, limiting their optical access and the available free expansion time.

Transporting a BEC out of an atom chip surface is therefore necessary for precision measurements. Several protocols involving magnetic or optical transport have been proposed. In this internship, a theoretical study of the performance of displacing degenerate gases will be performed. Two types of traps will be considered: magnetic chip traps in combination with external coils and optical traps made by accelerating optical lattices.

The underlying principle of addressing the external degrees of freedom of an atomic system with these potentials is well understood and the student would merely have to apply it and assess the limits in distance and displacement times with a condition on the perturbation communicated to the atoms. The methods considered would start with a classical approach to find an optimized trajectory for a point-like particle with a minimum oscillation amplitude at the end of the ramp. In a second step, the calculated trap trajectory would be used as a time-dependent potential where the atomic wave packets evolve. This dynamics will be followed by solving Gross-Pitaevskii equations to account for the interactions within the condensed cloud of atoms. This study is perfectly reasonable for an internship duration of 5 months since the numerical toolbox is already available to the team in Orsay (contact person: E. Charron, email: eric.charron@u-psud.fr).

A collaboration with the E. M. Rasel team in Hanover, Germany (Institute of Quantum Optics, contact person: N. Gaaloul, email: gaaloul@iqo.uni-hannover.de) would be pursued to take advantage of the experimental and theoretical expertise of this group in the kind of manipulations mentioned above. The internee would have the chance to spend two months in this team.

References:

[1] T. van Zoest et al., Science **328**, 1540 (2010).
[2] H. Müntinga et al., Phys. Rev. Lett. **110**, 093602 (2013).
[3] J. Rudolph et al. New J. Phys. **17**, 079601 (2015).

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

Si oui, financement de thèse envisagé/ *financial support for the PhD***: Allocation École Doctorale**

Lasers, Optique, Matière	X	Lumière, Matière, Interactions	
Plasmas : de l'espace au laboratoire			