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 :

Responsable du stage / *internship supervisor*:

Nom / *name*:	Boiron	Prénom/ *first name* :	Denis
Tél :	01 64 53 33 54	Fax :	
Courriel / *mail*:	denis.boiron@institutoptique.fr		

Nom du Laboratoire / *laboratory name*: Laboratoire Charles Fabry de l'Institut d'Optique

Code d'identification : UMR8501 Organisme : Institut d'Optique Graduate School

Site Internet / *web site*: www.atomoptic.fr

Adresse / *address:* 2 avenue Fresnel, 91127 Palaiseau

Lieu du stage / *internship place*: Laboratoire Charles Fabry

Titre du stage / *internship title*: Two particle interference and entanglement

Résumé / *summary*

Our group has perfected methods to detect cold atom clouds released from a trap in three dimensions and with single atom sensitivity. We have been using this method to perform fundamental experiments on entanglement produced by non-linear processes in Bose-Einstein condensates. A recent example is the demonstration of the Hong-Ou-Mandel effect for atoms [1]. We are currently working on a version of a two particle interference effect [2] which, after making some improvements, will allow a test of Bell's inequalities. This would be the first time that such inequalities have been tested for the motional degrees of freedom of freely falling, massive particles. Preliminary experiments are underway and one of the tasks of the internship will be to participate in the acquisition of the data and its analysis.

We use a particuar type of non-linear process in a Bose-Einstein condensate to produce entangled atom pairs. However, there exist many other processes which can produce entanglement and a second line of our research to explore them. We are currently investigating an effect analogous to the dynamical Casimir effect in quantum electrodynamics. The dynamical Casimir effect corresponds to the creation of photon pairs by a mirror moving in vacuum [3]. Instead of producing photon pairs, our mechanism produces *phonon* pairs in a Bose-Einstein condensate. We have demonstrated the basic effect [4], and we are planning an experiment to observe the entanglement of these phonons. A second part of the internship will be to work on the design and the preliminary phases of the execution of this experiment.

[1] R. Lopes *et al.*, Nature **520**, 66-68 (2015), arXiv:1501.03065.
[2] P. Dussarrat *et al.*, Phys. Rev. Lett. **119,** 173202 (2017), arXiv:1707.01279.
[3] P. D. Nation *et al.*, Rev. Mod. Phys. 84, 1 (2012).
[4] J.-C. Jaskula *et al.*, Phys. Rev. Lett. **109**, 220401 (2012), arXiv:1207.1338.

Toutes les rubriques ci-dessous doivent obligatoirement être remplies

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***: various possibilities, to be discussed**

Lumière, Matière, Interactions	**x**	Lasers, Optique, Matière	**x**

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