Spécialité de Master « Optique, Matière, Plasmas »

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

Proposition de stage

Date de la proposition : ***1 / 10 / 14***

Responsable du stage / *internship supervisor*:

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Nom du Laboratoire / *laboratory name*: SUPA School of Physics and Astronomy

Code d'identification : Organisme : University of St Andrews

Site Internet / *web site*: www.st-andrews.ac.uk/coldatoms

Adresse / *address:* School of Physics and Astronomy, North Haugh, St Andrews, KY16 9SS, UK

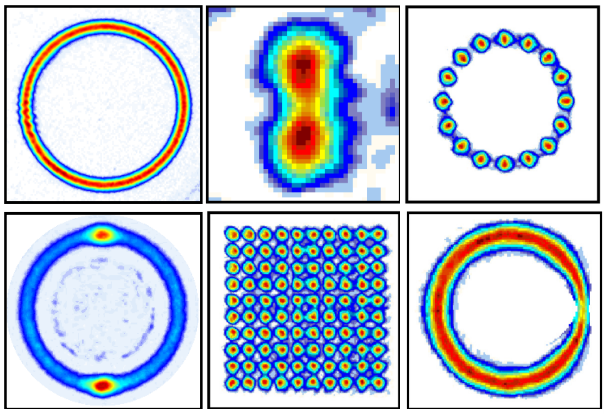
Lieu du stage / *internship place*: SUPA School of Physics and Astronomy, University of St Andrews

Titre du stage / *internship title*: **Holographic Optical Traps for Rotation Sensing with Ultracold Atoms**

Résumé / *summary*

A recent area of interest in the field of cold atomic physics is the development of non-trivial spatially- and temporally-varying optical trapping geometries, which may be realized using Fourier-engineered optical traps (those based on phase-only spatial modulation of the light to tailor the intensity in the Fourier plane of an optical system). Recently developed methods for phase-only holograms allow the calculation of smooth optical traps of arbitrary complexity [1, 2]. However the output of these algorithms, when applied to real devices, does not give high-quality optical traps.

We have developed a simple and robust feedback-enhanced algorithm to improve the accuracy of optical traps generated by phase-only spatial light modulators (SLMs) [3, 4] and find that this algorithm reduces the discrepancy between target and experimental light distribution to the level of a few percent (RMS error).



Examples of holographically-generated optical atom traps

Our current goal is to use these holographic optical traps to investigate the sensitivity of a Bose-Einstein Condensate of ^{87}Rb atoms to rotations. Superconducting quantum interference devices (SQUIDs) are well-known for their ability to measure extremely small magnetic fields. An analogous device has been constructed using superfluid ^{3}He [5], producing two-path quantum interference that is sensitive to rotation of the interferometer. This sensitivity is also a property of ultracold Bose gases trapped in geometries containing Josephson junctions [6].

The use of an SLM to generate the trapping geometries of interest allows flexibility in designing the spatial- and temporal-properties of such a trap, and can be used to probe the rotation sensitivity by stirring a Bose gas in a ring trap to a known rotation speed.

During the internship, the student will participate in the upgrade of an existing experimental apparatus for the production of Bose-Einstein Condensates of ^{87}Rb, and will also perform numerical calculations of Computer Generated Holograms with both existing and new algorithms. Experience will be gained in the use of lasers, optics, vacuum, magnetic fields, electronics, radiofrequency sources, computer control of the apparatus and Computer Generated Holography. There is also the possibility of performing calculations of the optimal experimental parameters for achieving high rotation sensitivity. The subsequent PhD thesis may continue the investigations of rotation sensing, or the flexibility inherent in the approach of holographic optical trapping can be exploited to extend investigations to almost any trapping geometry of interest.

[1] M. Pasienski and B. DeMarco, Opt. Express **16**, 2176 (2008)
[2] T. Harte *et al.*, arXiv:1408.0188
[3] G. D. Bruce *et al.*, Phys. Scr. **T143** 014008 (2011)
[4] G. D. Bruce *et al.*, arXiv:1409.3151
[5] R W Simmonds, et al., Nature **412**, 55-58 (2001)
[6] C Ryu, et al., Phys. Rev. Lett. **111**, 205301 (2013)

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***: Departmental Scholarship**

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