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: 02.10.2014

Responsable du stage / *internship supervisor*: Remi Geiger

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Nom du Laboratoire / *laboratory name*: SYRTE, Systèmes de Référence Temps-Espace

Code d'identification : UMR 8630 **Organisme :** Observatoire de Paris, CNRS, LNE et UMPC

Site Internet / *web site*: http://syrte.obspm.fr/tfc/capteurs_inertiels/

Adresse / *address:* 61 avenue de l'Observatoire - 75014 Paris

Lieu du stage / *internship place*: Observatoire de Paris

Titre du stage / *internship title*: **Theoretical modelling of atom interferometry in an optical cavity**

Résumé / *summary*

Atom interferometers offer interesting applications in geophysics, inertial sensing, metrology and fundamental physics. France is engaged in designing, building and operating a large-scale underground instrument based on optical and atom interferometry to study gravitation in general, for geophysics and gravitational wave detection applications in particular. This effort is coordinated in the framework of the MIGA project (*Matter-wave laser Interferometric Gravitation Antenna)* which involves 15 expert French laboratories in atom interferometry, laser physics, gravitational physics and geophysics, as well as private companies. Within the MIGA project, SYRTE is in charge of the design and realization of the cold atom source and of the coordination of the atom interferometry part of the project.

The MIGA antenna consists of atom interferometers situated at different positions in a 300-meter long Fabry-Perot optical cavity. The intra-cavity light field is used to drive the two-photon transitions that realize the atom interferometer. Combining the information of the atom interferometers allows extracting the signature of various gravitational effects, in particular that of a gravitational wave and of fluctuating local gravitational fields.

This internship, which may be followed by a PhD thesis, will aim at modelling the coupling of an atom interferometer with an optical cavity as implemented in the MIGA instrument. You will be part of the MIGA team in the group at SYRTE and will extensively use your knowledge and skills in atomic physics, optics, and numerical simulations.

The physics of the optical cavity coupled to the atoms will be investigated. I particular, the influence of stray light which might couple in the transverse cavity modes and interact with the atoms will be studied in detail. Optical simulations of the field taking into account the vibrations of the cavity mirrors as well as the laser phase noise will be performed. Moreover, the propagation of the stochastic laser field in the cavity will be studied, and the resulting phase noise impacting the final measurement will be evaluated using the sensitivity function formalism developed at SYRTE. The theoretical modelling will aim at estimating the sensitivity limit of the MIGA instrument and at designing the future optical sub-systems. While the focus of the PhD thesis will be on the theoretical modelling, experiments will be performed in parallel on the atom interferometers based at SYRTE, and on a MIGA prototype based at the LP2N laboratory in Bordeaux, to test the models.

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*: CIFRE, CNES, DGA, Equipex MIGA

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

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