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*:	BATTELIER	Prénom/ *first name* :	Baptiste
Tél :	+33 5 57 01 72 24	Fax :	
Courriel / *mail*:	baptiste.battelier@institutoptique.fr		

Nom du Laboratoire / *laboratory name*:

Code d'identification : UMR5298 Organisme : LP2N/IOGS

Site Internet / *web site*: http://www.lp2n.fr/

Adresse / *address:* Institut d'Optique d'Aquitaine rue François Mitterrand 33400 Talence

Lieu du stage / *internship place*: Laboratoire Photonique Numérique Nanosciences

Titre du stage / *internship title*: **Interferometry with coherent atom sources for Space and Inertial Navigation**

Résumé / *summary*

The ICE project aims to develop a matter wave interferometer with two atomic species operating in microgravity. The development of a portable experiment for free fall test (airbus 0g) is underway in collaboration with SYRTE and led to the world's first demonstration of the use of atomic inertial sensor onboard and microgravity. Ultimately, we will carry out an initial comparison of atomic accelerometers with two different atomic species (potassium and rubidium) at 10 pm/s2, allowing to test the universality of free fall (equivalence principle). The project objectives are the validation of the various technical and technological choices being made on the experiment and a new design of an improved version with a coherent source (Bose Einstein condensate) using the full potential of microgravity.

The first test of the weak equivalence principle in microgravity thanks to a double species atom interferometer Rubidium/Potassium was achieved in May 2015. This technical prowess constitutes an important step, but there is still a lot of effort to supply in order to achieve a very high accurate test benefiting fully from micro-gravity. Today, there are many limitations: vibrations and trajectory of the plane, atom temperature, and systematics. The goal of the study will be to push back these limitations to approach the ultimate sensitivity. The development of this new generation of sensor is based on the using of an ultra-cold bi-species degenerated gas. To reach this goal, the setting up of a dipole trap with a fibered laser source to cool the atom cloud is planned. Studies will be led to get the most collimated atom source possible in order to limit the velocity dispersion, hence to limit the contrast loss for long interrogation times. To reach this goal, as well as the dipole trap, optics for atoms (lens, Bragg grating…) should be set up thanks to light beams. At last, a spatial imaging system will be put in place in order to increase the amount of information extracted from the measurement.

In parallel with the onboard experiments, a micro-gravity simulator installed in the laboratory will allow to put the experiment chamber and the measurement instruments (200 kg) in weightlessness during 500 ms, and in a highly repetitive way. In the manner of the plane experiment, atoms stayed at the center of the vacuum chamber, which allows the interrogation time without changing the environment (magnetic, optical…) of the experimental measurement.

The second goal of the study will be to push the development of a compact multi-axis inertial atom sensor. Indeed, beyond the tests of fundamental physics, the project also allows to explore potential applications with cold atom interferometers, such as inertial navigation. The realization of the multi-axis system will allow to do measurements of acceleration and rotation along the three axis of space and have a fully cold atoms inertial station to hand. To achieve all the necessary measurement, the student will have to test different architectures of atom interferometry. Since the experiment is on-board, tests in relevant environment are planned. This study with ultra-cold atoms complete prospectively the research activities with iXBlue.

The work will take place at LP2N within Institut d'Optique d'Aquitaine, with regular contacts with the company iXBlue for inertial navigation points. The candidate will be asked an advanced expertise in the following fields: atom physics and ultra-cold gas, laser, electronics, servo lock systems, computer science and signal processing.

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***: A définir**

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

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