Spécialité de Master « Optique, Matière, Paris »

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

Proposition de stage

Date de la proposition : 22/09/2018

Responsables du stage / *internship supervisor*:

Nom / *name*: Pereira dos Santos/Merlet | Prénom/ *first name* : Franck/Sébastien

Tél : 01 40 51 23 86 | Fax :

Courriel / *mail*: franck.pereira@obspm.fr, sebastien.merlet@obspm.fr

Nom du Laboratoire / *laboratory name*: SYRTE

Code d'identification : UMR 8630 | Organisme : Observatoire de Paris

Site Internet / *web site*: https://syrte.obspm.fr/spip/science/iaci/

Adresse / *address:* 61 av de l'Observatoire 75014 PARIS

Lieu du stage / *internship place*: **Laboratoire National de Métrologie et d'Essais (Trappes, Yvelines)**

Titre du stage / *internship title*: **ULTRACOLD ATOMS IN A QUANTUM GRAVIMETER**

Résumé / *summary*

We have developed at SYRTE a state of the art cold atom gravimeter, whose principle of operation is based on atom interferometry techniques. It uses free-falling 87Rb atoms, which experience a sequence of Raman pulses driven by counter-propagating vertical lasers. This creates an atom interferometer, whose phase shift is proportional to g, the Earth gravity acceleration. Our instrument measures g with a sensitivity better than conventional state of the art absolute gravimeters, with a record sensitivity of 5.7 10^{-9}g at 1s, limited by residual vibrations. After averaging, we typically reach statistical uncertainties in the low 10^{-10}g range.

We have recently implemented on the setup a crossed dipole trap with a high power fiber laser at 1.5 µm, in which we prepare ultracold atoms by evaporative cooling. We routinely produce samples of ultracold atoms, with temperatures in the 50 nK-10 µK range, and with much higher densities. Using this new source, we have recently improved the accuracy of the measurement of gravity by tackling the dominant systematic effects: Coriolis acceleration and wavefront distortions of the Raman lasers. Both effects being related to the motion of the atoms in the interferometer laser beams profile, the reduced expansion of the ultracold atoms allowed us to reduce the uncertainty in the evaluation of these effects by a factor of 3, down to 1.3 10^{-9}g, in a first series of interferometer measurements.

The aim of the internship is to improve the evaluation of these effects even further, by performing measurements at lower temperature, and with more atoms. This will require to optimize the evaporation sequence, by increasing the capture volume of the trap using modulation techniques. Yet, a drawback when using dense samples of ultracold atoms, eventually Bose-Einstein condensed, instead of a more dilute laser cooled source, arises from the effect of interatomic interactions, which are expected in our configuration to impart small biases to the measurement. The intern will take advantage of the well-controlled environment of our gravimeter to carry a detailed investigation of this new systematic effect. In the end, we target an accuracy below 10^{-9}g, which will make our instrument the best standard in absolute gravimetry worldwide

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*: **Contractual ressources**

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