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 : 15/11/18

Responsable du stage / *internship supervisor*:
Nom / *name*: Jakob Reichel et Carlos Garrido Alzar
Tél : 01 44 32 33 79 Fax :
Courriel / *mail*: jakob.reichel@ens.fr

Nom du Laboratoire / *laboratory name*: LKB
Code d'identification : UMR 8552 Organisme : ENS, CNRS
Site Internet / *web site*: www.lkb.ens.fr/atomchips
Adresse / *address:* Paris
Lieu du stage / *internship place*: LKB, 24 rue Lhomond et SYRTE, 61 av de l'Observatoire

Titre du stage / *internship title*: **Applying quantum technologies to enhance a trapped atom clock**

Résumé / *summary*

Spin squeezing is a quantum technology that uses many-particle entanglement to redistribute measurement uncertainty away from the quantity of interest and into a complementary variable which is not measured. Its principle has been demonstrated experimentally by several methods, but these proof-of-principle experiments were not intended to reach any metrologically relevant performance. The next, exciting step is now to apply spin squeezing in a true metrological context, where it becomes relevant to real atomic clocks and interferometers. In addition to the "real-life" relevance, new many-body quantum effects are likely to appear in this regime. Spin squeezing is particularly promising for atomic clocks using trapped atoms, such as recently developed, compact clocks intended for field applications and use in satellites.

In a long-standing collaboration with SYRTE/Observatoire de Paris, our group has built the Trapped-Atom Clock on a Chip (TACC) [1,2], which employs atom chip technology for compactness. The next-generation TACC, which is now starting to produce first results, includes an optical fiber-based microcavity to create spin squeezing. The cavity also gives access to other quantum enhancements such as nondemolition detection. The goal of this experiment to reach a stability in the 10-13 s-1/2 range, which would be a four orders of magnitude improvement over the squeezing-enhanced clock demonstrated in [3], and an order of magnitude better than the best commercial compact clocks. Moreover, it allows creating spin squeezing in an unexplored regime of high precision, where new quantum effects are likely to appear.

In this internship project, the student will contribute to this project by developing a laser system that will improve the coherence time of the atoms under measurement by compensating the light shift of the cavity probe field. This offers a great opportunity for an early-stage researcher to acquire a comprehensive set of skills in ultracold atomic physics, ranging from laser optics and lab techniques to theoretical modeling and data analysis.

[1] C. Deutsch et al., Phys. Rev. Lett. 105, 020401 (2010).
[2]. R. Szmuk et al., Phys. Rev. A 92, 012106 (2015).
[3] I. D. Leroux et al., Phys. Rev. Lett. 104, 250801 (2010).

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***:** ERC ou ED

Lumière, Matière, Interactions	Oui	Lasers, Optique, Matière	Oui

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