

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)

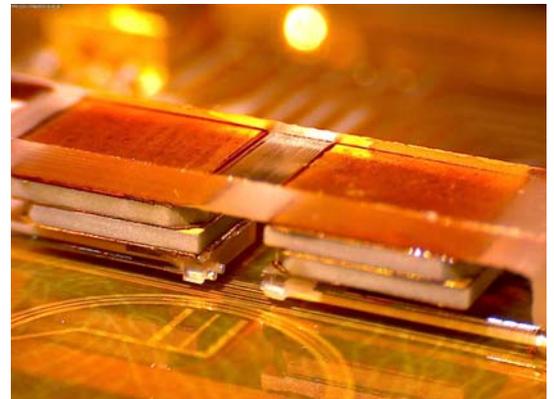
Date de la proposition : 28.11.17

Responsable du stage / internship supervisor:	
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Nom du Laboratoire Laboratoire Kastler Brossel	
Code d'identification :	UMR8552 Organisme : ENS/CNRS/UPMC/CdF
Site Internet / web site:	www.lkb.ens.fr/atomchips/
Adresse / address:	24 rue Lhomond, 75005 Paris
Lieu du stage / internship place:	, 24 rue Lhomond and SYRTE, 77 avenue Denfert-Rochereau

Titre du stage: Coherence-preserving measurement for improving an atomic clock on a chip

Quantum physics has advanced to the point where formerly “strange” quantum effects can now be realized in tabletop experiments, stimulating the development of novel quantum-based technologies. One prominent example is the emerging field of quantum sensing, where quantum concepts such as entanglement and nondestructive measurement are exploited in mechanisms that improve the sensitivity of atomic clocks and interferometers. While these fascinating mechanisms have been the subject of some pioneering proof-of-principle experiments, those experiments did not aim for a metrological level of precision. It is now important to bridge this gap and investigate these mechanisms under metrological conditions, where their relevance to actual atomic sensors can be validated and where new physics may appear that remained undetected at lower precision.

In collaboration with SYRTE, we have developed the Trapped-Atom Clock on a Chip, TACC, which operates close to the projection noise limit and currently has a stability [1] of $5.8 \times 10^{-13} \text{s}^{-1/2}$. This is in the relevant range for next-generation compact atomic clocks for use in geo-positioning and other mobile applications. Moreover, this clock acts as a test bed for the new physical effects appearing in future atomic clocks and sensors [2]. We have combined our fiber Fabry-Perot microcavities with the atom chip of TACC, opening the possibility to produce spin-squeezed states (a particular form of many-body entanglement that can reduce measurement noise) and nondestructive measurement. Repeated nondestructive measurements can eliminate the 2π ambiguity that is inherent to the frequency measurements in all traditional atomic clocks and sensors, thus enabling a “quantum phase lock” that would improve atomic clocks limited by local oscillator noise [3].



The internship has a theoretical and an experimental component. The student will model the cavity-based weak measurement and estimate the systematic shift that it induces on the clock frequency. This will allow identifying the most promising parameter regime for such a measurement in our clock cycle. Based on these results, he/she will then be able to test the repeated measurement scheme on the TACC experiment. During the internship, the student will have the opportunity to gain wide-ranging experience in state-of-the-art ultracold atomic physics.

[1] R. Szmuk, V. Dugrain, W. Mainault, J. Reichel and P. Rosenbusch, Phys. Rev. A 92, 012106 (2015).

[2] C. Deutsch et al, Phys. Rev. Lett. 105, 020401 (2010).

[3] R. Kohlhaas, A. Bertoldi, E. Cantin, A. Aspect, A. Landragin, and P. Bouyer, Phys. Rev. X 5, 021011 (2015).

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: Yes

Lumière, Matière, Interactions	Yes	Lasers, Optique, Matière	Yes
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