Proposition de stage/thèse

Date de la proposition : 16/10/2017

Responsable du stage / *internship supervisor*:

Nom / *name*:	**Lodewyck**	**Prénom/ *first name* :**	**Jérôme**
Tél :	**01 40 51 22 24**	**Fax :**	
Courriel / *mail*:	**jerome.lodewyck@obspm.fr**		

Nom du Laboratoire / *laboratory name*: Systèmes de Référence Temps Espace (SYRTE)

Code d'identification :UMR8630 **Organisme : Observatoire de Paris/CNRS/UMPC/LNE**

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

Adresse / *address:* 77, avenue Denfert Rochereau, 75014 Paris

Lieu du stage / *internship place*: 77, avenue Denfert Rochereau, 75014 Paris

Titre du stage / *internship title*: High stability optical lattice clocks

Résumé / *summary*

SYRTE is developing optical lattice clocks with strontium atoms. These clocks, in which an ensemble of 10^4 ultra-cold atoms tightly confined in an optical lattice are probed by an ultra-stable laser, are the most stable and accurate frequency standards. They have applications in fundamental physics (test of relativity, search for dark matter,...), in geodesy, in precise timing for astronomy or industry. Within the next 10 years, a redefinition of the SI second taking advantage of the high performances of optical clocks is expected.

Two strontium optical lattice clocks are now operational at SYRTE. They have contributed to the fine characterization of systematic effects, international clocks comparisons [3], tests of Lorentz invariance [2], the calibration of TAI (Temps Atomique International) [3].They have been used to demonstrate a non-destructive readout of the transition probability, using the dispersive properties of strontium, probed by a high finesse cavity surrounding the atoms [1]. This detection shows a very high signal-to-noise ratio (it can detection a few atoms in the lattice), while only seldom perturbing the atomic state. The aim of this internship proposed here is to exploit this detection in order to demonstrate an improved clock stability. For this, the detection will be used to recycle the detected atoms, thus ensuring a faster repetition rate of the clock sequence, and hence a better statistical resolution. With this method, the clock stability will approach the quantum projection noise, a fundamental quantum limit for the clock stability arising from the quantum nature of the individual atoms probed in the clock.

The internship project can be continued as a PhD. The student will further develop his work on the clock stability by taking advantage of new ultra-stable laser sources and quantum entanglement phenomenons in optical lattices. He will take part to international comparison campaigns using optical fibre links and the Pharao/ACES space clock.

More information at : https://syrte.obspm.fr/spip/science/fop/experiences/article/strontium-optical-lattice-clocks

[1] New J. Phys. **19** 083002 (2017) *A noise-immune cavity-assisted non-destructive detection for an optical lattice clock in the quantum regime*. G. Vallet, *et al.*
[2] Phys. Rev. Lett. **118** 221102 (2017) *Test of special relativity using a fiber network of optical clocks*. P. Delva *et al.*
[3] Nat. Commun. **7** 12443 (2016) *A clock network for geodesy and fundamental science*. C. Lisdat *et al.*
[4] Metrologia **53** 1123 (2016) *Optical to microwave clock frequency ratios with a nearly continuous strontium optical lattice clock*. J. Lodewyck *et al.*

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*:ANR

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