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 : 12 octobre 2018

Responsable du stage / *internship supervisor*:			
Nom / *name*:	Fang	Prénom/ *first name* :	Bess
Tél :	01 40 51 22 91	Fax :	
Courriel / *mail*:	bess.fang@obspm.fr		
Nom du Laboratoire / *laboratory name*: SYRTE			
Code d'identification : UMR8630		Organisme :	
Site Internet / *web site*: https://syrte.obspm.fr/spip/ Adresse / *address:* SYRTE, Observatoire de Paris, 61 avenue de l'Observatoire, 75014 Paris Lieu du stage / *internship place*: SYRTE			

Titre du stage / *internship title*: Optical phase locked loop for time and frequency metrology

Résumé / *summary*

Background :

The future of time and frequency metrology lies in the optical domain : the second, the unit of time will soon be defined via an optical transition in atoms ; optical clocks around the world have reported unprecedented performance in both stability and accuracy ; and optical fiber networks provide means of comparing distant clocks and disseminating frequency and time. In the heart of such developments, an essential tool is the ultra-stable lasers.

Standard ultra-stable lasers nowadays derive their frequency stability from a Fabry-Perot cavity, which has hit its fundamental stability limit since the early 2000s. Due to thermodynamic noise in the cavity, the fractional frequency stability of these lasers are at a few 10^{-16} at 1 s average time. Among the various paths taken in the search for improvement, a promising candidate is laser spectroscopy with rare earth doped ions at cryogenic temperatures. With an optimal choice of the crystalline matrix and dopant ion, very narrow spectroscopic features can be realized using the so-called 'Spectral Hole Burning' technique. These holes are then used as a reference to stabilize the frequency of lasers. Fundamental limit of such a system is currently unknown but expected to be below 10^{-18} at 1 s. This internship will contribute to the Spectral Hole Burning experiment of SYRTE.

Project :

Central to the SHB experiment is the ultra-low noise heterodyne detection using two phase-locked lasers. The phase relation between these two continuous wave lasers is locked on a stable micro-wave signal using an optical phase locked loop (OPLL). The residual relative phase noise between the lasers enters directly into the detection noise. For the ultimate performance of our detection scheme, it is therefore crucial to optimize the OPLL.

Conventional solutions based on analog electronics exist since more than 30 years. They constitute the standard phase lock schemes already present on our experiment. However, the advent of digital electronics provides the attractive possibilities of agile frequency control and atomization. We have therefore collaborated with the startup company Koheron for a digital OPLL based on commercial FPGA (Red Pitaya). The intern will first test the functionalities of the digital OPLL in order to evaluate its performance in terms of locking bandwidth and residual noise. The former could be potentially limited by digitization. Optimization should be carried out for our specific system. A comparison with an existing and optimized analog OPLL will be carried out. Hybrid solutions combining the bandwidth of the analog system and the agility of the digital system will be explored. If time allows, the intern will also try to expand the FPGA system to include a network analyzer in order to access all parameters (gain and phase) of the system.

Profile :

We are looking for a serious candidate with professionalism. Technically, he/she should be familiar with standard optics, laser, analog and digital electronics. Prior experience with FPGA programming is appreciated but not necessary. Given the international context of the subject and the laboratory, technical English is indispensable.

Toutes les rubriques ci-dessous doivent obligatoirement être remplies

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : Not for October 2019**

Si oui, financement de thèse envisagé/ *financial support for the PhD***: N.A.**

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

*Fiche à transmettre (fichier pdf **obligatoirement**) sur le site http://stages.master-omp.fr*