

Stage de master 2/ Master 2 Internship

Delta Kick Squeezing in a Differential Atom Interferometer

Date de la proposition : 22/10/2026

Responsable du stage / internship supervisor:	
Nom / name: PEREIRA DOS SANTOS	Prénom/ first name : Franck
Tél : 01 40 51 23 86	Courriel / mail: franck.pereira@obspm.fr
Nom du Laboratoire / laboratory name: LTE	
Etablissement / institution : Observatoire de Paris	Code d'identification : UMR 8255
Site Internet / web site: https://syrt.obspm.fr/spip/science/iaci/	
Adresse / address: 61 avenue de l'Observatoire, 75014 Paris	
Lieu du stage / internship place: Paris	

Résumé / summary

Our team at LTE develops inertial sensors (gyrometers, accelerometers...) based on atom interferometry technics. The development of these instruments benefits from the maturity of ultracold atom technology and the advantage of light beamsplitters, easy to implement and efficient, namely two photon transitions and more specifically stimulated Raman transitions. If these methods allow now for the development of commercial products with applications in geophysics on the field, and of onboard instruments in ships or planes for inertial navigation and geoscience, increasing significantly the performances of such instruments remains possible, in particular by using advanced quantum metrology methods to surpass the standard quantum limit.

The aim of this internship is the implementation of the "Delta-Kick squeezing" (DKS) technique in an atom interferometer. DKS relies on the engineering of atom atom interactions in a BEC in free fall through atomic lensing methods based on pulse sequences realized with highly detuned high power laser beams. The focusing of the matter waves transiently increases the strength of the interactions, which induces strong correlations between the atoms, and leads to squeezing in the population difference between the two interferometer paths, and eventually to phase sensitivity below the standard quantum limit.

We are implementing this method in a free fall atom interferometer based on Raman light beamsplitters and ultra-cold atoms produced by evaporative cooling. Having reduced the impact classical sources of noise to their lowest limit and having optimized the detection noise, we are able to demonstrate the squeezing of the collective state via spin tomography, and are presently busy evaluating the gain brought by entanglement on the interferometer phase measurement noise. In the frame of the internship, we plan to extent this implementation to a differential measurement, by operating two spatially separated interferometers simultaneously. This configuration offers the advantage of a strong suppression of common mode noise sources in the difference of the phases of the two interferometers, which will ease to highlight the gain in measurement sensitivity brought by the use of spin squeezed states.

The intern will work on the preparation of this differential interferometer, which will be based on the vertical splitting of a single BEC source using laser pulses. He or she will then optimize the simultaneous lensing on the two interferometers, and demonstrate sub shot noise differential phase measurements. He or she will conduct the experimental studies and participate in the analysis of the results. He or she will have extensive theoretical support for the modelling of the experiment, the optimization of the measurement sequence and for the analysis of the results.

Ce stage pourra-t-il se prolonger en thèse ? Possibility of a PhD ? : YES