Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: SYRTE
CNRS identification code: UMR 8630
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Internship location:
Observatoire de Paris, 61 avenue de l'Observatoire, 75014 PARIS

Thesis possibility after internship: YES
Funding: ANR + TBD If YES, which type of funding:

ULTRA-SENSITIVE GRAVITY GRADIOMETER

Our team at SYRTE develops inertial sensors (gyrometers, accelerometers…) based on atom interferometry technics. The development of this technology is linked to the use of cold atoms and laser beamsplitters, easy to implement and efficient, namely two photon transitions and more specifically stimulated Raman transitions. 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 if using large multiphoton transitions, which increases the separation between the two arms of the interferometer and thus the sensitivity to inertial forces. We are carrying on a new project of an atomic gradiometer based on these new technics. In this instrument, that measures the Earth gravity gradient, two ultracold atomic clouds will be prepared on atom chip traps, and launched upwards thanks to an accelerated lattice. During their free fall, they undergo a sequence of laser pulses which creates two simultaneous interferometers. The detection of the atomic state at the output of the interferometers allows to measure the difference of the interferometer phase shifts, which is proportional to the difference in the accelerations felt by the two atomic clouds.

The experimental setup is now operational and we are currently optimizing its key subsystems: atom launching in atomic fountains using Bloch elevators, LMT beamsplitting based on high order Bragg diffraction, and atomic detection. The task of the internship will be to realize first gravity gradient measurements with a Bragg interferometer in our setup, and optimize the measurement sensitivity. For that, he will have to optimize the beamsplitter efficiency and the interferometer contrast, which tend to decrease when the momentum transferred to the atoms by the Bragg lasers increases. He will work on improving our control of the frequency and phases of the Bragg lasers, so as to be able to tailor optimized phase profiles in order to increase the fidelity of the laser pulses using quantum control methods. He will also work on reducing the impact of the differential phase noise on the interferometer noise, using optimized phase lock loop techniques.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics:	YES	Macroscopic Physics and complexity:	NO
Quantum Physics:	YES	Theoretical Physics:	NO