

INTERNSHIP PROPOSAL

(One page maximum)

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Thesis possibility after internship: YES

Funding: NO

A continuous cold-atom interferometer to achieve quantum noise detection limit in inertial force measurements

Context: Cold atom inertial sensors have many applications in fundamental physics (testing the laws of gravitation, gravitational astronomy), geosciences (measuring the Earth's gravity field or rotation) and inertial navigation [1]. The operation of these sensors is based on atomic interferometry, taking advantage of superpositions between quantum states of different momentum in an atom, generated by optical transitions with two (or more) photons in order to realize accurate sensors. LTE (formerly SYRTE) is a pioneering laboratory in this field, recognized worldwide for its expertise in the metrology of these quantum sensors [2,3].

The project aims in developing continuous measurements using **cold atom interferometers** in order to improve their sensitivity while maintaining their accuracy. The first developments in **continuous operation** have already demonstrated record performance for rotation measurements [4], but need to be modified to realise their full potential for rotation measurements, but also acceleration measurements. Ultimately, these sensors must **reach the detection limit, intrinsically linked to quantum projection noise**. This method is very general in atomic quantum sensors and can also be applied to different schemes of interferometer, atomic clocks...

Master thesis work: This continuous measurement requires a sequence whose cycle time is twice as short as the interrogation time. To achieve this regime, certain modifications must be made to the existing experiment in order to simultaneously realise atomic beam splitters and mirror for three independent atomic samples. In particular, this involves the change of the **Raman lasers system used to manipulate the atomic wave packets**. The preparation and detection of atomic samples must also be modified, as must the timing sequence, to ensure that the light emitted by the atoms during these stages does not disturb the atoms inside the interferometer.

References: [1] R. Geiger et al, AVS Quantum Sci. 2, 024702 (2020) ; [2] R. Gautier et al, Science Advances (2022) ; [3] L. Sidorenkov et al, Phys. Rev. Lett. 125, 213201 (2020) ; [4] D. Savoie et al, Science Advances, eaau7948 (2018);