PostDoc position: Ultrasensitive quantum gravimetry

Laboratory: SYRTE – Observatoire de Paris, 77 avenue Denfert-Rochereau, 75014 Paris, France
Contacts: Franck Pereira dos Santos (franck.pereira@obspm.fr); Leonid Sidorenkov (leonid.sidorenkov@obspm.fr)
Website: https://syrte.obspm.fr/spip/science/iaci/
Key words: atom interferometry, inertial sensor, cold atoms, gradiometry, quantum optimal control
Skills required: atomic physics, optics, lasers, instrumentation, data analysis

Summary: The Atom Interferometry and Inertial Sensors group (IACI) of SYRTE opens a 24-months post-doctoral position dedicated to development of ultra-sensitive gravi-gradiometers. The applicant will be involved into two ongoing projects: the research on the novel technologies to enhance the sensitivity and accuracy of SYRTE atomic gravi-gradiometer [1]; and the EU Horizon collaborative project FIQUgS [2] on mobile quantum gravimetry for geophysics applications.

Research project: A significant improvement in the performance of atomic inertial sensors is linked to the development of novel sensor architectures and enabling technologies. We are carrying on a new project of an *atomic gradiometer* sensing the gradient of the Earth gravity acceleration. Differential signal is *free of common-mode vibrational and laser noise*, which provides a perfect platform for exploring cutting-edge techniques (atom chips, large momentum transfer (LMT) beam splitting, hybridization with other sensors, etc.) to reach an unprecedented level of sensitivity, better than 1 Eötvös (=10^{-9} s^{-2}) at 1 s measurement time on the ground. Combined with an ability to discriminate the position and the mass of the gravitational source, allowed by a simultaneous access to g and ∇g, such sensors open intriguing perspectives for applications in geoscience both on the ground (natural resources exploration, $C0_2$ storage) and in space (Earth gravity field mapping), as well as for the tests of fundamental physics and inertial navigation [3].

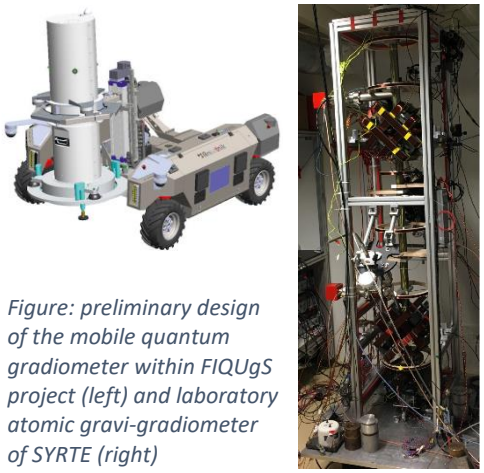

Figure: preliminary design of the mobile quantum gradiometer within FIQUgS project (left) and laboratory atomic gravi-gradiometer of SYRTE (right)

Working environment and mission: The post-doc will work in a dynamic team consisting of three permanent researchers and three PhD students, with a significant scientific autonomy and responsibilities in daily supervision of experiments. Within the projects, he/she will interact with a number of academic and industrial partners of the group and benefit from in-house theoretical support. The specific tasks will include:

- conducting the indoor metrological evaluation/test campaign for quantum gravimeter and gradiometer at LNE premises in Trappes: planning, modelling, implementation, data analysis etc. (within the FIQUgS project);
- research and development of novel technologies for enhanced sensitivity of atomic inertial sensors: (i) LMT atom-optics enhanced with quantum optimal control (SYRTE gradiometer), (ii) advanced top-hat laser beam shaping (FIQUgS and SYRTE gradiometer), (iii) ultracold atoms / BEC on atom chip (auxiliary table-top experiment for further implementation into SYRTE gradiometer);
- metrological characterization of the SYRTE gradiometer and study of its limits of stability and accuracy

Position details: The salary is set between 3081,33 € and 4756,76 € brutto per month, depending on experience. The funding is secured for 24 months, while the application to external fellowships can be supported once a candidate joins the group. The position is to be filled as soon as possible. Our group commits to the equal opportunities policy and, in particular, encourages the application of women candidates.

[1] R. Caldani, et al., PRA **99**, 033601 (2019), R. Piccon, et al., PRA **106**, 013303 (2022)
[2] https://www.cnrs.fr/fr/actualite/fiqugs-unir-les-forces-des-gravimetres-quantiques-et-des-capteurs-classiques; https://www.fiqugs.eu/
[3] R. Geiger et al., AVS Quantum Sci. **2**, 024702 (2020)