

Post-doctorate position: Hydrogen deceleration for its first observation of the Gravitational Quantum States

Job status: Full time post-doctorate, mainly experimental position. 12 months contract (possibility of extension). **Start date:** February 2024 - January 2025.

Location: Laboratoire Kastler Brossel, Sorbonne Université, CNRS, ENS, Collège de France. 4 place Jussieu, 75005 Paris.

Project: This project aims to perform the first observation of Gravitational Quantum States on hydrogens in flight. This experiment is part of the international collaboration GRASIAN: **GRA**vity **S**pectroscopy and **I**nterferometry with ultra-cold **A**toms and **N**eutrons (<https://grasian.eu>). The Gravitational Quantum states [1,2] will be realized inside a narrow region formed by a mirror (high reflective flat surface) on the bottom and a rough scattering surface (called an absorber), placed above the mirror. The vertical confinement of the H beam entering this region is realized by gravity (top confinement) and Quantum Reflexions occurring on the mirror (bottom confinement), leading to the formation of the gravitational quantum states. This experiment is currently being under development at ETH Zurich (Switzerland), in the group of P. Crivelli, member of GRASIAN and group leader of the exotic matter group at the Institute for Particle Physics and Astrophysics and at the Stefan Meyer Institute (SMI) at Vienna, Austria, in the group of Eberhard Widmann. **The generation of slow hydrogen atoms is crucial for the experiment**, and this postdoc position offers the opportunity to work **on developing a Zeeman decelerator**, in collaboration with one of our collaborator's lab in Ile de France: Laboratoire Aimé Cotton (LAC), **to slow down a cryogenic hydrogen beam** as well as to take part of the **measurement campaigns** planned in 2024-2025 that will be happened at our collaborator's lab at the Stefan Meyer Institute of Vienna, Austria.

The main activities of this position will consists of take in charges:

- In Paris : the main mission of this postdoc will be first to work on the simulations to design the best Zeeman decelerator type ("comoving type of trap" [3] or Sisyphus type [4]). Then the second time will be to proceed to the first trials using a cryogenic hydrogen source available at LAC (Orsay, 91) with the group of D. Comparat. After the missions at SMI : data analysis and writing article.

- Missions in situ at the SMI lab, Vienna, Austria :

+ First measurements on the QGS states using the same cryogenic source of hydrogen atoms then the one at LAC. Optimisation of the background rest atomic hydrogen gas by adjusting the differential pumping stages and the collimating slits.

Profile of the applicant: The candidate should have a Ph.D in applied physics, optics or a related discipline. A fluent knowledge of English is a pre-requisite (some notion in French will be also of use). The successful candidate will be highly motivated, creative, with demonstrated abilities to work in a collaborative environment. An experimental background in optical and mechanical conception software (as Solidwork or Catia or equivalent.) is preferred. Atomic physics and spectroscopy knowledge is also an advantage.

Expected Salary: 2963.51 €gross per month (indice majoré 537).

Contact person: Interested candidates are invited to apply, by email with a CV, reference and a cover letters, to Pauline Yzombard: pauline.yzombard@lkb.upmc.fr



References of interest:

- [1] V.V. Nesvizhevsky *et al*, *Quantum states of neutrons in the Earth's gravitational field*, Nature 415 (2002) 297,
- [2] V.V. Nesvizhevsky *et al*, *Study of the neutron quantum states in the gravity field*, Europ. Phys. J. C 40 (2005) 479
- [3] T Damjanovic *et al.* , *A traveling wave Zeeman decelerator* J. Phys.: Conf. Ser. 1412 122014 (2020)
- [4] D. Comparat, *Molecular cooling via Sisyphus processes*, Phys. Rev. A 89, 043410 (2014)