Post: **Postdoctoral Researcher in Experimental Atomic and Molecular Physics**
Location: Laboratoire de Physique des Lasers (LPL), CNRS-Univ Sorbonne Paris Nord, Villetaneuse, France
Laboratoire Aimé Cotton (LAC), CNRS, Université Paris Saclay, Orsay, France
Team: Metrology, Molecules and Fundamental Tests (MMFT, LPL), Correlated cold matter (MFC, LAC)
Contract: Fixed Term, 2 years, starting as soon as possible

Coherent Microwave manipulation of atoms and molecules in cryogenic environments for fundamental studies

Job description:
The 2-year post-doctoral position is part of the project EDMMA (*Towards an Electric Dipole Moment with atoms and molecules in Matrix*) funded by ANR. The long-term goal of EDMMA is to develop very sensitive methods to measure the electric dipole moment (EDM) of electrons in atoms or molecules embedded in a cryogenic matrix of rare gas or para-hydrogen. This requires to control and measure the spin of atoms or molecules in this cryogenic environment using microwave and optical radiations. This project is a collaboration between Laboratoire Aimé Cotton (LAC), Laboratoire de Physique des Lasers (LPL), Institut des Sciences Moléculaires d'Orsay (ISMO) and Centre de recherche sur les Ions, les Matériaux et la Photonique (CIMAP). The successful applicant will be successively hosted by two Paris region laboratories: LPL (1st year) and LAC (2nd year).

LPL is currently developing a new-generation molecular clock for precision vibrational spectroscopy of cold species in the gas phase. The proposed technology, at the forefront of cold molecule research and frequency metrology, opens up prospects for using molecules to test fundamental physics (chirality and parity violation) and explore limits of the Standard Model. During year 1, the successful applicant will work on a molecular jet Ramsey interferometry setup based on a cryogenic buffer-gas-cooled molecular beam. She/he will primarily implement in a cryostat the microwave (MW) instrumentation already working at room temperature needed to manipulate and detect with high sensitivity internal molecular states by measuring free induction decay (FID) signals. A collection of designs of increasing sensitivity will be tested, using either MW pick-up antennas or MW resonators for Purcell enhanced detection.

During year 2, the post-doctoral researcher will transfer this MW knowledge to LAC. She/he will work on an experiment that uses caesium (Cs) atoms embedded in a cryogenic matrix with the aim of measuring a possible permanent electric dipole moment of the electron that should result in an energy level shift for the caesium valence electron. She/he will construct a similar MW setup dedicated to measure relaxation and coherence times of the hyperfine structure of Cs in an argon matrix. The pros and cons of detecting FID signals in the optical domain (in the absorption of an optical pumping beam) or directly in the MW (using pick-up antennas) will be assessed. Importantly, the influence of the external electric and magnetic fields on the coherence time will be studied.

The successful applicant will strongly interact with both groups throughout the duration of the project and will thus have a decisive role to maximise the synergy between them, for an optimal knowledge transfer.

Keywords:
atomic and molecular physics, quantum physics, precision measurements, electric dipole moment of the electron (eEDM), cryogenic, cold atoms/molecules, matrix isolation spectroscopy, buffer-gas cooling, frequency metrology, Ramsey spectroscopy, microwave, optics and lasers, vacuum techniques, electronics, programming and simulation.

Publications from the teams:
LPL: Santagata *et al*, Optica **6**, 411 (2019); Cournol *et al*, Quantum Electron. **49**, 288 (2019), arXiv:1912.06054; Tokunaga *et al*, New J. Phys. **19**, 053006 (2017), arXiv:1607.08741; Argence *et al*, Nature Photon. **9**, 456 (2015), arXiv:1412.2207
LAC: Cournol *et al*, Phys Rev A **97**, 031401 (2018), arXiv:1709.06797; Viteau *et al*, Science **321**, 232 (2008), arXiv:0806.3829

Requirements:
The applicant should have a PhD in a relevant area of experimental physics or chemical physics: molecular, atomic physics, spectroscopy, optics and lasers, quantum optics. She/he will be expected to display the initiative and creativity, together with the appropriate skills and knowledge, required to meet the project goals.

Interested applicants should email a CV, a brief description of research interests and the contact details of 2 referents to B. Darquié (benoit.darquie@univ-paris13.fr) and D. Comparat (daniel.comparat@universite-paris-saclay.fr).