Post:	**PhD student position in Experimental Molecular Physics**
Department:	**Laboratoire de Physique des Lasers, CNRS-Université Paris 13**
Location:	**Villetaneuse, France**
Team:	**Metrology, Molecules and Fundamental Tests**
Supervisor:	**Anne Amy-Klein (professor, amy@univ-paris13.fr)**
Co-Supevisor:	**Benoît Darquié (tenured researcher, benoit.darquie@univ-paris13.fr)**
Contract type:	**Fixed Term (36 months)**

Precision Measurements and tests of fundamental physics with cold molecules

Job Description:
A PhD student position is available to pursue experimental research in the field of precise spectroscopic measurements with cold molecules in the gas phase. The position is focused on the development of a new-generation molecular clock specifically designed for precision vibrational spectroscopy of complex polyatomic molecules. The proposed technology is at the forefront of cold molecule research and frequency metrology, and opens possibilities for using polyatomic molecules to perform tests of fundamental physics and explore the limits of the standard model. The apparatus will be used in the first place for the measurement of the tiny energy difference between enantiomers of a chiral molecule induced by electroweak interactions, a signature of parity (left-right symmetry) violation.

Compared to atoms, molecular systems, owing to their numerous degrees of freedom, offer promising perspectives for improving tests of fundamental physics and precision measurements in general (tests of fundamental symmetries, measurements of fundamental constants or their variation in time, tests of postulates of quantum mechanics, search for dark matter, …). Many of these experiments can be cast as measurements of resonance frequencies of molecular transitions highlighting the importance of frequency metrology. They also require advanced manipulation techniques already standard for atoms: individual states addressing, high detection rates, long coherence times, cooling of internal and external degrees of freedom.

The successful applicant will take an active role in various aspects of the development of the experiment which constitute major steps in providing such techniques for molecules:
- development of an intense source of cold and slow polyatomic molecules, produced in a cryogenic chamber, called a buffer-gas-cooled beam; this is one of the latest cold molecule technology that has so far mostly been implemented on simple species;
- precise probing of these cold molecules with high-purity mid-infrared quantum cascade lasers (QCLs) calibrated against primary frequency standards using saturated absorption spectroscopy and Ramsey interferometry, the same quantum optics method as used in the world's best atomic clocks;
- implementation of a high-sensitivity microwave detector, for the detection of individual internal quantum states populations of cold molecules;
- development of advanced manipulation techniques combining ultrastable RF, microwave and optical fields to obtain individual state addressing, high detection rates, long coherence times, cooling of various degrees of freedom, …

Keywords: frequency metrology, Ramsey interferometry, Doppler-free methods, precision measurements, parity violation, chiral molecules, molecular beams, buffer-gas cooling, cold molecules, frequency comb lasers, quantum cascade lasers, molecular physics, quantum physics, optics and lasers, vacuum techniques, electronics, programming and simulation

Relevant publications:
Santagata *et al*, Optica **6**, 411 (2019); Cournol *et al*, Quantum Electron. **49**, 288 (2019) ; Tokunaga *et al*, New J. Phys. **19**, 053006 (2017), arXiv:1607.08741 ; Argence *et al*, Nature Photon. **9**, 456 (2015), arXiv:1412.2207

Requirements: The applicant should have an (almost) completed master degree in a relevant area of experimental physics or chemical physics: atomic, molecular and optical physics, spectroscopy, lasers, quantum optics. He/She will be expected to display the initiative and creativity, together with the appropriate skills and knowledge, required to meet the project goals.