Université Sorbonne Paris Nord

Position: PhD thesis and Master's internship in experimental atomic and molecular physics.
University: Sorbonne Paris Nord, Laboratoire de Physique des Lasers (LPL)
Contract: The start date of the PhD program is between September-November 2021. The contract duration is 36 months. We offer the possibility of a short Master's internship from March-July 2021.
Requirements: We are looking for candidates with a good background in general physics, quantum mechanics and atomic physics. A Master's degree is required for registering in the PhD program.

Title: ***Atoms and molecules interacting with surfaces: Experimental measurements in vapor cells***
Thesis supervisor: Athanasios Laliotis (laliotis@univ-paris13.fr), Isabelle Maurin (isabelle.maurin@univ-paris13.fr)

Group: The SAI (Spectroscopie Atomique aux Interfaces) group is widely recognized for optical measurements of the atom-surface interaction by vapor cell spectroscopy and has a wide network of collaborations, exchanging research visits with Germany (Rostock), Uruguay, Singapore, Brazil (Pernambuco and Paraiba), and Japan (Tokyo). The group's work and collaborations are currently funded by an ANR-DFG projet ('SQUAT'), a French-German bilateral PROCOPE program and an International French-Uruguayan Laboratory (LIA). Our laboratory is on the Villetaneuse campus of the University Sorbonne Paris Nord, 10-15min train ride from downtown Paris.

Scientific Background:
Macroscopic surfaces modify the fluctuations of the electromagnetic field in vacuum giving rise to interactions between atoms or molecules and macroscopic objects. The interaction of atoms and molecules with the macroscopic environment, known as the Casimir-Polder interaction, is a fundamental problem of quantum electrodynamics and nanophotonics with implications in metrology, precision measurements and our understanding of the properties of matter and vacuum.

The SAI group has developed selective reflection and thin vapor cell spectroscopy as techniques to probe Casimir-Polder interactions between dielectric surfaces and excited atoms in the nanometric range (typically ~100nm). The group has studied the coupling of atoms with surface polariton waves and demonstrated the near field temperature dependence of Casimir-Polder interactions. The group is also studying molecule-surface interactions.

Current research projects:
Molecule-surface interactions are of fundamental interest due to the complex molecular geometry. Theoretical studies suggest that molecule-surface interactions depend on molecular orientation and chirality but experimental studies remain so far scarce. The goal of this SAI project is to perform molecule-surface spectroscopy in thin cells of nanometric thickness filled with molecular gas (NH_3, SF_6, OCS). The strong confinement of molecules inside the thin cell will shift the molecular rovibrational transitions that will be probed by transmission spectroscopy using quantum cascade laser sources. Thin cells for this experiment will be fabricated in the Sorbonne Paris Nord clean room facilities.

Rydberg-surface interactions: Highly excited, Rydberg, atoms have huge electric dipole moments and interact strongly with their environment, making them attractive candidates for quantum technology applications. The goal of this SAI project is to perform spectroscopic Rydberg-surface interaction measurements in atomic vapour cells. We also plan to study higher order phenomena (beyond dipole-dipole effects) in the Rydberg-surface interaction that arise due to the large size of highly excited atoms, which becomes comparable to their distance from the surface.

Relevant publications: A. Laliotis et al., *Nat. Commun* (2014), H. Failache et al., *Phys. Rev. Lett*. (1999), E.A Chan et al., *Sci. Adv*., 4: eaao4223 (2018), J. C de Aquino Carvalho et al., *Phys Rev A* (2018).