PhD offer in Paris

Post: PhD student position and Master 2 internship
Location : Laboratoire de Physique des Lasers (LPL), CNRS-Univ Sorbonne Paris Nord, Villetaneuse, France
Team: Interferometry and optics for atoms (http://www-lpl.univ-paris13.fr/UK/Equipe-OIA-page-01.awp)
Advisor: Dr. Quentin Bouton (quentin.bouton@univ-paris13.fr)
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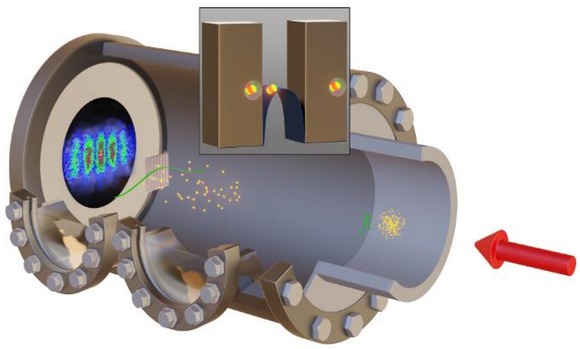
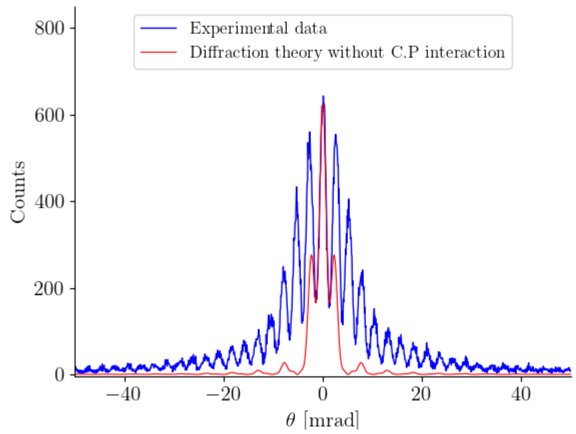
Casimir-Polder interaction probed by cold atom diffraction through a nanograting

A striking feature of quantum mechanics is the possibility of energy change ΔE during a time Δt due to the Heisenberg principle ($\Delta E \Delta t \geq \hbar/2$). It leads to quantum fluctuations that create virtual photons and generate a quantized field. In particular, the presence of boundaries, given for example by a surface and an atom, modifies this field. It results in a force between the surface and the atom, known as the Casimir-Polder (C-P) force. This force becomes preponderant at the nanoscale and thus plays a major role in a multitude of areas of Physics, ranging from atomic physic to physical chemistry.

Despite its simplicity, combined with strong scientific and technological interests, C.P interaction, at its fundamental level, remains largely unexplored mainly due to challenges associated with precise control of the atom-surface distance and knowledge of the surface characterization. In this context, our team has built a slow atomic beam interacting with a nanograting [1]. This jet interacts with a carefully self-engineered nanograting, leading to a diffraction pattern dominated by the C-P force. This unique configuration allows us to study precisely the C-P interaction, with a record agreement between the theory and the experiment better than 10% [2].





Left: Sketch of the experiment. Neutral Argon atoms interact with a nanograting within the C-P potential. This interaction with the nanograting leads to a diffraction pattern. Information related to the C-P potential are extracted from the analysis of the interference pattern. Right: Experimental diffraction spectrum of metastable argon through a nanograting at 26 m/s (in blue). The angle θ is the diffraction angle. In red, theoretical curve without considering the C-P interaction. The difference between the blue and red curve underlines how strongly the diffraction spectrum is dominated by the C.P interaction.

In order to achieve an in-depth understanding of the C.P interaction, the aim of the project is to increase the precision of the measurements. To realize this goal, the successful applicant will take an active role in various aspects of the development of the experiment such as the characterization of the atomic source or the installation of an optical dipole trap (to increase the atomic flux and reduce the atomic velocity). Besides, the candidate will be involved in a collaboration with the Hanover theory group in Germany (Institute of Quantum Optics, Leibniz University) to develop a realistic model in efficiently solving dynamics of cold atomic matter waves [3]. The middle term goal of this project will be focused on exploiting a light field in order to engineer the C-P potential by altering the atomic properties close to the surface.

We are looking for a candidate with skills and interest in experimental work, as well as solid knowledge in optics and atomic physics. The beginning of this project can start with a master internship for a start in spring 2023. This PhD thesis will start in September 2023.

[1] T. Taillandier-Loize et al., J. *Phys. D: Appl. Phys.* ***49*** *135503 (2016).*
[2] C. Garcion, et al. *Phys. Rev. Lett*. **127**, 170402 (2021).
[3] F. Fitzek et al. *Sci. Rep.* **10**, 22120 (2020).

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