

Spécialité de Master « Optique, Matière, Plasmas »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition :

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Site Internet / web site:	http://www.lkb.ens.fr/-Themes-de-recherche,74-?lang=en		
Adresse / address:	4 place Jussieu, Tour 12-13, 75005 Paris		
Lieu du stage / internship place:	idem		

Titre du stage / internship title: *Quantum free fall of an atomic wave packet*

Résumé / summary

Quantum reflection is a generic phenomenon for matter waves in a rapidly varying potential. It has been observed in particular for atoms experiencing an attractive Casimir-Polder potential in the vicinity of a solid surface. It is an important question in the GBAR experiment (*Gravitational Behaviour of Antihydrogen at Rest*) which aims at measuring the free fall acceleration of neutral antihydrogen atoms in the terrestrial gravitational field [1].

A fraction of the cold antihydrogen atoms falling onto the detection plate will be reflected before touching it and this will affect the free fall measurement. Our group has carried out accurate evaluations of the Casimir-Polder potential [2], as well as the quantum reflection above the detection plate [3]. He has also proposed new techniques which should lead to improved accuracies of the measurement [4,5].

Up to now, the free fall of the cold antimatter cloud and the quantum reflection have been analyzed within a classical treatment of the center-of-mass motion of antihydrogen atoms. The proposed project aims at extending this analysis to a full quantum treatment of the free fall of the wave packet.

[1] P. Pérez and Y. Sacquin, *Class. Quantum Grav.* **29** (2012) 184008.

[2] A. Lambrecht et al., *New Journal of Physics* **8**, 243 (2006).

[3] G. Dufour et al., *Phys. Rev. A* **87** 012901 (2013), *Phys. Rev. A* **87** 022506 (2013).

[4] G. Dufour et al., *Eur. Phys. J. C* **74** (2014) 2731.

[5] A.Yu. Voronin et al., *J. Phys. B* **45** (2012) 165007.

The scattering approach used to calculate Casimir interactions is based on the methods of quantum optics. The quantum reflection is calculated by solving the Schrödinger equation for the atomic matter waves. The project implies analytical calculations as well as numerical simulations.

Toutes les rubriques ci-dessous doivent obligatoirement être remplies

Ce stage pourra-t-il se prolonger en thèse ? Possibility of a PhD ? :

Si oui, financement de thèse envisagé/ financial support for the PhD:

Lasers, Optique, Matière	x	Lumière, Matière, Interactions	x
Plasmas : de l'espace au laboratoire			

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