Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: SPEC
CNRS identification code: UMR 3680 CEA-CNRS
Internship director'surname: Hervé BERCEGOL
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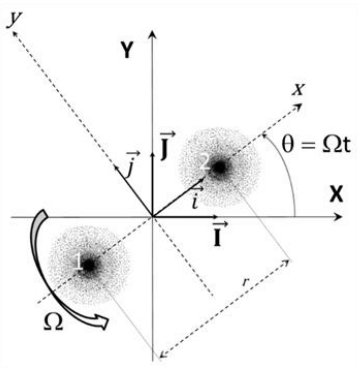
Internship location: CEA Saclay, SPEC laboratory, site de l'Orme des Merisiers, bat. 772.

Thesis possibility after internship: YES/~~NO~~
Funding already obtained for a PhD: ~~YES~~/NO If YES, which type of funding:

Vacuum friction on colliding atomic and subatomic structures

Summary (half a page maximum)



The quantum vacuum is populated with fluctuating, lowest energy states of particles and fields, a typically quantum, rather fascinating feature[1]. There are a few experimental demonstrations of consequences of vacuum fluctuations on static material structures, like the Lamb shift and the Casimir effect. When material systems evolve dynamically, a friction force is theoretically predicted, the so-called dynamical Casimir effect.
We have been investigating these phenomena as a possible cause of the second law of thermodynamics. A rotating pair of atoms experiences a torque from the zero-point electromagnetic field of the vacuum, calculated for identical[2] as well as for dissimilar atoms[3].
The material system exchanges angular momentum with the underlying vacuum. This is reminiscent of the spin of the electron, which appears as intimately linked to the interaction of the particle with the vacuum fields: the zero-point electromagnetic field and Dirac field of electron-positron pairs. The goal of this internship is to calculate the dynamical effect of the Dirac sea on atomic collisions. We will consider the underlying dynamics of electrons, as well as the effect of nuclei, which will be protons as a starting point.
A preliminary knowledge of Quantum Electrodynamics theory and calculations is necessary.

[1] Milonni, P. W. *The quantum vacuum: an introduction to quantum electrodynamics* (A.P., San Diego, 1994).
[2] Bercegol, H., Lehoucq, R., "Vacuum friction on a rotating pair of atoms", *Phys. Rev. Lett.***115**, 090402 (2015)
[3] De Izarra, A. « Effet du champ électromagnétique du vide sur les collisions atomiques », Univ. Tours, 2016.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: ~~YES~~/NO Soft Matter and Biological Physics: ~~YES~~/NO
Quantum Physics: YES/~~NO~~ Theoretical Physics: YES/~~NO~~