INTERNSHIP PROPOSAL

(One page maximum)

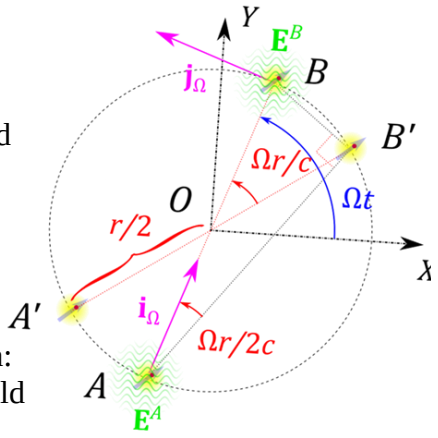
Laboratory name: Service de Physique de l'Etat Condensé (SPEC/SPHYNX)
CNRS identification code: UMR 3680
Internship director'surname: Hervé Bercegol
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Internship location: CEA Saclay, site de l'Orme des Merisiers, Université Paris Saclay.

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding:CFR

COUPLED FRICTION EFFECTS OF DIRAC SEA AND ELECTROMAGNETIC VACUUM ON ATOMIC MOVEMENTS

Summary (half a page maximum)

Quantum fluctuations induce conservative macroscopic forces such as the Casimir effect. They could also cause dissipative forces, termed vacuum (or quantum) friction. Up to now, this friction effect has been calculated with consideration of the electromagnetic fluctuations only, i.e. without taking into account the Dirac Sea. This project is devoted to the extension of our research in this direction: electrons, as main contributors of the matter-field interaction, also interact with electron-positron virtual pairs in the quantum vacuum.



2 atomic oscillators A & B (separated by a distance r) rotate, one around the other at a rotation speed Ω.

A first step, realized in 2026, has been adapting the present semi-classical framework to include vacuum polarization in quantum friction acting on a rotating pair of atoms. In the master's internship, a similar step shall be taken to include electron-positron pair creation. In doing so, one encounters a modification of the high-energy end of Fourier integrals; thus, one will determine a friction component linked with the interaction with charge fluctuations, excited at high virtual photon energy. On this research path, one shall pay attention to maintaining the mathematical coherence of the whole framework. The complete goal of the PhD thesis is a consistent and mathematically sound quantum relativistic treatment of rotational quantum friction at the atomic level.

Collaboration : Prof. Éric Séré, CEREMADE, Université Paris Dauphine – PSL.

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

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