



# Stirring the electromagnetic quantum vacuum

Stage Master 2

**Responsible:** Bart van Tiggelen, LPMC, UGA/CNRS, Grenoble.

[Bart.van-tiggelen@grenoble.cnrs.fr](mailto:Bart.van-tiggelen@grenoble.cnrs.fr)

<https://lpmmc.cnrs.fr/spip.php?article303>

The electromagnetic vacuum has an energy whose spectrum is Lorentz-invariant. This fundamental concept imposes the well-known ultraviolet catastrophe at large frequencies, which is one of the most fundamental problems in modern physics. The Casimir effect is a manifestation of the existence of low-energy vacuum photons. High energy, relativistic vacuum photons induce the Lamb shift in the energy levels of atoms. Recent work in our group established that the quantum vacuum can also carry momentum and angular momentum, and that again relativistic, virtual photons are involved.

The subject of this internship is to get acquainted with the quantum electrodynamics (QED) of the quantum vacuum, in particular in the presence of external magnetic fields, and how it interacts with quantum matter. We will try to explore how the quantum vacuum influences the kinetic angular momentum of electrons in high energy states of atoms, that orbit with large momentum. A classical analogy exists with dielectric matter exposed to a uniform electromagnetic noise, that is worth exploring.

The internship will explore orders of magnitude, precise analytical and numerical calculations can be carried out as a Ph.D project, where also relativistic corrections will be considered.

A close experimental collaboration exists with Dr. Geert Rikken at the LNCMI.

**Keywords:** QED, magneto-optics, light scattering

