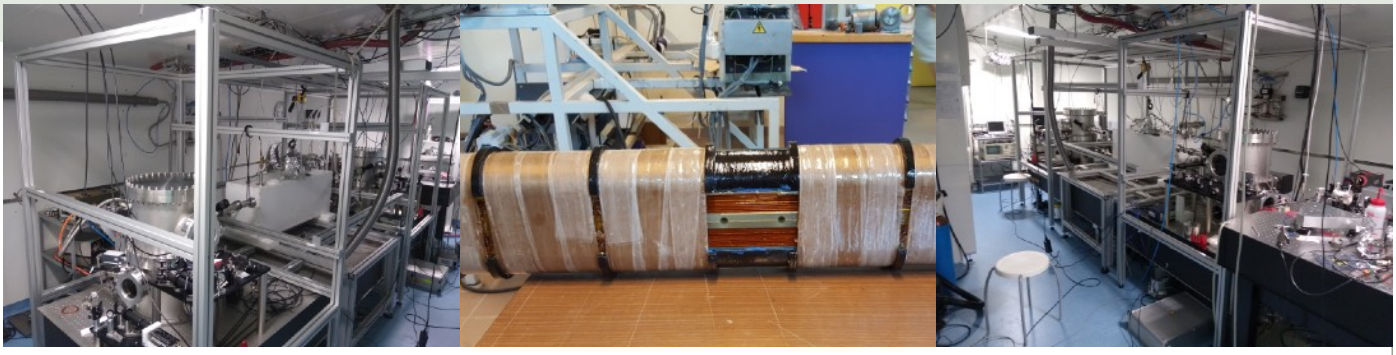
M2 Training position
PhD position available in 2025

Vacuum Magnetic Birefringence

Optical tests of quantum electrodynamics



Summary

The BMV project (Vacuum Magnetic Birefringence) is an ambitious experiment whose goal is to check in-laboratory predictions for vacuum energy in quantum electrodynamics. This theory predicts that vacuum, in the presence of a magnetic field, behaves as a birefringent medium. The experiment blends intense pulsed magnetic fields with a sensitive optical apparatus, centered around a high-finesse cavity.

Funding for a PhD position is also available for Octobre 2025.

Detailed subject

Classical electrodynamics was modified in the early XXth century to take into account quantum mechanics, giving rise to quantum electrodynamics (QED). QED is currently the best tested theory in the world (with the measurements of the anomalous magnetic moment of the electron, the Lambshift, the Rydberg constant, the hydrogen hyperfine structure, etc.). Nevertheless, there exist phenomena predicted by this theory which yet eludes observation, such as the effect of optical non-linearity of vacuum, or more specifically the birefringence of vacuum in presence of a magnetic field. Vacuum birefringence is a minute effect, rendering its experimental measurement very challenging task. Thanks to recent technological improvements at LNCMI in Toulouse, we are closer than ever to observing this phenomenon for the first time. The principle of our experiment is to measure the ellipticity acquired by linearly polarized light travelling through vacuum in a region of intense magnetic field.
The BMV experiment has one of the best sensitivities in the world. A new set-up is ready employing a novel coil technology and coupled with a new high-performance optical set up. A thesis position will be available for our group next year.

Publications linked to the theme

- R. Battesti *& al*, *High magnetic fields for fundamental physics*, Phys. Reports (2018), DOI : 10.1016/j.physrep.2018.07.005
- J. Agil, R. Battesti, and C. Rizzo, Vacuum birefringence experiments : optical noise, The European Physical Journal D 76, 10 (2022)
- J. Agil, R. Battesti, C. Rizzo, On the speed of light in a vacuum in the presence of a magnetic field, Eur. Phys. J. H 48, 2, (2023).

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The student will be inserted into the research group. The experiment sits in a clean room where the student will experience numerous skills during his training such as optics, ultra-high vacuum, magnetic fields, electronics, Fabry-Perot cavities, and metrology.