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The VMB@CERN experiment

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Nonlinear electrodynamic effects in vacuum have been predicted since the early days of Quantum Electrodynamics (QED) with the formulation of the Euler effective Lagrangian in 1935. Vacuum magnetic birefringence is one of these effects. Although experimental efforts have been active for more than 40 years, a direct laboratory observation of vacuum magnetic birefringence is still lacking as the effect is extremely small ($\Delta n = 4 \times 10^{-24}$ @ B = 1T).
In order to detect such small birefringences, experiments employ high-sensitivity polarimeters and long optical paths in intense magnetic fields. Fabry-Perot optical cavities usually provide the required increase in optical path. Unfortunately, none of the previous experiments reached shot noise-limited sensitivity: the cavity mirrors generate a birefringence noise that is enhanced by the cavity in the same way as the vacuum birefringence signal.
The VMB@CERN collaboration proposed in 2019 an experimental setup to overcome the intrinsic mirror noise limit by employing a spare LHC superconducting magnet and a new polarization modulation scheme that uses two co-rotating half-wave plates inside the optical cavity. A proof of principle feasibility study for the experiment is currently underway at the INFN unit of Ferrara. I will present measurements of the systematic effects in our polarimeter and the methods we used to reduce them to establish the first locks of the optical cavity with the rotating half-wave plates.

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