The Vacuum Birefringence Experiment at BMV

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In electrodynamics, vacuum is classically defined as a region where light travels at the well-known constant, c. At the turn of the century, the advent of modern physics in the form of quantum mechanics laid the groundwork for the development of the theoretical framework of quantum electrodynamics (QED). While it is a well-tested theory, there still exist unobserved phenomena predicted by QED. As a result of the QED vacuum polarization field, a particularly intriguing effect is the yet-unmeasured birefringence of vacuum as a medium for light propagation.

The leading experiments at PVLAS (Polarizzazione del Vuoto con LASer; Ferrara, Italy) [1] and BMV (Biréfringence Magnétique du Vide; Toulouse, France) [2] employ magnetic fields to produce a region of anisotropic vacuum and probe this region with a linearly polarized laser field in an ultra-precise polarimeter. The difficulty in measuring this vacuum magnetic birefringence (VMB) rests in obtaining the sensitivity required to measure the minuscule birefringence, $\Delta n_{\rm vac} = k_{\rm vac} B^2$, produced by an external magnetic field B, where the QED predicted VMB constant is $k_{\rm vac} \approx 4 \times 10^{-24}\,{\rm T}^{-2}$. The BMV project works toward this end through two means: first, through collaboration with the Laboratoire National des Champs Magnétique Intenses (LNCMI) facility in the design of custom pulsed magnets tailored to VMB signal production; and second through the development and characterization of a cavity-enhanced polarimeter for signal detection [3][4]. Here we present the status of this search with a focus on the BMV instrument.

References

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