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MAGPI: Measurement of Axion Gradients with Photon Interferometry

Wednesday 28 June 2023 16:40 (20 minutes)

In this talk, I will present a novel technique to search for axions with a CP-violating monopole coupling $\tilde{g}_Q$ to bulk SM charges $Q \in \{B, L, B-L\}$. Gradients in the static axion field configurations sourced by matter induce achromatic circular photon birefringence via the axion-photon coupling $g_{\phi\gamma}$. Circularly polarized light fed into an optical or (open) radio-frequency (RF) Fabry-Perot (FP) cavity develops a phase shift that accumulates up to the cavity finesse: the fixed axion spatial gradient prevents a cancellation known to occur for an axion dark-matter search. The relative phase shift between two FP cavities fed with opposite circular polarizations can be detected interferometrically. This time-independent signal can be modulated up to non-zero frequency by altering the cavity orientations with respect to the field gradient. Multi-wavelength co-metrology techniques can be used to address chromatic measurement systematics and noise sources. I will show projections indicating that, with Earth acting as the axion source, this approach could enable reach beyond current constraints on the product of couplings $\tilde{g}_Q g_{\phi\gamma}$ for axion masses $m_\phi < 10^{-5}$eV. If shot-noise-limited sensitivity can be achieved, an experiment using high-finesse RF FP cavities could reach a factor of $\sim 10^6$ into new parameter space for $\tilde{g}_Q g_{\phi\gamma}$ for masses $m_\phi < 10^{-10}$eV.

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