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Probing axion-like particles with LST-1 observations of blazars

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Axion-like particles (ALPs) are theoretical particles proposed in several extensions of the Standard Model of elementary particles. Aside from being viable dark matter candidates, their predicted interaction with photons in external magnetic fields makes them particularly relevant in observations of very-high-energy (VHE) gamma-ray sources. Specifically, this interaction is expected to leave imprints in the observed spectra, altering the spectral energy distribution (SED) of the target and causing energy-dependent oscillations in the photon flux.

In the presence of magnetic fields with strengths on the order of microgauss (O(μG)) and for ALP masses in the neV range, these oscillations emerge in the GeV energy band, coinciding with the highest energy sensitivity of LST-1. Our study focuses on LST-1 observations of blazars, including Mrk 421, Mrk 501, 1ES 1959+650, and BL Lac. Tests on the ALP hypothesis are conducted using more than 100 ALP models, with constraints computed via the likelihood-ratio method and further combined at the test statistic level.

This study is the first to constrain ALP parameters by combining datasets from multiple sources, providing a unique opportunity to explore combined constraints on the ALP parameter space while highlighting the challenges and advantages of this approach.

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