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Spin Identification of Dark Sector Mediators through Angular Distributions

Tuesday, 1 December 2026 14:00 (30 minutes)

Spin correlations between the production and decay of Long-Lived Particles (LLPs) are commonly neglected in event generators used for LLP searches, potentially limiting the interpretation of experimental sensitivities. In this talk, we present spin-correlation effects in scenarios where LLPs are produced in pseudoscalar meson decays, such as $\pi^0, \eta, \eta' \to AX \to Af\bar{f}$, with X denoting the LLP. We report a consistent implementation of production-decay spin correlations within the FORESEE framework, extending its capabilities beyond the standard unpolarized case. Using the dark photon (DP) as a benchmark LLP, we show that spin correlations induce distinctive angular signatures in the final-state fermions. In particular, the cosine of the fermion polar angle, defined with respect to the beam axis in the DP rest frame, provides sensitivity to the LLP spin. We apply this framework to the FASER2, NA62, SHiP, and DUNE experiments, adopting conservative assumptions for angular reconstruction systematics. We obtain 95% CL exclusion limits in the coupling-mass plane, demonstrating the potential of current and future experiments not only to discover LLPs, but also to discriminate between polarized and unpolarized production scenarios. These results highlight the phenomenological importance and robustness of angular observables as complementary probes of new physics at the intensity frontier.

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