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Transverse Spin Asymmetry as a New Probe of SMEFT Chirality-Flip Operators

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Electroweak chirality-flip operators in the Standard Model Effective Field Theory (SMEFT) are important indirect probes of quantum effects of new physics beyond the Standard Model (SM), yet they remain poorly constrained by current experimental analyses for lack of interference with the SM amplitudes in constructing traditional cross-section observables. In this talk, we point out that chirality-flip operators flip fermion helicities so are ideally studied through transverse spin asymmetries. We illustrate this at a future electron-positron collider with transversely polarized beams, where such effect exhibits as azimuthal $\cos\phi$ and $\sin\phi$ distributions which originate from the interference of the dipole operators with the SM and are linearly dependent on their Wilson coefficients. We also propose to investigate the semi-leptonic scalar/tensor four-fermion operators of leptons and quarks through the transverse double spin asymmetry (DSA) at Electron-Ion Collider, where both the lepton and nucleon beams could be highly transversely polarized, and which could lead to non-trivial azimuthal $\cos 2\phi$ and $\sin 2\phi$ distributions that are also linearly dependent on their Wilson coefficients. This new method can improve the current constraints on the chirality-flip couplings by one to two orders of magnitude, without depending on other new physics operators, and can also simultaneously constrain both their real and imaginary parts, offering a new opportunity for probing potential CP-violating effects. Therefore, our work opens up a new avenue to utilize these transverse spin asymmetries for exploring the new physics effects from the chirality-flip operators, which could be extended to muon collider and muon-ion collider.

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