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Single Transverse Spin Asymmetry as a New Probe of SMEFT Dipole Operators

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Electroweak dipole 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 cross section observables. In this Letter, we point out that dipole operators flip fermion helicities so are ideally studied through single 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 electron dipole operators with the SM and are linearly dependent on their Wilson coefficients. This new method can improve the current constraints on the electron dipole 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.

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