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Transverse spin effects and light-quark dipole moments at colliders

We propose a novel series of methods to investigate light-quark dipole interactions at colliders. These methods include: (1) utilizing the azimuthal asymmetry of a collinear dihadron pair $(h_1 h_2)$ produced in association with an additional hadron h' at lepton colliders; (2) examining the azimuthal asymmetries of a collinear dihadron in semi-inclusive deep inelastic lepton scattering off an unpolarized proton target at the Electron-Ion Collider. These asymmetries provide a unique means to observe transversely polarized quarks, which arise from quantum interference in the quark spin space, and are exclusively sensitive to dipole interactions at the leading power of the new physics scale. Consequently, they exhibit a linear dependence on the dipole couplings, free from contamination by other new physics effects. This approach has the potential to significantly strengthen current constraints by one to two orders of magnitude. By combining all possible channels of h', this novel approach enables the disentanglement of the up and down quark dipole moments. Additionally, by controlling the center-of-mass energy and the electron ' s longitudinal polarization, it separates the contributions of photon and weak boson. Furthermore, it allows for a simultaneous determination of both the real and imaginary parts of the dipole couplings, offering a new avenue for investigating potential CP-violating effects at high energies.

Primary author: 文, 新锴 (PKU)

Co-authors: YAN, Bin (IHEP); YU, Zhite (Jlab); YUAN, C.-P. (MSU)

Presenter: 文, 新锴 (PKU)

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