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Quark orbital angular momentum in the proton from a twist-3 generalized parton distribution

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Quark orbital angular momentum in the proton is evaluated via a Lattice QCD calculation of the second Mellin moment of the twist-3 generalized parton distribution $\widetilde{E}_{2T}$ in the forward limit. The connection between this approach to quark orbital angular momentum and approaches previously utilized in Lattice QCD calculations, via generalized transverse momentum-dependent parton distributions and via Ji's sum rule, is reviewed. This connection can be given in terms of Lorentz invariance and equation of motion relations. The calculation of the second Mellin moment of $\widetilde{E}_{2T}$ proceeds via a finite-momentum proton matrix element of a quark bilocal operator with a straight-line gauge connection and separation in both the longitudinal and transverse directions. The dependence on the former component serves to extract the second Mellin moment, whereas the dependence on the latter component provides a transverse momentum cutoff for the matrix element. Furthermore, a derivative of the matrix element with respect to momentum transfer in the forward limit is required, which is obtained using a direct derivative method. The calculation utilizes a clover fermion ensemble at pion mass 317 MeV. The resulting quark orbital angular momentum is consistent with previous evaluations through alternative approaches, albeit with greater statistical uncertainty using a comparable number of samples.

Topical area

Structure of Hadrons and Nuclei

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