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Perturbative study of renormalization and mixing for asymmetric staple-shaped Wilson-line operators on the lattice

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We present one-loop perturbative results of the renormalization functions for a complete set of nonlocal quark bilinear operators containing an asymmetric staple-shaped Wilson line, using a family of improved lattice actions. This study is relevant for the nonperturbative investigations regarding the renormalization of the unpolarized, helicity and transversity transverse-momentum dependent parton distribution functions (TMDPDFs) in lattice QCD. We employ a number of different versions of regularization-independent (RI′) renormalization prescriptions which address the power and logarithmic divergences of such non-local operators, the pinch-pole singularities at infinite Wilson-line lengths, as well as the mixing among operators of different Dirac structures, as dictated by discrete symmetries. All cancelations of divergences and admixtures are confirmed by our results at one-loop level. We compare all the different prescriptions and we provide the conversion matrices at one-loop order which relate the matrix elements of the staple operators in RI′ to the reference scheme $\overline{\text{MS}}$.

Topical area

Structure of Hadrons and Nuclei

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