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Renormalization of Transverse-Momentum-Dependent Parton Distribution on the Lattice

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To calculate the transverse-momentum-dependent parton distribution functions (TMDPDFs) from lattice QCD, an important goal yet to be realized, it is crucial to establish a viable nonperturbative renormalization approach for linear divergences in the corresponding Euclidean quasi-TMDPDF correlators in large-momentum effective theory. We perform a first systematic study of the renormalization property of the quasi-TMDPDFs by calculating the relevant matrix elements in a pion state at five lattice spacings ranging from 0.03 fm to 0.12 fm. We demonstrate that the square root of the Wilson loop combined with the short distance hadron matrix element provides a successful method to remove all ultraviolet divergences of the quasi-TMD operator, and thus provides the necessary justification to perform a continuum limit calculation of TMDPDFs. In contrast, the popular regularization independent momentum subtraction renormalization (RI/MOM) scheme fails to eliminate all linear divergences.

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