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Self-Renormalization of Quasi-Light-Front Correlators on the Lattice

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Large-momentum effective theory provides a way to extract the parton physics from lattice data based on first-principle calculation. In applying large-momentum effective theory, renormalization of the Euclidean correlators in lattice regularization is a challenge due to linear divergences in the self-energy of Wilson lines.
Based on lattice QCD matrix elements of the quasi-PDF operator at lattice spacing a= 0.03 fm $\sim$ 0.12 fm with clover and overlap valence quarks on staggered and domain-wall sea, we design a strategy to disentangle the divergent renormalization factors from finite physics matrix elements, which can be matched to a continuum scheme at short distance such as dimensional regularization and minimal subtraction. Our results indicate that the renormalization factors are universal in the hadron state matrix elements. Moreover, the physical matrix elements appear independent of the valence fermion formulations.
These conclusions remain valid even with HYP smearing which reduces the statistical errors albeit reducing control of the renormalization procedure.
Moreover, we find a large non-perturbative effect in the popular RI/MOM and ratio renormalization scheme, suggesting favor of the hybrid renormalization procedure proposed recently. We show the unpolarized isovector nucleon PDF calculated under hybrid renormalization scheme in comparison with other schemes. The hybrid renormalization scheme can give a better prediction for the negative x region (the antimatter region), which is consistent with the antimatter asymmetry measured by experiments.

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