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Asymptotic Long-Distance Expansion of Euclidean Correlators in Lattice Parton Applications

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Bilinear Euclidean quark and gluon correlators with Wilson links have been used widely for applications of large-momentum effective field theories to computing non-perturbative collinear and soft parton physics. Due to color confinement, these correlators decay exponentially at large spatial distances, a behavior crucial for computing momentum-space Fourier transformations with controlled errors from lattice QCD data. Using heavy-quark effective theory reduction, dispersive analysis, Lorentz symmetry, and heavy-flavor spectra, we determine the leading and next-to-leading asymptotic behaviors and relate the expansion parameters to binding energies of heavy-flavor hadrons. We demonstrate the results through two-loop calculations in ϕ^3 theory and from the perspective of locality and analyticity. We also study the impact of the asymptotic analysis on realistic lattice QCD data and demonstrate reliable error estimates.

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