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Disentangling long and short distances in momentum-space TMDs

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The extraction of nonperturbative TMD physics is made challenging by prescriptions that shield the Landau pole, which entangle long- and short-distance contributions in momentum space. The use of different prescriptions then makes the comparison of fit results for underlying nonperturbative contributions not meaningful on their own. We propose a model-independent method to restrict momentum-space observables to the perturbative domain. This method is based on a set of integral functionals that act linearly on terms in the conventional position-space operator product expansion (OPE). Artifacts from the truncation of the integral can be systematically pushed to higher powers in $\Lambda_{\rm QCD}/k_T$. We demonstrate that this method can be used to compute the cumulative integral of TMD PDFs over $k_T \leq k_T^{\rm cut}$ in terms of collinear PDFs, accounting for both radiative corrections and evolution effects. This yields a systematic way of correcting the naive picture where the TMD PDF integrates to a collinear PDF, and for unpolarized quark distributions we find that when renormalization scales are chosen near $k_T^{\rm cut}$, such corrections are a percent-level effect. We also show that, when supplemented with experimental data and improved perturbative inputs, our integral functionals will enable model-independent limits to be put on the non-perturbative OPE contributions to the Collins-Soper kernel and intrinsic TMD distributions.

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