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Off-lightcone Wilson-line operators in gradient flow

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Off-lightcone Wilson-line operators are constructed using local operators connected by time-like or space-like Wilson lines, which ensure gauge invariance. Off-lightcone Wilson-line operators have broad applications in various contexts. For instance, space-like Wilson-line operators play a crucial role in determining quasi-distribution functions (quasi-PDFs), while time-like Wilson-line operators are essential for understanding quarkonium decay and production within the potential non-relativistic QCD (pNRQCD) framework. In this work, we establish a systematic approach for calculating the matching from the gradient-flow scheme to the $\overline{\text{MS}}$ scheme in the limit of small flow time for off-lightcone Wilson-line operators. By employing the one-dimensional auxiliary-field formalism, we simplify the matching procedure, reducing it to the matching of local current operators. We provide one-loop level matching coefficients for these local current operators. For the case of hadronic matrix element related to the quark quasi-PDFs, we show at one-loop level that the finite flow time effect is very small as long as the flow radius is smaller than the physical distance z , which is usually satisfied in lattice gradient flow computations. Applications include lattice gradient flow computations of quark/gluon quasi-PDFs, gluonic correlators related to quarkonium decay and production in pNRQCD, and spin-dependent potentials in terms of chromoelectric and chromomagnetic field insertions into a Wilson loop.

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