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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 cononumberected 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 $\overline{\rm MS}$ 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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