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Unlocking Higher Moments of Parton Distribution Functions in Lattice QCD

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We describe a novel procedure, based on the gradient flow for fermion and gauge fields, to determine moments of parton distribution functions of any order in lattice QCD. This method resolves the problems that have hampered the determination of moments of any order of parton distribution functions on the lattice. The flowed matrix elements of twist-2 operators renormalize multiplicatively, and the matching with the physical matrix elements can be obtained using continuum symmetries and the irreducible representations of Euclidean 4-dimensional rotations. In this new framework, it is possible to choose operators with identical Lorentz indices and still retain multiplicative renormalization and matching. One can then use twist-2 operators exclusively with temporal indices, substantially improving the signal-to-noise ratio in the computation of the hadronic matrix elements. We test the method numerically by estimating moments of parton distribution functions of pseudoscalar mesons as a function of flow-time and performing a perturbative matching to determine the renormalized moments in the $\overline{\text{MS}}$ scheme.

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