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Two-current Correlations and the Pion Valence Quark Distribution from Lattice QCD

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An understanding of the partonic structure of hadrons is an essential ingredient in making precise predictions and measurements of hadronic cross-sections and various Standard, and Beyond Standard, Model parameters. Direct first-principles calculations of parton distribution functions (PDFs) via lattice QCD (LQCD) were historically limited to the lowest few moments, principally due to the time-dependence of PDFs and the breaking of rotational symmetry via the lattice cutoff. Several encouraging proposals have since been developed that relate lattice calculable quantities with PDFs via frameworks akin to QCD factorization. We report results of one such LQCD formalism, wherein the pion valence quark distribution is extracted through a short-distance collinear factorization of space-like separated vector and axial-vector current correlations. Together with the NLO perturbative kernel for this current combination, computations on four distinct gauge ensembles quantify the systematics inherent in this approach. These data when parametrized with a flexible z-expansion fit supplemented with lattice correction terms, yield a physical limit valence distribution that is found to be consistent with experiment across the entire Bjorken-x region and favors a softer approach to $x = 1$.

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