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Impact of gauge fixing precision on the continuum limit of non-local quark-bilinear lattice operators

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We analyze the gauge fixing precision dependence of some non-local quark-blinear lattice operators interesting in computing parton physics for several measurements, using 5 lattice spacings ranging from 0.032 fm to 0.121 fm. Our results show that gauge dependent non-local measurements are significantly more sensitive to the precision of gauge fixing than anticipated. The impact of imprecise gauge fixing is significant for fine lattices and long distances. For instance, even with the typically defined precision of Landau gauge fixing of 10^{-8}, the deviation caused by imprecise gauge fixing can reach 12 percent, when calculating the trace of Wilson lines at 1.2 fm with a lattice spacing of approximately 0.03 fm. Similar behavior has been observed in ξ gauge and Coulomb gauge as well. For both quasi PDFs and quasi TMD-PDFs operators renormalized using the RI/MOM scheme, convergence for different lattice spacings at long distance is only observed when the precision of Landau gauge fixing is sufficiently high. To describe these findings quantitatively, we propose an empirical formula to estimate the required precision.

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