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Soft modes in the background field method for SIDIS jet

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Abstract

We present a factorization formula for the $e + h \rightarrow e + \text{jet} + X$ cross section at small transverse momenta up to next-to-leading power, derived using the background field method (BFM) with explicit inclusion of soft modes. Our derivation is compared to alternative approaches, such as soft-collinear effective theory and the BFM without soft modes. We find agreement at the level of the final expressions at the perturbative order that we are working at and formulate a condition that would need to be satisfied at higher orders. We discuss the relation between soft modes and zero-bin subtractions at NLP which leads to a proper definition of twist-3 operators with subtracted rapidity and endpoint divergences. Additionally, we construct the most general form factors for this process, taking into account the polarization of the initial states. These structure functions are shown to be sensitive to the perturbatively calculable components of the jet function, opening a path to precise determinations of twist-3 hadronic distributions. Finally, we illustrate our formalism with phenomenological results for a specific azimuthal asymmetry whose leading-order contribution depends solely on a twist-3 hadronic distribution and a twist-2 jet function.

