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Obtaining the Collins-Soper Kernel and Intrinsic Soft Function with Lattice QCD

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TMD quantities, such as TMDPDFs, provide essential information on the three-dimensional structure of hadrons and serve as key nonperturbative inputs for high-energy scattering processes, including SIDIS and Drell–Yan production. Unlike collinear PDFs, TMDs involve near-light-cone Wilson lines and therefore suffer from rapidity divergences arising from the separation of soft and collinear dynamics. A properly defined soft subtraction is required to remove these divergences, while the rapidity-scale dependence of TMDs is governed by the Collins–Soper kernel. In addition, the intrinsic soft function encodes the rapidity-independent, long-distance soft-gluon contribution that is essential for a complete nonperturbative description of TMD factorization.

In this presentation, I will first introduce the theoretical role of the Collins–Soper kernel and the intrinsic soft function in TMD physics. I will then discuss how these quantities can be accessed from lattice QCD within the LaMET framework. Finally, I will present our recent extension of this program, including improved lattice calculations, next-to-leading-order matching, controlled extrapolations toward the continuum and physical pion-mass limits, and the determination of the intrinsic soft function at transverse separations up to about 1 fm.

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