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Using 1-Jettiness to Measure 2 Jets in DIS 3 ways

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We predict cross sections in deep inelastic scattering (DIS) for the production of two jets—one along the proton beam direction created by initial state radiation (ISR) and another created by final state radiation after the hard collision. Our results include fixed order corrections and a summation of large logarithms up to next-to-next-to-leading logarithmic (NNLL) accuracy in resummed perturbation theory. We make predictions for three versions of a DIS event shape 1-jettiness, each of which constrains hadronic final states to be well collimated into two jets along the beam and final-state jet directions, but which differ in their sensitivity to the transverse momentum of the ISR from the proton beam. We use the tools of soft collinear effective theory (SCET) to derive factorization theorems for these three versions of 1-jettiness. The sensitivity to the ISR gives rise to significantly different structures in the corresponding factorization theorems—for example, dependence on either the ordinary or the generalized $k_\perp$-dependent beam function. We give numerical results for Q2 and x values explored at the HERA collider, emphasizing that the target of factorization based analyses is to open the door for higher-precision jet phenomenology in DIS.

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