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Factorization of Non-Global LHC Observables and Resummation of Super-Leading Logarithms

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We present a systematic formalism based on a factorization theorem in soft-collinear effective theory to describe non-global observables at hadron colliders, such as gap-between-jets cross sections. The cross sections are factorized into convolutions of hard functions, capturing the dependence on the partonic center-of-mass energy, and low-energy matrix elements, which are sensitive to the low scale characteristic of the veto imposed on energetic emissions into the gap between the jets. The scale evolution of both objects is governed by a renormalization-group equation, which we derive at one-loop order. By solving the evolution equation for the hard functions for arbitrary 2⟶M jet processes in the leading logarithmic approximation, we accomplish for the first time the all-order resummation of the so-called "super-leading logarithms" discovered in 2006, thereby solving an old problem of quantum field theory. We study the numerical size of the corresponding effects for different partonic scattering processes and explain why they are sizable for pp⟶2jets processes, but suppressed in H/Z+jet production. The super-leading logarithms are given by an alternating series, whose individual terms can be much larger than the resummed result, even in very high orders of the loop expansion. Resummation is therefore essential to control these effects. We find that the asymptotic fall-off of the resummed series is much weaker than for standard Sudakov form factors.

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