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On qualitative aspects of the choice of factorization schemes at NLO

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Although the choice of a factorization scheme is as important as the choice of a factorization scale, the dependence of theoretical predictions (at finite order) on the choice of a factorization scheme has been little investigated. This is due to the fact that the freedom in the choice of a factorization scheme is enormous, even at NLO. Every factorization scheme can be unambiguously specified by the corresponding higher order splitting functions, which can be chosen at will. However, in practice not all possible choices provide reasonable predictions at NLO. The NLO splitting functions that correspond to an applicable factorization scheme should satisfy some nontrivial conditions, which can be easily formulated in the space of Mellin moments. If these conditions are not satisfied, then the corresponding parton distribution functions diverge for low x as x^xi with xi=-4.63 for nf=3 and xi=-3.85 for nf=4 where nf is the number of active flavours. This occurs even if the NLO splitting functions have better low x behaviour than the LO ones. The NLO hard scattering cross-sections behave for low x in a similar way as the parton distributions. It is likely that in such a factorization scheme the cancellation between large negative and positive numbers in expressions for physical quantities is incomplete at NLO and the obtained results are thus unreasonable. An example of a factorization scheme which appears at first sight as applicable but which does not satisfy the conditions is the factorization scheme in which all NLO splitting functions vanish and which would thus be otherwise optimal for generating NLO initial state parton showers, because in this scheme the NLO initial state parton showers are formally identical to the LO ones. It is worth mentioning that the conditions give no restriction on non-singlet splitting functions.

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