Threshold resummation of heavy coloured-particle cross sections

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A precise theoretical description of the pair-production of heavy coloured particles is hampered by quantum corrections to the partonic cross sections of the form $\alpha_s^n \ln^m \beta$ and $(\alpha_s/\beta)^k$, which arise from soft-gluon emission and Coulomb exchange, respectively. Near the production threshold, defined by the limit $\beta \equiv \sqrt{1-4M^2/\hat{s}} \to 0$, such terms are parametrically enhanced, possibly leading to a breakdown of perturbation theory, and should ideally be resummed to all orders in the strong coupling α_s. In this talk I discuss how resummation of soft and Coulomb corrections can be achieved through an effective-theory description of the pair-production process, in which long-distance degrees of freedom with $q^2 \ll M^2$ are still dynamical, while the effect of *hard* modes with $q \sim M$ is encoded in the effective couplings of the low-energy theory. In [1] and [2], it has been shown that in such description the partonic cross section factorizes according to

$$\hat{\sigma} = \sum_S \sum_i H_i^S(\mu) \int d\omega \sum_{R_\alpha} J_{R_\alpha}^S(E-\omega/s) W_i^{R_\alpha}(\omega,\mu)\,, \tag{1}$$

where H_i^S, $J_{R_\alpha}^S$ and $W_i^{R_\alpha}$ are determined, respectively, by hard, Coulomb and soft modes only. In this approach, large logarithms of β are resummed to all orders by solving renormalization-group evolution equations for the functions H_i^S and $W_i^{R_\alpha}$, while resummation of Coulomb singularities, contained in $J_{R_\alpha}^S$, is obtained via techniques developed in the context of PNRQCD. The formalism has been recently applied to $t\bar{t}$ (Refs. [3], [4]) and to squark-antisquark production (Ref. [2]), where resummation effects on the total cross section were found to be sizeable, and thus relevant for phenomenological analysis at Tevatron and LHC.

References

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