Non-global logarithms in hadron collisions at $N_c = 3$[†]

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Recently, there have been a lot of activities in developing Monte Carlo algorithms for simulating parton showers beyond the large-N_c (leading-N_c) approximation where $N_c = 3$ is the number of colors. Traditionally, in most event generators, the large-N_c approximation has been the only practical way to keep track of the color indices of many partons involved. Among other observables, the finite-N_c corrections are particularly important but difficult to quantify for the so-called non-global observables[1] which are sensitive to the wide-angle emission of soft gluons in restricted regions of phase space. In Ref. 2), we have developed a framework to resum non-global logarithms at $N_c = 3$ by improving and completing the earlier attempt.[3] Numerical results are so far available only for two observables in e^+e^- annihilation: interjet energy flow[2] and the hemisphere jet mass distribution.[4] In this work we demonstrate that our approach can be practically applied to hadron collisions where it is probably most useful. We do so by explicitly computing the rapidity gap survival (or 'veto') probabilities in Higgs plus dijet production $pp \to HjjX$. The relevant logarithms are of the form $(\alpha_s \ln Q/E_{out})^n$ where Q is the hard scale (Higgs mass or jet transverse momentum) and $E_{out} \ll Q$ is the veto scale.

Consider quark-quark scattering $q_i(p_1)q_j(p_2) \to q_k(p_3)q_l(p_4)H$ where $i, j, k, l = 1, 2, 3$ are color indices. The outgoing quarks with momenta p_3, p_4 are back-to-back and detected as two jets in the forward and backward directions. We are interested in the probability that the energy emitted in the central rapdiity region $\pi - \theta_{in} > \theta > \theta_{in}$ is less than E_{out}.

The leading-order amplitude can be written as

$$\mathcal{M}_{ijkl} = M_1 \delta_{ki}\delta_{lj} + M_8 t^a_{ki} t^a_{lj}. \quad (1)$$

where $M_{1,8}$ are amplitudes in the singlet and octet channel. We dress up (1) by attaching soft gluons to external legs in the eikonal approximation. We then square it and average over color indices to get the cross section

$$M_1^2 P^1_{qq} + \frac{N_c^2 - 1}{4N_c^2} M_8^2 P^8_{qq}. \quad (2)$$

$P^{1,8}$ are the gap survival probabilities in the singlet and octet channels.

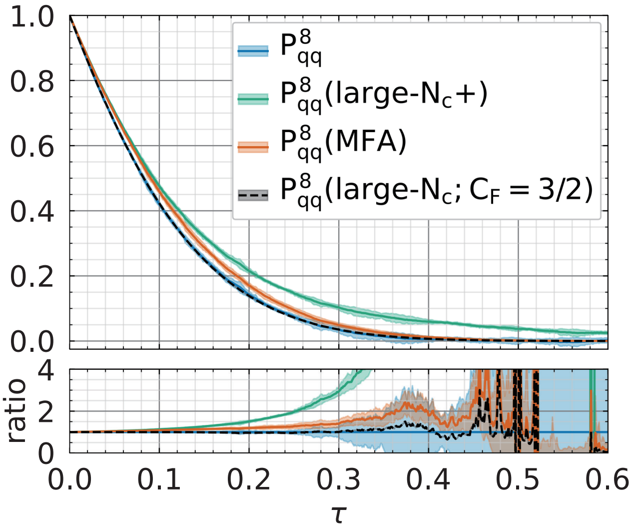

Fig. 1. Gap survival probability in $qq \to qqH$, color-octet channel.

$$P^1_{qq} = \frac{1}{N_c^2}\left\langle \mathrm{tr}(U_3U_1^\dagger)\mathrm{tr}(U_4U_2^\dagger)\right\rangle, \quad (3)$$

$$P^8_{qq} = \frac{\left\langle \mathrm{tr}(U_3U_2^\dagger)\mathrm{tr}(U_4U_1^\dagger) - \frac{\mathrm{tr}(U_3U_1^\dagger)\mathrm{tr}(U_4U_2^\dagger)}{N_c^2}\right\rangle}{N_c^2 - 1}, \quad (4)$$

where U_α is the fundamental Wilson line in the direction of α. We compute these probabilities as a function of

$$\tau = \frac{\alpha_s}{\pi} \ln \frac{P_T}{E_{out}}. \quad (5)$$

The result for P^8_{qq} for $\theta_{in} = \pi/3$ is shown in Fig. 1 together with its various approximations. Surprisingly, we find a very good agreement with the large-N_c approximation in which P is simply computed from the solution of the Banfi-Marchesini-Smye equation.[5] A similar conclusion is reached for other channels including gluons in the initial state. While we do not fully understand the reason of this agreement at the moment, if it turns out to be a robust feature, it is good news because one can approximately get full-N_c results in hadron collisions using the known large-N_c frameworks.[1,5]

References
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