Squark and gluino production at hadron colliders

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Motivation: searches for supersymmetry at hadron colliders

- Production of coloured supersymmetric particles (squarks and gluinos) is a very important supersymmetry (SUSY) discovery channel at hadron colliders

Threshold-resummed predictions for squark and gluino production total cross sections

Tevatron

The NLL/NLO cross sections for inclusive squark and gluino production at the Tevatron as a function of average particle mass.

LHC

The NLL/NLO cross sections for inclusive squark and gluino production at the LHC as a function of average particle mass.

Summary

- Total cross sections for all squark and gluino production processes at the LHC and the Tevatron calculated at NLL (NLO) accuracy
- Calculations of one-loop soft anomalous dimension match the physical picture: at production threshold, radiation of soft gluons from the total colour charge of the pair of produced particles
- NLL corrections to the NLO cross sections can be of order of few percent, depending on the process and the considered mass range
- Including NLL corrections lead to significant reduction of the theoretical error due to scale variation

Publications

A. Kulesza and L. Motyka, Phys. Rev. Lett. 102, 111802 (2009); arXiv:0807.2403 [hep-ph]
A. Kulesza and L. Motyka, Phys. Rev. D80, 055004 (2009); arXiv:0903.4749 [hep-ph]
H. Baer, H. Fritzsch, S. Heinrich, M. Krämer, M. Krämer, A. Kulesza, E. Laenen and I. Nielsen, arXiv:0908.4418 [hep-ph], submitted to JHEP

Soft anomalous dimensions

- One-loop soft anomalous dimension matrices $\beta_{\nu}$ for $2g-2$ processes with non-singlet colour structure and massive, final-state particles are calculated by combining appropriate colour structure with one-loop integrals corresponding to the following diagrams calculated in the minimal approximation.

Hard function

- At NLL accuracy, the hard function at threshold is given by Mellin moments of the contributions to leading-order cross sections from different colour channels.

Resummed cross sections

Resummation of soft gluon corrections is performed in the space of Mellin moments $N$ taken w.r.t. variable $x$, in which the cross section factorizes:

$$\langle N \rangle \approx -\frac{1}{\log N} \langle N \rangle_{\nu}$$

Schematic representation of factorization for the 2->2 process involving all four particles carrying colour.

The soft function $S_{\nu}$ is obtained through solving renormalization-group equation:

$$\frac{d}{d\ln N} S(N)_{\nu} = -\frac{1}{J_{\nu} N_{\nu}} \langle N \rangle_{\nu} - S(N)_{\nu} + \sum_{\nu} S(N)_{\nu}$$

The factor $S_{\nu}$ is taken as $S_{\nu}(N_{\nu})_{\nu} = \langle N \rangle_{\nu}$ in which the cross section factorizes.

Threshold resummation of soft gluon corrections

- The logarithmic terms contribute substantially to the full higher-order corrections, as seen at NLO. In the threshold limit $N \to \infty$, they diverge, leading to breakdown of the conventional fixed-order perturbation theory
- The predictive power of the perturbation theory can be restored in the threshold limit if the most dominant logarithmic contributions are taken into account in all orders.