Phenomenological Studies in QCD Resummation

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The talk describes some new developments [1-4] in the field of QCD soft-gluon resummation. Particular emphasis is put on phenomenological applications.
The hadronic annihilation cross sections for electroweak boson production (γ^*, W, Z, H) provide important test cases for resummation techniques in QCD. The talk describes the application of a simultaneous, joint resummation of threshold and transverse momentum singularities in these cross sections, as well as in the prompt-photon cross section $pp \to \gamma X$. The latter cross section is of great importance in QCD and for examining the gluonic structure of the nucleon.
To be more specific, at measured transverse momentum $Q_T \ll Q$, with Q the pair or boson mass, annihilation cross sections have contributions $\alpha_s^n \ln^{2n-1}(Q_T^2/Q^2)/Q_T^2$ at each order of perturbation theory. These terms organize themselves into a function that describes the Sudakov suppression of the cross section at small Q_T. The perturbative corrections have an analogous behavior at "partonic threshold", $z = Q^2/\hat{s} = 1$, where one encounters terms of the form $\alpha_s^n \ln^{2n-1}(1-z)/(1-z)$. These singular corrections reflect the lack of phase space for soft radiation when the partons have just enough energy to produce the observed final state. Like the singularities at $Q_T = 0$, they can be resummed to all orders. Because the dynamical origins of the large corrections in both threshold and transverse momentum resummations are in soft gluon emission, it is possible to develop a formalism that encompasses both [1,2]. In this "joint" resummation, both transverse momentum and energy conservation for soft emission are respected.
There is a close relation between resummation and nonperturbative corrections through the running of the strong coupling in the presence of soft emission. We will also discuss how joint resummation can give insight into the way nonperturbative dynamics is expressed in infrared safe hard scattering functions.
We also present studies on the effects of soft-gluon resummation on spin asymmetries. These results are important with respect to the new high-energy $\vec{p}\vec{p}$ spin physics program at BNL-RHIC.

References

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