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Introduction

Quantum Chromodynamics (QCD) is the theory of the strong interaction among quarks and gluons. One of the most important properties of QCD is asymptotic freedom, which predicts the coupling constant to be small in the high energy region. This allows us to calculate cross-section using the perturbative approach. However, in regions characterized by a large scale hierarchy, the perturbative expansion is violated due to large logarithmic enhancements, thus it cannot be truncated at any fixed order. Therefore, it must be resummed to all orders.

A deep understanding of the structure of Infrared Singularities in QCD plays a key role for the all order structure of perturbation theory. Beside of the deeper understanding of perturbative quantum field theory at high orders, it also has many practical applications. For example, infrared and collinear safety (IRC) is the guiding principle for devising observables. On the other hand, for the phenomenological aspect, jet physics, i.e. the properties of jet and inventing new jet observables, becomes more and more import at the high precision era of LHC. It is crucial to separate the signal of interest from the background of quark and gluons, e.g. search for BSM particles or Higgs physics.

In our present study, we investigate an observable that measures QCD radiation in the signal events.

Research activity

- Pull Angle
  Jet Pull[1] is a powerfull observable that can probe colour flow between two jets. Following from my work on resummation for the pull magnitude, I applied the Sudakov safe[2] technique on pull angle, which is most sensitive to colour flow. In order to explain the discrepancy between simulation and experimental data, I also include an estimation of non-perturbative contribution. This work resulted into a publication[I] in PRD Rapid Communications.

- Safe Pull
  Despite I was able to obtain a first-principle description for pull angle, it still suffered from large theoretical uncertainties, due to the fact that pull angle is Sudakov safe instead of infrared and collinear safe. Motivated by this, I start to study the safe projections[II] of pull vector, I have proved the NLL resummation formula, similar to the formalism developed for the projections of transverse momentum: ϕ^* and a_T[3]. In my calculation, I also found some interesting asymmetry behavior, which may help to probe azimuthal asymmetry[6] in the colour radiation pattern.

- Non-Global Logarithms
  To achieve higher accuracy precision calculation, non-global logarithms (NGLs) must be

included. NGLs were first introduced and resummed using Monte-Carlo (MC) simulation in Ref.[4]. As an alternative to the MC approach, Banfi, Marchesini and Syme (BMS) have derived an evolution equation[5] for leading NGLs at large N_c limit.

Recently, I start working on a new project toward resum the leading NGLs using the BMS equation with neural network method. As a first step, I have calculated the partially resummed result by solving the linear part of BMS equation.

Conferences

Jun 2019 Parton Showers and Resummation 2019, ESI, Vienna
Talk: Jet Pull

Apr 2019 XXVII International Workshop on Deep Inelastic Scattering, Torino
Talk: First Principle Prediction for the Pull Angle

Oct 2018 HARPS Mini-Workshop, Genova
Talk: Resummation for the Pull Magnitude

Publications

[I] A. J. Larkoski, S. Marzani and C. Wu, Phys. Rev. D **99**, no. 9, 091502 (2019) doi:10.1103/PhysRevD.99.091502 [arXiv:1903.02275 [hep-ph]].

[II] A. J. Larkoski, S. Marzani and C. Wu, "Safe use of jet pull," in preparation.

References

[1] J. Gallicchio and M. D. Schwartz, Phys. Rev. Lett. **105**, 022001 (2010) doi:10.1103/PhysRevLett.105.022001 [arXiv:1001.5027 [hep-ph]].

[2] A. J. Larkoski, S. Marzani and J. Thaler, Phys. Rev. D **91**, no. 11, 111501 (2015) doi:10.1103/PhysRevD.91.111501 [arXiv:1502.01719 [hep-ph]].

[3] A. Banfi, M. Dasgupta and R. M. Duran Delgado, JHEP **0912**, 022 (2009) doi:10.1088/1126-6708/2009/12/022 [arXiv:0909.5327 [hep-ph]].

[4] M. Dasgupta and G. P. Salam, Phys. Lett. B **512**, 323 (2001) doi:10.1016/S0370-2693(01)00725-0 [hep-ph/0104277].

[5] A. Banfi, G. Marchesini and G. Smye, JHEP **0208**, 006 (2002) doi:10.1088/1126-6708/2002/08/006 [hep-ph/0206076].

[6] S. Catani, M. Grazzini and H. Sargsyan, JHEP **1706**, 017 (2017) doi:10.1007/JHEP06(2017)017 [arXiv:1703.08468 [hep-ph]].