Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

QCD factorization and effective field theories at the LHC

By

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Quantum Chromodynamics (QCD) is the main tool for making precise theoretical predictions for proton-proton collisions at the Large Hadron Collider (LHC). A key lesson from QCD is that physics looks different at different energy scales, under renormalization group evolution. The simplest example is the running coupling, but more examples come from QCD factorization of hadron scattering and effective field theories. A hard scattering event in hadron collisions involves two widely separated scales: the hadron mass scale and the hard momentum transfer scale. The parton distribution functions, describing a light-cone view of the internal structure of a proton, are evolved from the hadronic scale to the hard scattering scale using the DGLAP evolution equation, to set the initial conditions for hard scattering of point-like partons.

In more complicated collider measurements, more than two widely-separated scales are involved, and more sophisticated evolution equations are needed, forming the basis of “resummation" calculations for hadron collisions. We apply threshold resummation and p_T resummation to the production of W^+W^- boson pairs. Our results, adopted by the CMS Collaboration for experimental analysis, reduced tension between theory and experiment.

The production of a Higgs boson in association with a hadronic jet is analyzed using the method of effective field theory. The largeness of the top quark mass enables us to integrate out the top quark, which is the assumption behind many theoretical calculations in the literature. But if the Higgs boson is produced with a large transverse momentum, we begin to probe the finiteness of the top quark mass, and possible novel effects beyond the Standard Model of particle physics.

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