Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Heavy Quarks and Interjet Radiation

By

Ilmo Sung

In the first part of this thesis, we show how properties of Quantum Chromodynamics (QCD) can be used directly or indirectly to discover physics beyond the standard model (BSM) in collider experiments. We introduce a method to determine the color SU(3) gauge content of BSM resonances from new physics signals by investigating the pattern of soft gluon radiation into specified regions of a detector. We use energy flow, treated by perturbative QCD and factorization, as a tool to analyze properties of new physics. This approach allows the analytical prediction of the distribution of soft gluon radiation into a rapidity region of a detector, reflecting the gauge content of heavy resonances. The results, in general, predict more radiation for singlet than for octet resonances. We also introduce the use of the collinear enhancement in perturbative QCD amplitudes to distinguish products of highly-boosted massive particle decay from QCD jets whose collinear structure is described by a factorized jet function. At the LHC, events with highly-boosted massive particles such as top, W, Z and Higgs may be a key ingredient for the discovery of new physics. In many decay channels, these particles would be identified as high-p_t jets, and any such signal of definite mass must be disentangled from a large background of QCD jets. We discover that this background far exceeds such signals, and relying solely on jet mass as a way to reject QCD background from signal would probably not suffice in most case. To solve this problem, we find that jets from QCD are characterized by different patterns of intrajet energy flow compared to highly-boosted heavy particle decays. Based on this observation, we introduce several event shapes that could be used to disentangle signals from backgrounds.

In the second part of this thesis, we study two-loop anomalous dimension matrices in QCD and related gauge theories for products of Wilson lines coupled at a point. We verify by an analysis in Euclidean space that the contributions to these matrices from diagrams that link three massive Wilson lines do not vanish in general. This differs from the pattern found with massless external lines. We, however, show that for two-to-two processes the two-loop anomalous dimension matrix is diagonal in the same color exchange basis as the one-loop matrix for scattering at ninety degrees in the center of mass.

Date: May 7, 2010
Time: 10:00am
Place: YITP Common Room, Math Tower 6-125

Program: Physics
Dissertation Advisor: George Sterman