Abstract

The Standard model (SM) of particle physics has been very successful in explaining the fundamental interactions of the elementary particles, seen in the nature. However, the SM itself can not be a fundamental theory for it can not explain certain issues like the hierarchy problem. To address such issues in the SM is the main motivation for many beyond the standard model (BSM) physics scenarios like super symmetry, extra dimensions. With the advent of the Large Hadron Collider (LHC) where the center of mass energy will be $\sqrt{S} = 14$ TeV, it will be very much possible to test these theories and to constrain the model parameters. Eventually, the collider phenomenology of the BSM scenarios has gained a lot of interest and a very rich collider signals have been predicted in the literature, most of which are based on a leading order (LO) computation in the perturbation theory. However at the hadron colliders like the LHC, where the gluon fluxes are very high, the QCD corrections will in general be very significant. For the signal cross sections, in addition to the SM subprocesses, many other subprocesses from the BSM sector will enter both at the leading order and next-to-leading order (NLO) levels in the perturbation theory. Hence a naive approximation of the SM K factor to be the same as in the BSM sector is not justifiable and to quantify such higher order (NLO) QCD corrections one needs to perform an explicit computation. These higher order corrections will then be useful in obtaining the bounds on the model parameters from the experimental data. (Chapters 1 and 2).

In the warped extra dimension model (RS), we have explicitly computed the NLO QCD corrections to the well known di-photon production process at the LHC, using a semi-analytical two cut-off phase space slicing method which makes it easy to imple-
ment various experimental kinematic cuts and the isolation algorithm (for suppressing both QED singularities and the fragmentation photons) on the final state photons. We have checked that our results are stable against the variation of the slicing parameters over a wide range and found that our SM results are in agreement with those in the literature. Then, we presented the signals for the RS model in various kinematic distributions and found that the NLO QCD corrections have really enhanced the cross sections. We have studied the factorization scale uncertainties and found that they are decreased considerably at NLO compared to LO. We also presented the RS model predictions at the Tevatron (Chapters 3 and 4).

In the case of Drell-Yan process, we have quantified various QCD uncertainties in both the large and warped extra dimension models. For the uncertainty due to the parton distribution functions (PDFs), we have considered three different parton density sets, MRST2001, CTEQ6L/M and ALEKHIN. Regarding the scale uncertainties, the important observation we made is that the factorization scale uncertainties get reduced by around a factor of 2.75 in going from LO to NLO, independent of the model and irrespective of the collider (Chapter 5).

We have also considered the di-jet production process in the unparticle physics. We find that only the spin-0 unparticles have significant contributions while the spin-2 unparticles don’t have any noticeable enhancements over the SM predictions. In the case of scalar unparticles, we have presented the invariant mass, transverse momentum and rapidity distributions of the dijet and found the signal enhancements over the SM background are more than an order of magnitude (Chapter 6.)