INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title:
Soft-Virtual Computation and Threshold Resummation in QCD for Drell-Yan process in Standard Model and Beyond

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Thesis Submitted to the Department/ Center	:	**Physics**
Date of completion of Thesis Viva-Voce Exam	:	**17/09/2021**
Key words for description of Thesis Work	:	Particle Physics, Perterbative QCD, Soft-virtual Computation, Resummation, Drell-Yan production

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This thesis arises in the context of precision calculation in QCD in the framework of soft-virtual computation and threshold resummation for the Drell-Yan process in the Standard Model and beyond. Soft-virtual corrections capture significant contributions near partonic threshold region $z \to 1$. In the absence of complete fixed order results at higher orders, the first step to achieve the precise theoretical results is soft-virtual computation. This kind of calculation has been successfully performed in many SM and beyond SM processes. Another way to improve the accuracy of the results for inclusive cross-section over the fixed order is to resum threshold enhanced logarithms to all orders. These logarithms play a crucial role in the threshold region. The threshold resummation is well understood in the Mellin-N space. We follow the conventional procedure to obtain soft-virtual coefficients from the available form factor in the literature. We use these coefficients to get resum results using standard methodology. The Drell-Yan process in hadron collisions is essential because of its clean final state. In the context of QCD calculation, three-loop soft-virtual results are available in the literature for the SM DY process. Here, we use these SV results to give the predictions for inclusive dilepton production as well as on-shell Z, W ± productions at next-to-next-to-next-to leading logarithmic (N 3 LL) accuracy and match these results with three loop soft-virtual results using the minimal prescription procedure. In addition to the standard ln N exponentiation, we study the numerical impact of exponentiating N -independent part of the universal soft function and the complete form factor that appears in the resummed predictions in N space. We extend this precision phenomenology to other scenarios where dilepton can be produced via spin-2 particle. For this, we consider large extra dimensions (ADD) and warped extra dimension scenarios. In these cases, the dilepton can be produced via both the $q\bar{q}$ and gg initiated subprocesses at the LHC as spin-2 particle couples universally to the SM particles via energy-momentum tensor. Therefore, dilepton production via spin-2 particle at LHC is a combination of Higgs like and DY like process. Consequently, the QCD

phenomenology of this process is very interesting to study. Precision studies in QCD have been done for this process and observed a large K-factor at NLO mimicking the large QCD correction for Higgs production at LHC. Here, we present the complete NNLO QCD correction for RS model and extend this analysis by resumming the threshold logarithms up to NNLL accuracy. For the ADD case, we present the results up to N3LL accuracy and match these with three loop soft-virtual results. Further, we study the dilepton production scenario at the LHC via spin-2 particles with non-universal couplings i.e spin-2 particles couple to SM fermions and gauge bosons with different couplings. The phenomenology of such a graviton is similar, to some extent, to that of the RS model. However, unlike the RS model, the parameter space of this model is much flexible and less constrained because of its non-universal couplings. The complete NNLO QCD corrections are already available in the literature. We extend this precision to NNLO+NNLL accuracy in QCD and study a detailed phenomenology of this model. These precise results will be helpful to extract SM parameters accurately and to provide stringent bound on model parameters in the search of such BSM scenarios at the present LHC and future high energy hadron colliders.
