Snowmass2021 Letter of Interest

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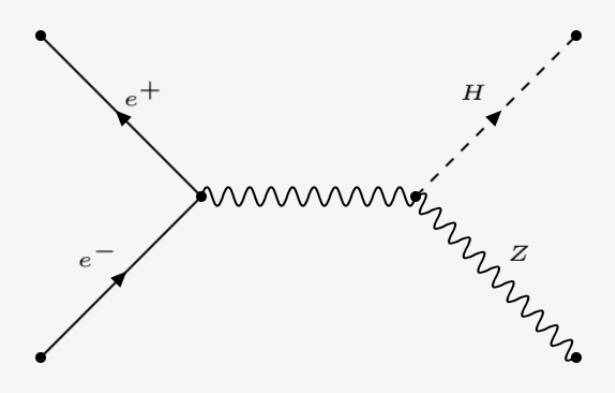
NNLO electroweak correction to Higgs and Z associated production at future Higgs factory

Recent years, several choices of future electron-positron collider have been proposed, i.e. ILC/CEPC/FCC-ee. They are also called Higgs factory because the major project mission is to investigate the Higgs boson with much better precision than the LHC. According to the design reports of the different versions of the Higgs factory, most of the Higgs couplings can be measured up to 1% accuracy[1]. The main process for the Higgs production is $e^+e^- \to HZ$, and the accuracy of the production rate can be 0.5%[1].



However, according to the previous works on the theoretical predictions to the cross section of $e^+e^- \to HZ$, which includes the NLO electroweak[2,3,4] and mixed electroweak-QCD corrections[5], the theoretical uncertainties of the total cross section is at the level of several precentage, This indicates the theoretical prediction to the production rate of $e^+e^- \to HZ$ cannot satisfy the requirement of the experiment analysis. Therefore, it will be inevitable to include the NNLO electroweak correction effect to reduce the theoretical uncertainty, so that the uncertainties of the Higgs couplings by combining the experiment data and theoretical prediction can reach 1% level as proposed by the reports of Higgs factory.

The NNLO electroweak correction to $e^+e^- \to HZ$ includes 25377 two-loop Feynman diagrams by using the Feynman gauge, which involves multiple scales. And the evaluation of multi-scale two-loop Feynman diagram is still very challenging in general. Therefore, it would be very important to organize working group to accomplish this achievement.

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