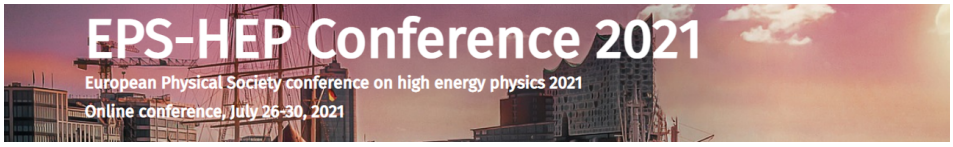

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Three-loop standard model Feynman diagrams for the Z-boson EWPOs

The study of the Z-boson decay was crucial for the success of the LEP experiment. In e^+e^- collisions, with the centre of mass energy matched to its mass, i.e. $\sim$ 91 GeV, a huge number of Z-bosons was produced ($\sim 10^6$). Significant statistics allowed for precise measurements of its decay products along with the Standard Model (SM) parameters. The precision of LEP was so high that quantum corrections had to be taken into account, proving the correctness of SM as a quantum gauge theory.

Future Circular Collider in its lepton mode (FCC-ee) is one of the next-generation colliders along with ILC, CLIC and CEPC. It is planned to be a circular collider with a circumference of 100 km. Operating at the Z resonance it will be able to produce $\sim 10^{12}$ Z-bosons.

This enormous statistics makes FCC a very demanding project from the perspective of theory and it will lead to at least one order of magnitude smaller experimental uncertainties of the electroweak observables (e.g. Z-boson decay width). These experimental errors are one to two orders of magnitude smaller than current theoretical errors and more precise theoretical calculations are needed to meet experimental demands. It means that the 3-loop electroweak corrections to the Z-boson decay are needed.

The complexity of the problem will be presented based on comparisons of diagrams, topologies and integrals at the 3-loop level with the two-loop case. Methods used in the calculation of 3-loop radiative corrections for the Z-boson decay electroweak observables are also discussed.

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Collaboration / Activity

FCC-ee

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