Contents

Introduction

Brief introduction on the Standard Model, with particular attention on the Electroweak Interaction.
Description of contemporary experimental research at colliders (LHC, etc.) and modern problems, such as the recent measurements of the *W boson mass discrepancy*.
Explanation of the necessity of high-precision predictions from the model.

Chapter 1

Quantum Field Theory and Gauge Theories

Brief introduction of Quantum Field Theory, which allow us to formulate our theories of fundamental interactions of particles in terms of fields. This leads us to obtain predictions of *scattering amplitudes* and *cross sections* for collider physical processes. Description of perturbative method of calculation in terms of Feynman diagrams and description of the loop integrals appearing in *beyond-the-leading-order predictions*.

Description of a Gauge Field Theory and the perturbative methods in these kind of theories, with the gauge-fixing. Description of the Electroweak Interaction in terms of gauge theory. Description the Background Field method for the EW Gauge Theory.

Description of the *photon-fermion form factor*. The goal of the thesis is the NNLO 2-Loop computation of the photon-fermion form factor in the Electroweak Interaction.

Description of the methods to perform the computation: Express the loop integrals in terms of Scalar Integrals (Passarino-Veltman method) and reduce this set of integrals to a set of Master Integrals.

Description of some QFT results, useful to test our predictions:

- Independence of the results from the gauge-fixing parameter.
- Ward Identity for the scattering amplitude:

Chapter 2

Algorithms

Description of the programs, packages and algorithms used for the predictions:

- FeynAts
- ABISS
- Kira

Chapter 3

Implementation and calculation

Exaplnation of how I actually used the the programs described in previous chapter to implement the codes for the form-factor predictions, with the relative consistency tests:

- ξ-independence test for 1-Loop amplitude in process $q\bar{q} \to \mu\bar{\mu}$.
- Computation of the EW 2-Loop form factor for the photon-muon vertex.
- Ward identity test for the EW 2-Loop form factor for the photon-muon vertex.

Chapter 4

Results

Conclusions