Precision supersymmetric phenomenology at the Large Hadron Collider

DIRECTEUR DE THESE : MICHEL RAUSCH DE TRAUBENBERG, BENJAMIN FUKS
INSTITUT PLURIDISCIPLINAIRE HUBERT CURIEN, 23 RUE DU LOESS, 67000 STRASBOURG
TEL : 03 88 10 65 33 ; E-MAIL : michel.rausch@iphc.cnrs.fr

The Standard Model of particle physics has for many years passed impressively all experimental tests. The latter include the recent observation of a neutral scalar particle compatible with a Standard-Model Higgs boson by the general-purpose experiments ATLAS and CMS, at the Large Hadron Collider (LHC) at CERN. However, the mass of a fundamental scalar field is drastically affected by quantum corrections, which leads to the conceptual question of its stabilization with respect to the Planck scale lying orders of magnitude away from the weak scale. Over the last decades, large classes of alternative theories have been proposed in order to extend the Standard Model and cure this issue. Among these, weak-scale supersymmetry, and in particular its minimal version, the Minimal Supersymmetric Standard Model (MSSM), is one of the most theoretically and experimentally studied option. It is known to solve this socalled hierarchy problem by introducing partners of the Standard Model degrees of freedom with opposite statistics. In addition, several other conceptual problems of the Standard Model are addressed, such as the unification of the gauge couplings at high energies or the question of a dark matter candidate.

Progresses in the field of Monte Carlo tools show that we are now capable to simulate all the relevant Standard Model processes at the LHC with an unprecedented level of accuracy. However, the challenges for precision predictions for new physics are still being currently addressed. In this Ph.D. thesis, the candidate will be asked to join the effort leading to the development of automated precision tools for Beyond the Standard Model theories, to validate them and employ them for phenomenological investigations. Pioneering studies in the framework of the MSSM will be redone with the new generation tools, and non-minimal supersymmetric models, possibly using effective field theories or simplified models focusing on the sector of the top quark, will be addressed.

This thesis will be conducted in close interaction with the ERC Advanced Grant LHCtheory at CERN, which projects advanced new levels of precision. The thesis will also be embedded within a project of the theory-LHC France initiative on Monte Carlo simulations.