Title : **Study of the Higgs boson properties at the CERN LHC**

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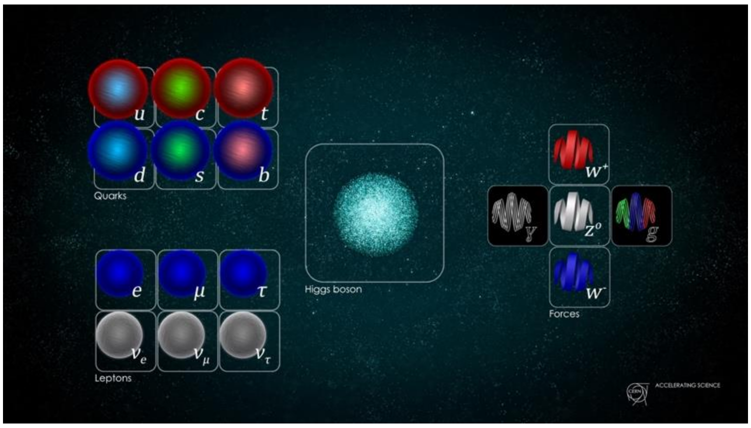
Research Area : **High Energy Physics**

Methods: Data analysis of an experimental particle physics experiment

PhD track subject :

The theories and discoveries of thousands of physicists since the 1930s have resulted in a remarkable insight into the fundamental structure of matter: everything in the Universe is found to be made from a few basic building blocks called fundamental particles, governed by fundamental forces. Our best understanding of how these particles and forces are related to each other is encapsulated in the Standard Model of particle physics and an essential component of the Standard Model is a particle called the *"Higgs boson*".



Fundamental particles of the Standard Model

The Higgs boson was discovered in 2012 at the CERN Large Hadron Collider, the world's largest and most powerful particle accelerator ever built. This discovery is one of the main breakthroughs of particle physics of this century: on one side, it permits to shed a light on the mechanism that generate the masses of the particles within the Standard Model and on the other side, it opens a huge landscape of new avenues for research. Indeed, although the Standard Model accurately describes the phenomena within its domain, it is still incomplete and perhaps it is only a part of a bigger picture that includes new physics hidden deep in the subatomic world or in the dark recesses of the Universe There are also important questions that the Standard Model does not answer, such as "*What is dark matter?", or "What happened to the antimatter after the big bang?"*, *"Why are there three generations of quarks and leptons with such a different mass scale?"* and more.
The ambitious research subject of this PhD track proposal aims to help answering these questions via the study Higgs boson properties. To reach this goal the candidate will analyse the LHC proton-proton collision data. In detail, she/he will measure the strength and tensor structure of the Higgs boson and search indirectly for new physics through small deviations of this structure with respect to the Standard Model predictions. One deliverable of the project will be the determination of the Higgs boson self-interaction that it could have implications on our understanding of fundamental interactions not only at the electroweak scale but also at higher energies. For example, in the case that a deviation of the Higgs boson self-interaction with respect its Standard Model prediction will be observed, it can be connected with a first order strong electroweak phase transition and hence an explanation of one of the mystery of the Universe, the observed matter vs anti-matter asymmetry.

References:

The CERN LHC : https://home.cern/science/accelerators/large-hadron-collider
Higgs boson discovery : https://arxiv.org/abs/1207.7235
Probing baryogenesis through the Higgs boson self-coupling : https://arxiv.org/abs/1711.00019