

## MAP-fis Essay Proposal, 2016-2017

*(please write in English)*

Supervisor

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Title

Search for CP violation in ttH production

Area

*(Materials, Optics, Condensed Theory, High Energy Theory,....);*

Particle Physics

Summary of Proposal

The observed asymmetry between matter and antimatter in the Universe is usually believed to require the existence of CP-violating interactions beyond the Standard Model (SM). Such interactions can be generated in the Higgs sector, by allowing the Higgs boson physical state to be a mixed state of CP-even and CP-odd components [1].

Supersymmetric models [2] and two Higgs doublets models (2HDM) [3] predict the possibility of CP-odd and CP-violating Higgs bosons interactions. In the SM, the Higgs boson is a spin 0, CP-even particle. The SM hypothesis has been tested for the 125 GeV Higgs boson at the LHC, against several alternative models. Spin 1 and spin 2 scenarios, as well as the spin 0 pure CP-odd scenario, were excluded with confidence levels above 99% [4]. The analyses focused on Higgs couplings to Z and W, which are suppressed for a CP-odd Higgs boson. The CP structure of the Higgs couplings to fermions remains to be studied and is not necessarily the same as that of the couplings to vector bosons. As the top quark is the most massive fermion, and thus expected to have the largest Yukawa coupling, ttH production in the LHC is a privileged process for directly measuring Yukawa couplings and for studying the Higgs couplings CP nature. Sensitivity to the relative CP-even and CP-odd components can be obtained by exploiting the kinematics of the ttH decays. Several discriminating observables have been proposed in the literature[5].

The student should review the latest phenomenological studies about search for a CP-odd component of the 125 GeV Higgs boson in ttH production, and describe the expected evolution of excluded parameters phase space. The experimental strategies currently being employed towards the search of SM ttH production at the LHC will also be reviewed[6].

The student is expected to focus on CP violation studies of the Higgs interactions in particular in connection with models of Physics Beyond the Standard Model (BSM). The latest experimental results regarding searches for extended Higgs sectors and CP violation should be reviewed and interpreted in terms of constraints in the parameter spaces of BSM.

## References

(to allow students first look at topic)

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- 3.- "Theory and phenomenology of two-Higgs-doublet models", G. C. Branco et al., Phys.Rept. 516 (2012) 1-102
- 4.- ATLAS Collaboration: Eur. Phys. J. C75 (2015) no.10, 476; Physics Letters B 753 (2016) 69–85; Eur. Phys. J. C76 (2016) 658
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