XXVII International Symposium on Lepton Photon Interactions at High Energies

Contribution ID: **110** Type: **not specified**

Going beyond "kappa-framework": Higgs Pseudo-observables

Friday 21 August 2015 15:45 (15 minutes)

Summary

We define a set of pseudo-observables (PO) in Higgs decays that describe, in great generality, possible deviations from the Standard Model (SM). The pseudo-observables can be determined from experimental data, providing a systematic generalization of the "κ-framework" so far adopted by the LHC experiments. The pseudo-observables are defined from on-shell decay amplitudes, allow for a systematic inclusion of higher-order QED and QCD corrections and can be computed in any Effective Field Theory (EFT) approach to Higgs physics. We implement PO in the Monte Carlo event generator, which could be used in future phenomenological and experimental studies.

These PO should be considered as independent variables in the absence of specific symmetry or dynamical assumptions; however, relations among themselves and also between Higgs and non-Higgs PO arise in specific NP frameworks. Testing if such relations are verified by data provides a systematic way to investigate the nature of the Higgs particle and, more generally, to test the underlying symmetries of physics beyond the SM.

Therefore, we analyze the reduction of the number of independent PO following from the hypotheses of lepton-universality, CP invariance, custodial symmetry, and linearly realized electroweak (EW) symmetry breaking. In particular, we present a systematic evaluation of the bounds on the Higgs PO that follow from the EW constraints in the linear EFT regime. Using such bounds, detailed predictions for $h \to 4\ell$ decay rates, dilepton spectra, and lepton-universality ratios are presented. These predictions can be interpreted as a series of tests that, if falsified by future $h \to 4\ell$ data, would allow us not only to establish the existence of NP but also to exclude that h is the massive excitation of a pure $SU(2)_L$ doublet.

This presentation is mainly based on the following (arXiv) references: 1412.6038 and 1504.04018.

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Session Classification: Contributed talks from poster session

Track Classification: Oral presentations of selected posters