

Natural Alignment and CP Violation Beyond the Standard Model

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The current LHC Higgs data suggest that the couplings of the observed 125 GeV Higgs boson must be remarkably close to the Standard Model (SM) expectations. This implies that any Beyond-the-Standard-Model physics due to an extended Higgs sector must lead to the so-called SM alignment limit, where one of the Higgs bosons behaves exactly like that of the SM. In the context of the Two Higgs Doublet Model (2HDM), this alignment is often associated with either decoupling of the heavy Higgs sector or fine-tuning the parameters of the 2HDM potential. In the first part of my talk, I will review the Higgs symmetries required for achieving natural alignment without decoupling or fine-tuning. However, the exact imposition of these symmetries lead to CP conservation in the Higgs potential. In the second part of my talk, I will then show how CP violation could be maximised in this case by spontaneous, soft and explicit breaking of these symmetries, while maintaining agreement with LHC data and constraints on a non-zero electron electric dipole moment. Finally, if time permits, I will discuss the collider signatures for a 2HDM Higgs sector in the natural alignment limit, which dominantly lead to third-generation quarks in the final state, like 4 tops, and can serve as a useful observational tool during the last upgraded phase of the HL-LHC.

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