

Contribution ID: **170** Type: **Poster**

Reduction of Couplings in the 2HDM: A Numerical Study of the Scalar Sector

Extensions of the Standard Model with additional scalar fields increase the number of parameters in the theory and motivate the search for relations among its couplings. In this work, we investigate this possibility within the general real two-Higgs-doublet model (R2HDM) using the reduction of couplings method. We propose an ansatz that expresses the seven quartic couplings as functions of the gauge couplings and use it as a starting point to search for approximate solutions to the reduction equations. The ansatz is not derived from the renormalization group equations but provides a proposed functional framework whose compatibility with the renormalization group evolution can be assessed through the reduction equations. To carry out this study, we developed RoC v.10, a computational software package designed to investigate approximate solutions to these equations. Using this framework, we perform a preliminary numerical exploration of the scalar parameter space, subject to the theoretical and phenomenological constraints considered in the analysis. We examine the distribution of the light Higgs boson mass, its dependence on the boundary scale, and the correlations among the quartic couplings, aiming to identify physically interesting regions and patterns that may guide the search for relations among them.

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Session Classification: Posters & Empanadas

Track Classification: Beyond the Standard Model