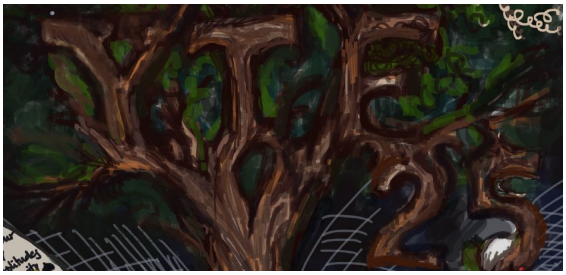

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Charting Higgs Self-Coupling Limits in a General Extended Scalar Sector

Wednesday 17 December 2025 14:38 (7 minutes)

Constraining the Higgs self-coupling at collider experiments allows us to better understand the shape and properties of the Higgs potential, which is a promising avenue into New Physics beyond the Standard Model (SM). The current experimental uncertainties on the Higgs self-coupling, parametrised by κ_λ, are of $\mathcal{O}(100\%)$, while Higgs couplings to the weak gauge bosons, parametrised by κ_V, have been constrained to just a few percent. Given that κ_V and κ_λ are correlated quantities beyond the SM, can we ever see New Physics effects in κ_λ, despite the tight experimental bounds on κ_V? In this project, I explore the limits of the Higgs self-coupling in general extended scalar sectors. In the singlet extension to the SM, I calculate the allowed region in κ_V-κ_λ space both analytically and numerically. Distinguishing between the spontaneous and explicit $\mathbb{Z}_2$-breaking cases, we find that the latter causes a deviation in κ_λ more than 10 times larger than the former. We further derive analytical expressions for the allowed region in κ_V-κ_λ in a general $\mathbb{Z}_2$-symmetric extended scalar sector, where an arbitrary combination of electroweak scalar multiplets are added to the SM. In the alignment limit, this reduces to a function of the electroweak charges of the multiplets, the coupling constants in the associated potential, and the masses of the emerging particles. We show this explicitly for the $\mathbb{Z}_2$-symmetric 2-Higgs-Doublet model. Like in the $\mathbb{Z}_2$-symmetric singlet model, κ_V imposes more stringent constraints than κ_λ.

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