Contribution ID: **203** Type: **not specified**

Entanglement maximization and mirror symmetry in Two-Higgs-Doublet-Models

Tuesday 20 May 2025 15:15 (15 minutes)

We consider 2-to-2 scatterings of Higgs bosons in a CP-conserving two-Higgs-doublet model (2HDM) and study the implication of maximizing the entanglement in the flavor space, where the two doublets Φ_a, $a = 1, 2$, can be viewed as a qubit: $\Phi_1 = |0\rangle$ and $\Phi_2 = |1\rangle$. More specifically, we compute the scattering amplitudes for $\Phi_a \Phi_b \to \Phi_c \Phi_d$ and require the outgoing flavor entanglement to be maximal for a full product basis such as the computational basis, which consists of $\{|00\rangle, |01\rangle, |10\rangle, |11\rangle\}$. In the unbroken phase and turning off the gauge interactions, entanglement maximization results in the appearance of an $U(2) \times U(2)$ global symmetry among the quartic couplings, which in general is broken softly by the mass terms. Interestingly, once the Higgs bosons acquire vacuum expectation values, maximal entanglement enforces an exact $U(2) \times U(2)$ symmetry, which is spontaneously broken to $U(1) \times U(1)$. As a byproduct, this gives rise to Higgs alignment as well as to the existence of 6 massless Nambu-Goldstone bosons. The $U(2) \times U(2)$ symmetry can be gauged to lift the massless Goldstones, while maintaining maximal entanglement demands the presence of a discrete Z_2 symmetry interchanging the two gauge sectors. The model is custodially invariant in the scalar sector, and the inclusion of fermions requires a mirror dark sector, related to the standard one by the Z_2 symmetry.

Mini Symposia (Invited Talks Only)

Plenary (Invited talks only)

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Session Classification: Electroweak

Track Classification: Electroweak, Higgs, and Top Quark Physics