Contribution ID: **9** Type: **not specified**

Mass bounds in 2HDMs in the SM-like limit.

Wednesday 22 July 2015 16:40 (20 minutes)

We consider 2HDMs with a softly broken global U(1) symmetry and the fermion transformations under this symmetry. We study the implication of a criterion of naturalness for a broad class of two Higgs doublet models (2HDMs). In particular, we assume the cancellation of quadratic divergences in what are called the type I, type II, lepton-specific and flipped 2HDMs. This results in a set of relations among masses of the physical scalars and coupling constants, a generalization of the Veltman conditions of the Standard Model. Assuming that the lighter uncharged scalar is the observed Higgs particle of mass ~125 GeV, and imposing further the constraints from the electroweak T-parameter, perturbative unitarity constraints and stability constraints produce
a range for the masses of each of the remaining physical scalars.

Summary

The two- Higgs doublet models are one of the most widely investigated scenarios that go beyond the Standard Model (SM). There are many motivations for 2HDMs. The primary motivation being supersymmetry. Another motivation for 2HDMs comes from axion models. Still another motivation for the 2HDMs is the fact that the SM is unable to generate a baryon asymmetry of the universe of sufficient size.

This work basically deals with the set of Veltman conditions pertaining to the 2HDMs. The mass ranges of the physical Higgs bosons have been concluded considering the Veltman conditions, the perturbative unitarity conditions, the stability conditions and electroweak T parameter of the most general 2HDM potential in the alignment limit. The conjecture that some unknown symmetry is responsible for keeping the Higgs boson light at 125 GeV does not hold for the Standard Model, where the coefficient of the quadratic divergence of Higgs boson self-energy is far from zero. The Veltman conditions are arrived at by setting the quadratic divergences to zero. In 2HDMs such quadratic divergences can be cancelled if the Veltman conditions are strictly obeyed and we use this concept to derive the mass ranges of the physical Higgs so that all the scalar masses remain at the electroweak scale and the naturalness problem can be avoided.

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Session Classification: Student talks