Contribution ID: **69** Type: **Afternoon Session**

Vacuum stability from generalized Higgs interactions

Tuesday 18 April 2017 18:05 (15 minutes)

We investigate the non-perturbative renormalization group flow of the Higgs potential beyond conventional perturbative approximations and reanalyze arguments that relate a lower mass bound for the Higgs boson with vacuum stability. In addition, we study the impact of higher order operators on this lower bound from an effective field theory point of view.
For the class of standard bare Higgs potentials of quartic type at a given ultraviolet cutoff scale, we show that a finite infrared Higgs mass range emerges naturally from the RG flow itself. Higgs masses outside the resulting bounds cannot be connected to any conceivable set of bare parameters in this standard model quartic class. A lower bound for the Higgs mass arises from the requirement of a well-defined partition function, i.e., stability of the bare potential. This consistency bound can, however, be relaxed considerably by more general forms of the bare potential without necessarily introducing new metastable minima. We identify a simple renormalization group mechanism for this diminishing of the lower bound. Thus, Higgs masses smaller than the conventional infrared window do not necessarily require new physics at low scales or give rise to instability problems.

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Session Classification: Tuesday Afternoon

Track Classification: Higgs and the Standard Model