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Softening Higgs Naturalness: an Effective Field Theory Analysis

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We use an effective field theory (EFT) prescription to accommodate naturalness in the Standard Model (SM) Higgs sector. We study the 1-loop corrections to the Higgs mass which are generated by the (complete) set of relevant effective operators of dimension n>4, assuming that the SM's degrees of freedom and gauge symmetries are valid up to some new physics scale \Lambda. We find that there are only three classes of higher dimensional effective operators which can balance the SM's 1-loop corrections to the Higgs mass, and that these operators can be generated in the underlying heavy theory through tree-level exchanges of a heavy singlet or triplet scalar, a heavy isosinglet, doublet or isotriplet fermion and a heavy isosinglet or isotriplet vector-boson. Using the EFT naturalness as a guide, we demonstrate how naturalness can be restored within simple toy models containing these heavy degrees of freedom. In particular, we show that the SM Higgs sector can be kept natural up to an arbitrary large scale if certain relations hold between the masses and couplings of the heavy and SM fields; the amount of fine-tuning required depends on the amount of fine-tuning one is willing to tolerate in the Higgs mass corrections.

Summary

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