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New methods to probe Standard Model Extensions via Proton Decay and Neutrino Masses

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Baryon and lepton number are excellent low-energy symmetries of the Standard Model (SM) that tightly constrain the form of its extensions. In this paper we investigate the possibility that these accidental symmetries are violated in the deep UV, in such a way that one multiplet necessary for their violation lives at an intermediate energy scale M above the electroweak scale. We write down the simplest effective operators containing each multiplet that may couple linearly to the SM at the renormalisable level and estimate the dominant contribution of the underlying UV model to the pertinent operators in the SMEFT: the dimension-5 Weinberg operator and the baryon-number-violating operators up to dimension 7. Our results are upper bounds on the scale M for each multiplet-operator pair, derived from neutrino-oscillation data as well as prospective nucleon-decay searches. We also analyse the possibility that both processes are simultaneously explained within a natural UV model. In addition, we advocate that our framework provides a convenient and digestible way of organising the space of UV models that violate these symmetries.

Abstract

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