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Understanding couplings of the standard model as IR fixed points

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TF Topical Groups:

■ (TF08) BSM model building

It was shown that all the couplings in the standard model except those related to first two generations can be understood from the IR fixed point structure of renormalization group equations in the minimal supersymmetric model extended by one complete vectorlike family with the scale of new physics in a multi-TeV range [1]. The pattern of seven largest couplings can be predicted in terms of three parameters related to scales: the GUT scale (or the fundamental scale of the model), the scale of new physics (vectorlike matter and superpartners), and $\tan\beta$. Random large values of couplings at M_G inevitably lead to electroweak scale values very close to the observed ones. This is quite an intriguing possibility that allows for predictions of SM parameters even if the fundamental symmetries or model parameters at the fundamental scale remain obscure. Besides the possibilty of completely random boundary conditions, this scenario also offers a different understanding of the origin of gauge and Yukawa couplings in GUT models [2, 3].

The suggested multi-TeV scale of new physics is somewhat too high for the LHC (although a part of the spectrum might be within the reach) but it is accessible at future colliders. The scenario requires two Higgs doublets and vectorlike matter and thus it provides an independent motivation for the exploration of their combined signatures (LOI related to studies of such signatures at the LHC and future colliders was submitted with other collaborators to TF07 and EF02, 08).

We plan to summarize the scenario, explore it further and possibly extend it to understanding of other parameters of the standard model. Suggestions for collaborations and combinations with other ideas are welcome.

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[3] R. Dermisek and N. McGinnis, Phys. Rev. D **99**, 035033 (2019), arXiv:1810.12474 [hep-ph].

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