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Naturalness problem : Off the Beaten Track - connection with Diphoton excess at 750 GeV

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One of the ways to address the fine-tuning problem of Higgs mass in the Standard Model is to assume the existence of some symmetry which keeps the quantum corrections to the Higgs mass to a manageable level. This condition, known after Veltman who first propounded it, is unfortunately not satisfied in the SM, given that we know all the masses. We discuss how one can get back the Veltman Condition if one or more gauge singlet scalars are introduced in the model. Furthermore, the fine-tuning problem of the new scalars necessitates the introduction of vectorlike fermions. Thus, singlet scalar(s) and vector fermions are minimal enhancements over the Standard Model to alleviate the fine-tuning problem. We also show that the model predicts Landau poles for all the scalar couplings, whose positions depend only on the number of such singlets. Thus, introduction of some new physics at that scale becomes inevitable. We also suggest that the recently observed diphoton excess at 750 GeV comes from a quasi-degenerate bunch of gauge singlet scalars produced and decaying through one or more vector-like fermions. This explains the broad nature of the resonance, even though the decay is loop-mediated. At the same time, the model keeps the new Yukawa couplings in the perturbative region, which is necessary for the stability of the potential. Some more such extensions, with higher scalar multiplets like complex scalar triplet and Two Higgs Doublet, will also be discussed in the context regarding the Fine-tuning problem.

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