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Classically conformal U(1)′ extended Standard Model and Higgs vacuum stability

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We consider the minimal U(1)′ extension of the Standard Model (SM) with conformal invariance at the classical level, where in addition to the SM particle contents, three generations of right-handed neutrinos and a U(1)′ Higgs field are introduced. In the presence of the three right-handed neutrinos, which are responsible for the seesaw mechanism, this model is free from all the gauge and gravitational anomalies. The U(1)′ gauge symmetry is radiatively broken via the Coleman-Weinberg mechanism, by which the U(1)′ gauge boson (Z′ boson) mass as well as the Majorana mass for the right-handed neutrinos are generated. The radiative U(1)′ symmetry breaking also induces a negative mass squared for the SM Higgs doublet to trigger the electroweak symmetry breaking. In this context, we investigate a possibility to solve the SM Higgs vacuum instability problem. The model includes only three free parameters (U(1)′ charge of the SM Higgs doublet, U(1)′ gauge coupling and Z′ boson mass), for which we perform parameter scan, and identify a parameter region resolving the SM Higgs vacuum instability. We also examine naturalness of the model. The heavy states associated with the U(1)′ symmetry breaking contribute to the SM Higgs self-energy. We find an upper bound on Z′ boson mass, mZ′⊠6 TeV, in order to avoid a fine-tuning severer than 10 % level. The Z′ boson in this mass range can be discovered at the LHC Run-2 in the near future.

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