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NSI from a flavorful Z' model

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Abstract

We propose a $U(1)_X$ extension of the Standard Model (SM), where generation dependent $U(1)_X$ charges are assigned for the SM fermions. In the presence of a right handed neutrino (RHN) for each generation, this model is free from all the $U(1)_X$ related anomalies. Associated with the $U(1)_X$ symmetry breaking, the RHNs acquire their Majorana masses and then the seesaw mechanism works to generate light neutrino masses with the electroweak symmetry breaking. Due to the flavor-dependence of the $U(1)_X$ gauge boson (Z') coupling with the SM fermions, the neutrino non-standard interaction (NSI) arises through the Z' mediated processes. We study a feasibility of the Deep Underground Neutrino Experiment (DUNE) for testing this flavorful Z' model through the Z' induced NSI effects.

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KEY FEATURES

We enlist the interesting features of the $U(1)_X$ model we are going to propose:

- In association with the generation dependent $U(1)_X$ charge assignment, three $SU(2)_L$ doublet Higgs fields with different $U(1)_X$ charges are introduced and each Higgs doublet "privately" couples with fermions in its corresponding generation.

- In the quark sector, new vector-like quarks are introduced to reproduce the realistic CKM matrix.

- In the lepton sector, the charged lepton mass matrix and neutrino Dirac mass matrix are flavor diagonal while the RHN mass matrix is a general complex symmetric matrix. Therefore, the neutrino flavor structure is originate from the flavor structure among RHNs.

- The SM Higgs sector is extended to three Higgs doublet model and the Higgs boson phenomenology is also worth investigating.

- The flavor dependent Z' boson coupling leads to the neutrino NSI, which can be tested by DUNE. We will study the search limit by DUNE for the model parameters, a $U(1)_X$ gauge coupling, Z' boson mass and x_i $(i = 1, 2, 3)$ which parametrize the $U(1)_X$ charge assignments of each generation, along with the current experimental limits.

- Our model can include more varieties of interesting physics, such as dark matter physics and the inflationary universe.

- Our model can be tested at the High Luminosity LHC (HL-LHC), the Future Circular Collider (FCC-hh/ee/eh) and at the International Linear Collider.