Contribution ID: **34** Type: **Oral**

A natural Z′-portal Majorana dark matter in alternative U(1) extended Standard Model

Thursday 23 May 2019 14:00 (20 minutes)

We consider a non-exotic gauged U(1)_X extension of the Standard Model (SM), where the U(1)_X charge of a SM field is given by a linear combination of its hypercharge and Baryon-minus-Lepton (B–L) number. All the gauge and mixed gauge-gravitational anomalies are cancelled in this model with the introduction of three right-handed neutrinos (RHNs). Unlike the conventional minimal U(1)_X model, where a universal U(1)_X charge of −1 is assigned to three RHNs, we consider an alternative charge assignment, namely, two RHNs (Nˆ{1,2}_R) have U(1)_X charge −4 while one RHN (N_R) has a +5 charge. With a minimal extension of the Higgs sector, the three RHNs acquire their Majorana masses associated with U(1)_X symmetry breaking. While Nˆ{1,2}_R have Yukawa coupling with the SM lepton doublets and play an essential role for the 'minimal seesaw' mechanism, NR is isolated from the SM particles due to its U(1)_X charge and hence it is a natural candidate for the dark matter (DM) without invoking additional symmetries. In this model context, we investigate the Z′-portal RHN DM scenario, where the RHN DM communicates with the SM particles through the U(1)_X gauge boson (Z′ boson). We identify a narrow parameter space by combining the constraints from the observed DM relic abundance, the results of the search for a Z′ boson resonance at the Large Hadron Collider Run-2, and the gauge coupling perturbativity up to the Planck/Grand Unification scale. For a special choice of U(1)_X charges for the SM fields allows us to extend the model to SU(5)×U(1)_X grand unification. In this scenario, the model parameter space is more severely constrained, which will be explored at future high energy collider experiments.

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Session Classification: Dark Matter, Astroparticle Physics

Track Classification: Dark Matter, Astroparticle Physics