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Muon $(g-2)$ and XENON1T Excess with Dark Matter in $L_\mu - L_\tau$ Model

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Motivated by the growing evidence for lepton flavour universality violation after the first results from Fermilab's muon $(g-2)$ measurement, we revisit one of the most widely studied anomaly free extensions of the standard model namely, gauged $L_\mu - L_\tau$ model, known to be providing a natural explanation for muon $(g-2)$. We also incorporate the presence of dark matter (DM) in this model in order to explain the recently reported electron recoil excess by the XENON1T collaboration. We show that the same neutral gauge boson responsible for generating the required muon $(g-2)$ can also mediate interactions between electron and dark matter. We consider two scenarios to explain the XENON1T excess; one with dark fermions boosted by DM annihilation and the other with inelastic down scattering of DM. In the former case, the required DM annihilation rate into dark fermion require a hybrid setup of thermal and non-thermal mechanisms to generate DM relic density. In the later case, a Dirac fermion DM, naturally stabilised due to its chosen gauge charge, is split into two pseudo-Dirac mass eigenstates due to Majorana mass term induced by singlet scalar which also takes part in generating right handed neutrino masses responsible for type I seesaw origin of light neutrino masses. The inelastic down scattering of heavier DM component can give rise to the XENON1T excess for keV scale mass splitting with lighter DM component. We fit our model with XENON1T data for both the cases and also find the final parameter space by using bounds from $(g-2)_\mu$, DM relic, lifetime of heavier DM, DM-electron scattering rate, neutrino trident production rate as well as other flavour physics, astrophysical and cosmological observations. The tightly constrained parameter space from all requirements remain sensitive to ongoing and near future experiments, keeping the scenario very predictive.

Summary

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