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Singlet-doublet fermion and triplet scalar dark matter with radiative neutrino masses

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We present a detailed study of a combined singlet-doublet fermion and triplet scalar model for dark matter. These models have only been studied separately in the past. Together, they form a simple extension of the Standard Model that can account for dark matter and explain the existence of neutrino masses, which are generated radiatively. However, this also implies the existence of lepton flavour violating processes. In addition, this particular model allows for gauge coupling unification. The new fields are odd under a new Z_2 symmetry to stabilise the dark matter candidate. We analyse the dark matter, neutrino mass and lepton flavour violation aspects both separately and in conjunction, exploring the viable parameter space of the model. This is done using a numerical random scan imposing successively the neutrino mass and mixing, relic density, Higgs mass, direct detection, collider and lepton flavour violation constraints. We find that dark matter in this model is fermionic for masses below about 1 TeV and scalar above. The narrow mass regions found previously for the two separate models are enlarged by their coupling. While coannihilations of the weak isospin partners are sizeable, this is not the case for fermions and scalars despite their often similar masses due to the relatively small coupling of the two sectors, imposed by the small neutrino masses. We observe a high degree of complementarity between direct detection and lepton flavour violation experiments, which should soon allow to fully probe the fermionic dark matter sector and at least partially the scalar dark matter sector.

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