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Neutrino Portal Dark Matter: From Dwarf Galaxies to IceCube

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It has been suggested that the baseline scenario of collisionless cold dark matter over-predicts the numbers of satellite galaxies, as well as the dark matter (DM) densities in galactic centers. This apparent lack of structure at small scales can be accounted for if one postulates neutrino-DM and DM-DM interactions mediated by light O(MeV) force carriers. We consider a simple, consistent model of neutrinophilic DM with these features where DM and a "secluded" SM-singlet neutrino species are charged under a new U(1) gauge symmetry. An important ingredient of this model is that the secluded sector couples to the Standard Model fields only through neutrino mixing. We observe that the secluded and active neutrinos recouple, leading to a large relic secluded neutrino population. This relic population can prevent small-scale halos from collapsing, while at the same time significantly modifying the optical depth of ultra-high-energy neutrinos recently observed at Icecube. We find that the bulk of the parameter space accommodating an (a)symmetric thermal relic has potentially observable consequences for the IceCube high energy signal, with some of the parameter space already ruled out by the existing data. Future data may confirm this mechanism if either spectral absorption features or correlations with nearby sources are observed.

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