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Constraints on the properties of ν MSM dark matter using the satellite galaxies of the Milky Way

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Low-mass galaxies provide a powerful tool with which to investigate departures from the standard cosmological paradigm in models that suppress the abundance of small dark matter structures. One of the simplest metrics that can be used to compare different models is the abundance of satellite galaxies in the Milky Way. Viable dark matter models must produce enough substructure to host the observed number of Galactic satellites. Here, we scrutinize the predictions of the neutrino Minimal Standard Model (ν MSM), a well-motivated extension of the Standard Model of particle physics in which the production of sterile neutrino dark matter is resonantly enhanced by a lepton asymmetry in the primordial plasma. This process enables the model to evade current constraints associated with non-resonantly produced dark matter. Independently of assumptions about galaxy formation physics we rule out, with at least 95 per cent confidence, all parameterizations of the ν MSM with sterile neutrino rest mass, $M_s \leq 1.4$ keV. Incorporating physically motivated prescriptions of baryonic processes and modelling the effects of reionization strengthen our constraints, and we exclude all ν MSM parameterizations with $M_s \leq 4$ keV. Unlike other literature, our fiducial constraints do not rule out the putative 3.55 keV X-ray line, if it is indeed produced by the decay of a sterile neutrino; however, some of the most favoured parameter space is excluded. If the Milky Way satellite count is higher than we assume, or if the Milky Way halo is less massive than $M_{200}^{\text{MW}} = 8 \times 10^{11} M_\odot$, we rule out the ν MSM as the origin of the 3.55 keV excess. We find that other works have obtained overly stringent constraints partly because of an error in publicly available codes to compute dark matter momentum distributions.

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