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Probing Secret Interactions of eV-scale Sterile Neutrinos with the Diffuse Supernova Neutrino Background

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Sterile neutrinos with mass in the eV-scale and large mixings of order θ_0 ⊠ 0.1 could explain some anomalies found in short-baseline neutrino oscillation data. We consider a neutrino portal scenario in which eV-scale sterile neutrinos have self-interactions via a new gauge vector boson φ. Their production in the early Universe via mixing with active neutrinos can be suppressed by the induced effective potential in the sterile sector. We study how different cosmological observations can constrain this model, in terms of the mass of the new gauge boson, Mφ, and its coupling to sterile neutrinos, g_s. We explore how to probe part of the allowed parameter space of this particular model with future observations of the diffuse supernova neutrino background by the Hyper-Kamiokande and DUNE detectors. For Mφ ~ 5 – 10 keV and g_s ~ 10^(−4) – 10^(−2), as allowed by cosmological constraints, we find that interactions of diffuse supernova neutrinos with relic sterile neutrinos on their way to the Earth would result in significant dips in the neutrino spectrum which would produce unique features in the event spectra observed in these detectors.

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