

SN1987A constraints on the neutrino-dark-fermion interaction from resonant scattering with $C\nu B$

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Neutrino self-interactions mediated by a light scalar offer a compelling resolution to cosmological tensions and may naturally arise in neutrino mass generation mechanisms. When the scalar also couples to a light dark-sector fermion, supernova neutrinos can resonantly annihilate with the cosmic neutrino background ($C\nu B$) into invisible dark radiation, depleting the flux en route to Earth. We use this depletion to constrain the neutrino-scalar coupling from the SN1987A data. Within a Bayesian framework we analyze the data for two supernova neutrino emission models, a parameterized model and a 2D hydrodynamic simulation, and for two coupling types, a mass-independent one and a mass-proportional one. Our results show that new-physics limits from SN1987A cannot be quoted independently of the heavy-flavor emission, the flavor conversion, or the coupling structure. Finally, we forecast that a future high-statistics burst recorded by Hyper-Kamiokande would restore a meaningful upper bound even when flavor conversion is included.

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