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The Neutrino Magnetic Moment Portal and Supernovae: New Constraints and Multimessenger Opportunities

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We scrutinize the hypothesis that gauge singlet fermions - sterile neutrinos - interact with Standard Model particles through the transition magnetic moment portal. These interactions lead to the production of sterile neutrinos in supernovae followed by their decay into photons and active neutrinos which can be detected at γ-ray telescopes and neutrino detectors, respectively. We find that the non-observation of active neutrinos and photons from sterile-neutrino decay associated to SN1987A yields the strongest constraints to date on magnetic-moment-coupled sterile neutrinos if their masses are inside a 0.1 – 100 MeV window. Assuming a near-future galactic supernova explosion, we estimate the sensitivity of several present and near-future experiments, including Fermi-LAT, e-ASTROGAM, DUNE, and Hyper-Kamiokande, to magnetic-moment-coupled sterile neutrinos. We also study the diffuse photon and neutrino fluxes produced in the decay of magneticmoment coupled sterile neutrinos produced in all past supernova explosions and find that the absence of these decay daughters yields the strongest constraints to date for sterile neutrino masses inside a 1 – 100 keV window.

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