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Supernova cooling from neutrino-devouring dark matter

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Supernova cooling provides a powerful probe of physics beyond the Standard Model (SM), in particular for new, light states interacting feebly with SM particles. Unlike previous supernova studies focusing on annihilation or bremsstrahlung, we identify neutrino-initiated conversion as a dominant and previously unexplored production channel for fermionic dark matter (DM) via the neutrino-devouring process inside a core-collapse supernova, which contributes to the excessive cooling of the supernova. By incorporating state-of-the-art supernova simulation data and the full time evolution information, we derive stringent and robust limits on DM interactions.

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