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Supernova bounds on new scalars from resonant and soft emission

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The observations of supernovae can place strong bounds on the couplings of particles beyond the standard model, with masses all the way up to $\sim 200\text{MeV}$. We study new scalar particles and show that for masses less than the plasma frequency in the supernova core, they are predominantly produced by resonant mixing with an emergent in-medium degree of freedom known as the longitudinal photon. Unlike the nucleon-nucleon bremsstrahlung production mechanism which dominates at larger masses, this mechanism is free from nuclear physics uncertainties.

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