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Axion-like Particles from Hypernovae

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It was recently pointed out that very energetic subclasses of supernovae (SNe), like hypernovae and superluminous SNe, might host ultra-strong magnetic fields in their core.
Such fields may catalyze the production of feebly interacting particles substantially, changing the predicted emission rates.
Here we consider the case of axion-like particles (ALPs) and show that the predicted large scale magnetic fields in the core contribute significantly to the ALP production, via a coherent conversion of thermal photons.
Using recent state-of-the art SN simulations including magnetohydrodynamics, we find that if the ALPs have masses $m_a \sim \mathcal{O}(10)\,\mathrm{MeV}$, their emissivity via magnetic conversions is over two order of magnitude larger than previously estimated. Moreover, the radiative decays of these massive ALPs would lead to peculiar delays in the arrival times of the daughter photons. Therefore, high-statistics gamma-ray satellites can potentially discover MeV ALPs in an unprobed region of the parameter space and shed light on the magnetohydrodinamical nature of the SN explosion.

Primary authors: LUCENTE, GIUSEPPE (University of Bari); Dr CAPUTO, Andrea (University of Tel Aviv and Weizmann); VITAGLIANO, Edoardo; CARENZA, Pierluca (INFN Bari); MIRIZZI, Alessandro; GIANNOTTI, Maurizio (Barry University)

Presenter: LUCENTE, GIUSEPPE (University of Bari)

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