

Detecting light axion-like particles from supernovae in nearby galaxies

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Axion-like particles (ALPs) coupled to nucleons can be efficiently produced in core-collapse supernovae (SNe) and then, if they couple to photons, convert into gamma rays in cosmic magnetic fields, generating short gamma-ray bursts. Though ALPs from a Galactic SN would induce an intense and easily detectable gamma-ray signal, such events are exceedingly rare. In contrast, a few SNe per year are expected {in nearby galaxies} within $\sim \mathcal{O}(10)$ Mpc, where strong magnetic fields can enable efficient ALP-photon conversions, offering a promising extragalactic target.

This motivates full-sky gamma-ray monitoring, ideally combined with deci-hertz gravitational-wave detectors to enable time-triggered searches from nearby galaxies. We show that, under realistic conditions, a decade of coverage could reach sensitivities {to ALP-photon coupling $g_{a\gamma}$

gtrsim $10^{-15} \text{ GeV}^{-1}$ for ALP masses m_a

lessim 10^{-9} eV ,

probing a currently-unexplored large region of the parameter space below the longstanding SN 1987A bound.

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