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Investigating the gamma-ray burst from decaying MeV-scale axion-like particles produced in supernova explosions

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We investigate the characteristics of the gamma-ray signal following the decay of MeV-scale Axion-Like Particles (ALPs) coupled to photons which are produced in a Supernova (SN) explosion. This analysis is the first to include the production of heavier ALPs through the photon coalescence process, enlarging the mass range of ALPs that could be observed in this way and giving a stronger bound from the observation of SN 1987A. Furthermore, we present a new analytical method for calculating the predicted gamma-ray signal from ALP decays. With this method we can rigorously prove the validity of an approximation that has been used in some of the previous literature, which we show here to be valid only if all gamma rays arrive under extremely small observation angles (i.e. very close to the line of sight to the SN). However, it also shows where the approximation is not valid, and offers an efficient alternative to calculate the ALP-induced gamma-ray flux in a general setting when the observation angles are not guaranteed to be small. We also estimate the sensitivity of the Fermi Large Area Telescope (Fermi-LAT) to this gamma-ray signal from a future nearby SN and the possibility of reconstructing ALP properties in the case of a detection is discussed.

Submitted on behalf of a Collaboration?

No

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