Executive summary: Constraining the diffuse supernova axion-like-particle background with high-latitude Fermi-LAT data

1 What is this contribution about?

This contribution presents an analysis of gamma-ray data taken by the Fermi Large Area Telescope (LAT) that constrains the parameter space of axion-like particles (ALPs) via an extragalactic large-scale diffuse signal which is the result of the cumulative emission of all past core-collapse supernovae in the universe and the re-conversion of ALPs in the Galactic magnetic field of the Milky Way via the Primakoff process.

2 Why is it relevant / interesting?

As we currently lack a local core-collapse supernova in the Milky Way, extragalactic supernovae of this type are an excellent means to probe the existence of axion-like particles or, at the very least, to constrain their properties, for example, in terms of the coupling strength to photons. Axion-like particles are a suitable candidate for dark matter and, thus, experimental limits on their parameter space are essential to rule out (or corroborate) this possible solution to the nature of dark matter.

3 What have we done?

On one side, we have improved the currently available characterisation of the expected axion-like particle flux produced during a core-collapse supernova by invoking a larger set of supernova progenitor masses for numerical simulations of these violent processes. On the other side, we have employed a binned template-based maximum likelihood analysis of Fermi-LAT gamma-ray data to constrain the ALP parameter space assuming different models for the astrophysical gamma-ray emission in the Milky Way and its magnetic field. This improves on a previous study that only exploited the spectral shape of the ALP-induced gamma-ray flux as spatial information of the ALP signal are now additionally taken into consideration.

4 What is the result?

We gain a factor of two improvement with respect to the previous work that solely exploited the spectral shape of the ALP signal. Moreover, this analysis incorporates the uncertainty on the spectral shape of the ALP signal due to the fact that the progenitors of core-collapse supernovae follow an initial mass distribution, which contains mass ranges that may lead to failed supernovae and hence to a weaker ALP flux.