Measurement of anisotropies in the large-scale diffuse gamma-ray emission

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Summary
§ We have performed the first measurement of the angular power spectrum in the large-scale diffuse emission at energies from 1-50 GeV.
§ We have compared results from data and a simulated model (Galactic diffuse + 11-month sources + isotropic) to identify significant differences in anisotropy properties
§ We have found that: at multipoles greater than ~ 100, the excess power in the data suggest a contribution from a point source population not present in the model. Also, at large angular scales (l<100) angular power above the noise is seen in the data and model, probably due to contamination from the galactic diffuse.
§ Due to decreasing photon statistics, the amplitude of anisotropies detectable by this analysis decreases with increasing energy. For this reason, the non-detection of power above the noise level at 10-50 GeV does not exclude the presence of anisotropies at the level of those detected at 1-10 GeV

Introduction
The angular distribution of photons in the diffuse gamma-ray background contains information about the presence of unresolved source populations (USP).

Fluctuations on small scales may originate from an USP if they are different from those expected from the Poisson noise due to finite statistics.

Recent studies have predicted the contributions to the angular power spectrum from extragalactic and galactic dark matter annihilation or decay.

I present the results of an anisotropy analysis of the diffuse emission measured by the Fermi-LAT.

There are predictions for the angular power spectra of various unresolved gamma-ray populations in the literature, e.g. [1-5]. Predicted values of CI at l=100 cover a large range, e.g., ~1e-4 for blazars [1], ~1e-7 for starforming galaxies [2], and ~1e-4 to ~1 for dark matter [3, 4, 5].

The angular power spectrum (APS) as a metric for anisotropy

We consider the APS C_l of intensity fluctuations,

$$\delta I(\psi) = \langle I(\psi) - \langle I \rangle \rangle$$

where \(I(\psi)\) is the intensity in the direction \(\psi\).

The APS is given by

$$C_l = \langle a_{lm}^2 \rangle$$

where \(a_{lm}\) are determined by expanding \(\delta I(\psi)\) in spherical harmonics,

$$\delta I(\psi) = \sum_{l,m} a_{lm} Y_{lm}(\psi)$$

Method
-> Select regions of the sky which are mapleready clean
- mask sources in the 11-month catalog with a 2 deg angular radius.
- mask the galactic plane |b|<30 deg.
-> Calculate angular power spectrum of the data in several energy bins using the HEALPix package (Gorski et al. 2005).
-> Focus on multipoles greater than 100 (angular scales <1-2 deg), because the contamination from Galactic diffuse is likely to be small.
-> Compare results from data and simulated model to identify significant differences in anisotropy properties.
-> Error bars on points indicate 1-sigma statistical uncertainty in the measurement; systematic uncertainties are NOT included.

Data
~22 months of data
diffuse class events
energy range: 1 GeV - 50 GeV
5 energy bins for APS
instrument response P6V 3, for data and simulations
binned into order 9 HEALPix maps, pixels of -0.1 deg/side

Simulations
model simulated with globssim (Fermi Science Tools)
GAL: Galactic diffuse model
(CAT: 11-months source catalog
ISO: isotropic background
MODEL = GAL + CAT + ISO

References

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