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The Denoised, Deconvolved, and Decomposed Fermi gamma-ray sky

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We analyze the 6.5 year all-sky data from the Fermi Large Area Telescope restricted to gamma-ray photons with energies between 0.6-307.2 GeV. Raw count maps show a superposition of diffuse and point-like emission structures and are subject to shot noise and instrumental artifacts. Using the D3PO inference algorithm, we model the observed photon counts as the sum of a diffuse and a point-like photon flux, convolved with the instrumental beam and subject to Poissonian shot noise. The D3PO algorithm performs a Bayesian inference in this setting without the use of spatial or spectral templates; i.e., it removes the shot noise, deconvolves the instrumental response, and yields estimates for the two flux components separately. The non-parametric reconstruction uncovers the morphology of the diffuse photon flux up to several hundred GeV. We present an all-sky spectral index map for the diffuse component. We show that the diffuse gamma-ray flux can be described phenomenologically by only two distinct components: a soft component, presumably dominated by hadronic processes, tracing the dense, cold interstellar medium and a hard component, presumably dominated by leptonic interactions, following the hot and dilute medium and outflows such as the Fermi bubbles. A comparison of the soft component with the Galactic dust emission indicates that the dust-to-soft-gamma ratio in the interstellar medium decreases with latitude. The spectrally hard component exists in a thick Galactic disk and tends to flow out of the Galaxy at some locations. Furthermore, we find the angular power spectrum of the diffuse flux to roughly follow a power law with an index of 2.47 on large scales, independent of energy. Our first catalog of source candidates includes 3106 candidates of which we associate 1381 (1897) with known sources from the second (third) Fermi source catalog. We observe gamma-ray emission in the direction of a few galaxy clusters hosting known radio halos.

Collaboration

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