GODDARD SPACE FLIGHT CENTER

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The Contribution of Unresolved Blazars to the Extragalactic Gamma-ray Background*

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1. Introduction

Since blazars constitute the class of gamma-ray emitters with the largest number of identified members, they are expected to have a significant contribution to the extragalactic gamma-ray background (EGB) as measured by the *Fermi* Large Area Telescope (*Fermi*-LAT) and the Energetic Gamma-ray Experiment Telescope (EGRET). The question of whether unresolved blazars comprise the bulk of the EGB is a question of the emission properties of blazars, their cosmological source density, and the angular resolution of the gamma-ray detector.

2. Objectives

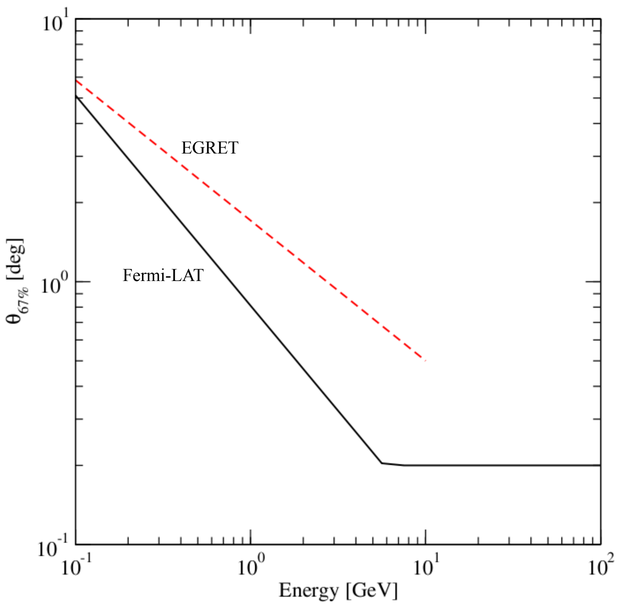
To model the blazar contribution to the EGB as measured by both *Fermi* and EGRET using a luminosity function determined from radio surveys and the observed radio-γ correlation. In so doing, we account for well known survey biases, particularly that of source confusion arising from the large source density of faint blazars and the large angular resolutions of both the EGRET and *Fermi*-LAT detectors.

3. Method

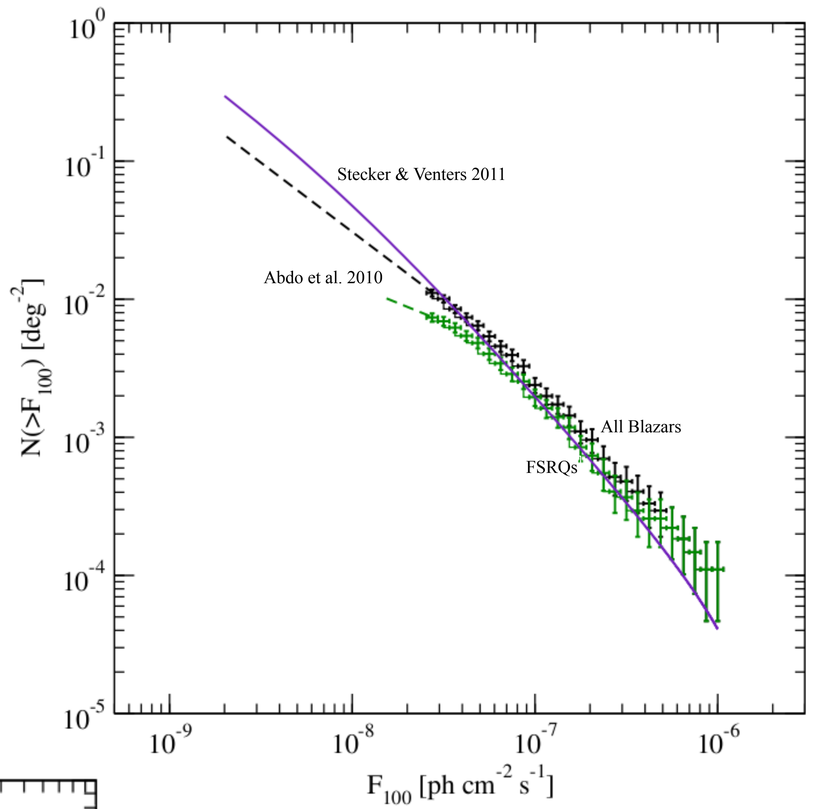
- **Luminosity Function.** Given the correlation between the radio luminosities of blazars and their gamma-ray luminosities ($L_\gamma \sim 10^{3.2} L_r$), as in Stecker & Salamon (1996) we employ the FSRQ radio luminosity function of Dunlop & Peacock (1990) corrected for cosmology.
- **Blazar Spectra.** We employ a likelihood analysis fitting blazar spectral indices to a Gaussian spectral index distribution (SID) with mean (Γ_0) and (σ_0). For FSRQs, we get $\Gamma_0 = 2.45$ and $\sigma_0 = 0.15$.
- **Source Confusion.** The probability, P, of finding a nearest neighbor source with $S \geq S_{\rm min}$ within the minimum angular separation, $\theta_{\rm min}$, for a source density, N, is $P = 1-\exp(-\pi N \theta^2_{\rm min}(E))$. Then, the source density criterion is given by $N_{SDC}=-\ln(1-P_{\rm min})/\pi\theta^2_{\rm min}(E)$. The limiting flux, $S_{\rm min}$, is then determined from the modeled source counts.
- **Blazar Contribution to the EGB.** The blazar contribution is given by

$$I_E(E_0) = \iiint F_{\rm ph}(E_0,z,L_\gamma,\Gamma)\rho_\gamma p_L(\Gamma) d^2V_{\rm com}/dz d\Omega\, dL_\gamma dz d\Gamma,$$

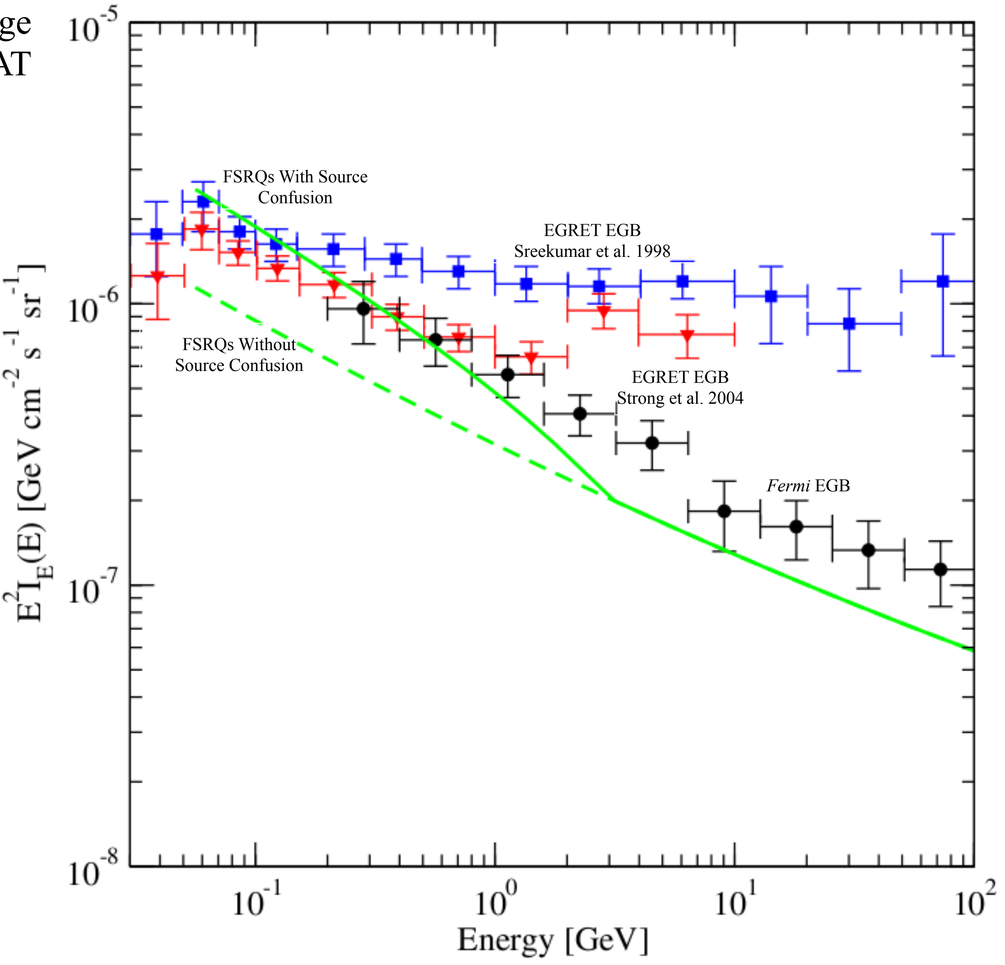
where $F_{\rm ph}(E_0,z,L_\gamma,\Gamma)$ is the blazar spectrum, ρ_γ is the luminosity function, and $p_L(\Gamma)$ is the SID.



Angular Resolution of the *Fermi*-LAT detector (black) and EGRET (red)



Source Counts with Models



Unresolved Blazar Contribution to the EGB

4. Results

The large source density of faint blazars and the large angular resolution of the *Fermi*-LAT at energies below ~ 1 GeV result in significant source confusion in the blazar population, increasing their contribution to the EGB at lower energies. If blazars do comprise the bulk of the EGB, then since the *Fermi*-LAT angular resolution at these energies is similar to that of EGRET, the *Fermi* EGB spectrum at these energies would be similar to that of EGRET, but lower than that of EGRET at energies at which the *Fermi*-LAT resolution is substantially better than that of EGRET as evidenced in the data. The shape of the unresolved blazar spectrum reproduces well the shape of the EGB.

*Stecker & Venters 2011, ApJ, *in press* (arXiv:1012.3678)