The Spectral Index Distribution of Blazars: Prospects for GLAST

Tonia Venters

with Vasiliki Pavlidou

The University of Chicago

Outline

- Past Work
- Monte Carlo Studies
- Determining ISIDs from Maximum Likelihood Studies
- Investigating Spectral Index Hardening using Maximum Likelihood
- Conclusions

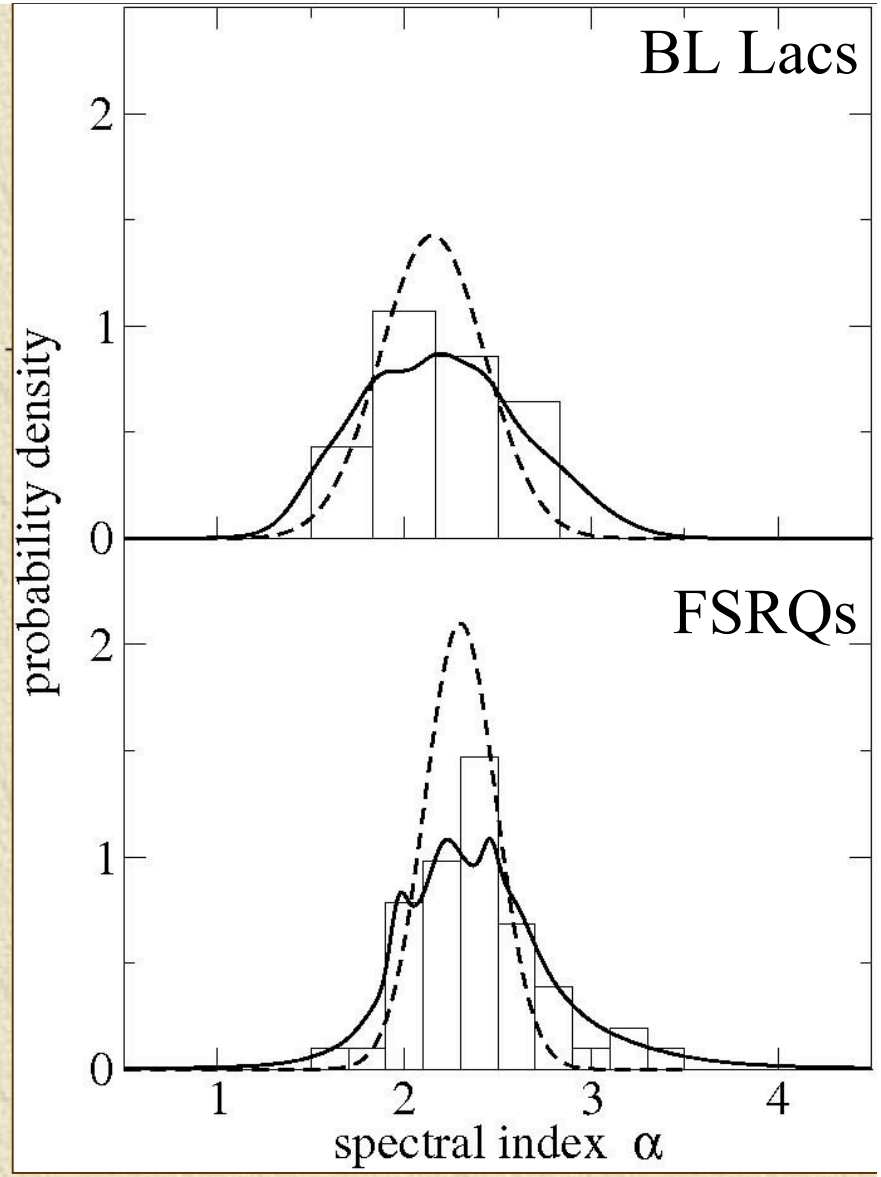
Past Work

Stecker and Salamon (1996)

⇨ importance of the SID

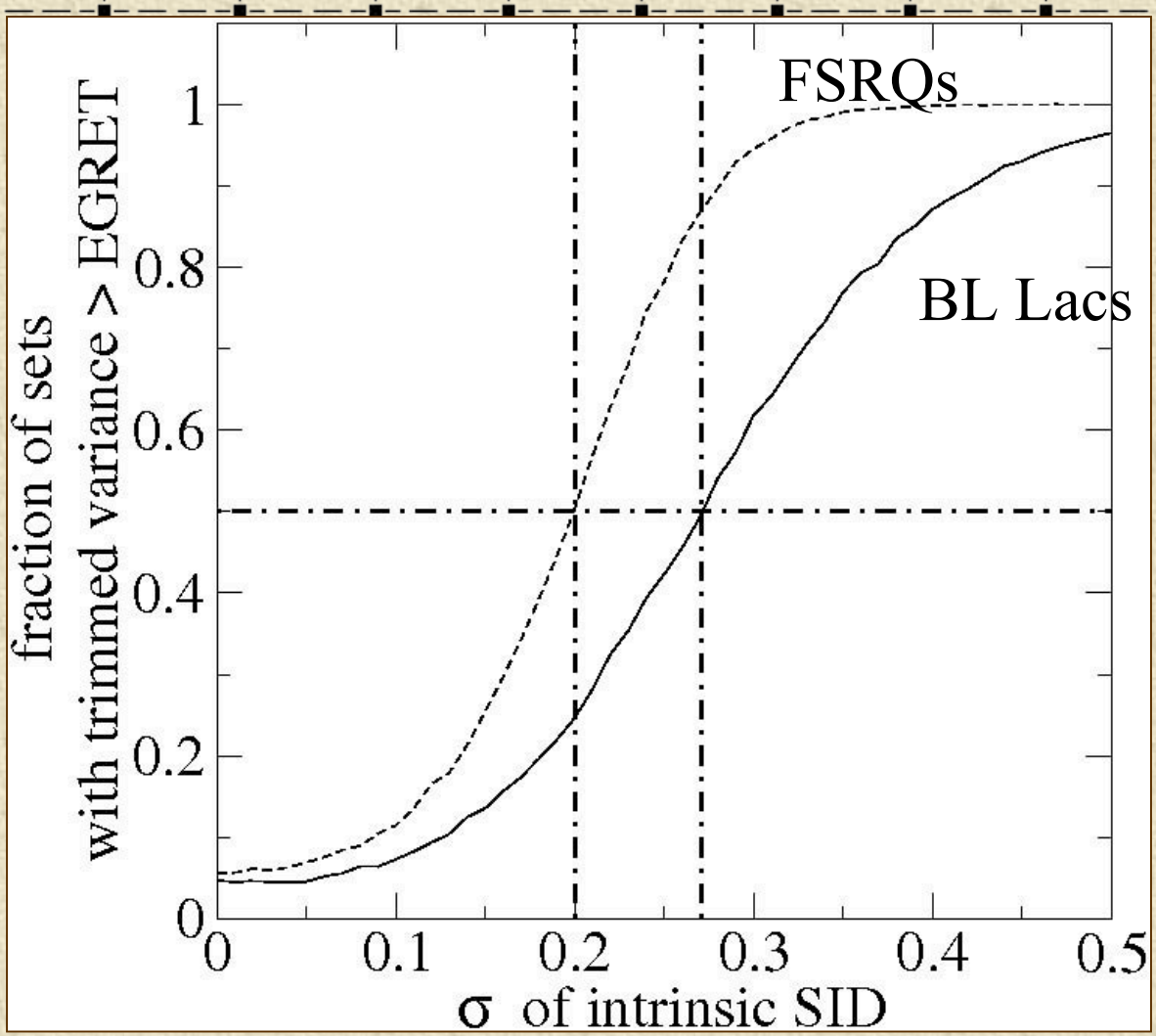
⇨ importance of accounting for measurement error

Affect the blazar contribution to the EGRB → concavity of the spectrum



$$p(\alpha) = \frac{1}{N}\sum_{i=1}^{N}\frac{1}{\sigma_i\sqrt{2\pi}}e^{-\frac{(\alpha-\alpha_i)^2}{2\sigma_i^2}}$$

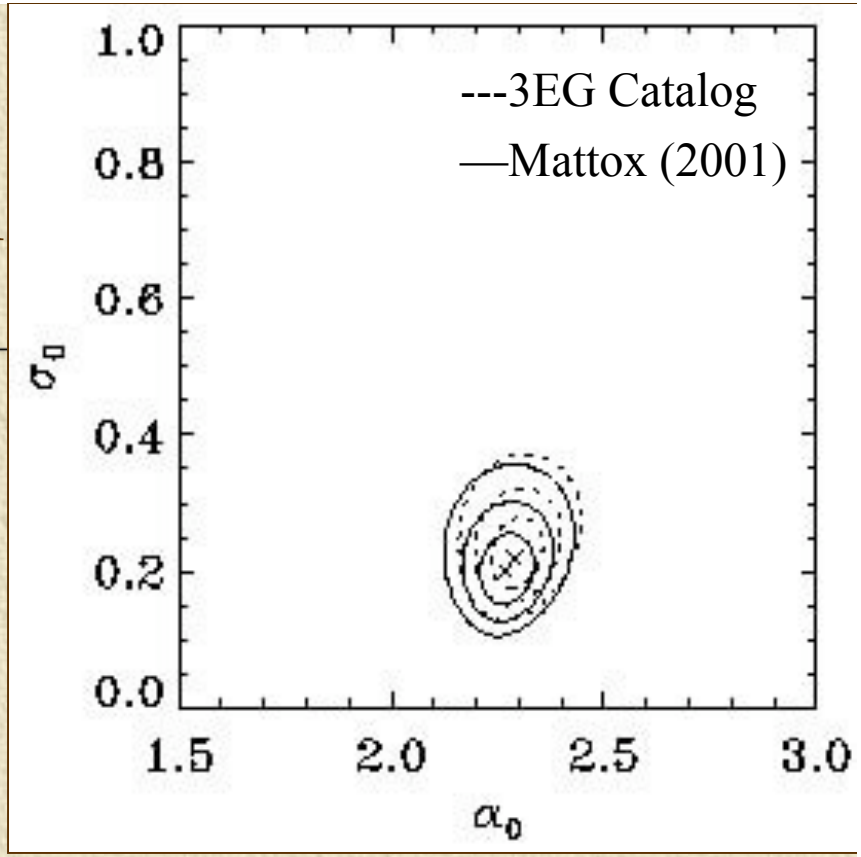
Hints from Monte Carlo…



The Maximum Likelihood Approach

$$P(x_i \mid y_j) \propto P(x_i) \times L(y_j \mid x_i)$$

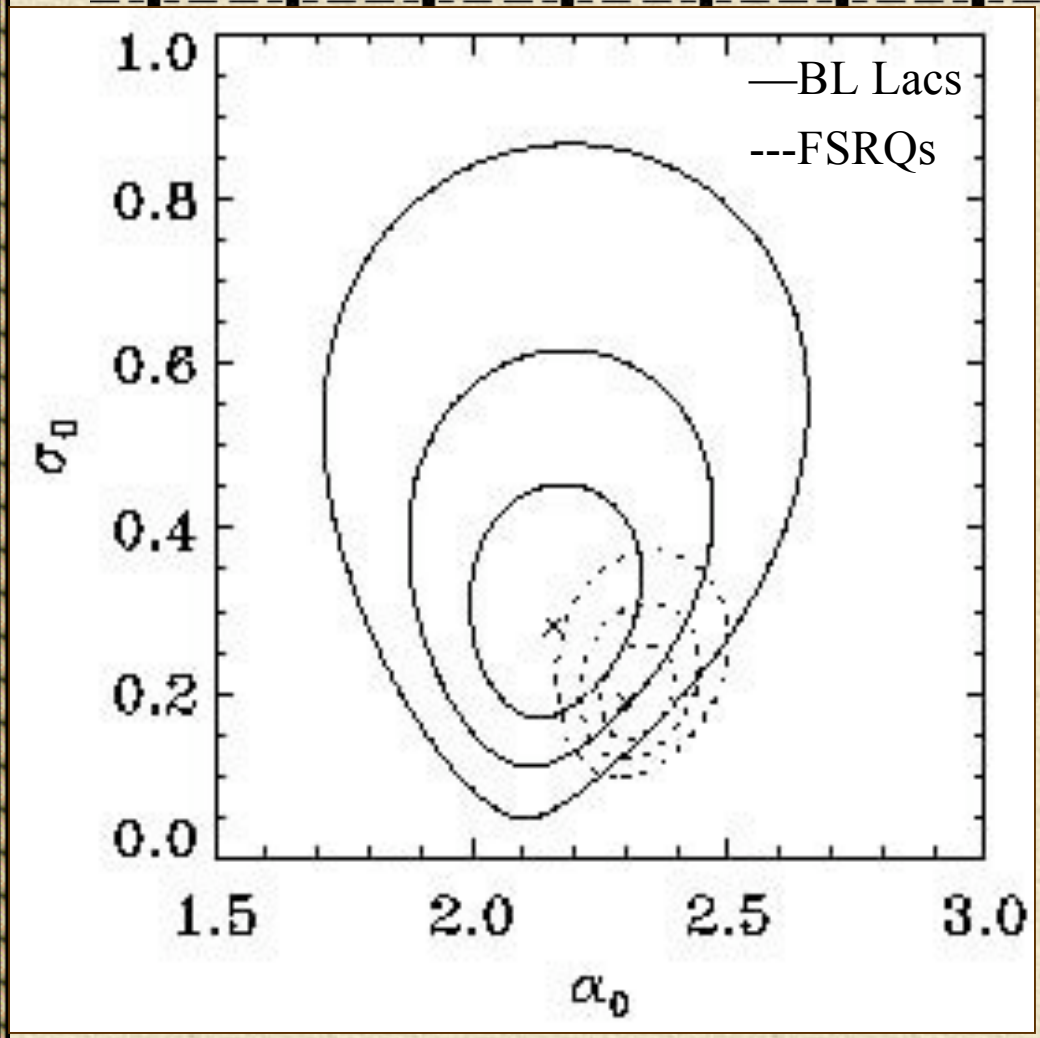
$$L = \prod_{j=1}^{N} l_j$$



$$l_j = \int d\alpha \frac{\exp[-(\alpha-\alpha_j)^2/(2\sigma_j{}^2)]}{\sqrt{2\pi}\sigma_j} \frac{\exp[-(\alpha-\alpha_0)^2/(2\sigma_0{}^2)]}{\sqrt{2\pi}\sigma_0}$$

$$L = \left(\prod_{j=1}^{N} \frac{1}{\sqrt{\sigma_0{}^2 + \sigma_j{}^2}} \right) \exp\left[-\frac{1}{2} \sum_{j=1}^{N} \frac{(\alpha_j - \alpha_0)^2}{\sigma_0{}^2 + \sigma_j{}^2} \right]$$

The ISIDs—Maximum Likelihood in Action



Separate populations?

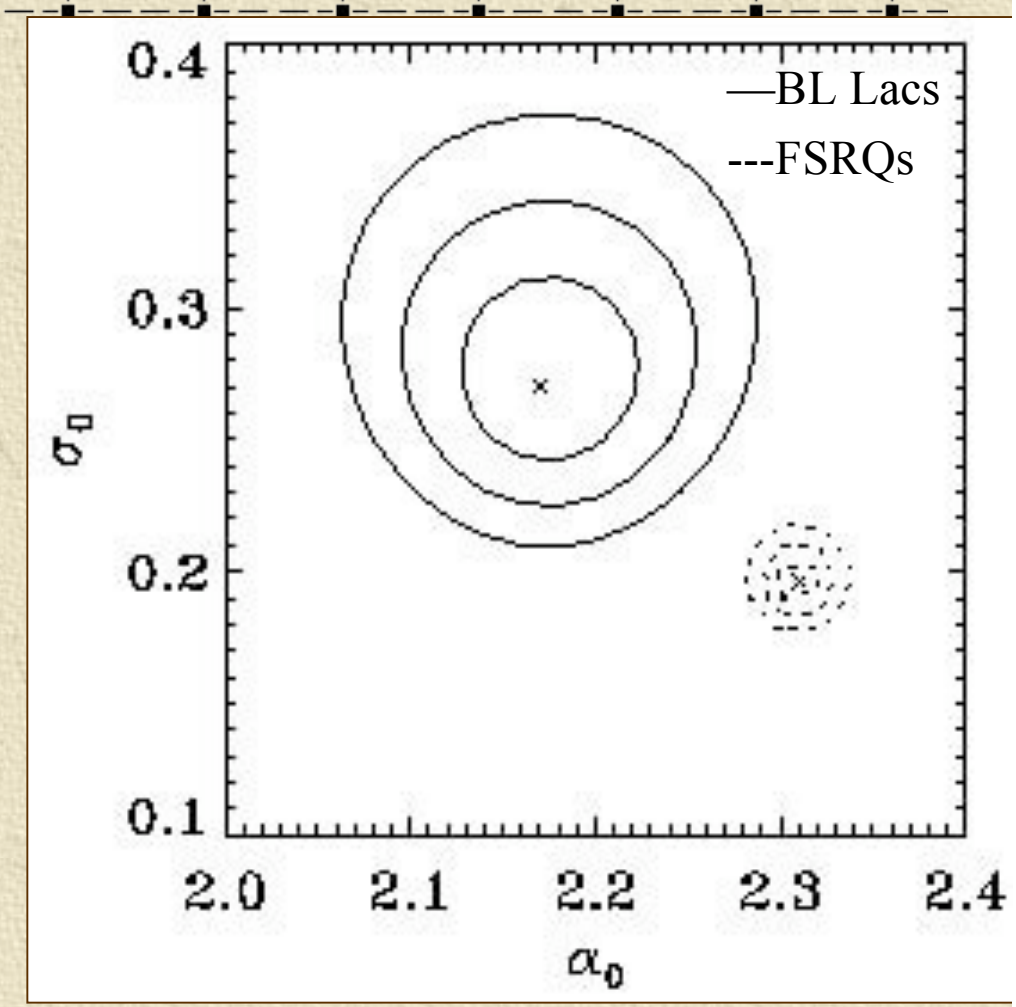
GLAST to the Rescue!!!

- Simulate GLAST data using the number distributions in Dermer (2006)
- Draw *true* spectral indices from EGRET ISIDs
- Uncertainty determined from the number of detectable photons:

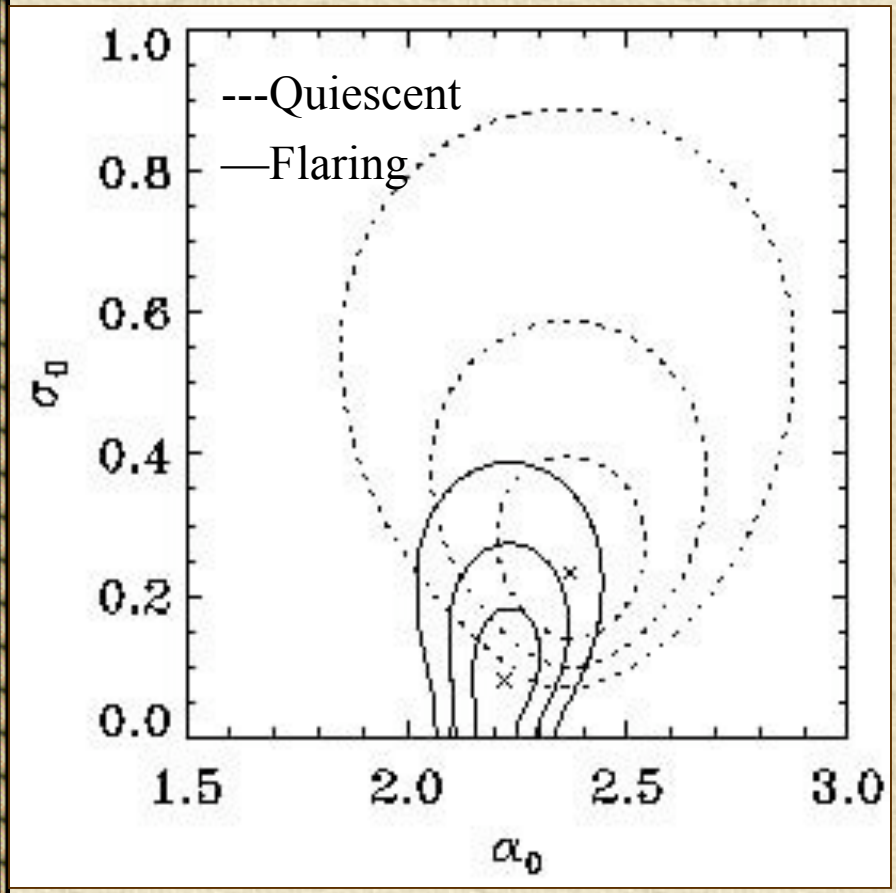
$$N_{\text{photon}} = F\Delta tA$$

$$\sigma = 7.0 \times N_{\text{photon}}^{-0.7}$$

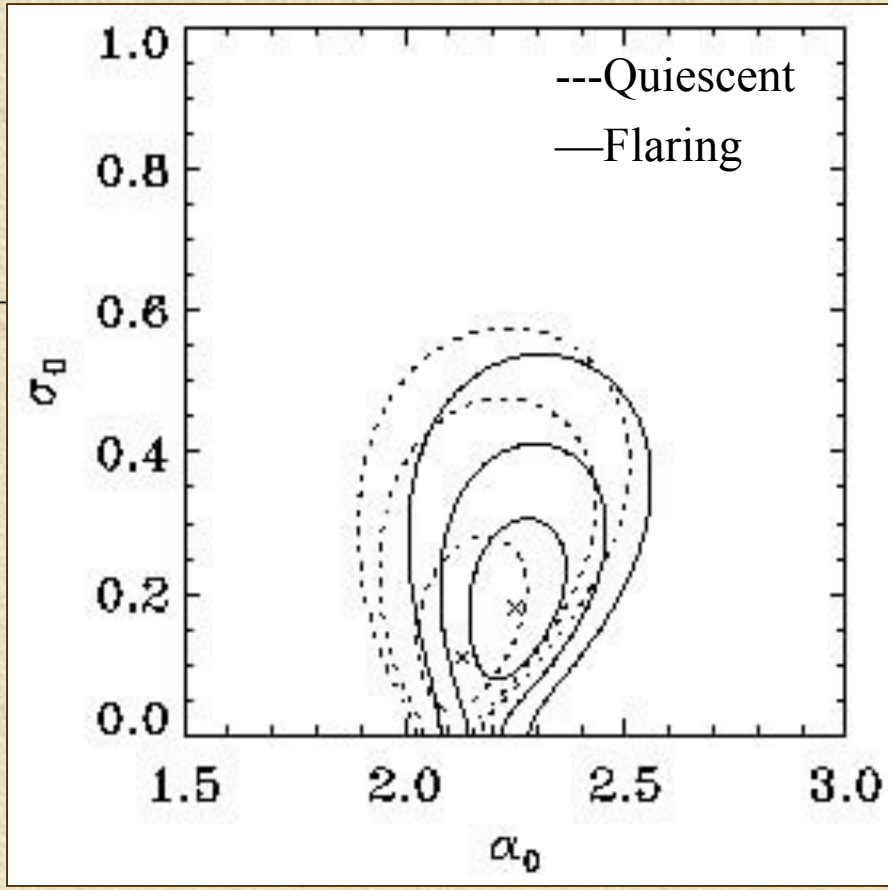
- Draw *measured* spectral index from Gaussian with mean being the *true* spectral index and sigma the uncertainty



Spectral Index Hardening?

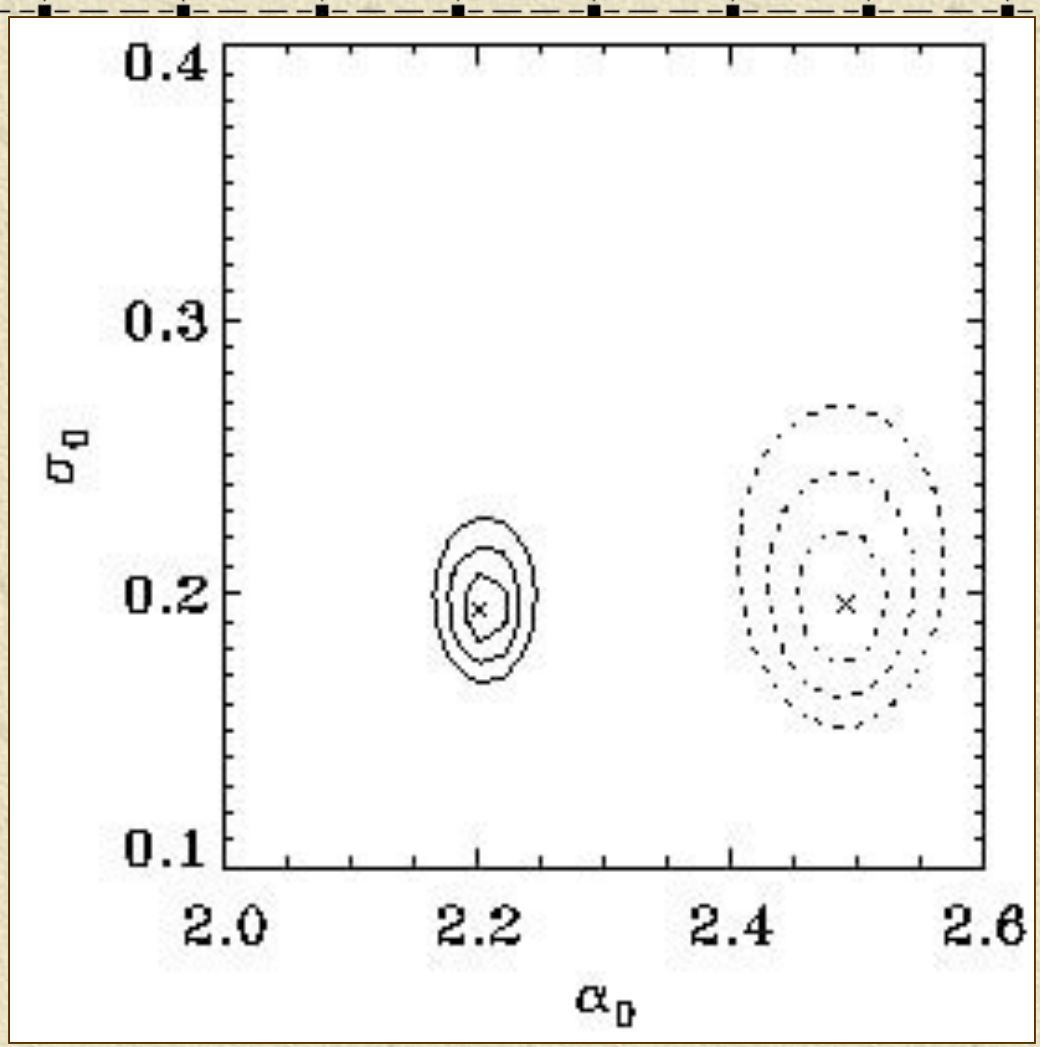


Simulated EGRET data



Real EGRET data

Spectral Index Hardening—The GLAST Answer



Conclusions

- Maximum Likelihood ISID of the blazar population is a Gaussian with **mean = 2.29** and **σ = 0.22** ⇨concavity in the spectrum of the blazar contribution to the EGRB is relatively small.
- Some indication that BL Lacs and FSRQs are spectrally distinct
- No evidence for spectral index hardening

GLAST will settle all issues!!!!

References

Dermer, C. D. 2006, ArXiv Astrophysics e-prints, arXiv:astro-ph/0605402

Mattox, J. F., Hartman, R. C., & Reimer, O., ApJS, 135, 155

Stecker, F. W. & Salamon, M. H. 1996, ApJ, 464, 600

Pavlidou, V. & Venters, T. M., 2007, EGRB paper, in preparation

Venters, T. M., & Pavlidou, V., 2007, this talk, on astro-ph soon!