# The Epeak - Fluence Bimodality: A fundamental discriminator between long and short GRBs

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### **BATSE 5B Spectral Catalog**

2,106 GRBs

19,936 Spectra

#### 9,971 2-Sec Peak Flux Spectra

- ★ Band: 1429 (67.9%)
- ★ Comp: 1858 (88.2%)
- ★ Log<sub>10</sub> Gauss: 1739 (82.6%)
- \* Power Law: 856 (40.6%)
- ★ SBPL: 1909 (90.6%)

#### 9,965 3.5 Sigma Fluence Spectra

- ✤ Band: 1362 (64.7%)
- ★ Comp: 1807 (85.8%)
- ★ Log<sub>10</sub> Gauss: 1645 (78.1%)
- \* Power Law: 905 (43.0%)
- ★ SBPL: 1872 (88.9%)

#### Epeak and Fluence for Short and Long GRBs

 $\chi^2_{\nu} \leq 3\sigma$  confidence level

 $\sigma_{E_p} \le 0.4E_p, \quad \sigma_{F_\gamma} \le 0.4F_\gamma$ 



Fluence Distribution



Long :  $\overline{S_{\gamma}} = 3.56 \times 10^{-6} \text{ erg/cm}^2$ Short :  $\overline{S_{\gamma}} = 3.30 \times 10^{-7} \text{ erg/cm}^2$ 

### Epeak/Fluence Ratio for Short and Long GRBs



#### Bimodal Distribution! Detector selection effects?

#### The Ghirlanda & Amati Relations



#### Testing the Lower Limits with BATSE

$$H_0 = 74 \text{ km Mpc}^{-1} \text{ s}^{-1} \quad \Omega_m = 0.3 \quad \Omega_\Lambda = 0.7$$



Lower Limits

II4I Long GRBs Amati fails for 86.8% Ghirlanda fails for 0.0%



f<sub>B</sub>

= 1.0

I 67 short GRBs Amati fails for 99.4% Ghirlanda fails for 0.0%



Short GRBs 090510 & 090927 are consistent with the Ghirlanda relation 6/19 Long GRBs consistent with the Amati relation

#### Testing the Lower Limits with GBM



Initial GBM results are consistent with BATSE results

## **Concluding Thoughts**

- The Epeak/fluence ratio is a discriminator between long and short bursts and does not rely on the full  $T_{90}$  of the burst.
- Short bursts are harder than long bursts and are possibly uncollimated (or very near so) if the Ghirlanda relation is to be believed.
- Preliminary results from Fermi/GBM appear to confirm the uncollimation of short bursts.
- Only 6 of the 19 long GBM redshift bursts are consistent with the Amati relation, but both short bursts are fully consistent with the Ghirlanda relation.
- The Ghirlanda relation appears to be a global lower limit in the  $E_{peak}$ -fluence plane and an upper limit in the  $E_{peak}$ - $E_{iso}$  plane.
- Fermi should be able to complete the energy ratio distribution by detecting high-Epeak short GRBs

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