A catalog of flaring gamma-ray sources

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Variability in gamma rays with Fermi

- New sources detected or identified through their variability
- Fermi continuous full-sky monitoring for the multi-wavelength community

• Current flaring monitoring with the Fermi-LAT
  - Automated Science Processing, based on daily peak finder and likelihood analysis
  - Fermi blog, Monitored sources light curves, ATels
We compare the *observed* photon counts to the *expected* value from long-term average.

- Arbitrary time binning and energy range
- Simple and fast
- No systematics due to the modeling of the diffuse emission
  → particularly suited for *plane transients*
- Unbiased view of the whole sky, including negative fluctuations

**Principle**

**Relative Excess > 100 MeV**

**Significance**

April 2011
Method

- **Observed** counts maps are generated by counting events within a 68% containment radius as a function of Energy and Incidence angle \((E, \theta)\).

- An **expected** counts map is generated from:

\[
N_{\text{expected}} = \sum_{E, \theta} N_{\text{total}} \cdot \frac{E_{\text{week}}}{E_{\text{total}}}
\]

\(E\): exposure \((E, \theta)\)

- Significance using Poisson statistics
Extract peaks with significance >5σ above 100MeV or >5.5σ above 800MeV → expect ~1 false flare over entire sky and 206 weeks
Analysed about 4 years of data in weekly bins (2008-08-04 to 2012-07-16)

Yields 1286 significant weekly flares.

Weekly analysis

Motion of the Sun: appears as variable source along ecliptic

- Exclude flares within 15° of the Sun.

Preliminary
Tests with non-variable full-sky simulations for 36 months of data.

➤ method works: Significance follow a Gaussian distribution with RMS 1.0

Systematics errors on level similar to the 2% adopted for the variability analysis of the 2FGL catalog (Nolan et al. 2012)

➤ Vela and Geminga compatible with constant
• Weekly flares grouped using a Minimum Spanning Tree algorithm
• Built a catalog of 218 flaring sources

167 sources associated with 2FGL blazars
29 sources with no 2FGL association

Find the 4 most fluent GRBs:
GRB080916C, GRB090510, GRB090902B, GRB090926A
Galactic plane transients

From the AGN flare density in the extragalactic sky, we expect 23±2 flares in the Galactic plane.

Total of 27 Galactic plane transients.

7 of known Galactic origin:
- 3 Binary systems
- Crab Nebula
- 3 novae

(Talk by C. Cheung)

20 sources coincident with AGNs

From the AGN flare density in the extragalactic sky, we expect 23±2 flares in the Galactic plane.
• Instantaneous access to lightcurve for any point in the sky

• Compare different AGN populations:

FSRQs  
ex: 3C 273 with 22 weeks flaring

BL Lacs  
ex: OJ 287 with 7 weeks flaring

Talk by B. Lott and others
Conclusion

• First all sky catalog of *Fermi*-LAT flaring sources: 218 detected on weekly timescales.

• Variable source populations:
  – Characterize AGN populations properties
  – New Galactic gamma-ray transient population: Novae
  – Other Galactic sources expected with known binaries and AGN density.

• Toward an exhaustive view of the variable sky

• Ongoing additional projects:
  – Real time online product available to the public
  – Testing on other time scales
Backup
Sensitivity

Average weekly flux required for catalog detection

Preliminary