Characterizing high-energy light curves of Fermi/LatGRBs

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Abstract

A systematic analysis of the light curves of Gamma-Ray Burst (GRBs) with redshift and detected at high-energy (> 100 MeV) by Fermi/LAT has never been done before our work, because there were only a handful of detections. Now we have 20 of those, which we can use to characterize the GRBs in their rest frame. We compared a characteristic decay times T_c of GRBs with redshifts using the new ``Pass 8'' data, and used a Crystal Ball function to parametrize GRB characteristics. An unexpected anti-correlation between T_c and the peak flux was observed. This means that brighter peaked GRBs have shorter durations. There is also no correlation between the T_c and the decay index, which makes the anti-correlation with brightness more clear. This results appears to be consistent with the External Shock model, which is one of the competing hypothesis on the origin of the high-energy emission. We did not observe any bimodality, which is seen in GRBs at lower energies.

Determining the Duration of High Energy Gamma Ray Bursts

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- What is a Gamma Ray Burst?
- Why look at them?
- What can you find?

Gamma Rays

Gamma Ray Bursts

- -100 to 0 sec
- Faint background
- Handful of Photons

Gamma Ray Bursts

- 0 to 100sec
- Bright source
- HIGH ENERGY photons

5 minutes later...

Gamma Ray Bursts

- 300 to 400sec
- Faint background
- Handful of photons
- Detection about every 2 to 3 weeks
- How fast did this happen?

Gamma Ray Bursts

- High energy jets?
- Relativistic shockwaves?
- What was the source?
- Hidden internal engine
 - ❖ Black Hole formation
 - ❖ Neutron star collision

Never Been Done

- Duration at low energy carries lot of information
 - ❖ short Vs long GRBs
- At high-energy (> 100 MeV) it has never been studied before Fermi
 - ❖ Before the LAT only a handful of detections (EGRET)
 - ❖ In the first GRB catalog, duration for 13 out of 28 bursts (needed bright GRBs).

Possible discoveries...

New Classifications

- By measuring durations for both bright and faint GRBs we can gain hints for classification.
- Other characteristics may correlate to duration.
- Different information on the engine and/or shocks for different duration and brightness.

We just need a larger sample size...

Fermi Satellite

- Since the beginning of LAT operation in 2008 we now have 102 GRBs cataloged above 100MeV (as of Aug 12, 2015, source: GRB list on confluence)
- With this larger sample size we can study the distribution of the duration
- We now have a better analysis tools(and data) allowing the computation of duration for faint as well as bright GRBs
- Pass 8
 - ❖ More precision
 - ❖ Declassifying Pass 7 triggers!

Fitting Model to Data

- Adaptive binning
- Power law models (Crystal Ball)
- Bayesian Analysis
- Markov Chain Monte Carlo

Fitting Models to Data

- Power law models (Crystal Ball)
 - ❖ 5 parameters(μ , σ , index, N , t_0)
- Markov Chain Monte Carlo

Example: Very Bright (bn090510016)

Example: Very Faint (bn081024891)

More to do...

- Process more durations after fitting more GRBs
- Looking for correlation between characteristics and duration.

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