A6.1 GRB Visualization Tool

Date: 5 July 2002 (draft v3)
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Function

This tool plots GRB lightcurves using LAT, GBM and/or other missions' data. The data may consist of individual or binned events over specified energy bands, and therefore different types of lightcurves will be possible: lightcurves in separate plots, lightcurves stacked on a single plot, points on an energy-time plot, etc. The binned data can be presented as events per bin or normalized events in that bin (events per energy per time per area). Data can also be compared to spectral fits.

Scripting should allow recreating a previously developed plot.

Inputs

- LAT photon data (from D1, extracted by U1; a special photon cut for bright, localized sources may be used)
- GBM count data
- LAT binned data (from A6.2) with normalizations
- GBM binned data (from either A6.2 or continuous data accumulated by the GBM) with normalizations
- Data from other missions (e.g., Swift, AGILE).
- Spectral fits

Databases required

None

Outputs

Plots on the user's screen, stored in a file, or sent to a printer.

Performance requirements

Plotting should be fast. The interface should allow easy manipulation of the plots.

Other modules required

None

Host environment

Client computer

Existing counterparts

Many packages (e.g., SOAR , RMfit) plot burst lightcurves.

Open issues for definition or implementation

1. How much flexibility should the visualization tool provide the user?

A6.2 GRB Event Binning Tool

Date: 5 July 2002 (draft v3)
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Function

This tool bins GRB event data in time and energy from the LAT, GBM and/or other missions. The binned data may be plotted by A6.1 or fit by A6.6.

The user will be offered a variety of methods of identifying the time bins:
1. User defined bins—The user inputs the time boundaries
2. S/N bins—The user inputs the desired S/N for each bin
3. Bayesian Blocks

The user must also specify the desired energy bins. For the automated time binning methods, the user must specify the energy band to be considered.

Background data that is already binned (e.g., for the GBM data) will be concatenated with the binned counts.

The input of energy or time bin boundaries should be possible both interactively and through files. The time bins may be derived from already binned data, e.g., the user may want to bin the LAT and GBM data using the time bins of data from another mission.

Inputs

- LAT photon data (from D1, extracted by U1; a special photon cut for bright, localized sources may be used)
- GBM count data
- Event data from other missions (e.g., Agile, Swift)
- Time and energy bin boundaries
- Exposures relevant to each datatype.

Databases required

None

Outputs

- Number of photons/counts/events in each time-energy bin.
- The related normalization for each bin (energy, time, effective area) to convert the counts per bin into counts per energy per time per area for that bin.

Performance requirements

The binning should not be computationally intensive or require much memory.

Other modules required

None

Host environment

Client computer

Existing counterparts

Existing burst tools such as RMfit are capable of binning time-tagged events.

An optimal "Bayesian Blocks" decomposition algorithm has been developed recently (Scargle et al.) and is available as a set of IDL routines.

This tool may first be developed for Swift data.

Open issues for definition or implementation

1. How closely tied together should the visualization (A6.1) and binning tools be? Should they be one tool? Users will probably want to iterate between binning and looking at the resulting lightcurves.

A6.3 Continuous GBM Data Rebinning Tool

Date: 5 July 2002 (draft v3)
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Function

This tool rebins continuous GBM data. The binned data may be plotted by A6.1 or fit by A6.6.

The user will be offered a variety of methods of identifying the time bins:
1. User defined bins—The user inputs the time boundaries
2. S/N bins—The user inputs the desired S/N for each bin
3. Bayesian Blocks

The user can also specify the desired energy bins. For the automated time binning methods, the user must specify the energy band to be considered.

The input of energy or time bins should be possible both interactively and through files. The time bins may be derived from already binned data, e.g., the user may want to rebin the GBM data using the time bins of data from another mission.

Inputs

- GBM continuous data
- Time and energy bin boundaries
- Exposures relevant to each datatype.

Databases required

None

Outputs

- Number of photons/counts/events in each time-energy bin.
- The related normalization for each bin (energy, time, effective area) to convert the counts per bin into counts per energy per time per area for that bin.

Performance requirements

The binning should not be computationally intensive or require much memory.

Other modules required

None

Host environment

Client computer

Existing counterparts

Existing burst tools such as RMfit are capable of binning time-tagged events.

An optimal “Bayesian Blocks” decomposition algorithm has been developed recently (Scargle et al.) and is available as a set of IDL routines.

Open issues for definition or implementation

1. The same as for A6.2

A6.4 GRB Temporal Analysis

Date: 5 July 2002 (draft v3)
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Function

This tool will provide the user with a variety of tools to perform standard and specialized temporal analysis methods on burst lightcurves. Included will be:

1. Fourier transforms
2. Wavelets
3. Cross-correlations between different energy bands
4. Pulse decomposition.

The tool will operate on both binned and event data.

Inputs

- LAT photon data (from D1, extracted by U1; a special photon cut for bright, localized sources may be used)
- GBM count data
- LAT binned data (from A6.2)
- GBM binned data (from either A6.2 or continuous data accumulated by the GBM)
- Data from other missions (e.g., Swift, AGILE).
- Spectral fits

Databases required

None

Outputs

Plots and values relevant to each technique.

Performance requirements

Different techniques will vary in their resource requirements. The analyses should be able to run on the user's computer in a reasonable amount of time (e.g., less than an hour for the most computationally intensive technique operating on a large amount of data).

Other modules required

None

Host environment

Client computer

Existing counterparts

While these tools have been applied to gamma-ray burst lightcurves, they have not been incorporated into standard analysis packages such as SOAR or RMfit.

Open issues for definition or implementation

1. Which techniques should be included?
2. Should there be separate tools for binned and unbinned data?

A6.5 LAT GRB Exposure Tool

Date: 5 July 2002 (draft v3)
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Function

This tool will extract the LAT exposure relevant to a gamma-ray burst. In general, this will be a small set of numbers since the burst will occur on a relatively short timescale compared to the change of the LAT's inclination angle to the burst, and the burst photon flux will be insufficient to change the livetime fraction during the burst. However, provision must be made for very long or very intense bursts for which this is not true.

Inputs

- The time and position of the burst

Databases required

D2—Pointing , livetime and mode history

Outputs

- The exposure as a function of energy and time.

Performance requirements

The calculations should not be computationally expensive.

Other modules required

None

Host environment

Client computer

Existing counterparts

This tool will be related to U2.

Open issues for definition or implementation

1. The precise form of the exposure will depend on the formulation of the fitting.
2. Can the same exposure be used for binned and unbinned photons?

A6.6 GRB Binned Spectral Analysis Tool

Date: 5 July 2002 (draft v3)
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Function

This tools performs standard spectral analysis of LAT, GBM and/or other missions' binned burst spectra. The data to be fit are assumed to be one-dimensional vectors of binned counts. The LAT data must be extracted over a region a few PSFs in radius so that all the burst counts are included, or alternatively, a correction must be made for the excluded photons. The blending of burst and non-burst LAT photons because of the LAT's PSF is treated by using a background before and after the burst. Because the LAT bins may be sparsely populated, the analysis may require using the Cash statistic rather than χ^2.

XSPEC may fulfill the requirements of this tool.

This tool should fit series of spectra.

Inputs

- LAT binned data (from A6.2)
- GBM binned data (from either A6.2 or continuous data accumulated by the GBM)
- Binned data from other missions (e.g., Swift, AGILE).
- Response functions for the other missions
- Choice of fitting spectrum
- Initial parameter values

Databases required

D6 – CALDB for both LAT and GBM data. The exposure handles the LAT's spatial response, but the energy redistribution is necessary for fitting.

Outputs

Spectral fits

Performance requirements

The fitting should be fairly fast.

Other modules required

None

Host environment

Client computer

Existing counterparts

This is the standard spectral analysis found in XSPEC, RMfit and SOAR.

Open issues for definition or implementation

1. Should this tool include its own visualization package, or will A6.1 suffice? XSPEC has visualization capabilities.
2. Will the large number of GBM counts overpower the few LAT photons in a joint fit? Is a relative weighting of the data from different detectors necessary or justified?
3. At what burst intensity do the assumptions underlying the standard spectral analysis break down?
4. If the F-test and the Maximum Likelihood Ratio Test are inappropriate for most comparisons of different model fits, what tools should be provided to assist in such comparisons? Can we provide tables appropriate for our data? Should we build in simulation tools for the user to perform the necessary Monte Carlo calculations?

A6.7 GRB Unbinned Spectral Analysis Tool

Date: 5 July 2002 (draft v3)
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Function

This tools performs spectral analysis of LAT, GBM and/or other mission's unbinned burst data.

Inputs

- LAT photon data (from D1, extracted by U1; a special photon cut for bright, localized sources may be used)
- GBM count data
- Unbinned data from other missions (e.g., Swift, AGILE).
- Response functions for the other missions
- Choice of fitting spectrum
- Initial parameter values

Databases required

D6 – CALDB for both LAT and GBM data. The exposure handles the LAT's spatial response, but the energy redistribution is necessary for fitting.

Outputs

Spectral fits

Performance requirements

If there are many counts then the calculation may be computationally expensive.

Other modules required

None

Host environment

Client computer

Existing counterparts

None(?)

Open issues for definition or implementation

1. Same as for A6.6.