Swift Observation of GRB 070224

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0   Revisions

Version 2 includes updated UVOT upper limits, and new XRT observations and analysis. The XRT light curve (Fig. 2) has been updated to include the final observations of GRB 070224 which extended through March 12, 2007.

1   Introduction

BAT triggered on GRB 070224 at 20:27:58 UT (Trigger 261880) (Racusin, *et al.*, *GCN Circ.* 6137). This was a rate-trigger on a intermediate length burst with $T_{90} = 34 \pm 1$ *sec.* Swift slewed to this burst immediately and XRT began follow-up observations at $T + 143$ *sec*, and UVOT at $T + 132$ *sec*.

Our best position is the astrometrically corrected XRT location RA($J2000$) = $179.02792 deg$ ($11h56m6.7s$), Dec($J2000$) = $-13.3304 deg$ ($-13d19'49.6''$) with an error radius of 2.6 arcsec (90% confidence, including boresight uncertainties).

2   BAT Observation and Analysis

Using the data set from $T - 20$ to $T + 50$ *sec*, further analysis of BAT GRB 070224 has been performed by the Swift team (Tueller, *et al.*, *GCN Circ.* 6141). The BAT ground-calculated position is RA($J2000$) = $178.987 deg$ ($11h55m57.0s$), Dec($J2000$) = $-13.356 deg$ ($-13d21'20.1''$) with an error radius of 2.0 *arcmin*, (systematic and statistical, 90% containment). The partial coding was 100%.

The masked-weighted light curves (Fig.1) starts at trigger time T with two overlapping peaks, and returns to background at about $T + 50$ *sec*. $T_{90}(15 - 350keV)$ is 34 ± 1 *sec* (estimated error including systematics).

The time-averaged spectrum from $T - 13.8$ to $T + 24.3$ *sec* is best fitted by a simple power law model. This fit gives a photon index of 2.42 ± 0.30. For this model the total fluence in the $15 - 150$ *keV* band is $(3.1 \pm 0.5) \times 10^{-7} ergs/cm^2$ and the 1-sec peak flux measured from $T - 13.76$ *sec* in the $15 - 150$ *keV* band is 0.3 ± 0.1 $ph/cm^2/sec$. All the quoted errors are at the 90% confidence level.

3   XRT Observations and Analysis

Based on an accurate mapping between the XRT and UVOT detector coordinate systems, we have used the simultaneous UVOT V-band images to astrometrically correct (relative to stellar catalogues, e.g. USNO-B1) the XRT world coordinate system, and thereby refine the XRT position. We obtain a new XRT position at RA($J2000$) = $179.02792 deg$ ($11h56m6.7s$), Dec($J2000$) = $-13.3304 deg$ ($-13d19'49.6''$) with an error radius of 2.6 arcsec (90% confidence, including boresight uncertainties, Racusin *et al.*, *GCN Circ.* 6151). This position is 8.1 *arcsec* from the initial XRT position reported by Racusin *et al.*, *GCN Circ.* 6137, 3.8 *arcsec* from the refined XRT position reported by Racusin *et al.*, *GCN Circ.* 6143, and 2.0 *arcsec* from the optical afterglow, first reported by Thoene *et al.*, *GCN Circ.* 6142.

The $0.3 - 10$ *keV* light curve (Fig.2) can be modeled by a broken power-law with initial steep decline with a slope of $3.31^{+0.26}_{-0.23}$, followed by a shallow slope of $0.62^{+0.07}_{-0.08}$, beginning at $T + 652^{+143}_{-99}$ *sec*
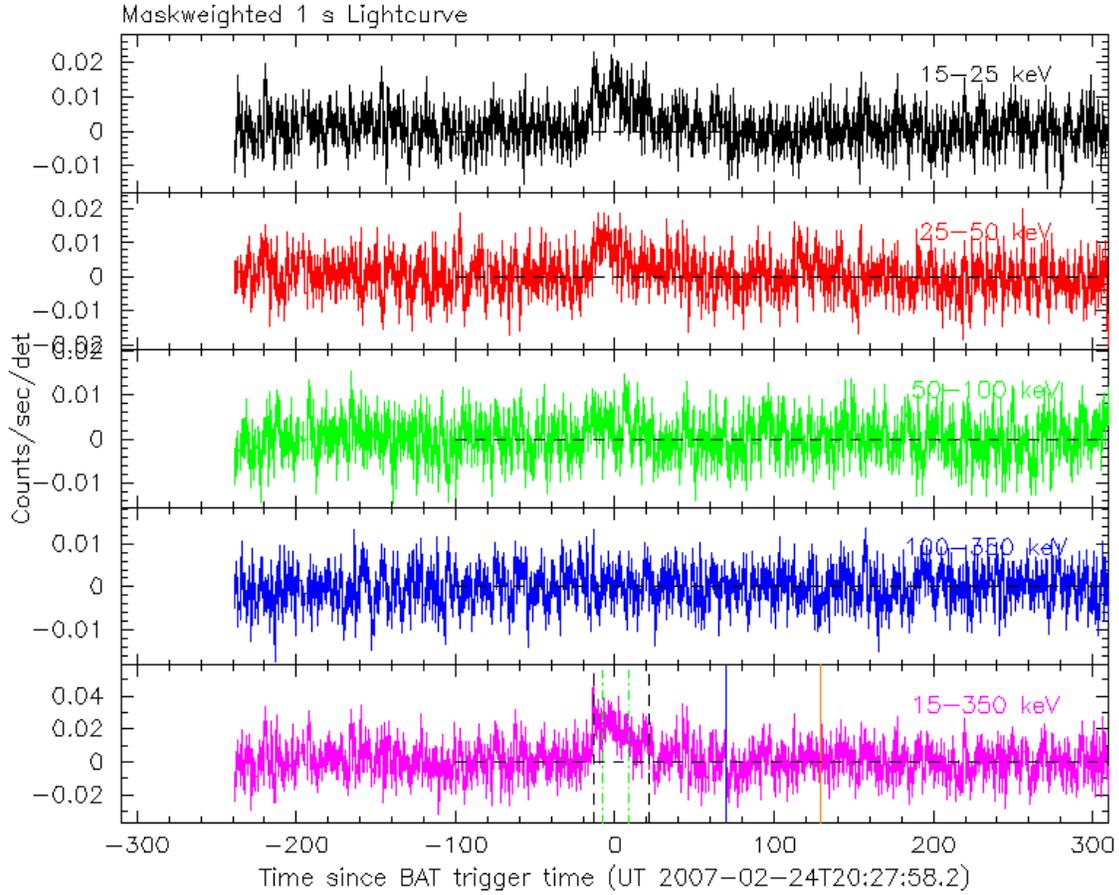
Maskweighted 1 s Lightcurve

Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T_0 is 20:27:58 UT.

$(\chi^2/dof = 0.71, dof = 16)$.

Assuming the break at 652 *sec*, the spectra before and after the break in the X-ray light curve can be modeled by an absorbed power-law with spectral indices of $2.12^{+0.32}_{-0.15}$ (simultaneous WT & PC mode fit), and $1.66^{+0.46}_{-0.39}$, respectively. The N_H column density is consistent with Galactic column density $(4.1 \times 10^{20} cm^{-2})$ in both cases. The average observed (unabsorbed) flux over $0.3 - 10\ keV$ is $3.2 \times 10^{-11}\ ergs/cm^2/sec$ $(3.2 \times 10^{-11}\ ergs/cm^2/sec)$ and $1.3 \times 10^{-13}\ ergs/cm^2/sec$ $(1.4 \times 10^{-13}\ ergs/cm^2/sec)$, respectively.

4   UVOT Observation and Analysis

The UVOT began observing the field of GRB 070224 132 sec after the initial BAT trigger (Racusin *et al.*, *GCN Circ.* 6137). No new sources were detected in any of the UVOT observations at the position of the NOT optical afterglow (Thoene *et al.*, *GCN Circ.* 6154). The 3-sigma upper limits for detecting a source are summarized in Table 1.
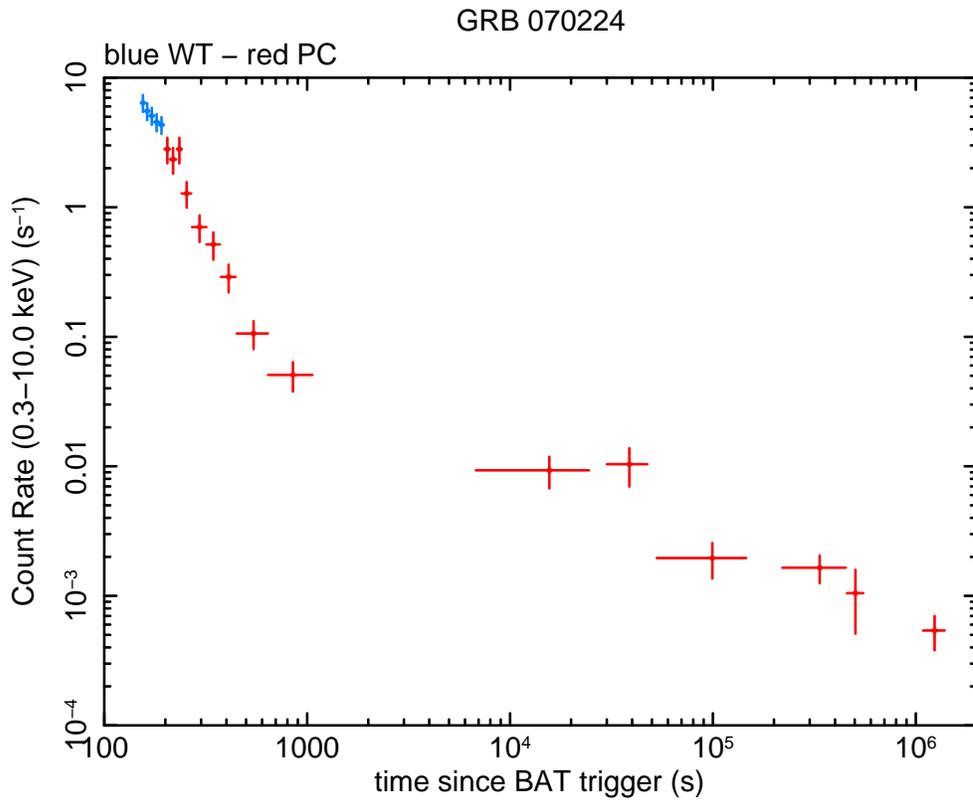
GRB 070224

Figure 2: XRT Light curve. Counts/sec in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is 1 count/sec $= \sim 4.8 \times 10^{-11} \ ergs/cm^2/sec$.

Filter	Start	Stop	Exposure	3-Sigma UL
V	35,712	126,303	1553	20.9
B	7159	128,636	1987	22.0
U	6954	93,932	1952	21.8
UVW1	6750	145,987	4321	22.1
UVM2	12,574	143,883	4621	22.5
UVW2	29,833	122,852	4358	22.5

Table 1: Magnitude limits from UVOT observations. The values quoted above are not corrected for the expected Galactic extinction corresponding to a reddening of $E_{B-V} = 0.06$ mag towards the direction of the burst (Schlegel et al. 1998).