

Swift Observation of GRB 110402A

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1 Introduction

BAT triggered (Trigger 450545) on GRB 110402A at 00:12:57 UT (Ukwatta et al., 2011). Swift slewed to the burst ~ 9 minutes after the trigger due to earth limb constraint. This was a 11.87σ image-trigger on a burst with $T_{90} = 60.9 \pm 6.9$ sec. The XRT began observing the field at 00:22:01.5 UT, 544.3 seconds after the BAT trigger. XRT found a fading, uncatalogued X-ray source. Our best position is the enhanced XRT location at $RA(J2000) = 197.40226$ deg (13h 09m 36.54s), $Dec(J2000) = +61.25285$ deg (+61d 15' 10.3'') with an uncertainty of 2.0 arcsec (90% confidence, including boresight uncertainties), reported by Beardmore et al. (2011). The UVOT started settled observations at $\sim T + 548$ sec and detected a faint optical afterglow consistent with the XRT position. In addition, GRB 110402A was detected by KonusWind (Golenetskii et al., 2011) and also by the Fermi GBM (Bhat et al., 2011).

2 BAT Observation and Analysis

Using the data set from $T - 239$ to $T + 963$ sec, further analysis of BAT GRB 110402A has been performed by BAT team (Stamatikos et al., 2011). The BAT ground-calculated position is $RA(J2000) = 197.432$ deg (13h 09m 43.7s), $Dec(J2000) = 61.247$ deg (+61d 14' 49.6'') ± 1.7 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 10% (the bore sight angle was 48.1 deg).

The mask-weighted light curve (Fig. 1) shows 5 spikes (each with a duration less than 0.5 sec) with the first at $\sim T + 1.5$ sec and the last at $\sim T + 6$ sec. These are followed by softer emission out to $\sim T + 90$ sec. T_{90} (15-350 keV) is 60.9 ± 6.9 sec (estimated error including systematics).

The spectral lag analysis of the BAT data from $T+0.8$ sec to $T+6.0$ sec (the initial 5 spikes), yields a lag of $3.7_{-2.9}^{+2.5}$ msec for the 25-50 to 100-300 keV bands using a lightcurve binning of 4 msec. While the 5.2 sec duration for the 5 spikes is formally beyond the canonical 2-s boundary in duration for short bursts, the small lag value favors a short burst identification (Barthelmy et al., 2011).

The time-averaged spectrum from $T - 0.4$ to $T + 69.7$ sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.59 ± 0.17 . The fluence in the 15 – 150 keV band is $3.4 \pm 0.4 \times 10^{-6}$ erg cm^{-2} . The 1-sec peak photon flux measured from $T + 3.18$ sec in the 15 – 150 keV band is 4.1 ± 0.7 ph cm^{-2} sec. All the quoted errors are at the 90% confidence level.

The results of the batgrbproduct analysis are available at http://gcn.gsfc.nasa.gov/notices_s/450545/BA/.

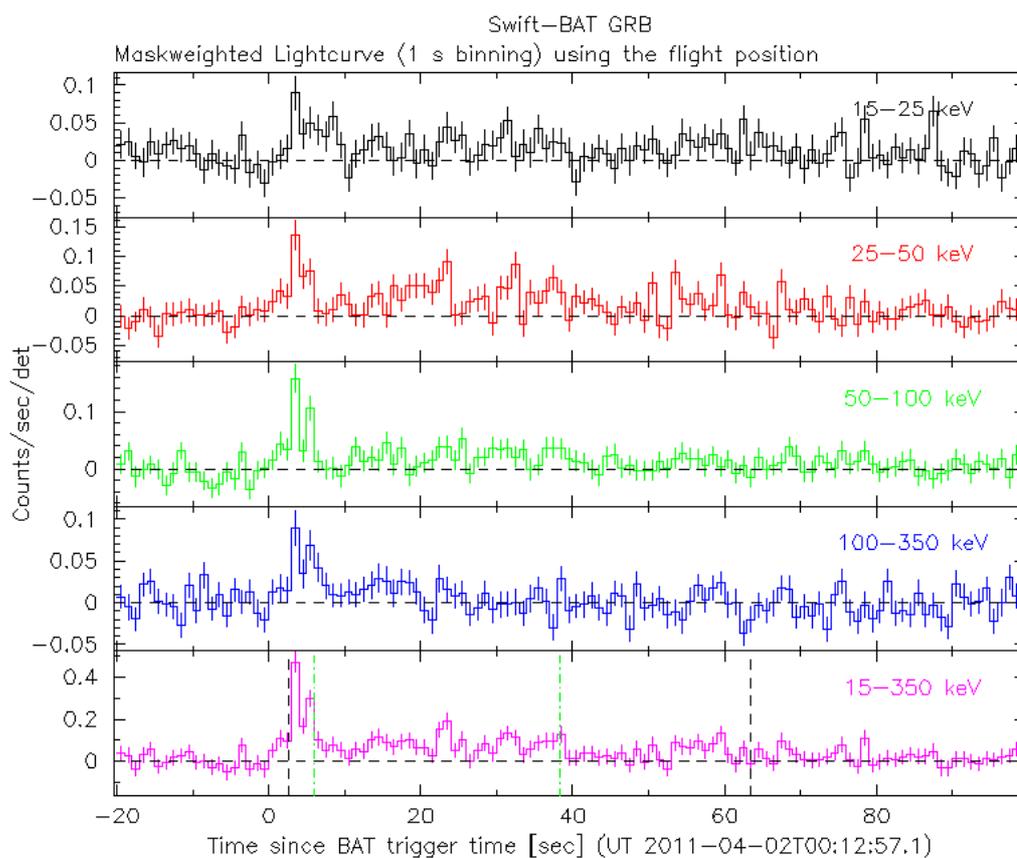


Figure 1: The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T_0 is 00:12:57 UT.

3 XRT Observations and Analysis

XRT data were collected from $T + 552$ s to $T + 24.7$ ks. The data are entirely in Photon Counting (PC) mode. The best position of the X-ray afterglow is the enhanced XRT position (Beardmore et al., 2011)

RA(J2000) = 13h 09m 36.54s

Dec(J2000) = +61d 15' 10.3"

with an uncertainty of 2.0 arcsec (radius, 90% confidence).

The late-time light curve (from $T+6.4$ ks) can be modelled with a power-law decay with a decay index of $\alpha = 1.3 \pm 0.4$.

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of $2.31^{+0.25}_{-0.27}$. The best-fitting absorption column is $10.0^{+2.9}_{-5.6} \times 10^{20} \text{ cm}^{-2}$, in excess of the Galactic value of $1.6 \times 10^{20} \text{ cm}^{-2}$ (Kalberla et al., 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is $3.3 \times 10^{-11} (4.8 \times 10^{-11}) \text{ erg cm}^{-2} \text{ count}^{-1}$.

A summary of the PC-mode spectrum is given below.

Total column: $10.0^{+2.9}_{-5.6} \times 10^{20} \text{ cm}^{-2}$

Galactic foreground: $1.6 \times 10^{20} \text{ cm}^{-2}$

Excess significance: 2.9σ

Photon index: $2.31^{+0.25}_{-0.27}$

The results of the XRT-team automatic analysis are available at http://www.swift.ac.uk/xrt_products/00450545.

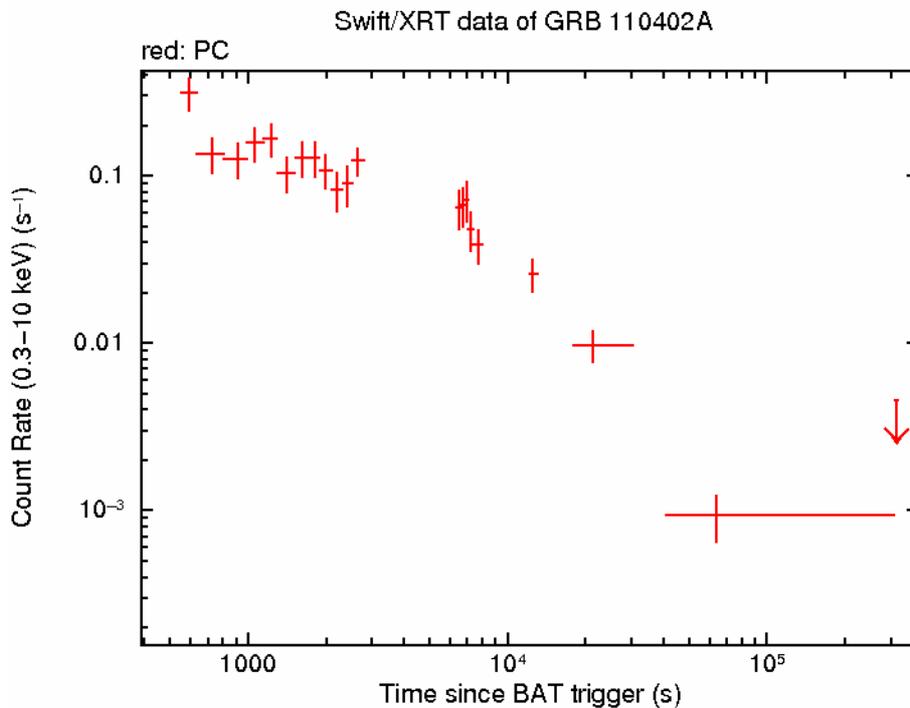


Figure 2: XRT Lightcurve. Count rate in the 0.3 – 10 keV band is plotted with Photon Counting (PC) mode data. The approximate conversion is 1 count/sec = $\sim 3.3 \times 10^{-11} \text{ ergs/cm}^2/\text{sec}$.

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 110402A, 548 seconds after the BAT trigger (Swenson et al., 2011). We detect a faint new source consistent with the enhanced Swift XRT position.

Preliminary magnitudes and 3-sigma upper limits using the UVOT photometric system Poole et al. (2008) for the first finding chart (FC) exposure and subsequent exposures are:

Filter	Tstart (s)	Tstop (s)	Exposure (s)	Magnitude
white (FC)	548	698	147	> 20.5
white	548	24657	1628	20.89 ± 0.11
v	704	18897	510	> 20.1
b	803	24593	1544	20.84 ± 0.20
u	778	30417	430	> 20.6
w1	754	30390	1296	20.39 ± 0.22
m2	7176	7376	197	> 19.7
w2	6767	18791	1112	20.29 ± 0.20

Table 1: Magnitudes and limits from UVOT observations

The values quoted above are not corrected for the Galactic extinction due to the reddening of $E(B-V) = 0.02$ in the direction of the burst (Schlegel et al., 1998).

References

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