

Swift Observations of GRB 101224A

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1 Introduction

BAT triggered on GRB 101224A at 05:27:13 UT (Trigger 440955) (Krimm *et al.*, *GCN Circ.* 11484). This was an 256-msec rate-trigger on a short, hard burst with $T_{90} = 0.2 \pm 0.01$ sec. Swift slewed immediately to the burst. The best position is the XRT enhanced position (Page *et al.*, *GCN Circ.* 11485): RA($J2000$) = 285.92460° (19h 03m 41.91s), Dec($J2000$) = +45.71350° (+45°42'48".5) with an error of 3.2 arcsec (radius, systematic plus statistical, 90% containment).

The prompt emission from GRB 101224A was also detected by *Fermi*/GBM (McBreen, *GCN Circ.* 11489).

Optical identification of a possible host galaxy was made from images taken before and after the burst. Nugent & Bloom (*GCN Circ.* 11491) report a faint ($R = 20.5 \pm 0.2$ mag) object within the XRT error circle from 49 co-added archival images from the DeepSky* project at Palomar Observatory. Based on Nordic Optical Telescope (NOT) observations taken 15.4316 hr after the BAT trigger, Xu, Ilyin & Fynbo (*GCN Circ.* 11492) detect the DeepSky* object and report that it is extended along the North-South axis to a considerable extent.

2 BAT Observation and Analysis

Using the data set from T-239 to T+963 sec, further analysis of GRB 101224A was performed by the Swift/BAT team (Markwardt *et al.*, *GCN Circ.* 11486). The partial coding was 53%. The mask-weighted light curve (Figure ??) consists of a pair of overlapping peaks of total duration 0.2 sec. T_{90} (15-350 keV) is 0.2 ± 0.01 s (estimated error including systematics).

The time-averaged spectrum from T+0.0 to T+0.3 sec is best fit by a power law with an exponential cutoff. This fit gives a photon index -0.93 ± 1.52 , and E_{peak} of 95.7 ± 35.2 keV ($\chi^2 = 62.87$ for 56 d.o.f.). For this model the total fluence in the 15-150 keV band is $5.8 \pm 1.1 \times 10^{-8}$ erg cm⁻² and the 1-sec peak flux measured from T-0.34 sec in the 15-150 keV band is 0.7 ± 0.2 ph cm⁻² s⁻¹. A fit to a simple power law gives a photon index of 1.05 ± 0.26 ($\chi^2 = 71.61$ for 57 d.o.f.). All the quoted errors are at the 90% confidence level.

The hardness ratio S(50-100 keV)/S(25-50 keV) is 1.94, which when plotted against burst duration, places GRB 101224A among the short-hard bursts in the distribution.

3 XRT Observations and Analysis

The XRT results (Pagani & Krimm, *GCN Circ.* 11488) are based on 7.6 ks of XRT data for GRB 101224A from 86 s to 24.5 ks after the BAT trigger. The data are entirely in Photon Counting (PC) mode. The afterglow is detected during the first orbit with 12 background subtracted source counts in 1.3 ks of PC data, at a count rate of 1.0×10^{-2} count s⁻¹ (see Figure ??). However no source is detected in the following orbits (1 background subtracted source count in 6.3 ks of PC data), for a 3σ upper limit of 1.4×10^{-3} count s⁻¹.

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of 3.1 ± 1.4 . The best-fitting absorption column is $1.1_{-0.6}^{+3.5} \times 10^{21}$ cm⁻², consistent with the Galactic value of 4.4×10^{20} cm⁻² (Kalberla *et al.*, 2005). The counts to observed

(unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is $2.9 \times 10^{-11} (5.1 \times 10^{-11}) \text{ erg cm}^{-2} \text{ count}^{-1}$.

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 101224A 83 s after the BAT trigger (Landsman, *GCN Circ.* 11490). No optical afterglow consistent with the refined XRT position is detected in the initial UVOT exposures. Preliminary 3σ upper limits using the UVOT photometric system (Poole *et al.*, 2008, *MNRAS*, **383**, 627) for the first finding chart (FC) exposures and subsequent exposures are:

Filter	Start	Stop	Exposure (s)	Magnitude
white (FC)	83	233	147	> 20.8
white	83	7201	659	> 21.9
u (FC)	296	546	246	> 19.6
u	296	23977	1583	> 20.8
v	628	12647	1173	> 20.2
b	551	24555	1030	> 21.4
w1	677	30339	1644	> 20.8
m2	652	30016	2569	> 20.8
w2	601	11734	1179	> 20.7

Table 1: Magnitude limits from UVOT observations.

The values quoted above have not been corrected for the Galactic extinction due to the reddening of $E_{B-V} = 0.05$ mag in the direction of the burst (Schlegel *et al.*, 1998, *ApJ Suppl.* **500**, 525).

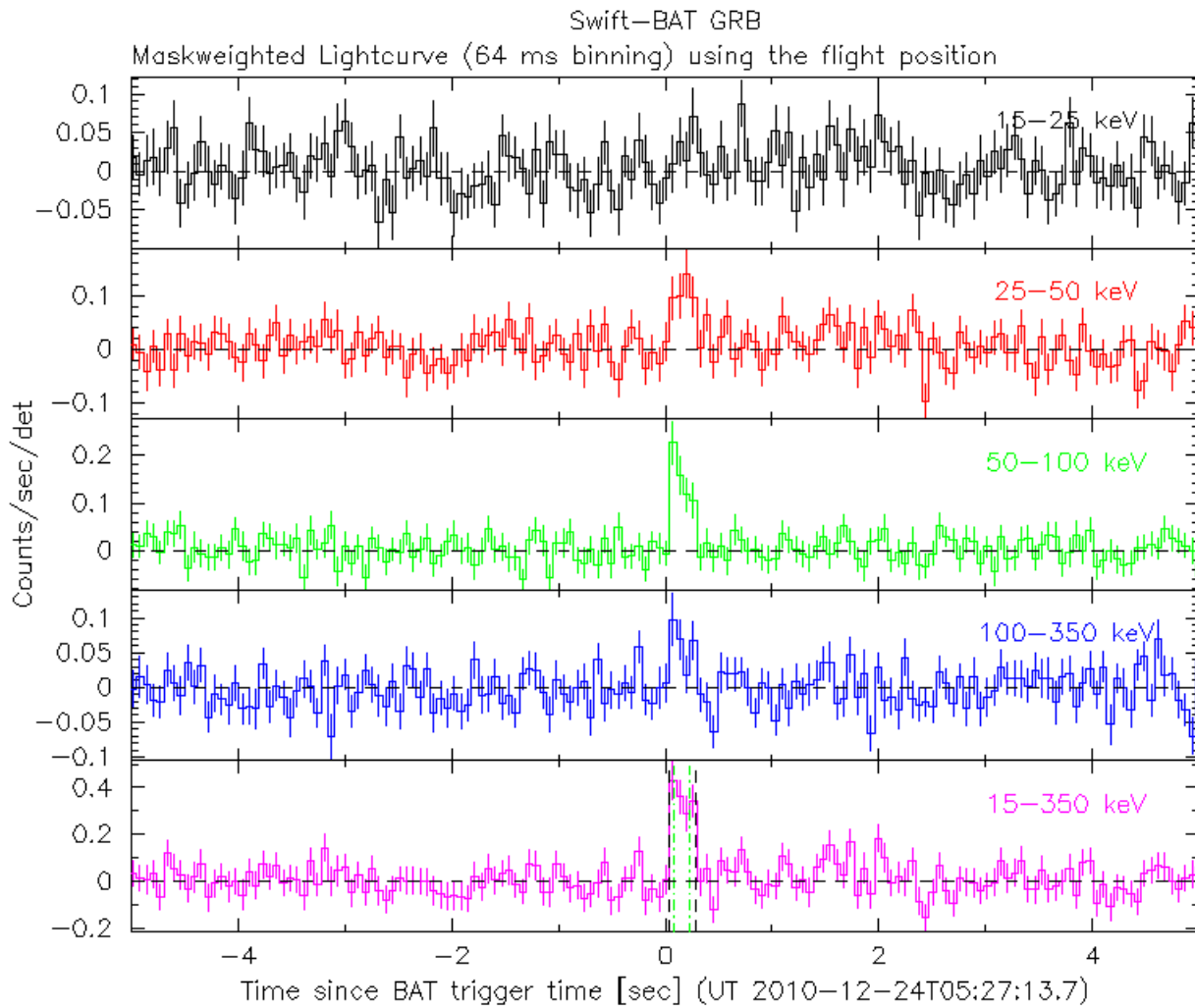


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det = 0.16 cm^2).

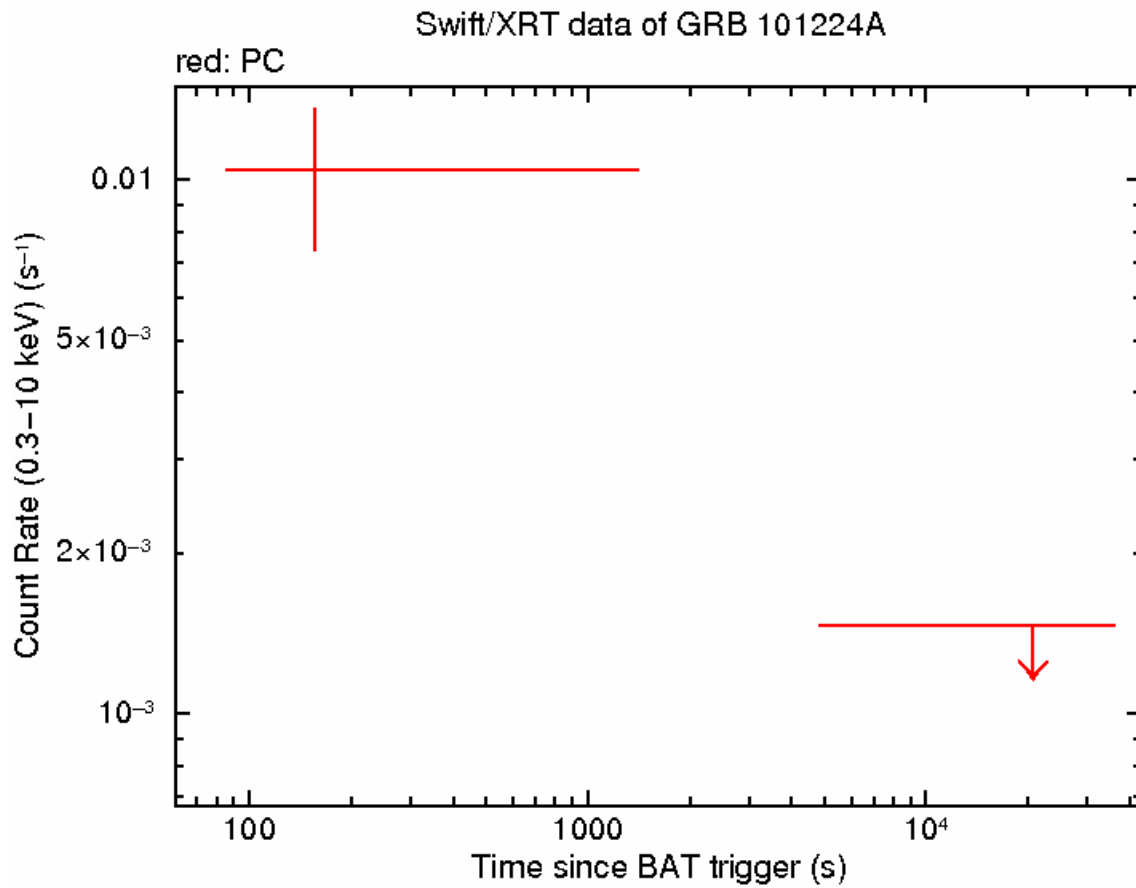


Figure 2: XRT light-curve. Counts s^{-1} in the 0.3-10 keV band for the Photon Counting mode (red). The approximate conversion of the 0.3 – 10 keV observed flux is $1 \text{ count } s^{-1} \sim 2.9 \times 10^{-11} \text{ erg } cm^{-2} s^{-1}$.