

Swift Observations of GRB 100425A

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1 Introduction

At 02:50:45 UT on 2010-04-25, the Swift Burst Alert Telescope (BAT) triggered and located GRB 100425A (trigger=420398). Swift slewed immediately to the burst and found an X-ray counterpart of the burst in the XRT (Grupe et al., *GCN Circ.* 10673)

The best *Swift* position of this burst is the XRT position given in Goad et al. (*GCN Circ.* 10686) with RA-2000 = 19h 56m 47.16s, and Dec-2000 = $-26^{\circ} 25' 50.5''$ with an uncertainty of $1.5''$.

The optical afterglow had several ground-based follow-up observations by GROND and VLT/X-shooter (Olivares et al., *GCN Circ.* 10683; Malesani et al., *GCN Circ.* 10680) who also reported a redshift of $z=1.755$ (Goldini et al., *GCN Circ.* 10684).

2 BAT Observation and Analysis

At 02:50:45 UT on 2010-04-25, the Swift Burst Alert Telescope (BAT) triggered and located GRB 100425A (trigger=420398, Grupe et al., *GCN Circ.* 10673). Using the data set from T-61 to T+242 s, the BAT ground-calculated position is RA, Dec = 299.161, -26.463 deg which is

$$\text{RA(J2000)} = 19\text{h } 56\text{m } 38.7\text{s}$$

$$\text{Dec(J2000)} = -26^{\circ} 27' 47.5''$$

with an uncertainty of 2.4 arcmin, (radius, sys+stat, 90% containment). The partial coding was 48% (Markwardt et al. *GCN Circ.* 10685).

The mask-weighted light curve (Figure 1) shows three peaks. The first, precursor peak at T-45 s, then the mean peak at T-2 s to T+10 s, and the third peak at T+35 s to T+65 s. T_{90} (15-350 keV) is 37.0 ± 2.4 s (estimated error including systematics).

The time-averaged spectrum from T-2.1 to T+39.4 s is best fit by a single power law model. The power law index of the time-averaged spectrum is 2.42 ± 0.32 ($\chi^2 = 57$ for 57 d.o.f.). For this model the total fluence in the 15-150 keV band is $4.7 \pm 0.9 \times 10^{-7}$ ergs cm^{-2} . The 1s peak photon flux measured from T+0.27 s in the 15-150 keV band is 1.4 ± 0.2 photons $\text{s}^{-1} \text{cm}^{-2}$. 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/420398/BA/

3 XRT Observations and Analysis

The XRT began observing the field of GRB 100425A at 02:50:03.9 UT, 78.8 seconds after the BAT trigger. Using 5331 s of XRT Photon Counting mode data and 8 UVOT images for GRB 100425A, Goad et al. (*GCN Circ.* 10686) found an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): RA, Dec = 299.19651, -26.43069 which is equivalent to:

RA (J2000): 19h 56m 47.16s

Dec (J2000): $-26^{\circ} 25' 50.5''$

with an uncertainty of $1.5''$ (radius, 90% confidence). The latest position can be viewed at http://www.swift.ac.uk/xrt_positions. Position enhancement is described by Goad et al. (2007, *A&A*, 476, 1401) and Evans et al. (2009, *MNRAS*, 397, 1177).

A spectrum formed from the WT mode data (106s exposure) can be fitted with an absorbed single power-law model with a photon spectral index of 4.00 ± 0.15 (Grupe, *GCN Circ.* 10691). The absorption column density at a redshift of $z=1.755$ is $1.49_{-0.17}^{+0.18} \times 10^{22} \text{ cm}^{-2}$, in addition to the Galactic value of $8.6 \times 10^{20} \text{ cm}^{-2}$ (Kalberla et al. 2005). The PC mode spectrum has a photon spectral index of 2.30 ± 0.13 and a best-fit absorption column density consistent with the Galactic value. Based on the PC mode spectrum, the counts to observed (unabsorbed) 0.3-10 keV flux conversion factor is 3.8×10^{-11} (5.2×10^{-11}) $\text{ergs cm}^{-2} \text{ counts}^{-1}$.

The 0.3 – 10 keV light curve given below (Fig.2) displays a standard X-ray light curve (Nousek et al. 2006, Zhang et al. 2006). The X-ray afterglow light curve can be modeled with a multiple broken power-law model with the following decay slopes and break times:

$$\alpha_1 = 5.46 \pm 0.30$$

$$T_{\text{break1}} = 325_{-15}^{+22} \text{ s}$$

$$\alpha_2 = 0.55_{-0.05}^{+0.06}$$

$$T_{\text{break2}} = 45.6_{-35.2}^{+18.1} \text{ ks}$$

$$\alpha_3 = 1.26_{-0.18}^{+0.33}$$

4 UVOT analysis

The Swift/UVOT began settled observations of the field of GRB 100425A 88 s after the BAT trigger (Grupe et al., *GCN Circ.* 10673) with the finding chart in white filter. Oates & Grupe (*GCN Circ.* 10689) reported that no optical afterglow was detected within the enhanced XRT error circle position (Goad et al., *GCN Circ.* 10686), at the location of source B detected by the VLT (Malesani et al., *GCN Circ.* 10680) and GROND (Olivares et al., *GCN Circ.* 10683). The photometry is complicated by the presence of the VLT source A within the source aperture.

3σ upper limits for the summed images are listed in Table 1.

Filter	T_{Start}	T_{stop}	Exposure	Mag
white (FC)	88	238	147	>19.37
white	88	5778	513	>19.59
u (FC)	301	551	246	>18.92
u	301	6796	650	>19.08
v	631	11961	1317	>19.76
b	556	5573	236	>19.71
uvw1	680	6600	432	>19.44
uvm2	4757	12580	997	>20.87
uvw2	606	11048	1318	>21.26

Table 1: Magnitudes from UVOT observations of GRB 100425A. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight of $E_{\text{B-V}} = 0.15$ mag. All photometry is on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

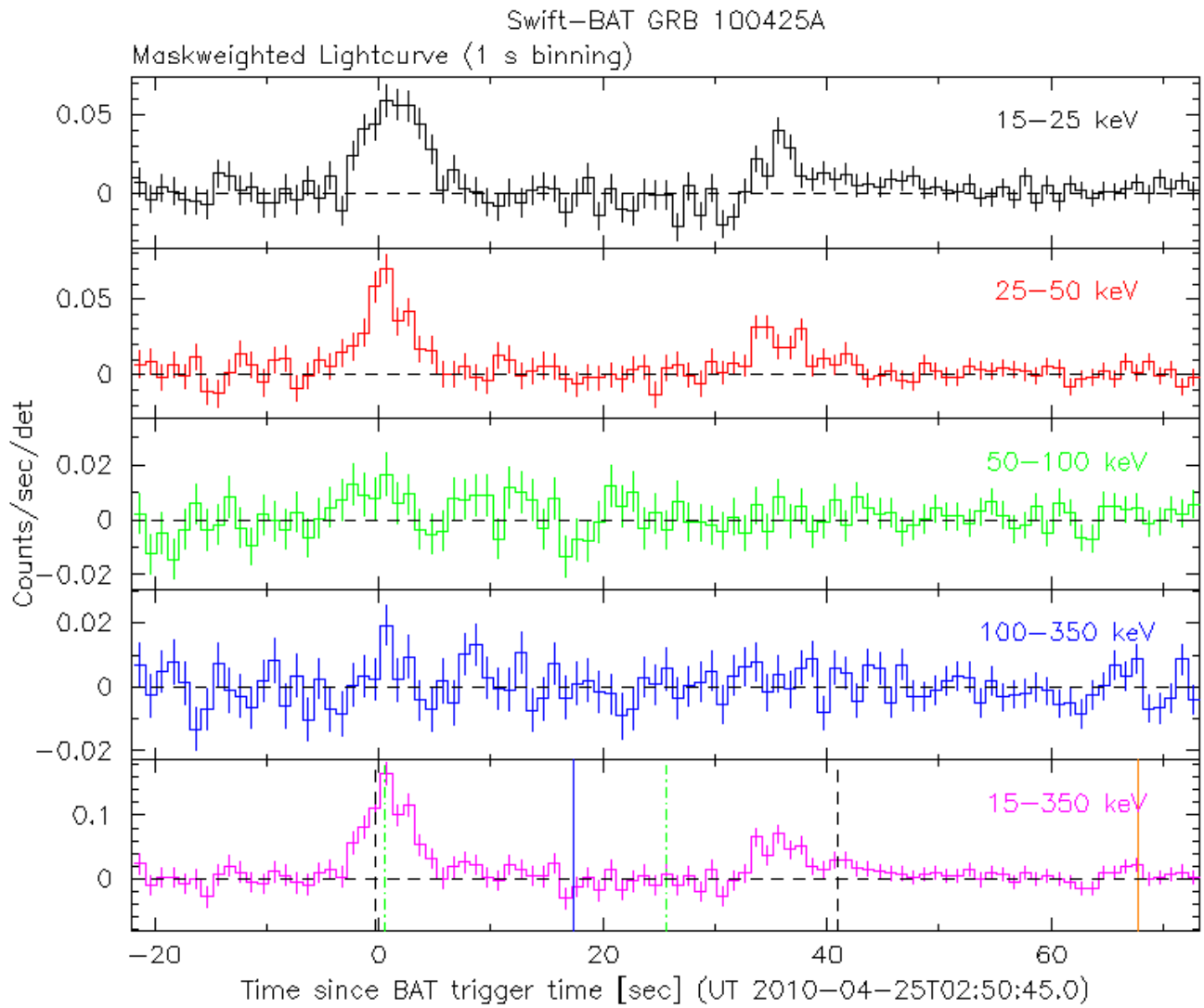


Figure 1: BAT Light curve of GRB 100425A.

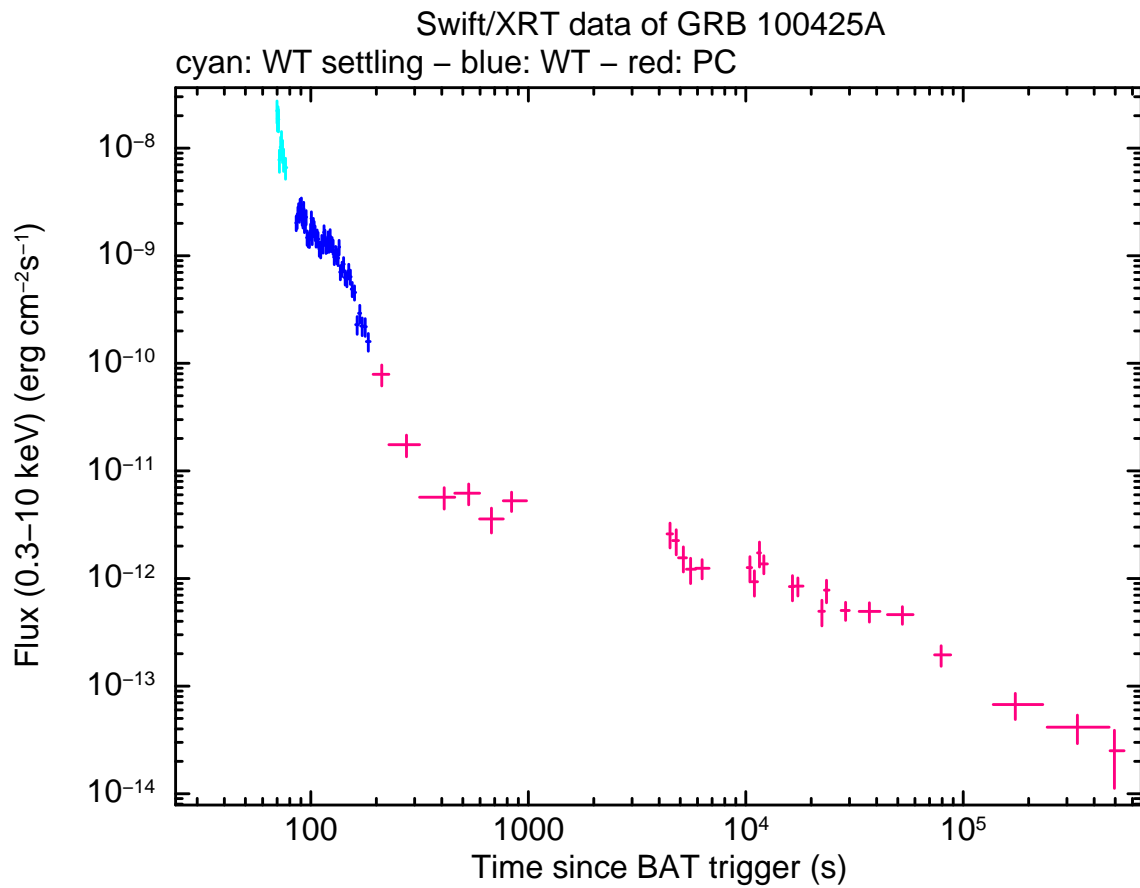


Figure 2: XRT flux light curve of GRB 100425A in the 0.3–10 keV band. The approximate conversion is $1 \text{ count s}^{-1} = \sim 3.8 \times 10^{-11} \text{ ergs s}^{-1} \text{ cm}^{-2}$.