

## Swift Observation of GRB 110213A

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### 1 Introduction

At 05:17:29 UT, the Swift Burst Alert Telescope (BAT) triggered and located the long GRB 110213A (trigger=445414, D'Elia et al., GCN Circ. 11705). The BAT light curve shows a steep rise followed by a slow decline out to T+30 s.

Swift slewed immediately, and the narrow field instruments were on target 92 seconds later. The X-ray telescope XRT detected a bright X-ray afterglow. The enhanced Swift/XRT position RA (J2000)=  $02^h 51^m 51.37^s$  and Dec (J2000)=  $+49^d 16' 21.2''$  with an uncertainty of 1.5 arcsec (radius, 90% confidence) was given by Osborne *et al.* (GCN Circ. 11712). UVOT began settled observations of the field 100 s after the BAT trigger showing an initial flux peak around T+300s after which the GRB declines in brightness until around T+1500s when a small rebrightening occurs.

Several detections from ground-based facilities have been reported. A tentative redshift was reported by P.A. Milne (GCN Circ. No 11708) of  $z=1.46$ .

This burst triggered also Konus-Wind, showing an emission detected up to  $\sim 2$  MeV (Golenetskii et al. GCN Circ. No 11723), and the Fermi Gamma-ray Burst Monitor (Foley et al. GCN Circ. No 11727).

### 2 BAT Observation and Analysis

Using the data set from T-239 s to T+963 s from prompt telemetry downlink (Barthelmy et al. GCN Circ. No 11714), the BAT ground-calculated position is RA, Dec = 42.978, 49.278 deg which is RA(J2000) =  $02^h 51^m 54.8^s$  and Dec(J2000) =  $+49^d 16' 41.4''$  with an uncertainty of 1.4 arcmin, (radius, sys+stat, 90% containment). The partial coding was 5%. The masked-tagged light curve shows low-level emission starting at about T-30 s and then a steep rise starting at T-3 s to a peak at T+0.5 s, followed by a slow decline out to about T+30 s (Fig. 1).  $T_{90}$  (15-350 keV) is  $48.0 \pm 16.0$  s (estimated error including systematics). The time-averaged spectrum from T-31.2 to T+32.8 s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $1.83 \pm 0.12$ . The fluence in the 15-150 keV band is  $(5.9 \pm 0.4) \times 10^{-6}$  erg  $\text{cm}^{-2}$ . The 1-sec peak photon flux measured from T+8.31 s in the 15-150 keV band is  $(1.6 \pm 0.6)$  ph  $\text{cm}^{-2}$   $\text{s}^{-1}$ . 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/445414/BA/>

### 3 XRT Observations and Analysis

The data comprise 121 s in Windowed Timing (WT) mode (the first 8 s were taken while Swift was slewing) with the remainder in Photon Counting (PC) mode. The enhanced XRT position for this burst was given by Osborne et al. (GCN. Circ 11712). From 81 s to 54.5 ks after the BAT trigger, the light curve can be modelled with a series of power-laws (Stratta et al. GCN Circ. No 11721). The initial decay index is  $\alpha_1 = 5.2^{+0.5}_{-0.4}$ . At T+141 s the decay flattens to an  $\alpha_2$  of  $-0.22^{+0.10}_{-0.14}$ . The light curve breaks again at T+1489 s to a decay with  $\alpha_3 = 1.10^{+0.07}_{-0.08}$ , before a final break at T+9954 s after which the decay index is  $\alpha_4 = 2.14^{+0.10}_{-0.09}$ . A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of  $(2.11 \pm 0.07)$ . The best-fitting absorption

column is  $(2.81_{-0.23}^{+0.24}) \times 10^{21} \text{ cm}^{-2}$ , in excess of the Galactic value of  $2.2 \times 10^{21} \text{ cm}^{-2}$  (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is  $4.1 \times 10^{-11}$  ( $6.8 \times 10^{-11}$ )  $\text{erg cm}^{-2} \text{ count}^{-1}$ .

Detailed light curves in both count rate and flux units are available in both graphical and ASCII formats at [http://www.swift.ac.uk/xrt\\_curves/00445414](http://www.swift.ac.uk/xrt_curves/00445414).

## 4 UVOT Observation and Analysis

The Swift/UVOT began settled observations 100 s after the BAT trigger (Kuin & D’Elia GCN Circ. No 11718). UVOT data show an initial peak around T+300 s after which the GRB declines in brightness until around T+1500 s when a small rebrightening occurs. Detailed UVOT light curve is available at [http://gcn.gsfc.nasa.gov/swift\\_gnd\\_ana.html](http://gcn.gsfc.nasa.gov/swift_gnd_ana.html). A tentative redshift was reported by P.A. Milne (GCN Circ. No 11708) of  $z=1.46$ , which is consistent with the much fainter magnitudes found in the uvm2 and uvw2 UVOT filters. The refined UVOT position (90% confidence limit,  $0.5''$  accuracy) with reference to USNO-B1 is RA (J2000) =  $02^h 51^m 51.39^s$  and DEC (J2000) =  $49^d 16' 23.54''$ . Preliminary magnitudes in the UVOT photometric system (Poole et al. 2008, MNRAS, 383, 627) for the first finding chart (FC) exposures and summed with subsequent exposures up to about 2500s are reported in Table 1. The quoted values are not corrected for the Galactic extinction due to the reddening of  $E(B-V) = 0.32$  in the direction of the burst (Schlegel et al. 1998). All photometry is on the UVOT photometry system described in Poole et al. (2008, MNRAS, 383, 627).

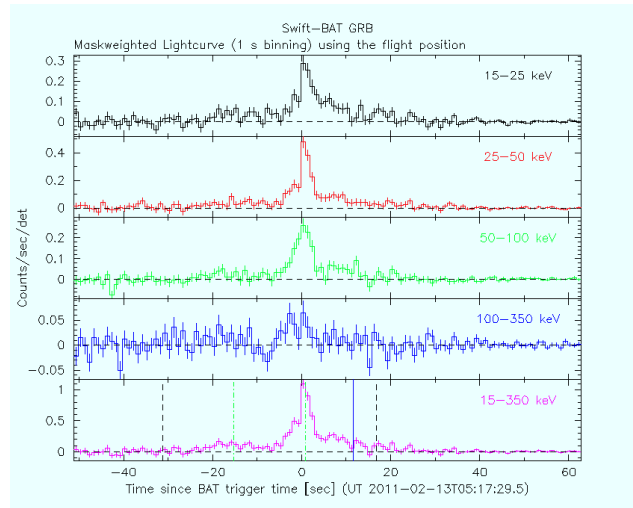


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts  $\text{s}^{-1} \text{ illuminated-detector}^{-1}$  (note illum-det =  $0.16 \text{ cm}^2$ ) and the time is in seconds from trigger.

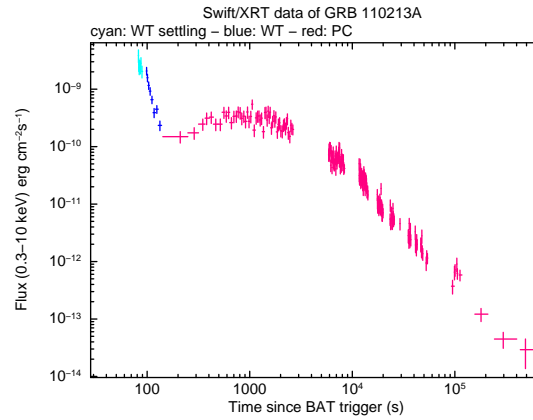


Figure 2: XRT Lightcurve. Counts  $s^{-1}$  in the 0.3-10 keV band: Window Timing mode (cyan for settling and blue for settled observations), Photon Counting mode (red). The approximate conversion to observed (unabsorbed) flux is  $1 \text{ count } s^{-1} \sim 4.1(6.7) \times 10^{-11} \text{ erg cm}^{-2} s^{-1}$ .

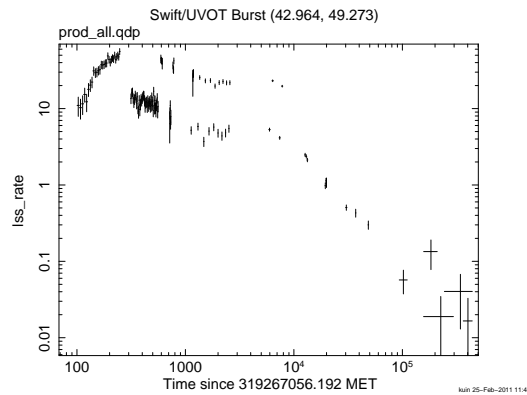


Figure 3: UVOT Lightcurve. Count rate in the white and u band versus time from trigger.

Filter	T_start (s)	T_stop (s)	Exp (s)	mag (Vega)
white_FC	100	250	147	$16.36 \pm 0.05$
u_FC	312	562	246	$15.54 \pm 0.04$
white	100	2579	517	$16.57 \pm 0.01$
v	642	2455	227	$16.19 \pm 0.04$
b	568	2206	178	$16.77 \pm 0.03$
u	312	2529	448	$15.94 \pm 0.02$
uvw1	692	2505	198	$17.28 \pm 0.08$
uvm2	667	2479	218	$18.72 \pm 0.20$
uvw2	618	2606	238	$19.10 \pm 0.18$

Table 1: Magnitude from UVOT observations.