

Swift Observation of GRB 130608A

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1 Introduction

BAT triggered on GRB 130608A at 23:14:21 UT (Trigger 557771) (Krimm *et al.*, *GCN Circ.* 14827). This was a 64.0-sec image trigger on a long burst with $T_{90} = 151.4$ sec. Swift slewed to this burst immediately and XRT began follow-up observations at $T + 161.6$ sec, and UVOT at $T + 168$ sec. Our best position is the XRT location RA(J2000) = $24^{\circ}.61111$ (01h 38m 26.67s), Dec(J2000) = $+41^{\circ}.50289$ ($+41^{\circ} 30' 10''.4$) with an error of 1.7 arcsec (90% confidence, including boresight uncertainties). No optical counterpart was detected, either by UVOT or by ground-based telescopes.

2 BAT Observation and Analysis

Using the data set from $T - 239$ to $T + 963$ sec, further analysis of BAT GRB 130608A has been performed by Swift team (Krimm, *et al.*, *GCN Circ.* 14833, *GCN Circ.* 14850). The BAT ground-calculated position is RA(J2000) = $24^{\circ}.597$ (01h 38m 23.3s), Dec(J2000) = $+41^{\circ}.492$ ($+41^{\circ} 29' 30''.5$) ± 2.5 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 45% (the bore sight angle was $41^{\circ}.18$).

The masked-weighted light curve (Fig. 1) shows a broad peak starting at $\sim T - 25$ sec, peaking at $\sim T + 5$ sec, and ending at $\sim T + 50$ sec. This was preceded by precursor emission from $\sim T - 150$ sec to $\sim T - 90$ sec. BAT did not trigger on this precursor because it occurred during a slew to the field containing the burst. $T_{90}(15 - 350$ keV) is 151.38 ± 10.84 (estimated error including systematics).

The time-averaged spectrum from $T - 134.19$ to $T + 22.20$ sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.71 ± 0.41 ($\chi^2 = 55.4$ for 57 d.o.f.). The fluence in the 15 – 150 keV band is $9.0 \pm 1.9 \times 10^{-7}$ erg cm $^{-2}$. The 1-sec peak photon flux measured from $T + 19.06$ sec in the 15 – 150 keV band is 0.6 ± 0.3 ph cm $^{-2}$ s $^{-1}$. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

Using the first 9.4 ksec of the XRT data of GRB 130608A (Beardmore, *et al.*, *GCN Circ.* 14832, Page *et al.*, *GCN Circ.* 14838), (98 s in Windowed Timing mode and the remainder in Photon Counting mode), the refined XRT position is RA(J2000) = $24^{\circ}.61111$ (01h 38m 26.67s), Dec(J2000) = $+41^{\circ}.50289$ ($+41^{\circ} 30' 10''.4$) with an error of 1.7 arcsec (90% confidence, including boresight uncertainties).

The 0.3 – 10 keV light curve can be modeled with an initial power-law decay with an index of $\alpha = 4.33$ ($+0.26, -0.23$), followed by a break at $T + 653$ s to an α of 0.40 ($+0.11, -0.12$).

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of 3.23 ($+0.27, -0.25$). The best-fitting absorption column is 1.0 ($+0.4, -0.3$) $\times 10^{21}$ cm $^{-2}$, in excess of the Galactic value of 6.6×10^{20} cm $^{-2}$ (Kalberla *et al.* 2005). The PC mode spectrum has a photon index of 2.40 ($+0.36, -0.11$) and a best-fitting absorption column consistent with the Galactic value. The counts to observed (unabsorbed) 0.3 – 10 keV flux conversion factor deduced from this spectrum is 3.0×10^{-11} (4.0×10^{-11}) erg cm $^{-2}$ count $^{-1}$.

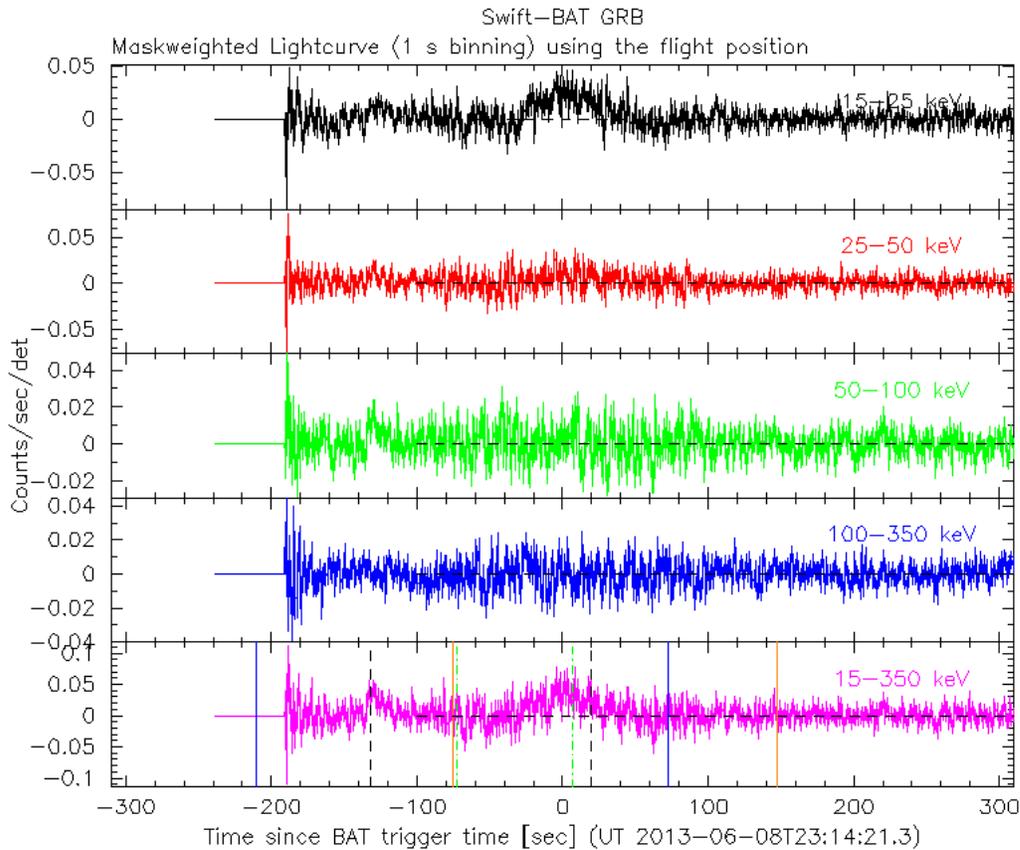


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det = 0.16 cm^2) and T_0 is 23:14:21.3 UT.

4 UVOT Observation and Analysis

The UVOT began observing the field of GRB 130608A starting 168 sec after the initial BAT trigger (Holland & Krimm, *GCN Circ.* 14870). No new source was detected within the XRT error circle in any exposures down to a 3σ magnitude limit. Upper limits are summarized in Table 1. These upper limits are not corrected for the expected extinction due to the Galactic reddening of $E(B-V) = 0.05$ mag (Schlafly et al. 2011, *ApJ*, 737, 103).

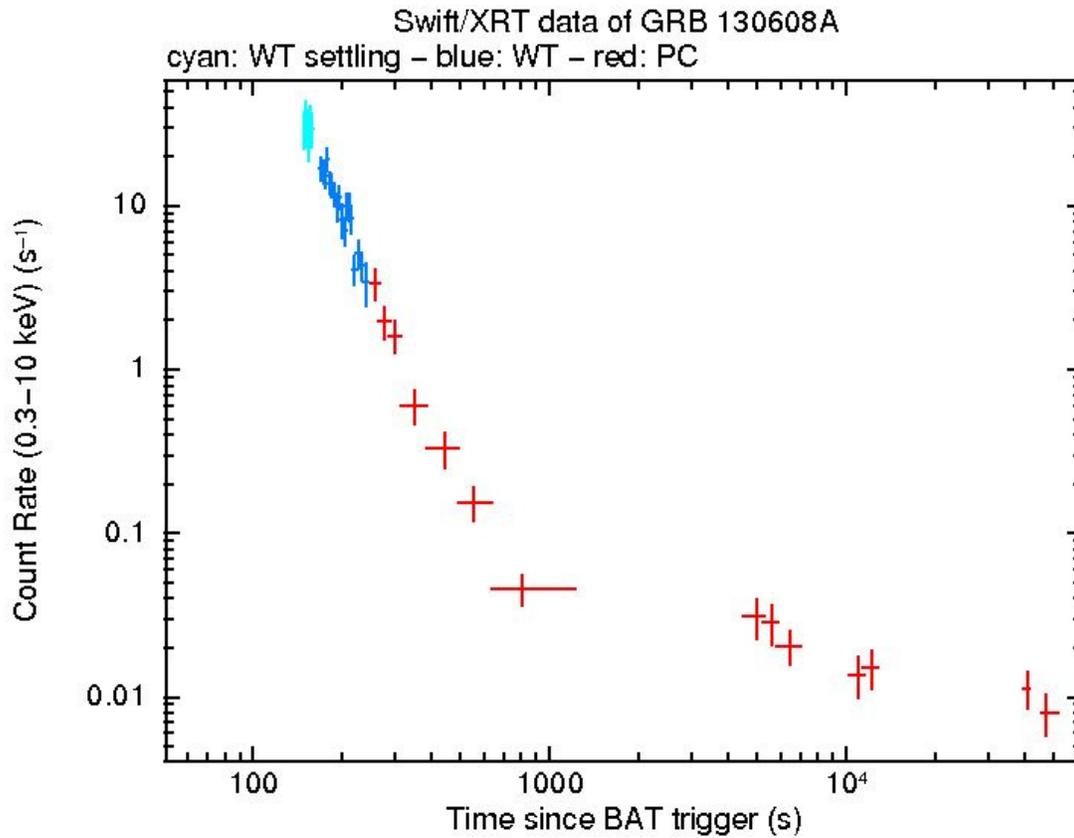


Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Settling mode (cyan), Window Timing mode (blue), Photon Counting mode (red).

Filter	Start	Stop	Exposure	3σ upper limit
WHITE (finding)	169	318	147	> 21.0
	607	626	19	> 19.6
u (finding)	327	576	246	> 20.1
	731	750	19	> 18.4
v	657	12,041	1154	> 20.6
b	583	6742	452	> 20.8
u	4899	6536	393	> 20.5
uvw1	706	6331	432	> 20.6
uvm2	681	12,759	1134	> 21.3
uvw2	632	11,127	1199	> 21.5
white	858	6946	560	> 21.5

Table 1: Magnitude limits from UVOT observations. The start and stop times are relative to the BAT trigger time.