Swift Observation of GRB 130408A

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1 Introduction

BAT triggered on GRB 130408A at 21:51:38 UT (Trigger 553132) (Lien, *et al.*, *GCN Circ.* 14361). This was a 4.096 sec rate-trigger on a long burst with $T_{90} = 28 \pm 13$ sec. Swift slewed to this burst immediately and XRT began follow-up observations at $T + 149.9$ sec, and UVOT at $T + 134$ sec. Our best position is the UVOT location: RA, Dec = 134.40540, –32.36081 deg, which is equivalent to:
RA (J2000): 08h 57m 37.30s
Dec (J2000): -32d 21' 38.9"
with an uncertainty of 0.5 arcsec (radius, 90% confidence).

The prompt emission also triggered the Konus-Wind (Golenetskii *et al.*, *GCN Circ.* 14368) and the Suzaku WAM (Takaki *et al.*, *GCN Circ.* 14376).

A redshift of $z = 3.76$ is determined by both the VLT/X-shooter (Hjorth *et al.*, *GCN Circ.* 14365) and the Gemini-S/GMOS (Tanvir *et al.*, *GCN Circ.* 14366).

The optical/NIR afterglow of the burst is also detected by Skynet Optical Observatory (Trotter *et al.*, *GCN Circ.* 14375) and the the ANDICAM instrument on the 1.3m telescope at CTIO (Cobb, B E., *GCN Circ.* 14374).

2 BAT Observation and Analysis

Using the data set from T-240 to T+960 sec from the recent telemetry downlink, further analysis of GRB 130408A has been performed by the BAT team (Baumgartner *et al.*, *GCN Circ.* 14373). The BAT ground-calculated position is RA, Dec = 134.398, -32.363 deg, which is
RA(J2000) = 08h 57m 35.5s
Dec(J2000) = -32d 21' 45.9"
with an uncertainty of 2.2 arcmin, (radius, sys+stat, 90% containment). The partial coding was 6%.

T90 (15-350 keV) is 28 ± 13 sec (estimated error including systematics). The mask weighted light curve (Fig. 1) has a main FRED-like component with a rise time of about 2 sec and decline of 5 sec, peaking at time T+1 sec, followed by a smaller peak at T+12 sec. There is possible low-level emission out to about T+33 sec.

The time-averaged spectrum from T-0.1 to T+33.5 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.28 ± 0.26. The fluence in the 15-150 keV band is $2.3 \pm 0.4 \times 10^{-6}$ erg cm^{-2}. The 1-sec peak photon flux measured from T+1.12 sec in the 15-150 keV band is 4.9 ± 1.0 ph cm^{-2} sec^{-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/553132/BA/`

3 XRT Observations and Analysis

The XRT team analyzed 6.2 ks of XRT data for GRB 130408A, from 134 s to 28.6 ks after the BAT trigger (D'Elia *et al.*, *GCN Circ.* 14369). The data comprise 28 s in Windowed Timing (WT) mode (the first 9 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 Beardmore *et al.* (*GCN Circ.* 14367): RA, Dec = 134.40543, -32.36089 deg, which is equivalent to:
RA (J2000): 08h 57m 37.30s
Dec (J2000): -32d 21' 39.2"
with an uncertainty of 1.7 arcsec (radius, 90% confidence).

Figure 2 shows the XRT light curve. The light curve can be modelled with a series of power-law decays. The initial decay index is alpha=0.39 (+0.06, -0.07). At T+3999 s the decay steepens to an alpha of 8.0 (+0.0, -3.0) before breaking again at T+4518 s to a final decay with index alpha=0.97 (+0.14, -0.15).

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of 2.00 (+0.08, -0.07). The best-fitting absorption column is consistent with the Galactic value of 2.0×10^{21} cm^{-2} (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 3.9×10^{-11} (5.6×10^{-11}) erg cm^{-2} count^{-1}.

A summary of the PC-mode spectrum is thus:
Galactic foreground: 2.0×10^{21} cm^{-2}
Intrinsic column: 0 (+4.9, -0) $\times 10^{21}$ cm^{-2} at z=3.758
Photon index: 2.00 (+0.08, -0.07)

The results of the XRT-team automatic analysis are available at
http://www.swift.ac.uk/xrt_products/00553132.

4   UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 130408A 134 s after the BAT trigger. A bright but rapidly fading source is detected in the initial exposures (Siegel and Lien, *GCN Circ.* 14363) with a position consistent with detections by Melandri *et al.*(*GCN Circ.* 14362), Sudilovsky *et al.*(*GCN Circ.* 14364) and Beardmore *et al.*(*GCN Circ.* 14367).

The preliminary UVOT position is:
RA(J2000) = 08:57:37.30 = 134.40540
DEC(J2000) = -32:21:38.9 = -32.36081
with a 90%-confidence error radius of about 0.5 arc sec.

Filter	T_start(s)	T_stop(s)	Exp(s)	Mag
white	156	305	147.4	16.80 ± 0.05
white	3708	3900	189.2	20.29 ± 0.22
white	6083	10367	924.3	21.99 ± 0.35
v	134	145	10.1	15.75 ± 0.15
v	4201	4400	196.7	19.61 ± 0.35
b	3503	6078	393.2	>20.84
u	313	5872	236.2	>20.55
uvw1	4611	4752	139.0	>19.82
uvm2	4405	4605	196.6	>19.75
uvw2	3996	21851	1748.0	>21.56

Table 1: Magnitude and limits from UVOT observations

Preliminary detections and 3-sigma upper limits using the UVOT photometric system (Breeveld *et al.* 2011, AIP Conf. Proc. 1358, 373) for the early and summed exposures are shown in Table 1.

The magnitudes in the table are not corrected for the Galactic extinction due to the reddening of E(B-V) = 0.258 in the direction of the burst (Schlegel *et al.* 1998).

Figure 3 and 4 show the UVOT light curve in optical and UV, respectively.

References

[1] Baumgartner et al., 2013, GCN Circ. 14373

[2] Beardmore et al., 2013, GCN Circ. 14367

[3] Breeveld, A. A., Landsman, W., Holland, S. T., et al. 2011, American Institute of Physics Conference Series, 1358, 373

[4] Cobb, B E., 2013, GCN Circ. 14374

[5] DElia et al., 2013, GCN Circ. 14369

[6] Golenetskii et al., 2013, GCN Circ. 14368

[7] Hjorth et al., 2013, GCN Circ. 14365

[8] Kalberla, P. M. W., Burton, W. B., Hartmann, D., et al. 2005, A&A, 440, 775

[9] Lien, et al., 2013, GCN Circ. 14361

[10] Melandri et al., 2013, GCN Circ., 14362

[11] Schlegel, D. J., Finkbeiner, D. P., & Davis, M. 1998, ApJ., 500, 525

[12] Siegel and Lien, 2013, GCN Circ. 14363

[13] Sudilovsky et al., 2013, GCN Circ. 14364

[14] Takaki et al., 2013, GCN Circ. 14376

[15] Tanvir et al., 2013, GCN Circ. 14366

[16] Trotter et al., 2013, GCN Circ. 14375
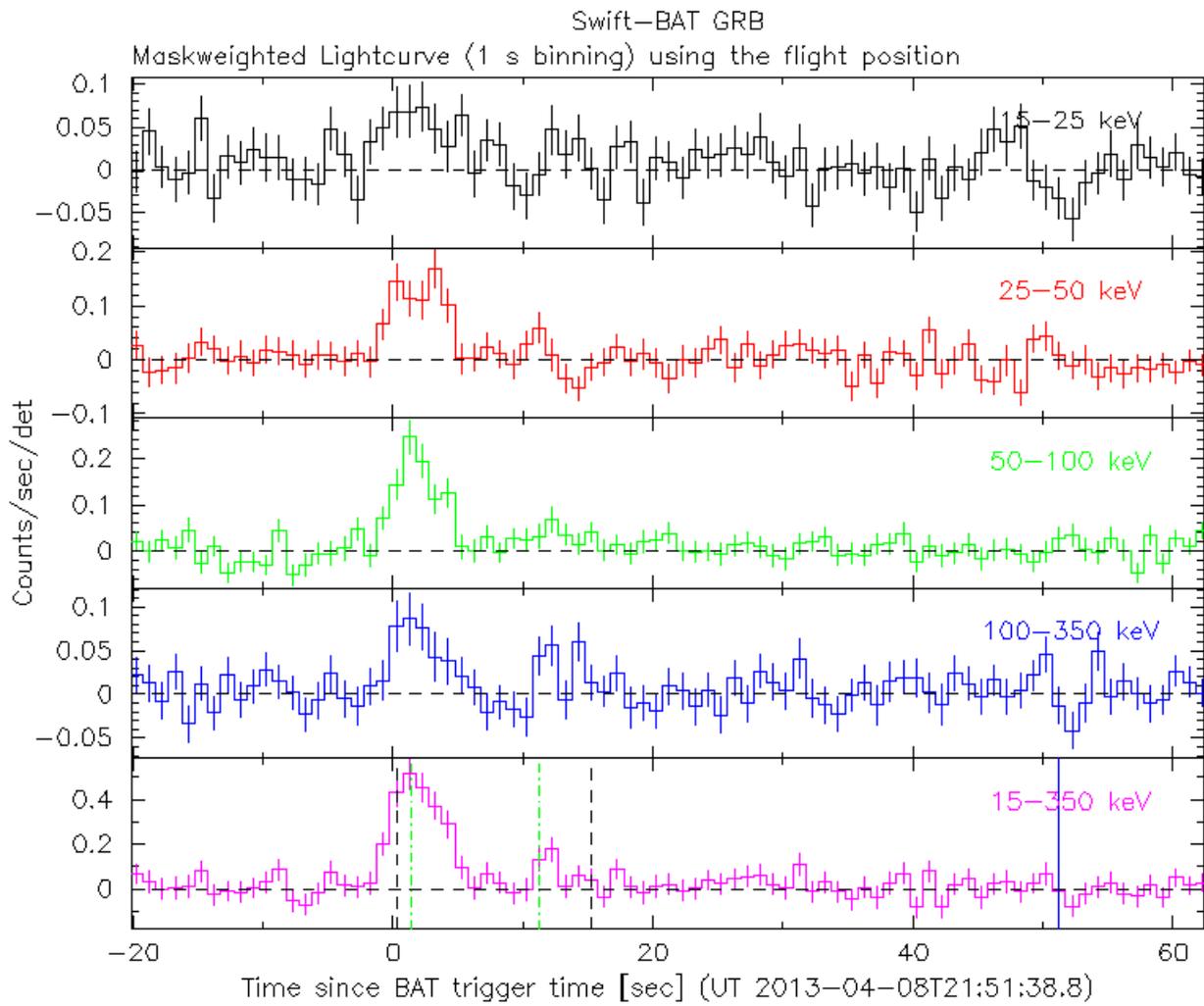
Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det = 0.16 cm^2) and T_0 is 21:51:38 UT.
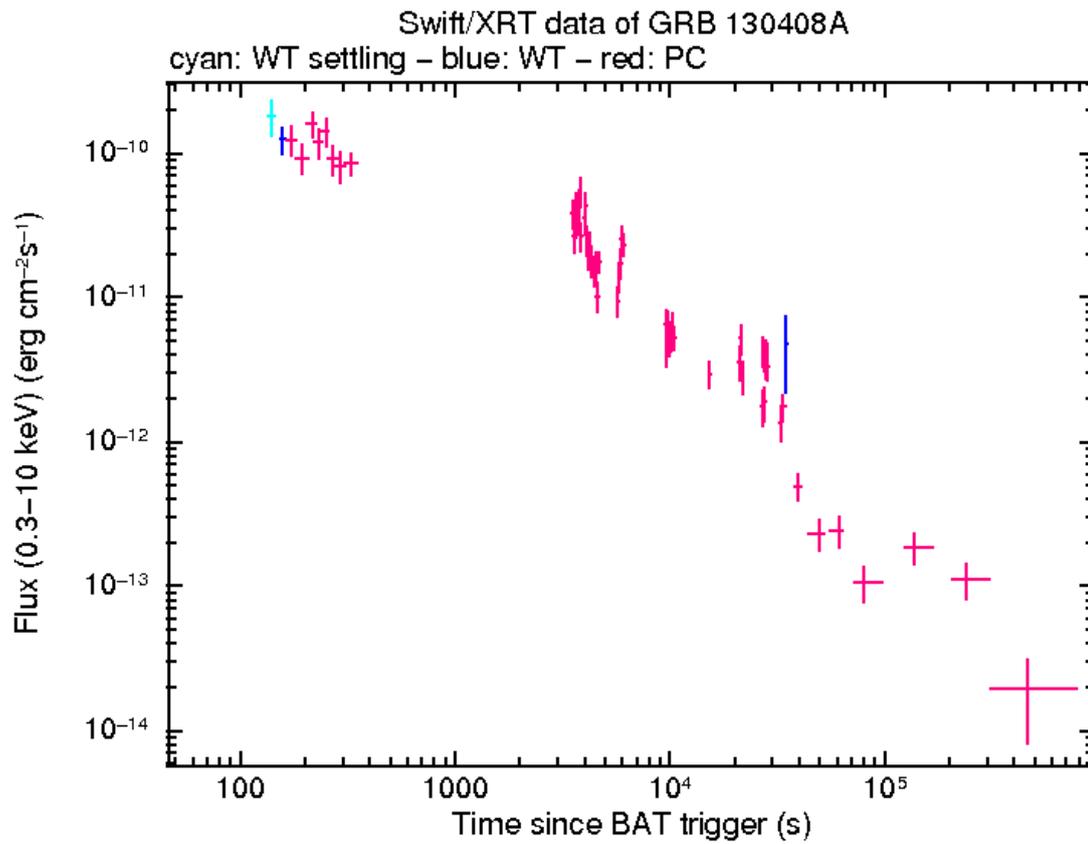
Figure 2: XRT Lightcurve in the 0.3-10 keV band: Window Timing Settling mode (cyan), Window Timing mode (blue), Photon Counting mode (red).

Swift/UVOT BURST (134.408, −32.361) Target ID 553132
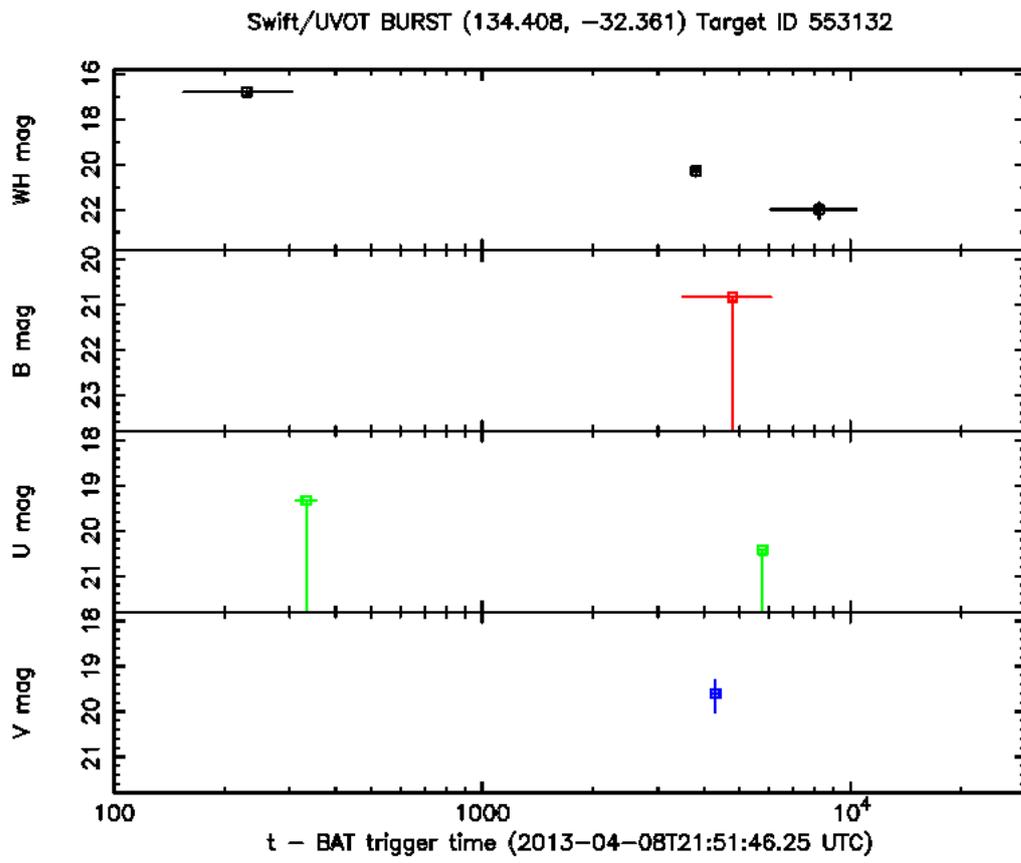
Figure 3: UVOT Optical Lightcurve.
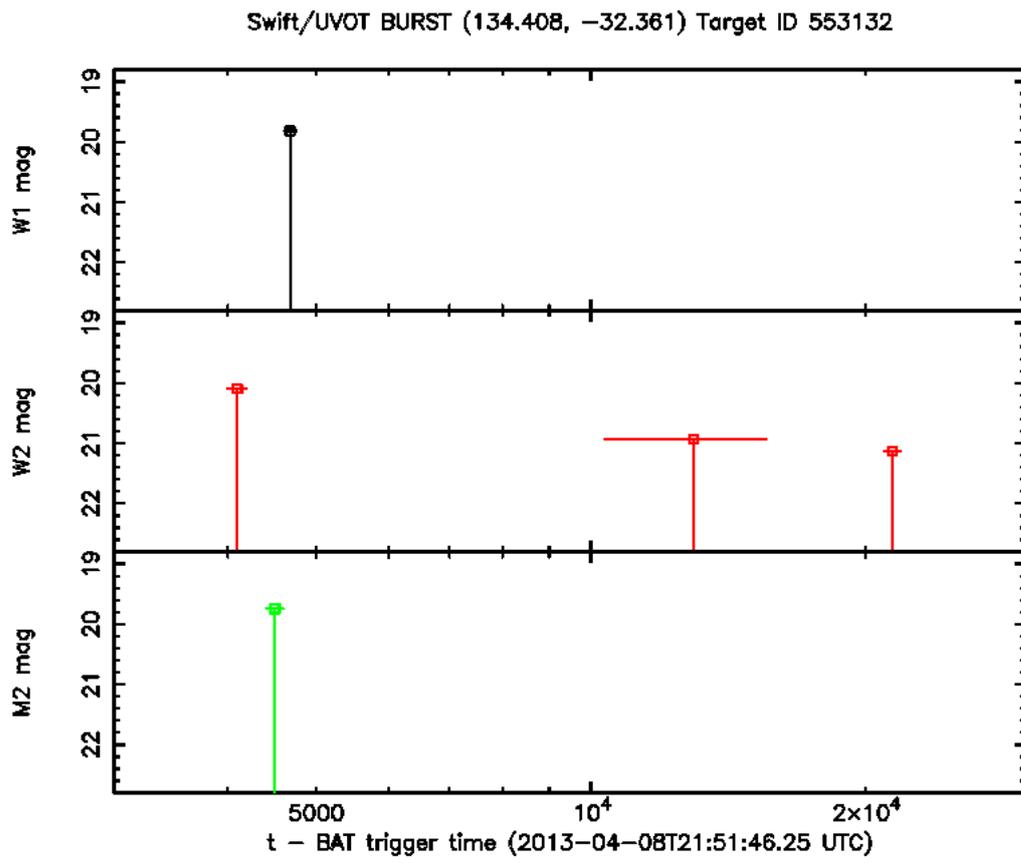
Figure 4: UVOT UV Lightcurve.