Swift Observations of GRB 130816A

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1 Introduction

Swift/BAT triggered on GRB 130816A on 2013 August 16 at 01:46:55 UT (Trigger 556545) (Holland et al. 2013). This was a long–soft burst with a duration of $T_{90} = 29.91$ s (Sakamoto et al. 2013). *Swift* slewed immediately to this burst and follow-up observations started with the XRT 87.5 s after the BAT trigger and UVOT 91 s after the BAT trigger. The best *Swift* position is the XRT location, RA, Dec (J2000.0) = 197.°14081, −58.°944476, which corresponds to

$$\begin{aligned} \text{RA (J2000.0)} &= 13^{\rm h}08^{\rm m}33.^{\rm s}791 \\ \text{Dec (J2000.0)} &= -58^\circ56'41.''1 \end{aligned}$$

with an uncertainty of 1.″8 (radius, 90% containment, including systematics).

This burst was also observed by *Fermi*/GBM (Fitzpatrick & Younes 2013). REM found an infrared afterglow (Covino et al. 2013) at a position consistent with the XRT position, and GROND observed the afterglow in the optical and infrared (Varela et al. 2013). The GROND photometry are consistent with a photomeric redshift of $z <\approx 5$.

2 BAT Observation and Analysis

The BAT data set from $T - 240$ to $T + 962$ s was analysed to obtain the following information. The BAT ground-calculated position is RA, Dec (J2000.0) = 197.°093, −58.°996, which corresponds to

$$\begin{aligned} \text{RA (J2000.0)} &= 13^{\rm h}08^{\rm m}22.^{\rm s}3 \\ \text{Dec (J2000.0)} &= -58^\circ59'47'' \end{aligned}$$

with an uncertainty of 2.′6, (radius, systematic + statistical errors, 90% containment). The partial coding was 35%.

The mask-weighted light curve (Figure 1) shows a two-peak structure. The first peak starts about $T - 28$ s and ends at about $T - 23$ s. The second peak starts about $T - 3$ s and ends at about $T + 33$ s. BAT triggered on the second peak. T_{90} (15–350 keV) is 29.97 ± 1.36 s (estimated error including systematics).

The time-averaged spectrum from $T - 28.06$ to $T + 2.56$ s is best fit by a power law with a photon index of 1.86 ± 0.34. The total fluence in the 15–150 keV band is $(4.3 \pm 1.0) \times 10^{-7}$ erg cm^{-2}. The 1-s peak photon flux measured from $T - 0.04$ s in the 15–150 keV band is 1.5 ± 0.2 ph cm^{-2} 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/566545/BA/`.

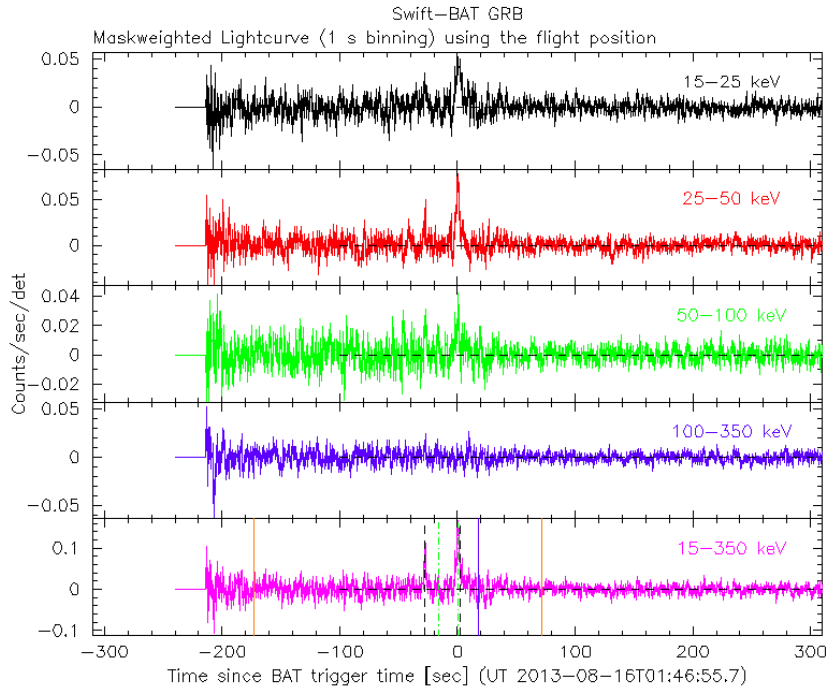

Figure 1: BAT light curves. The mask-weighted 1 s light curves in the four individual plus total energy bands. The units are count s^{-1} illuminated-detector^{-1} and T_0 is 01:46:55.7 UT.

3 XRT Observation and Analysis

The *Swift*/XRT began observing GRB 130816A at 01:48:23.2, 87.5 s after the BAT trigger. The astrometrically-corrected X-ray position (using the XRT–UVOT alignment and matching UVOT field sources to the USNO-B1.0 catalogue) is RA, Dec (J2000.0) = 197.°14081, −58.°94476 (Goad et al. 2013), which corresponds to

$$\begin{aligned} \text{RA (J2000.0)} &= 13^{\rm h}08^{\rm m}33.^{\rm s}79 \\ \text{Dec (J2000.0)} &= -58°56'41.''1 \end{aligned}$$

with an uncertainty of 1.″8 (radius, 90% containment).

The X-ray light curve (Figure 2) can be modelled with a power-law decay with an index of $\alpha = 0.62 \pm 0.08$.

A spectrum formed from the Photon Counting mode data can be fit with an absorbed power-law with a photon spectral index of 2.1 ± 0.3. The best-fitting absorption column is $6.2^{+2.0}_{-1.7} \times 10^{21}$ cm^{-2} in excess of the Galactic value of 3.9×10^{21} cm^{-2} (Kalberla et al. 2005). The counts-to-observed (unabsorbed) 0.3–10 keV flux conversion factor deduced from this spectrum is 4.7×10^{-11} (9.1×10^{-11}) erg cm^{-2} count^{-1}. The results of the XRT team's automated analysis are available at `http://www.swift.ac.uk/xrt_products/00566545`.

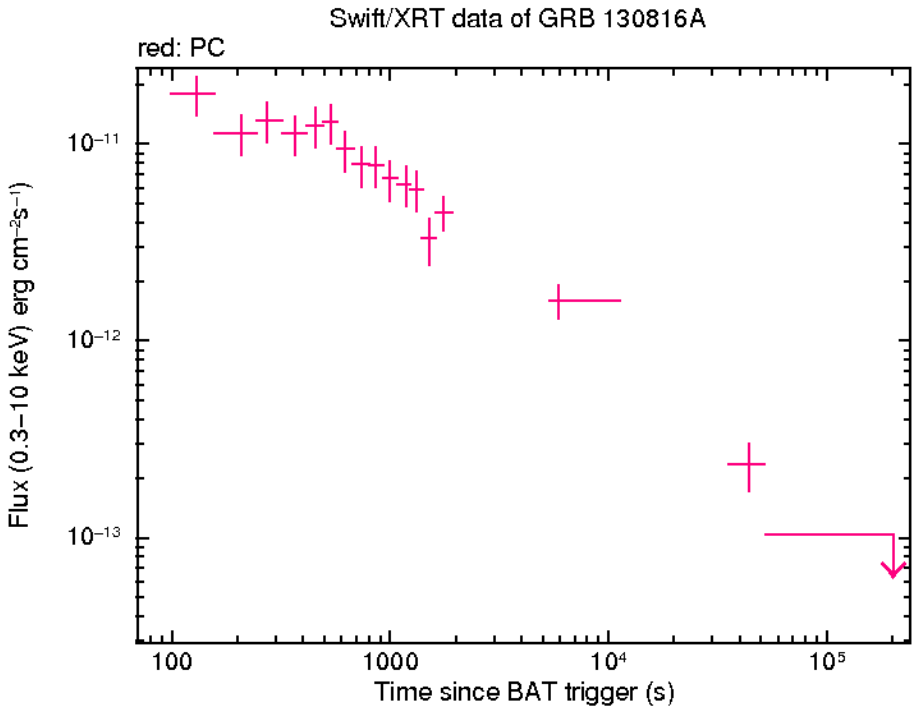

Figure 2: XRT flux light curves in erg cm^{-2} s^{-1} in the 0.3–10 keV band: Photon Counting mode (red). The conversion factor to observed (unabsorbed) flux is 4.7×10^{-11} (9.4×10^{-11}) erg cm^{-2} count^{-1}.

4 UVOT Observation and Analysis

The *Swift*/UVOT observed of the field of GRB 130816A starting 73 s after the BAT trigger with settled observations starting at 91 s. There is no evidence for an afterglow in the UVOT data. Preliminary 3-σ upper limits using the UVOT photometric system (Breeveld et al. 2011) for the finding chart (FC) and coadded exposures are given in Table 1. These data are not corrected for the Galactic extinction due to the reddening of $E_{B-V} = 0.70$ mag in the direction of the burst (Schlafly et al. 2011). GRB 130816A was 4 degrees above the Galactic Plane, so this extinction value is highly uncertain.

References

Breeveld et al., 2011, AIP Conf. Proc. 1358, 373

Covino, S., et al., 2013, GCN Circ. 15098

Fitzpatrick, G. & Younes, G., 2013, GCN Circ. (15104)

Goad, M. R., et al., 2013, GCN Circ. 15100

Holland, S. T., et al., 2013, GCN Circ. 15097

Kalberla, P. M. W., et al., 2005, A&A, 440, 775

Sakamoto, T., et al., 2013, GCN Circ. 15105

Schlafly, E. F., et al., 2011, ApJS, 737, 103

Varela, K., et al., 2013, GCN Circ. 15101

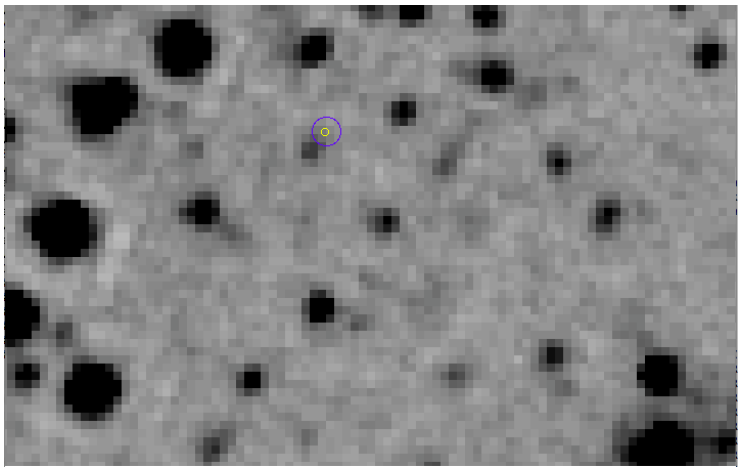

Figure 3: UVOT white finding chart for GRB 130816A. The blue circle indicates the UVOT-enhanced XRT error circle, the yellow circle is the Covino et al. (2013) position. North is up and east is to the left.

Filter	$T_{\rm start}$	$T_{\rm stop}$	Exp (s)	Mag
white (FC)	91	241	147	>20.8
u (FC)	303	554	246	>19.9
v	633	1924	156	>19.2
b	559	1850	136	>20.0
u	707	1825	117	>19.5
uvw1	682	1801	117	>19.3
uvm2	658	1944	151	>19.4
uvw2	609	1900	156	>19.7
white	584	1875	284	>21.1

Table 1: UVOT 3-σ upper limits for GRB 130816A. $T_{\rm start}$ and $T_{\rm stop}$ are the times, in seconds since the BAT trigger, of the start and stop of the observations. Exp is the total exposure time.