

Swift Observation of GRB 080707

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Swift Team:

1 Introduction

BAT triggered on GRB 080707 at 08:27:53 UT (Trigger 316204) (Schady, et al., *GCN Circ.* 7947), and *Swift* slewed immediately to this burst. This was a 1.024 sec rate-trigger with a significance of 20.37. GRB 080707 was a long, double-peaked burst, with $T_{90} = 27.1 \pm 1.1$ sec. The afterglow was detected by both the XRT and UVOT, and our best position is the UVOT location, RA(*J*2000) = 32.61833 deg (02h10m28.40s), Dec(*J*2000) = 33.10950 deg (+33d06'34.2") with a 90% error circle of 1.1 arcsec.

A faint afterglow was detected by the ground based telescope GROND (Clemens, et al., *GCN Circ.* 7948), and the VLT (Fynbo, et al., *GCN Circ.* 7949), and from spectra acquired with the VLT, a redshift estimate of $z = 1.23$ was inferred from the detection of FeII and MgII absorption features, with a conservative upper limit of $z < 2.2$, based on the lack of the Lyman alpha forest at blue wavelengths.

2 BAT Observation and Analysis

Using the data set from $T - 240$ to $T + 280$ sec, the BAT ground-calculated position is RA(*J*2000) = 32.627 deg (02h10m30.5s), Dec(*J*2000) = 33.100 deg (+33d06'01.1") ± 1.8 arcmin, (radius, systematic and statistical, 90% containment) (Sato, et al., *GCN Circ.* 7952). The partial coding was 93%.

The masked-weighted light curve (Fig.1) consists of two main peaks of roughly equivalent peak flux, where the first is a boxcar shape from $T - 2$ sec to $T + 4$ sec, and the second has a fast-rising, exponential-decaying profile (FRED), beginning at $T + 23$ sec and decaying to background by $T + 32$ sec. T_{90} (15 – 350 keV) is 27.1 ± 1.1 sec (estimated error including systematics).

The time-averaged spectrum from $T - 1.8$ to $T + 26.6$ sec is best fitted by a simple power-law model. The power law index of the time-averaged spectrum is 1.77 ± 0.19 . The fluence in the 15–150 keV band is $(5.2 \pm 0.6) \times 10^{-7}$ erg cm⁻² and the 1-sec peak flux measured at $T + 0.22$ sec in the 15–150 keV band is 1.0 ± 0.1 ph cm⁻² sec⁻¹. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

The XRT began observations of GRB 080707 68.3 sec after the BAT trigger and detected a bright, fading, uncatalogued X-ray source. Using 1482 sec of overlapping XRT Photon Counting PC mode and UVOT data, the astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue) is RA(*J*2000) = 32.61860 deg (02h10m28.46s), Dec(*J*2000) = 33.10983 deg (+33d06'35.4") ± 1.5 arcsec (radius, 90% confidence).

The 0.3 – 10 keV light curve (Fig.2) decays as a double broken power law with an initial decay index of $\alpha_{X,1} = 5.3^{+1.0}_{-0.7}$ that breaks at $t_{break,1} = 150^{+12}_{-11}$ sec to a shallow decay index of $\alpha_{X,2} = 0.3 \pm 0.1$. A second break occurs at $t_{break,2} = 8000^{+7000}_{-4000}$ sec, where the decay index steepens to $\alpha_{X,3} = 1.0 \pm 0.1$.

The X-ray spectrum, using 1.64 ks of Photon Counting data from the latter part of orbit 1 and from orbit 2 ($T + 96$ sec to $T + 6384$ sec), is well fit with a power-law with a photon index of $\Gamma = 2.1^{+0.4}_{-0.5}$, absorbed by a Galactic column of 6.99×10^{20} cm⁻² (Kalberla, et al., 2005), and by a column at the inferred redshift of the host galaxy ($z = 1.23$; Fynbo, et al., *GCN Circ.* 7949), which can only be

constrained to be $N_H < 1.23 \times 10^{22} \text{ cm}^{-2}$. All errors are at the 90% confidence level.

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4 UVOT Observation and Analysis

The UVOT observed the field of GRB 080707 79 s after the BAT trigger, and faint, uncatalogued source was detected in the early white and v -band observations at $\text{RA}(J2000) = 32.61833 \text{ deg } (02h10m28.40s)$, $\text{Dec}(J2000) = 33.10950 \text{ deg } (+33d06'34.2'') \pm 1.1 \text{ arcsec}$ (radius, 90% confidence), consistent with the enhanced XRT error circle (Starling, et al., *GCN Circ.* 7951), and the GROND position (Clemens, et al., *GCN Circ.* 7948). The measured magnitudes in the UVOT photometric system (Poole, et al., 2008) and 3σ upper limits for detecting a source in co-added frames are given in Table 1.

References

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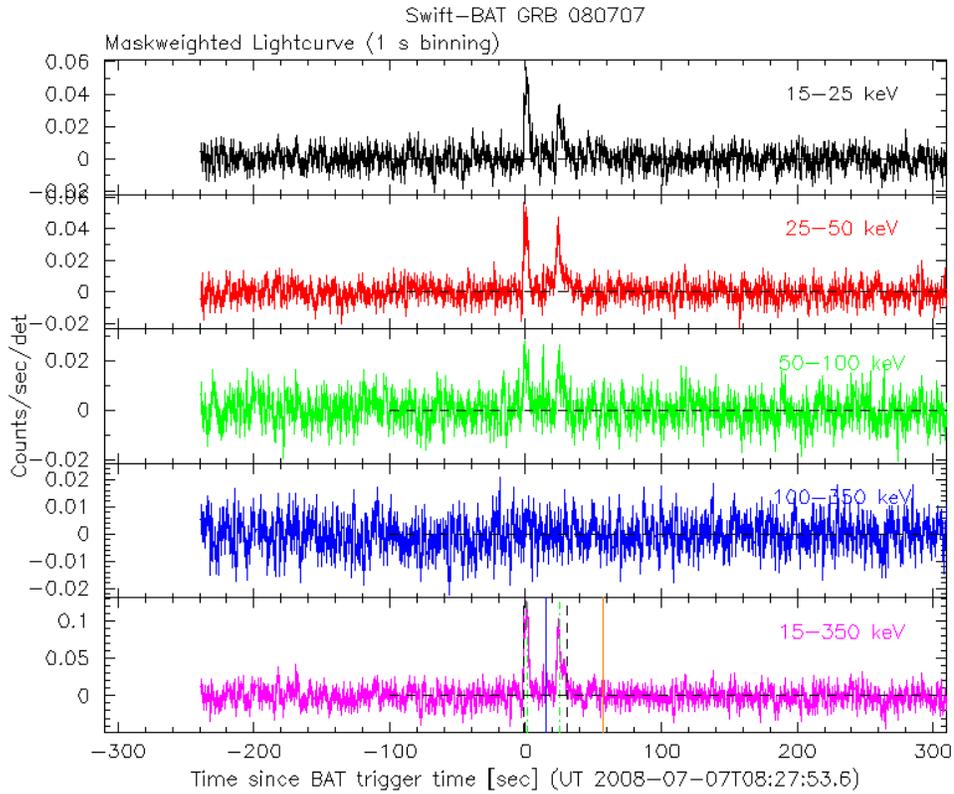


Figure 1: BAT Light curve. The mask-weighted 1-sec light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T is 08:27:53 UT.

Filter	T_{start} (sec)	T_{stop} (sec)	Exposure (sec)	Mag/ 3σ UL
white	80	5469	294.0	21.09 ± 0.31
white	11355	12221	844.3	> 21.93
v	186	5880	590.1	19.97 ± 0.31
b	3971	18004	1502.6	> 21.74
u	640	17362	1040.0	> 21.18
uvw1	616	16449	1101.7	> 21.41
uvm2	591	22234	1101.7	> 21.29
uvw2	5477	5676	196.6	> 20.22

Table 1: Magnitudes from UVOT observations. The values quoted are not corrected for the expected Galactic extinction corresponding to a reddening of $E(B-V)=0.10$ mag in the direction of the burst (Schlegel, Finkbeiner & Davis, 1998).

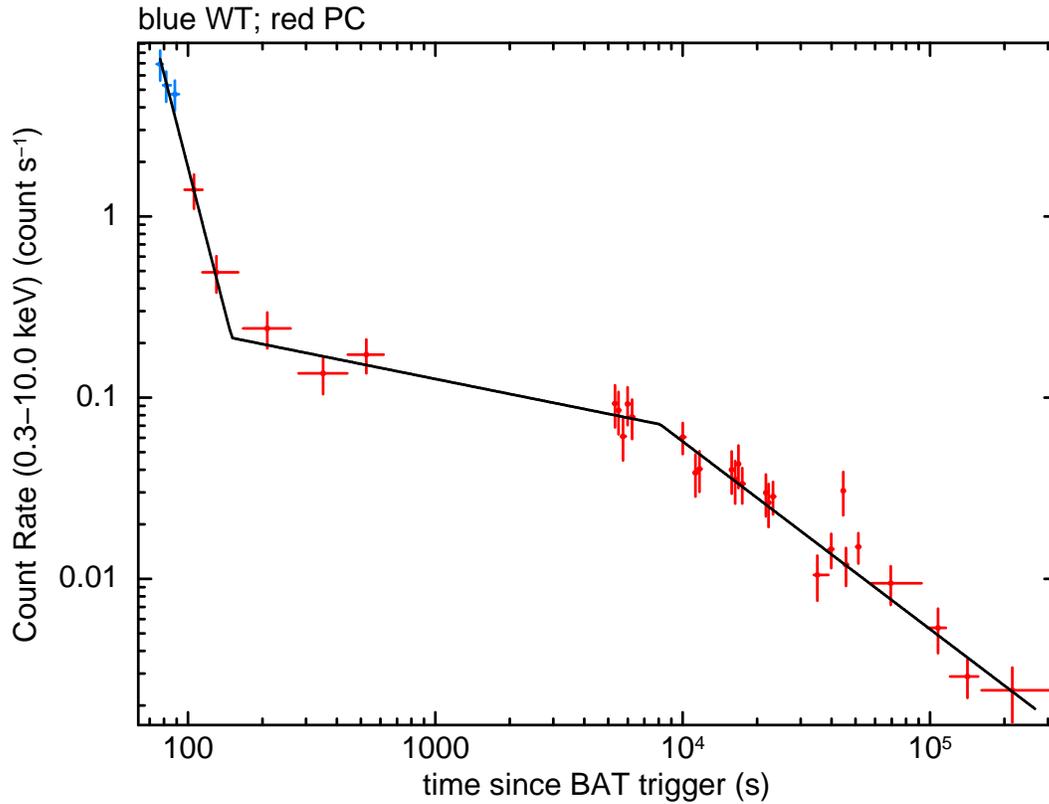


Figure 2: XRT Light curve. Counts/sec in the 0.3 – 10 keV band taken in Window Timing mode (blue) and Photon Counting mode (red). The double broken power law fit is shown in black. The approximate conversion of the absorbed flux is 1 count/sec = 4.5×10^{-11} erg cm⁻² sec⁻¹.