

Swift Observations of GRB 080413A

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1. INTRODUCTION

At 02:54:19 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 080413A (trigger 309096; Beardmore *et al.* GCN Circ. 7594). Swift slewed immediately to the burst, and XRT and UVOT detected an afterglow in observations starting about 61 seconds after the trigger. The optical afterglow was discovered by the ROTSE-III collaboration (Rykoff and Rujopakarn GCN Circ. 7593), and it was also detected with TAROT (Klotz *et al.* GCN Circ. 7595), REM (Antonelli *et al.* GCN Circ. 7597), BOOTES (Kubanek *et al.* GCN Circ. 7603), SMARTS (Cobb GCN Circ. 7609), and MOA-II (Fukui *et al.* GCN Circ. 7622). Thoene *et al.* (GCN Circ. 7602) found a redshift of 2.433 by based on several narrow absorption features detected with the VLT. Cucchiara *et al.* (GCN Circ. 7616) confirmed the redshift. Observations at 8.46 GHz with the VLA did not detect the afterglow (Chandra and Frail GCN Circ. 7614). The prompt emission was detected with the WAM instrument on *Suzaku* (Enoto *et al.* GCN Circ. 7624). The best Swift position for the burst is from the UVOT observations, which are reported below.

2) BAT OBSERVATION AND ANALYSIS

The Swift team reported (Tueller *et al.* GCN Circ. 7594) BAT results using the data from T-239 to T+454 sec. The BAT ground-calculated position is RA (J2000) = 287.301° (19h 09m 12.1s), Dec (J2000) = -27.677° (-27° 40' 36.8") with an uncertainty of 1.0' (90% containment radius including both statistical and systematic errors). The partial coding was 81%.

The mask-weighted light curve (Figure 1) shows four peaks. The first starts at T-0.1 sec, and peaks at T+2.0 sec. The second peak overlaps with the first and peaks at about T+7 sec. The third and fourth peaks are well separated with peaks at T+16 and T+47 sec respectively. The light curve returns to baseline at about T+80 sec. T_{90} (15-350 keV) is 46 ± 1 sec. (estimated error including systematics).

The time-averaged spectrum from T-0.1 to T+50.3 sec is best fit by a simple power-law model with a power law index of 1.57 ± 0.06 . The fluence in the 15-150 keV band is $3.5 \pm 0.1 \times 10^{-6}$ erg-cm⁻². The 1-sec peak photon flux measured from T+1.64 sec in the 15-150 keV band is 5.6 ± 0.2 photons-cm⁻²-sec⁻¹. All the quoted errors are at the 90% confidence level.

3. XRT OBSERVATIONS AND ANALYSIS

Swift obtained total of 11.5 ks of XRT data from T+67 s to T+149 ks. The UVOT-enhanced position has been improved since Osborne *et al.* (GCN Circ. 7594) with the receipt of more data. The best XRT position, obtained using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue, is RA (J2000) = 287.29907° (19h 09m 11.78s), Dec (J2000) = -27.67779° (-27° 40' 40.0") with an uncertainty of 1.6" (radius, 90% confidence).

The X-ray light curve (Fig. 2) is well fitted by a broken power-law decay, with a flare at about T+5000 s. The initial slope is 2.85 (+0.20/-0.18) with a break at T+168 (+22/-17) s to a shallower slope of 1.27 (± 0.07).

A spectrum obtained from all of the WT mode data can be fit with an absorbed power-law model with a photon index $\Gamma=3.12$ (+0.16/-0.15). A redshifted absorbing column of 1.53 (+0.43/-0.38) $\times 10^{22}$ cm⁻², at a redshift of $z=2.433$ (Thoene *et al.* GCN Circ 7602) is necessary in addition to the Galactic column of 8.71×10^{20} cm⁻² (Kalberla *et al.* 2005). The observed (unabsorbed) 0.3-10 keV flux in this spectrum is 4.1×10^{-10} (1.71 $\times 10^{-9}$) erg-cm⁻²-s⁻¹. All the quoted errors are at the 90% confidence level.

4. UVOT OBSERVATIONS AND ANALYSIS

The Swift/UVOT observed the field of GRB 080413A starting at T+77 sec. and detected the afterglow in the white, v, b and u filters. The best-fit UVOT position for the afterglow is RA (J2000) = 287.29900° (19h 09m 11.76s), Dec (J2000) = -27.67785° (-27° 40' 40.3") with an uncertainty of 0.5" (radius, 90% confidence). This position is consistent with the enhanced XRT position and the position reported by ROSTE-III (Rykoff *et al.* GCN Circ. 7593). The magnitudes and 3- σ upper limits for the observations are reported in Table 1. The magnitudes are not corrected for the Galactic extinction corresponding to a reddening of $E_{B-V} = 0.16$ mag. (Schlegel *et al.* 1998, ApJS, 500, 525). The photometry uses the UVOT flight system described by Poole *et al.* (MNRAS 383, 627 (2008)).

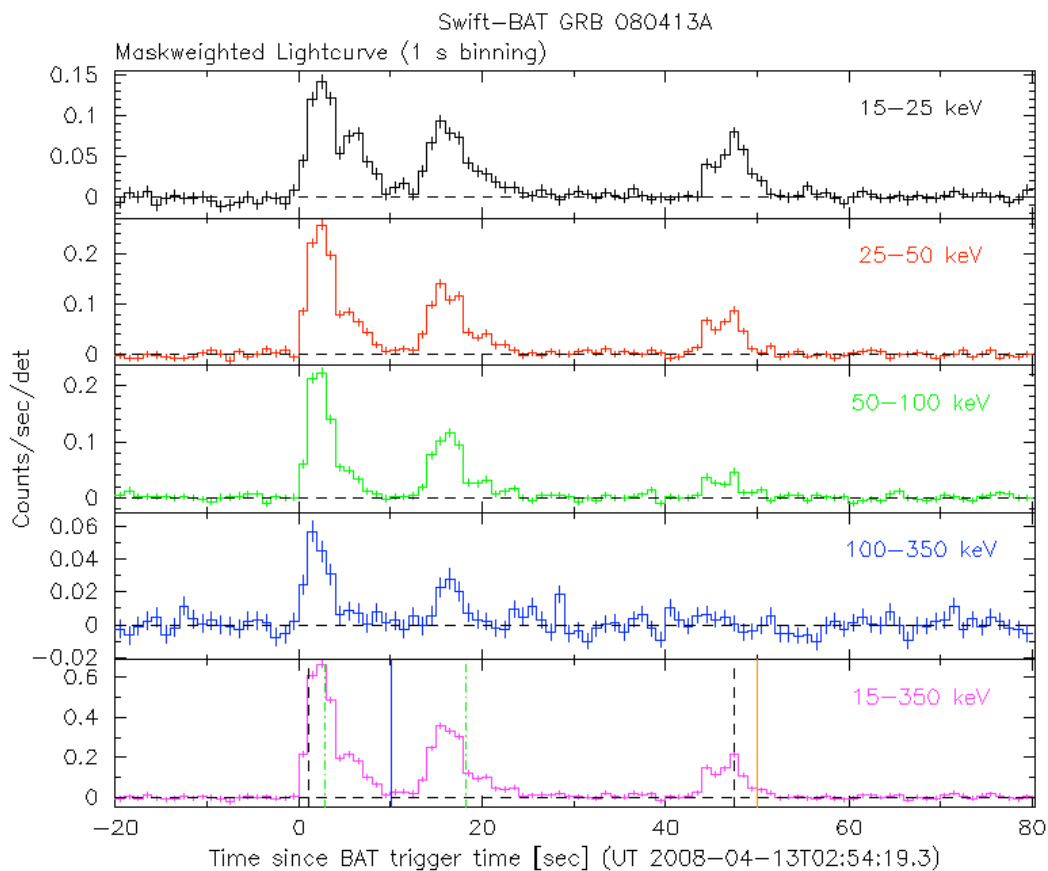


Fig.1: The BAT mask-weighted light curve in the 4 individual plus total energy bands. The units are counts s^{-1} illuminated-detector $^{-1}$. Each illuminated detector has an area of 0.16 cm^2 .

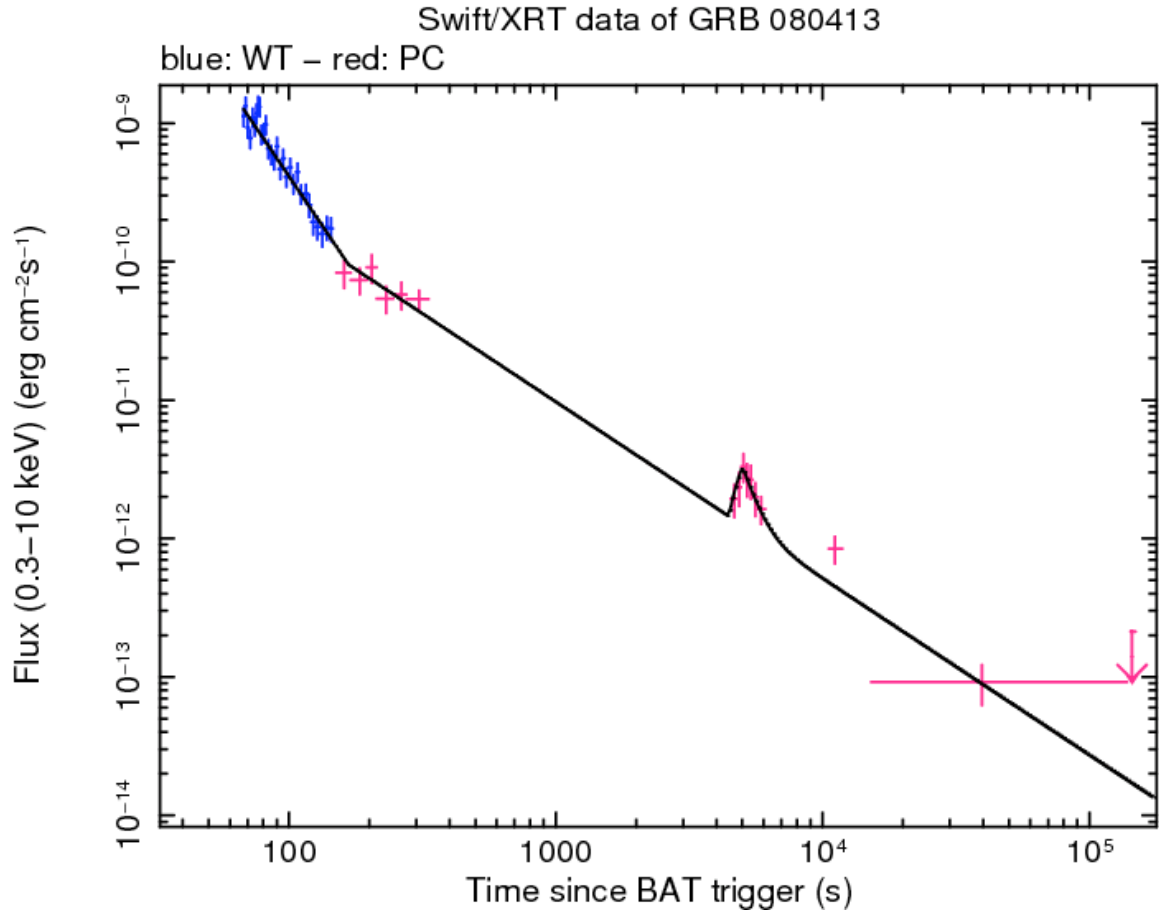


Fig. 2: XRT light curve in the 0.3-10 keV band.

Filter	T_{middle} (sec)	Exposure (s)	Magnitude / $3\text{-}\sigma$ UL
white	126	98	15.37 ± 0.01
v	268	169	15.08 ± 0.03
b	5273	197	19.33 ± 0.21
u	5068	197	19.05 ± 0.22
w1	4863	197	>19.55
m2	4658	197	>19.48
w2	5684	197	>19.57

Table 1. Detections and upper limits from UVOT observations.

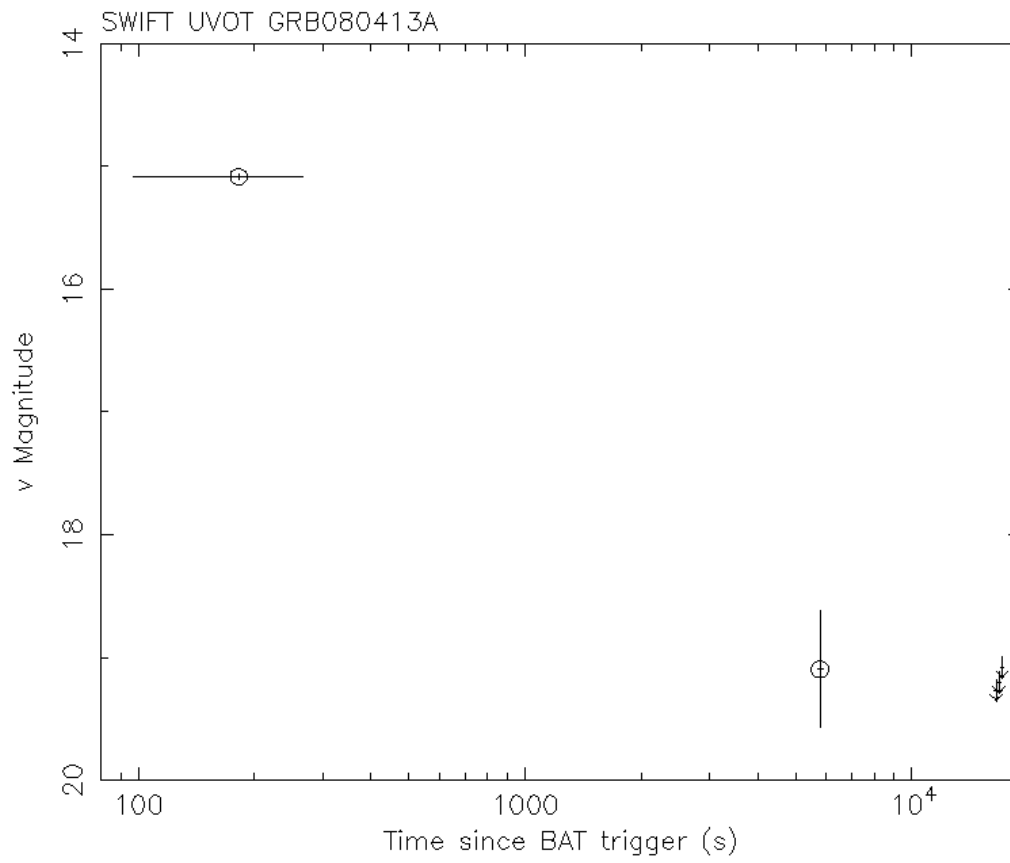


Fig. 3: The UVOT light curve in the v filter.