

## Swift Observation of GRB 090113

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### 1 Introduction

BAT triggered on GRB 090113 at 18:40:39 UT (Trigger 339852) (Krimm, *et al.*, *GCN Circ.* 8804). This was an 0.128-sec rate-trigger on a intermediate length burst with  $T_{90} = 9.1 \pm 0.9$  sec. Swift slewed to this burst immediately and XRT began follow-up observations at  $T + 70.9$  sec, and UVOT at  $T + 79$  sec. Our best position is the XRT position  $RA(J2000) = 32.05678^\circ$  (02h 08m 13.63s),  $Dec(J2000) = +33.42857^\circ$  ( $+33^\circ 25' 42''.9$ ) with an error of 1.7 arcsec (90% confidence).

Although there were a number of prompt optical follow-up observations (Swan *et al.*, *GCN Circ.* 8805; Postigo *et al.*, *GCN Circ.* 8810; Olivares *et al.*, *GCN Circ.* 8812; Lee *et al.*, *GCN Circ.* 8814), no optical counterpart was detected. The deepest early limit (Postigo *et al.*, *GCN Circ.* 8810) was  $R > 23.4$  at 2.08 hrs. after the burst.

### 2 BAT Observation and Analysis

Using the data set from T-240 to T+723 sec, further analysis of GRB 090113 has been performed by the Swift/BAT team (Tueller *et al.*, GCN 8808). The BAT ground-calculated position is  $RA, Dec = 32.067^\circ, -33.436^\circ$ , which is  $RA(J2000) = 02h 08m 16.0s$   $Dec(J2000) = +33^\circ 26' 08''.4$  with an uncertainty of 1.0 arcmin, (radius, sys+stat, 90% containment). The partial coding was 81% (the bore sight angle was  $30.7^\circ$ ).

The mask-weighted light curve (Figure 1) shows multiple peaks starting at T-10 sec and ending at T+30 sec.  $T_{90}$  (15-350 keV) is  $9.1 \pm 0.9$  sec (estimated error including systematics).

The time-averaged spectrum from T-0.9 to T+10.0 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $1.60 \pm 0.10$ . The fluence in the 15-150 keV band is  $7.5 \pm 0.4 \times 10^{-7}$  *erg cm*<sup>-2</sup>. The 1-sec peak photon flux measured from T+1.46 sec in the 15-150 keV band is  $2.5 \pm 0.2$  *ph cm*<sup>-2</sup> *s*<sup>-1</sup>. All the quoted errors are at the 90% confidence level.

### 3 XRT Observations and Analysis

Using 5.5 ks of XRT data of GRB 090113 in Photon Counting (PC) mode), the enhanced XRT position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue; Goad *et al.*, GCN 8809) is  $RA(J2000) = 32.05678^\circ$  (02h 08m 13.63s),  $Dec(J2000) = +33.42857^\circ$  ( $+33^\circ 25' 42''.9$ ) with an error of 1.7 arcsec (90% confidence).

The 0.3 – 10 keV light curve (Fig.2) shows an initial period of roughly constant emission with some possible flares. After this period, the light curve can be modelled with a power-law decay with a decay index of  $\alpha = 0.991 \pm 0.042$ .

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of  $\Gamma = 2.28 \pm 0.20$  and  $n_H = (3.2 \pm 0.61) \times 10^{21}$  *cm*<sup>-2</sup> – in excess of the Galactic value of  $6.7 \times 10^{20}$  *cm*<sup>-2</sup> (Kalberla *et al.* 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is  $4.0 \times 10^{-11}$  ( $7.8 \times 10^{-11}$ ) *erg cm*<sup>-2</sup> *count*<sup>-1</sup>.

## 4 UVOT Observation and Analysis

After analysis of Swift Ultraviolet/Optical Telescope (UVOT) data of GRB 090113 (Oates and Krimm, GCN 8813), starting 79 sec after the BAT trigger, there is no detection of any source at the enhanced Swift XRT position (Goad et al. GCN 8809). Due to subsequent trigger 339853 the automatic target sequence was cut short and only the white and u finding charts were taken in the first orbit. In the u finding chart and in the second orbit of data the XRT position lies outside of the UVOT images.

Filter	Start	Stop	Exposure	Magnitude
White	79	229	147	> 20.73
uvw1	10472	16249	931	> 20.60
uvm2	6283	10465	936	> 20.58
uvw2	4180	22029	1082	> 20.91

Table 1: Magnitude limits from UVOT observations.

The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight of  $E_{B-V} = 0.08$  mag. All photometry is on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

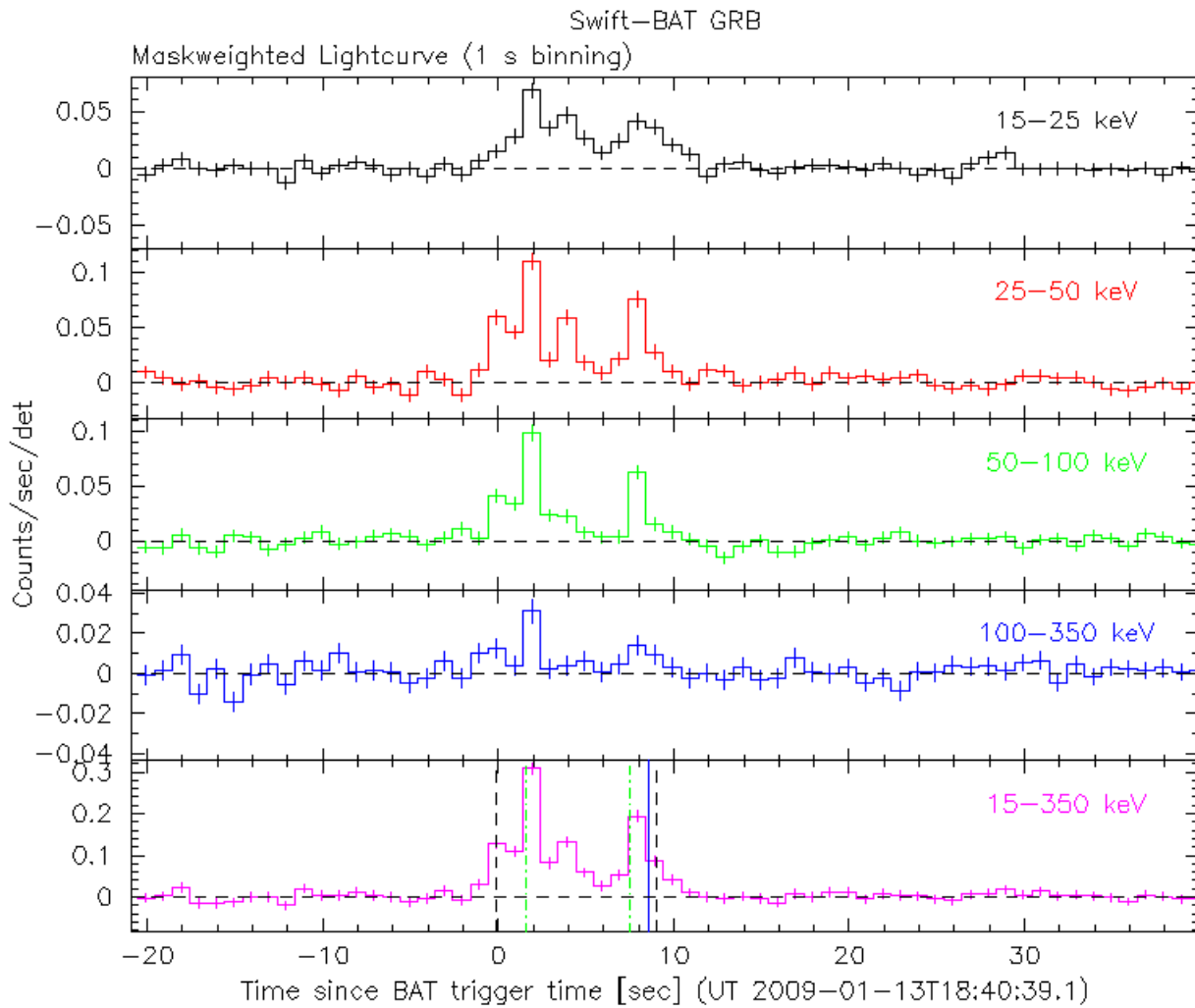


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det =  $0.16 \text{ cm}^2$ ).

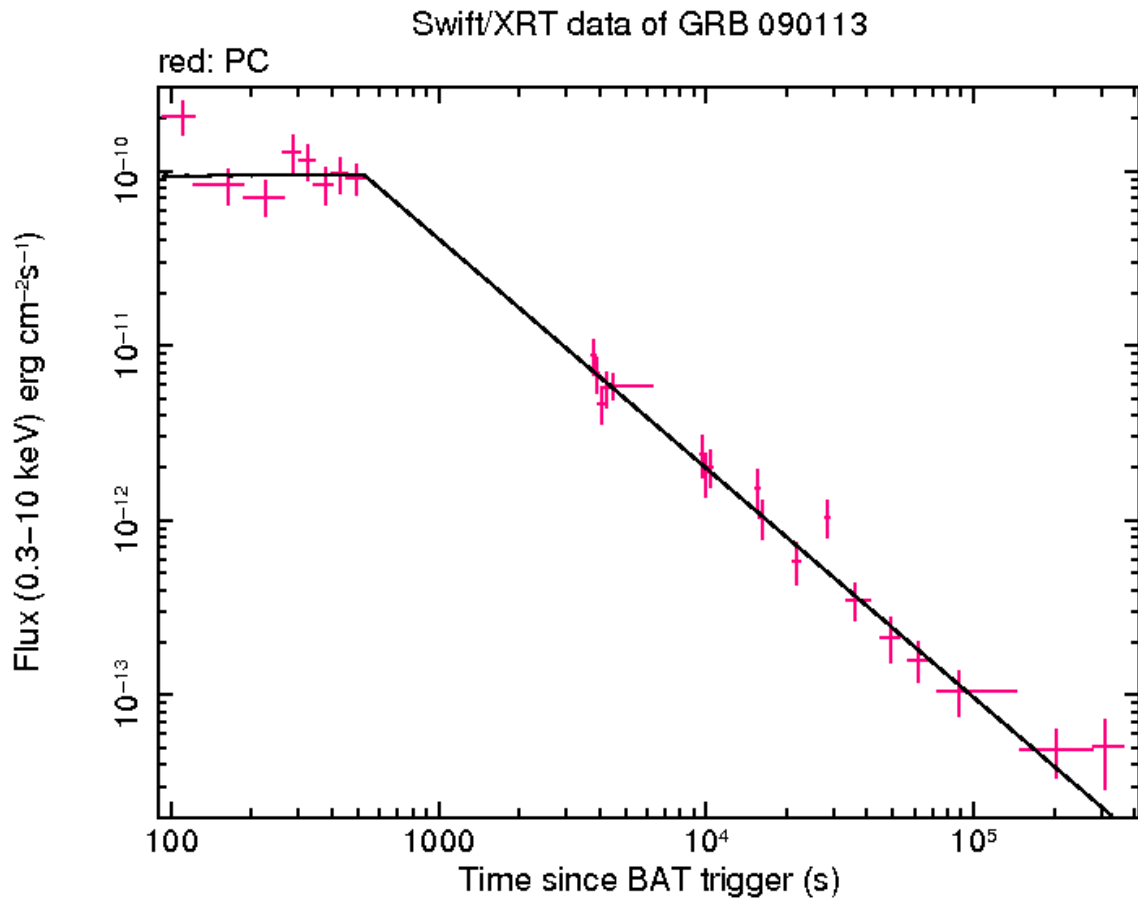


Figure 2: XRT Lightcurve. Flux in the 0.3-10 keV band: Photon Counting mode (red).