

## Swift Observation of GRB 070208

*G. Sato (GSFC), S. D. Barthelmy (GSFC), M. L. Conciatore (ASDC), F. E. Marshall (GSFC),  
D. N. Burrows (PSU), P. Roming (PSU), N. Gehrels (GSFC), for the Swift Team*

### 1 Introduction

BAT triggered on GRB 070208 at 09:10:34.3 UT (Trigger 259714) (Sato, *et al.*, *GCN Circ.* 6074). This was a 1.408 sec rate-trigger on a burst with  $T_{90} = 48 \pm 2$  sec. Swift slewed to this burst immediately and XRT began follow-up observations at T+116 sec, and UVOT at T+119 sec. Our best position is the XRT location RA (J2000) = 13h11m32.73s, Dec (J2000) = +61°57'55".2 with an error of 3.7 arcsec (90% confidence, including boresight uncertainties). This position is consistent with the position of the optical afterglow reported by Bloom (*GCN Circ.* 6079). Cucchiara *et al.* (*GCN Circ.* 6083) reported a spectroscopic redshift of  $z = 1.165$  from the Gemini-North telescope + Gemini Multi-Object Spectrograph.

### 2 BAT Observation and Analysis

Using the data set from  $T - 239$  to  $T + 552$  sec, the BAT ground-calculated position is RA (J2000) = 197.896° (13h11m35.0s), Dec (J2000) = 61.946° (61°56'44".3) with an uncertainty of 3.5 arcmin, (radius, sys+stat, 90% containment). The partial coding was 50% (the bore sight angle was 39.4°).

The mask-weighted lightcurve (Figure 1) shows two peaks. The first (at T+0) is FRED-like with a duration of  $\sim 7$  sec. The second starts at  $\sim T + 35$  sec and ends at  $\sim T + 50$  sec. T90 (15–350 keV) is  $48 \pm 2$  sec (estimated error including systematics).

The time-averaged spectrum from  $T - 1.0$  to  $T + 47.8$  is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $1.96 \pm 0.37$ . The fluence in the 15–150 keV band is  $4.3 \pm 1.0 \times 10^{-7}$  ergs cm $^{-2}$ . The 1-sec peak photon flux measured from  $T - 0.26$  sec in the 15–150 keV band is  $0.9 \pm 0.2$  ph cm $^{-2}$  s $^{-1}$ . All the quoted errors are at the 90% confidence level.

Fitting the two peaks separately with a simple power law model, the power-law indices are  $2.17^{+0.53}_{-0.44}$  ( $T - 2$  to  $+5$ ) and  $1.69^{+0.36}_{-0.34}$  ( $T + 25$  to  $+50$ ). Given the widths of the two peaks and that the second peak is spectrally harder than the first, we conclude that this burst is a long GRB and is not a short hard burst with extended emission.

### 3 XRT Observations and Analysis

Using the data from the first seven orbits of XRT data of GRB 070208 (11.7 ksec in Photon Counting mode), the refined XRT position is RA (J2000) = 13h11m32.73s, Dec (J2000) = +61°57'55".2 with an uncertainty of 3.7 arcsec (90% containment). This position is 0.3 arcsec from the XRT position quoted in Sato *et al.* (*GCN Circ.* 6074), 72 arcsec from the ground-calculated BAT position reported by Markwardt *et al.* (*GCN Circ.* 6081) and 1.7 arcsec from the fading source reported by Guidorzi *et al.* (*GCN Circ.* 6077; see also Fox *et al.*, *GCN Circ.* 6078).

The 0.3–10 keV X-ray light-curve (Fig.2), after an initial slow rising phase, shows a steep decay ( $\alpha \sim -3.6$ ) during the second orbit (from  $T + 4.3$  ks to  $+6.7$  ks). Starting from the third orbit, the light-curve shows a power-law decline with a decay index of  $1.7 \pm 0.3$ .

The X-ray spectrum is well fitted by an absorbed power-law with a photon index of  $2.6 \pm 0.2$  and column density of  $2.6 \pm 0.4 \times 10^{21}$  cm $^{-2}$ . We note the Galactic column density in the direction of the source is  $1.7 \times 10^{20}$  cm $^{-2}$ . The 0.3–10 keV observed flux was  $1.5 \times 10^{-12}$  ergs cm $^{-2}$  s $^{-1}$ , which

corresponds to an unabsorbed flux of  $3.5 \times 10^{-12}$  ergs cm $^{-2}$  s $^{-1}$ .

## 4 UVOT Observation and Analysis

The UVOT began observing the field of GRB 070208 starting 119 sec after the BAT trigger. An afterglow is detected but it is blended with the nearby galaxy pointed out by Guidorzi *et al.* (*GCN Circ.* 6077). The fluxes in a 2'' aperture centered on the position from Bloom (*GCN Circ.* 6079) in the initial White and V exposures are higher than the fluxes in later exposures (Fig.3). Assuming the differences are due to the afterglow, there is a possible ( $1.6 \sigma$ ) detection in White and a  $3 \sigma$  detection in V. The estimated  $2 \sigma$  upper limit in White is 20.6 magnitudes, and the estimated V magnitude is  $19.4 \pm 0.3$  ( $1 \sigma$ ).

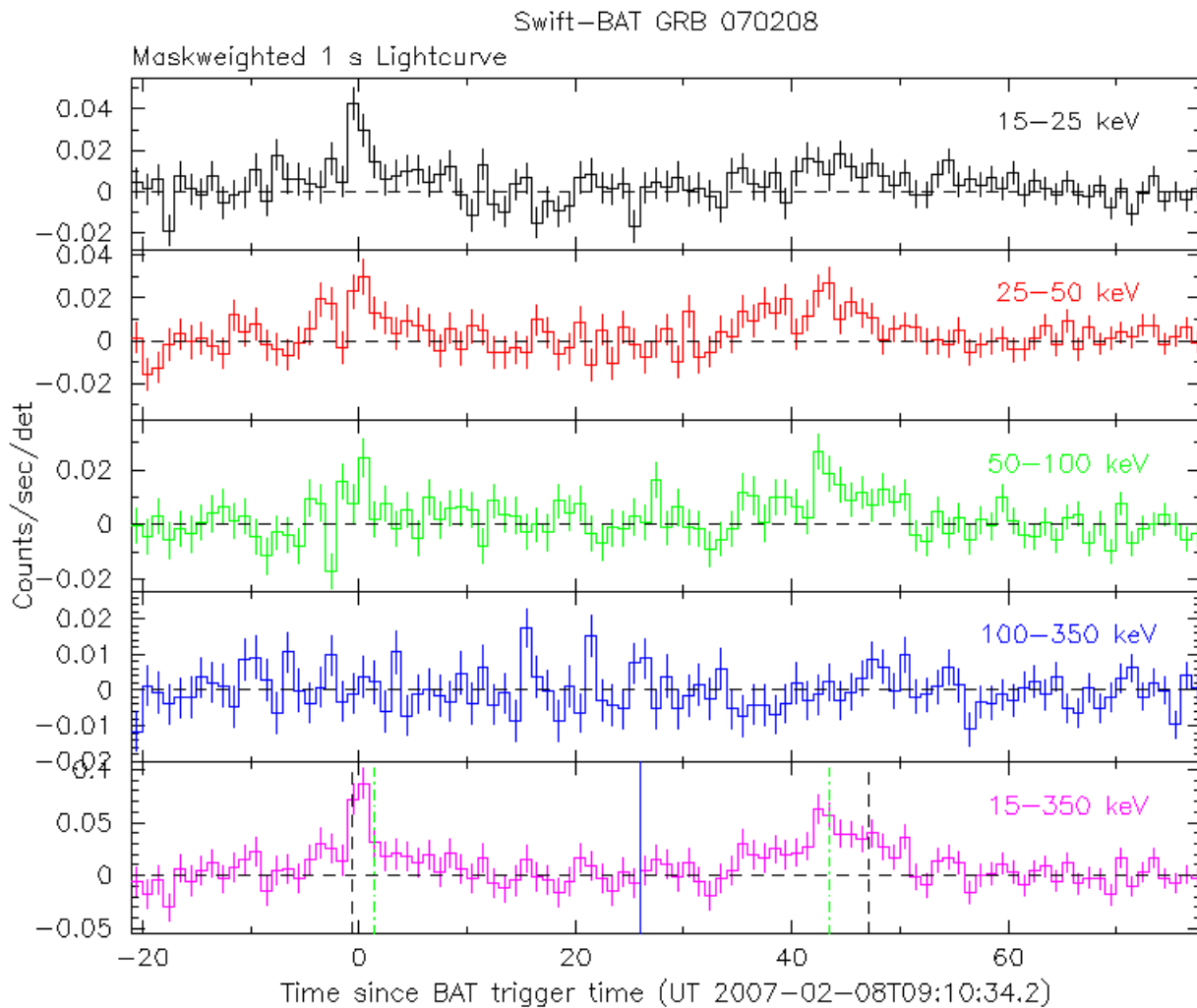


Figure 1: BAT light curve for GRB 070208. The mask-weighted light curve in the 4 individual plus total energy bands. The green and black dotted lines bracket the  $T_{50}$  and  $T_{90}$  intervals. The blue solid line is the start of the slew. The units are counts/sec/illuminated-detector and  $T_0$  is 09:10:34.2 UT.

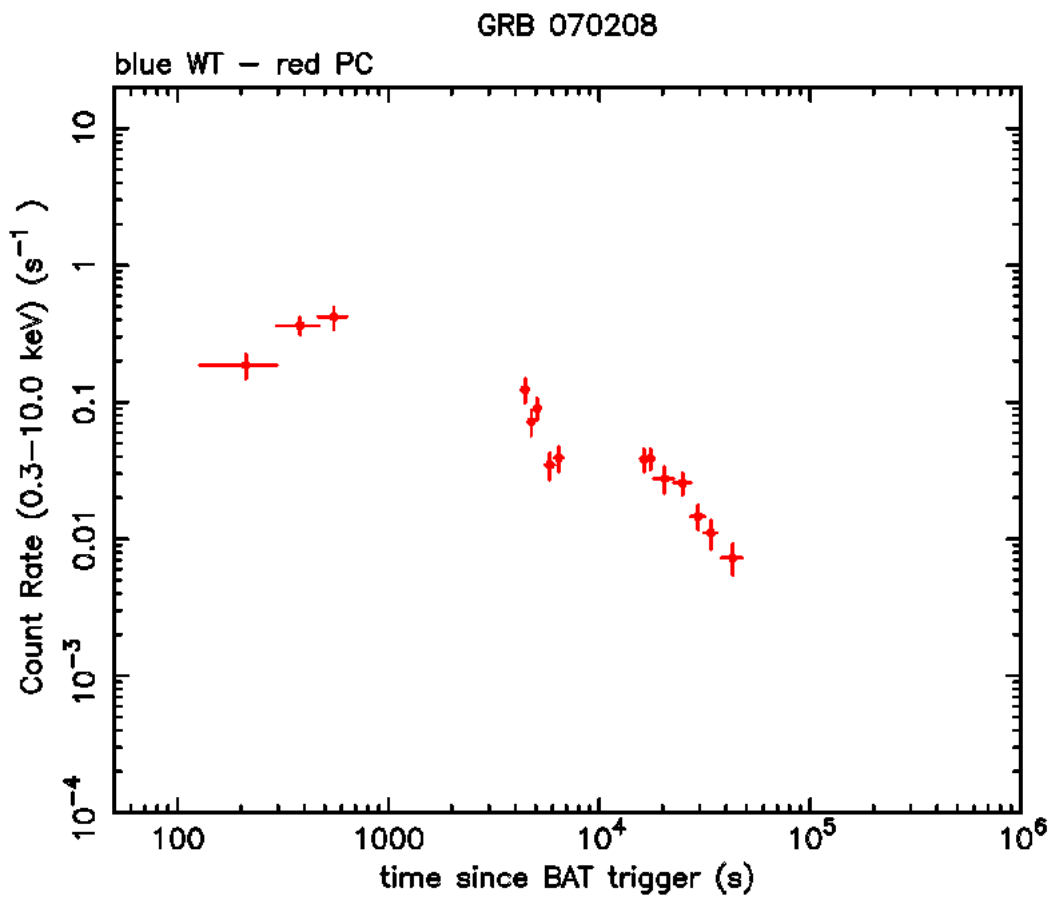


Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band in Photon Counting mode. The approximate conversion to the observed flux is  $1 \text{ count s}^{-1} = \sim 4.82 \times 10^{-11} \text{ ergs cm}^{-2} \text{ s}^{-1}$ .

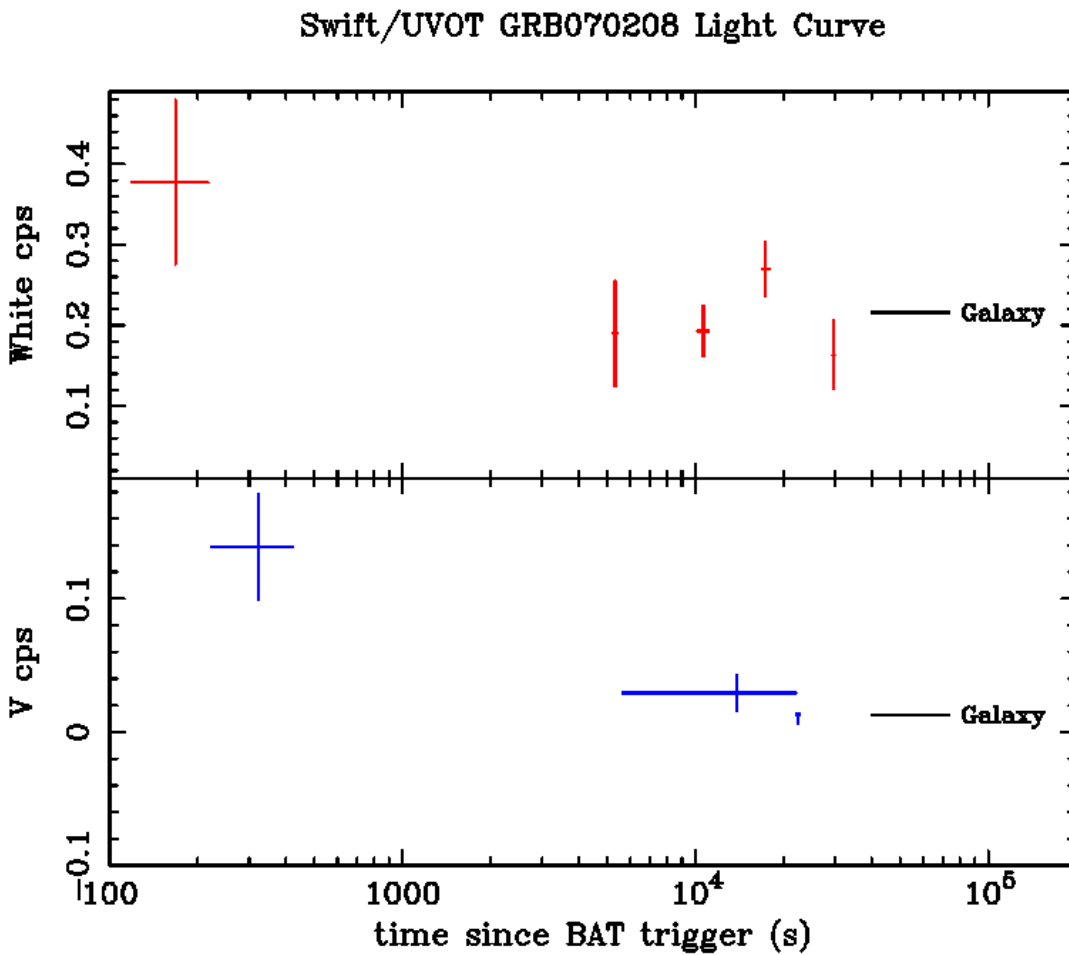


Figure 3: UVOT light curve using a 2 arc-second aperture. Note that the afterglow emission is not separated from the nearby galaxy contribution. The lines indicate the estimated contribution from the galaxy. The count rates have not been corrected for aperture loss.