

## Swift Observations of GRB 090205

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### 1 Introduction

The Swift BAT triggered on and located GRB 090205 at 23:03:14 UT (trigger=342121) (Perri et al., GCN Circ. 8884). Swift slewed immediately to the burst and XRT and UVOT observations of the field started 88 and 92 seconds after the trigger, respectively. The best Swift position is the XRT localization at RA(J2000)= 220.9114 deg, Dec(J2000)= -27.8528 deg, RA(J2000)= 14<sup>h</sup>43<sup>m</sup>38.74<sup>s</sup>, Dec(J2000)= -27<sup>d</sup> 51' 10.1", with an error radius of 1.4 arcsec (90% confidence).

The optical/NIR afterglow was detected from the ground by VLT (D'Avanzo et al., GCN Circ. 8887) and GROND (Kruehler & Greiner, GCN Circ. 8888). A photometric redshift estimate of  $z = 4.7 \pm 0.3$  was provided by GROND (Kruehler & Greiner, GCN Circ. 8888) and then confirmed and refined by VLT observations that provided a spectroscopic redshift of  $z = 4.6497 \pm 0.0025$  (Thoene et al., GCN Circ. 8889, Fugazza et al., GCN Circ. 8892). Upper limits in radio were set by VLA at 8.46 GHz (Chandra & Frail, GCN Circ. 8896).

Based on its high redshift, relatively bright optical afterglow and variable X-ray afterglow, the Swift team declared GRB 090205 to be a burst of interest to be followed by Swift to late time (Gehrels & Perri, GCN Circ. 8890).

### 2 BAT Observations and Analysis

Using the data set from T-239 s to T+455 s (Cummings et al., GCN Circ. 8886), the BAT ground-calculated position is RA(J2000)= 220.917 deg, Dec(J2000)= -27.848 deg, RA(J2000)= 14<sup>h</sup>43<sup>m</sup>40.0<sup>s</sup>, Dec(J2000)= -27<sup>d</sup> 50' 51.4", with an uncertainty of 2.0 arcmin, (radius, sys+stat, 90% containment). The partial coding was 100%.

The mask-weighted light curve (Figure 1) shows a single peak starting at  $\sim T-5$  s, peaking at  $\sim T+3$  s and returning to background at  $\sim T+100$  s.  $T_{90}$  (15–350 keV) is  $8.8 \pm 1.8$  s (estimated error including systematics).

The time-averaged spectrum from T-2.9 s to T+6.6 s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $2.15 \pm 0.23$ . The fluence in the 15–150 keV band is  $(1.9 \pm 0.3) \times 10^{-7}$  erg cm<sup>-2</sup>. The 1-second peak photon flux measured from T+4.09 s in the 15–150 keV band is  $0.5 \pm 0.1$  ph cm<sup>-2</sup> s<sup>-1</sup>. 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/342121/BA/>

### 3 XRT Observations and Analysis

Swift-XRT began observing the field of GRB 090205 at 23:04:42.4 UT, 87.6 seconds after the BAT trigger (Perri et al., GCN Circ. 8884).

Using all the XRT available data, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment with 23074 seconds of overlapping time and matching UVOT field sources to the USNO-B1 catalogue): RA(J2000)= 220.9114 deg, Dec(J2000)= -27.8528 deg, RA(J2000)= 14<sup>h</sup>43<sup>m</sup>38.74<sup>s</sup>, Dec(J2000)= -27<sup>d</sup> 51' 10.1", with an uncertainty of 1.4 arcsec (radius, 90% confidence) (Evans et al., GCN Circ. 8885).

The 0.3–10 keV light curve (Figure 2) from T+94 s up to  $\sim$ T+580 s can be modelled by a simple power-law decay with a slope  $\alpha_1 = -1.4 \pm 0.3$ . A re-brightening is observed at around T+1 ks. At later times, starting from T+1.5 ks, the light curve can be fit with a power-law model with a best fit decay index of  $\alpha_2 = -1.2 \pm 0.1$  with superimposed flaring/re-brightening episodes at  $\sim$ T+6 ks and  $\sim$ T+20 ks.

The average X-ray spectrum (0.3–10 keV) up to T+83 ks is well fit by an absorbed power-law model with a photon index  $\Gamma = 2.1 \pm 0.1$  and a total column density consistent with the Galactic one in the direction of the source ( $N_H = 7.7 \times 10^{20} \text{ cm}^{-2}$ , Kalberla et al. 2005). The average observed 0.3–10 keV flux for this spectrum is  $(1.1 \pm 0.1) \times 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$ . All the quoted errors are at the 90% confidence level.

## 4 UVOT Observation and Analysis

The UVOT began settled observations of the field of GRB 090205 starting 92s after the BAT trigger (Landsman & Perri, GCN 8893).

The optical/UV afterglow was not detected and the corresponding 3-sigma upper limits are listed in Table 1. The values quoted are not corrected for the expected Galactic extinction in the direction of the burst of  $E_{(B-V)} = 0.12 \text{ mag}$  (Schlegel et al. 1998). All photometry is in the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627). The UVOT non-detections are consistent with the spectroscopic redshift of 4.6497 reported by Fugazza et al. (GCN Circ. 8892).

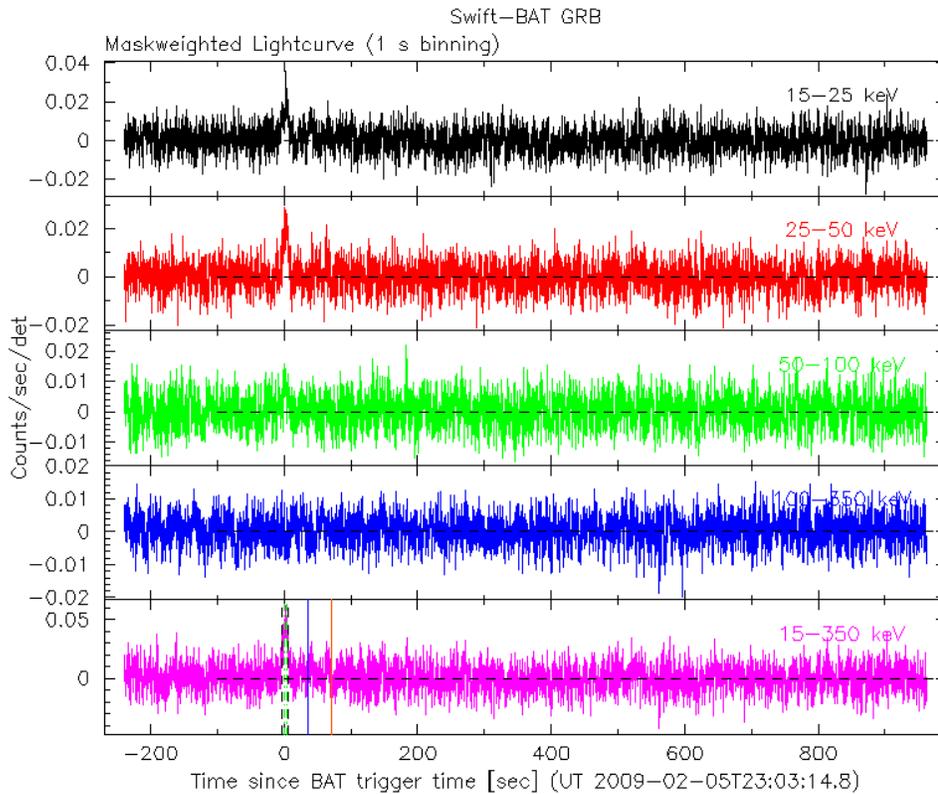


Figure 1: BAT light-curve. The mask-weighted light curve in the 4 individual plus total energy bands. Green dotted line:  $T_{50}$ , Black dotted line:  $T_{90}$ . Blue: Slew start, Orange: Slew end Time. The units are  $\text{counts s}^{-1} \text{ illuminated-detector}^{-1}$  (note  $\text{illum-det} = 0.16 \text{ cm}^2$ ).

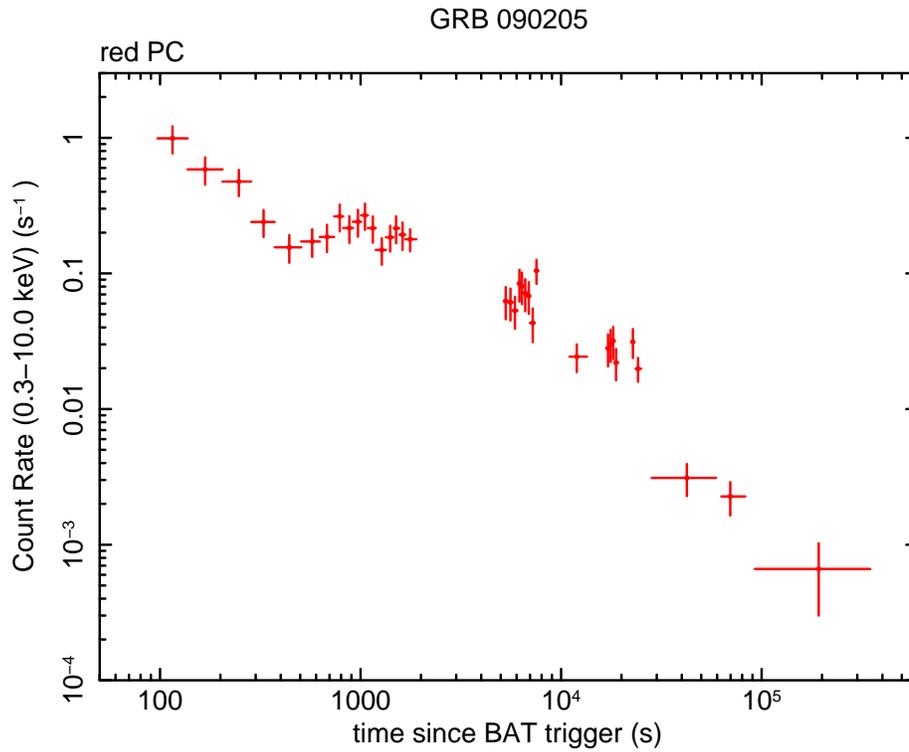


Figure 2: XRT light-curve. Count rates in the 0.3–10 keV band taken in Photon Counting mode are plotted. The approximate conversion of the 0.3–10 keV observed flux is  $1 \text{ count/s} \sim 3.6 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$ .

Filter	T_start (s)	T_stop (s)	Exp (s)	Mag
white	92	242	148	> 21.1
white	92	7633	824	> 21.9
v	580	12829	1234	> 20.7
b	506	34930	2073	> 21.7
u	250	500	246	> 20.5
u	298	18581	1660	> 21.4
uvw1	629	17668	1415	> 21.4
uvw2	604	23148	1882	> 21.4
uvw3	555	11915	1322	> 21.5

Table 1: 3-sigma upper limits from UVOT observations.