

Swift Observation of long GRB 090429B

T. N. Ukwatta (GSFC/GWU), J. R. Cummings (GSFC/UMBC), C. B. Markwardt (GSFC/UMD), M. Stamatikos (GSFC/ORAU), A. Rowlinson (U. Leicester), M. M. Chester (PSU), S. D. Barthelmy (GSFC), D. N. Burrows (PSU), P. Roming (PSU), N. Gehrels (GSFC), for the Swift Team

1 Introduction

BAT triggered on GRB 090429B at 05:30:03 UT (Trigger 350854) (Ukwatta, *et al.*, *GCN Circ.* 9281). This was a 1.024 sec rate-trigger on a long burst with $T_{90} = 5.5 \pm 1.0$ sec. Swift slewed immediately to the burst. Narrow field instruments started observations at $\sim T + 106$ sec, and our best position is the UVOT-enhanced XRT location RA(*J*2000) = 210.66707 deg (14h02m40.10s), Dec(*J*2000) = +32.17072 deg (+32d10'14.6") with an uncertainty of 1.8 arcsec (90% confidence, including boresight uncertainties), reported by Beardmore *et al.*, *GCN Circ.* 9288.

2 BAT Observation and Analysis

Using the data set from $T - 60$ to $T + 243$ sec, further analysis of BAT GRB 090429B has been performed by BAT team (Stamatikos, *et al.*, *GCN Circ.* 9290). The BAT ground-calculated position is RA(*J*2000) = 210.672 deg (14h02m41.2s), Dec(*J*2000) = 32.167 deg (+32d10'02.0") ± 1.3 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 84% (the bore sight angle was 24.5 deg).

The mask-weighted light curve (Fig. 1) shows a main peak starting at $\sim T - 4$ sec, peaking at $\sim T - 0.1$ sec, and ending around $T + 3$ sec. There are two very weak peaks: $\sim T + 30$ to $\sim T + 70$ sec, and $\sim T + 100$ to $\sim T + 110$ sec (Fig. 2). T_{90} (15-350 keV) is 5.5 ± 1.0 sec (estimated error including systematics). There is an apparent 4 sigma high energy excess in the mask weighted light curve in the 100–350 keV band, around $T - 15$ (see Fig. 1), but it does not appear to be statistically significant after considering the large number of bursts and light curve bins that have been examined by Swift BAT.

The time-averaged spectrum from $T - 4.54$ to $T + 2.4$ sec is best fit by a power law with an exponential cutoff. This fit gives a photon index of 0.47 ± 0.77 , and E_{peak} of 42.1 ± 5.6 keV (chi squared 29.6 for 56 d.o.f.). For this model the total fluence in the 15–150 keV band is $3.1 \pm 0.3 \times 10^{-7}$ erg/cm² and the 1-sec peak flux measured from $T - 0.28$ sec in the 15–150 keV band is 1.6 ± 0.2 ph/cm²/sec. A fit to a simple power law gives a photon index of 1.96 ± 0.13 (chi squared 45.3 for 57 d.o.f.). 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/350854/BA/

3 XRT Observations and Analysis

The XRT team has analyzed 8.9 ks of XRT data for GRB 090429B, from 104 s to 29.9 ks after the BAT trigger. The data are entirely in Photon Counting (PC) mode.

The best position of the X-ray afterglow is the UVOT-enhanced XRT position (Beardmore, *et al.*, *GCN Circ.* 9288)

RA(*J*2000) = 14h 02m 40.10s
Dec(*J*2000) = +32d 10'14.6"

with an uncertainty of 1.8 arcsec (radius, 90% confidence).

The 0.3–10 keV X-ray light curve (Fig. 3) initially shows a slow rise, which can be fitted with a power-law of index 0.89 (+0.36, −0.46). At around $T + 642$ s the light curve breaks to a power-law decay, with index 1.20 (+0.11, −0.10).

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of 2.00 (+0.15, −0.24). The best-fitting absorption column is $10.0 (+4.2, -5.3) \times 10^{20}$, in excess of the Galactic value of $1.2 \times 10^{20} \text{ cm}^{-2}$ (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3 – 10 keV flux conversion factor deduced from this spectrum is $3.8 \times 10^{-11} (4.9 \times 10^{-11}) \text{ erg cm}^{-2} \text{ count}^{-1}$.

The results of the XRT-team automatic analysis are available at http://www.swift.ac.uk/xrt_products/00350854.

4 UVOT Observation and Analysis

The Swift/UVOT observed the field of GRB 090429B starting 78 s after the BAT trigger. Settled exposures started at $T+99$ s. No afterglow is detected at the position of the XRT afterglow (Beardmore *et al.*, *GCN Circ.* 9288). 3-sigma upper limits for detecting a source in the white finding chart and the co-added images, using a 5 arcsecond radius circular aperture, are:

Filter	Tstart (s)	Tstop (s)	Exposure (s)	Magnitude
white (fc)	99	249	150	>21.0
white	591	10856	1241	>22.2
v	640	12550	1213	>20.6
b	567	6769	381	>20.8
u	311	6621	669	>20.8
uvw1	690	6416	419	>20.5
uvm2	665	6211	439	>21.4
uvw2	616	11762	1339	>20.3

Table 1: Magnitude limits from UVOT observations

The quoted upper limits have not been corrected for the expected Galactic extinction corresponding to a reddening of $E_{B-V} = 0.015$ in the direction of the XRT position (Schlegel, *et al.* 1998, *ApJS*, 500, 525). All photometry is on the UVOT photometry system described in Poole *et al.* (2008, *MNRAS*, 383, 627).

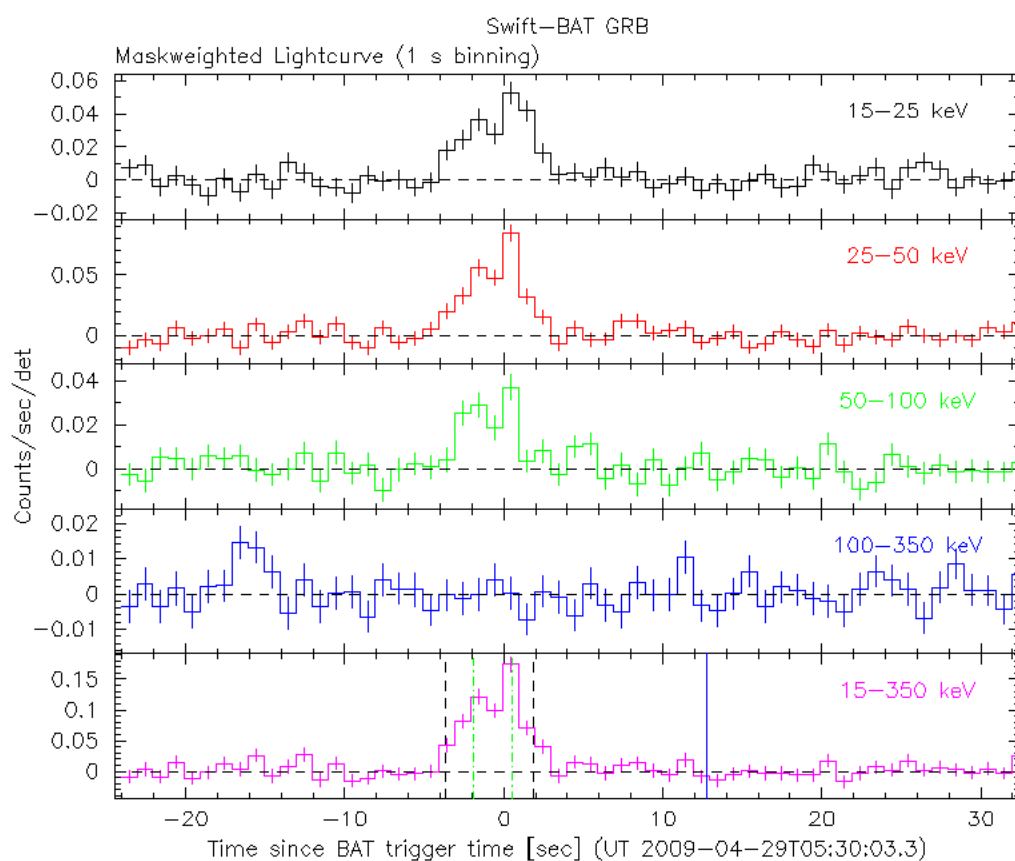


Figure 1: The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T_0 is 05:30:03 UT.

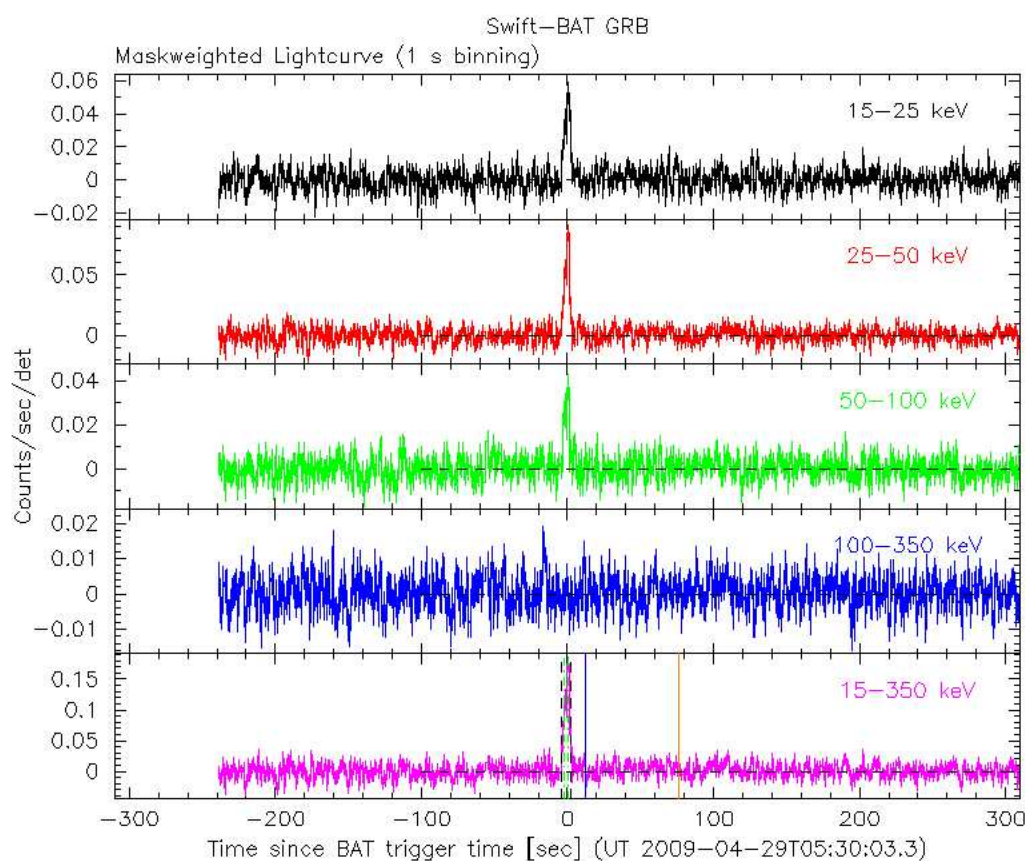


Figure 2: The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T_0 is 05:30:03 UT.

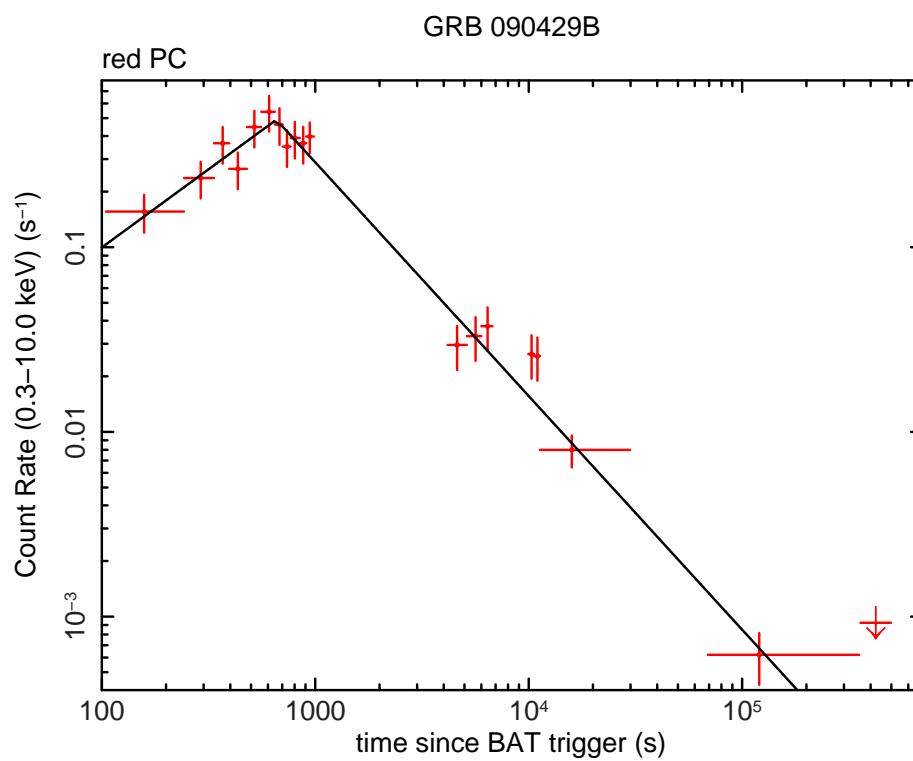


Figure 3: XRT Lightcurve. Counts/sec in the 0.3 – 10 keV band. The approximate conversion is 1 count/sec = $\sim 3.8 \times 10^{-11}$ ergs/cm²/sec.