

Swift Observation of GRB 091020

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1 Introduction

BAT triggered on GRB 091020 at 21:36:44 UT (Trigger 373458) (Racusin, *et al.*, *GCN Circ.* 10048). This was a rate-trigger on a intermediate length burst with $T_{90} = 34.6$ sec. Swift slewed to this burst immediately and XRT began follow-up observations at $T + 81$ sec, and UVOT at $T + 89$ sec. Our best position is the UVOT location $RA(J2000) = 175.760deg$ (11h42m55.2s), $Dec(J2000) = +50.97833deg$ (+50d58'42.0") with an error of 0.5 arcsec (radius, 90% confidence).

2 BAT Observation and Analysis

Using the data set from $T - 240$ to $T + 962$ sec, further analysis of BAT GRB 091020 has been performed by Swift BAT team (Palmer, *et al.*, *GCN Circ.* 10051). The BAT ground-calculated position is $RA(J2000) = 175.727deg$ (11h42m54.4s), $Dec(J2000) = +50.977deg$ (+50d58'36.6") with an error of 1.0 *arcmin*, (radius, systematic and statistical, 90% containment).

The mask-weighted light curves (Fig.1) began with a small hump at $T - 10$ sec, rising sharply to a peak at $T + 2$ sec and decaying exponentially out to $T + 50$ sec, with a much smaller peak superimposed at $T + 33$ sec. T_{90} (15 – 350 keV) is 39.0 ± 4.9 sec (estimated error including systematics).

The time-averaged spectrum from $T - 8.7$ to $T + 38.3$ sec is best fitted by a simple power law model. The power law index of the time-averaged spectrum is 1.53 ± 0.07 . The fluence in the 15 – 150 keV band is $3.7 \pm 0.1 \times 10^{-6}$ *ergs/cm²*. The 1-sec peak photon flux measured from $T + 1.14$ sec in the 15 – 150 keV band is 4.2 ± 0.3 *ph/cm²/sec*. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

Using 1088 sec of XRT Photon Counting mode data and 1 UVOT image for GRB 091020, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): $RA(J2000) = 175.73005deg$ (11h42m55.21s), $Dec(J2000) = +50.97839$ (+50d58'42.2") with an error of 1.8 *arcsec* (radius, 90% confidence). This position is within 4.0 *arcsec* of the initial XRT position, and 0.2 *arcsec* from the optical afterglow candidate, reported by Oates *et al.*, *GCN Circ.* 10054.

The 0.3 – 10 keV light curve (Fig.2) shows an initial steep decline with a slope of $3.5_{-0.4}^{+0.7}$, following by a shallower slope of 0.89 ± 0.04 , beginning at $T + 135 \pm 20$ sec. At $(6.7_{-1.1}^{+0.9}) \times 10^3$ sec the light curve breaks with a slope of 1.38 ± 0.04 . There is a small flare superimposed at $T + 190$ sec.

Three segments of the X-ray lightcurve can be modeled with an absorbed power-law with spectral indices of 2.34 ± 0.14 , 2.15 ± 0.13 , and $2.22_{-0.08}^{+0.07}$, respectively. The best fitted absorption column at a redshift of 1.7 (Xu, *et al.*, *GCN Circ.* 10053) is $9.4_{-2.0}^{+2.1} \times 10^{21}$, $5.4_{-1.7}^{+1.8} \times 10^{21}$, and $6.4_{-1.0}^{+0.9} \times 10^{21}$ *cm⁻²*, respectively in addition to the Galactic value (1.4×10^{20} *cm⁻²*).

The average observed (unabsorbed) flux over 0.3–10 keV for the three spectral intervals corresponding to the light curve segments excluding the flare (spanning a time of 80 – 120, 300 – 6500, 6500 – 1×10^6 seconds after the trigger, respectively) is 1.1×10^{-9} , 5.0×10^{-11} , 9.8×10^{-13} (1.7×10^{-9} , 6.4×10^{-11} , 1.3×10^{-12}) *ergs/cm²/sec*, respectively.

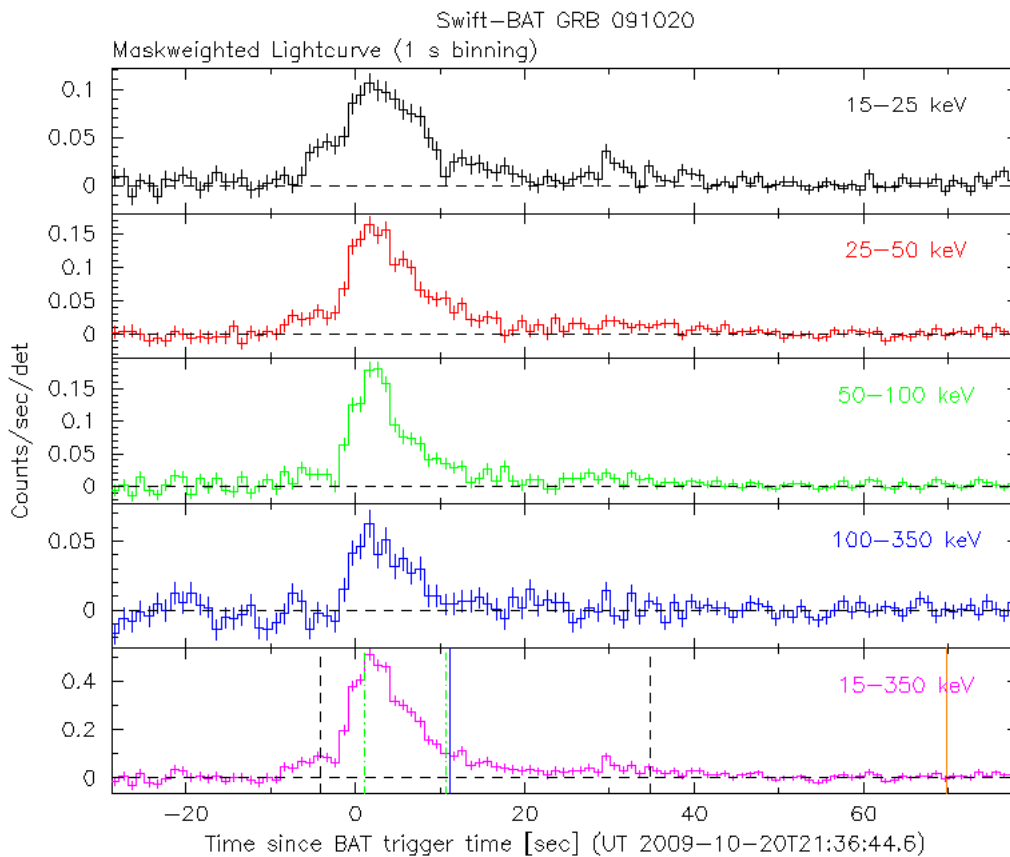


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T_0 is 21:36:44 UT.

4 UVOT Observation and Analysis

The UVOT began observing the field of GRB 091020 at 21:38:13 UT, 89 sec after the initial BAT trigger (Racusin *et al.*, *GCN Circ.* 10048). We detect the optical afterglow in all filters at the refined UVOT position $RA(J2000) = 175.760deg$ (11h42m55.2s), $Dec(J2000) = +50.97833deg$ (+50d58'42.0") with an error of 0.5 arcsec (radius, 90% confidence). This position is consistent with the enhanced XRT position (Beardmore *et al.*, *GCN Circ.* 10050). The detection in the *white*, *v*, *b* and *u* filters and the weak detection in the *uvw1* filter is consistent with a redshift $z \sim 1.7$, which is consistent with the redshift reported by NOT (Xu, *et al.*, *GCN Circ.* 10053).

The multi-filter UVOT light curve (Figure 3) shows an initial rise followed by a power-law decay with similar shape to that of the XRT light curve. These magnitudes are not corrected for the Galactic extinction corresponding to a reddening of $E_{B-V} = 0.02$ mag (Schlegel *et al.*, 1998, *ApJS*, 500, 525). The photometry is on the UVOT photometric system described in Poole *et al.* (2008, *MNRAS*, 383,627).

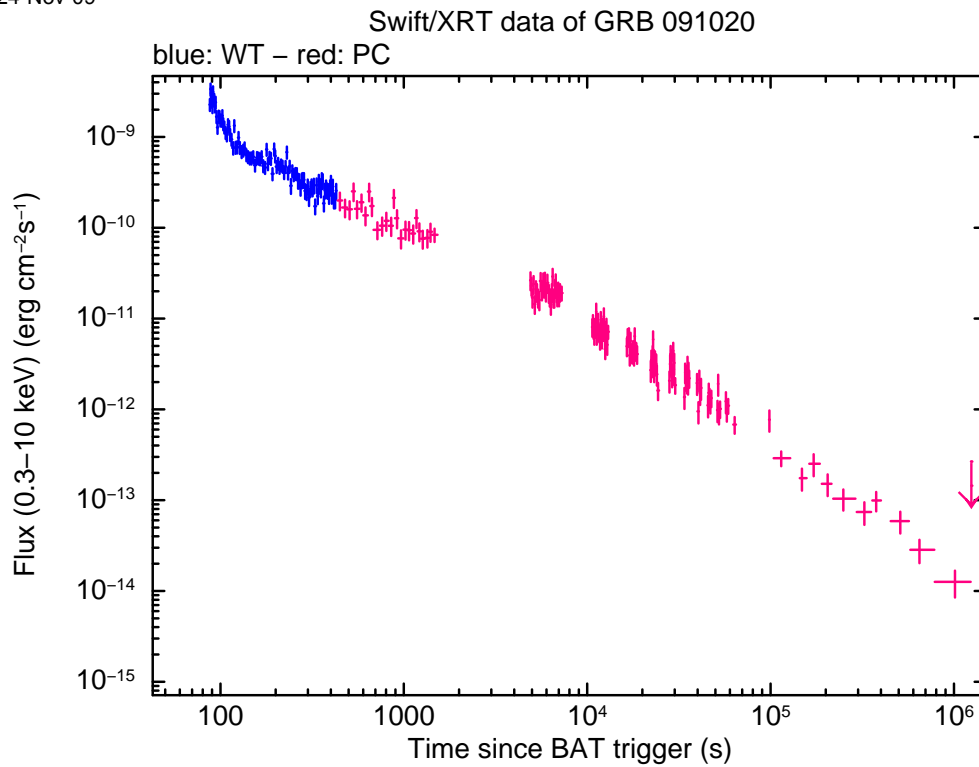


Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate observed (unabsorbed) conversion is $1 \text{ count/sec} = \sim 3.4 \times 10^{-11}$ ($\sim 4.4 \times 10^{-11}$) $\text{ergs/cm}^2/\text{sec}$.

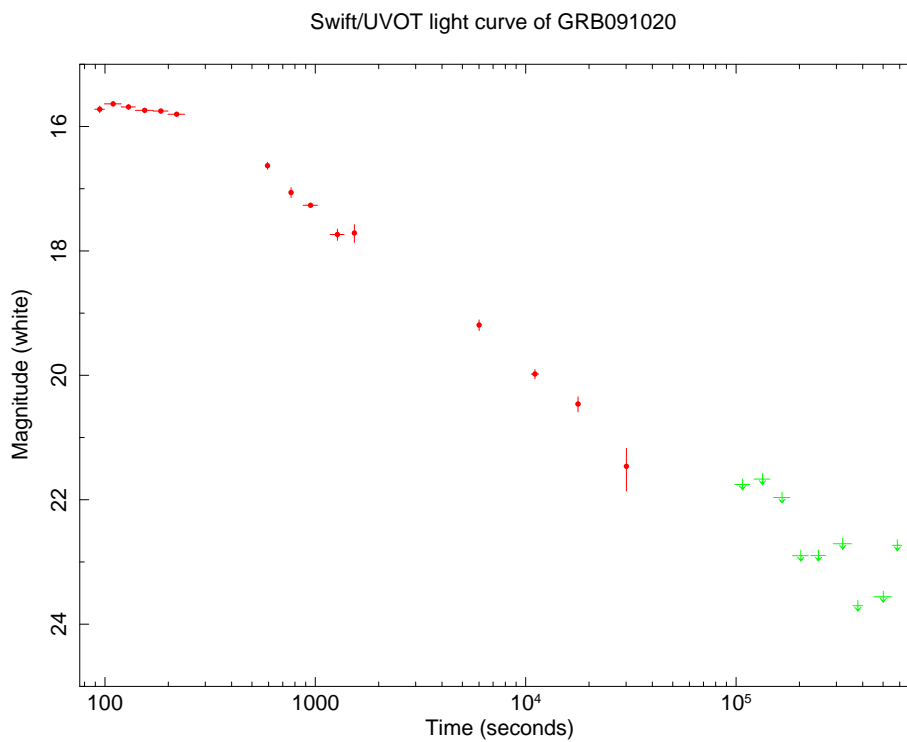


Figure 3: UVOT white filter light curve. The red points are detections, and the green points are 3-sigma upper limits.