

Swift Observations of GRB 070220

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1 Introduction

At 4:44:33 UT, on February 20, 2007, BAT triggered on GRB 070220 (trigger #261299) (Stamatikos et al., GCN Circ. 6114). This was a bright, long GRB with a T90 of 129 seconds in BAT. Swift slewed immediately allowing for XRT and UVOT follow-up observations at T+79 and T+88 seconds, respectively. Our best astrometrically corrected position is that of the XRT afterglow located at RA, DEC (J2000) = 2h 19m 6.83s, +68d 48' 16.1", with a 90% confidence level uncertainty error radius of 2 arcsec, as given in Beardmore et al., GCN Circ. 6118.

2 BAT Observations and Analysis

Using the data set from T-240 to T+962 seconds telemetry down links, further analysis of BAT GRB 070220 was performed by the Swift team (Parsons et al., GCN Circ. 6121). The BAT ground-calculated position is RA, Dec (J2000) = 34.800 (2h 19m 11.9s), +68.800 deg (+68d 48' 1.6") with an uncertainty of 1 arcmin, (radius, sys+stat, 90% containment). The partial coding was 64%.

The mask-weighted light curve (Figure 1), shows a multiple peaked structure. T90 (15-350 keV) is 129 ± 6 seconds (estimated error including systematics). The time-averaged spectrum from T-17 to T+240 seconds is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.45 ± 0.04 . The fluence in the 15-150 keV band is $1.06 \pm 0.02 \times 10^{-5}$ ergs/cm². The 1-sec peak photon flux measured from T+12 seconds in the 15-150 keV band is 5.88 ± 0.29 photons/cm²/s. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

The XRT began observing the field at 4:45:51 UT, 79 seconds after the BAT trigger. Using the first two orbits of Swift-XRT data available for GRB 070220, which were obtained prior to the satellite entering the Malindi Gap, further analysis was performed by the Swift team (Beardmore et al., GCN Circ. 6118), based upon a total exposure of 217 seconds in Window Timing (WT) mode and 4090 seconds in Photon Counting (PC) mode.

Using the PC data, we find a refined XRT position, which has been astrometrically corrected by matching the UVOT images with the USNO-B1 catalog, of RA, DEC (J2000) = 2h 19m 6.83s, +68d 48' 16.1", with an uncertainty of 2.0 arcsec (90% confidence). This position is 72.0 arcsec and 3.0 arcsec away from the original BAT and XRT positions, respectively, as quoted in Stamatikos et al., GCN Circ. 6114.

The 0.3 – 10.0 keV X-ray light curve (Figure 2) out to T+63 ks can be fit by a double broken power law, with parameters: $\alpha_1 = 1.76 \pm 0.06$, $t_b^1 = 407_{-47}^{+38}$ sec, $\alpha_2 = 1.01 \pm 0.04$, $t_b^2 = 15.2_{-2.3}^{+1.8}$ ksec, and $\alpha_3 = 2.63 \pm 0.38$. The requirement for the second break causes the count rate predictions to be attenuated as follows: T+24^h $\sim 1.1 \times 10^{-3}$ counts/s, T+48^h $\sim 1.7 \times 10^{-4}$ counts/s, and T+72^h $\sim 6.0 \times 10^{-5}$ counts/s.

The WT spectrum from T+85s to T+294s can be modeled by an absorbed power law, with a photon index of 1.55 ± 0.08 and a column density of $(4.9 \pm 0.5) \times 10^{21}$ cm⁻² (compared with the Galactic

value in this direction of $3.8 \times 10^{21} \text{ cm}^{-2}$). The $0.3 - 10.0 \text{ keV}$ observed flux over this time interval is $(1.21 \pm 0.05) \times 10^{-9} \text{ ergs/cm}^2/\text{sec}$, which corresponds to an unabsorbed flux of $(1.65 \pm 0.10) \times 10^{-9} \text{ ergs/cm}^2/\text{sec}$. With a count rate of 17.0 count/s for this spectrum, we estimate a count to unabsorbed flux conversion factor of $9.7 \times 10^{-11} \text{ ergs/cm}^2/\text{sec}$.

4 UVOT Observations and Analysis

No new optical source was found in any of the UVOT observations, inside the refined 2 arcsec XRT error circle given in Beardmore et al., GCN Circ. 6118, either in the first white filter exposure or in the summed exposures in all filters up to $\sim T+2^h$. Upper limits, summarized in table 1, derived for the initial White filter exposure as well as for the co-added exposures in all filters, have been reported in de Pasquale and Stamatikos et al., GCN Circ. 6120.

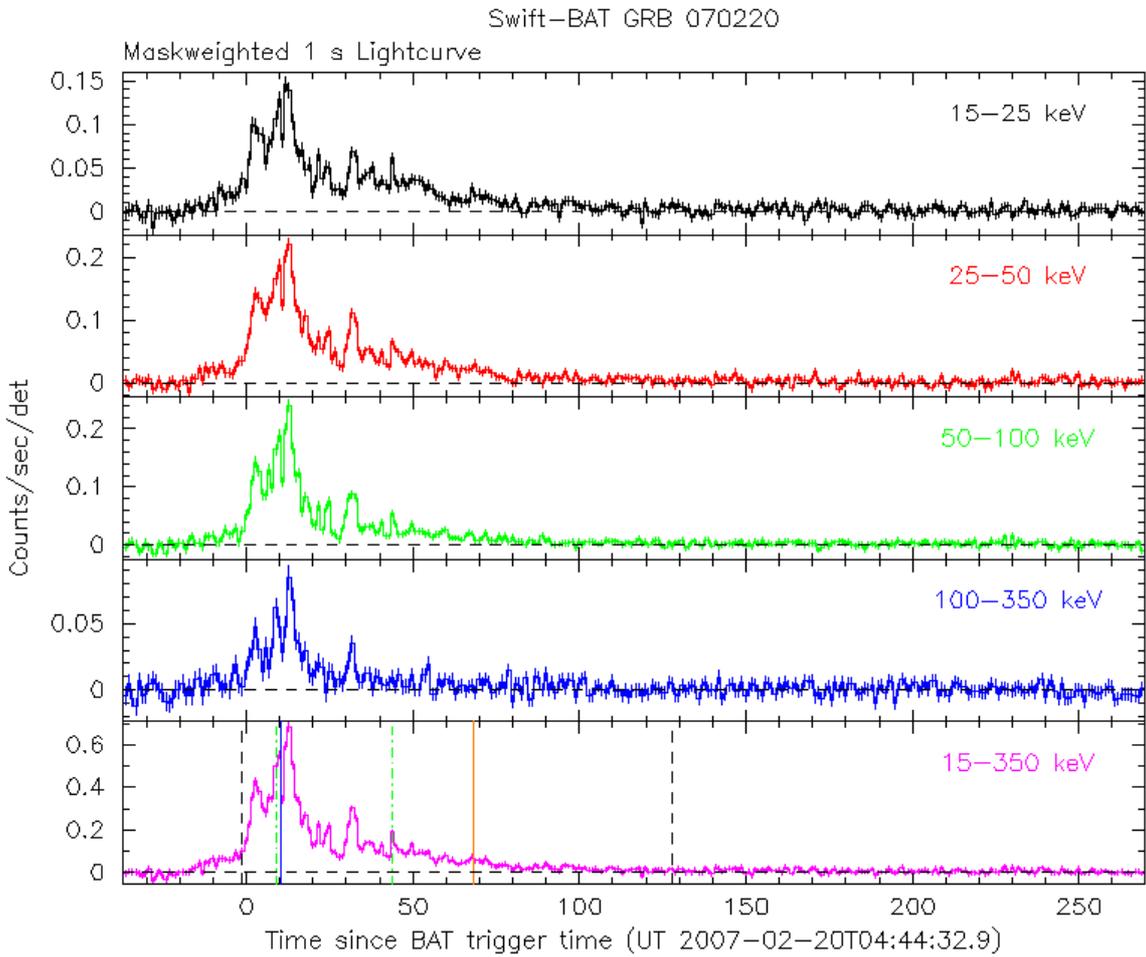


Figure 1: BAT Light curve for GRB 070220. The mask-weighted light curve in the 4 individual plus total energy bands. The green and black dotted lines bracket the T50 and T90 intervals, respectively, while the blue and orange solid lines bracket the start and end of the slew, respectively. The time of each bin is in the middle of the bin. The units are counts/sec/illuminated-detector and T_0 is 4:44:33 UT.

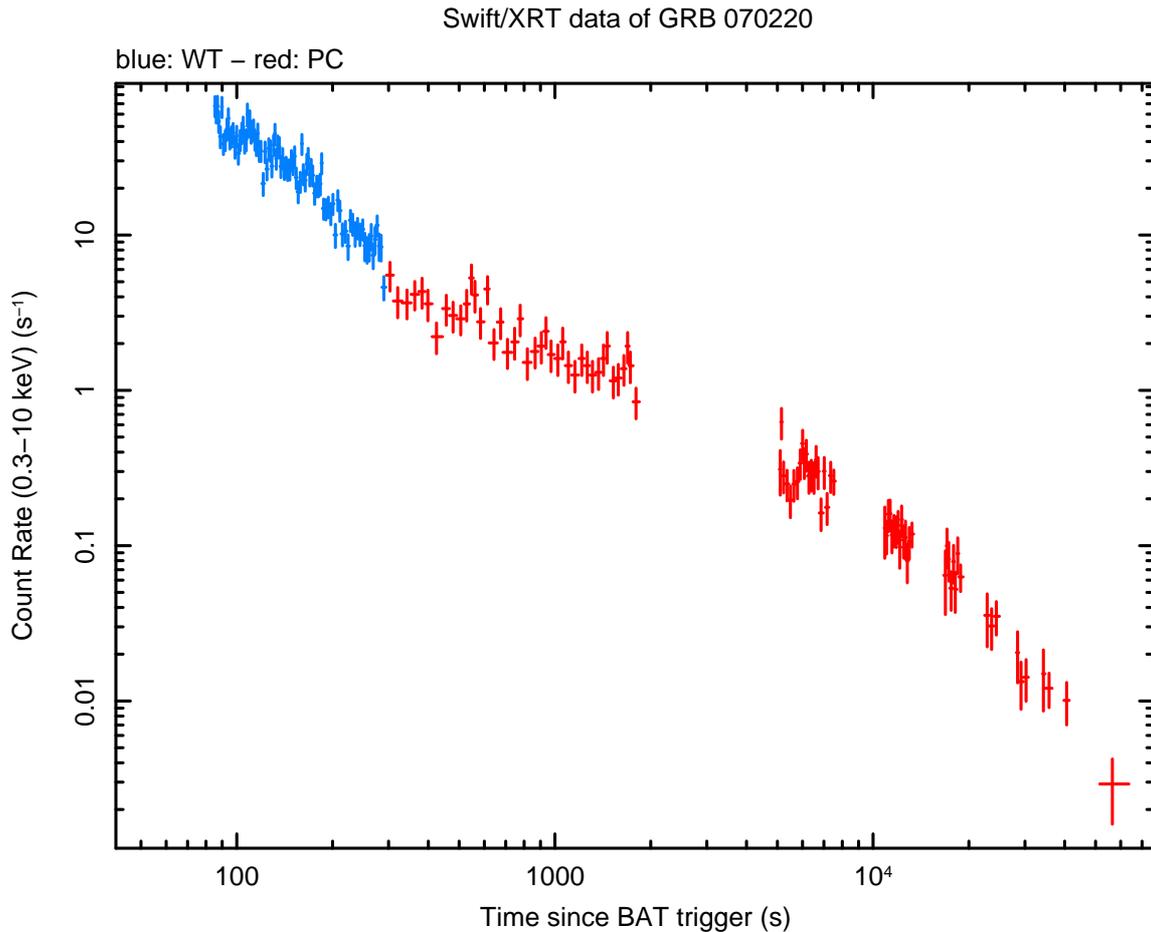


Figure 2: XRT Lightcurve for GRB 070220. Counts/sec in the 0.3 – 10 keV band. Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is $1 \text{ count/sec} \approx 9.7 \times 10^{-11} \text{ ergs/cm}^2/\text{sec}$.

Filter	T_{Start} (sec)	T_{Stop} (sec)	Exposure Time (sec)	3σ U.L. (Magnitude)
White (finding)	90	190	98	19.6
V	195	7101	1278	20.0
B	673	6487	276	20.2
U	649	7627	410	20.0
UVW1	625	7510	498	19.7
UVM2	601	7306	498	20.1
UVW2	701	6897	498	20.1
White	90	6691	638	20.6

Table 1: Optical afterglow magnitude upper limits from UVOT observations of GRB 070220. Note that the magnitudes have not been corrected for the expected Galactic extinction of $A_V \sim 2 \text{ mag}$, corresponding to a reddening of $E_{B-V} = 0.9 \text{ mag}$ towards the direction of the burst (Schlegel et al., ApJ 500: 525-553, 1998).