Swift Observations of GRB 061121

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1 Introduction

BAT triggered on and located GRB 061121 at 15:22:29UT (trigger=239899; Page et al., GCN Circ. 5823) and slewed immediately. The trigger itself was actually a pre-cursor to a larger event, thus the narrow field instruments were on target in time for the main burst, about 70 seconds later. The best Swift position is that determined from the UVOT detection of the afterglow at RA(J2000) = 09h 48m 54.55s, Dec(J2000) = −13d 11' 42.4" with a 90% confidence interval of 0.6 arcsec (Marshall et al., GCN Circ. 5833). Bloom, Perley & Chen (GCN Circ. 5826) reported a spectroscopic redshift of 1.314 from the Keck I 10m telescope + LRIS.

2 BAT Observation and Analysis

The BAT ground-calculated position is RA(J2000) = 147.228 deg (09h 48m 54.8s), Dec(J2000) = −13.188 deg (−13d 11' 16.6") +/- 0.9 arcmin, (radius, sys+stat, 90% containment). The partial coding was 100%.

The mask-weighted light-curve (Fig. 1) starts with a small smooth pulse at T-5 s and returns to instrumental background level at T+20 s. The second, and much brighter, pulse started at T+50 s with a series of overlapping peaks, the last of which was the brightest. Then there was a roughly exponential decay out to T+200 s. T90 (15-350 keV) is 81 +/- 5 s (estimated error including systematics).

The time-averaged spectrum from T-0.8 to T+121.8 is best fit by a simple power-law model. The power-law index of the time-averaged spectrum is 1.41 +/- 0.03. The fluence in the 15-150 keV band is (1.37 +/- 0.02) × 10^{-5} erg cm^{-2}. The 1-s peak photon flux measured from T+74.48 s in the 15–150 keV band is 21.1 +/- 0.5 ph cm^{-2} s^{-1}.

The isotropic equivalent energy using the reported redshift of 1.314 (GCN Circ. 5826) is 7e52 erg in the 35 keV – 347 keV band at the GRB rest frame.

All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

The XRT began observing the burst 55 seconds after the initial trigger.

Using ∼3.2 ks of Photon Counting (PC) data from the first two orbits of data, we derive a refined position of RA(J2000) = 09h 48m 54.54s, Dec(J2000) = −13d 11' 42.4", with an estimated error radius of 3.5 arcsec (90% confidence, using the updated teldef file as described by Burrows et al. in GCN Circ. 5750). This is 26.1 and 0.1 arcsec from the ground-calculated BAT and refined UVOT positions respectively.

During the main burst (∼74s after the trigger), the detected X-ray emission peaked at a count rate of ∼2400 count s^{-1} (corrected for pile-up; Fig. 2). After 200s, the decay follows a slope of $\alpha_1 = 0.36$ +/- 0.07, until about 3 ks after the trigger, when the decay steepens to $\alpha_2 = 1.4$ +/- 0.4.

The Windowed Timing mode data between 200 and 600s after the trigger (i.e., when the data are clearly no longer piled-up) can be fitted with a photon index of 2.25 +/- 0.12, with a total absorbing

column of 2.3e21 cm^{-2}; comparison with the PC data from orbit 2 shows no further spectral evolution. This absorption is significantly in excess of the Galactic value of 5.1e20 cm^{-2}. Taking the redshift to be 1.314 (GCN Circ. 5826), the excess NH is equivalent to a value of 9.6e21 cm^{-2} in the rest-frame of the burst. The observed (unabsorbed) flux for this spectrum is 2.51e-10 (3.81e-10) erg cm^{-2} s^{-1}.

All the quoted errors are at the 90% confidence level.

4 UVOT Observation and Analysis

The UVOT began observing the field 62 s after the BAT trigger. An optical counterpart was detected in the White filter (160-650 nm) at a position RA(J2000) = 09h 48m 54.55s, Dec(J2000) = −13d 11' 42.4" with a 90% confidence interval of 0.6 arcsec.

The afterglow was detected in each of the UVOT filters, and was still easily detected in the White filter 7026 seconds after the BAT trigger.

The early photometry results are given in Table 1, where Midpoint is the average time of the exposure, in seconds, since the BAT trigger. The quoted errors do not include the 0.1 mag systematic uncertainty in the photometric zero points. The values quoted are not corrected for the expected Galactic extinction of E(B-V) = 0.04 mag (Schlegel et al. 1998).

Fig. 3 shows the UVOT finding chart for this burst, while Fig. 4 plots the light-curve in the White, V, B and U filters.

Filter	Midpoint	Exposure	Mag	Err
V	368	393	17.06	0.05
B	650	10	17.7	0.2
U	631	10	17.2	0.2
UVW1	4981	197	19.6	0.2
UVM2	6208	197	19.8	0.3
UVW2	5800	197	20.4	0.3
White	112	98	16.23	0.03
White	7026	197	18.7	0.1

Table 1: UVOT magnitudes in all filters.

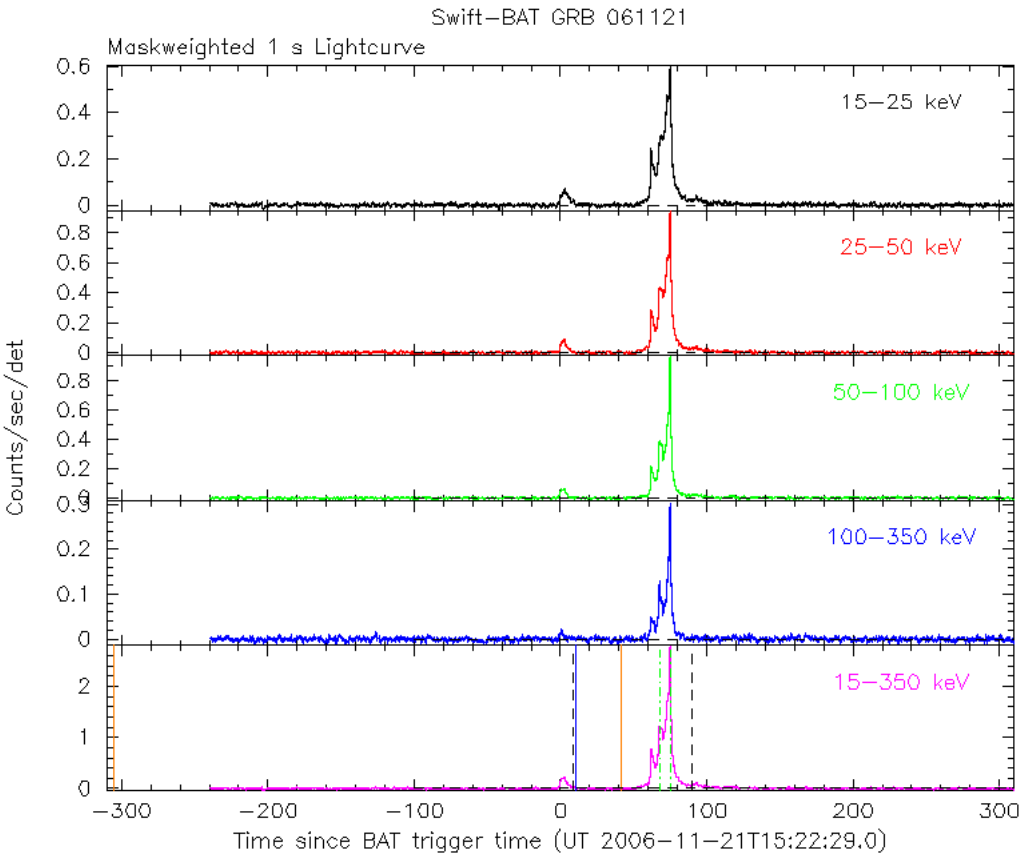

Figure 1: BAT light-curve. The mask-weighted light-curve in the 4 individual plus total energy bands. The units are counts/s/illuminated-detector (note illum-det = 0.16 cm^2) and T_0 is 15:22:29 UT.

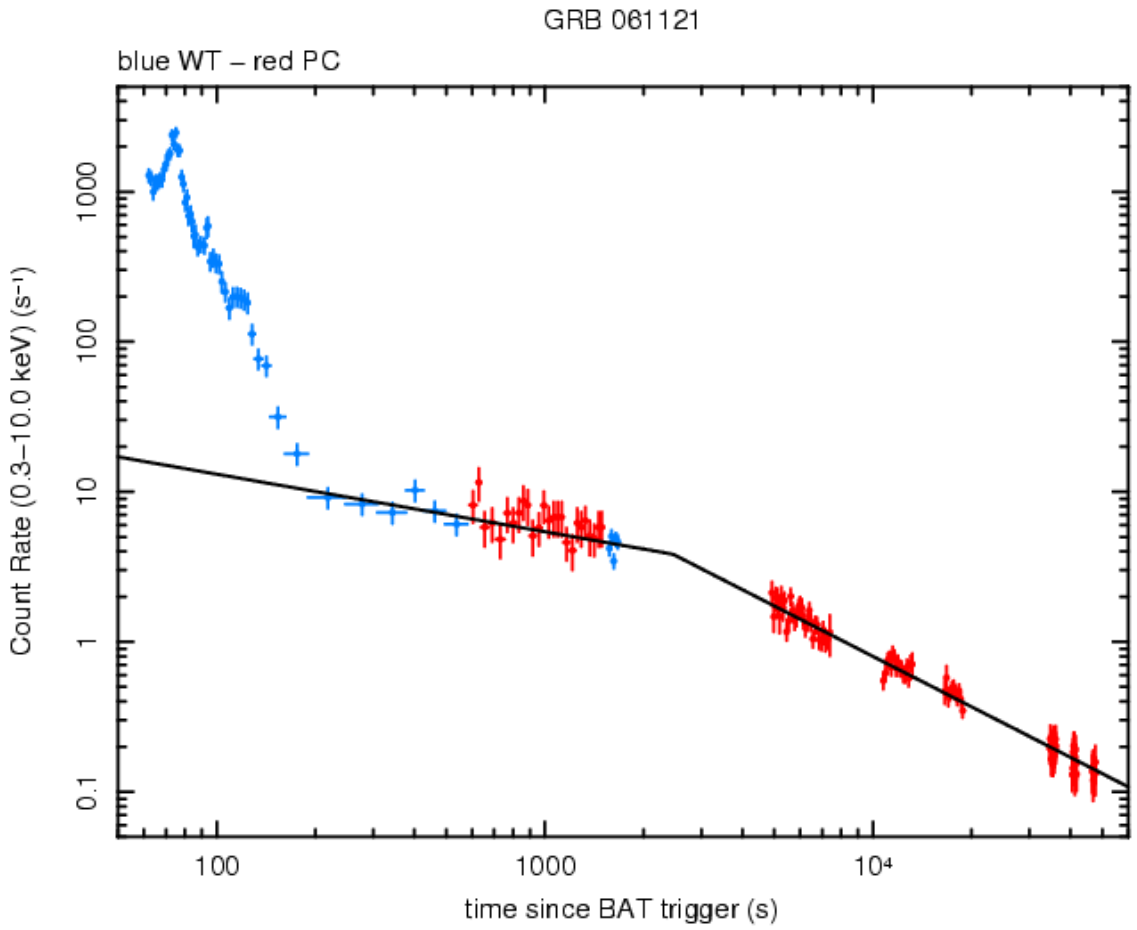

Figure 2: XRT light-curve. Count rate light-curve in the 0.3-10 keV band: Windowed Timing mode is shown in blue, Photon Counting mode in red. Fitting from 200 s onwards, the decay slope, $\alpha_1 = 0.36$ +/- 0.07, until about 3 ks after the trigger, when it steepens to $\alpha_2 = 1.4$ +/- 0.4 The approximate counts to flux conversion is 1 count $s^{-1} = 3.8 \times 10^{-11}$ erg cm^{-2} s^{-1}.

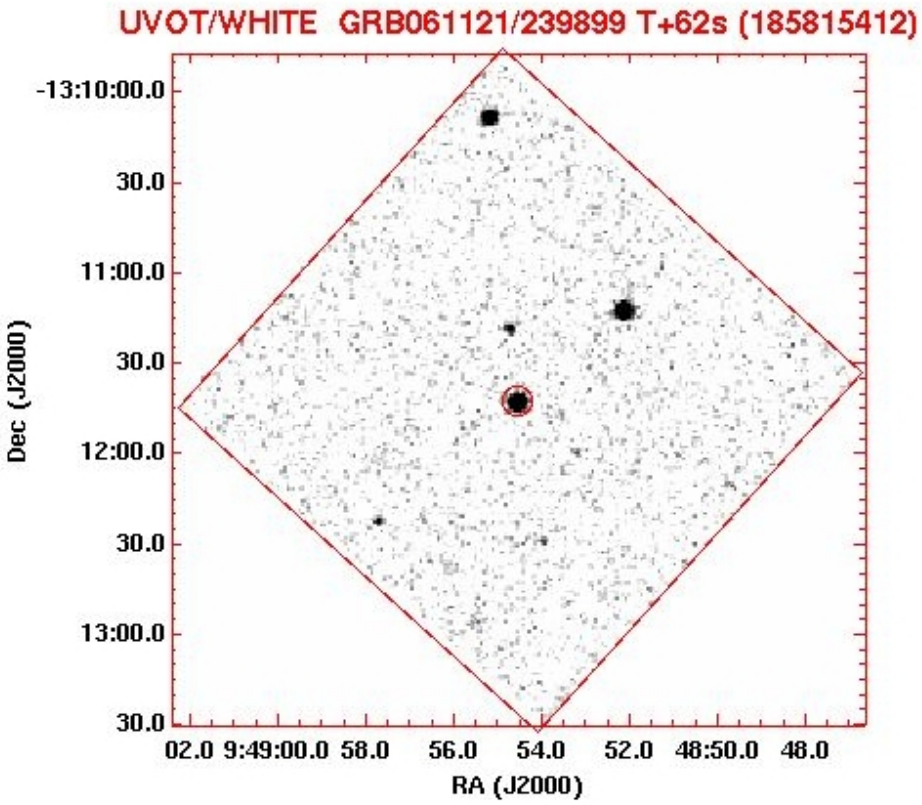

Figure 3: UVOT finding chart. The plot shows the initial 100-sec exposure with white filter. The afterglow is identified with the red circle.

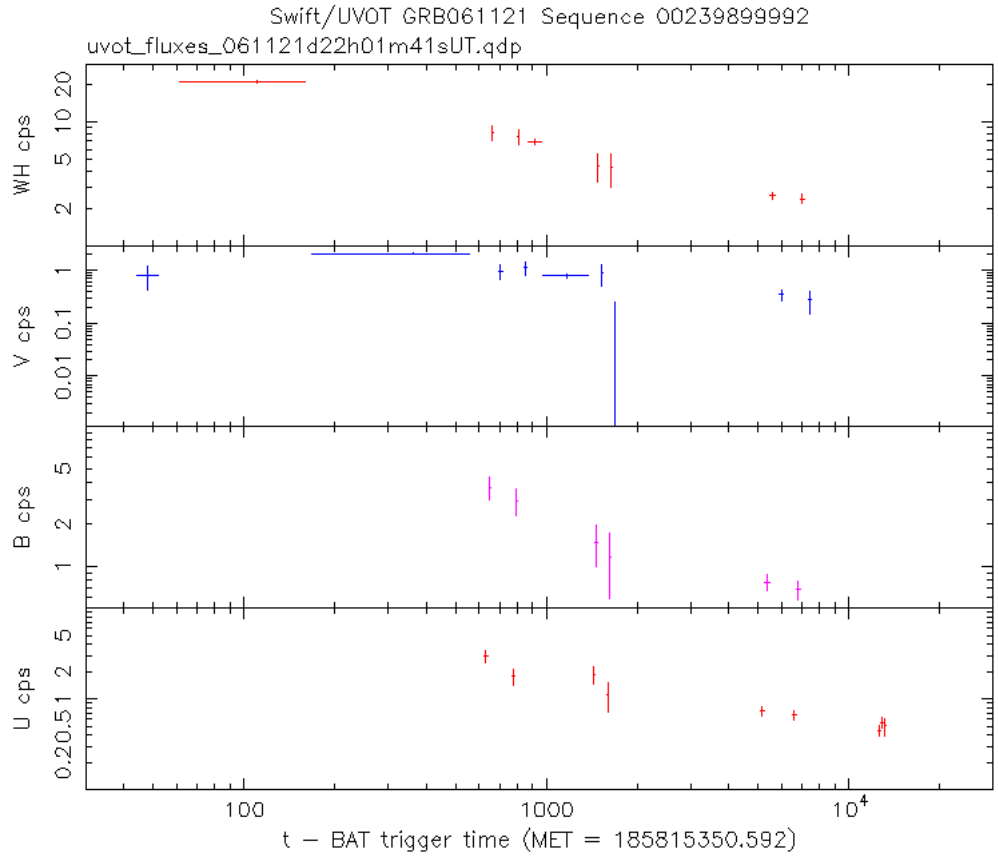

Figure 4: UVOT light-curve. Count rates in the White, V, B, and U filters for the initial ∼10 ks are shown. Note that the rates have not been corrected for anti-coincidence loss.