

Swift Observations of GRB 070518

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1 Revisions

- Updated XRT light curve with data up to 1.7×10^6 s.
- Updated figure with UVOT light curves.
- Added description of the optical decay behaviour at late times.

2 Introduction

BAT triggered on GRB 070518 at 14:26:21 UT (Trigger 279592; Guidorzi, *et al.*, *GCN Circ.* 6415). This was a 1.024-s rate-trigger on a long burst. XRT observations began at $T + 70$ s and discovered the X-ray afterglow. UVOT began observing at $T + 82$ s and found the optical counterpart with the White filter with ~ 18 mag. Our best position is the UVOT location RA(J2000)= 254.1986 deg ($16^{\text{h}}56^{\text{m}}47.7^{\text{s}}$), Dec(J2000)= +55.2951 deg ($+55^{\text{d}}17'42.3''$) with an error of 1 arcsec (90% confidence).

The optical afterglow was still detected at $T + 86$ hr with $R = 23.56 \pm 0.05$ by the Large Binocular Telescope (LBT); the light curve from 10 minutes to 100 hours can be fit with a power law with index 0.95 ± 0.05 superposed to a host galaxy of $R = 23.8 \pm 0.1$ mag (Garnavich *et al.*, *GCN Circ.* 6462).

3 BAT Observation and Analysis

Using the data set from $T - 119$ s to $T + 183$ s from recent telemetry downlinks, the BAT ground-calculated position is RA(J2000) = 254.221 deg ($16^{\text{h}}56^{\text{m}}52.9^{\text{s}}$), Dec(J2000)= +55.285 deg ($+55^{\text{d}}17'05.6''$) with an error of 1.8 arcmin (radius, sys+stat, 90% containment). The partial coding was 84%.

The mask-weighted lightcurves (Fig. 1) show a single peak starting a $\sim T - 5$ s and ending at $\sim T + 10$ s. T_{90} (15–350 keV) is 5.5 ± 0.2 s (estimated error including systematics).

The time-averaged spectrum from $T - 1.8$ s to $T + 4.5$ s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.11 ± 0.25 . The fluence in the 15–150 keV band is $(1.6 \pm 0.2) \times 10^{-7}$ erg cm^{-2} . The 1-s peak photon flux measured from $T + 0.12$ s in the 15–150 keV band is 0.7 ± 0.1 ph cm^{-2} s^{-1} . All the quoted errors are at the 90% confidence level (Krimm *et al.*, *GCN Circ.* 6417).

4 XRT Observations and Analysis

Using the data from the first two orbits of XRT data of GRB 070518 (4.2 ks in Photon Counting mode), the refined XRT position is RA(J2000) = 254.1980 deg ($16^{\text{h}}56^{\text{m}}47.52^{\text{s}}$), Dec(J2000)= +55.2944 deg ($+55^{\text{d}}17'40.0''$) with an error radius of 3.9 arcsec (90% confidence). This is 2.5 arcsec from the initial X-ray position (Guidorzi *et al.*, *GCN Circ.* 6415), 2.8 arcsec from the UVOT position and 57 arcsec from the BAT refined position (Krimm *et al.*, *GCN Circ.* 6417).

The final XRT light curve (Fig. 2) was derived from 185 ks total net exposure, lasting from $T + 70$ s to $T + 1.7 \times 10^6$ s. After an initial flaring behaviour up to $T + 200$ s, we modelled the subsequent light

curve with a single component of the model by Willingale *et al.* (2007) [1], and found a transition time from the exponential to the power-law component of $T_c = 49_{-23}^{+36}$ ks, and a final power-law index of $\alpha_c = 0.89_{-0.15}^{+0.21}$. The parameter t_c , characterising the exponential component, $\exp(-t_c/t)$, turned out to be negative, $t_c = -1420 \pm 60$ s. While this parameter lost the meaning of rise time (no rise), the model provides a good description ($\chi^2/\text{dof} = 27.0/23$).

Alternatively, we tried to fit the light curve from $T + 200$ s with a broken power law, but the fit was bad ($\chi^2/\text{dof} \geq 43.25/23$, null hypothesis probability ≤ 0.6 %).

The last point shown in Fig. 2 is a $3\text{-}\sigma$ upper limit.

Notably, the final power-law index is the same as that measured contemporaneously in the optical, 0.95 ± 0.05 (Garnavich *et al.*, *GCN Circ.* 6462).

We extracted two spectra from the WT data during the flaring activity, due to a strong spectral evolution. The first spectrum, from 77 s to 158 s, can be fit with an absorbed power law with a photon index of $\Gamma_1 = 2.3 \pm 0.1$ and column density of $(9.6 \pm 1.6) \times 10^{20} \text{ cm}^{-2}$ significantly in excess of the Galactic value ($2.2 \times 10^{20} \text{ cm}^{-2}$; Dickey & Lockman, 1990). The second spectrum, from 165 s to 253 s, has a photon index of $\Gamma_2 = 2.9 \pm 0.1$ and same column density as that of the first spectrum.

The absorbed (unabsorbed) 0.3–10.0keV flux for the first spectrum is 5.1×10^{-10} (7.2×10^{-10}) $\text{ergs cm}^{-2} \text{ s}^{-1}$.

Detailed light curves in both count rate and flux units are available in both graphical and ASCII formats at http://www.swift.ac.uk/xrt_curves/.

5 UVOT Observation and Analysis

The Swift UVOT began observing the field of GRB 070518 82 s after the trigger. The afterglow was clearly detected in all the 7 filters. This suggests a redshift lower than 0.7.

The estimated magnitudes and $2\text{-}\sigma$ upper limits for all the filters are reported in Table 1 and shown in Fig. 3. The values are not corrected for the expected Galactic extinction corresponding to a reddening of $E_{B-V} = 0.017$ mag along the line of sight to the GRB (Schlegel *et al.* 1998).

Assuming a single power law, the decay index is $\alpha_V \sim 1.17$ in V band. The extrapolated V magnitude at $T + 10$ h is 22.59.

References

- [1] Willingale, R. *et al.* 2007, ApJ, accepted (astro-ph/0612031)

Filter	Start (s)	Exposure (s)	Mag
White	82	93	18.16 ± 0.06
White	680	10	19.47 ± 0.11
White	873	94	19.14 ± 0.09
White	1480	10	19.66 ± 0.56
White	1640	10	19.75 ± 0.53
White	5517	97	20.08 ± 0.14
White	6951	197	21.33 ± 0.20
V	187	391	19.31 ± 0.13
V	978	391	20.08 ± 0.24
V	1519	40	> 20.1
V	5927	363	21.05 ± 0.48
B	666	10	19.60 ± 0.59
B	816	29	20.28 ± 0.87
B	1617	20	20.93 ± 1.03
B	5313	195	19.38 ± 0.35
B	6747	197	21.43 ± 0.51
U	640	20	18.51 ± 0.27
U	791	39	19.72 ± 0.37
U	1592	20	19.45 ± 0.43
U	5108	196	20.57 ± 0.31
U	6542	196	20.34 ± 0.26
UVW1	617	39	18.65 ± 0.29
UVW1	1408	59	20.19 ± 0.5
UVW1	6336	197	20.73 ± 0.4
UVM2	1383	39	19.04 ± 0.42
UVM2	6131	534	20.98 ± 0.36
UVW2	695	39	19.46 ± 0.41
UVW2	1656	20	> 20.03
UVW2	5723	393	21.08 ± 0.35

Table 1: Magnitudes from UVOT observations. Upper limits are 2σ .

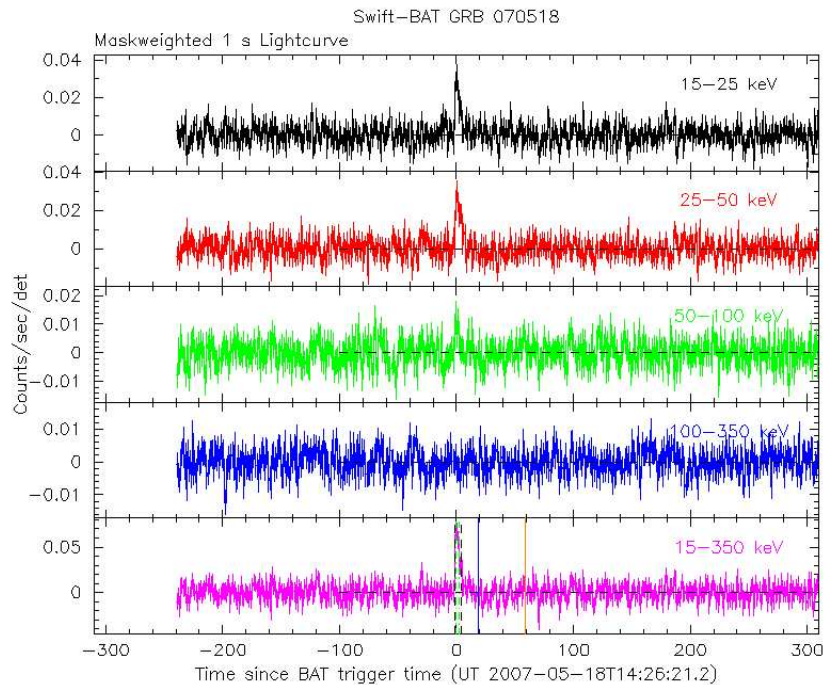


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/s/illuminated-detector (note illum-det = 0.16 cm^2) and T_0 is 14:26:21 UT.

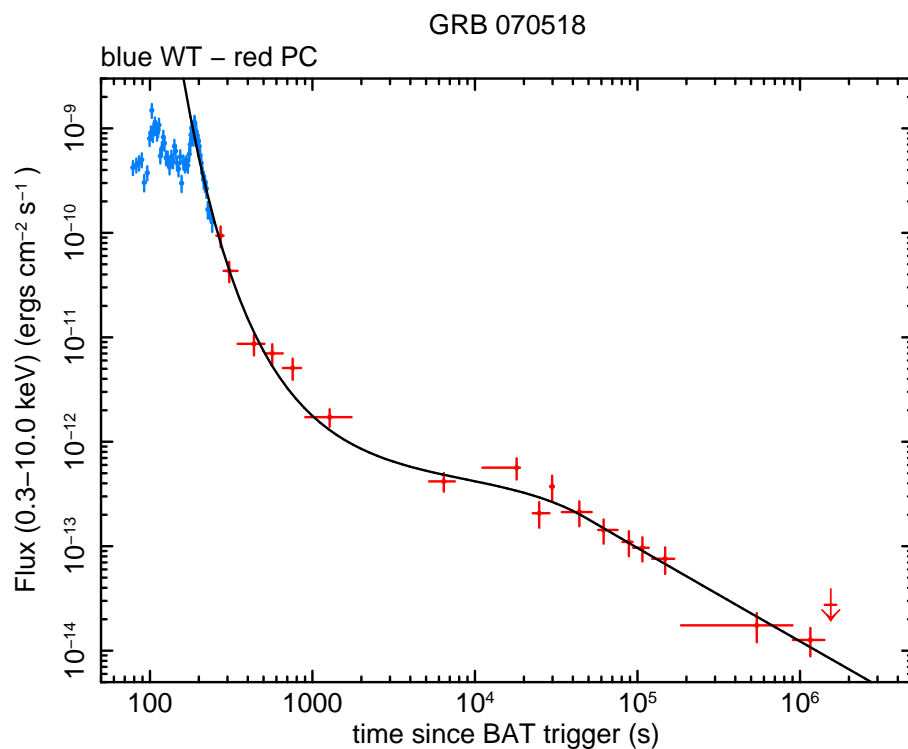


Figure 2: XRT Lightcurve. Flux in the 0.3-10 keV band: Windowed Timing (blue) and Photon Counting (red) modes. The approximate conversion is $1 \text{ count/s} \sim 3.2 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$.

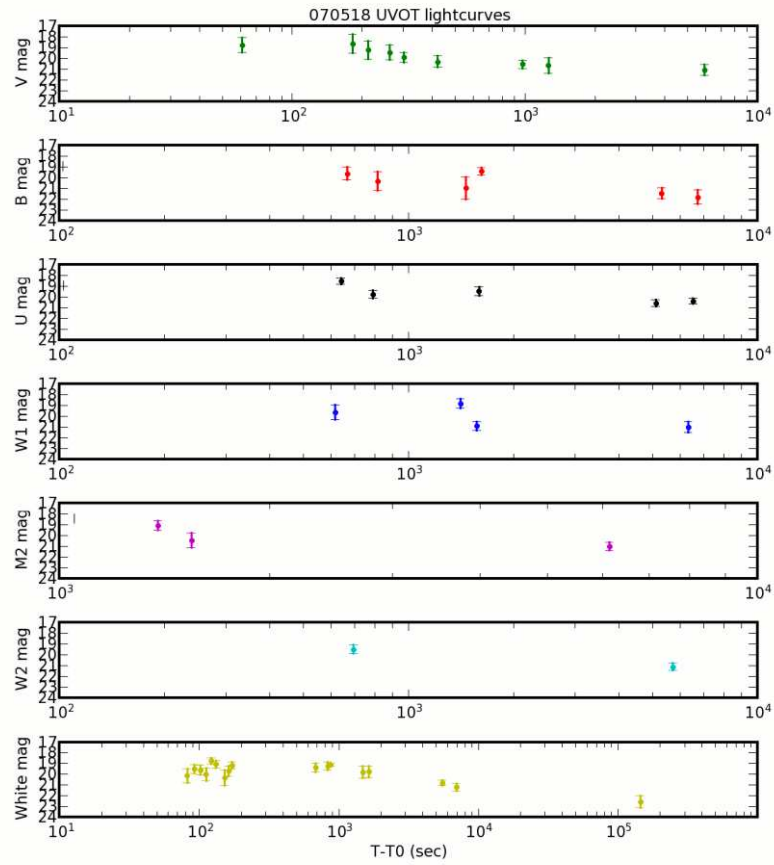


Figure 3: UVOT Lightcurve.