Swift Observation of GRB 070412

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1 Revisions

- Updated XRT light curve using data out to $T + 8 \times 10^5$s.

2 Introduction

BAT triggered on and located GRB 070412 at 01:27:03 UT (trigger=275119; Romano et al., GCN Circ. 6273). The BAT light curve showed a double-peaked structure with peaks at approximately 5 and 30 seconds and a total duration of about 40 s. The peak count rate was $\sim$ 2400 counts s^{-1} (15–350 keV), at $\sim$5 s after the trigger. Swift slewed immediately, and the narrow field instruments were on target 61 seconds later. The best Swift position is that determined from the XRT detection of the afterglow at RA(J2000)= 181.5426 deg, Dec(J2000)= +40.1438 deg, RA(J2000)= $12^{\rm h}06^{\rm m}10.22^{\rm s}$, Dec(J2000)= $+40^{\rm d}$ 08' 37.8", with a 90% confidence interval of 4 arcsec (Romano et al., GCN Circ. 6287). No detection from ground-based facilities has been reported.

3 BAT Observation and Analysis

Using the data set from T−239.3 to T+962.8 s the BAT team reported further analysis of GRB 070412 (Sakamoto et al., GCN Circ. 6290). The BAT ground-calculated position is RA(J2000)= 181.525 deg, Dec(J2000)= +40.133 deg, RA(J2000)= $12^{\rm h}06^{\rm m}6.1^{\rm s}$, Dec(J2000)= $+40^{\rm d}$ 07' 57.0", with an uncertainty of 1.5 arcmin, (radius, sys+stat, 90% containment). The partial coding was 98%.

The mask-weighted light curve (Figure 1) shows a double-peaked structure with the first peak from approximately T−4 s to T+10 s and a second 2-s long peak at T+30 . T90 (15–350 keV) is 34 ± 2 s (estimated error including systematics). The spacecraft slewed away from the burst location at T+122 s, although the burst remained in the partially coded field of view until T+716 s, when the spacecraft slewed away again.

The time-averaged spectrum from T−4.1 s to T+31.2 s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.45 ± 0.20. The fluence in the 15–150 keV band is $4.8 \pm 0.7 \times 10^{-7}$ erg cm^{-2}. The 1-s peak photon flux measured from T+5.32 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.

4 XRT Observations and Analysis

Using the data from the first four orbits of XRT data of GRB 070412 (2.4 ks in Photon Counting mode), the refined XRT position is RA(J2000)= 181.5426deg, Dec(J2000)= +40.1438deg, RA(J2000) = $12^{\rm h}06^{\rm m}10.22^{\rm s}$, Dec(J2000)= $+40^{\rm d}$ 08' 37.8", with a 90% confidence interval of 4 arcsec (Romano et al., GCN Circ. 6287). This is 10.5 arcsec away from the initial XRT position quoted in Romano et al. (GCN Circ. 6273).

Using the whole dataset, which includes 40s in WT and 87.2 in PC mode we find that the 0.3–10 keV X-ray light curve can be fit with a simple power-law with a decay slope of 1.06+/−0.02 ($\chi^2_{\rm red} = 2.97$ for 25 dof), although the initial descent could be due to a flare or the tail of the prompt emission (slope

of ~ -3.5). The light curve can be also fit with a broken power-law, with indices $\alpha_1 = 0.98 \pm 0.04$ and $\alpha_2 = 1.45^{+0.14}_{-0.21}$ with a break at $t_{\rm b} = (19.8^{+13.7}_{-9.8})$ ks ($\chi^2_{\rm red} = 1.94$ for 23 dof). Comparison of the two models yields an F-test probability of 2.968×10^{-03}. In both fits the large values of $\chi^2_{\rm red}$ are driven by the initial, steep portion of the light curve, as well as a few points which may be part of flares.

The X-ray spectrum from the XRT/WT data (40s starting from T+67.8) can be fit by an absorbed power-law with a photon index of 2.2 ± 0.5 and column density of $(1.8^{+1.1}_{-0.9}) \times 10^{21}$ cm^{-2}, higher than the Galactic column density in the direction of the source (1.95×10^{20} cm^{-2}). The unabsorbed (absorbed) 0.3-10 keV flux for the WT spectrum is 3.3×10^{-10} (2.2×10^{-10}) erg cm^{-2} s^{-1}. The XRT/PC data (2.4ks starting from T+3386) are consistent with the WT data, and can be fit by an absorbed power-law with a photon index of $2.3^{+0.6}_{-0.5}$ and column density of $(2.5^{+1.4}_{-1.2}) \times 10^{21}$ cm^{-2}. The unabsorbed (absorbed) 0.3–10 keV flux for the PC spectrum is 6.1×10^{-10} (3.3×10^{-10}) erg cm^{-2} s^{-1}.

5 UVOT Observation and Analysis

The Swift/UVOT observed the field of GRB 070412 starting 97.6 s after the BAT trigger (Schady et al., CGN Circ. 6293). No new source is detected within the XRT refined position (Romano et al., GCN Circ. 6282) or at the position reported by Jelinek et al. (GCN Circ. 6279) and Berger et al. (GCN Circ. 6280) in any of the UVOT filters, in either single or co-added exposures. The 3-sigma upper limits reported in Table 1, where Tmid is the mid time of the exposure. The reported upper limits are uncorrected for the estimated Galactic reddening of $E(B-V) = 0.02$ mag.

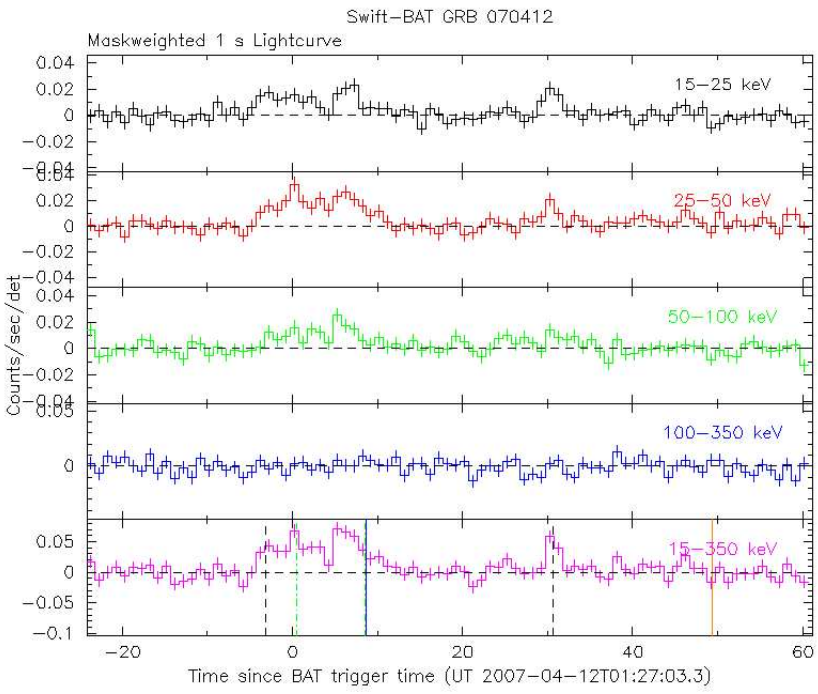

Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. Green dotted line: T50, Black dotted line: T90, Blue: Slew start, Orange: Slew end Time of each bin is in the middle of the bin. The units are counts s^{-1} illuminated-detector^{-1} (note illum-det = 0.16 cm^2) and T_0 is 2007-04-12 01:27:03.40 UT.

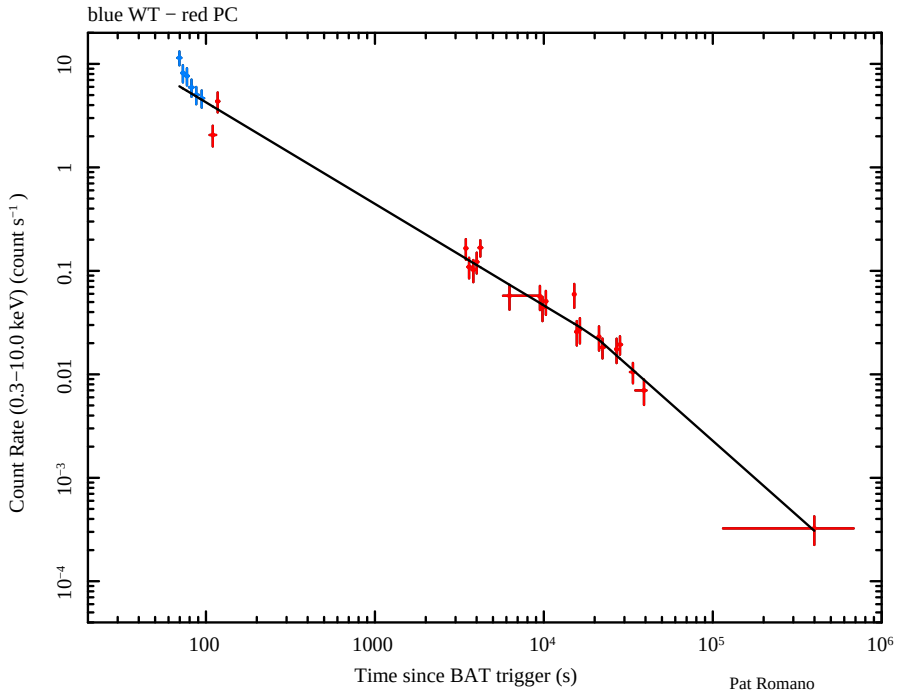

Figure 2: XRT Lightcurve. Counts s^{-1} in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is 1 count s^{-1} $\sim 5.5 \times 10^{-11}$ erg cm^{-2} s^{-1}.

Filter	Tmid (s)	Exp. (s)	3-sig UL mag
White	9252	936	20.55
V	17432	1769	20.52
B	5763	171	20.22
U	23567	1082	21.12
UVW1	23107	1284	20.52
UVM2	19141	1082	20.65
UVW2	14440	1195	20.94

Table 1: Magnitude limits from UVOT observations.