Swift Observation of GRB 101030A

A. Melandri (INAF-OAB), E. A. Hoversten (PSU), S. D. Barthelmy (GSFC), D. N. Burrows (PSU), M. H. Siegel (PSU), and N. Gehrels (GSFC), for the Swift Team

1 Introduction

At 15:56:29 UT the Swift BAT triggered on GRB 101030A (Trigger 437408) (Melandri, et al., GCN Circ. 11386). Swift slewed immediately to the burst. The BAT on-board calculated location is RA, Dec = (166.390, −16.387) deg, which is

RA(J2000) = 11\text{h} 05\text{m} 34\text{s}
Dec(J2000) = −16° 23′ 11″

with an uncertainty of 3 arcmin (radius, 90% containment, including systematic uncertainty). The BAT light curve shows that the burst began with a bright peak starting at around \( T − 70 \) s from the trigger, followed by a second episode consisting of two overlapping peaks with a duration of about 80 s. The first peak occurred during a pre-planned slew, so the BAT could not trigger on it; it is also possible that BAT missed emission from the burst before \( T − 100 \) s. The peak count rate was \( \sim 2000 \text{ counts/s (15 − 350 keV)} \), at \( \sim 0 \) s after \( T_0 \).

The XRT began follow-up observations at \( T + 65.7 \) s after the BAT trigger finding a bright, fading, uncatalogued X-ray source with an enhanced position RA, Dec = (166.38198, −16.37812) deg, which is

RA (J2000) = 11\text{h} 05\text{m} 31.68\text{s}
Dec (J2000) = −16° 22′ 41.2″

with an error of 1.9″ (90% confidence, including boresight uncertainties) (Evans, et al., GCN Circ. 11387). The initial flux in the 2.5 s image was \( 2.81 \times 10^{-9} \text{ erg cm}^{-2} \text{ s}^{-1} (0.2 − 10 \text{ keV}) \)

UVOT took a finding chart exposure of 150 s with the White filter starting \( T + 73 \) s after the BAT trigger. No credible afterglow candidate has been found in the initial data products. The 2.7′ × 2.7′ sub-image covers 100% of the XRT error circle. The typical 3-sigma upper limit has been about 19.6 mag. The 8′ × 8′ region for the list of sources generated on-board covers 100% of the XRT error circle. The list of sources is typically complete to about 18 mag. No correction has been made for the expected extinction corresponding to \( E(B−V) \) of 0.04.

2 BAT Observation and Analysis

Using the data set from \( T − 60 \) to \( T + 243 \) s further analysis of BAT GRB 101030A has been performed by Swift team (Barthelmy, et al., GCN Circ. 11388). The BAT ground-calculated position is RA(J2000) = 166.390 deg (11\text{h} 05\text{m} 33.6″), Dec(J2000) = −16.389 deg (−16° 23′ 22.0″) ± 1.1′ (radius, sys+stat, 90% containment). The partial coding was 96%.

The mask-weighted light curve (Fig.1) shows the burst already in progress as it came into the BAT FoV at \( T − 60 \) s during a pre-planned slew. The light curve decreases from that time and nearly returns to background levels at \( T − 18 \) s. Then it begins to rise again, peaking at \( T + 1 \) s and \( T + 9 \) s and returning to background at \( T + 70 \) s. There is possible emission at the 2\( σ \) level from \( T + 130 \) s to \( T + 170 \) s. \( T_{90}(15 − 350\text{keV}) \) is 92.0 ± 50 s (estimated error including systematics).

The time-averaged spectrum from \( T − 55.2 \) to \( T + 47.8 \) s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.82 ± 0.10. The fluence in the 15 − 150 keV band is \((2.0\pm0.1) \times 10^{-6} \text{ergs/cm}^2\). The 1-sec peak photon flux measured from \( T + 8.78 \) s in the 15 − 150 keV band is 0.9 ± 0.1 \( \text{ph/cm}^2/\text{sec} \). All the quoted errors are at the 90% confidence level.
3 XRT Observations and Analysis

We have analysed 7.4 ks of XRT data for GRB 101030A (Melandri, et al., GCN Circ. 11386), from 71 s to 19.2 ks after the BAT trigger. The data comprise 118 s in Windowed Timing (WT) mode with the remainder in Photon Counting (PC) mode. The enhanced XRT position for this burst was given by Evans, et al., GCN Circ. 11387.

The light curve (Fig.2) can be modelled with a series of power-law decays. The initial decay index is $\alpha_1 = 2.32^{+0.26}_{-0.33}$. At $T + 112$ s the decay steepen to an $\alpha_2 = 3.97^{+0.24}_{-0.22}$. The light curve breaks again at $T + 478$ s to a decay with $\alpha_3 = -0.08^{+0.18}_{-1.43}$, before a final break at $T + 5105$ s after which the decay index is $\alpha_4 = 1.12^{+0.22}_{-0.21}$.

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of $2.87^{+0.15}_{-0.13}$. The best-fitting absorption column is $1.83^{+0.26}_{-0.24} \times 10^{21}$ cm$^{-2}$, in excess of the Galactic value of $4.2 \times 10^{20}$ cm$^{-2}$ (Kalberla et al. 2005). The PC mode spectrum has a photon index of $2.11^{+0.12}_{-0.20}$ and a best-fitting absorption column of $8.1^{+2.7}_{-3.5} \times 10^{20}$ cm$^{-2}$. The counts to observed (unabsorbed) 0.3 – 10 keV flux conversion factor deduced from this spectrum is $3.6 \times 10^{-11} (4.6 \times 10^{-11})$ erg cm$^{-2}$ count$^{-1}$.

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 101030A at $T + 73$ s (Hoversten & Melandri, GCN Circ. 11389) after the BAT trigger (Melandri, et al., GCN Circ. 11386). No new source was detected at the enhanced Swift XRT position (Evans, et al., GCN Circ. 11387). UVOT magnitude 3-sigma upper limits are summarized in Table 1. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight of $E(B-V) = 0.04$ (Schlegel et al. 1998). All photometry is on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

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Table 1: Magnitude limits from UVOT observations
Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands (15 - 25, 25 - 50, 50 - 100, 100 - 350 and 15 - 350 keV).
Figure 2: XRT Lightcurve. It can be modelled with a series of power-law decays, reported in the text. Data are from WT mode (blue) and PC mode (red); green vertical lines mark the times where the power-law decay changes.