Swift Observation of GRB 081008

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1 Introduction

BAT triggered on GRB 081008 at 19:58:09 UT (Trigger 331093) (Racusin, et al., GCN Circ. 8344). This was a rate-trigger with $T_0 = 185.5$ sec. Swift slewed to this burst immediately and XRT began follow-up observations at $T+87$ sec, and UVOT at $T+96$ sec. Our best position is the UVOT location RA($J2000$) = 279.95833deg (18h39m52.4s), Dec($J2000$) = $-57.431111deg (-57d25'52.87''$) with an uncertainty of 0.6 arcsec (radius, 90% confidence).

2 BAT Observation and Analysis

Using the data set from $T−240$ to $T+963$ sec, further analysis of GRB 081008 was performed by the Swift team (Palmer, et al., GCN Circ. 8351). The BAT ground-calculated position is RA($J2000$) = 279.966deg (18h39m52.4s), Dec($J2000$) = $-57.4333deg (-57d25'58.8''$) with an uncertainty of 1.1 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 81%.

The masked-weighted light curves (Fig.1) start at trigger time $T$ showing two strong peaks at $T+0$ sec and $T+110$ sec. $T_0(15−350 keV)$ is $185.5 \pm 40.3$ (estimated error including systematics).

The time-averaged spectrum from $T−65$ to $T+201$ sec is best fitted by a simple power law model. A cutoff-power law model is also an acceptable fit with an $E_{peak}$ of 88 keV. The power law index of the time-averaged spectrum is $1.69 \pm 0.07$. The fluence in the 15 − 150 keV band is $(4.3 \pm 0.2) \times 10^{-6}$ ergs/cm$^2$ and the 1-sec peak flux measured from $T + 7.52$ sec in the 15 − 150 keV band is $1.3 \pm 0.1$ ph/cm$^2$/sec. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

Using 8661 sec of XRT Photon Counting mode data and 8 UVOT images for GRB 081008, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): RA($J2000$) = 279.95776deg (18h39m49.86s), Dec($J2000$) = $-57.431888deg (-57d25'54.8''$) with an uncertainty of 1.4 arcsec (radius, 90% confidence). This position is within 3.2 arcsec of the initial XRT position, and 3.0 arcsec from the optical afterglow candidate, reported by Schady et al. (GCN Circ. 8348).

The 0.3 – 10 keV light curve (Fig.2) shows an initial steep decline with a slope of $10.1^{+1.3}_{-1.5}$, followed by a shallow slope of $0.9 \pm 0.1$, beginning at $T + 296 \pm 17$ sec. At $(15.4^{+8.2}_{-7.3}) \times 10^3$ sec the light curve breaks with a slope of $1.8^{+0.5}_{-0.3}$ ($\chi^2$/dof = 47.4/84).

The Window Timing (WT) mode spectrum can be modeled with an absorbed power-law with photon index of $1.81 \pm 0.03$, intrinsic $N_H$ column density of $(6.7 \pm 0.7) \times 10^{21}$ cm$^{-2}$ at a redshift of $z = 1.967$ (Cucchiara et al., GCN Circ. 8346), and a Galactic $N_H$ of $7.1 \times 10^{20}$ cm$^{-2}$. The Photon Counting (PC) mode spectrum can be modeled with an absorbed power-law with photon index of $1.91^{+0.08}_{-0.08}$, intrinsic $N_H$ column density of $(5.7^{+14.1}_{-5.7}) \times 10^{20}$ cm$^{-2}$ at a redshift of $z = 1.967$ and the Galactic $N_H$. The average observed (unabsorbed) flux over 0.3 – 10 keV for the WT spectrum (93-410 seconds after the BAT trigger) is $3.1 \times 10^{-9}$ (3.9 $\times$ 10$^{-9}$) ergs/cm$^2$/sec. The average observed (unabsorbed) flux over 0.3 – 10 keV for the PC spectrum (420 – 6.9 $\times$ 10$^4$ seconds after the BAT trigger) is $3.4 \times 10^{-11}$ (4.0 $\times$ 10$^{-11}$) ergs/cm$^2$/sec.
Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and $T_0$ is 19:58:09 UT.

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 081008 96 sec after the BAT trigger (Schady et al., GCN Circ. 8348). A new fading source was detected at the ROTSE position (Rykoff et al., GCN Circ. 8343) in the white, v, b, u and uvw1 filters, consistent with a redshift of $z=1.967$ reported by Cucchiara et al. (GCN Circ. 8346). The light curve is best fit by a broken power-law with $\alpha_1 = 0.73 \pm 0.01$, $t_{break} = 3250_{-711}^{+655}$, and $\alpha_2 = 1.33 \pm 0.11$ (90% confidence). The UVOT refined position is RA(J2000) = 279.95833deg (18h39m49.87s), Dec(J2000) = $-57.431111$deg ($-57d25'52.87"$) with an estimated uncertainty of 0.6 arcsec (radius, 90% confidence).

The UVOT multiband light curve normalized to the white band filter (Fig. 3) is not corrected for the Galactic extinction corresponding to a reddening of $E(B-V) = 0.10$ mag (Schlegel et al., 1998, ApJS, 500, 525).
Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is 1 count/sec = \( \sim 5.0 \times 10^{-11} \) ergs/cm\(^2\)/sec.

Figure 3: UVOT multiband light curve normalized to the white band filter in observed Counts/sec. The optical transient was detected in white, v, b, u, and uvw1.