Swift Observation of GRB 070125

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0 Revisions

This version includes the BAT raw lightcurve, and new observations and analysis of XRT and UVOT observations shown in Fig.2 & Fig.3, respectively. We also address reports of an optical jet break by Halpern et al. (*GCN Circ.* 6096) and Garnavich et al. (*GCN Circ.* 6165) in the context of the XRT observations.

1 Introduction

GRB070125 was detected by Mars Odyssey (HEND and GRS), Suzaku (WAM), INTEGRAL (SPI-ACS), and RHESSI at 07:20:45 UT during a Swift slew. BAT detected the source marginally after the slew, but did not trigger. The marginal BAT source is coincident with the IPN triangulation (Hurley *et al.*, *GCN Circ.* 6024) of the burst. With processing, the source is detectable in the first 4 BAT 64-second images (15-50 keV) after the slew, or 6 minutes after T0. $T_{90} = 60$ seconds. Swift observed GRB70125 as a ToO observation beginning at 20:18:48 UT, 46.7 ks after the trigger.

Our best position is the UVOT localization at RA($J2000$) = $117.82392 deg$ ($07h51m17.74s$), Dec($J2000$) = $31.1617 deg$ ($+31d09'4.2''$) with an error radius of 0.5 arcsec.

2 BAT Observation and Analysis

GRB070125 occured while Swift was slewing and was not in the BAT field-of-view during the beginning of the prompt emission. BAT did not trigger, but did detect GRB070125 in 4 64-seconds images after the slew with a significance of 8.2 sigma. The BAT ground-calculated position is RA($J2000$) = $117.850 deg$ ($07h51m24s$), Dec($J2000$) = $+31.140 deg$ ($-31d08'24.0''$) with an error radius of 2.5 *arcmin*, (systematic and statistical, 90% containment).

The raw BAT light curve (Fig.1) started during the burst as it came into the BAT field-of-view at $T + 12$ *sec* with a broad bump with superimposed peaks, and returns to background at about $T + 100$ *sec*. $T_{90}(15 - 350 keV)$ is ~ 60 *sec*.

3 XRT Observations and Analysis

Using the data from the first day of XRT data of GRB 070125 (5.4 *ksec* in Photon Counting mode), the refined XRT position is RA($J2000$) = $117.82529 deg$ ($7h51m18.07s$), Dec($J2000$) = $+31.1508 deg$ ($+31d09'02.9''$), with an error radius of 3.7 *arcsec* (90% confidence, including boresight uncertainties). This position is 85 *arcsec* from the initial BAT position, and 4.1 *arcsec* from the optical afterglow candidate, reported by Cenko *et al.*(*GCN Circ.* 6034).

The $0.3 - 10$ *keV* light curve (Fig.2) begins at 46 *ks* and continues until it was no longer detectable at 1.6 Ms after the burst. The lightcurve can be fit by several models, but due to the late slew, the faintness of the afterglow, and variability within the X-ray lightcurve, we cannot clearly distinguish between single or broken power law models. All quoted errors on the model fits are 90% confidence.

The simplest model is a single power-law with a slope of 1.56 ± 0.1 with $\chi^2/dof = 2.1$ for 17 degrees of freedom. The main residual, at ~ 110 *ks*, can be interpreted as X-ray flaring. If we ignore these 3

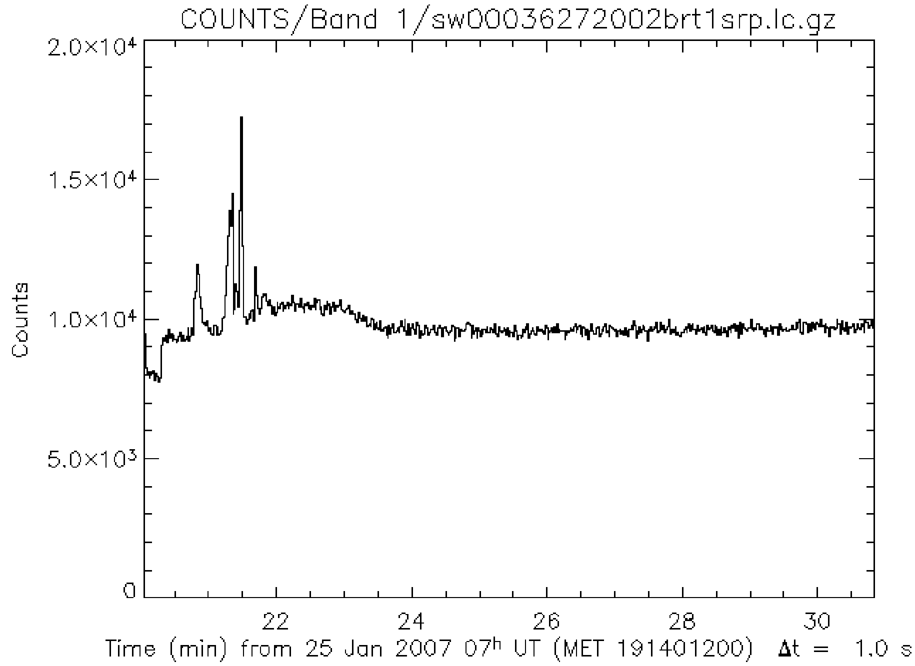

Figure 1: BAT Light curve. The raw BAT light curve in units of counts/sec/BAT.

data points, a single power law fits the rest of the data with a slope of 1.57 ± 0.07, with $\chi^2/dof = 0.82$ for 14 degrees of freedom.

We obtain a better fit to the entire data set using a broken power-law. The best is for an initial slope of 1.2 ± 0.7 followed by a break at 117 ± 93 ks to a slope of 1.9 ± 0.1, with $\chi^2/dof = 1.6$ for 15 degrees of freedom. If we exclude the points near 110 ks this fit is very poorly constrained, but produces similar slopes and break time with $\chi^2/dof = 0.9$ for 12 degrees of freedom.

Halpern et al. (*GCN Circ.* 6096) report an optical break after > 4 days to a decay slope of > 2.2 suggesting a jet break, which is supported by a late optical data point by Garnavich et al. (*GCN Circ.* 6165). We have attempted to fit the XRT data with a break at a similar time, resulting in a fit with initial decay slope of 1.5 ± 0.1 followed by a break at 596 ± 328 ks (or 6.9 ± 3.8 days) to a slope of 2.5 ± 1.2, with $\chi^2/dof = 1.9$, $dof = 15$. This model is consistent with that of the optical data, but is not a global minimum in χ^2, is not formally acceptable, is not well constrained, and has large uncertainties in the fit parameters. If we exclude the points near 110 ks, we obtain a very poorly constrained fit with similar parameters but with $\chi^2/dof = 0.77$ for 12 degrees of freedom, indistinguishable from the single power law decay.

We conclude that we cannot distinguish between a single power law with a small flare near 110 ks and a broken power law fit to the X-ray afterglow. We therefore cannot confirm the reported optical break. Our data are consistent with this break, but are equally consistent with no break, or with an earlier break.

Assuming a break in the lightcurve at $\sim 120ks$, the spectra of these two portions of the X-ray lightcurve can be modeled with an absorbed power-law with spectral indices of 2.05 ± 0.25, and 2.10 ± 0.28, respectively. The fit NH column density is $8.6 \pm 5.8 \times 10^{20} cm^{-2}$ consistent with galactic column density ($4.8 \times 10^{20} cm^{-2}$). The average observed (unabsorbed) flux over $0.3-10$ keV for this spectrum (spanning a time of $46 - 120$ ks, and $120 - 227$ ks after the trigger) is 3.0×10^{-12} and 6.5×10^{-13} $ergs/cm^2/sec$, respectively.

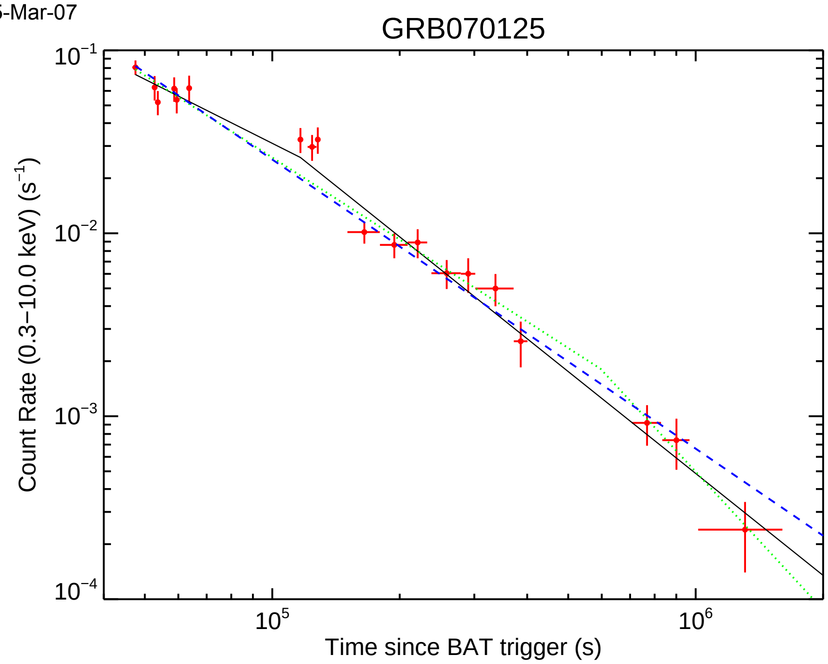

Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Photon Counting mode (red). The approximate conversion is 1 count/sec = $\sim 2.5 \times 10^{-12}$ $ergs/cm^2/sec$. Solid black line shows broken power-law fit, blue dashed line shows single power-law fit, and green dotted line shows broken power-law fit with initial break guess at > 4 days.

4 UVOT Observation and Analysis

The afterglow of GRB 070125 (Hurley *et al.*, *GCN Circ.* 6024) was detected in all 6 UVOT filters ranging from V (central wavelength of 546 nm) to UWW2 (central wavelength of 193 nm) until ~ 5 days after the burst. The V filter lightcurve (Fig. 3) is fit by a power-law with decay slope of 1.1 ± 0.25.

Detection of absorption lines by Fox et al. (*GCN Circ.* 6071) establish a lower limit to the redshift of 1.547, and the detection in all 6 UVOT filters indicates that the redshift cannot be much higher. This is consistent with the prior reports by Prochaska et al. (*GCN Circ.* 6031, *GCN Circ.* 6032), and Pelangeon et al. (*GCN Circ.* 6033, *GCN Circ.* 6059).

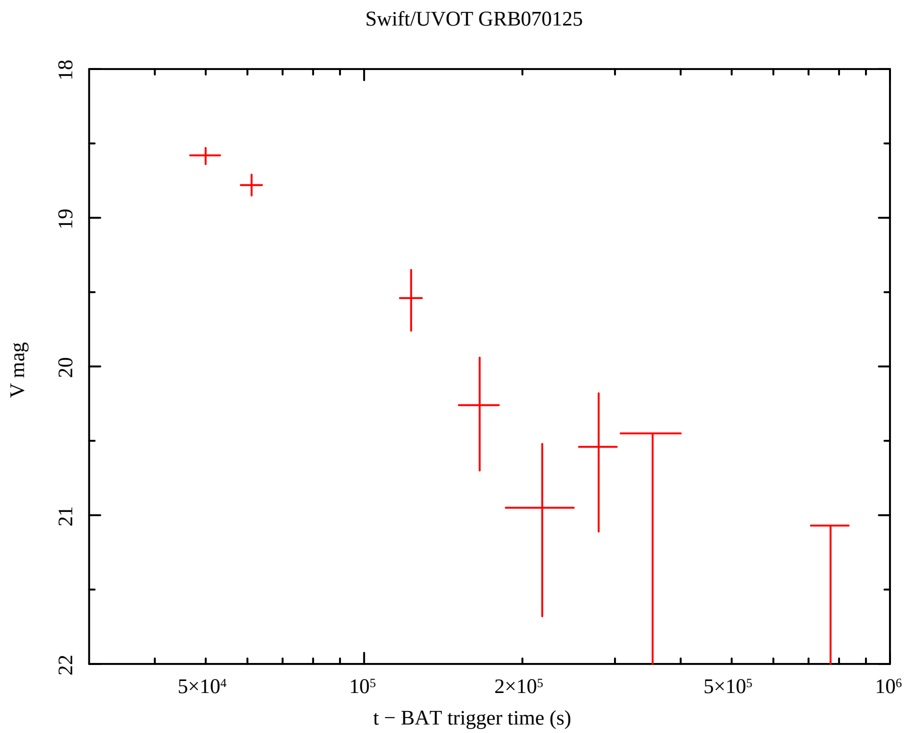

Figure 3: UVOT V filter Lightcurve.