Swift Observations of GRB 070328

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for the Swift Team:

0. REVISIONS

- Updated XRT light curve and position using data out to T+190 ks
- Addition of Konus-Wind Epeak value
- Correct some boilerplate text referring to figures and in figure captions.

1. INTRODUCTION

At 03:53:53 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 070328 (trigger=272773). Swift slewed immediately to the burst. This was a rate trigger with T90 = 69 ± 5 sec, with a faint hard X-ray tail extending to about 150 seconds after the trigger. Our best position is from the Swift XRT, based on 60 ks of afterglow data and astrometric matching:

RA(J2000) = 04h 20m 27.60s
Dec(J2000) = -34d 04' 00.4"

with an estimated error radius of 1.30 arcsec (90% containment). To date, no optical afterglow has been detected by Swift UVOT, or reported by ground based observatories. Konus-Wind detected the burst (Golenetskii et al., GCN Circ. 6230), and determined an Epeak of 496 +172/-117 keV using the GRBM spectral model.

2) BAT OBSERVATION AND ANALYSIS

The following analysis uses the data set from T-120 to T+183 sec (Stamatikos et al, GCN Circ 6225). The BAT ground-calculated position is RA, Dec = 65.110, -34.077 deg which is,

RA(J2000) = 4h 20m 26.4s
Dec(J2000) = -34d 4' 38.9"

with an uncertainty of 0.6 arcmin, (radius, sys+stat, 90% containment). The partial coding was 60%.

The mask weighted light curve shows a burst profile which consists of a rise starting at T-10, multiple spikes peaking between T+0 and T+22, and a gradual decay detected out to T+140 (see Figure 1). T_{90} (15-350 keV) is 69 ± 5 sec (estimated error including systematics).

The time-averaged spectrum from T-8.5 to T+133 is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.26 ± 0.04. The fluence in the 15-150 keV band is 8.9 ± 0.2 x 10^{-6} erg/cm^2. The 1-sec peak photon flux measured from T+0.78 sec in the 15-150 keV band is 4.2 ± 0.2 ph/cm^2/sec. All the quoted errors are at the 90% confidence level.

3. XRT OBSERVATION AND ANALYSIS

We have analyzed Swift-XRT data covering times out to 190 ks after the trigger, which includes 1.3 ks of Windowed Timing (WT) mode data, and the remainder in Photon Counting (PC) mode data (Evans et al. GCN Circ 6227, plus new original work). Using the PC mode data we find the astrometrically corrected XRT refined position (by matching the UVOT images with the USNO-B1 catalogue) of,

RA(J2000) = 04h 20m 27.60s
Dec(J2000) = -34d 04' 00.4"

with an estimated error radius of 1.3 arcsec (90% containment). This position lies 39.7 arcsec from the refined BAT position listed above, and 8.4 arcsec from the on-board XRT position reported in GCN Circ. 6224.

The XRT light curve begins 95 s after the trigger, and decays as a power-law with alpha1=1.32 +0.28/-0.12 until 184 +9/-22 s after the trigger (see Figure 2). At this point the decay shallows to alpha2=0.29±0.05. This shallow decay continues until 655 +28/-27 s after the trigger, when the lightcurve breaks again to alpha3=1.39±0.01. This power law continues to at least T+190ks (See Figure 2). All errors are quoted at the 90% confidence level.

The WT spectrum from the first two orbits of Swift data can be modeled with a power-law of Gamma=2.22±0.03 with a total absorbing column of 2.6 $\pm 0.4 \times 10^{21}$ cm^{-2}, compared to the Galactic value of 2.1×10^{20} cm^{-2}. The PC mode data from the first two orbits give almost identical values, however with larger errors, as there are fewer counts in the spectrum.

4. UVOT OBSERVATION AND ANALYSIS

Swift/UVOT began its initial finding chart exposure of the field of the burst 98 s after the Swift/BAT trigger (Marshall & Markwardt, GCN Circ 6229). No afterglow candidate is seen in the refined XRT error region in any of the early UVOT exposures. Three-sigma upper limits for the initial finding chart exposure and for the total exposure for each of the UVOT filters are provided in Table 1. The times in the table are from the Swift/BAT trigger.

The upper limits in Table 1 are not corrected for extinction. The Galactic reddening in the direction of the burst is $E_{B-V} = 0.04$ mag (Schlegel et al. 1998).

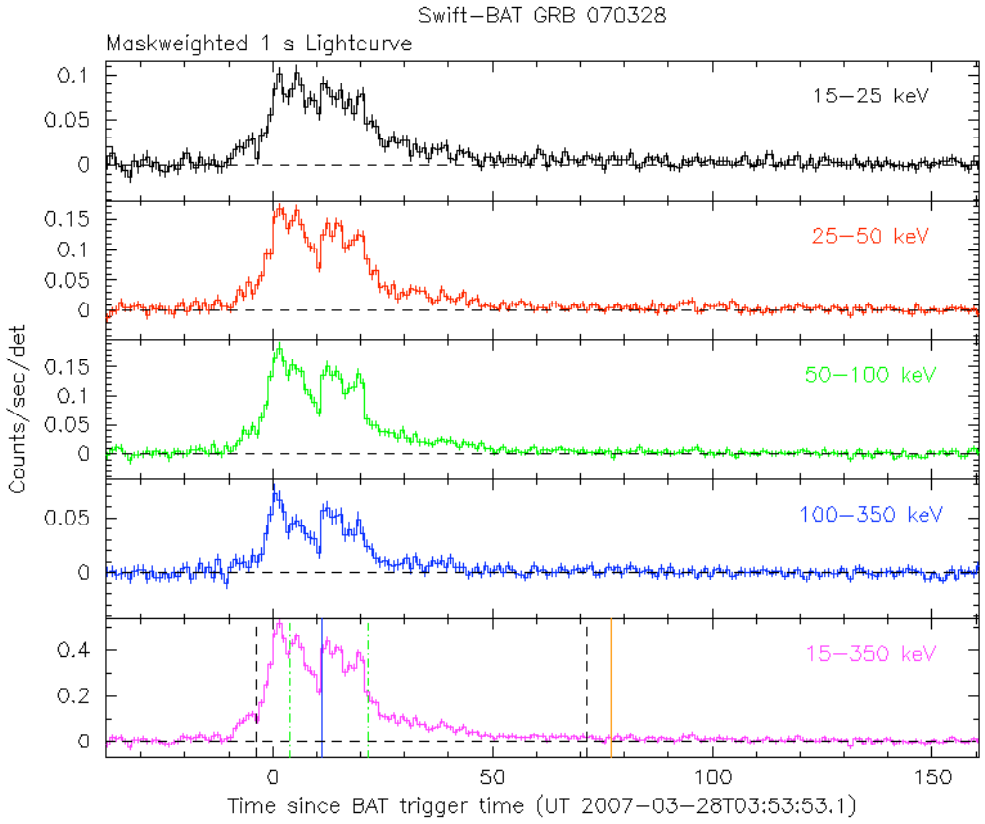

Fig.1: BAT Lightcurve with 1 second time bins. The light curve in 4 individual bands, plus the total band. The vertical dashed line indicates the T_{90} burst interval, and the blue/red lines indicate the start/stop of the slew to the burst.

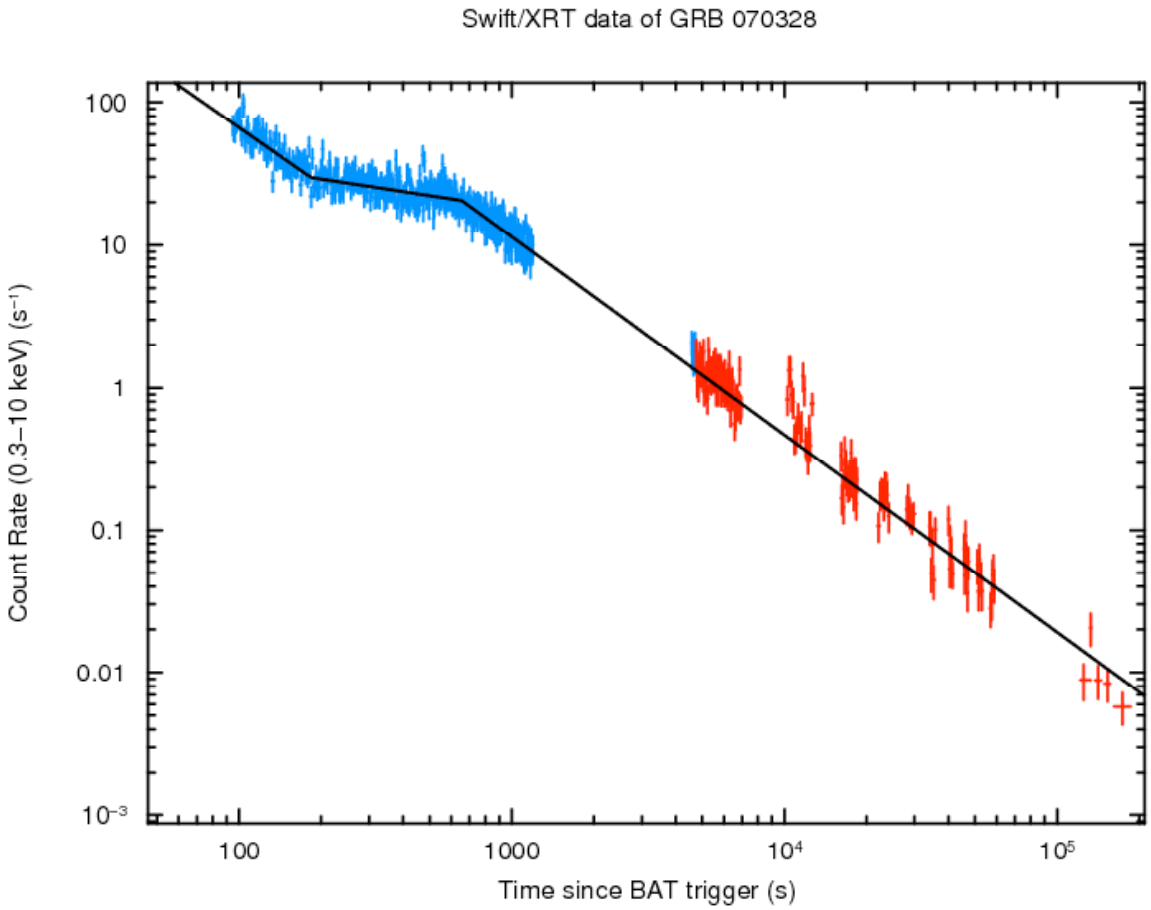

Fig. 2: Swift XRT Lightcurve. The blue points were taken in Windowed Timing (WT) mode, and the red points were taken in Photon Counting (PC) mode. The approximate conversion is 1 count/sec = 9.33 x 10^{-11} erg/cm^2/sec.

Table 1: UVOT Upper Limits.

Filter	T_start(s)	T_stop(s)	Expo(s)	Mag (3-σ UL)
WHITE	98	198	98	19.6
WHITE	98	6984	567	21.1
V	79	11988	1721	20.7
B	682	6823	397	20.3
U	657	6619	429	20.4
UVW1	634	6414	1197	21.6
UVW2	711	11076	1101	21.5