Swift Observations of GRB 130929A

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for the Swift team

1. Introduction

At 09:36:33 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 130929A (trigger=572308) (Marshall *et al*. GCN Circ. 15269). Swift slewed immediately to the burst. At the time of the trigger, the initial BAT position was 63° from the Sun (3.4 hours West) and 64° from the 29%-illuminated Moon. **Table 1** contains the best reported positions from Swift, and the latest XRT position can be viewed at http://www.swift.ac.uk/xrt_positions.

Table 2 is a summary of GCN Circulars about this GRB from observatories other than Swift.

Standard analysis products for this burst are available at http://gcn.gsfc.nasa.gov/swift_gnd_ana.html.

2. BAT Observations and Analysis

As reported by Palmer *et al*. (GCN Circ. 15272), the BAT ground-calculated position is RA, Dec = 135.028, -47.554 deg which is RA(J2000) = $09^h00^m06.7^s$ Dec(J2000) = -47°33'14.6" with an uncertainty of 1.6 arcmin, (radius, sys+stat, 90% containment). The partial coding was 44%.

The mask-weighted light curve (**Figure 1**) shows a single FRED peak. T_{90} (15-350 keV) is 11.10 ± 2.98 s (estimated error including systematics).

The time-averaged spectrum from T-1.93 to T+11.50 s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.00 ± 0.18. The fluence in the 15-150 keV band is 6.9 ± 0.8 x 10^{-7} erg cm^{-2}. This fluence is larger than that of 30% of the long GRBs in the Second BAT GRB Catalog (Sakamoto *et al*. 2011). The 1-s peak photon flux measured from T+1.32 s in the 15-150 keV band is 1.7 ± 0.3 ph cm^{-2} s^{-1}. All the quoted errors are at the 90% confidence level.

The results of the batgrbproduct analysis are available at http://gcn.gsfc.nasa.gov/notices_s/572308/BA/.

3. XRT Observations and Analysis

Analysis of the initial XRT data was reported by Osborne *et al*. (GCN Circ. 15273). We have analysed 15 ks of XRT data for GRB 130929A, from 237 s to 47.1 ks after the BAT

trigger. The data are entirely in Photon Counting (PC) mode. The enhanced XRT position for this burst was given by Goad *et al*. (GCN Circ. 15271).

The light curve (**Figure 2**) can be modelled with a power-law decay with a decay index of α=1.30 (+0.11, -0.09).

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of 2.2 (+0.7, -0.6). The best-fitting absorption column is 3.2 (+1.3, -1.1) x 10^{22} cm^{-2}, in excess of the Galactic value of 7.1 x 10^{21} cm^{-2} (Kalberla *et al*. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 7.7 x 10^{-11} (2.7 x 10^{-10}) erg cm^{-2} $count^{-1}$.

A summary of the PC-mode spectrum is thus:
Total column: 3.2 (+1.3, -1.1) x 10^{22} cm^{-2}
Galactic foreground: 7.1 x 10^{21} cm^{-2}
Excess significance: 3.9 σ
Photon index: 2.2 (+0.7, -0.6)

The results of the XRT team automatic analysis are available at
http://www.swift.ac.uk/xrt_products/00572308.

4. UVOT Observations and Analysis

The Swift/UVOT began settled observations of the field of GRB 130929A 280 s after the BAT trigger (Marshall GCN Circ. 15275). No optical afterglow consistent with the XRT position (Goad *et al*. GCN Circ. 15271) is detected in the initial UVOT exposures. **Table 3** gives preliminary magnitudes using the UVOT photometric system (Breeveld *et al*. 2011, AIP Conf. Proc., 1358, 373). No correction has been made for Milky Way extinction.

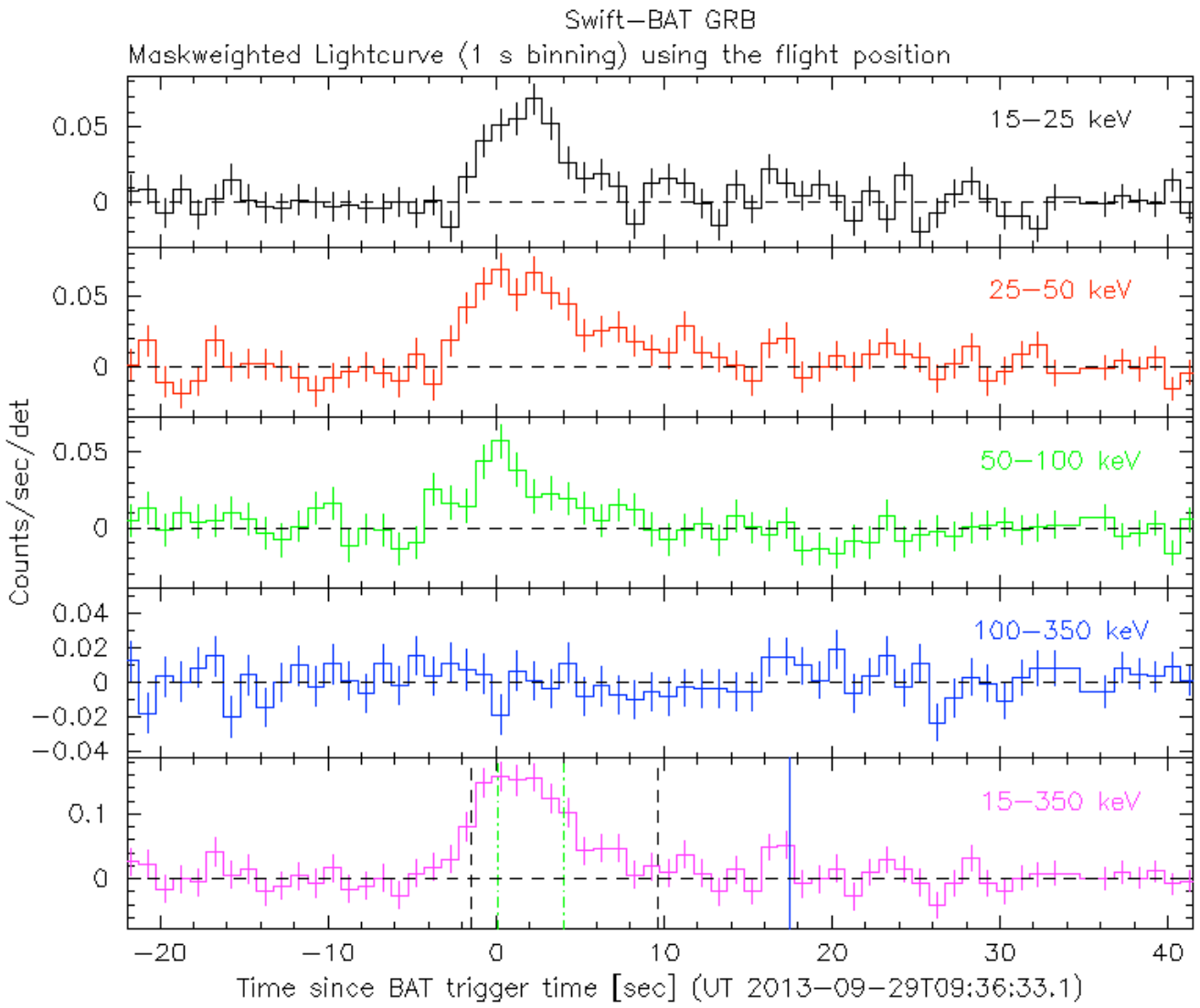

Figure 1. The BAT mask-weighted light curve in the four individual and total energy bands. The units are counts s^{-1} illuminated-detector^{-1}.

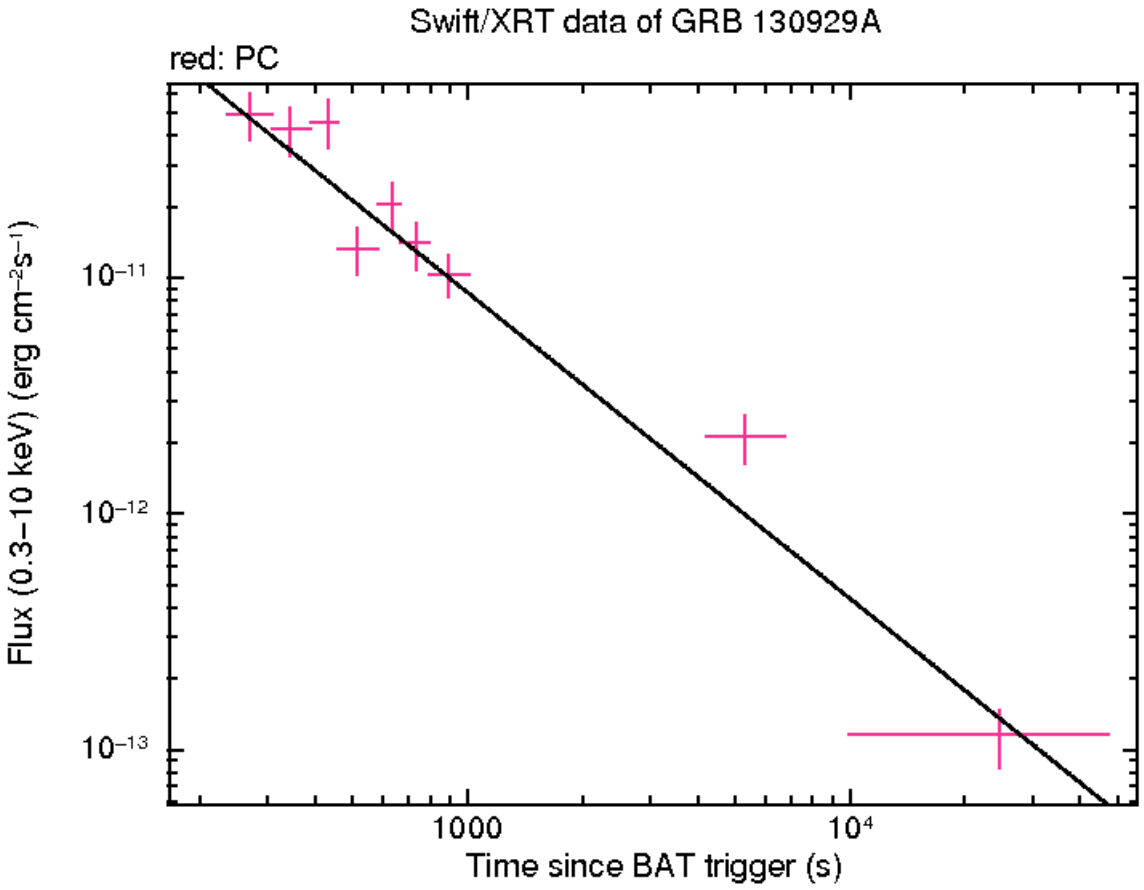

Figure 2. The XRT light curve.

RA (J2000)	Dec (J2000)	Error	Note	Reference
$09^h00^m05.73^s$	-47°33'38.7"	1.7"	XRT-final	UKSSDC
$09^h00^m05.67^s$	-47°33'38.7"	1.9"	XRT-enhanced	Goad *et al*. GCN Circ. 15271
$09^h00^m06.7^s$	-47°33'14.6"	1.6'	BAT-refined	Palmer *et al*. GCN Circ. 15272

Table 1. Positions from the Swift instruments.

Band	Authors	GCN Circ.	Subject	Observatory	Notes
Optical	Klotz *et al*.	15270	TAROT La Silla observatory optical observations	TAROT	

Table 2. Summary of GCN Circulars from other observatories sorted by band and then circular number.

Filter	T_{start}(s)	T_{stop}(s)	Exp(s)	Mag
$white_{FC}$	280	430	147	>21.0
white	280	1008	334	>21.4
v	586	4628	236	>19.7
b	512	705	39	>19.0
u	487	10592	709	>20.6
w1	462	6710	255	>19.6
m2	437	6505	308	>19.7
w2	562	4423	236	>19.7

Table 3. UVOT observations reported by Marshall (GCN Circ. 15275). The start and stop times of the exposures are given in seconds since the BAT trigger. The preliminary 3-σ upper limits are given. No correction has been made for extinction in the Milky Way.