Swift Observation of GRB 081210

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1 Introduction

BAT triggered on GRB 081210 at 20:19:34 UT (Trigger 337073) (Krimm, *et al.*, *GCN Circ.* 8648). This was a 2.048-sec rate-trigger on a intermediate length burst with $T_{90} = 146 \pm 8$ *sec*. Swift slewed to this burst immediately and XRT began follow-up observations at $T + 71.9$ *sec*, and UVOT at $T + 80$ *sec*. Our best position is the UVOT position RA($J2000$) = 70.48417° (04h 41m 56.20s), Dec($J2000$) = −11.25741° (−11°15′26″.7) with an error of 0.64 arcsec (90% confidence).

GRB 081210 was also detected by INTEGRAL/SPI-ACS (Savchenko, private communication).

2 BAT Observation and Analysis

Using the data set from T-240 to T+651 sec further analysis of GRB 081210 has been performed by the Swift/BAT team (Barthelmy et al., GCN 8649). The BAT ground-calculated position is RA, Dec = 70.485, -11.263 deg, which is RA(J2000) = 04h 41m 56.5s Dec(J2000) = -11d 15' 46.0" with an uncertainty of 1.0 arcmin, (radius, sys+stat, 90% containment). The partial coding was 96% (the bore sight angle was 14.5°).

The mask-weighted light curve (Figures 1,2) shows several peaks. The first starts at T-30 sec. The second and brightest peaks at T+18 sec. The third peaks at T+135 sec. There is possible forth peak at T+180 sec. T90 (15-350 keV) is 146 ± 8 sec (estimated error including systematics).

The time-averaged spectrum from T-12.9 to T+143.0 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.42 ± 0.14. The fluence in the 15-150 keV band is $1.8 \pm 0.2 \times 10^{-6}$ $erg\ cm^{-2}$. The 1-sec peak photon flux measured from T+17.97 sec in the 15-150 keV band is 2.5 ± 0.2 $ph\ cm^{-2}\ s^{-1}$. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

Using 4.9 ks of XRT data of GRB 081210 (the first 387 s were obtained in Windowed Timing (WT) mode and the remainder in Photon Counting (PC) mode), the enhanced XRT position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue; Osborne et al., GCN 8650) is RA($J2000$) = 70.4841° (04h 41m 56.19s), Dec($J2000$) = −11.257° (−11°15′27″.8) with an error of 1.4 arcsec (90% confidence, including boresight uncertainties). This position is within 5.3 arcsec of the initial XRT position, and 1.07 arcsec from the UVOT optical afterglow candidate.

The $0.3 - 10$ keV light curve (Fig.3) shows an initial period of flaring activity. A strong peak is seen at T+138 s coincident with the third peak seen by the BAT. Further peaks are seen at T+219 s, 317 s and 391 s. During this time the underlying light curve, while difficult to constrain, is clearly decaying, with a power-law index of around 1.5. Around T+5000 s the decay flattens, to a slope of 0.74 ± 0.24. There is a steepening of the light curve at T+1.5 ks.

The WT spectrum is clearly dominated by the flaring activity – it can be modelled with an absorbed power-law with $\Gamma = 1.65 \pm 0.06$ and $n_H = (1.6 \pm 0.15) \times 10^{21}$ cm^{-2} – the Galactic value is 4.6×10^{20} cm^{-2}. The PC spectrum is probably more reflective of the afterglow and has $\Gamma = 1.91 \pm 0.12$ and $n_H = 6.1^{+2.5}_{-1.5} \times 10^{20}$ cm^{-2} – consistent with Galactic.

4 UVOT Observation and Analysis

Further analysis of Swift Ultraviolet/Optical Telescope (UVOT) data of GRB 081210 (Immler, Holland, and Krimm, GCN 8654), starting 80 sec after the BAT trigger, gives a detection of an optical source consistent with the enhanced XRT position (Osborne et al., GCN 8650) in the white (Figure 4) and u filters at 12.6σ and 3.8σ levels of confidence, respectively. (The UVOT position is given in the Introduction). The source is not detected in any of the other UVOT filters at the limiting magnitudes reported in Table 1. The event data in the white filter shows a flare peaking at approximately 130 s after the BAT trigger (Figure 5), which approximately coincides with the flare seen in the X-ray and hard X-ray light curves. Upper limits are summarized in Table 1. The values quoted above are in the UVOT photometric system (Poole et al. 2008, MNRAS, 383, 627) and are not corrected for the expected Galactic extinction along the line of sight which corresponds to a reddening of E(B-V) = 0.077 mag (Schlegel et al. 1998).

Filter	Start	Stop	Exposure	Magnitude
White (finding)	80	1009	318	19.91 ± 0.08
v	622	816	244	> 19.99 (3σ UL)
b	548	741	39	> 19.78(3σ UL)
u	292	716	265	20.15 ± 0.29
uvw1	672	866	39	> 18.74(3σ UL)
uvm2	647	840	136	> 19.55(3σ UL)
uvw2	598	5251	235	> 20.47(3σ UL)

Table 1: Magnitude limits from UVOT observations.

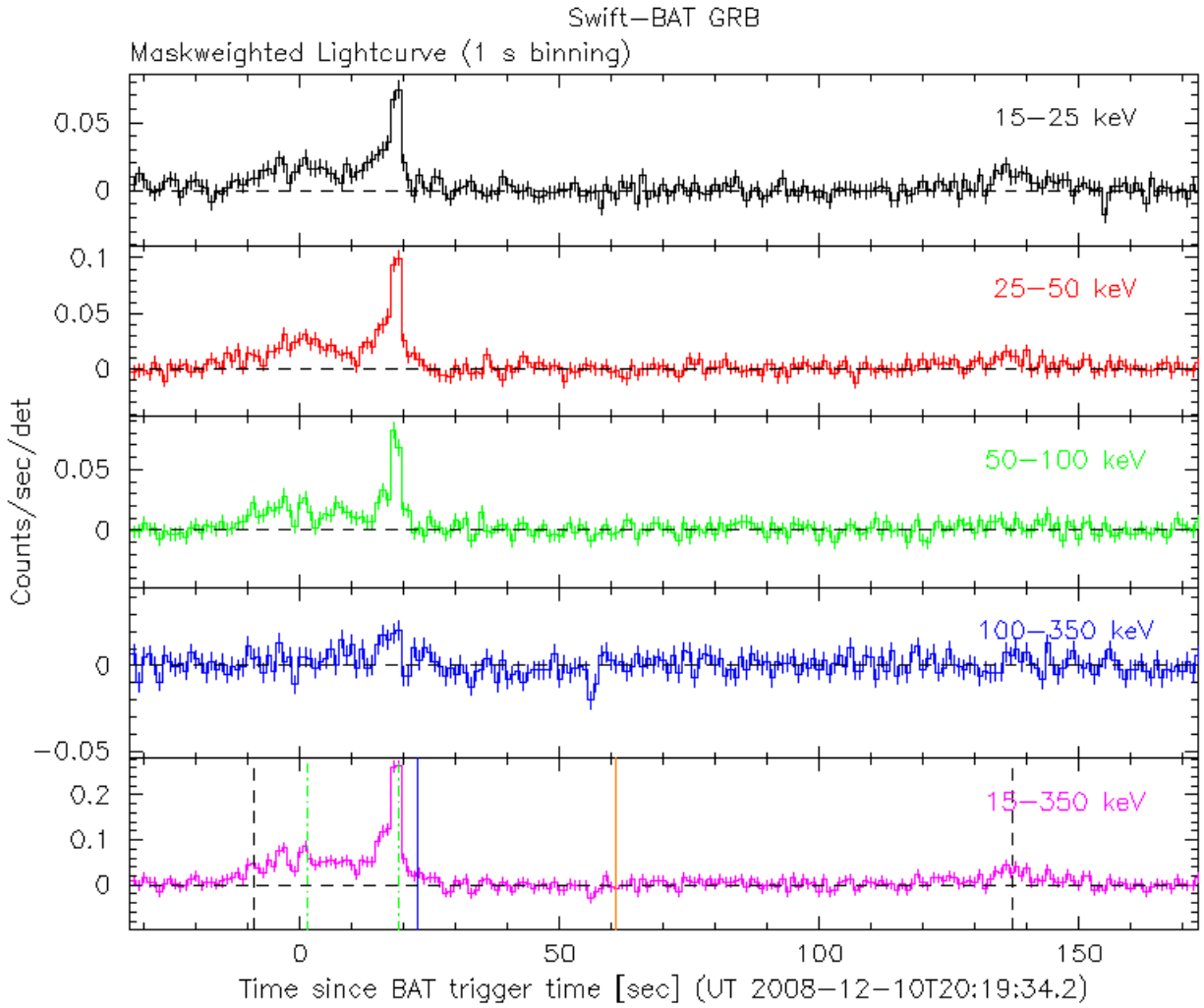

Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det = 0.16 cm^2).

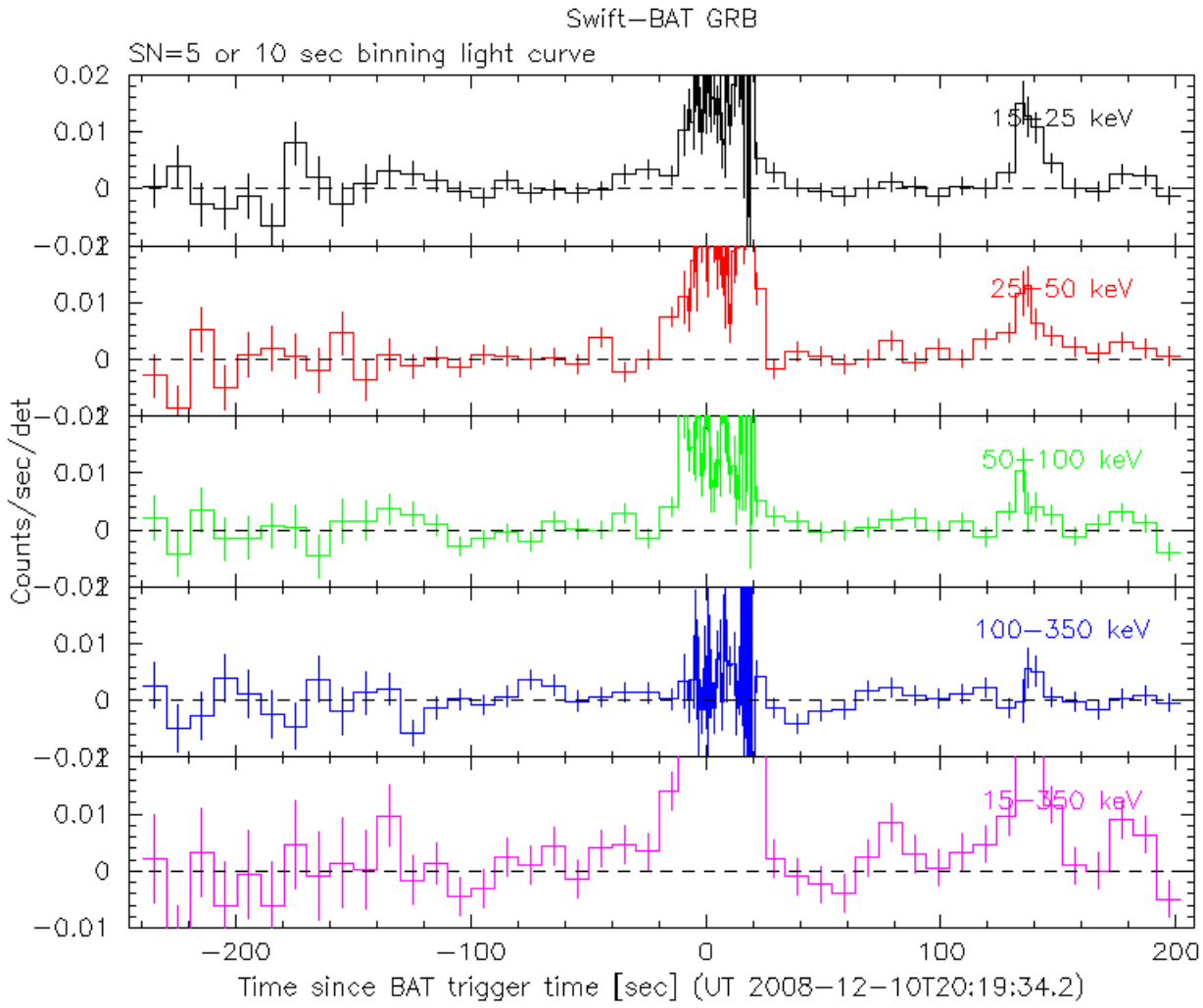

Figure 2: BAT Light curve showing the earlier and later weak peaks. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det = 0.16 cm^2).

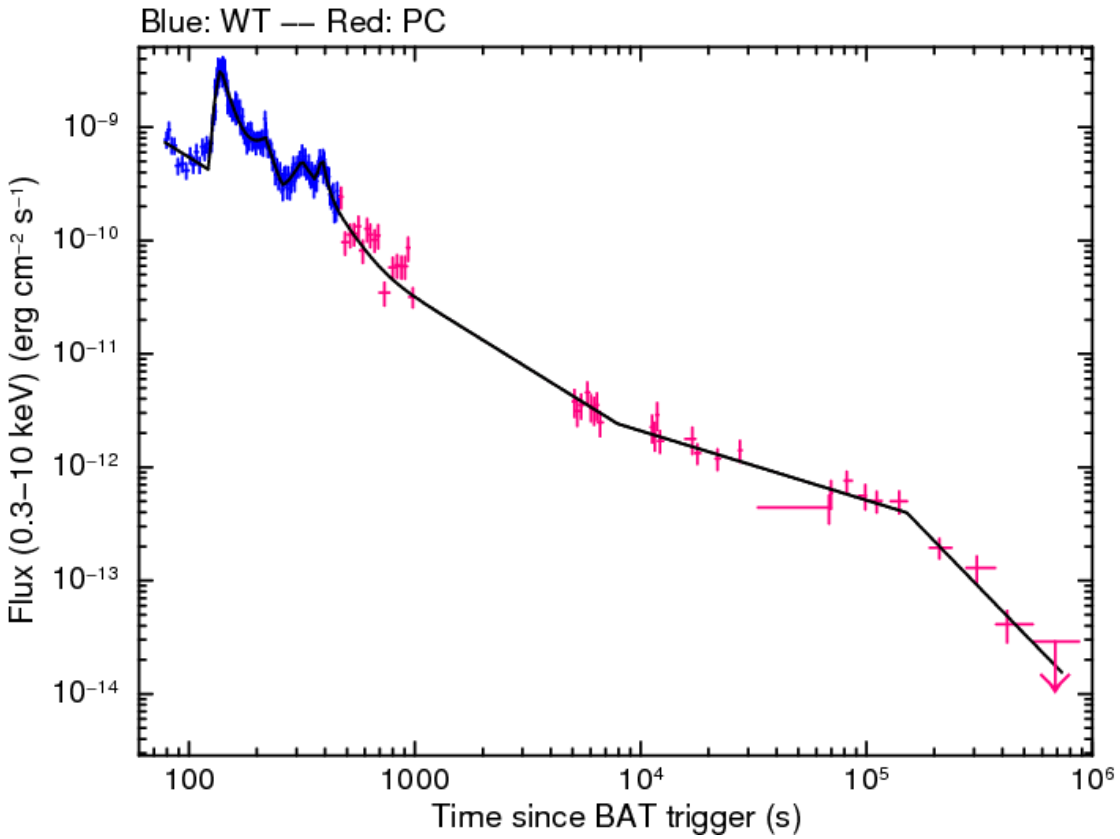

Figure 3: XRT Lightcurve. Flux in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red).

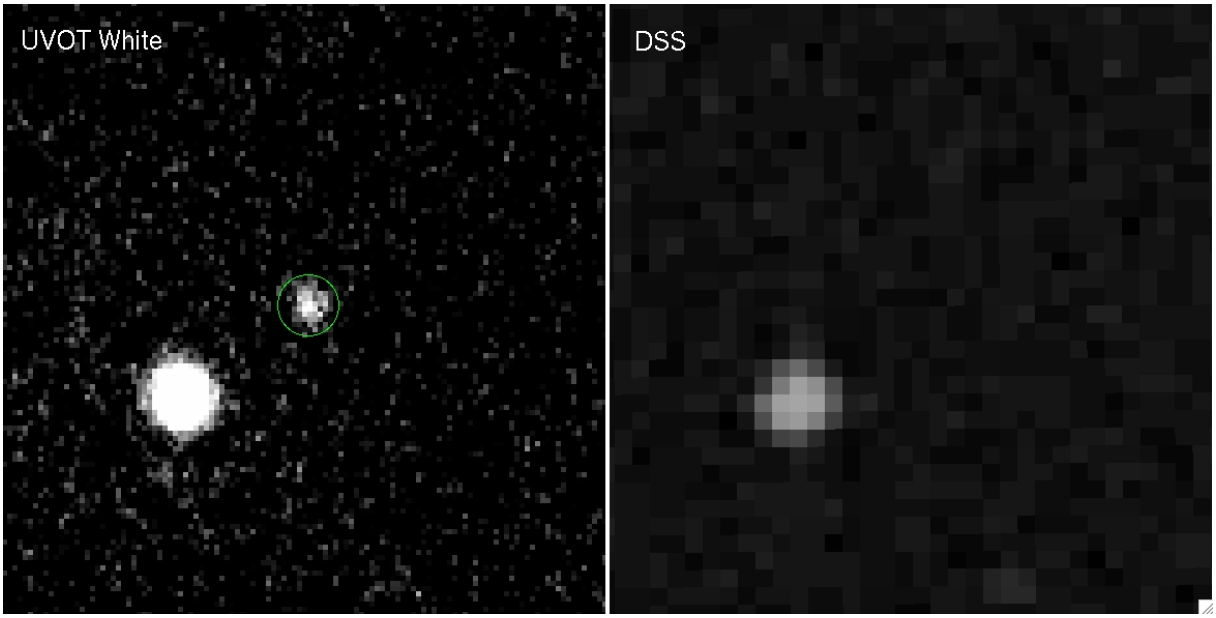

Figure 4: UVOT white and DSS images.

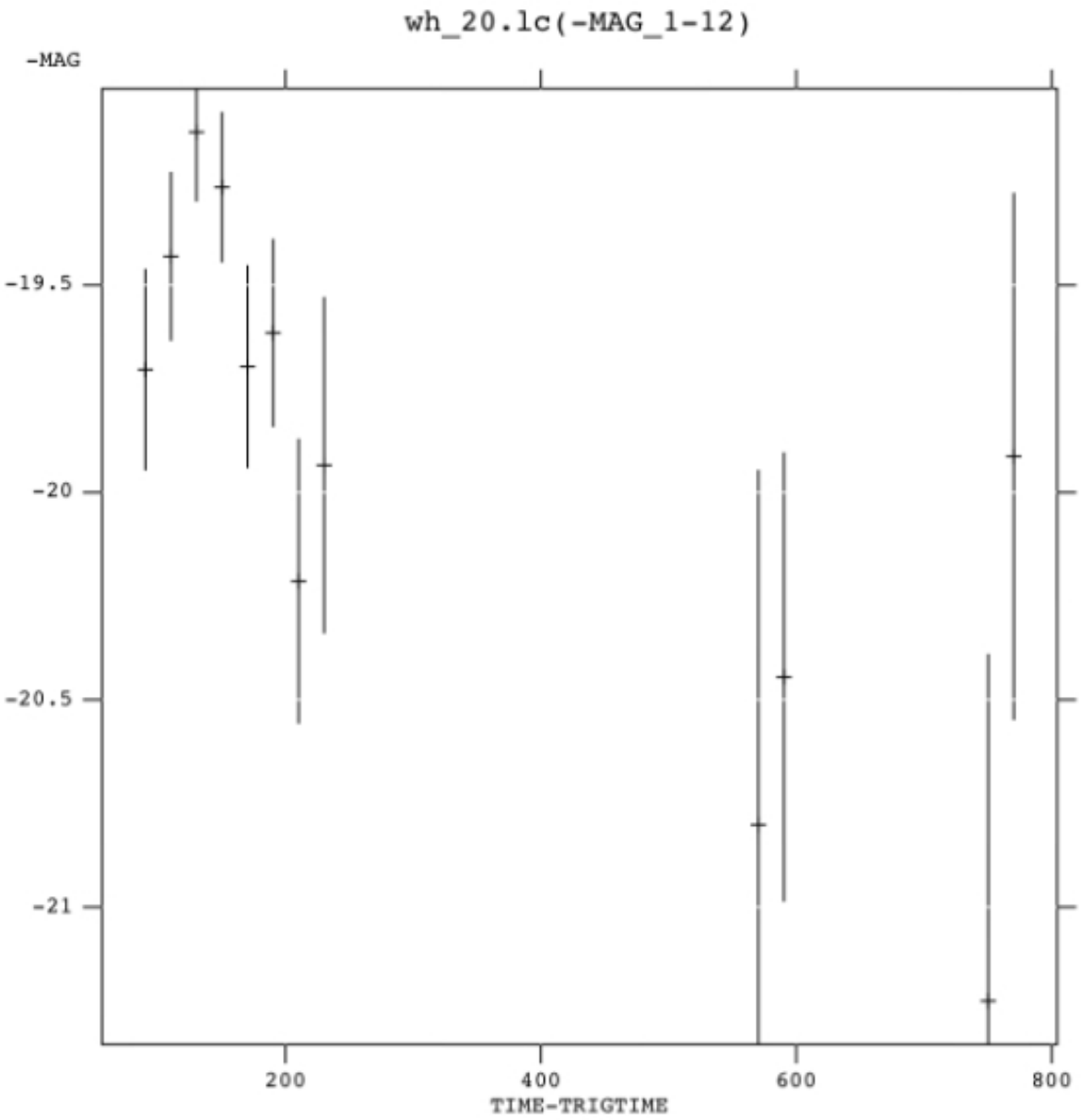

Figure 5: UVOT white filter light curve, showing the presence of a flare at around T+130 sec.