

# Watcher Observations of Prompt and Afterglow Optical Emission from GRB 080905B

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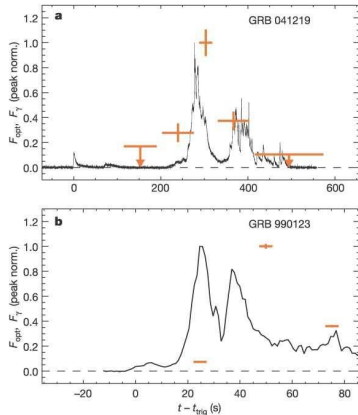
Annapolis, 2010



# Outline

- 1 Watcher Robotic Telescope
  - Motivation
  - Telescope Overview
- 2 080905B Results
  - Prompt Emission
- 3 Summary

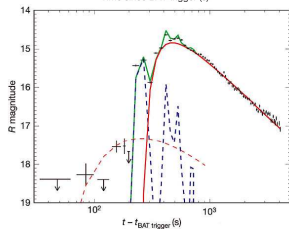
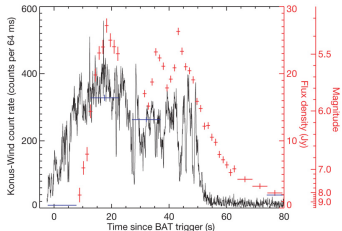
# Prompt Optical Observations



- The figure shows GRB 041219A (Vestrand et al., 2005) and 990123 (Akerlof et al., 1999)
- Are the Optical and Gamma-Ray emission correlated?

Figure: Vestrand et al. (2005)

# Other Interesting Bursts



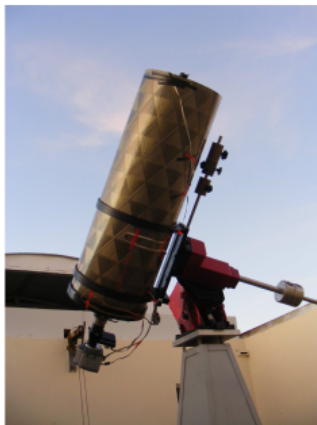
- 080319B (Naked Eye Burst) [Racusin et al., 2008]
- 050820A [Vestrand et al., 2006]

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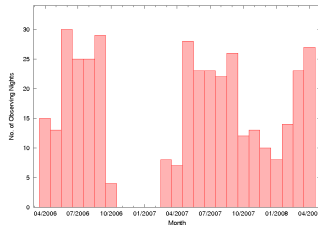
# Technical Specifications

- Watcher is a fully automated optical telescope
- The primary goal is the detection of optical prompt and afterglow emission from GRBs.
- Since June 2009 using an Andor iXon CCD with a 8.02 arcminute FOV
- Previously had an Apogee AP6e CCD with a 14.5 arcminute FOV



# Observing conditions

- It is located at Boyden Observatory, Bloemfontein, South Africa ( $29^{\circ} 02' 20''$  South,  $26^{\circ} 24' 20''$  East)
- The altitude is 1387m
- Duty cycle due to weather is  $\sim 70\%$



# Software

- The telescope is controlled by RTS2 [Kubanek et al. 2009]
  - Allows fully automatic operation of a remote observatory without human intervention
  - Responds to GCN alerts
  - Contacts users via email when a GRB is observed
- Standard photometry was applied.

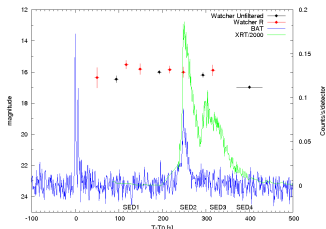
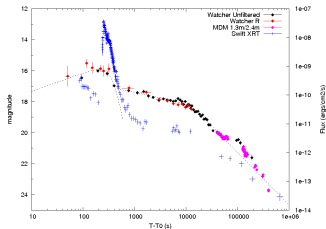


# Results to date

- Watcher has followed up on 330 GRBs to date
- 51 of these have been observed in under 2 minutes
  - 25 have been observed in under a minute



# 060526



- Observation of this GRB began 36.2 s after the BAT trigger
- Was followed up by the XRT at  $T_0+73$  s
- The afterglow lightcurve was modelled with some energy injection beginning at  $\sim 700$  s
- It is proposed that the energy injection is due to the interaction of shells with different Lorentz factors after the onset of the afterglow
- Theone et al., 2010 in press

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# GRB080905B Gamma-Ray Lightcurve

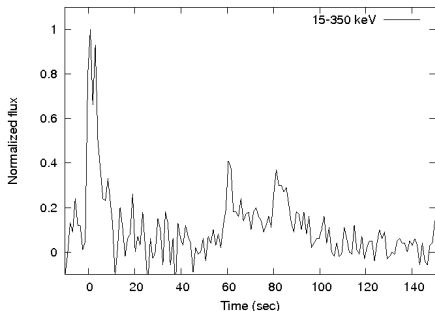


Figure: BAT Lightcurve

- Located at RA = 20:06:57 and DEC = -62:33:47 (J2000)
- The afterglow is slightly blended with 2MASS galaxy 2MASXJ20065732-6233465 located 4 arcsecs from the GRB
- The redshift of this galaxy was measured to be  $z < 1.7$
- However this is not the host galaxy as VLT observations obtained a redshift of  $z = 2.374$

# Gamma Ray Spectrum

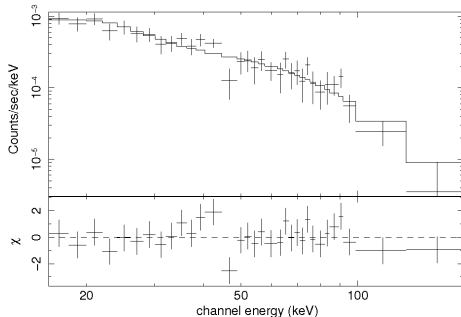


Figure: BAT Spectrum (15-150 keV)

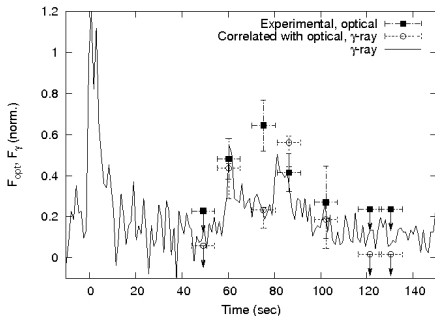
- $T_{90} = 95 \pm 9$  s
- For a power law fit  $F_\nu \propto \nu^{-\alpha}$   
 $\alpha = 1.75^{+0.15}_{-0.15}$
- Fluence =  
 $2.3^{+0.1}_{-0.4} \times 10^{-6} \text{ erg cm}^{-2}$
- Peak Flux =  
 $2.3^{+0.1}_{-0.9} \times 10^{-7} \text{ erg cm}^{-2} \text{ s}^{-1}$
- $E_{iso} = 3 \times 10^{52} \text{ erg}$  for  $z = 2.374$

# Prompt Optical

- Watcher began observations beginning at  $T_0+44.3$  s
- Exposure times of 10s were taken from 44.3 s-656.3 s
  - 30 seconds from 660.3-3591.3 s
  - 60 seconds from 3718.3-7264.3 s
- All images were taken with the Clear filter
- The contribution of the 2MASS galaxy was subtracted using images taken a long time after the trigger
- The afterglow was also observed by UVOT [Stroh et al., GCN 8182] and VLT [Vreeswijk et al., GCN 8191]

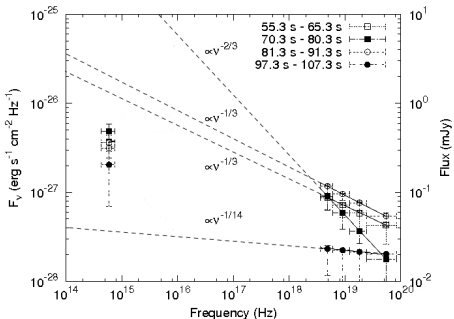


# Prompt Optical



- Apart from the peak of the optical emission (70.3-80.3 s) the optical and gamma-ray data are well correlated.

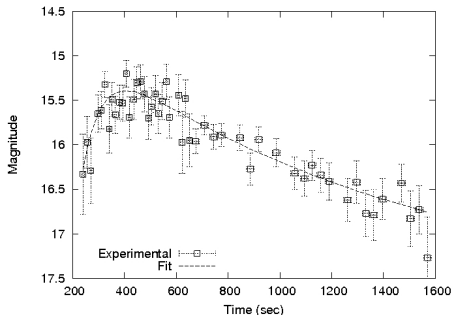
# Broadband Spectra



- Data from four BAT energy bands and Watcher
- Note the change in slope for 70.3-80.3 s - additional component?
- A break is required between the optical and gamma-ray band



# Optical Afterglow



- $\alpha_r = 3.07 \pm 0.52$   
 $\alpha_d = -1.34 \pm 0.147$

- 

$$\Gamma(t_{peak}) = \left[ \frac{3E_{iso}(1+z)^3}{32\pi nm_{\rho}c^5\eta t_{peak}^3} \right]^{1/8} \quad (1)$$

[Molinari et al., 2007]

- $\Gamma_0 \approx 250$  for a homogeneous surrounding medium
- $\Gamma_0 \approx 90$  for a wind environment
- Consistent with the fireball model

# Summary

- Watcher is a robotic telescope in South Africa
- Many bursts have been seen by Watcher and other robotic systems
- Prompt Optical emission differs for many GRBs
- For GRB080905B we found:
  - $\Gamma_0 \sim 250$
  - Prompt data correlated with the gamma-ray data apart from the peak of the optical emission