

ASTR 288C

Homework 5

Due: 12 October 2009

The first five questions are based on the lab work for lecture 5.

1. What are the detector and sky coordinates of the X-ray afterglow of GRB 090929B?

Detector Coordinates: (X,Y) = (453.37,460.38)

Sky Coordinates: (RA,Dec) = (07:50:52.6,-00:39:27) (J2000.0)

2. What is the corrected source count rate from the afterglow?

$$C = 0.1736 \pm 0.0057 \text{ count s}^{-1}$$

We want the fully-corrected count rate, not just the total counts.

3. What is the signal-to-noise ratio of the source?

$$30.83$$

4. What is the count rate from the background?

$$C_{\text{bkg}} = (3.378 \pm 0.380) \times 10^{-6} \text{ count s}^{-1} \text{ pixel}^{-1}$$

- 5.

- a. What is the flux from the source if the photon index is 2? Include the uncertainty.

$$F = (5.785 \pm 0.190) \times 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$$

Some people got $(6.26 \pm 0.20) \times 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$. I accepted this because all of the steps leading to it were done correctly, so it is probably just due to a typo in entering values into WebPIMMS.

- b. What is the flux if the photon index is 2.1?

$$F = 5.551 \times 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$$

Bonus mark for including uncertainty, which was not asked for.

- c. Is the assumption that the photon index is 2 instead of 2.1 reasonable? Explain.

The uncertainty in the flux is $0.190e-12$ while the change due to the change in the photon index is $0.234e-12$. These numbers are similar (within 2-sigma), so the assumption that the photon index is 2 is reasonable. An answer of "no" is acceptable if it is correctly explained.

6. Was an optical afterglow observed for GRB 090929B? Use the information in the GCN Circulars for this burst at <http://gcn.gsfc.nasa.gov/other/090929.gcn3>. Be aware that there are Circulars for two gamma-ray bursts in this file (because two gamma-ray bursts occurred on 29 Sep 2009).

Yes. GCN Circular 9967 reported the discovery of an optical afterglow with the RAPTOR telescope.

**TITLE: GCN CIRCULAR
NUMBER: 9967
SUBJECT: GRB 090929B: RAPTOR Discovery of Optical Counterpart
DATE: 09/09/29 16:46:34 GMT
FROM: James Wren at LANL <jwren@nis.lanl.gov>**

J. Wren, W.T. Vestrand, P.R. Wozniak, H. Davis, B. Norman of Los Alamos National Laboratory report:

The RAPTOR telescope system responded to Swift trigger 371050 (Pagani et al., GCN 9963) under good observing conditions. Our narrow-field instruments began observing the location at 10:20:53.37 UTC, 11.77 minutes after the initial BAT trigger. Our initial images show an $R \sim 16.8$ optical counterpart at the enhanced XRT location (Page et al., GCN 9965). The object fades steadily reaching $R \sim 18.0$ at 10:50 UTC. Our unfiltered images were calibrated against the USNO-B1 R-band. Unfortunately, an 11th magnitude star is only 19 arcseconds away, limiting our photometric accuracy. Further analysis is ongoing.

Note that some telescopes did not detect an optical afterglow. This is normal. It only takes one detection at the location of the X-ray afterglow, with confirmed fading for the optical afterglow, to discover the optical afterglow.