

# Gamma-ray Burst Optical Afterglow Observations at Nyrola Observatory

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## Introduction

Nyrölä Observatory is an amateur observatory located in Finland. It is located in countryside near town Jyväskylä and is operated by a 200 member astronomy club. The equipment used in these observations consists of 16-inch Meade LX200 telescope, Santa Barbara Instrument Group ST7E and ST8XE CCD cameras and photometric B, V & Rc filters.

Our five person GRB team has been involved with gamma-ray bursts since 1999, when the observatory was joined to the GRB Coordinates Network. Observatory computer is receiving socket alerts in real time and the observers are notified via text messages to their mobile phones (GSM/SMS). Since that twenty GRB fields have been imaged: four of them showing optical afterglows and sixteen upper-limit observations. The observers have joined also to the AAVSO International High Energy Network in year 2000.

## Observations

The first successful afterglow observation was GRB 000926 (GCN 813) after several unsuccessful observing attempts. This afterglow was observed after the transient coordinates were published on GCN Circulars. It demonstrated that the detection of 20 magnitude targets was indeed possible.

The second observation was a short-hard burst GRB 010119 (GCN 920) that was observed 42 hours after the burst. The upper-limit for optical transient was  $R=19.5$  magnitudes. This observation is also included in a paper by K. Hurley et. al. "Afterglow upper limits for four short duration, hard spectrum gamma-ray bursts".

GRB 010222 (GCN 990) was observed all night from 12 to 22 hours after the burst. Observations were done with photometric filters and the fading of the transient was measured in V and R bands.

GRB 021004 was observed fading from  $R_c=17.9$  to 18.4 (7.5 to 11 hours from the burst).

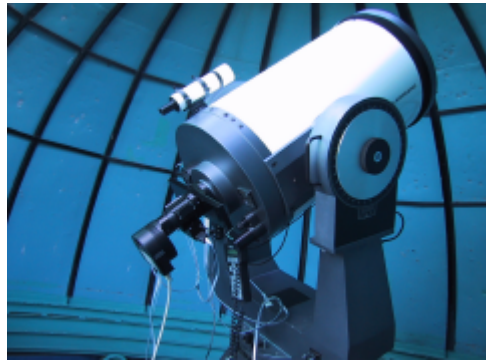
The extremely bright afterglow of GRB030329 was observed on three nights, including time resolved R-band photometry starting 9 hours after the burst that showed the afterglow to fade from  $R=14.5$  to  $R=14.8$ . On the second night, starting 2.3 days after the burst, the afterglow was observed in two bands (V and R) for 5.5 hours. The dataset shows the afterglow at  $R=16.8$ . Our last data point is 7.4 days after the burst when the afterglow was still observable at  $R=18.6$ .

Following GCN Circulars have been issued by the authors: GCN 813, GCN 920, GCN 990, GCN 1019, GCN 1570, GCN 1591, GCN 1849, GCN 2010, GCN 2058, GCN 2156, GCN 2397, GCN 2390, GCN 2392 and GCN 2563.

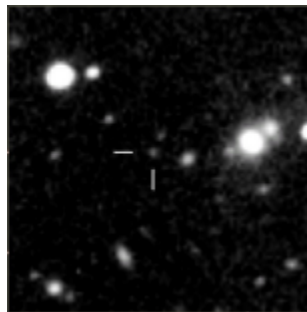
Details available on: <http://nyrola.jklsirius.fi/grb/>

## Acknowledgments

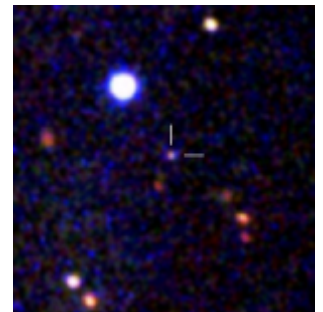
We want to thank Jyväskylän Sirius and Jenny and Antti Wihuri Foundation for providing the observatory, Gamma-ray Burst Coordinates Network and specially Dr. Scott Barthelmy, American Association of Variable Stars Observers for providing the ST8XE CCD and Dr. Arne Henden for mentoring.



**Image1.** The 16-inch Meade LX200 telescope with SBIG ST7E CCD-imager of Nyrölä Observatory.



**Image2.** The optical afterglow of GRB 000926 imaged on September 28, 2000.



**Image3.** GRB 010222. A color composite (BVR) of the afterglow imaged on February 22, 2001.

Burst	GRB age	Filter	Magnitude
GRB000926	43.0	-	<b>20.0</b>
GRB010119	42.0	Rc	>19.5
GRB010222	12.4	B	<b>19.8</b>
	13.6	Rc	<b>19.6</b>
	14.6	V	<b>19.7</b>
GRB010324	10.9	-	>18.8
GRB010412	29.0	Rc	>19.0
GRB020322	44.0	-	>21.0
GRB020409	34.0	V	>19.0
GRB020411	19.0	V	>19.0
GRB020819	5.0	Rc	>19.0
GRB021004	7.8	Rc	<b>17.9</b>
	12.1	V	<b>19.2</b>
	13.1	Rc	<b>18.8</b>
GRB021020	25.0	Rc	>19.5
GRB021211	11.0	Rc	>20.0
GRB030131	20.0	Rc	>20.0
GRB030227	9.5	Rc	>19.0
GRB030328	10.0	Rc	>19.0
GRB030329	9.0	Rc	<b>14.5</b>
	56.0	Rc	<b>16.8</b>
	57.0	V	<b>17.2</b>
	177.0	Rc	<b>18.6</b>
XRF030824	4.0	Rc	>19.0
GRB030913	2.0	Rc	>18.0
GRB031220	13.9	Rc	>20.5
GRB040403	15.0	Rc	>20.4

**Table1.** Optical GRB observations. GRB age is hours from the burst. Magnitude reference is USNOA2.0 except for GRB010222 and GRB030329 where Henden field photometry was used.