

Compiled by Marc Türlér

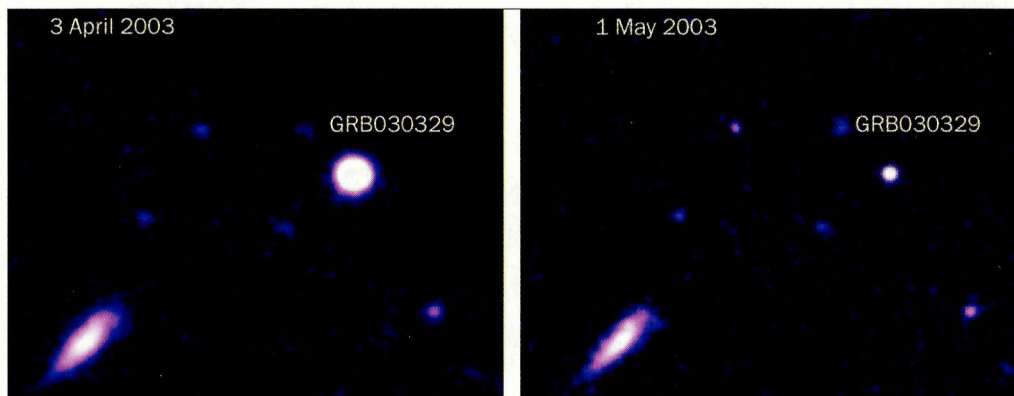
Gamma-ray burst supports hypernova hypothesis

"He who seeks finds." After decades of speculation on the nature of gamma-ray bursts (GRBs), the very bright event known as GRB030329 is finally unveiling their origin. This burst is a "Rosetta stone" for scientists, revealing for the first time that a GRB and a supernova – the two most energetic explosions known in the universe – occur simultaneously. Thanks to this telling burst, a team of astronomers has pieced together the key elements of the so-called "collapsar" model of long-duration GRBs, from star death to the dramatic birth of a black hole.

NASA's High-Energy Transient Explorer satellite (HETE-II) initially detected the burst on 29 March 2003 (at 11:37:14 UTC) in the constellation Leo. For more than 30 seconds the burst outshone the entire universe in gamma rays. Its unusual brightness triggered an unprecedented hunt for optical observations around the world (*CERN Courier* June 2003 p13). Within 24 hours a first, very detailed, spectrum of the burst's optical afterglow was obtained by the Very Large Telescope (VLT) of the European Southern Observatory (ESO) at the Paranal Observatory in Chile. The spectrum displays a redshift of 0.1685, corresponding to a distance of 2650 million light-years. This is near for a GRB and explains why this burst is among the 0.2% brightest bursts ever recorded. It provides the long-awaited opportunity to test the many hypotheses and models proposed since the discovery of the first GRBs in the late 1960s (*CERN Courier* June 2003 p5).

The afterglow of GRB030329 lingered for weeks in lower energy X-ray and visible light, allowing continued spectral observations with the VLT over a period of one month. The results were published in *Nature* (J Hjorth *et al.* 2003) by members of the Gamma-Ray Burst Afterglow Collaboration (GRACE) at ESO. According to the group of 27 researchers from 17 institutes, the spectral changes of the fading source give irrefutable evidence of a direct connection between the GRB and "hypernova" explosion of a very massive, highly evolved star. This is based on the gradual emergence of a supernova-type spectrum, revealing the extremely violent explosion of a star. With velocities well in excess of 30 000 km/sec (10% the velocity of light), the ejected material is moving at record speed, testifying to the enormous power of the explosion.

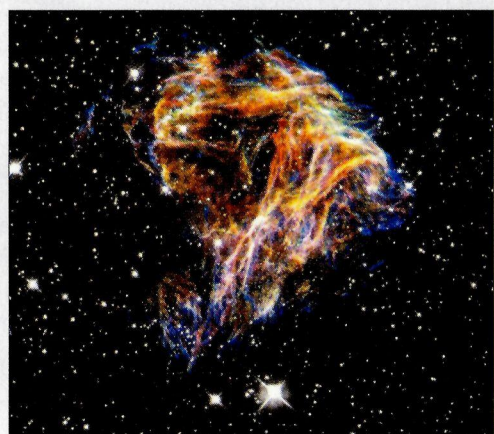
Hypernovae are rare events and probably



Images obtained at the 8.2 m VLT telescopes show the fading image of the optical afterglow of GRB030329, as seen on 3 April (four days after the GRB event) and 1 May 2003. (ESO.)

Picture of the month

The delicate filaments in this image from NASA's Hubble Space Telescope are sheets of debris from a stellar explosion in our neighbouring galaxy the Large Magellanic Cloud (LMC). This small companion galaxy to the Milky Way is only visible from the southern hemisphere. The filamentary material of this supernova remnant, denoted LMC N 49, will eventually be recycled into building new generations of stars in the LMC. The Sun and planets are constructed from similar debris of supernovae that exploded in the Milky Way billions of years ago. (NASA, The Hubble Heritage Team, STScI/AURA.)



caused by the explosion of stars of the "Wolf-Rayet" type. These WR-stars were originally formed with a mass greater than 25 solar masses and consisted mostly of hydrogen. During their WR-phase, having stripped themselves of their outer layers, they consist almost purely of helium, oxygen and heavier elements, produced by intense nuclear burning during the preceding phase of their short life. Such a dense star of about 10 solar masses will rapidly deplete its fuel, triggering a Type Ic supernova/GRB event. The core collapses, without the star's outer part "knowing". A black hole forms inside, surrounded by a disc of accreting matter, and within a few seconds launches a jet of matter away from the black hole that ultimately makes the GRB. The jet passes through the outer shell of the star and, in conjunction with vigorous winds of newly forged radioactive nickel-56 blowing off the disc inside, shatters the star. The GRACE team

say this "collapsar" model, introduced by Stan Woosley of the University of California in 1993, best explains the observation of GRB030329.

"We've been waiting for this for a long, long time," said lead author Jens Hjorth. "This GRB gave us the missing information. From these detailed spectra we can now confirm that this burst, and probably other long GRBs, are created through the core collapse of massive stars. Most other leading theories are now unlikely."

As Stan Woosley, one of the co-authors, points out, this does not mean the GRB mystery is completely solved because, "we cannot reach any conclusion yet on what causes short GRBs." Many astronomers think these bursts, lasting less than two seconds, might be caused by neutron star mergers, but they are still waiting for their "Rosetta stone" burst.

Further reading

J Hjorth *et al.* 2003 *Nature* **423** 847.

CCD X-Ray Detectors

Quantum 315



Quantum 210


Detector Type:

Array (3x3); 315mm x 315mm

Array (2x2); 210mm x 210mm

Number of Pixels:

6144 x 6144; 37.75 million

4096 x 4096; 16.8 million

Pixel Size at Detector Surfaces:

51 x 51 microns

51 x 51 microns

Phosphor (optimized):

1 X-ray Angstrom

1 X-ray Angstrom

Spatial Resolution FWHM:

90 microns; 1.76 pixels

90 microns; 1.76 pixels

Taper Ratio:

3.7 to 1

3.7 to 1

Optical Coupling (CCD to Taper):

Direct bond

Direct bond

CCD Type:

Thomson THX 7899

Thomson THX 7899

CCD Pixel Size:

14 x 14 microns

14 x 14 microns

Operating Temperature:

-50 degrees Celcius

-45 degrees Celcius

Cooling Type:

Thermoelectric

Thermoelectric

Dark Current:

0.015 e/pixel/sec

0.015 e/pixel/sec

Controller Electronics:

ADSC Custom

ADSC Custom

Readout Times (Full Resolution):

1 second

1 second

Read Noise (Pixel Rate):

(1 MHz): 18 electrons estimated

(1 MHz): 18 electrons typical

Full Well Depth (Full Resolution):

270,000 electrons typical

270,000 electrons typical

Dimensions:

 34.7 in. L x 17.7 in. W x 18.1 in. H
(880.6 mm x 450.0 mm x 460.0 mm)

 31.7 in. L x 13.7 in. W x 12.4 in. H
(804.5 mm x 346.8 mm x 315.6 mm)

Weight:

294 lbs. (133.0 kg)

128.0 lbs. (58.0 kg)

Delivery:

Typical delivery is 17 - 22 weeks, dependent upon system ordered. Pricing discount available for purchase of more than one system at time of sale. Contact the ADSC sales office for more details.

Warranty:

ADSC warrants both parts and labor for any defects due to faulty material or workmanship for one year from the date of original installation.

Options:

Available options include: Goniostat, Mirrors, and Support Tables. Total turn-key systems are also available.

Service Contracts:

Annual service contracts are available from end of warranty period for up to three years at a nominal cost. Call for details.

Sales Information:

Voice: (858) 486-0618

Fax: (858) 486-0722

email: sales@adsc-xray.com



ADSC

area detector systems corporation

12550 Stowe Drive
Poway, California 92064 USA
voice: (858) 486-0444
fax: (858) 486-0722
website: www.adsc-xray.com