

The race to observe gamma-ray bursts

More and more astronomers are joining the race for the first optical images from gamma-ray bursts. After the precise localization of a new gamma-ray burst, several institutes try to obtain an image of its optical counterpart as quickly as possible. What makes this "sport" so exciting is that nobody knows when or where the next gamma-ray burst will occur. Luck plays an important role in the quest. Among the telescopes around the world that are ready to respond immediately to an alert, only a few are able to take advantage as the bursts occur during the night, well above the horizon and during good weather conditions.

The story of one of the most exciting of these races has recently been published in *Nature* (Fox *et al.* 2003). The starter's shot was the detection by NASA's High Energy Transient Explorer (HETE) satellite of a gamma-ray burst, named GRB021004, on 4 October 2002 at 12:06:14 UT. Just 193 seconds later, the Japanese Automated Response Telescope at the Institute for Physical and Chemical Research (RIKEN) pointed on the location sent out by HETE to make the first image of the burst. Sharper images were performed a few minutes later by the Near Earth Asteroid Tracking (NEAT) camera mounted on one of the Mount Palomar telescopes near San Diego, California. The fading afterglow of this



An artist's impression of the Swift spacecraft – due for launch in December 2003 – observing a gamma-ray burst. Swift will be dedicated to observing bursts and their afterglows. (Spectrum Astro.)

burst was then followed, for several weeks, by some 40 optical telescopes around the world, as well as by six radio telescopes.

GRB021004 is the second gamma-ray burst, after GRB990123 in January 1999, to be observed in the optical less than 15 minutes after the burst. Although detected slightly later in the optical than GRB990123, it was the best-observed gamma-ray burst at that time. Now, however, all the attention is focused on GRB030329, which is on the way to take the lead over GRB021004. Detected

by HETE on 29 March 2003, GRB030329 is one of the brightest and closest gamma-ray bursts on record. With a cosmological redshift of $z=0.17$, it is approximately two billion light-years away, as opposed to other bursts such as GRB021004 ($z=2.32$) that are located at more than 10 billion light-years away.

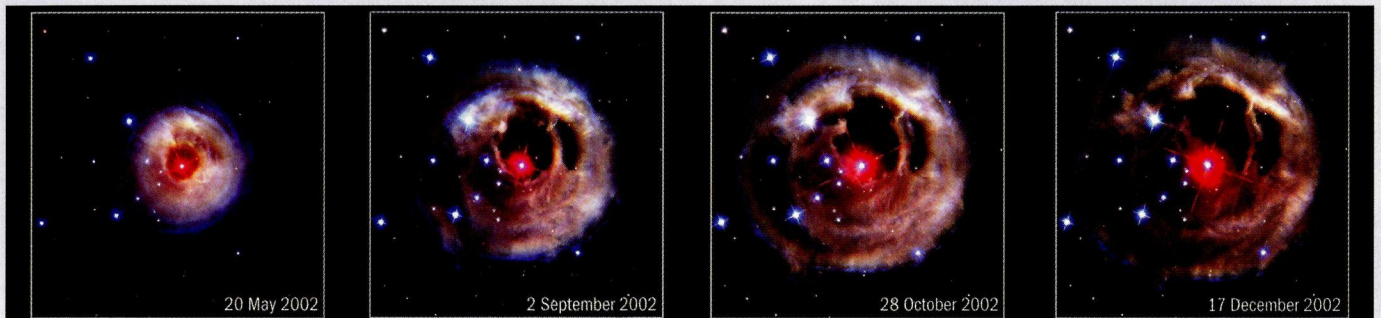
The unprecedented number of observations of these two recent gamma-ray bursts has tended to confirm their association with supernovae. The violent flash of gamma rays is thought to arise from ultra-relativistic particles thrown out by a cataclysmic event such as the collapse of a massive star – for example in the "cannonball" model (see p5). Such models apply to gamma-ray bursts lasting several seconds; bursts shorter than about 2 seconds are thought to be due to the coalescence of two neutron stars to form a black hole.

Currently, two satellites are able to provide and distribute accurate burst locations within seconds – HETE and INTEGRAL (*CERN Courier* March 2003 p13). In December 2003, NASA will launch the Swift spacecraft, which will have an even greater capability to detect and locate bursts, as well as on-board optical, ultraviolet and X-ray telescopes.

Further reading

D W Fox *et al.* 2003 *Nature* **422** 284.

Picture of the month



In January 2002, the supergiant star V838 Monocerotis, located about 20 000 light-years away in the constellation Monoceros (the Unicorn), suddenly became 600 000 times more luminous than the Sun. This made it temporarily the brightest star in our galaxy. The light from this dramatic eruption created a unique phenomenon known as a "light echo" when it reflected off dust shells around the red star at the centre. This sequence of pictures from the NASA/ESA Hubble Space Telescope's Advanced Camera for Surveys, obtained between May and December 2002, shows apparent changes in the appearance of the circumstellar dust as different parts are illuminated sequentially. From the first to last image, the apparent diameter of the nebula appears to balloon from four to seven light-years. This creates the illusion that the dust is expanding into space faster than the speed of light. In reality the dust shells are not expanding at all, but it is simply the light from the stellar flash that is sweeping out into the nebula. (NASA, European Space Agency and H E Bond (STScI).)