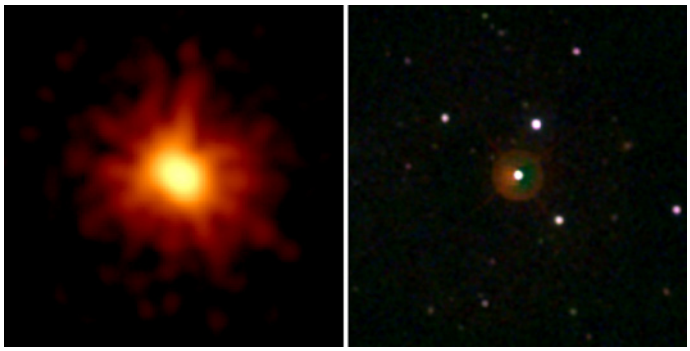
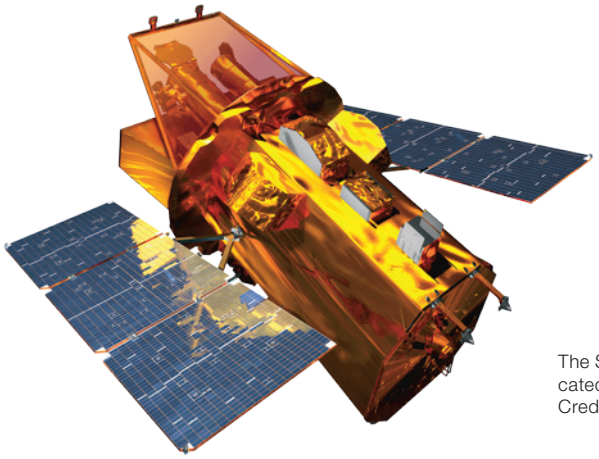
An illuminating blast from the Universe's past

— *The incredible story of the brightest gamma ray burst ever seen*

Four decades ago, blasts of gamma-ray radiation were discovered originating from the farthest regions of the Universe. Once poorly understood, these powerful fits of stellar rage known as gamma-ray bursts are now revealing themselves. On 19 March 2008 astronomers had perhaps the best view yet of a gamma-ray burst thanks to an array of observatories and telescopes that saw a jet of material firing towards the Earth at an astounding 99.99995 percent of the speed of light.



The dazzling afterglow was watched by Swift's X-ray Telescope (left) and Optical/Ultraviolet Telescope (right). Credit: NASA/Swift/ Stefan Immler, et al.



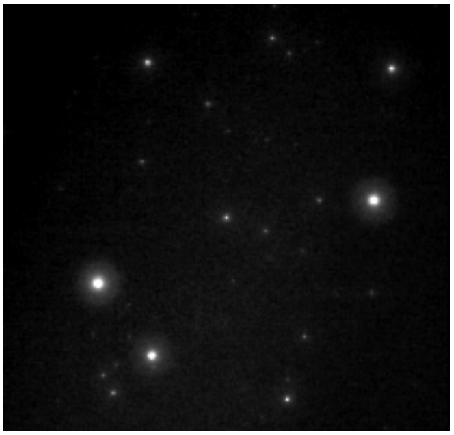
The Swift space observatory is dedicated to studying gamma-ray bursts. Credit: NASA.

The burst, officially known as GRB 080319B, was not just emitting gamma rays. It was shining in visible light too, thanks to the energy emitted from the violent afterglow. This afterglow is difficult to observe, but with telescopes around the globe watching — some even before the burst was actually discovered (thanks to a fortunate coincidence as they were observing another burst in the same direction) — astronomers could study the burst in unprecedented detail. The visible-light glow from the burst was so bright that, for just under a minute, people could have seen it with the naked eye. The lucky few who might have spotted the burst, could have seen further than anyone else on Earth as the burst broke the record for the most distant object visible to the naked eye (magnitude 5.8).

Gamma-ray bursts are believed to be the result of the release of titanic amounts of energy at the very moment a black hole or a neutron star is born. Analysis indicates they are amongst the most powerful events known since the Big Bang. It is difficult, however, to view a burst from start to finish, and over a broad range of wavelengths, because they appear without warning and last anything from a few seconds to several minutes. Theory suggests that the flood of radiation is produced when a massive star collapses and forms a black hole or neutron star — at least for the majority of bursts. This releases a tremendous quantity of energy in a very short time resulting in the brief spike — a blast of radiation — that catches our attention.

In March 2008, NASA's Swift spacecraft was bombarded by a shower of gamma rays emanating from the constellation of Boötes in the northern hemisphere. The Burst Alert Telescope was monitoring the skies for this kind of event. As its sensors lit up, Swift alerted astronomers on the ground to the incoming radiation — the sign that something had exploded in the distant Universe. In a distant galaxy some 7.5 billion years ago, a massive star had died and collapsed. A black hole was born and the blast of gamma rays from this cataclysmic genesis was now battering Swift's sensors.

After the initial detection Swift made follow-up observations with its onboard instruments. Astronomers quickly notified an impressive array of other ground-based telescopes and observatories to join in. These instruments also began making detailed observations of the burst, now named GRB 080319B. The wide-field robotic visible-light telescope Pi of the Sky at Las Campanas Observatory already had the gamma-ray burst in its sights, as did the TORTORA camera attached to the 0.6-m Rapid Eye Mount (REM) telescope at ESO La Silla. These telescopes were monitoring another burst close by, and the new burst just happened to be observed as well.



Located near the middle of the image is the visible-light afterglow of the burst seen by the Pi of the Sky telescope. Credit: Pi of the Sky.

"We were actually almost peering directly down the jets of GRB 080319B — like looking down the end of a pressure hose as it comes on"

The REM telescope leapt into action to observe the burst. Credit: ESO.

Just 10 minutes after the burst first appeared, one of the powerful 8.2-m Unit Telescopes from ESO's Very Large Telescope on Paranal Mountain began collecting the data that allowed astronomers to measure the burst's distance.

Ultraviolet, visible-light and near-infrared observations of the afterglow were also made with other instruments, including those on Swift, the REM, the Liverpool Telescope, the Faulkes Telescope North, and Gemini-North.

Although the actual gamma-ray burst, GRB 080319B, was brief, its afterglow was visible for several months (see the light curve above). For three weeks the NASA/ESA Hubble Space Telescope was even able to show that the burst was outshining its parent galaxy. The observations show that GRB 080319B was the brightest ever gamma-ray burst seen in visible and X-ray wavelengths, and one of the brightest bursts ever in terms of its gamma-ray output. X-ray and visible-light observations continued for more than a month after the initial detection as the afterglow dimmed into obscurity.

Thanks to this global collaboration, astronomers have gained a wealth of information. The combined high quality observations of GRB 080319B make them the most extensive set of observations to date of a gamma-ray burst. Further studies indicate that two jets are present and that we were actually almost peering directly down the jets of GRB 080319B — like looking down the end of a pressure hose as it comes on. With these observations of one outstanding burst, astronomers have been able to learn more about the complex and intriguing astrophysics of gamma-ray bursts in general. There is, however, still much to learn from these observations and hopefully other bursts in the future. The story is far from over.

Some of the participating telescopes and observatories

- Swift: www.nasa.gov/swift
- Konus-Wind: http://heasarc.gsfc.nasa.gov/docs/heasarc/missions/wind.html
- Pi of the Sky: http://grb.fuw.edu.pl/index.html
- Rapid Eye Mount (REM): http://golem.merate.mi.astro.it/projects/rem/
- Liverpool Telescope: http://telescope.livjm.ac.uk/
- Faulkes Telescope North: http://faulkes-telescope.com/
- Very Large Telescope (VLT): http://www.eso.org/projects/vlt/
- Gemini North: http://www.gemini.edu/
- Hubble Space Telescope: http://spacetelescope.org/ & http://hubblesite.org/
- Hobby-Eberly Telescope (HET): http://www.as.utexas.edu/mcdonald/het/het.html
- Westerbork Synthesis Radio Telescope (WSRT): http://www.astron.nl/p/observing.htm
- Very Large Array (VLA): http://www.vla.nrao.edu/
- Peters Automated Infrared Imaging Telescope (PAIRITEL): http://astro.berkeley.edu/~jbloom/Autotel/
- Katzman Automatic Imaging Telescope (KAIT): http://astro.berkeley.edu/~bait/kait.html
- Nickel Telescope: http://www.ucolick.org/public/telescopes/nickel.html
- Spitzer Space Telescope: http://www.spitzer.caltech.edu/