Naked-Eye Gamma-ray Burst Aimed Directly at Earth

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Sept. 10, 2008: Astronomers announced today that a remarkable gamma-ray burst visible to the human eye earlier this year came from an explosive stellar jet aimed almost directly at Earth.

Right: Click to view a streaming animation of the explosive stellar jet, an artist's concept.

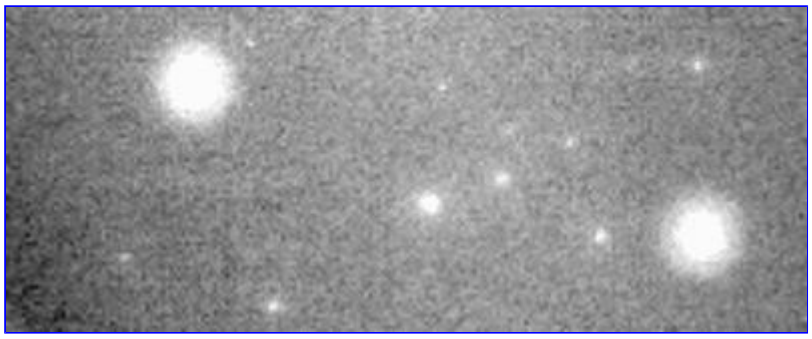
NASA's Swift satellite detected the explosion - formally named GRB 080319B - at 2:13 a.m. EDT on March 19, 2008, and pinpointed its position in the constellation Bootes. The gamma-ray burst became bright enough to see even without a telescope. Observations of the event by a global array of satellites and ground-based observatories have since given scientists the most detailed portrait of a burst ever recorded.

"Swift was designed to find unusual bursts," said Swift principal investigator Neil Gehrels at NASA's Goddard Space Flight Center in Greenbelt, Md. "We really hit the jackpot with this one."

In a paper to appear in Thursday's issue of Nature, Judith Racusin of Penn State University and a team of 92 coauthors report on observations across the spectrum that began 30 minutes before the explosion and followed its afterglow for months. The team concludes the burst's extraordinary brightness arose from a jet that shot material directly toward Earth at 99.99995 percent the speed of light.

Within the next 15 seconds, the burst brightened enough to be visible in a dark sky to human eyes. It briefly crested at a magnitude of 5.3 on the astronomical brightness scale. Incredibly, the dying star was 7.5 billion light-years away.

Telescopes around the world already were studying the afterglow of another burst when GRB 080319B exploded just 10 degrees away. TORTORA, a robotic wide-field optical camera operated in Chile with Russian-Italian collaboration, also caught the early light: movie. TORTORA's rapid imaging provided the most detailed look yet at visible light associated with a burst's initial gamma-ray blast.



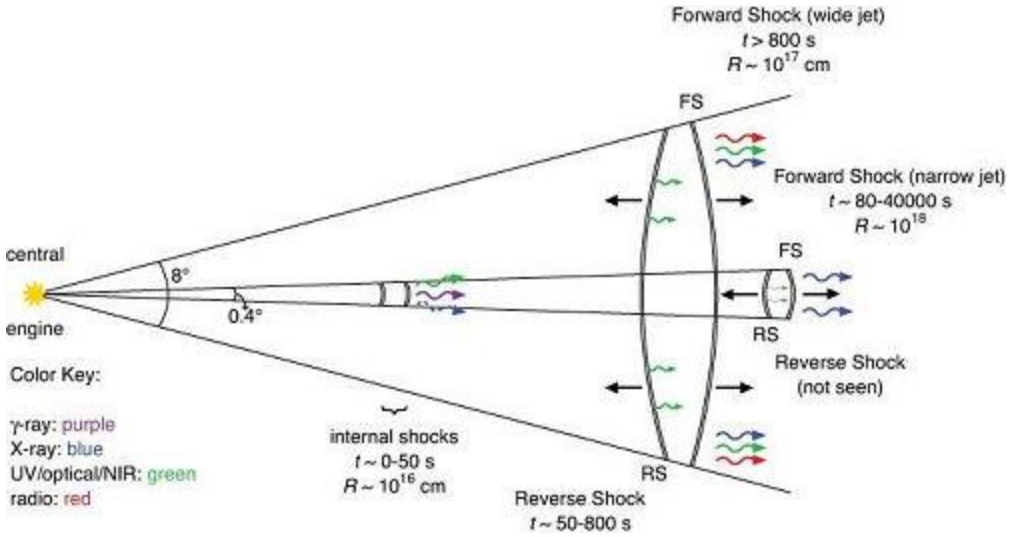
Above: GRB 080319B makes a brief appearance among the stars of Bootes in a movie

made by Pi of the Sky, a Polish group that monitors the sky for afterglows and other short-lived phenomena. [More]

Immediately after the blast, Swift's UltraViolet and Optical Telescope and X-Ray Telescope indicated they were effectively blinded. Racusin initially thought something was wrong with the telescopes. Within minutes, however, as reports from other observers arrived, it was clear this was a special event.

Gamma-ray bursts are the most luminous explosions in the Universe. Most occur when massive stars run out of nuclear fuel. As a star's core collapses, it creates a black hole or neutron star that, through processes not fully understood, drive powerful gas jets outward. These jets actually punch through the collapsing star, carrying matter and beaming radiation into space.

The team believes the jet directed toward Earth contained an ultra-fast component just 0.4 of a degree across. This core resided within a slightly less energetic jet about 20 times wider.



Above: A two-component jet model explains the timing and spectral evolution of GRB 080319B. Credit: Nature/Judith Racusin. [larger image]

"It's this wide jet that Swift usually sees from other bursts," Racusin explained. In the case of GRB 080319B, the narrow jet was seen as well, resulting in the burst's unusual brightness. "Maybe every gamma-ray burst contains a narrow jet, too, but astronomers miss them because we don't see them head-on."

Such an alignment occurs by chance only about once a decade, so GRB 080319B was a rare catch indeed.

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Author: Dr. Tony Phillips | Credit: Science@NASA

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Swift is managed by Goddard. It was built and is being operated in collaboration with Penn State, the Los Alamos National Laboratory, and General Dynamics in the U.S.; the University of Leicester and Mullard Space Sciences Laboratory in the United Kingdom; Brera Observatory and the Italian Space Agency in Italy; plus additional partners in Germany and Japan.

At the same moment Swift saw the burst on March 19th, the Russian KONUS instrument on NASA's Wind satellite also sensed the gamma rays and provided a wide view of their spectral structure. A robotic wide-field optical camera called "Pi of the Sky" in Chile simultaneously captured the burst's first visible light. The system is operated by institutions from Poland.

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