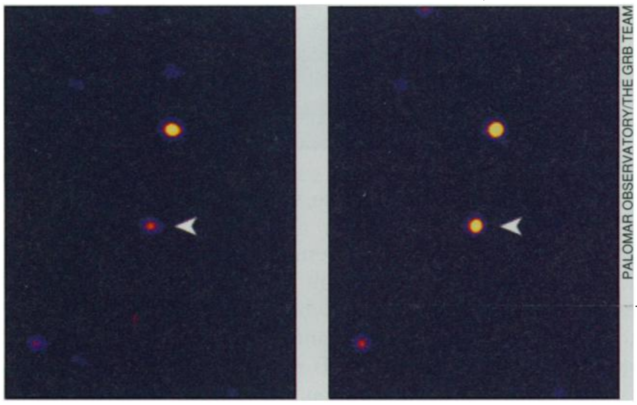
ASTRONOMY

It's Official: Gamma Bursts Come From Far, Far Away

Ebullient astronomers think they may have solved one of astronomy's most durable puzzles: where in the universe the mysterious flashes of energy called gamma-ray bursts come from. Occurring at a random position in the sky about once a day, these seconds- to minutes-long pulses of gamma rays originate either from local sources in or near our Milky Way galaxy or from vastly more powerful events in the far reaches of the universe. Now, by detecting the afterglow of a burst on 8 May—Ascension Day—in the northern constellation Camelopardalis (the Giraffe) and measuring its distance, a team of observers has delivered a verdict: Gamma-ray bursts come from far beyond our galaxy, at cosmological distances.

"I think this is a victory," says Princeton astronomer Bohdan Paczyński, a longtime proponent of the cosmological view. Adds John Heise of the Space Research Organization Netherlands (SRON), a project scientist for Beppo-SAX, the satellite that was crucial to the discovery: "We finally got the proof. It's fantastic!" Some advocates of the local view are still holding out, but many astronomers are now considering a new puzzle: what kind of distant cataclysms could explain the bursts, which would have to be the most energetic events in the cosmos.



PALOMAR OBSERVATORY/THE GRB TEAM

Distant flash. One and 2 days after the 8 May gamma-ray burst, visible light from the source continued to brighten.

The brief gamma-ray flashes themselves have yielded little information about their sources, so astronomers have been hunting for counterparts at other wavelengths. That search quickened with the launch of Beppo-SAX, an Italian-Dutch project, just over a year ago. Gamma-ray detectors have poor angular resolution, making it hard to know where to look for a visible-light counterpart, but Beppo-SAX also carries two wide-field x-ray cameras, built at SRON's Utrecht laboratory, that operate in tandem with the gamma detector. The sharper view of the x-ray cameras enables astronomers to narrow down the location of a gamma-ray burst, giving colleagues with optical and radio telescopes a smaller patch of sky in which to search.

Beppo-SAX scored its first success when a burst detected on 28 February guided a Dutch team led by Jan van Paradijs of the University of Amsterdam and the University of Alabama, Huntsville, to an optical counterpart (*Science*, 21 March, p. 1738). The rapidly fading optical source lay within a smear of light that looked like a very distant galaxy. However, a couple of weeks later, a group led by Patrizia Caraveo of the Istituto di Fisica Cosmica in Milan, Italy, reported that Hubble Space Telescope observations seemed to indicate that the optical source was moving across the sky. Motion would be imperceptible at a distance greater than a few hundred light-years, they argued, so the source must be nearby (*Science*, 25 April, p. 529).

Now, the "Ascension burst" tips the scales sharply back toward the cosmological explanation. Notified by an Internet alert from the Beppo-SAX team, Howard Bond of the Space Telescope Science Institute in Baltimore discovered a point of light at the burst position less than 7 hours after the event, through a modest 90-centimeter telescope at the Kitt Peak National Observatory in Arizona. Over the next several days, the point brightened, then faded.

Then, on 11 May, Mark Metzger and colleagues at the California Institute of Technology used the 10-meter Keck II telescope on Mauna Kea, Hawaii, to capture a spectrum of what had become known as Bond's star. They found that the light contained absorption lines—in effect, shadows from material in front of the source. And the lines, from the elements iron and magnesium, were drastically shifted toward the red end of the spectrum by the expansion of the universe. This redshift, of 0.835, indicated that the absorbing material lies several billion light-years away, and the optical source is at least that far off.

British theorist Martin Rees of Cambridge University notes that "the important question is whether the optical event is related to the gamma-ray burst." But he thinks "this seems quite probable." Paczyński has fewer reservations: "It is a very direct proof that at least this one burst was at a considerable redshift." The same would then be true for all other bursts, he says, because it is "very unlikely" that there could be two separate classes of gamma-ray bursts. Says Paczyński's co-worker, Ralph Wijers of Cambridge University: "We can finally forget about the local hypothesis."

Don Lamb of the University of Chicago, a proponent of the local view, isn't convinced, saying that he has "increasing doubts that [Bond's star] has anything to do with the gamma-ray burst." Lamb points out that the variable object shows all the signs of being a so-called BL Lacertae object, a kind of turbulent, energetic galaxy. Because such galaxies haven't been found at the sites of previous bursts, Lamb thinks the burst and the high-redshift optical variable are unrelated. "Time will tell," he says; "that's the wonderful thing in science."

Caraveo, whose team had reported that the earlier burst counterpart was moving and therefore nearby, is also doubtful. She sees "no reason to withdraw [their] claim," saying that her team's motion-finding technique "has been tested with a source of comparable brightness seen by the same instrument of the Hubble Space Telescope." Van Paradijs, however, is convinced that the Italians "were wrong. Other groups, working with the same data, were unable to confirm the reported motion. In my opinion, there is no question anymore" about the validity of the cosmological model.

If gamma-ray bursts are indeed at cosmological distances, as most astronomers now seem to believe, the question is what kind of astrophysical mechanism could spark these extremely energetic events. The varying brightness of the visible afterglow may help theorists narrow the field of possibilities. Another clue came on 13 May, when astronomers at the Very Large Array radio telescope in New Mexico spotted a flaring source of radio waves at the position of Bond's star.

Rees says that the observations so far agree with a scenario he has proposed, in which a titanic event—probably two neutron stars colliding—generates a blast wave that emits first gamma rays, then the lower energy optical and radio waves, as it slams into the surrounding interstellar medium. "The observed light curves are quite easy to explain," he says. Observers and theorists alike are sure to have plenty to discuss when they gather on the Italian island of Elba for a gamma-ray burst workshop at the end of this month.

–Govert Schilling

Govert Schilling is an astronomy writer in Utrecht, the Netherlands.