MEETING GAMMA RAY BURST SYMPOSIUM

Gamma Ray Bursts Keep Playing Coy

HUNTSVILLE, ALABAMA—Since 1991, astronomers have met here every 2 years to puzzle over gamma ray bursts, mysterious flashes of energy that may come from the most powerful explosions since the big bang. These events have surrendered many clues to their location and nature over the past couple of years. At the 5th Huntsville Gamma Ray Burst Symposium, held 19 to 22 October, they dropped another hint or two—and another puzzle.

"X-ray Flashes" Puzzle Astronomers

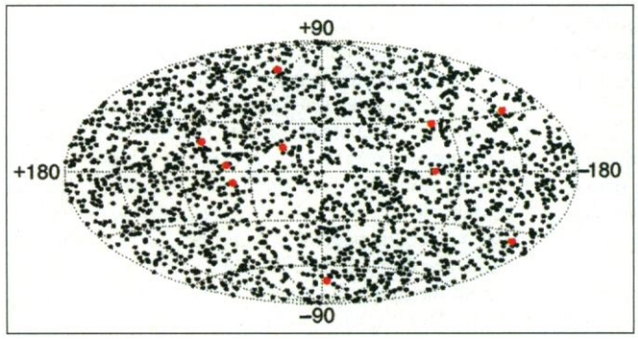
It may sound like a feeble joke, but astronomers say they have discovered a new kind of gamma ray burst: one without gamma rays. At the symposium last week, astronomer John Heise of the Space Research Organization Netherlands announced that the Dutch-Italian satellite BeppoSAX has spotted strange outbursts of x-rays that look exactly like the byproducts of a gamma ray burst—they just don't come with gamma rays.

A mystery for decades, gamma ray bursts have recently been linked to some of the most energetic events in the cosmos: vast supernova explosions that spawn black holes in the far reaches of the universe (*Science*, 15 October, p. 395). Invisible from Earth because the atmosphere absorbs gamma radiation, they are spotted about once a day by BeppoSAX and other Earth-orbiting satellites. BeppoSAX also detects flashes of x-rays, which have accompanied every gamma burst in the field of view of its x-ray cameras so far, and which also emanate from astronomical objects such as flare stars and x-ray novae. Now, Heise is reporting still another kind of x-ray burst.

Sifting through the BeppoSAX data, Heise found nine x-ray explosions that resemble the x-ray signal from normal gamma ray bursts in every respect—they last tens of seconds, are scattered randomly across the sky, and have comparable spectra—except that no gamma rays were seen. "These are certainly not normal flare stars or other known objects," says Heise. "It could be a completely new class of events."

But the "x-ray flashes," as Heise prefers to call them, could be related to gamma ray bursts after all, says Stan Woosley of the University of California, Santa Cruz. Woosley has developed theoretical models for what he calls "dirty" gamma ray bursts: If a cosmic explosion happens in a place where the interstellar gas is relatively dense, the gamma rays could easily be absorbed by the gas while some x-rays escape, he says. However, Woosley's model predicts a different kind of x-ray spectrum from the ones BeppoSAX has measured.

Quick follow-up observations made immediately after a burst to look for an "afterglow" at other wavelengths, including optical and radio, could reveal the true nature of Heise's mysterious flashes. And those could come quickly: Immediately after Heise's announcement, Luigi Piro of the Istituto di Astrofisica Spaziale in Rome, the mission scientist for BeppoSAX, decided that x-ray flashes will from now on get the same treatment as gamma ray bursts: BeppoSAX's narrow-field x-ray cameras will pinpoint their exact location as soon as possible, to tell optical and radio telescopes where to look for an afterglow.



Blast pattern. A sky map shows the distribution of gamma ray bursts recorded by NASA's Compton Gamma Ray Observatory; the 10 most recent are shown in red.

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A Yardstick for Gamma Ray Bursts?

Astronomers may have found a simple way to measure the distance to gamma ray bursts, mysterious explosions that occur about once every day in the far corners of the universe. A study presented at the symposium showed that there is a neat correlation between the amount of "flickering" in a burst and its intensity—a correlation that, if it holds up, would tell astronomers the distance of any new burst quickly.

When a satellite detects a gamma ray burst, astronomers can tell the direction it came from, but not its distance. To do that, they must immediately train ground-based telescopes on the burst's afterglow. From the redshift—a measure of the amount of cosmic expansion since the radiation was emitted—they can determine how far away it occurred. So far, that has been done for only six gamma ray bursts; the distance of the 2500-plus other observed bursts is anyone's guess.

But those six bursts, say Enrico Ramirez-Ruiz and Ed Fenimore of Los Alamos National Laboratory in New Mexico, show a striking relationship: When the astronomers corrected for distance to determine the intrinsic brightness of the bursts, they found that the brightest flickered the most, while less luminous ones were much smoother. If this relation holds for all gamma ray bursts, it will be easy to determine their distances. The amount of flicker indicates the true brightness, and comparing this with the observed brightness gives the distance.

"It's an amazing find," says Don Lamb of the University of Chicago. "The correlation looks awfully good." Knowing the distances of thousands of gamma ray bursts should reveal how early in the history of the universe these explosions occurred, says Lamb. If gamma ray bursts are caused by collapsing supermassive stars, as some popular models suggest, this would tell astronomers how early star formation began.

A team led by Jay Norris of NASA's Goddard Space Flight Center in Greenbelt, Maryland, sees evidence for another luminosity indicator. These investigators note that in most bursts, the highest energy gamma ray photons arrive slightly earlier than the lower energy ones. According to Norris, for the six bursts with known distances, this spectral lag is smallest for the most luminous bursts and larger for the fainter ones. Both the flickering and the spectral lag might reflect conditions in a jet of matter that, in some scenarios, spews out from the explosion at nearly the speed of light, speculates Ramirez-Ruiz. He adds: "It smells like physics. It should tell us something about the progenitors" of gamma ray bursts.

Astronomers should know within a year or so whether these distance indicators hold up. For example, says Lamb, if another half-dozen bursts with measured redshifts show the neat relation between flickering and brightness, astronomers can be confident that they've found a new cosmic yardstick.

—GOVERT SCHILLING

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