Astronomy

Shedding more light on gamma-ray bursts

Spitting out a torrent of radiation and then vanishing without a trace, gamma-ray bursts are among the most mysterious phenomena known in the universe. New findings from the Compton Gamma Ray Observatory (GRO), launched in 1991, may eventually help settle a debate about the origin of these bursts, says Bohdan Paczynski of Princeton University.

Last month, researchers announced that GRO had detected the highest-energy gamma-ray flash ever recorded (SN: 4/24/93, p.260). Brenda Dingus of NASA's Goddard Space Flight Center in Greenbelt, Md., says the finding suggests that gamma-ray bursts beam their energy rather than spewing it in all directions. If this interpretation proves correct, the bursts detected by GRO represent only a small fraction of the total number in the sky – those that happen to beam their radiation toward Earth. Dingus estimates that if gamma-ray bursts originate in a halo around our galaxy, they may be 100 times more numerous than indicated by GRO; if they originate far beyond our galaxy, they could be a million times more numerous.

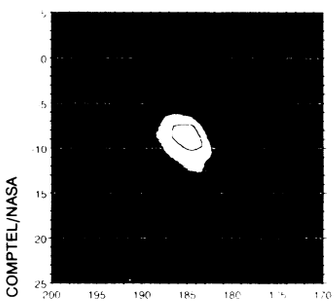


Image depicts highest-energy gamma-ray burst ever detected.

Dingus says she favors the beam model because it would explain how the record-breaking burst recently detected could contain such a large number of high-energy gamma rays. High-energy gamma rays easily collide with lower-energy gamma rays, annihilating each other to produce pairs of subatomic particles. Relatively few high-energy photons are left to stream into space. However, if gamma-ray bursts beam their energy, most photons would travel in the same direction. Fewer head-on collisions would exist and more high-energy photons might reach Earth.

An analysis of the first 220 bursts recorded by GRO's Burst and Transient Source Experiment (BATSE) may offer indirect support for the beam model, says Chryssa Kouveliotou of NASA's Marshall Space Flight Center in Huntsville, Ala. She told SCIENCE NEWS that the unpublished results suggest these bursts fall into two classes: about 60 higher-energy flashes lasting less than 2 seconds and 160 lower-energy flashes that lasted longer. The two types, she notes, have the same intensity range.

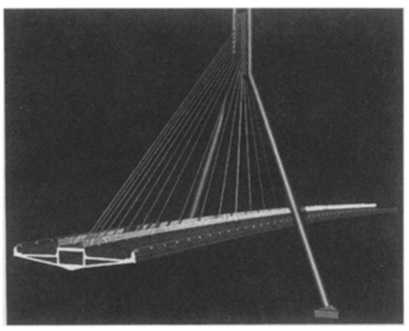
Kouveliotou proposes that both classes stem from the same type of beamed source. She speculates that some bursts seem to have a shorter duration because only a portion of the beam is aimed directly at Earth. Thus, GRO would record only part of the event. She adds that BATSE has detected fewer faint bursts than expected; Paczynski says this offers more evidence that bursts originate outside our galaxy. The shortfall of faint bursts, he says, may indicate that bursts did not exist in the early universe or that faint bursts are so distant that their radiation has shifted to wavelengths longer than those of gamma rays.

The 600 bursts so far seen by BATSE, Kouveliotou notes, continue to show the same pattern – an even distribution across the sky. Because of Earth's off-center location in the Milky Way, she says, the symmetric distribution argues against a burst source associated with our own galaxy unless the bursts originate in a huge halo whose inner diameter is double that of the Milky Way. Jon E. Hakkila of Mankato (Minn.) State University and his colleagues calculate that if BATSE eventually records another 2,000 bursts that are evenly distributed, the halo required to match the data would be so large and uniform that scientists would have to abandon the halo theory.

Materials Science

First all-composite auto bridge planned

Is crumbling infrastructure getting you down? Does defense-industry downsizing cramp your style? Tired of traffic gridlock? A consortium of businesses, defense contractors, and academics is addressing these concerns with one grand idea: a new auto bridge built of advanced composite materials.


UCSD

Drawing of proposed advanced-composite bridge.

The bridge, which would span Interstate 5 in San Diego, would be the first of its kind made entirely of composites reinforced with glass, carbon, and polymer fibers. The 450-foot-long bridge could weigh one-tenth as much as a traditional steel-and-concrete version, says consortium member Frieder Seible of the University of California, San Diego. He and his colleagues expect it to be more durable, easier to build, and less sensitive to earthquakes.

With an initial grant from the Federal Highway Administration, the consortium has begun testing materials and designing the structure by computer simulation. Planners estimate the bridge will take four years to complete.

Easy-to-make, heat-resistant composite

To make brake pads for jumbo jets, nose cones for rockets, and other parts that must withstand harsh conditions, manufacturers typically rely on strong, lightweight, heat-resistant carbon composites. But scientists have found a sturdier alternative, according to a report presented last month at the American Ceramics Society meeting in Cincinnati.

Like the old composite made of carbon fibers embedded in an amorphous carbon base, the new material gains its strength from parallel carbon fibers. In the new composite, however, boron nitride serves as the base substance. The resulting material resists oxidative deterioration at 850°C, nearly double the threshold of the carbon-carbon composite, says principal researcher James Economy of the University of Illinois at Urbana-Champaign. Moreover, the new composite shows significantly improved strength and stiffness, he says.

The new material is also easier to make. "We can complete the fabrication in several days, eliminating the messy three- to six-month process for carbon-carbon composites," says Economy. "And we still get a yield of over 90 percent."

Organic polymer tested as optical link

Models of "information superhighways" use inorganic crystals to convert electric signals to light. Organic polymers, however, promise to be easier to integrate into a high-speed communications network, as well as mechanically tougher and less expensive than crystals (SN: 8/3/91, p.77).

Scientists at IBM's Almaden Research Center in San Jose, Calif., have shown that electro-optic polymers can impart the information from six cable television channels onto a single laser beam for transmission through optical fibers. "We're getting TV pictures that are very near commercial broadcast quality," says IBM's Barton A. Smith.

The investigators' TV test apparatus will help them further develop such promising polymers, says Smith, who presented his team's findings at the spring meeting of the Materials Research Society, held last month in San Francisco.