Gamma-ray bursts become a repeating puzzle

Almost daily since its launch in 1991, an Earth-orbiting observatory has detected cosmic fireworks ranking among the highest-energy flashes of radiation ever recorded. These gamma-ray bursts come at random from all parts of the sky. Even more perplexing, they vanish without a trace and don't coincide with any known source in the cosmos.

Now, researchers have obtained the first evidence that gamma-ray bursts repeat. The finding is heating up a long-running debate about where gamma-ray bursts come from and how far away they reside (SN: 2/5/94, p. 85).

As reported in a Dec. 10 circular of the International Astronomical Union, NASA's Compton Gamma Ray Observatory (GRO) detected four flashes of gamma rays emanating from the same patch of sky during a 1.5-day interval in late October. Other spacecraft also recorded the last three of these flashes.

Even with these other detections, astronomers still don't know the exact locations of the bursts and therefore can't be sure they come from the same source, note GRO researchers Charles A. Meegan, Valerie Connaughton, and Gerald J. Fishman of NASA's Marshall Space Flight Center in Huntsville, Ala. Because the fourth burst followed the third by only 700 seconds, with small flickers of radiation in between, some astronomers argue that they should be counted as a single, unusually long event. Nonetheless, astronomers deem it unlikely that even three flashes could come in short order from different sources in the same general patch of sky.

Burst repetition would appear to rule out one popular model that suggests these flashes stem from the collision of dense objects—either two isolated neutron stars or a neutron star crashing into a black hole—far beyond the Milky Way. Such distant mergers, which would occur at random, could account for the strikingly uniform distribution of gamma-ray bursts across the sky. Mergers could generate the titanic energies that would be required if gamma-ray bursts come from far away.

Such collisions can happen only once, however. "You can't have repetition when the source is annihilated," says Connaughton, who discussed the findings this week in Chicago at a symposium on relativistic astrophysics.

Martin J. Rees of the University of Cambridge in England notes that the new data do not affect other models that propose a distant origin for bursts. These include black holes that lie at the center of distant galaxies and episodically swallow nearby matter. Each time matter spirals into a black hole, it would emit a burst of gamma rays.

Repeating bursts would more directly support a less popular model, in which the flashes come from a huge halo girdling the Milky Way and extending halfway to Andromeda, the nearest spiral galaxy. In this model, proposed by Don Q. Lamb of the University of Chicago and his colleagues, neutron stars that have sped away from our galaxy's core inhabit the halo and generate gamma-ray bursts. These flashes would occur at the energy levels observed by the GRO.

Neutron stars contain huge magnetic fields that can strain their surfaces, producing intermittent quakes and generating recurrent bursts of gamma rays. Alternatively, comets, asteroids, or other debris near a neutron star could generate recurring bursts as they slam into the dense star.

Because Earth lies some 30,000 light-years from the Milky Way's center, the halo must be much bigger than the visible part of the galaxy to account for the uniform pattern of bursts seen from our planet's vicinity. If our galaxy sports a halo riddled with gamma-ray bursts, it's likely that other galaxies do also, says Lamb. A future mission may have detectors sensitive enough to detect Andromeda's halo, he says.

Other researchers say the new data haven't resolved anything. "I'm just as much in the dark as I ever was," declares Bohdan Paczynski of Princeton University. *—R. Cowen*

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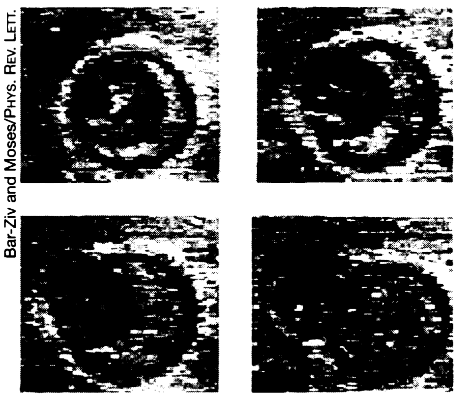
Laser beam triggers a membrane breach

The cell membrane serves as a tough, flexible barrier that protects a cell from its environment and holds in its components. Composed largely of fat molecules called lipids, this thin skin offers tremendous resistance to rupture and normally doesn't allow internal structures to pop out.

Researchers have now demonstrated that a low-power laser beam focused on an artificial structure that mimics a cell membrane can trigger the spontaneous ejection of material inside without permanently damaging either the membrane or the expelled object.



Bar-Ziv and Moses/Phys. Rev. Lett.

Within seconds, a vesicle (medium-sized inner circle) is expelled (from upper left to lower right) from the interior of a pressurized lipid membrane (large outer circle) about 9 micrometers wide.

Physicists J. David Moroz and Philip Nelson of the University of Pennsylvania in Philadelphia and Roy Bar-Ziv and Elisha Moses of the Weizmann Institute of Science in Rehovot, Israel, report their findings in an article to be published in Physical Review Letters.

The technique is a new way of selectively disrupting membranes, the researchers say. The ability to induce expulsion "hints at the exciting practical possibility of transforming membrane structure when and where we wish to do so."

In water, lipid molecules spontaneously assemble themselves into closed, saclike structures, or vesicles, analogous to cells. One vesicle can form inside another.

Focused on a lipid membrane, a laser beam's electromagnetic field induces molecular changes that tighten the membrane, increasing internal pressure. The disturbance causes the system to act as a pump, pulling water in by osmosis and forcing internal material out. When a vesicle floating within the sac encounters the outer wall, it sticks. Within a few seconds, it begins to emerge, gradually passing through the outer membrane. *— I. Peterson*