Gamma-ray bursts' highest power side unveiled by Fermi telescope

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(PhysOrg.com) -- Detectable for only a few seconds but possessing enormous energy, gamma-ray bursts are difficult to capture because their energy does not penetrate the Earth's atmosphere. Now, thanks to an orbiting telescope, astrophysicists are filling in the unknowns surrounding these bursts and uncovering new questions.

The Fermi Gamma-Ray Space Telescope, formerly called the Gamma-Ray Large Area Space Telescope, launched on June 11, 2008. As part of its mission, the telescope records any gamma-ray bursts within its viewing area.

"Fermi is lucky to measure the highest energy portion of the gamma-ray burst emission, which last for hundreds to thousands of seconds -- maybe 20 minutes," said Péter Mészáros, Eberly Chair Professor of Astronomy and Astrophysics and Physics, Penn State.

Most gamma-ray bursts occur when stars that are more than 25 times larger than our sun come to the end of their lives. When the internal nuclear reaction in these stars ends, the star collapses in on itself and forms a black hole. The outer envelope of the star is ejected forming a supernova.

"The black hole is rotating rapidly and as it is swallowing the matter from the star, the rotation ejects a jet of material through the supernova envelope," said Mészáros.

This jet causes the gamma-ray burst, which briefly becomes the brightest thing in the sky. However, unlike supernovas that radiate in all directions, gamma-ray bursts radiate in a very narrow area, and Fermi sees only jets ejecting in its direction. This, however, is the direction in which they send their highest energy photons. Any gamma-ray bursts on the other side of the black hole or even off at an angle are invisible to the telescope.

"We actually miss about 500 gamma-ray bursts for every one we detect," Mészáros told attendees today at the annual meeting of the American Association for the Advancement of Science in Vancouver, British Columbia.

The gamma-ray bursts that Fermi has seen have allowed astrophysicists to clarify previous theories about gamma-ray bursts.

"We have been able to rule out the simplest version of theories which combine quantum mechanics with gravity, although others remain to be tested," said Mészáros.

Mészáros notes that Fermi and other programs like the SWIFT telescope have shown that gamma-ray bursts last longer than we thought they did and that there are long and short gamma-ray bursts.

Fermi, a more specialized telescope than the SWIFT telescope which also detects gamma-ray bursts, enabled scientists to look at the very fast -- near the speed of light -- jets producing the gamma-ray emissions. While researchers are still modifying scientific theories on the nature of these bursts, thanks to Fermi, they now have actual measurements to add to the theoretical debate.

"Fermi has done much better in measuring how close to the speed of light the jet gets," said Mészáros. "But we still don't know if it is 99.9995

percent the speed of light or 99.99995 percent the speed of light."

Gamma-ray bursts occur in many places in the universe, but because they are a product of aging stars they may be able to shed some light on the beginnings of the universe. The bursts are visible at the longest distance from earth and therefore at the earliest time in the universe.

"We think we can detect them at the infancy of the universe," said Mészáros.

Wherever a gamma-ray burst exists, any planets in the vicinity suffer. Further away, the radiation from a gamma-ray burst would destroy the protective ozone in the upper atmosphere, allowing ultraviolet radiation to kill terrestrial plant life and animals would starve. Only sea life would remain unharmed. However, it is estimated that such nearby bursts can be expected only every 300 million years.

Because scientists believe that gamma-ray bursts also emit cosmic rays and neutrinos, other observatories are also observing these phenomena. Ice Cube Neutrino Observatory at the South Pole is trying to capture neutrinos, while the Pierre Auger Cosmic Ray Observatory in Argentina captures cosmic rays from these objects.

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