New discovery sheds new light on gamma-ray bursts

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A new type of light was detected from a recent gamma-ray burst, as discovered by Los Alamos National Laboratory and NASA scientists using both burst-detection satellites and a Los Alamos-based robotic telescope.
In a paper published in the May 12 issue of *Nature*, Los Alamos scientists and NASA announced the detection of a form of light generated by the same process that drives the gamma ray burst itself, yielding new insights about these enigmatic cosmic explosions -- the most powerful events since the Big Bang.

Dec. 19, 2004 at 01:42 Universal Time, both the European Space Agency's INTEGRAL satellite and NASA's Swift satellite detected the onset of a powerful gamma-ray burst in the direction of the constellation Cassiopeia. Within seconds, the RAPTOR (RAPid Telescopes for Optical Response) telescopes on site at Los Alamos swung into action to search for optical light from the explosion.

By responding so quickly, RAPTOR-S was the first optical telescope ever to begin observations before the gamma-ray light reached its peak brightness. The quick response allowed astronomers to study the relationship between the visible light variations and the gamma-ray variations for an unprecedented six and a half minutes. The results of that comparison is challenging what astronomers knew about the origin of visible light from gamma-ray bursts.

Until now, both the limited observations and the standard theory suggested that the gamma rays and the light from gamma-ray bursts had very different origins. But, these new, sensitive, RAPTOR observations show that there is a unique visible light that varies in concert with the gamma-rays.

"This close correlation indicates that both components have a common origin," said Tom Vestrand, the Los Alamos RAPTOR project leader, "and our best guess is they are generated by a shock driven into the GRB ejecta by the engine that powers the explosion." The GRB ejecta form a jet composed of the superheated material from the star that blew up. The ejecta, moving as a highly relativistic material, travels at 99.999 percent of the speed of light, launched by the cataclysmic explosion.

The extreme relativistic nature of the explosion means that the light from events that occur over the course of a day at the burst arrives at Earth within the span of minutes.

"The really exciting aspect of this new optical component is that when telescopes can get there fast enough to measure it, comparing its properties with those simultaneously observed in gamma rays will allow us to measure the physical characteristics of the jet and the burst engine," Vestrand added.

Robotic telescopes are fundamentally changing modern astronomy. NASA's recently launched Swift satellite has the ability to locate gamma-ray bursts rapidly, reorient itself autonomously for follow-up observing, and to distribute precise positions in seconds to an armada of ground-based telescopes located around the world.

"Robotic instruments like RAPTOR can observe GRBs during those critical first minutes of the explosion. And that's where the game is today" said Przemyslaw R. Wozniak, an Oppenheimer Postdoctoral Fellow at Los Alamos.

Astronomers at Los Alamos are also busy working on the future of robotic astronomy in the form of a program called the Thinking Telescopes Project.

"Humans do not have the attention span, response time or memory required to monitor the huge volume of data, recognize important variations, and respond in real time that one needs to monitor the night sky for important changes," said Vestrand.

The goal of Thinking Telescopes project is to merge robotic instrumentation with machine learning techniques and advanced massive database technology to build robotic telescope systems that can recognize and autonomously make follow up observations of important changes in the night sky without human intervention -- so called "thinking" telescopes.

For more about the Thinking Telescopes Project and RAPTOR go to www.thinkingtelescopes.lanl.gov/ or www.raptor.lanl.gov/ online