Swift finds a gamma-ray burst with a dual personality (w/ video)

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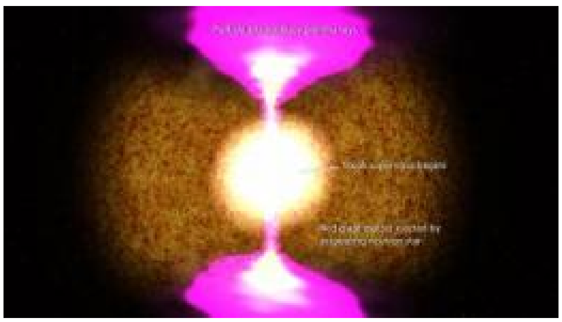

Frame from animation that interprets the Christmas burst as the merger of a red giant and a neutron star. Credit: NASA

(PhysOrg.com) -- A peculiar cosmic explosion first detected by NASA's Swift observatory on Christmas Day 2010 was caused either by a novel type of supernova located billions of light-years away or an unusual collision much closer to home, within our own galaxy. Papers describing both interpretations appear in the Dec. 1 issue of the journal *Nature*.

Gamma-ray bursts (GRBs) are the universe's most luminous explosions, emitting more energy in a few seconds than our sun will during its entire energy-producing lifetime. What astronomers are calling the "Christmas burst" is so unusual that it can be modeled in such radically different ways.

"What the Christmas burst seems to be telling us is that the family of gamma-ray bursts is more diverse than we fully appreciate," said Christina Thoene, the supernova study's lead author, at the Institute of Astrophysics of Andalusia in Granada, Spain. It's only by rapidly detecting hundreds of them, as Swift is doing, that we can catch some of the more eccentric siblings."

Common to both scenarios is the presence of a neutron star, the crushed core that forms when a star many times the sun's mass explodes. When the star's fuel is exhausted, it collapses under its own weight, compressing its core so much that about a half-million times Earth's mass is squeezed into a sphere no larger than a city.

The Christmas burst, also known as GRB 101225A, was discovered in the constellation Andromeda by Swift's Burst Alert Telescope at 1:38 p.m. EST on Dec. 25, 2010. The gamma-ray emission lasted at least 28 minutes, which is unusually long. Follow-up observations of the burst's afterglow by the Hubble Space Telescope and ground-based observatories were unable to determine the object's distance.

Thoene's team proposes that the burst occurred in an exotic binary system where a neutron star orbited a normal star that had just entered its red giant phase, enormously expanding its outer atmosphere. This expansion engulfed the neutron star, resulting in both the ejection of the giant's atmosphere and rapid tightening of the neutron star's orbit.

Once the two stars became wrapped in a common envelope of gas, the neutron star may have merged with the giant's core after just five orbits, or about 18 months. The end result of the merger was the birth of a black hole and the production of oppositely directed jets of particles moving at nearly the speed of light, followed by a weak supernova.

The particle jets produced gamma rays. Jet interactions with gas ejected before the merger explain many of the burst's signature oddities. Based on this interpretation, the event took place about 5.5 billion light-years away, and the team has detected what may be a faint galaxy at the right location.

"Deep exposures using Hubble may settle the nature of this object," said Sergio Campana, who led the collision study at Brera Observatory in Merate, Italy.

If it is indeed a galaxy, that would be evidence for the binary model. On the other hand, if NASA's Chandra X-ray Observatory finds an X-ray point source or if radio telescopes detect a pulsar, that goes against it.

Campana's team supports an alternative model that involves the tidal disruption of a large comet-like object and the ensuing crash of debris onto a neutron star located only about 10,000 light-years away. The scenario requires the break-up of an object with about half the mass of the dwarf planet Ceres. While rare in the asteroid belt, such objects are thought to be common in the icy Kuiper belt beyond Neptune. Similar objects located far away from the neutron star may have survived the supernova that formed it.

Gamma-ray emission occurred when debris fell onto the neutron star. Clumps of cometary material likely made a few orbits, with different clumps following different paths before settling into a disk around the neutron star. X-ray variations detected by Swift's X-Ray Telescope that lasted several hours may have resulted from late-arriving clumps that struck the neutron star as the disk formed.

In the early years of studying GRBs, astronomers had very few events to study in detail and dozens of theories to explain them. In the Swift era, astronomers have settled into two basic scenarios, either the collapse of a massive star or the merger of a compact binary system.

"The beauty of the Christmas burst is that we must invoke two exotic scenarios to explain it, but such rare oddballs will help us advance the field," said Chryssa Kouveliotou, a co-author of the supernova study at NASA's Marshall Space Flight Center in Huntsville, Ala.

NASA's Swift was launched in November 2004 and is managed by Goddard. It is operated in collaboration with several U.S. institutions and partners in the United Kingdom, Italy, Germany and Japan.(PhysOrg.com) --

Provided by NASA/Goddard Space Flight Center