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Fast-Flying Black Hole Yields Clues to Supernova Origin

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A nearby black hole, hurtling through the plane of our galaxy like a cannonball, has given what some astronomers say is their best evidence yet that stellar-mass black holes are made in supernova explosions. The black hole, called GRO J1655-40, is streaking across space at a rate of 250,000 miles per hour. That speed is four times faster than the average velocity of the stars in that galactic neighborhood. The most likely "cannon blast" is the explosive kick of a supernova, one of the universe's most titanic events.

Even though, by definition, black holes swallow light, the runaway black hole has a companion star, allowing astronomers to track it. NASA Hubble Space Telescope's sharp view allowed astronomers to measure the black hole's motion across the sky in images taken in 1995 and 2001. Combining the Hubble data with separate measurements of its radial motion toward Earth taken from ground-based telescopes yields the true "space velocity" of the black hole, and shows that it is streaking across the plane of our Milky Way in a highly elliptical orbit.

"This is the first black hole found to be moving fast through the plane of our galaxy," says Felix Mirabel of the French Atomic Energy Commission and the Institute for Astronomy and Space Physics of Argentina. "This discovery is exciting because it shows the link of a black hole to a supernova," aside from observing gamma-ray busts from hypernovae (even more powerful stellar explosions), which are believed to make black holes. Mirabel's results appear in the November 19 issue of Astronomy and Astrophysics.

Though the black hole is roughly heading in our direction, it is at a "safe" distance, 6,000 to 9,000 light-years away, in the direction of the constellation Scorpius. Mirabel believes the black hole may have been born in the inner disk of our galaxy, where the highest rate of star formation is taking place.

An aging, evolved star whirls around the black hole, completing one orbit just every 2.6 days. The hole is slowly devouring the companion, which apparently survived the supernova that originally created the black hole. This process makes blowtorch-like jets that stream away from the black hole at a significant fraction of the speed of light. It is the second "microquasar" discovered in our galaxy (meaning that it is a scaled-down model of monster black holes at the cores of extremely active galaxies, called quasars.)

Astronomers have known about stellar-mass black holes (ranging anywhere from 3.5 to approximately 15 solar masses) since the early 1970s. The only conceivable mechanism for making such black holes would be the implosion of the core of a star when it dies. The implosion sends out a shockwave that rips the rest of the star to shreds as a supernova. If the surviving core is greater than 3.5 times our Sun's mass, no forces can stop the collapse, and it will shrink to an infinitely small and dense singularity.

Astronomers have catalogued even faster-moving neutron stars catapulted by a supernova explosion. The black hole is moving relatively slower because it has much more mass and so has more resistance to being accelerated.

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