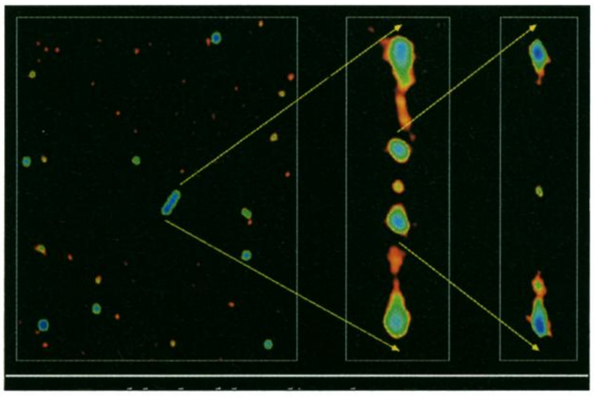


Born again. Radio galaxy B1834+620 shows an outer pair of lobes—evidence of an earlier incarnation.

works is anybody's guess.

The plot thickened when Arno Schoenmakers of the Netherlands Foundation for Research in Astronomy in Dwingeloo and colleagues found evidence that the jetmaking machinery can shut down and fire itself up again after millions of years. In the 21 June issue of the *Monthly Notices of the Royal Astronomical Society*, they report finding what they call double-double radio galaxies—classic double-lobed galaxies sporting a second, older pair of radio lobes much farther out than the first.

"Apparently, it's a very rare phenomenon," Schoenmakers says. So far, he and his colleagues have turned up just eight examples: three in a large radio survey of the northern sky, carried out with the Westerbork Synthesis Radio Telescope in the Netherlands, and five others in the astronomical literature. All are enormous, with outer lobes stretching 2.5 million to 8 million light-years apart—dozens of times the diameter of our Milky Way. By studying the energy distribution of the radio waves (higher energies fade faster than lower energies), the astronomers estimate that the outer lobes are 100 million years old, give or take a factor of 2 or so. There is no trace of a jet between the older and younger lobes; evidently the polar geysers stayed dormant for millions of years before erupting again.

What could give jets a new lease on life? Without a good theory of how jets form in the first place, astronomers can only speculate. According to David Merritt of Rutgers University in Piscataway, New Jersey, the jump-start might occur when two galaxies collide. "A merger could be responsible for the second jet," he says, "since mergers tend to bring gas into the center where they can fuel the 'engine' that drives the jet."

But Schoenmakers thinks that scenario is unlikely. Because mergers can occur at any time in a galaxy's history, he says, at least some merger-driven double-doubles would be expected to be smaller and younger than the lobes he observes. "There seems to be a relation with age," he says. "Something happens to the core when it has been active for a very long time."

Schoenmakers's favorite theory is that the central black hole is running out of fuel. Perhaps, after pulling a steady stream of gas into itself for millions of years, the black hole simply starts to exhaust the supply. "It's like your car is running out of gas," he says, "and the engine starts to sputter." If so, the radio galaxy's reincarnation may be a temporary hiccup before a final death.

If the sputtering model is correct, the depths of space might hold radio galaxies with three sets of radio lobes—triple-doubles. "That would be a major discovery," Schoenmakers says.

—GOVERT SCHILLING

ASTRONOMY

Neighborhood Gamma Ray Burst Boosts Theory

Titanic explosions that emit powerful flashes of energetic gamma rays are one of astronomy's hottest mysteries. Now an analysis of the nearest gamma ray burst yet detected has added weight to the popular theory that they are expelled during the death throes of supermassive stars.

Very large stars die spectacular deaths at a relatively young age. Some explode as brilliant supernovas; the most massive stars probably collapse into black holes. Computer simulations suggest that the birth of a black hole can be accompanied by the release of tremendous amounts of energy, so these "collapsars" are prime candidates for the source of gamma ray bursts. If so, the bursts should occur in star-forming regions, as massive stars die before they are able to escape from their cosmic cradle. Unfortunately, most galaxies where gamma ray bursts originate are billions of light-years away, so even the keen-eyed Hubble Space Telescope can't tell if gamma ray bursts occur in star-forming regions.

On 25 April 1998, however, a relatively faint gamma ray burst was detected much closer to home—in a galaxy just 140 million light-years away. Moreover, the burst coincided with a supernova, suggesting a link between gamma ray bursts and the deaths of massive stars (*Science*, 19 June 1998, p. 1836). Stephen Holland of the Danish Center for Astrophysics with the Hubble Space Telescope in Aarhus and his colleagues observed the host galaxy of this gamma ray burst in June with the Hubble.

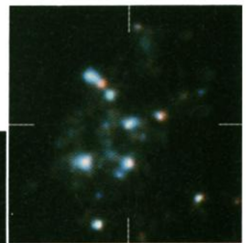
The Hubble images of the galaxy, known as ESO 184-G82, show that the burst indeed occurred in a giant star-forming region. According to Holland's team, which released the images on 27 June, part of the light at the exact burst position may be the fading glow of the supernova, but the surrounding bright objects are either young star clusters or very hot, massive stars.

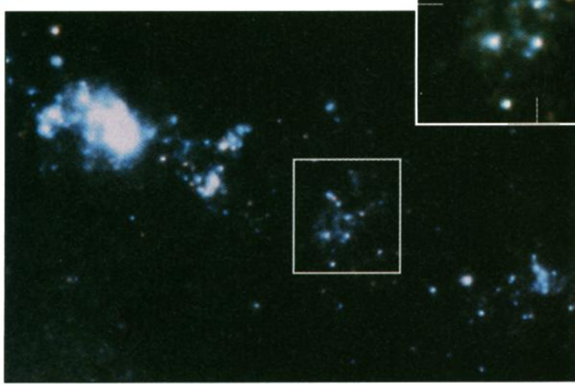
The Hubble evidence would be even stronger, astronomers say, if the explosion in ESO 184-G82 weren't such a peculiar event. The supernova was much more powerful than average, but the gamma ray burst was only a fraction of a percent as intense as a normal burst. Team member Jens Hjorth of the University of Copenhagen in Denmark says he believes that "normal" gamma ray bursts also occur in star-forming regions. By analyzing light from the host galaxy of a more typical burst, which reached Earth on 23 January 1999, Hjorth and colleagues found evidence of knotlike structures that look like star-forming regions. But that galaxy was billions of light-years away—too far to get direct evidence of what lay inside it.

Titus Galama of the California Institute of Technology in Pasadena, who in 1998 discovered the supernova that accompanied the gamma ray burst of 25 April, says the Hubble observations are "not surprising. This is where you expect [gamma ray bursts] to occur." Hjorth agrees. "But we've had so many surprises in this field," he says, "that it's good to see that something we expect is actually happening."

—GOVERT SCHILLING

Govert Schilling is an astronomy writer in Utrecht, the Netherlands.





Rocking the cradle. Gamma ray burst in galaxy ESO 184-G2 took place in a region where stars are born.

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