colleagues report their newly discovered *inv* mutation maps to chromosome 4. The mutation discovered three decades ago by the Jackson Labs team of Hummel and Chapin, which alters organ position 50% of the time, on the other hand, lies on chromosome 12, indicating that it isn't in the *inv* gene. And there are probably other genes as well that are involved in the determination of the left-right patterning of the organism.

That means that the genetics of this process won't be unraveled immediately. And even when it is, it may not be immediately applicable to human beings. While the discovery of the effect the *inv* mutation has on mouse embryo organ alignment has insiders excited, all are quick to point out that it may ultimately have little direct relevance to human development. Even Overbeek says: "It's not clear from previous evidence that human embryos undergo the same embryonic turning as mice—although humans obviously have definite sidedness." Still, one of the first researchers to map the Hummel-Chapin mutation, Martina Brueckner of the Yale University Medical School's Department of Pediatric Cardiology, says: "I would bet on the same gene being found in man." That would be good news indeed.

–Tania Ewing

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ASTRONOMY

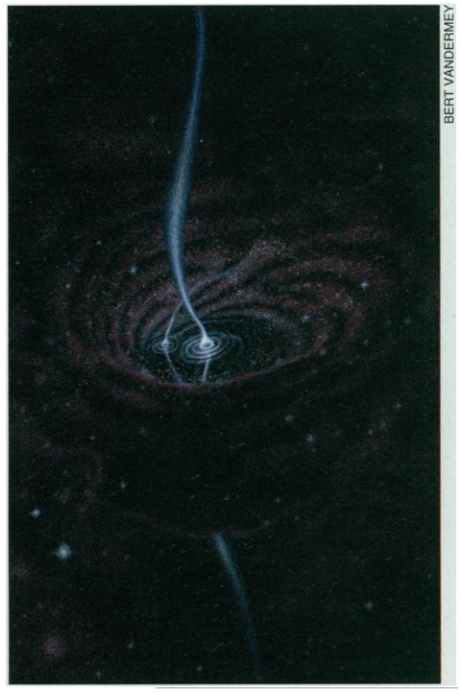
Quasars: Double Darkness in Draco

The conventional picture of a quasar is more than enough to strain credibility. A black hole as massive as millions of suns lurks at the center of a galaxy, sucking in stars and gas. As they whirl inward toward the black hole, the stars and gas are heated to incandescence, generating brilliance that makes a quasar visible from the far corners of the universe. But even that outlandish picture isn't enough to explain the antics of a quasar 3 billion light-years away in the constellation Draco. After 5 years of observing wiggles in a jet of material that squirts from the heart of the quasar 4C 73.18, a group of radio astronomers in the Netherlands and the United States has concluded that the quasar may harbor not one but two giant black holes, locked in a tight orbit around each other.

The new evidence, described by Nico Roos of Leiden Observatory, Jelle Kaastra of the Leiden Laboratory for Space Research, and Christian Hummel of the U.S. Naval Observatory in a forthcoming paper in *Astrophysical Journal*, helps to bear out a hypothesis advanced more than a decade ago by astronomers Mitchell Begelman of the University of Colorado, Roger Blandford of the California Institute of Technology, and Martin Rees of Cambridge University. They proposed that at least some of the hundreds of known quasars are home to "binary" black holes, created when their host galaxies merged with other galaxies. Even before the latest observations, astronomers had begun to see hints of black hole pairs in other quasars. But Rees thinks the new observations make "a better case than most" for a binary black hole.

Begelman and his colleagues based their 1980 proposal on an idea, put forward by other theorists, that many quasars and "active" galaxies may be ignited when galaxies collide. The scenario holds that such mergers hurl material into the heart of the merged galaxy, where it rains down into the quasar and stokes its brilliance. Begelman, Blandford, and Rees took the next step: They realized that if the second galaxy also contains a quasar, the collision will lob a second black hole into the heart of the merged galaxy, creating a binary.

According to Sterl Phinney of Caltech, some of the first evidence supporting this picture came from objects like the active galaxy 3C 75, which has two visible nuclei, each presumably harboring a black hole. Then, in 1988, a group of Scandinavian and U.S. astronomers reported new evidence for a black hole binary in the quasar-like object OJ 287 based on the pattern of its outbursts, which implied that the tidal pull of a massive companion is disrupting the inflow of material. And last year, Kaastra and Roos saw clues in the jets of radio-emitting plasma that spurt from the quasar 3C 273 and the giant elliptical galaxy M87. Both jets seemed to precess, or wander, slowly around the axis of the galactic nucleus, as if something—perhaps another black hole—were slowly tugging each quasar into a new orientation.



BERT VANDERMEY

Two to tango. In an artist's conception of the heart of the quasar 4C 73.18, two black holes do a slow dance.

The jet of 4C 73.18 has now yielded more vivid evidence for the binary black hole scenario, as the British magazine *New Scientist* first reported earlier this month. Monitoring it through radio telescopes, a team of observers led by Hummel detected wiggles, much like the wiggles that appear in water spouting from a garden hose when you shake the end. After 5 years of observations, Hummel, Roos, and Kaastra say the signs are unmistakable: Something as massive as the black hole itself must be tugging it back and forth.

The culprit, Roos and his colleagues conclude, is another giant black hole, circling the one emitting the jet every 3 years. To explain the 3-year period, the pair would have to be separated by only about 30 times the average distance between the sun and Pluto. From the tightness of the black holes' orbit and the quasar's brilliance, the researchers estimate that each black hole must pack about 100 million times the sun's mass.

The wiggly jet of 4C 73.18 may add weight to the merger scenario for the birth of some quasars. But it's also a sign of mortality, at least for the twin black holes themselves. Theorists including Caltech's Phinney have suggested that the paired black holes would gradually spiral closer together as they lose energy through encounters with gas and stars. If their slow dance gets close enough, they may even roil the fabric of space and time and give rise to the gravity waves predicted by Einstein's theory of general relativity. The gravity waves would carry off still more energy from the black holes, and before long they would actually merge.

The two black holes at the heart of 4C 73.18, Roos thinks, are already close enough to be generating gravity waves. In about a million years, he calculates, the black holes will collide in a titanic burst of gravitational radiation—a powerful, though invisible, culmination to their brilliant double career as a quasar powerhouse.

–Ray Jayawardhana

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