any, effect on fluid transport in uninfected mouse intestines, indicating that the rotavirus was behind the excessive neural activity. The researchers confirmed these observations with studies in living mice. Whereas 14 of 15 rotavirus-infected mice developed diarrhea, only 6 of 14 did when the team treated the animals by injecting the anesthetic lidocaine into the abdomen.

By quantifying the effects of lidocaine and other nerve-suppressing agents on the isolated intestines, the researchers estimate that fully two-thirds of the intestine's secretory response to rotavirus is mediated by neurons. The "simplest" explanation for this, says Lundgren, is that rotavirus infection triggers the release of chemicals in the gut that activate nerve endings beneath the intestinal lining. The activated nerves then turn on secretory reflexes in cells of the intestinal lining that discharge chloride ions into the bore of the intestine. This action is thought to draw water into the bore by osmosis.

Researchers still need to fill out the details of this mechanism. In particular, they don't yet know the identity of the nerve-stimulating substance released during rotavirus infection—information that would be important to anyone trying to develop drugs that block the neural activity, says Helen Cooke, a gastrointestinal physiologist at Ohio State Medical School in Columbus.

Also unclear is whether pharmaceutical companies will take up the challenge of developing such drugs. They tend to shy away from investing in disorders such as rotavirus diarrhea that are important in developing nations but do not represent a big market elsewhere. Still, Lundgren says, his team's work suggests that many forms of diarrhea are caused by enteric nervous system stimulation. "If we are right," he adds, "we could use one drug for every type of diarrhea." And the drug companies might find that a far more attractive prospect. **–INGRID WICKELGREN**

ASTROPHYSICS

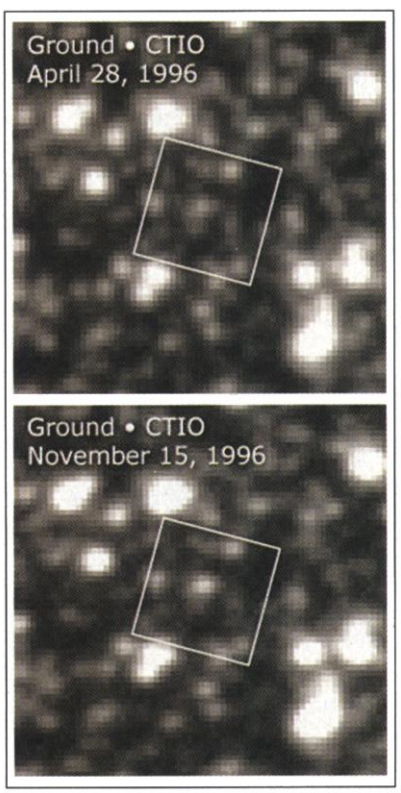
Black Holes Begin to Lose Their Mystery

ATLANTA—From the fringes of the universe to nearby reaches of our own galaxy, black holes are becoming more than obscure figures on the cosmic stage. Several findings released here last week at a meeting of the American Astronomical Society offer insights into the many forms that black holes can assume. Those guises, it appears, are determined largely by the ages of the black holes and their dietary habits.

Astronomers have long suspected that most, if not all, large galaxies harbor black holes, including our own Milky Way (*Science*, 7 January, p. 65). In the distant universe, the most powerful black holes shine as quasars—highly energetic cores of galaxies fed by streams of hot gas spiraling into the holes. NASA's Chandra X-ray Observatory now may have unveiled the precursors to those voracious black holes—remote objects that emit torrents of x-rays but whose visible light may be shrouded by thick veils of dust. Tens of millions of the objects would dot the sky, although Chandra thus far has scanned for them only within a patch one-fifth the size of the full moon.

Chandra identified these remote blips as some of the main sources of a previously mysterious glow of x-rays, first seen during a rocket flight in 1962, that fills the sky. The objects may have dominated the centers of galaxies that formed within a billion years of the big bang, speculate astronomers Amy Barger of the University of Hawaii, Honolulu, and Richard Mushotzky of NASA's Goddard Space Flight Center in Greenbelt, Maryland. If so, they would easily rank as the most distant black holes yet detected.

In our galactic neighborhood, the identification of black holes has become almost routine. The Hubble Space Telescope has fingered 20 such objects at the cores of nearby galaxies, including three new ones described at the meeting by astronomer Douglas Richstone of the University of Michigan, Ann Arbor. Powerful gravitational fields around these holes, which carry perhaps 50 million to 100 million times more mass than our sun, pull stars into tight whirling orbits that Hubble easily resolves.



The hole story? This distant star brightened and then dimmed over a period of 800 days beginning in 1996, its light possibly altered by an isolated black hole between us and the star.

But these black holes are dim shadows of the quasars that blazed billions of years ago, according to research by astronomers Neil Nagar and Andrew Wilson of the University of Maryland, College Park, and their colleagues. The team studied about 100 nearby galaxies with the Very Large Array, a set of 27 radio telescopes near Socorro, New Mexico. About 30% of the galaxies emitted weak levels of radio signals similar in detail to the emissions from quasars, Wilson says. Further analysis by the Very Long Baseline Array, a chain of radio telescopes stretching from Hawaii to the U.S. Virgin Islands, showed that the sources of those emissions were extremely compact. "The only known way to do that is with an accreting black hole," Wilson says.

Wilson regards such black holes as "dying quasars," because they consume perhaps 1000 to 100,000 times less matter than their bright ancestors in the distant universe. Indeed, the key difference may be that most galaxies around us today are mature and stable, says astronomer Virginia Trimble of the University of California, Irvine. Black holes in the centers of these galaxies apparently go hungry, she says, because stars and gas no longer travel on the perturbed orbits that typically push matter toward the core of younger and more vigorously churning galaxies.

Even closer to home, another team of astronomers may have spotted the first known black holes in the Milky Way that eat nothing at all. Two of these wanderers apparently revealed themselves when their gravity acted as lenses in space, temporarily warping and amplifying light from more distant stars (*Science*, 7 January, p. 67). Astronomer David Bennett of the University of Notre Dame in South Bend, Indiana, and other astronomers in the Massive Compact Halo Object (MACHO) collaboration estimate that each invisible object is a few thousand light-years away and about six times more massive than our sun, fingering them as likely black holes.

The work by the MACHO team "looks very plausible," says astrophysicist John Bahcall of the Institute for Advanced Study in Princeton, New Jersey, although he awaits more such lensing events for confirmation. Because black holes of this mass probably emerge naturally from the violent deaths of many giant stars, the Milky Way may brim with them. Bahcall says that these tiny brethren of the monster at our galaxy's heart could supply a sizable chunk of the elusive "dark matter" that makes the Milky Way far more hefty than it appears. **–ROBERT IRION**

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