New Evidence of Galactic Black Hole

Astronomers have repeatedly reported evidence that black holes lurk at the centers of galaxies. However, the latest finding all but settles the case, many scientists assert. Using a continent-wide array of radio telescopes, a U.S.-Japanese team last week reported "compelling evidence" that the center of a relatively nearby galaxy harbors a black hole as massive as 40 million suns.

The unusually high resolution of the network of 10 radio telescopes, collectively known as the Very Long Baseline Array (VLBA), enabled researchers to record structures deep within the spiral galaxy NGC 4258, which lies some 21 million light-years from Earth.

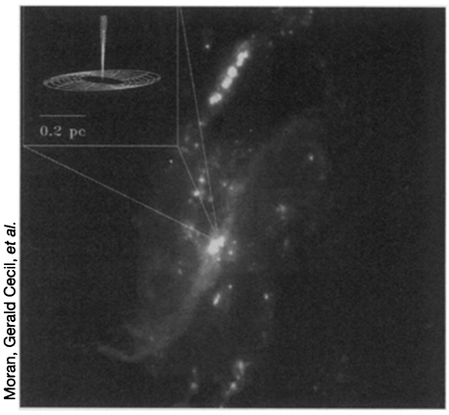
Spotting details 1,000 times smaller than those detected by visible-light telescopes, the team measured with unprecedented accuracy the swirling motion of a disk of gas and dust orbiting the galactic core. The inner part of the disk lies only about one-third of a light-year from the galaxy's center.

From this motion, clocked at 900 kilometers per second, the team infers that the core has a minimum density of 100 million suns per cubic light-year. That number exceeds the density of any other galactic center ever measured.

A cluster of ordinary stars with that density would have been torn apart long ago by collisions between individual stars, notes James M. Moran of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. His team says it has no choice but to conclude that the heart of NGC 4258 contains a supermassive black hole.

Moran and his colleagues reported their findings last week at a meeting of the American Astronomical Society in Tucson. They provide further details in the Jan. 12 NATURE and the upcoming Feb. 20 ASTROPHYSICAL JOURNAL.

"The work ... provides what may constitute the strongest case yet for a supermassive black hole in a galactic nucleus," writes Richard Barvainis of the Massachusetts Institute of Technology's Haystack Observatory in Westford. His commentary accompanies the NATURE report.



Moran, Gerald Cecil, *et al.*

Composite image shows visible-light picture of the inner region of the galaxy NGC 4258. Inset shows disk containing water masers observed by the VLBA.

"I was really blown away by their use of the [radio telescope] technology," says Patrick S. Osmer of Ohio State University in Columbus. "Maybe the public thinks that black holes have already been proved to exist, but this current study is much more definite. [The researchers] have probed much closer to the center of the galaxy than before."

If they indeed exist, black holes by their very nature can't be seen; astronomers must deduce their presence from their gravitational tug on surrounding stars, dust, or gas. Last year, another team made headlines when it used the Hubble Space Telescope to infer the existence of a massive black hole at the core of the elliptical galaxy M87 (SN: 6/4/94, p.356).

In the new study, Moran and his colleagues used the VLBA to study radio emissions produced by water molecules within a central galactic disk. The molecules act as masers, amplifying microwave radio emissions in much the same way a laser amplifies visible light and produces intense, pencil-thin beams of radiation. Because of the edge-on orientation of the disk, some of these beams shoot toward Earth, providing a clear view of the dynamics at the center of the galaxy. Unlike visible light, radio waves easily penetrate the dust present at the core of many galaxies.

"The work is enormously compelling," says Martin J. Rees of the University of Cambridge in England. "It's much better than all the public hype from the Hubble Space Telescope and M87." — *R. Cowen*

Improving humans' blood with crocodiles'

Anyone who has tried swimming laps without taking a breath, or having an underwater tea party as a kid, should respect crocodiles. Those thick-skinned reptiles can remain below the water's surface for over an hour.

Researchers had known that when crocodiles hold their breath underwater, carbon dioxide builds up in their blood, dissolves, and forms bicarbonate ions. Those ions bind to amino acids in hemoglobin, the oxygen-carrying component of red blood cells. The bicarbonate ions cause the hemoglobin to release oxygen molecules, making them more readily available to tissue, N. Hennakao Komiyama of the Medical Research Council (MRC) in Cambridge, England, and his colleagues explain in the Jan. 19 NATURE.

In contrast, bicarbonate ions do not bind to human hemoglobin, which therefore releases its oxygen much less readily than crocodile hemoglobin.

Scientists had not known, however, where on the crocodile hemoglobin's amino acid chains the bicarbonate ions bind. To find out, Komiyama and his colleagues first synthesized human and crocodile hemoglobin by means of genetic engineering. In both kinds of hemoglobin, 50 to 60 percent of the amino acid chains are the same. But only 12 of the 280 sites in the crocodile's amino acid sequences are involved in binding bicarbonate ions.

The researchers then introduced amino acids from crocodile hemoglobin into human hemoglobin "until we found out which amino acid was responsible for the [ion-binding] effect," says coauthor Kiyoshi Nagai, also of MRC. They discovered that the ions bind where two amino acid chains — the alpha and beta — meet, Nagai says.

Knowing this, the scientists created a hemoglobin hybrid — part crocodile, part human — that binds bicarbonate ions. "Our new hemoglobin looks almost like human hemoglobin," Nagai says.

The molecule may help researchers make high-quality artificial hemoglobin. "It opens up the possibility of engineering human hemoglobin to acquire this [ion-binding] property," says H. Franklin Bunn of Harvard Medical School in Boston.

"It's not too far-fetched to think of a surgical situation where ... it's difficult to oxygenate the patient and you might want to have hemoglobin that would unload oxygen with super efficiency," Bunn suggests. — *T. Adler*