Firm Evidence of Milky Way Black Hole

Astronomers have speculated for 25 years that a monster lurks at the center of the Milky Way. Now they appear to have proof.

The beast in our cosmic backyard is a black hole—a dark, dense object as massive as 2.5 million suns crammed into a space the size of the solar system.

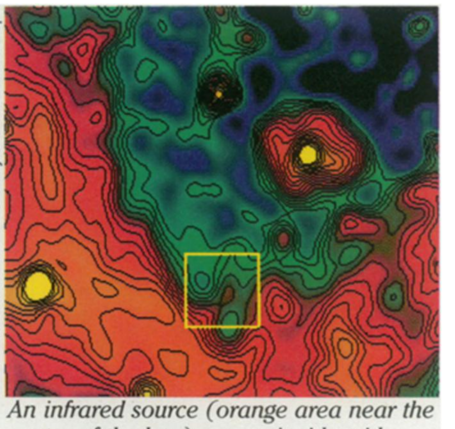
Over the years, two pieces of evidence have provided the strongest support for the idea of a black hole at the center of our galaxy. In 1974, researchers discovered a compact, powerful radio source, called Sagittarius A*. Scientists suggested that the emissions represent the last gasps of gas falling into this candidate black hole.

Other astronomers, including Reinhard Genzel of the Max Planck Institute for Extraterrestrial Physics in Garching, Germany, found hints of a black hole in measurements of the velocity of stars close to the center of the Milky Way. Stars within 1.5 light-years of that core whip around at a furious rate, they discovered. Researchers surmised that the rapidly orbiting stars are caught in the stranglehold of an unseen resident—an extremely massive, compact object too dense and too dark to be an ordinary grouping of stars.

That line of reasoning has an admitted shortcoming. Of the three components of the stars' velocity, astronomers had measured only one—the back-and-forth motion along the line of sight to Earth. Such motion is relatively easy to detect: Light emitted by an object moving toward Earth is shifted to bluer, or shorter, wavelengths; light emitted by an object moving away is shifted to redder, or longer, wavelengths.

Measuring the other two components, which represent the motion of stars across the sky, presented a more formidable task. Most scientists assumed that the unmeasured components would be comparable to the line-of-sight velocity. In the unlikely event that the stars move much more slowly across the sky than they do along the line of sight to Earth, the unseen heavyweight need not be as massive or compact as a black hole.

Using the European Southern Observatory's New Technology Telescope in La Silla, Chile, Genzel and his Max Planck colleague Andreas Eckart homed in on 40 stars—most lying within 0.3 light-year of the galactic core—and tracked their motion across the sky for 4 years. They now report that the velocities of the 20 stars whose motion they could reliably measure are indeed similar to the component along the line of sight. In addition, velocity falls off significantly at distances farther from the center.



Stolovy et al./Hale Telescope

An infrared source (orange area near the center of the box) may coincide with Sagittarius A.*

Taken together, the new and previous velocity measurements provide strong evidence that a massive, dark object lies within 0.05 light-year of Sagittarius A*, Genzel and Eckart report in the Oct. 3 NATURE.

"It's clear that they have closed a major loophole," says Mark Morris of the University of California, Los Angeles. "Astronomers will now have to face the fact that there's a large concentration of dark matter right at the nucleus."

The researchers note that their study still allows the possibility of a cluster of star-sized black holes at the galaxy's center, but they believe a single, massive black hole is more likely. Higher-resolution observations are likely to disprove the cluster model, Morris notes. A team led by UCLA's Andrea M. Ghez plans such a study with the W.M. Keck Telescope atop Hawaii's Mauna Kea.

In another study, Susan R. Stolovy of Cornell University and her colleagues have produced the first mid-infrared image of an object that seems to coincide with Sagittarius A*. The infrared emission they detect is greater than that predicted by some models of the suspected black hole. The emission might come from dust associated with material falling onto the black hole, the team reports in the Oct. 10 ASTROPHYSICAL JOURNAL LETTERS. *— R. Cowen*

The shape of more colors to come

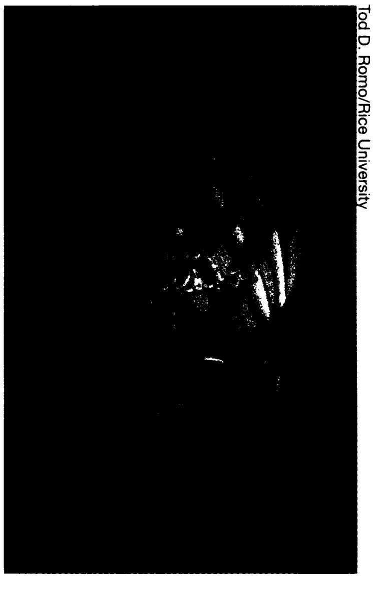
Perhaps it's fitting that green fluorescent protein (GFP), the substance that lights up jellyfish, turns out to look just like a can of paint. When attached to other proteins, GFP acts as a biological marker, causing them to glow as if they had been dipped in bright green pigment (SN: 6/4/94, p. 358).

Researchers would like to modify GFP to shine in a whole palette of colors, and knowing its shape should help. Recently, two groups have described GFP's three-dimensional crystal structure. Fan Yang and George N. Phillips Jr. of Rice University in Houston and Larry G. Moss of Tufts University School of Medicine in Boston report on the protein in the October NATURE BIOTECHNOLOGY. In the Sept. 6 SCIENCE, S. James Remington of the University of Oregon in Eugene and his colleagues describe a form mutated to produce a slightly brighter light.

In both structures, 11 sections of a GFP's folded amino acid chain form a cylinder that resembles the sides of a paint can; other sections form the lids. Inside sits the fluorophore, the amino acid complex that glows. So far, scientists mutating GFP have changed its color only slightly. "Knowledge of the structure will allow mutagenesis to proceed much more efficiently," Phillips says.

The structure also illuminates GFP's unusual fluorescence mechanism, says Douglas C. Youvan of KAIROS Scientific in Santa Clara, Calif. At first, the protein's fluorescence "looked pretty boring," he says. But when GFP is excited by light at a wavelength of 395 nanometers, an internal proton exchange disposes of some of the energy before the rest is shed as fluorescent light. The structure indicates possible sites where that proton transfer might occur.

Biologists couldn't wait to use the structure to expand their biological paint boxes—for example, by changing the amino acids in or near the fluorophore. Several groups, Phillips says, have already taken the results and are "mutating [GFP] like crazy." *— C. Wu*



Tod D. Romo/Rice University

The structure of green fluorescent protein.