

Repaired Hubble Finds Giant Black Hole

After years of hunting for black holes, astronomers say they have found the first convincing proof that one exists at the center of a galaxy.

To find their quarry, the researchers used the repaired Hubble Space Telescope to peer closer than ever before into the core of the giant elliptical galaxy M87, which lies 50 million light-years from Earth. Scientists have long suspected that M87, a powerful radio-wave emitter that has a jet of high-speed electrons squirting from its center, harbors a supermassive black hole. But they lacked conclusive proof.

The U.S. team announced last week that several lines of new evidence now confirm that a black hole, with a mass of 2.5 billion to 3.5 billion times that of the sun, lurks at the heart of M87, occupying a space no larger than the solar system.

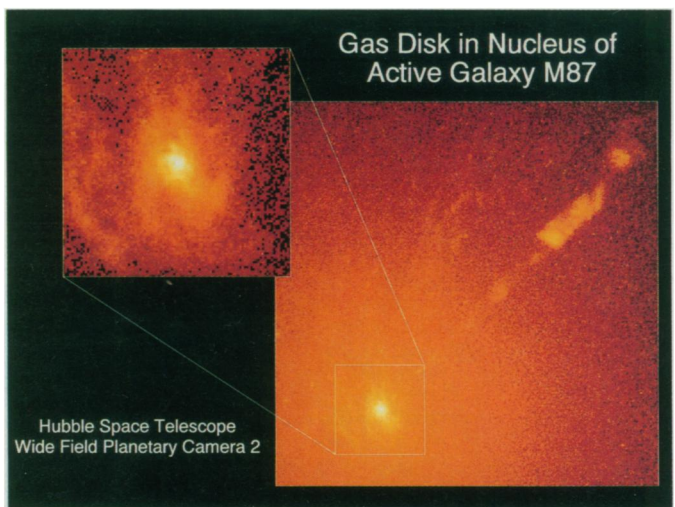
According to several scientists, the new report apparently confirms the existence of one of the most enigmatic of astrophysical entities — a body whose gravitational pull is so strong that nothing, not even light, can escape its grasp. If astronomers have indeed found the true fingerprints of a supermassive black hole, they may have identified the hidden engine that fuels a stunning array of fireworks at some galactic centers.

Holland C. Ford of the Space Telescope Science Institute and Johns Hopkins University in Baltimore and Richard J. Harms of the Applied Research Corp. in Landover, Md., announced the findings

last week at a press conference in Washington, D.C. Ford provided new details this week at a meeting of the American Astronomical Society in Minneapolis.

By definition, a black hole can't be seen. But astronomers can infer its presence by studying how it affects its surroundings. The gravitational tug of a black hole at the core of a galaxy should pack stars so densely that the intensity of starlight would rise steeply closer to the center. And stars and gas orbiting the core would whip around so rapidly that the tug from visible matter alone couldn't account for their motion.

Using such criteria, astronomers for more than a decade have tried to determine whether M87 contains a black hole. But the limitations of ground-based telescopes and the flawed Hubble mirror prevented them from measuring the intensity of starlight or the velocity of stars close enough to the galactic center. When Hubble received corrective optics to compensate for its misshapen mirror last December, a team led by Ford and Harms



Hubble image reveals a spiral-shaped disk of hot gas in galaxy M87. Previously known jet of high-speed electrons appears to emanate from the disk's center.

resumed the search for a black hole.

The team had intended to follow in the footsteps of previous researchers, examining starlight at the galaxy's core (SN: 1/25/92, p.52). But an image taken by Hubble's new wide-field and planetary camera in February changed that strategy. The camera, which resolved regions four times closer to the galaxy's heart than the old camera, revealed a central disk of gas trailed by spiral arms.

It is usually easier to obtain spectra of gas than of stars, Ford notes, because gas concentrates the light it emits into a few

Study reaffirms tamoxifen's dark side

Tamoxifen, a synthetic hormone often prescribed to treat breast cancer, can cause potentially malignant changes in the endometrium, or uterine membrane, of healthy postmenopausal women, researchers confirm in a new study.

Other studies have linked tamoxifen to increased risk of endometrial cancer (SN: 4/16/94, p.247). However, this is the first randomized, placebo-controlled trial of tamoxifen's effects on the uterus and ovaries of this group of women, Rajendra P. Kedar of King's College School of Medicine and Dentistry in London and his colleagues assert.

"They are the first," agrees Urania Margriples of Yale University School of Medicine. "It's amazing someone hasn't done something like this before." Sohaib Khan of the University of Cincinnati College of Medicine says the study is more carefully done than others, but "I don't think they really reached anything new."

Several ongoing studies are examining

whether tamoxifen might help prevent breast cancer in healthy women with a family history of the illness. To see if the drug causes endometrial changes, Kedar and his colleagues studied 111 women age 45 to 71 who took either tamoxifen or a placebo as part of one of these trials, they report in the May 28 LANCET.

Using a vaginal ultrasound probe, they measured the size of each woman's uterus and the thickness of her endometrium. The scientists also biopsied the endometrium and measured blood flow to the tissue, which if elevated may indicate an increased risk of cancer.

"Our study detected endometrial abnormalities at various times from the first tablet of tamoxifen," Kedar and his colleagues state. Kahn, however, questions whether the drug can cause such rapid changes.

The endometrium appeared abnormally thick in 24 of 61 women taking tamoxifen; in 10 of these 24 women, endo-

metrial cells underwent potentially precancerous changes. Only 5 of the 50 women given a placebo had an abnormal endometrium and none showed the cell changes. Five women taking the drug and one volunteer on placebo developed a polyp; the significance of this is not clear. Overall, women taking tamoxifen had a larger uterus and higher blood flow to that organ than those not taking the drug.

Researchers now understand better how tamoxifen helps prevent breast cancer. Investigators have known that the drug binds to estrogen receptors. Normally, estrogen turns on these receptors, which activate the genes important in events that can lead to cancer.

Tamoxifen, however, fails to turn on the receptors, and the new study, in the June 3 SCIENCE, suggests why. The drug keeps the receptors from hooking up with a protein, ERAP160, that they need to function, report Myles Brown of the Dana-Farber Cancer Institute in Boston and his colleagues. — T. Adler

discrete wavelengths rather than spreading it over a wide range of colors. The disk's orderly rotation allowed the team to calculate accurately the velocity of the gas at different locations, in effect "weighing" the purported black hole tug-ging on the material. Stars typically have more complex orbits, making velocity calculations harder.

Using Hubble's faint-object spectrograph, the astronomers measured the speeds of hydrogen and oxygen ions on opposite sides of the rotating disk. Light emitted from the part of the whirling disk approaching Earth is shifted to shorter, or bluer, wavelengths, while light from the other side, which is receding from Earth, is shifted to redder, or longer, wavelengths by the same amount.

The Hubble researchers found that the hydrogen ions in the disk rotate at 450 kilometers per second at a distance of 60 light-years from the center of the galaxy. Oxygen ions, which are likely to be

produced at a slightly hotter, inner region of the disk, rotate slightly faster; gas measured even closer to the center of M87 spins faster still—a sure sign that the core harbors a point mass, Holland says.

In contrast, the speed of the innermost part of the disk would drop to zero if the galaxy's center contained a diffuse distribution of matter, he adds.

The only way to explain why such a rapidly spinning disk doesn't fly apart is that a dense, unseen object—a gigantic black hole—provides the gravitational glue, Holland asserts.

When the results were tabulated, "We were all walking a few hundred feet off the ground," recalls Harms.

"I'm pretty convinced," says Douglas O. Richstone, a black hole hunter at the University of Michigan in Ann Arbor. But he notes that an alternative, though less likely, explanation could account for the findings. A large cluster of lower-density objects—white dwarfs or neutron stars—

might provide the gravitational tug seen in M87. Such a cluster, though confined to a small volume, might not collapse to form a black hole for 100 billion years, Richstone adds.

He says the most exciting implication of the black hole finding is that it fits with a popular theory about how active galaxies get their power. Researchers have suggested that the jet in M87 represents a vestige of a quasar that once shone brilliantly at the center of the galaxy. In this model, the black hole and the disk of gas that feeds it together form the engine that powered the quasar and has now nearly run out of gas.

Ford says Hubble may soon provide new evidence that a smaller black hole lies at the core of Andromeda, our galaxy's nearest spiral neighbor. Other researchers at the astronomy meeting presented data from the unrepaired telescope that hints Andromeda has a black hole with the mass of a few million suns. —R. Cowen

Hurricane experts predict better forecasts

When Hurricane Emily approached the United States last August, most of the forecasting models used by the National Hurricane Center in Coral Gables, Fla., predicted the storm would plow squarely into the Carolinas. But an experimental forecasting model run in Princeton, N.J., projected that Emily would turn before reaching the mainland, striking only Cape Hatteras. That information helped hurricane center meteorologists accurately predict Emily's curving path.

With hurricane season officially open on June 1, the National Weather Service is working to incorporate that successful research model into its regular forecasting routine. Along with a string of other new tools, the experimental model promises more accurate forecasts of the greatest storms on Earth, says Robert C. Sheets, director of the hurricane center.

The National Weather Service typically runs a suite of different forecasting models on supercomputers at its National Meteorological Center in Suitland, Md. But the new model, developed at the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, N.J., most realistically represents atmospheric physics.

Last year, results from the GFDL model arrived late at the hurricane center because it took researchers 6 hours to run each simulation on their supercomputer in Princeton. At the National Meteorological Center, an improved version of the model is now running on a Cray C90 supercomputer that the center recently acquired.

"Using the faster computer and a more efficient model, we can now run it in 20 minutes," says GFDL's Robert E. Tuleya,

who developed the model along with Morris Bender and Yoshio Kurihara.

As a measure of the model's forecasting ability, Tuleya compares how accurately it predicted the storm's track a day in advance. For Hurricane Emily, the GFDL model had an average error of 48 miles. The most accurate model in operation at the time missed Emily by 82 miles on average.

Hurricane forecasters also look to the GFDL model for help in anticipating the intensity of winds and the size of storms—two critical features that meteorologists cannot currently predict with skill.

Unlike other models, the GFDL model forecasts wind speeds around the storm, providing some measure of its size. "It's showing some skill. What we've seen is encouraging," says Jerry Jarrell, deputy director of the hurricane center.

Aside from modeling and computer improvements, hurricane forecasters have several new tools at their disposal. In April, the United States launched a much-needed geostationary weather satellite that should start providing routine images by late summer. The satellite will greatly enhance meteorologists' ability to track storms from their birth off the coast of Africa. The weather service is also updating its antiquated radar network system with new Doppler weather radars.

"In 2 years we think our 36-hour forecast will be as accurate as our 24-hour forecast was last year. So that's a marked improvement," says Sheets.

"Unfortunately," he adds, "population is increasing along the coast at a faster rate than our ability to forecast where the storm will go. We're fighting somewhat of a losing battle in that it's taking longer and longer for people to respond."

—R. Monastersky

Guiding the growth of the info highway

The Internet started as a modest network of networks linking the computers of researchers at universities and other institutions. In just a few years, however, it has expanded to encompass about 20,000 registered computer networks with 2 million host computers having direct links to the Internet and more than 15 million users in 63 countries. And it continues to grow at an explosive rate.

In essence, the Internet is a loosely organized, international collaboration of autonomous networks that makes possible communication from one computer to another through voluntary adherence to various standards and procedures. It is used daily by countless individuals for sending and receiving electronic mail, sharing information, and working together on projects.

Now, the Internet may serve as a model of how to build a national information infrastructure—a web of electronic superhighways connecting homes, workplaces, and public institutions. Last week, the National Research Council (NRC) issued a report, "Realizing the Information Future," which calls for the development of an "open data network" to achieve the kind of diversity and flexibility characteristic of the Internet.

Such a technological framework would embrace virtually all modes of information generation, transport, and use, including voice, data, and video communication, says computer scientist Leonard Kleinrock of the University of California, Los Angeles, who chaired the NRC panel responsible for the report.

At present, a hodgepodge of computer vendors, service providers, and communications companies is busily assembling