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Astronomers Edging Closer to Gaining Black Hole Image

By DENNIS OVERBYE

Astronomers are reporting today that they have moved a notch closer to seeing the unseeable.

Using a worldwide array of radio telescopes to obtain the most detailed look yet at the center of the Milky Way, they said they had determined that the diameter of a mysterious fountain of energy there was less than half that of Earth's orbit about the Sun.

The result strengthens the case that the energy is generated by a black hole that is gobbling stars and gas, they said. It also leaves astronomers on the verge of seeing the black hole itself as a small dark shadow ringed with light, in the blaze of radiation that marks the galaxy's center.

Until now, the existence of black holes - objects so dense that not even light can escape them- has been surmised by indirect measurements, say of stars or gas swirling in their grip. Seeing the black hole's shadow would require the ability to see about twice as much detail as can now be discerned. Such an observation could provide an important test of Albert Einstein's theory of general relativity, which predicts that black holes can exist.

"We're getting tantalizingly close to being able to see an unmistakable signature that would provide the first concrete proof of a supermassive black hole at a galaxy's center," Shen Zhiqiang of the Shanghai Astronomical Observatory, a leader of an international team of radio astronomers, said in a news release. Their report appears today in the journal Nature.

Another member of the team, Fred K. Y. Lo, director of the National Radio Astronomy Observatory in Charlottesville, Va., said that achieving the extra resolution could take several years and would probably require new radio telescopes.

"We're not there yet," he said, "but in time, no question, we will get there."

He added that seeing the shadow would be "proof of the pudding" that Einstein was right.

In an accompanying commentary, Christopher Reynolds of the University of Maryland wrote that such observations would "herald a new era in probing the structure and properties of some of the most enigmatic objects in the universe."

But other experts said it might be difficult, even if the extra resolution could be achieved, to untangle the detailed properties of the black hole from its blazing surroundings.

Astronomers have identified thousands of probable black holes. The candidates include objects billions of times as massive as the Sun at the centers of galaxies, where, it is theorized, gas and dust swirling toward their doom are heated and erupt with jets of X-rays and radio energy.

But the putative holes are too far away for astronomers to discern what would be their signature feature: a point of no return called the event horizon, in

effect an edge of the observable universe, from which nothing can return. Instead, the evidence for black holes rests mainly on the inference that too much invisible mass resides in too small a space to be anything else.

The center of the Milky Way is about 26,000 light-years away, in the direction of Sagittarius. The new observations conclude that at the center of the galaxy an amount of invisible matter equal to the mass of four million Suns is crammed into a region no more than 90 million miles across. That small size, the radio astronomers said, eliminates the most likely alternative explanation of the fireworks at the galaxy's center: a cluster of stars. Such a dense cluster would collapse in 100 years.

Even more conclusive proof would come from the observation of the black hole's shadow, which would be about five times the size of the event horizon and appear about as big as a tennis ball on the Moon as seen from Earth, according to calculations by Eric Agol of the University of Washington, Heino Falcke of the Max Planck Institute for Radio Astronomy in Germany and Fulvio Melia of the University of Arizona.

"For most people, seeing is believing," said Dr. Agol, who added that observations of the shadow could in principle be used to test whether general relativity is correct in such strange conditions and to measure how fast the black hole is spinning.

Martin Rees of Cambridge University in England, who with Donald Lynden-Bell in 1971 first proposed a black hole as the energy source at the Milky Way's center, said he was encouraged by this progress. But he cited studies suggesting that the shadow could be washed out by radiation or particles in front of the black hole, making definitive measurements hard.

As all the astronomers pointed out, getting to the next level of detail will require building new radio telescopes that operate at shorter wavelengths - and higher frequencies - than the Very Long Baseline Array of radio telescopes that were used to carry out the present observations.

"It's something I've been working on for 30 years," said Dr. Lo of the National Radio Astronomy Observatory. "It's been a long saga.

For a long time, he said, astronomers were peering through a haze. "Now we're seeing the thing in itself."

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