# Giant black holes even bigger than thought: study

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Courtesy American Astronomical Society and World Science staff

Astronomers have used computer simulations to calculate that a black hole at the heart of one the largest nearby galaxies is two to three times heavier than previously thought.

Weighing the equivalent of about 6.4 billion Suns, the black hole in galaxy M87 is the most massive yet measured with a reliable technique, and suggests that the accepted black hole masses in nearby large galaxies may be off by similar amounts, according to researchers.

This has consequences for theories of how galaxies form and grow, and might even solve a long-standing astronomical paradox, the scientists contend. Karl Gebhardt of The University of Texas at Austin detailed the findings June 8 at a press conference at the annual meeting of the American Astronomical Society in Pasadena, Calif.

They results are to be published later this summer in The Astrophysical Journal, in a paper by Gebhardt and Jens Thomas of the Max Planck Institute for Extraterrestrial Physics in Garching, Germany.

To try to understand how galaxies form and grow, astronomers must start with basic census information about today's galaxies. What are they made of? How big are they? How much do they weigh? Astronomers measure this last category, galaxy mass, by clocking the speed of stars orbiting within the galaxy.

Studies of the total mass, or weight, are important, Thomas said, but "the crucial point is to determine whether the mass is in the black hole, the stars, or the dark halo," the surrounding area.

"You have to run a sophisticated model to be able to discover which is which. The more components you have, the more complicated the model is." To model M87, Gebhardt and Thomas used one of the world's most powerful supercomputers, the Lonestar system at The University of Texas at Austin's Texas Advanced Computing Center.

Gebhardt and Thomas' model of M87 was more complicated than previous models of the galaxy, because in addition to modeling its stars and black hole, it takes into account the galaxy's "dark halo," a spherical region surrounding a galaxy that extends beyond its main visible structure, containing the galaxy's mysterious "dark matter."

"In the past, we have always considered the dark halo to be significant, but we did not have the computing resources to explore it as well," Gebhardt said. "We were only able to use stars and black holes before. Toss in the dark halo, it becomes too computationally expensive, you have to go to supercomputers."

The Lonestar result was a mass for M87's black hole several times what previous models have found, a totally unexpected result, Gebhardt said. He and Thomas simply wanted to test their model on "the most important galaxy out there," he explained.

Black holes are celestial objects so dense and heavy that their gravity permanently traps anything that floats too close by, including light rays. Most large galaxies are believed to harbor black holes at their cores.

M87 was one of the first galaxies suggested to harbor a central black hole nearly three decades ago. It also has an active jet shooting light out of the galaxy's core as matter swirls closer to the black hole, allowing astronomers to study the process by which black holes attract matter. All of these factors make M87 the "the anchor for supermassive black hole studies," Gebhardt said.

These new results for M87, together with hints from other recent studies and his own recent telescope observations, lead him to suspect that all black hole masses for the most massive galaxies are underestimated.

That conclusion "is important for how black holes relate to galaxies," Thomas said. "If you change the mass of the black hole, you change how the black hole relates to the galaxy." There is a tight relation between the galaxy and its black hole which had allowed researchers to probe the physics of how galaxies grow over cosmic time. Increasing the black hole masses in the most massive galaxies would cause this relation to be re evaluated.

Higher masses for black holes in nearby galaxies also could solve a paradox concerning the masses of quasars—active black holes at the centers of extremely distant galaxies, seen at a much earlier cosmic epoch. Quasars shine brightly as the material spirals in, giving off copious radiation before crossing the event horizon—the region beyond which nothing can escape.

"There is a long-standing problem in that quasar black hole masses were very large—10 billion solar masses," Gebhardt said. "But in local galaxies, we never saw black holes that massive, not nearly. The suspicion was before that the quasar masses were wrong," he said. But "if we increase the mass of M87 two or three times, the problem almost goes away."

Gebhardt also has made new telescope observations of M87 and other galaxies using new powerful instruments on the Gemini North Telescope and the European Southern Observatory's Very Large Telescope. He said these data, which will be submitted for publication soon, support the current model-based conclusions about black hole mass.

*Image: Astronomers have used computer simulations to calculate that a black hole at the heart of one the largest nearby galaxies is two to three times heavier than previously thought. Above is the galaxy, M87, classified as an elliptical galaxy. (Image courtesy NASA)*