New Massive Black Hole Smashes Record

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In this artist's portrayal of the IC 10 X-1 system, the black hole lies at the upper left and its companion star is on the right. The two objects orbit around a center of gravity once every 34.4 hours. The stellar companion is a type known as a Wolf-Rayet star. Such stars are highly evolved and destined to explode as supernovae. The black hole companion is shedding its outer envelope in a powerful wind, and some of this gas is captured by the black hole's powerful gravity. Credit: Aurore Simonnet/Sonoma State University/NASA

Using two NASA satellites, astronomers have discovered the heftiest known black hole to orbit a star. The new black hole, with a mass 24 to 33 times that of our Sun, is more massive than scientists expected for a black hole that formed from a dying star.

The newly discovered object belongs to the category of "stellar-mass" black holes. Formed in the death throes of massive stars, they are smaller

than the monster black holes found in galactic cores. The previous record holder for largest stellar-mass black hole is a 16-solar-mass black hole in the galaxy M33, announced on October 17.

"We weren't expecting to find a stellar-mass black hole this massive," says Andrea Prestwich of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., lead author of the discovery paper in the November 1 Astrophysical Journal Letters. "It seems likely that black holes that form from dying stars can be much larger than we had realized."

The black hole is located in the nearby dwarf galaxy IC 10, 1.8 million light-years from Earth in the constellation Cassiopeia. Prestwich's team could measure the black hole's mass because it has an orbiting companion: a hot, highly evolved star. The star is ejecting gas in the form of a wind. Some of this material spirals toward the black hole, heats up, and gives off powerful X-rays before crossing the point of no return.

In November 2006, Prestwich and her colleagues observed the dwarf galaxy with NASA's Chandra X-ray Observatory. The group discovered that the galaxy's brightest X-ray source, IC 10 X-1, exhibits sharp changes in X-ray brightness. Such behavior suggests a star periodically passing in front of a companion black hole and blocking the X-rays, creating an eclipse. In late November, NASA's Swift satellite confirmed the eclipses and revealed details about the star's orbit. The star in IC 10 X-1 appears to orbit in a plane that lies nearly edge-on to Earth's line of sight, The Swift observations, as well as observations from the Gemini Telescope in Hawaii, told Prestwich and her group how fast the two stars go around each other. Calculations showed that the companion black hole has a mass of at least 24 Suns.

There are still some uncertainties in the black hole's mass estimate, but

as Prestwich notes, "Future optical observations will provide a final check. Any refinements in the IC 10 X-1 measurement are likely to increase the black hole's mass rather than reduce it."

The black hole's large mass is surprising because massive stars generate powerful winds that blow off a large fraction of the star's mass before it explodes. Calculations suggest massive stars in our galaxy leave behind black holes no heavier than about 15 to 20 Suns.

The IC 10 X-1 black hole has gained mass since its birth by gobbling up gas from its companion star, but the rate is so slow that the black hole would have gained no more than 1 or 2 solar masses. "This black hole was born fat; it didn't grow fat," says astrophysicist Richard Mushotzky of NASA Goddard Space Flight Center in Greenbelt, Md., who is not a member of the discovery team.

The progenitor star probably started its life with 60 or more solar masses. Like its host galaxy, it was probably deficient in elements heavier than hydrogen and helium. In massive, luminous stars with a high fraction of heavy elements, the extra electrons of elements such as carbon and oxygen "feel" the outward pressure of light and are thus more susceptible to being swept away in stellar winds. But with its low fraction of heavy elements, the IC 10 X-1 progenitor shed comparatively little mass before it exploded, so it could leave behind a heavier black hole.

"Massive stars in our galaxy today are probably not producing very heavy stellar-mass black holes like this one," says coauthor Roy Kilgard of Wesleyan University in Middletown, Conn. "But there could be millions of heavy stellar-mass black holes lurking out there that were produced early in the Milky Way's history, before it had a chance to build up heavy elements."

Source: Goddard Space Flight Center