Most massive stellar black hole in our galaxy found

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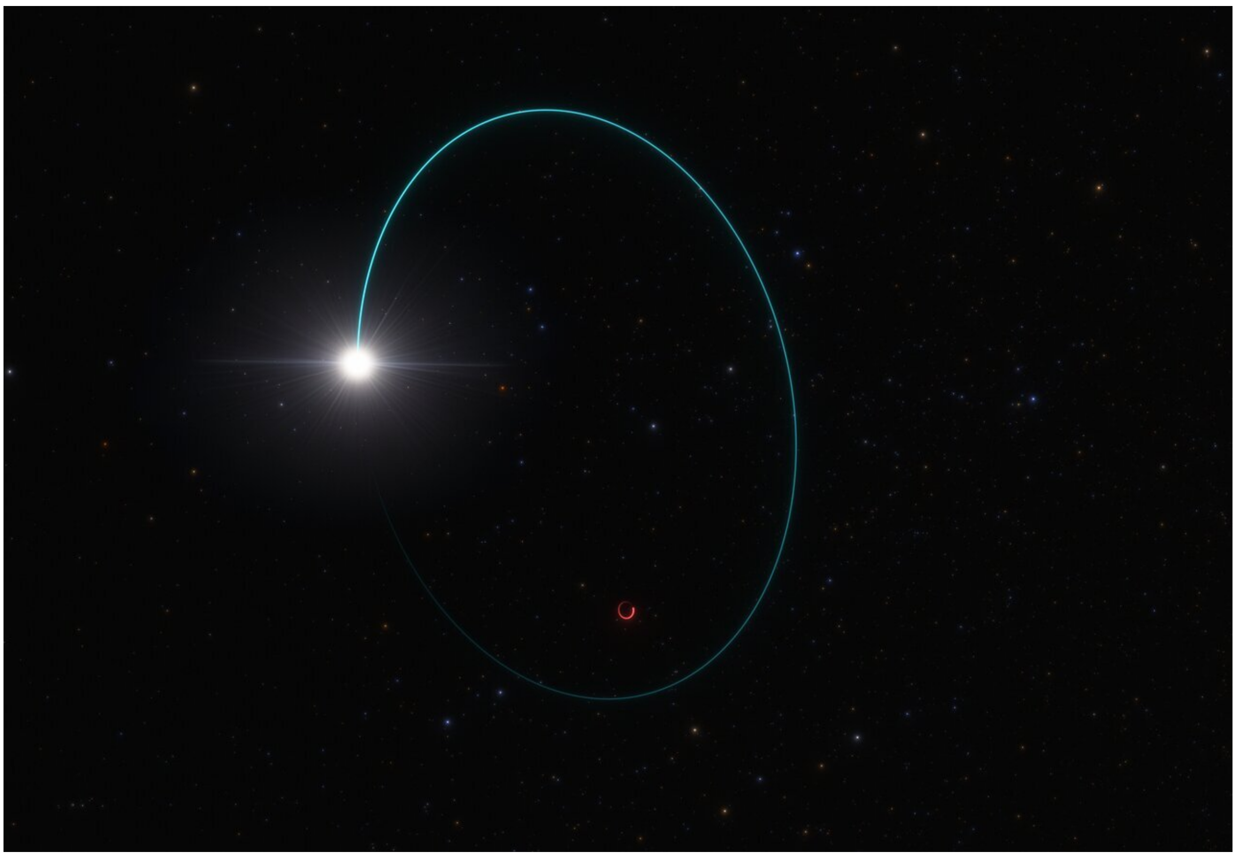

Astronomers have found the most massive stellar black hole in our galaxy, thanks to the wobbling motion it induces on a companion star. This artist's impression shows the orbits of both the star and the black hole, dubbed Gaia BH3, around their common center of mass. This wobbling was measured over several years with the European Space Agency's Gaia mission. Additional data from other telescopes, including ESO's Very Large Telescope in Chile, confirmed that the mass of this black hole is 33 times that of our sun. The chemical composition of the companion star suggests that the black hole was formed after the collapse of a massive star with very few heavy elements, or metals, as predicted by theory. Credit: ESO/L. Calçada

Astronomers have identified the most massive stellar black hole yet discovered in the Milky Way galaxy. This black hole was spotted in data from the European Space Agency's Gaia mission because it imposes an odd 'wobbling' motion on the companion star orbiting it. Data from the European Southern Observatory's Very Large Telescope (ESO's VLT) and other ground-based observatories were used to verify the mass of the black hole, putting it at an impressive 33 times that of the sun.

Stellar black holes are formed from the collapse of massive stars and the ones previously identified in the Milky Way are on average about 10 times as massive as the sun. Even the next most massive stellar black hole known in our galaxy, Cygnus X-1, only reaches 21 solar masses, making this new 33-solar-mass observation exceptional.

Remarkably, this black hole is also extremely close to us—at a mere 2,000 light-years away in the constellation Aquila, it is the second-closest known black hole to Earth. Dubbed Gaia BH3 or BH3 for short, it was found while the team was reviewing Gaia observations in preparation for an upcoming data release.

"No one was expecting to find a high-mass black hole lurking nearby, undetected so far," says Gaia collaboration member Pasquale Panuzzo, an astronomer at the Observatoire de Paris, part of France's National Center for Scientific Research (CNRS). "This is the kind of discovery you make once in your research life."

To confirm their discovery, the Gaia collaboration used data from ground-based observatories, including from the Ultraviolet and Visual Echelle Spectrograph (UVES) instrument on ESO's VLT, located in Chile's Atacama Desert. These observations revealed key properties of the companion star, which, together with Gaia data, allowed astronomers to precisely measure the mass of BH3.

Astronomers have found similarly massive black holes outside our galaxy (using a different detection method), and have theorized that they may form from the collapse of stars with very few elements heavier than hydrogen and helium in their chemical composition. These so-called metal-poor stars are thought to lose less mass over their lifetimes and hence have more material left over to produce high-mass black holes after their death. But evidence directly linking metal-poor stars to high-mass black holes has been lacking until now.

Stars in pairs tend to have similar compositions, meaning that BH3's companion holds important clues about the star that collapsed to form this exceptional black hole. UVES data showed that the companion was a very metal-poor star, indicating that the star that collapsed to form BH3 was also metal-poor—just as predicted.

The research, led by Panuzzo and titled "Discovery of a dormant 33 solar-mass black hole in pre-release Gaia astrometry" is published in *Astronomy & Astrophysics*.

"We took the exceptional step of publishing this paper based on preliminary data ahead of the forthcoming Gaia release because of the unique nature of the discovery," says co-author Elisabetta Caffau, also a Gaia collaboration member from the CNRS Observatoire de Paris. Making the data available early will let other astronomers start studying this black hole right now, without waiting for the full data release, planned for late 2025 at the earliest.

Further observations of this system could reveal more about its history and about the black hole itself. The GRAVITY instrument on ESO's VLT Interferometer, for example, could help astronomers find out whether this black hole is pulling in matter from its surroundings and better understand this exciting object.

More information: Discovery of a dormant 33 solar-mass black hole in pre-release Gaia astrometry. *Astronomy & Astrophysics*, 2024. aanda.org/10.1051/0004-6361/202449763

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