The aligned spin of a black hole

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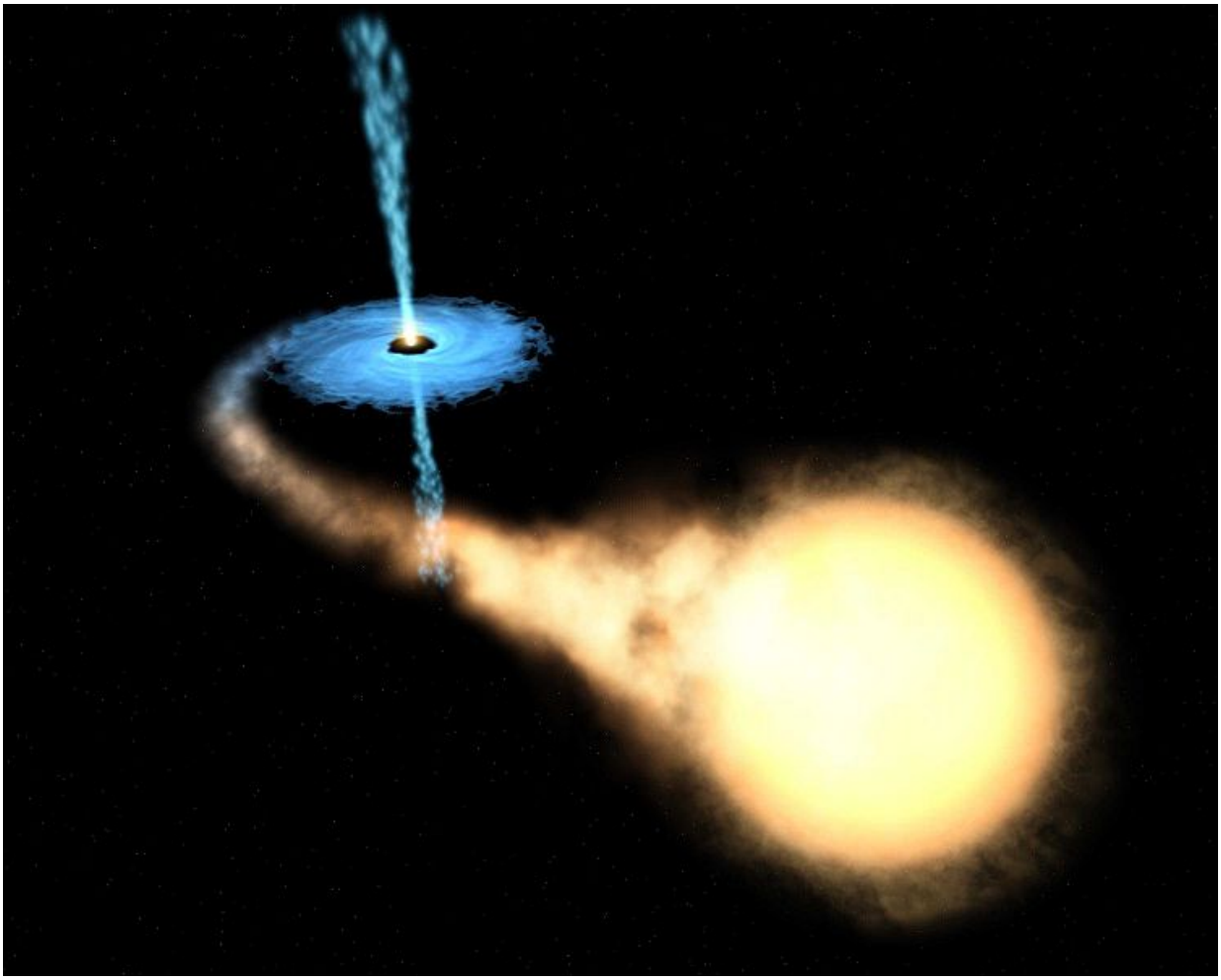

An artist's conception of an X-ray emitting black hole binary system. A new study has measured the spin of one notable example and confirmed, contrary to some earlier claims, that the spin is aligned with the spin of the accretion disk. Credit: NASA/ESA

A black hole in traditional theory is characterized by having "no hair," that is, it is so simple that it can be completely described by just three parameters, its mass, its spin, and its electric charge. Even though it may have formed out of a complex mix of matter and energy, all the specific details are lost when it collapses to a singular point. This is surrounded by a "horizon," and once anything – matter or light (energy) – falls within that horizon, it cannot escape. Hence, the singularity appears black. Outside this horizon a rotating, accreting disk can radiate freely.

Astronomers are able to measure the spins of black holes by closely modeling the X-ray radiation from the environment in one of two ways: fitting the continuum emission spectrum, or modeling the shape of an emission iron line from very highly ionized iron. So far the spins of ten stellar-mass black holes have been determined and the robustness of the continuum-fitting method has been well demonstrated. Recently one bright black hole, "Nova Muscae 1991," was found to be rotating in a sense opposite to the spin of its disk, a very unusual and curious result since both might be expected to develop somewhat in concert. The spin of this black hole had previously determined to be small, about ten percent of the limit allowed by relativity.

CfA astronomers Jeff McClintock, James Steiner and Jainfeng Wu and their colleagues have re-reduced archival data for this source, and obtained much improved measurements for the three key parameters needed in the continuum-fitting method: mass (11.0 solar-masses), disk inclination (43.2 degrees), and distance (16,300 light-years), each with a corresponding (and modest) uncertainty. Using the new numbers to reevaluate the model of the Nova Muscae 1991 spin, the scientists report that the spin is actually about five times larger than previously estimated. More significantly, that the spin is definitely prograde (aligned with the direction of the disk spin), and not retrograde. The new results resolve a potential mystery, and offer a confirmation of the general methods for modeling black holes.

More information: Zihan Chen et al. THE SPIN OF THE BLACK HOLE IN THE X-RAY BINARY NOVA MUSCAE 1991, *The Astrophysical Journal* (2016). DOI: 10.3847/0004-637X/825/1/45