Black hole loses its appetite for gassy cloud

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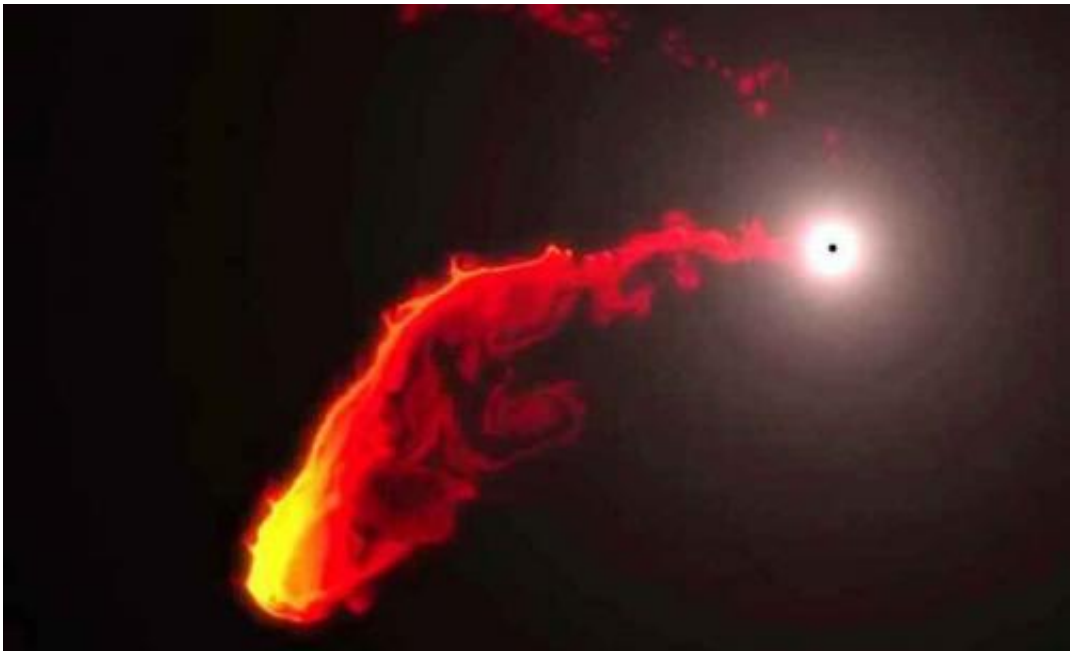

This simulation shows the possible behavior of a gas cloud (G2) that has been observed approaching the black hole at the center of the Milky Way. Graphic by ESO/MPE/Marc Schartmann

(Phys.org) —In a showdown of black hole versus G2 – a cloud of gas and dust – it looks like G2 won.

Recent research shows that G2 came within 30 billion kilometers of the super-massive black hole at the center of our galaxy, yet managed to escape from the gravitational pull of the black hole.

Initially, a supercomputer simulation prepared by two Lab physicists and a former postdoc more than two years ago suggested that some of G2 would survive, although its surviving mass would be torn apart, leaving it with a different shape and questionable fate.

The findings are the work of computational physicist Peter Anninos and astrophysicist Stephen Murray, both of AX division within the Weapons and Complex Integration Directorate (WCI), along with their former postdoc Chris Fragile, now an associate professor at the College of Charleston in South Carolina, and his student, Julia Wilson.

The team's simulations allowed the members to more efficiently follow the cloud's progression toward the black hole.

But recent observations by an outside group show that G2 managed to escape the appetite of the black hole.

"For it to have survived means that some gravity is keeping it intact," Murray said. "The mass of the gas cloud by itself is far too small to hold the cloud together. If there were nothing else there, the cloud would have been torn apart, as indicated by our models and those of other researchers."

The black hole is known as Sagittarius A-star (Sgr A*). "Sgr" is the abbreviation for Sagittarius, the constellation in the direction of the center of the Milky Way. Most galaxies have a black hole at their center, some thousands of times bigger than this one, which has a mass of about 4 million times that of our sun.

Astronomers originally noticed something in the region in 2002, but the first detailed determinations of G2's size and orbit came in 2012. The dust in the cloud has been measured at about 550 degrees Kelvin, approximately twice as hot as the surface temperature on Earth. The gas,

mostly hydrogen, is about 10,000 degrees Kelvin, or almost twice as hot as the surface of the sun.

"A star being present within the cloud would make sense, and was suggested by earlier workers trying to explain the origin of the G2 cloud, which is otherwise pretty mysterious," Murray said.

One idea was that the cloud might be the result of an old star losing mass. Based on the brightness of the object, the mass of the star was estimated to be pretty small (no more than about the mass of our sun), and "our models indicated that it would be insufficient to hold the cloud together against the tidal forces of the black hole," he said.

However, in the new study (link is external) appearing in the journal *Astrophysical Journal Letters*, the researchers found that G2 is pretty much intact after its passage near the black hole. Some of the gas does show distortion by the gravity of the black hole, but there is a core of warm gas that has remained essentially unchanged. That would indicate something significantly more massive than our sun holding it together. The authors propose that it is the result of the merger of a close binary star system (two stars in orbit around each other). Such mergers might be due to interaction with the tidal field of the black hole, and the result might be a puffed-up star whose outer atmosphere is seen as the warm core of G2 that survived passage by the black hole.

"That proposal means that we're seeing G2 very shortly after the merger of the two stars," Murray said. "While that's certainly possible, it does mean that we're seeing it at a special and relatively short-lived time. I haven't seen strong arguments that the object can't be a more typical star, somewhat more massive than our sun, undergoing normal mass loss as it nears the end of its life. Continued observations should let us determine just what's inside of G2."

More information: *Astrophysical Journal Letters*, iopscience.iop.org/2041-8205/796/1/L8/article

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