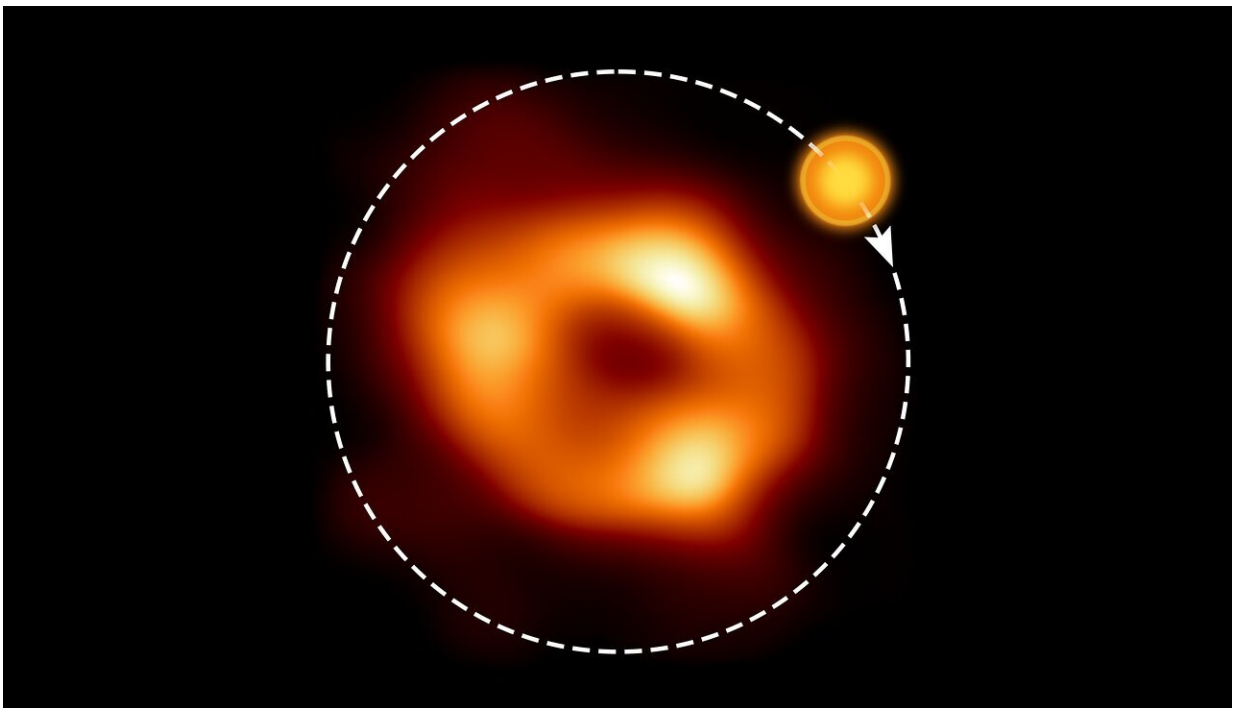


Astronomers detect hot gas bubble swirling around the Milky Way's supermassive black hole

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This shows a still image of the supermassive black hole Sagittarius A*, as seen by the Event Horizon Collaboration (EHT), with an artist's illustration indicating where the modelling of the ALMA data predicts the hot spot to be and its orbit around the black hole. Credit: EHT Collaboration, ESO/M. Kornmesser (Acknowledgment: M. Wielgus)

Using the Atacama Large Millimeter/submillimeter Array (ALMA), astronomers have spotted signs of a "hot spot" orbiting Sagittarius A*, the black hole at the center of our galaxy. The finding helps astronomers better understand the enigmatic and dynamic environment of our supermassive black hole.

"We think we're looking at a hot bubble of gas zipping around Sagittarius A* on an orbit similar in size to that of the planet Mercury, but making a full loop in just around 70 minutes. This requires a mind blowing velocity of about 30% of the speed of light," says Maciek Wielgus of the Max Planck Institute for Radio Astronomy in Bonn, Germany, who led the study published today in *Astronomy & Astrophysics*.

The [observations](#) were made with ALMA in the Chilean Andes—a radio telescope co-owned by the European Southern Observatory (ESO)—during a campaign by the Event Horizon Telescope (EHT) Collaboration to image [black holes](#). In April 2017 the EHT linked together eight existing [radio telescopes](#) worldwide, including ALMA, resulting in the [recently released first ever image of Sagittarius A*](#). To calibrate the EHT data, Wielgus and his colleagues, who are members of the EHT Collaboration, used ALMA data recorded simultaneously with the EHT observations of Sagittarius A*. To the team's surprise, there were more clues to the nature of the black hole hidden in the ALMA-only measurements.

By chance, some of the observations were done shortly after a burst or flare of X-ray energy was emitted from the center of the galaxy, which was spotted by NASA's Chandra Space Telescope. These kinds of flares, previously observed with X-ray and [infrared telescopes](#), are thought to be associated with so-called "[hot spots](#)," hot gas bubbles that orbit very fast and close to the black hole.

"What is really new and interesting is that such flares were so far only clearly present in X-ray and infrared observations of Sagittarius A*. Here, we see for the first time a very strong indication that orbiting hot spots are also present in radio observations," says Wielgus, who is also affiliated with the Nicolaus Copernicus Astronomical Center, Poland and the Black Hole Initiative at Harvard University, U.S..

"Perhaps these hot spots detected at [infrared wavelengths](#) are a manifestation of the same physical phenomenon: as infrared-emitting hot spots cool down, they become visible at [longer wavelengths](#), like the ones observed by ALMA and the EHT," adds Jesse Vos, a Ph.D. student at Radboud University, the Netherlands, who was also involved in this study.

The flares were long thought to originate from [magnetic interactions](#) in the very hot gas orbiting very close to Sagittarius A*, and the new findings support this idea. "Now we find strong evidence for a magnetic origin of these flares and our observations give us a clue about the geometry of the process. The new data are extremely helpful for building a theoretical interpretation of these events," says co-author Monika Mościbrodzka from Radboud University.

ALMA allows astronomers to study polarized radio emission from Sagittarius A*, which can be used to unveil the black hole's magnetic field. The team used these observations together with theoretical models to learn more about the formation of the hot spot and the environment it is embedded in, including the magnetic field around Sagittarius A*. Their research provides stronger constraints on the shape of this magnetic field than previous observations, helping astronomers uncover the nature of our black hole and its surroundings.

The observations confirm some of the [previous discoveries](#) made by the GRAVITY instrument at ESO's Very Large Telescope (VLT), which

observes in the infrared. The data from GRAVITY and ALMA both suggest the flare originates in a clump of gas swirling around the black hole at about 30% of the speed of light in a clockwise direction in the sky, with the orbit of the hot spot being nearly face-on.

"In the future we should be able to track hot spots across frequencies using coordinated multiwavelength observations with both GRAVITY and ALMA—the success of such an endeavor would be a true milestone for our understanding of the physics of flares in the Galactic center," says Ivan Marti-Vidal of the University of València in Spain, co-author of the study.

The team is also hoping to be able to directly observe the orbiting gas clumps with the EHT, to probe ever closer to the black hole and learn more about it. "Hopefully, one day, we will be comfortable saying that we 'know' what is going on in Sagittarius A*," Wielgus concludes.

This research was presented in the paper "Orbital motion near Sagittarius A*—Constraints from polarimetric ALMA observations" to appear in *Astronomy & Astrophysics*.

More information: M. Wielgus et al, Orbital motion near Sagittarius A*, *Astronomy & Astrophysics* (2022). [DOI: 10.1051/0004-6361/202244493](https://doi.org/10.1051/0004-6361/202244493)

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