A supermassive black hole's strong magnetic fields are revealed in a new light

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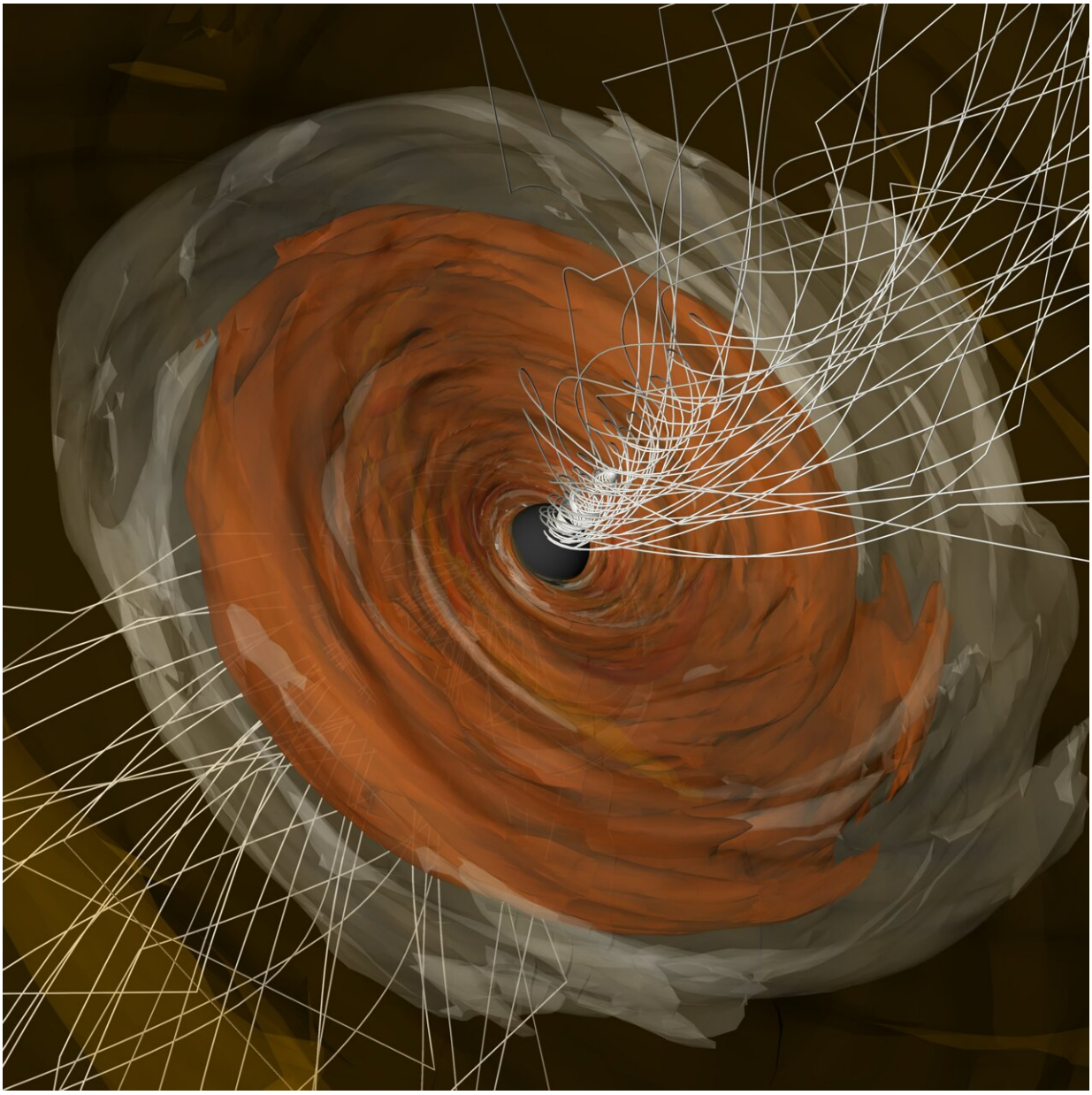

A computer simulation of a disk of plasma around the supermassive black hole at the center of the M87 galaxy. A new analysis of the circularly polarized, or spiraling light, in EHT observations shows that magnetic fields near the black hole are strong. These magnetic fields push back on infalling matter and help launch jets of matter at velocities near the speed of light out. Credit: George Wong

The Event Horizon Telescope (EHT) collaboration has published new results that describe for the first time how light from the edge of the supermassive black hole M87* spirals as it escapes the black hole's intense gravity, a signature known as circular polarization. The way light's electric field prefers to rotate clockwise or counterclockwise as it travels carries information about the magnetic field and types of high-energy particles around the black hole.

A new paper, published today in *The Astrophysical Journal Letters*, supports earlier findings from the EHT that the magnetic field near the M87* black hole is strong enough to occasionally stop the black hole from swallowing up nearby matter.

The Atacama Large Millimeter/submillimeter Array (ALMA) is the world's most powerful millimeter/ submillimeter telescope, and a key instrument for the EHT. The spiraling light at the heart of this research is actually made up of low frequency radio waves—light that can't be seen by the human eye or optical telescopes, but can be observed by the many radio telescopes, including ALMA, working together across the EHT.

"Circular polarization is the final signal we looked for in the EHT's first observations of the M87 black hole, and it was by far the hardest to analyze," says Andrew Chael, an associate research scholar at the

Gravity Initiative at Princeton University, who coordinated the project.

"These new results give us confidence that our picture of a strong magnetic field permeating the hot gas surrounding the black hole is the right one. The unprecedented EHT observations are allowing us to answer long-standing questions about how black holes consume matter and launch jets outside their host galaxies."

In 2019, the EHT released its first image of a ring of hot plasma close to the event horizon of M87*. In 2021, EHT scientists released an image showing the directions of the oscillating electric fields across the image. Known as linear polarization, this result was the first sign that the magnetic fields close to the black hole were ordered and strong. The new measurements of the circular polarization—which indicate how light's electric fields spiral around the linear direction from the 2021 analysis—provide yet more conclusive evidence for these strong magnetic fields.

ALMA provided both data and calibration for these results, and served as the array reference antenna for the EHT. Without the much greater sensitivity of ALMA as the reference antenna, circular polarization could not have been detected.

More information: First M87 Event Horizon Telescope Results. IX. Detection of Near-horizon Circular Polarization, *The Astrophysical Journal Letters*. DOI: 10.3847/2041-8213/acff70. iopscience.iop.org/article/10. … 847/2041-8213/acff70

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