OUT THERE

The Milky Way's Black Hole Comes to Light

The Event Horizon Telescope has once again caught sight of the "unseeable."

By Dennis Overbye

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Astronomers announced on Thursday that they had pierced the veil of darkness and dust at the center of our Milky Way galaxy to capture the first picture of "the gentle giant" dwelling there: a supermassive black hole, a trapdoor in space-time through which the equivalent of four million suns have been dispatched to eternity, leaving behind only their gravity and violently bent space-time.

The image, released in six simultaneous news conferences in Washington, and around the globe, showed a lumpy doughnut of radio emission framing empty space. Oohs and aahs broke out at the National Press Club in Washington when Feryal Ozel of the University of Arizona displayed what she called "the first direct image of the gentle giant in the center of our galaxy." She added: "It seems that black holes like doughnuts."

Dr. Ozel is part of the Event Horizon Telescope project, a collaboration of more than 300 scientists from 13 institutions that operates an ever-growing global network of telescopes to compose one large telescope as big as Earth.

The team's results are being published today in The Astrophysical Journal Letters.

The new image joins the first ever picture of a black hole, in the galaxy Messier 87, or M87, which the same team of researchers produced in 2019. "We have seen what we thought was 'unseeable,'" Sheperd Doeleman, an astronomer at the Harvard-Smithsonian Center for Astrophysics, said at the time.

The similarity in the pictures demonstrated that the 2019 image was not a coincidence, Dr. Ozel said.

Moreover, the features of the radio doughnut matched perfectly with predictions derived from the motions of stars and gas clouds around the galactic center. "This is an extraordinary verification of Einstein's general theory of relativity," said Michael Johnson, a team member and also of the Harvard-Smithsonian Center.

Einstein's bad dream

Andrea Ghez of the University of California, Los Angeles. Alex Welsh for The New York Times

Reinhard Genzel of the Max Planck Institute for Extraterrestrial Physics. Ksenia Kuleshova for The New York Times

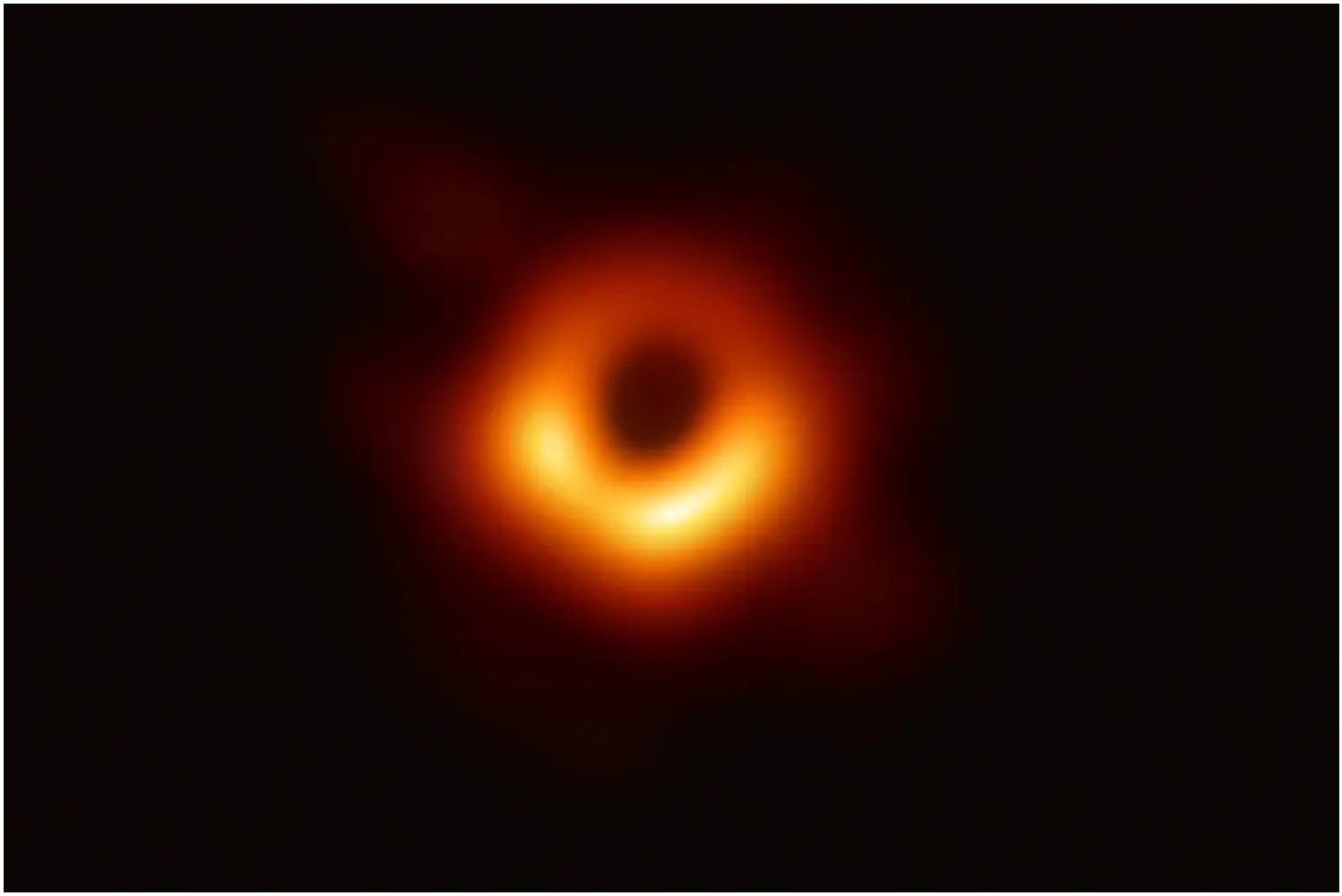
Black holes were an unwelcome consequence of Albert Einstein's general theory of relativity, which attributed gravity to the warping of space and time by matter and energy, much as how a mattress sags under a sleeper.

Einstein's insight led to a new conception of the cosmos, in which space-time could quiver, bend, rip, expand, swirl and even disappear forever into the maw of a black hole, an entity with gravity so strong that not even light could escape it.

Einstein disapproved of this idea, but the universe is now known to be speckled with black holes. Many are the remains of dead stars that collapsed inward on themselves and just kept going.

But there seems to be a black hole at the center of nearly every galaxy, ours included, that can be millions or billions of times as massive as our sun. Astronomers still do not understand how these supermassive black holes have grown so big.

Paradoxically, despite their ability to swallow light, black holes are the most luminous objects in the universe. Materials — gas, dust, shredded stars — that fall into a black hole are heated to millions of degrees in a dense maelstrom of electromagnetic fields. Most of that matter falls into the black hole, but some is squirted out by enormous pressures and magnetic fields.



The Event Horizon Telescope team scored its first triumph in April 2019, when it presented a picture of the M87 black hole. EHT Collaboration

Such fireworks, which can outshine galaxies by a thousandfold, can be seen across the universe; when first observed in the early 1960s, they were called quasars. Their discovery led physicists and astronomers to take seriously the notion that black holes existed.

What gave rise to such behemoths of nothingness is a mystery. Dense wrinkles in the primordial energies of the Big Bang? Monster runaway stars that collapsed and consumed their surroundings in the dawning years of the universe?

The center of the Milky Way coincides with a faint source of radio noise called Sagittarius A* (pronounced Sagittarius A-star). Astronomers including Andrea Ghez of the University of California, Los Angeles and Reinhard Genzel of the Max Planck Institute for Extraterrestrial Physics had calculated that whatever was there had the mass of 4.14 million suns. They reached that estimate by tracking the orbits of stars and gas clouds swirling about the center of the Milky Way and measuring their velocities at one-third the speed of light. For their achievement, Dr. Genzel and Dr. Ghez won the Nobel Prize in Physics in 2020.

If it was not a black hole, neither Einstein nor anyone else knew what it could be.

Chasing a shadow

Proving that it was a black hole was another job entirely.

According to research that goes back to a 1967 paper by the physicist James Bardeen, the Sagittarius black hole, if it were there, would appear as a ghostly dark circle amid a haze of radio waves. At 50 million miles across, this hollow shadow would appear about as big from Earth as an orange on the moon.

Astronomers have been trying to sharpen the acuity of their telescopes to resolve the shadow of that orange. But ionized electrons and protons in interstellar space scatter the radio waves into a blur that obscures details of the source. “It’s like looking through shower glass,” Dr. Doeleman said recently.

To see deeper into the black hole shadow, researchers needed to be able to tune their radio telescopes to shorter wavelengths that could penetrate the haze. And they needed a bigger telescope.