In a galaxy far, far away, astronomers capture first images of a black hole

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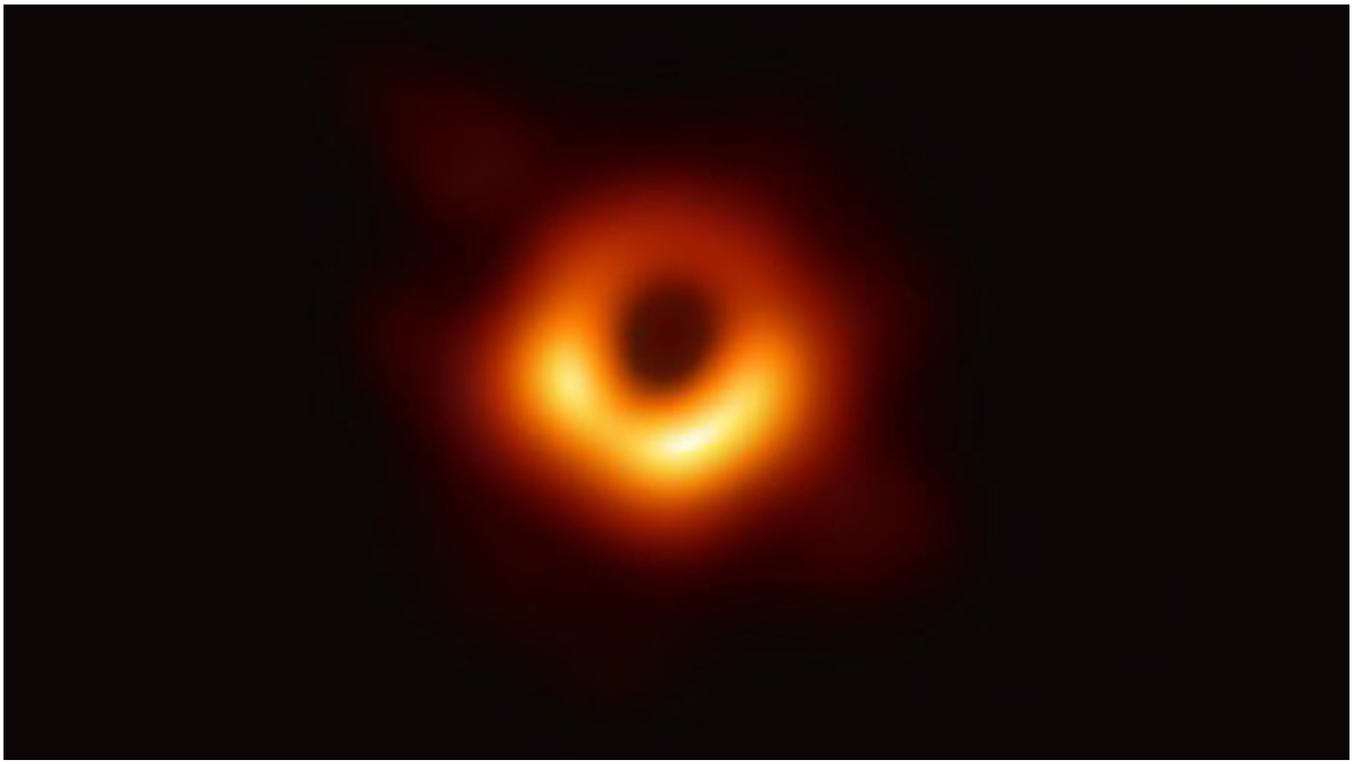

Scientists have captured the first direct image of a supermassive black hole. The cosmic portrait belongs to the black hole at the center of Messier 87, the largest galaxy we know of, about 54 million light-years away. Photo by: Event Horizon Telescope collaboration

Scientists have finally captured the first image of a black hole.

The new image is of a supermassive black hole located around 54 million light-years away from Earth. It sits at the center of Messier 87, the largest known galaxy.

The image was captured by the Event Horizon Telescope (EHT), a network of eight radio telescopes that operate in tandem.

A Weeklong Observation Effort

The image shows the boundary between light and dark around a black hole, called the event horizon. This region is the point of no return, where the gravity of the black hole is so extreme that nothing that enters can ever escape. At the center of the black hole, time and space become so curved upon themselves that the laws of physics break down completely.

Over the course of a week in April 2017, EHT astronomers on four continents coordinated their efforts to make observations of the supermassive black hole. The astronomers had to battle bad weather and glitchy electric grids. They donned oxygen tanks and climbed three-mile-high mountains to escape the interference of Earth's atmosphere.

The scientists then spent the past two years studying the data they had captured. Finally, they found what they felt confident was the image of a black hole.

Astrophysicist Feryal Ozel, a member of the EHT team, called the captured image the highlight of her career.

"We are able to image one more object in the universe that at one point people thought could not be possible," she said. "It hits that human explorer spirit — we got another look into the unknown."

Schwarzschild Theorized About Black Holes' Existence

The foundations for this discovery were laid more than 100 years ago, when Albert Einstein published the equations that defined modern gravitational physics. General relativity, first described in 1915, explained gravity as a force created when matter warps the geometry of space and time. In turn, curved space and time ("spacetime") tells matter how to move.

Months after Einstein produced the equations for general relativity, German physicist Karl Schwarzschild calculated that if an object is dense enough, it would create a bottomless pit in spacetime known as a "singularity." Anything within a certain radius of that pit — a region known as the "event horizon" — would be swallowed by its gravity. A black hole —another name for a singularity — consumes clouds of gas and stars that wander too close. Not even light can escape.

Einstein found the notion so ridiculous that he devoted an entire research paper to disproving it.

Yet it wasn't long before scientists started seeing proof of black holes' presence everywhere they looked. Models showed that black holes could form when giant stars died. Searches of the sky showed the paths of stars being bent by a black hole's tremendous gravity, and telescopes revealed the brilliant jets of light produced as the superheated material swirling around a black hole is splashed back into space. In 2016, scientists detected ripples in spacetime caused by black holes colliding. These ripples are called gravitational waves.

All the evidence suggested that Einstein was wrong about black holes, and that his theory was right.

However, seeing is believing, noted astrophysicist Dan Marrone, who sits on the EHT's science council.

"If we could actually fill in that final hole, show that the universe was working again in a way we arrived at by reason," he said, "that would be pretty cool."

A Doughnut On The Moon

The black hole in the center of Messier 87 was one of the two most promising targets for such a project, because it is particularly enormous. Still, it is so distant that it would appear to Earthlings as a doughnut on the moon. To see it in any kind of detail, scientists would need a telescope as big as the planet — and of course, no such thing existed.

So in the mid-2000s, scientists began linking up telescopes around the world to collect scores of observations, each from a slightly different perspective. The process was very tricky, and required a great deal of fine-tuning. Finally, in 2017, the EHT was ready for prime time.

Ozel helped coordinate the week of observations from the project's makeshift command center at the Massachusetts Institute of Technology. She recalled the surge of excitement as hundreds of astronomers around the world prepared for their first night of work.

"There was an element of the unknown," she said. Technical difficulties or bad weather at any of the eight sites could end up making a whole night of observations worthless.

After five nights of observing, the project had collected 5 billion megabytes of data. That is the equivalent of 960 hard drives containing two billion high-quality photographs.

Somewhere in that vast collection was the image of a black hole. Now the scientists had to find it, even though they weren't entirely sure what a black hole would look like. They had to rely on what theory told them a black hole should look like, and hope for a definite match.

Four subgroups at four different laboratories around the globe were assigned the task of locating the image. None were allowed to know what the others were doing, as a form of quality control. This is to make sure the results are accurate and independent.

"If the scientific goal wasn't so attractive and so full of potential, and if we hadn't spent so much time working toward this goal, I think it probably would have fallen apart," Ozel said. "The science kept us together."