Horizon
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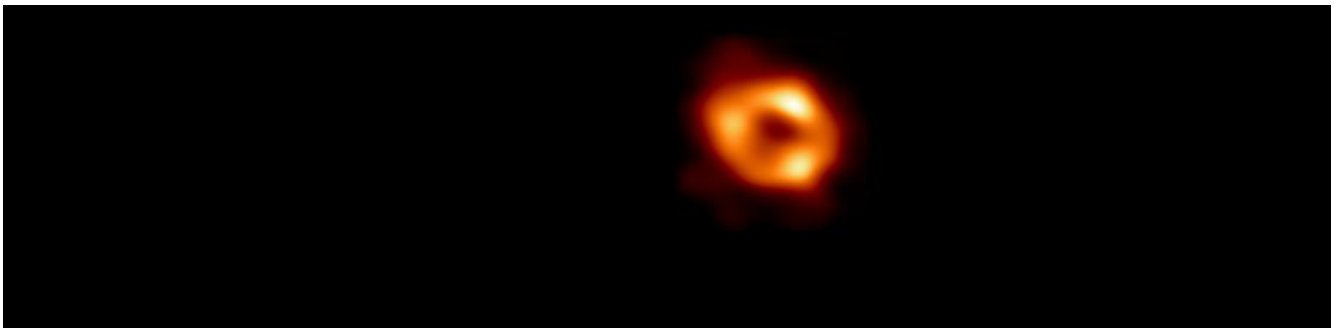

Event horizon: After photographing black holes, scientists are now making a movie

The first moving images of a black hole could reveal swirls of plasma and collapsing stars, deepening our understanding of the universe.

10 October 2024 - By JONATHAN O'CALLAGHAN

A widespread misconception has long equated black holes in space with nothingness, 'the end of everything'. But a global team of scientists, including EU-funded researchers, has managed to photograph them, discovering enough new evidence to take their probe even further.

Dutch-German astronomer and professor Heino Falcke is one of those who want to understand "the ultimate edge of our knowledge" – black holes.

A professor of astroparticle physics and radio astronomy at Radboud University in the Netherlands, Falcke is one of the leads of the Event Horizon Telescope (EHT), a global network of telescopes that captured the first image of a black hole in 2019.

Together with his colleagues, he now wants to go further and create the first video of these incredible and mysterious space objects.

Gaining further knowledge of black holes will be crucial to our understanding of the universe, Falcke said, and the new EU-funded BlackHolistic project, which will run until 2029, should provide vital clues.

With almost €14 billion in EU funding, the scientists aim to take the EHT's research further and deepen our knowledge of black holes, with the help of supercomputing hardware and a new radio telescope in Namibia.

"Black holes, to some degree, have the same physics as the Big Bang," Falcke said. "They're also astro-physically important as the most efficient energy producers in the universe and ultimately fascinating. They are mythical objects where time seems to come to a standstill."

Images from a galaxy far far away

In 2019, using its global network, the EHT produced an image of the black hole at the centre of M87, a galaxy 54 million lightyears away from Earth.

It was the first view of the ‘shadow’ of a black hole, the dark spot that denotes its ‘event horizon’, the boundary beyond which nothing – matter, energy, or even light – can escape its gravitational pull.

For this high-resolution image, Falcke received the 2023 Balzan Prize, including an award of €760 000. “That was absolutely amazing,” he said. “It’s one of the big prizes in science.” He also wrote a best-selling book about his research titled *Light in the Darkness*.

The EHT followed up with an image of Sagittarius A*, a black hole at the centre of our Milky Way galaxy, in 2022.

Now Falcke and a team of British, Dutch, Finnish and Namibian astronomers in BlackHolistic, together with the EHT, will film a landmark video of black holes.

With the help of a new 15-metre-wide telescope in Namibia called the Africa Millimetre Telescope (AMT), the goal is to produce hours-long videos of the swirling plasma and gas around the event horizons of M87 and Sagittarius A*.

“We made the first picture of a black hole. Now we want to take it a step further. We want to make the first movie of a black hole,” Falcke said.

By combining the AMT with existing EHT telescopes in North and South America, Europe and the South Pole, the team will be able to keep the black hole in the sights of these telescopes for longer. This will make filming easier.

Challenge: handling massive amounts of space data

M87 is a supermassive black hole, about 6 billion times the mass of our Sun. Still, it is hard to spot. Its event horizon is about the size of our solar system, but at a great distance from us.

As Earth rotates, the black hole will rise into view for different telescopes across the globe, allowing continuous images to be gathered every few days, and a composite of those images to be stitched together.

For Sagittarius A*, which is much smaller at about 4 million times the mass of our Sun, images will need to be taken every five minutes to see changes around the black hole.

The telescopes observe the black holes in radio waves, with their views stitched together through a process that uses electromagnetic waves to extract information and produce a single view. This is currently impossible to achieve with a single telescope.

Material around Sagittarius A*, mostly gaseous matter, moves much faster than that around M87, completing an orbit in a few hours compared to two weeks for M87. Observing it requires the use of Namibia’s AMT.

The amount of data produced by the telescopes is mind-boggling: five petabytes or more, or 5 billion gigabytes – too much to be transferred over the internet in a reasonable time. Instead, the data must be physically transported to processing facilities in the US and Germany.

For the upcoming black hole videos, Falcke warned, “this will just get worse. There’ll be much more data to come.”

Will we see stars ripped apart?

Michael Kramer, who was one of the leads, together with Falcke, on an earlier EU-funded space initiative, the 2014-2020 BLACKHOLECAM, said producing videos of black holes will provide much more information than single images. Kramer is a director at the Max Planck Institute for Radio Astronomy in Germany.

The images published before, he said, “had this bright spot around them” – large blobs of plasma being eaten by the black hole.

In the videos, these bright spots will move, he said. “By looking at how this plasma moves, you have a much better understanding of the dynamics. You can also get a better handle on the geometry, the orientation of the black hole.”

That motion should enable much more precise measurement of the black hole’s mass, just like we can calculate the mass of the Sun “by watching the planets and how they orbit around the centre of the Solar System”, explained Kramer.

The direction of the plasma will also reveal the orientation of the orbiting material as it slowly loses energy and spirals inward. It might even be possible to see a star being torn apart by the black hole if it ventures too close.

“That’d be cool,” said Falcke. “If it goes there, we’re ready.”

Mystery of the universe

“Black holes are part of our history,” he said. “Some elements in our body wouldn’t be here if black holes hadn’t transported them around in the course of the universe.”

He described the research efforts of BlackHolistic as “a bit daring”. But he noted that black holes are essentially “the simplest objects in the universe because they are described by just two numbers, how much mass they have and how much they rotate”.

“Every cell in your body is infinitely more complicated than a black hole.”

Despite that faux simplicity, there is much uncertainty about the confines of space and time inside a black hole that still puzzles researchers.

“I look for the mystery of the universe,” said Falcke, “and I believe there will always be a mystery.”

The first black hole videos will provide some answers, at least.

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- Event Horizon Telescope Collaboration
- The Event Horizon Telescope
- EU Space research