Albert Einstein's general theory of relativity. But although astrophysicists had theories, there was no clear indication — on the basis of that image alone — as to the origin of the radiation. The most likely explanation was that the glow resulted from the same mechanism that causes a stupendously bright jet of superheated matter to protrude far out from the host galaxy. Scientists knew that this jet existed long before the black hole was imaged, and it had been photographed with more conventional instruments, including the Hubble Space Telescope.

The bigger picture

The original M87* image was blurry, and showed only the immediate vicinity of the black hole's event horizon, the spherical surface that shrouds its interior. Any material that crosses the event horizon falls inwards, never to return. It was challenging to link the image to the larger-scale pictures of the jet.

In a paper published in *Nature* on 26 April, radio astronomers including Krichbaum crunched through a separate data set and found a cone of radio emissions emanating from the black hole in the same direction as the jet (R.-S. Lu *et al. Nature* **616**, 686–690; 2023).

The original M87* image used 2017 data from the Event Horizon Telescope (EHT), a network of observatories scattered across four continents that examined the black hole at a wavelength of 1.3 millimetres. The latest paper used data taken in 2018 with the Global Millimetre VLBI Array (GMVA), a separate and older network that shares many collaborators with the EHT and uses some of the same facilities, but observes at 3.5 millimetres.

Both networks use a technique called interferometry, which combines data taken simultaneously at several locations. The larger the separation between the participating observatories, the better the resolution and the more details astronomers can discern; going to shorter wavelengths has the same effect. With its lower resolution, the GMVA cannot see the ring as sharply as the EHT, and it needs some extra data massaging. But the GMVA is able to see a wider picture. "For the first time, we see how the jet connects to the ring," says Krichbaum (see 'Black-hole image evolves').

In a separate paper, published in *The Astrophysical Journal Letters* on 13 April, astrophysicist Lia Medeiros at the Institute for Advanced Study in Princeton, New Jersey, and her collaborators reanalysed the 2017 EHT data using a new machine-learning algorithm (L. Medeiros *et al. Astrophys. J.* **947**, L7; 2023).

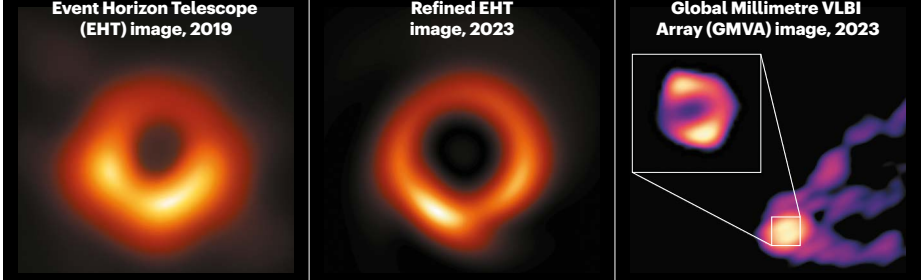
Algorithms that process the telescope data must overcome an intrinsic limitation of interferometry: even with observatories on opposite sides of the planet, the array does not truly gather data with an Earth-sized dish, but with shards of one. "There is an infinite number of images that are consistent with our data," Medeiros says. "You need to make a choice about which one you think is most likely."

In the 2019 results, the EHT team used conservative algorithms that artificially blurred the image. Medeiros's team developed an algorithm based on a technique called dictionary learning that maximizes the resolution — and produces a substantially thinner ring. Medeiros is eager to apply the method to data on Sagittarius A*, the black hole at the centre of our Galaxy. The EHT released an image of Sagittarius A* last year.

The EHT has also produced various versions of the M87* images, including one showing signatures of magnetic fields, and has used older data to show how the ring has evolved over the years, in images that can be combined into a movie. The collaboration conducted observation campaigns in 2018 and once a year between 2021 and 2023, but has not yet finished analysing those data. Most intriguingly, the 2023 campaign included observations at the challenging wavelength of 0.87 millimetres, which should further improve the resolution.

BLACK-HOLE IMAGE EVOLVES

Various astronomy teams have analysed observation data of M87* — the first black hole ever to be imaged — to create an evolving set of pictures of the abyss. Their studies are revealing details about the black hole and its environment.



Event Horizon Telescope (EHT) image, 2019

The EHT's first image of M87* showed a ring of light bent around the black hole's gravitational field. But it was unclear where that glow came from: perhaps the black hole's spinning 'accretion disk' of matter or its poles, where its jets of matter are thought to originate.

Refined EHT image, 2023

A machine-learning algorithm applied to the EHT data generated a sharper image with a thinner ring and a darker disk at the centre.

Global Millimetre VLBI Array (GMVA) image, 2023

The latest image of M87*, taken by a separate array called the GMVA, was blurrier than the original one — but it revealed the base of the jet emanating from the black hole's north pole. This suggests that the ring's light comes mainly from the jet.

L TO R: EHT COLLABORATION; MEDEIROS *ET AL.* (2023); R.-S. LU (SHAO)/E. ROS (MPIFR)/S.DAGNELLO (NRAO/AUI/NSF). GRAPHIC ASSEMBLED BY *NATURE*.

CHARLES LIEBER AVOIDS FURTHER JAIL TIME FOR LYING ABOUT CHINA TIES

Ex-Harvard chemist was among the first academics tried under the now-defunct US China Initiative.

By Natasha Gilbert

Charles Lieber, a prominent chemist convicted of hiding his research ties to China, will not serve any more prison time, a federal judge has ruled. On 26 April, Massachusetts district judge Rya Zobel sentenced Lieber, formerly at Harvard University in Cambridge, Massachusetts, to time already served — which amounted to two days of incarceration — plus two years of supervised release. He will spend the first six months of that release confined to his home. Lieber was also ordered to pay a US$50,000 fine, as well as $34,000 to the Internal Revenue Service (IRS), which he has already submitted.

Marc Mukasey, Lieber's lawyer, told *Nature* in a statement, "We are grateful for the outcome."

Lieber was found guilty by a jury in December 2021 on six counts of making false statements to federal agents, filing false tax returns and failing to disclose a foreign bank account in China. He told investigators that he was not associated with a Chinese recruitment programme — the Thousand Talents Plan — when in fact he was selected to lead a laboratory at the Wuhan University of Technology (WUT) in China. Participating in a foreign talent-recruitment programme is not illegal, but lying

about it to federal agents is.

Between 2012 and 2017, Lieber was paid around $200,000 for his work at the WUT — income that he illegally hid from the IRS, according to the court ruling. At the same time, he led a research team that received millions of US dollars in federal grants from agencies including the US Department of Defense and the National Institutes of Health.

Lieber, who was arrested in January 2020, was one of the first academic researchers tried under the US Department of Justice's now-defunct China Initiative — a government programme launched in 2018 to safeguard US labs and businesses from espionage. He was one of the few scientists not of Chinese heritage to be charged under the initiative, although his was one of the most-watched cases, given his stature in the research community. Lieber's lab had developed injectable brain implants, and he won the Wolf Prize in Chemistry in 2012, which some consider a precursor to the Nobel prize.

A significant sentence

The US government asked the judge to sentence Lieber to 90 days in prison, with one year of supervised release and a $150,000 fine. Lieber's legal team requested no prison time, citing his ill health. Lieber, aged 64, has follicular lymphoma, a blood cancer for which there is no cure. In Lieber's sentencing memorandum, his lawyers stated that for the past three years, the chemist has been mostly confined to his home and to hospitals. After 30 years at Harvard University, including a stint as the chair of its chemistry department, Lieber retired in March, according to student newspaper *The Harvard Crimson*.

Former colleagues and students wrote letters of support for Lieber that were submitted in his sentencing memorandum. For instance, Daniel Kahne, who researches antibiotic resistance at Harvard, said Lieber put huge effort into supporting and nurturing his students.

Frank Wu, a legal specialist on the China Initiative and president of Queens College, City University of New York, told *Nature* that Lieber's sentencing is significant and that it will influence similar cases. "Everyone who cares about the China Initiative should care about this specific case," he wrote in a statement.

Wu adds that Lieber's sentence is consistent with the outcome of other China Initiative cases and similar prosecutions in which judges of all backgrounds have shown scepticism about the US government's efforts to hold researchers accountable for hiding their ties to China.

Jenny Lee, a social scientist who studies research collaborations at the University of Arizona in Tucson says that the sentence is fair. "Dr Lieber already paid a huge cost in his damaged professional reputation. He was made an example of to the broader scientific community about undisclosed ties with China."

Members of Mexico's Air Force have been helping to disperse particles into clouds.

MEXICO IS SEEDING CLOUDS — SCIENTISTS AREN'T SURE IT WORKS

Researchers question the investment, given uncertainties about the rain-making technology.

By Myriam Vidal Valero

Farmers in Mexico desperate for rain are asking their government to 'bomb' the clouds. The country is experiencing its second-worst drought in a decade, and farmers are afraid for their crops and livestock. They've asked the Mexican government to use cloud-seeding technology to help them.

In February, the National Commission for Arid Zones (Conaza), a branch of the country's agriculture ministry, announced that it would launch a rain-stimulation programme in the northeastern and northwestern states of Tamaulipas and Baja California, respectively.

However, scientists warn that there is scant evidence that cloud seeding works, despite the Mexican government saying that it has had successes. Cloud seeding involves dispersing particles — usually crystalline silver iodide — into clouds. Because the particles have a crystal structure similar to that of ice, they attract water droplets to nucleate around them; eventually the droplets become heavy enough to fall as rain or snow.

Mostly, there is "theoretical evidence" that cloud seeding can increase precipitation, says Fernando García, a cloud physicist at the National Autonomous University of Mexico (UNAM) in Mexico City. Some rigorous experiments have resulted in a modest increase in precipitation.

But there is no evidence that it will work every time, García says. "I can modify [a cloud]. What I don't know is whether I'm going to increase rainfall or even suppress it, because that can happen, too."

Mexico's Ministry of Agriculture and Rural Development (Sader) and Conaza did not respond to *Nature*'s requests for comment.

Bombing the clouds

The Mexican government is working with the company Startup Renaissance to implement its cloud-seeding campaign. Alejandro Trueba, an agricultural engineer and the company's founder and director, approached Sader in 2019, offering to tackle the country's drought with RainMate, a silver iodide-based

JESUS BUSTAMANTE/REUTERS