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Physics

Gravitational wave detectors find their biggest black hole yet

Leah Crane

ASTRONOMERS have spotted two large black holes smashing together to form an even bigger one with a mass 142 times that of the sun – the largest black hole detected using gravitational waves.

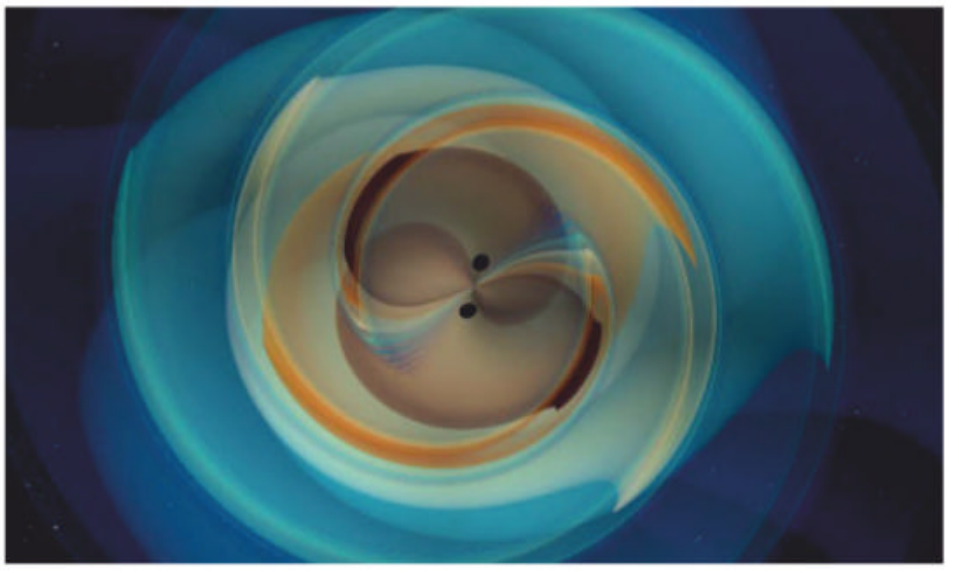
We have direct evidence for smaller and much larger black holes than these ones. Small black holes result from some dying stars and supermassive ones a million times as massive as the sun or more sit at the centres of galaxies. But the latest discovery, which was made at the Laser Interferometer Gravitational-wave Observatory (LIGO) and partner detector Virgo, is the first direct confirmation of an intermediate-mass black hole.

"At masses between 60 and 130 solar masses or so, it's impossible for a star to turn into a black hole, it just blows apart," says LIGO team member Nelson Christensen at the Observatory of Nice in France. "Astrophysicists theorised that we're not going to find any black holes in this gap [between smaller black holes formed by stars and supermassive ones] and we found at least one."

LIGO consists of a pair of enormous L-shaped detectors in the US, and Virgo is another detector in Italy. When massive objects in space move, they create ripples in space-time called gravitational waves that stretch and squeeze everything in their path. The three detectors use that stretching and squeezing to determine what caused the ripples.

On 21 May 2019, all three detectors found gravitational waves from a pair of black holes that were about 65 and 85 times the mass of the sun, respectively, spiralling towards one another and merging. The result of this colossal collision was a single black hole 142 times the mass of the sun, with eight solar masses worth of energy radiating away in the form of gravitational waves.

An artist's impression of two black holes poised to collide



MARK MYERS/OZGRAV

Just like the product of this collision, the two black holes that merged might not have formed from stars, but could also be second-generation ones, formed by yet more pairs of smaller black holes, says Christensen (*Physical Review Letters*, doi.org/d7zb).

"There has been indirect evidence for intermediate mass black holes, but this is a real observation of an event that's definitely above 100 solar masses," he says.

We might even have an idea of where this black hole is. Shortly after LIGO and Virgo picked up the merger, a sensitive astronomical camera in California, called the Zwicky Transient Facility (ZTF), spotted a burst of light in a galaxy close to where the gravitational wave measurements suggest the collision happened (arxiv.org/abs/2006.14122).

The flare was near the centre of the galaxy, where a dense disc of matter circles a supermassive black hole. Because this type of region is so crowded, we expect many objects, including black holes, to collide as they orbit the galaxy's centre, says Michael Coughlin at the University of Minnesota, who is part of the ZTF team. Then, as the black hole that results from the merger travels through the disc, it would crash through other matter and cause a burst of light.

"The association is a little suspect: the distances don't quite match," says Coughlin. "But this thing's gonna come around again, so it should cause another flare. That would be a smoking gun." ▮

Technology

A small patterned patch can hide a plane from drones

STICKING a small patch on a large object like a plane can hide it from artificial intelligence systems trained to spot objects in drone footage. The technology could help conceal military assets from drone surveillance, say Ajaya Adhikari and Richard den Hollander at the Netherlands Organisation for Applied Scientific Research.

They and their colleagues used an AI that generates a pattern to confuse a drone surveillance system called the YOLO object detector, which spots military objects in aerial images.

The researchers overlaid several patterns of different sizes on aerial photographs, and found that a certain pattern that looks a bit like colourful tie-dye prevented the object detector from spotting jet fighters in these images.

The most effective one was about 10 times smaller than the plane, and it worked best when placed atop the aircraft in the image rather than beside it. This size patch reduced the accuracy of the YOLO detector from 94 to 38 per cent (arxiv.org/abs/2008.13671).

Sticking a patch like this onto an object in real life could conceal it from surveillance, say the researchers. "We believe this technology will be applicable in other security domains where adversaries have an interest in concealing objects in images," say Adhikari and Hollander. For instance, similar technology developed last year conceals faces from surveillance cameras.

"The most effective confusing pattern was about 10 times smaller than the plane"

The researchers are also studying defences against such patches. "The detection of objects on the ground and the use of camouflage to prevent detection are in a continuous competition," they say. ▮

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