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Astronomy

The most distant black hole ever seen

Supermassive black hole 31 billion light years away could help settle an early cosmic mystery

Leah Crane

ASTRONOMERS have found the most distant black hole ever confirmed, at more than 31 billion light years from Earth. This object and others like it could finally settle the question of how supermassive black holes got so enormous so quickly in the early universe.

Priyamvada Natarajan at Yale University and her colleagues spotted the galaxy UHZ-1 in data from the James Webb Space Telescope (JWST). They then pointed the Chandra X-ray Observatory in the same direction to confirm the presence of a supermassive black hole at the centre of the galaxy.

"Many distant black holes are being detected and claimed with James Webb data, but the special thing with this one is to really confirm and pin it down," says Natarajan. "X-ray has always been the way we know for sure that we have a black hole – it's dead cert, no ambiguity." No other black hole this distant has ever been confirmed with X-rays before.

The extreme distance to UHZ-1 means we are observing it as it was about 470 million years after the big bang, when the universe was only about 3 per cent of its current age. The observations indicate that the black hole probably has a mass between 10 million and 100 million times that of the sun (*Nature Astronomy*, doi.org/k4nj; *The Astrophysical Journal Letters*, doi.org/k4nk).

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The combination of an early formation time and a huge mass makes this black hole particularly challenging to explain using traditional models of the formation of supermassive black holes. If it began as a star, which collapsed in on itself to become a black hole, it is hard to imagine how it could have got so massive in such a short period of time – even if the star was a particularly colossal one.

In recent decades, another possible formation mechanism has emerged: if enough gas flowed into the centre of a galaxy and then collapsed directly into a black hole, you could create a much heavier "seed" for a supermassive black hole to grow from. These heavy seeds could reach hundreds of thousands of solar masses, whereas the lighter seeds formed from stars couldn't get heavier than about 100 solar masses.

This black hole is one of the strongest pieces of evidence yet for the direct collapse model and the existence of heavy black hole seeds. "If it starts from a seed of roughly 10,000 solar masses, then we can reach the mass that we see in UHZ-1 very comfortably, with no extra constraints or caveats," says Natarajan. "This satisfies all of the requirements for being a heavy seed."

But satisfying all of the requirements doesn't make it a certainty, says Fabio Pacucci at the Harvard-Smithsonian Center for Astrophysics in Massachusetts. "If this is at 100 million solar masses, it's pretty big, but if it's at 10 million solar masses, it's not that big, so it could have possibly formed from a lighter seed," he says. "Everything hinges on finding more of these objects, possibly more massive, possibly at even higher distances, to really understand how the first population of black holes formed."

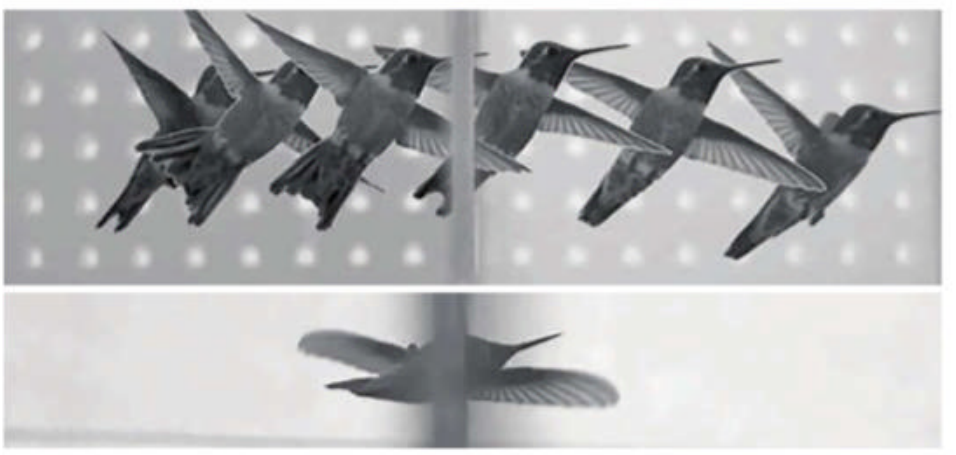
The good news is that JWST is uniquely equipped to find these black holes, and Chandra to confirm them, so those discoveries are likely to happen relatively soon, says Pacucci. ▮

Zoology

Hummingbirds have two ways to fly through tiny gaps

HIGH-speed cameras have revealed how hummingbirds fit through tiny gaps, which happens too quickly for the human eye to properly see.

Hummingbirds feed on nectar and often fly through small gaps in cluttered foliage as they flit from flower to flower. When one of the birds does this, "it looks like it literally just teleported", says Marc Badger at the University of California, Berkeley. To investigate how it happens, he and his colleagues filmed at 500 frames a second as Anna's hummingbirds (*Calypte anna*) passed through a gap between two compartments, and tracked the position of each bird's bill and wing tips. The hummingbirds' wingspans were about 12 centimetres and the gap could be shrunk to just 6 cm wide.



MARC BADGER

Shown from the side and below, one way hummingbirds navigate small gaps is to fly sideways

The birds used two strategies. One was to approach the gap slowly, hover near and then travel through sideways. The other was to approach quickly, fold their wings back and shoot through like a spear, before opening their wings again (*Journal of Experimental Biology*, doi.org/k4wf).

The slower strategy tended to give way to the speedier approach as the birds became more familiar with the set-up. But a 6-cm aperture forced them to use the braver strategy immediately. Badger thinks the birds risk injury by hitting the edges of the hole with their wings while going sideways. With wings tucked in, this danger is reduced, so there is an incentive to use the faster technique if possible.

"Their amazing wings make them good at hovering and good at flying fast, but that means they have to cope in tight situations," says Christopher J. Clark at the University of California, Riverside. "The manoeuvres these birds do to navigate through tight spaces put them in a class of their own." ▮

Matthew Sparkes