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WEEKLY 4 October 2025

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Space

Our black hole is windy, after all

First predicted in the 1970s, we may now have proof of wind coming from Sagittarius A*

Alex Wilkins

WE HAVE found hot wind blasting out from our galaxy's supermassive black hole for the first time, which could help explain its mysterious inactivity.

Compared with many other supermassive black holes that lie at the centres of galaxies, our black hole, called Sagittarius A* or Sgr A*, is relatively quiet. It doesn't shoot out vast, powerful jets like black holes in many other galaxies do, which are so bright we can spot them even in the earliest moments of the universe. But all supermassive black holes, including Sgr A*, are thought to produce winds – wafts of hot gas blasted out from near the black hole's event horizon, where gas is swirling and violently heating up.

These winds, however, have never been conclusively detected in Sgr A*, despite being predicted since the 1970s. This is partly because it is so difficult to observe the region around our galaxy's black hole, a tightly packed melange of stars, dust and gas called the circumnuclear disc (CND).

Now, Mark Gorski and Elena Murchikova at Northwestern University in Illinois have measured the innermost region of the CND in far greater detail than before using the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile. They found large regions of cold gas they didn't expect to be there, as well as a clear cone of hot gas cutting through it, which appears to be the missing wind (arXiv, doi.org/p69g).

Finding so much cold gas around the black hole at this distance was unexpected, says Gorski. The conventional wisdom was there was no point looking for it, as it probably didn't exist, he says. "When I presented this image to [my colleague], I said, 'Well, we have to focus on this now, because it has been such a problem for over 50 years'."

Gorski and Murchikova took five years of observations of the innermost part of the CND from ALMA and produced a map of cold gas within a few light years of Sgr A* that was 100 times sharper than previous observations. They achieved this by simulating how the bright light from Sgr A* flickered, and then subtracting it from the dim light of the cold gas.

> "Measuring this wind could help us understand why Sagittarius A* is relatively inactive"

From this, they could see a clear cone in which there was barely any cold gas. When they laid X-ray data – emissions produced by hot gas – overtop they found the two regions matched almost perfectly. They calculated the total energy needed to blow hot gas through this cone is equivalent to about 25,000 suns, meaning it can't have been produced from nearby stars, and there are no obvious supernovas that might have generated the hot gas either. This suggests the wind is coming from Sgr A* itself.

Measuring this wind could help explain why Sgr A* is relatively inactive and help us better understand black hole evolution.

If the results are confirmed, it could tell us more about the black hole itself, says Ziri Younsi at University College London, such as its direction of spin. ▮

For more on black holes, see p28

Environment

Climate change is making trees in the Amazon grow larger

THE average size of trees in the Amazon rainforest has been steadily increasing as carbon dioxide levels have risen, meaning these larger trees play a more important role in maintaining the forest as a carbon sink.

How forests will react to a changing climate is an open question. One hypothesis is that larger trees will decrease in abundance because they are more susceptible to climate-linked phenomena such as drought. Understanding this is crucial for future climate models because forests take up huge amounts of CO_2 from the atmosphere.

Adriane Esquivel-Muelbert at the University of Cambridge and her colleagues at the RAINFOR Amazon Forest Inventory Network have been measuring the diameter of trees in 188 plots with an average area of 12,000 square metres across the Amazon basin. The monitoring periods varied, but some were as long as 30 years. During that time, CO_2 concentrations in the atmosphere rose by nearly a fifth.

They found that, on average, trees have increased in diameter by about 3.3 per cent each decade (*Nature Plants*, doi.org/p69c).

Team member Rebecca Banbury Morgan at the University of Bristol, UK, says the structure of the Amazon rainforest is changing consistently across the whole basin. "We have more bigger trees and fewer smaller trees, so the average size has shifted up towards those bigger trees."

Normally the average diameter of trees in an area of undisturbed old-growth forest would stay roughly the same, she says, as saplings take the place of fallen big trees and grow. The researchers think the Amazon trees are responding to the increase in atmospheric CO_2 by growing more and accumulating more biomass.

PAULINE KINDLER

Measuring the diameter of a tree can tell us how much it has grown

This means the big trees are disproportionately important to the amount of carbon the forest can hold, and the consequences of losing them would be greater, says Esquivel-Muelbert.

"The important finding is that CO_2 has been acting as a fertiliser, increasing tree growth, and in many ways that is reassuring, because wood is a globally significant carbon sink," says Peter Etchells at Durham University, UK. "However, will this continue to be the case as the climate continues to change, potentially shifting the balance between growth, nutrients, temperature and CO_2?" ▮

Chris Simms