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Astrophysics

Dark energy may have been hiding in the cores of black holes all along

Alex Wilkins

MASSIVE black holes could be the source of dark energy and the accelerating expansion of the universe, according to observations of ancient, dormant galaxies with black holes at their centre.

The laws of physics suggest that gravity should cause the universe to contract, but a mysterious force, which physicists call dark energy, seems to be counteracting this and making the universe expand at an accelerating rate.

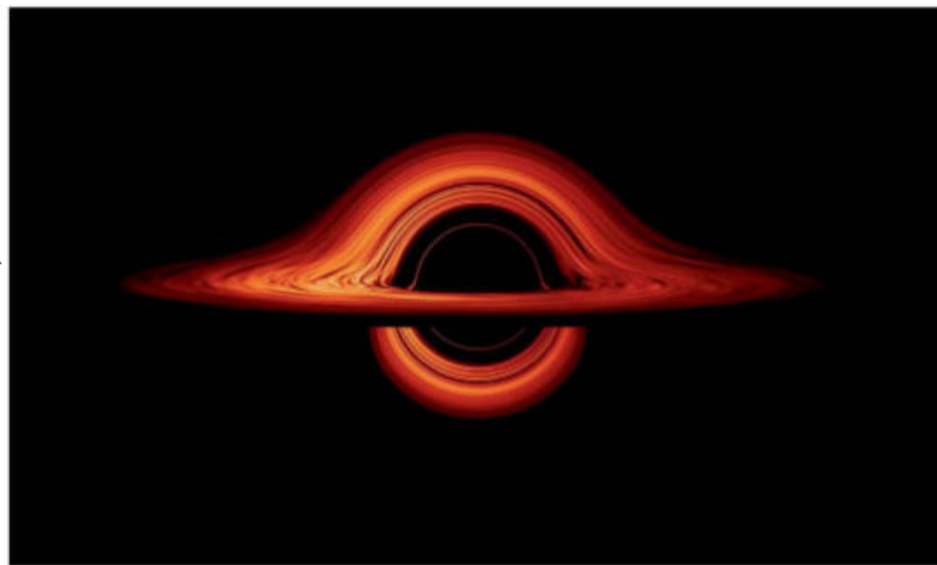
One possible explanation is that the source of this dark energy is black holes, but there hasn't been good experimental evidence to support this idea.

Chris Pearson at the Rutherford Appleton Laboratory in Harwell, UK, and his colleagues compared groups of galaxies with black holes at their centre: a young, distant group and a closer, older group that have stopped growing. They calculated that the black holes grew in mass by seven to 20 times, which can't be fully explained by the absorption of stellar material or mergers with other galaxies.

Instead, Pearson and his team

tried to account for the growth by proposing that it is related to the universe's accelerating expansion. "When we model that into what we see, we can actually explain the observations," says Pearson. "We can see that, in addition to these astrophysical processes for black hole growth, we can explain away this discrepancy in the mass growth by adding in the fact that they may contain

Simulation of a black hole, showing light distorted by its gravity



dark energy and they're coupled to the expansion of the universe."

The model they used involved an interpretation of Albert Einstein's general theory of relativity that says that black holes contain vacuum energy, a kind of energy that exists in space everywhere due to quantum particles popping in and out of existence (*The Astrophysical Journal*, doi.org/grsgnk).

"When we did the sums, we found that these black holes might actually be able to explain the entirety of what's required

to balance the universe with this dark energy," says Pearson.

If black holes really are the source of dark energy, it would also solve another outstanding cosmic conundrum: what happens at the centre of black holes – so-called singularities – where the laws of physics break down. Black holes with cores of dark energy avoid the need for singularities, but there weren't any easy ways to test this. "These have just been theories until now. Now, you've got the observational evidence that supports black holes having dark energy cores," says Pearson.

It is a solid and reasonable explanation of the observations, says Andy Taylor at the University of Edinburgh, UK, but the interpretation of Einstein's general theory of relativity it uses to explain the black hole growth hasn't been widely studied. "There's some nice discussion there, but we have to be cautious [because] it's not built on well-established theoretical principles, it's built on more speculative models." ■

Technology

Fully autonomous F-16 fighter jet takes part in dogfights

AN ARTIFICIAL intelligence has controlled a US F-16 fighter jet in fights against other aircraft in tests.

The series of AI-powered flights took place in December 2022, but have only just been revealed by the Defense Advanced Research Projects Agency (DARPA), the research and development branch of the US Department of Defense.

DARPA had already tested AI control of jets on a simulator as

part of its Air Combat Evolution programme. That research has now progressed to using a modified F-16 fighter jet. This jet, known as the X-62A, flew from the Air Force Test Pilot School at Edwards Air Force Base, California, several times during a single week.

A few AI algorithms were tested, attempting take-offs, landings and using simulated weapons in aerial battles. A human pilot was on board in case of emergency.

Autonomous military aircraft are being researched by countries around the world because they can be used in dangerous situations

without risk to human life – at least on the aggressor's side – and can operate at g-forces that would incapacitate or kill a human pilot.

Notable as the achievement might be, Kenneth Payne at King's College London says the tests aren't that important in the overall progress of autonomous vehicles.

"There's relatively not a lot of complexity. In some respects, dare one say, it's easier as a challenge

"In some respects, dare one say, it's easier as a challenge than autonomous cars"

than autonomous cars," says Payne. With cars, you are in a complex environment, especially in a city with narrow streets and lots of humans around, he says. "A lot of these problems are stripped back in aerial combat."

Having AIs control combat also raises ethical issues about whether an algorithm can make the right decisions in complex, high-stakes scenarios, says Payne. But given that many countries are working on such technology, AI warplanes are likely to be developed and used anyway, he says. ■
Matthew Sparkes