Horizon
The EU Research & Innovation Magazine

European Commission

Scientists hunt dark matter ‘stars’ that mimic black holes

Hypothetical dark matter stars known as ‘boson stars’ could leave telltale ripples across the cosmos, offering researchers a new way to probe the invisible forces shaping the universe.

12 February 2026 - By JONATHAN O’CALLAGHAN

In 2019, a strange event was observed in the depths of space. Called GW190521, the event sent out gravitational waves – invisible ripples in the universe – that were picked up on Earth. These waves appeared to mark the moment when two massive black holes, dozens of times the mass of our Sun, collided and merged. Or at least, that was the initial theory.

But what if there was another explanation? Physicist Carlos Herdeiro from the University of Aveiro in Portugal is leading an EU-funded research initiative called NewFunFiCO that is investigating the alternatives.

The NewFunFiCO team brings together physicists and astrophysicists from Spain, Portugal, Italy, Germany, Mexico, Brazil and China. Their goal is to explore whether some gravitational-wave signals could come from exotic objects in space that are theorised to exist, but have not yet been directly observed.

“The borderline mysteries of the universe are fascinating,” said Herdeiro. “And gravitational waves give us a new way to explore them.”

Listening to ripples in space-time

The team uses real data from the LIGO-Virgo-KAGRA network – a global system of ultra-sensitive detectors in the US, Italy and Japan that can measure incredibly tiny distortions in space-time. In Einstein’s theory, space and time form a connected fabric that underpins our perception of where and when everything happens.

Since gravitational waves were first detected in 2015, scientists have identified more than 150 merging black hole pairs. But their theory is that there might be other more exotic objects hiding in the data.

The most recent observation campaign, known as O4, ran from May 2023 to November 2025 and detected around 250 candidate events, many of which are still under analysis.

“We are still looking carefully at the data,” said Nico Sanchis-Gual from the University of Valencia, a co-lead on the project. “There may be signals that don’t quite fit what we expect from black holes.”

The boson star theory

Among the most intriguing candidates under investigation are boson stars – hypothetical ultra-compact objects that could look like black holes from afar. However, they do not have an event horizon, the boundary of a black hole from which nothing, not even light, can escape. From the outside they would look somewhat fuzzy, but inside they would be full of dark matter particles.

Boson stars might be made up of ultralight dark matter, possibly of invisible subatomic particles called axions that would be trillions upon trillions of times lighter than an electron.

Studying the possibility of having an object the size of a planet, with a mass similar to the Sun, but very different inside, has fascinated researchers. “It’s mind-blowing,” said Sanchis-Gual.

If they do exist, then it is possible they might occasionally collide and merge together, like we know star-sized black holes do, producing detectable gravitational waves. That’s where the NewFunFiCO team comes in, trying to look for the signal we would expect from such an event in LIGO’s data.

GW190521 might have been an example of such an event. “Were two of them to collide, they would produce a gravitational wave signal that fits that particular signal slightly better than two black holes,” Herdeiro said.

Clues to dark matter

It is not just boson stars the researchers are looking for. There are also mixed stars. For example, where a neutron star – the dense object left behind after a star explodes – has a dark matter core, and also gravastars, exotic objects that mimic black holes, but do not have the same structure at their centre and no event horizon.

“The goal is to take advantage of the golden era of gravitational wave observations we live in, and search for objects that have never been seen before but which theoretically could exist,” said Herdeiro.

“These exotic objects relate to some of the deep mysteries in physics, such as dark matter.”

If correct, the scientists’ findings could transform our understanding of dark matter and the universe as a whole. Even if not, it opens up exciting new avenues of physics that have not been widely explored before, and could be a way to uncover strange new phenomena in the cosmos.

On the hunt

NewFunFiCO runs until the end of 2026, having started in 2023 with funding provided by the EU’s Marie Skłodowska-Curie Actions programme.

“One of the key aspects here is that we involve European partners with non-European partners,” said Herdeiro. That means exchanging knowledge but also culture. “This is why EU funding has been so important. It gives a different dimension to the world.”

The benefits of such ambitious programmes spill over to the general public too, Herdeiro added. “Black holes, cosmology, the beginning of the universe, they capture people’s imagination,” he said.

Other benefits are economic. “Large experimental infrastructures have spin-offs that people are not aware of,” he said, giving the example of how LIGO required extremely precise detectors, which has led to developments in broader electronics.

The quest to measure tiny distortions in space-time has pushed laser interferometry (measuring minuscule changes in distance with laser light), sophisticated vibration isolation systems and ultra-precise optics to unprecedented levels of sensitivity.

Similar technologies are now used in areas such as precision manufacturing, medical imaging and navigation systems.

The biggest takeaway, however, is that there may be strange objects in the universe on the cusp of discovery, hidden clumps of dark matter masquerading as stars.

“The main vision right now is that there’s some dark matter particle,” said Sanchis-Gual. “So this is a possibility.”

If even one such object is confirmed, it would give physicists one of their first real clues as to what dark matter is – and change how we see the universe.

Research in this article was funded by the Marie Sk?odowska-Curie Actions (MSCA) programme. The views of the interviewees don’t necessarily reflect those of the European Commission. If you liked this article, please consider sharing it on social media.

More info

- NewFunFiCO (CORDIS)
- NewFunFiCO project website
- EU Space research
- The Event Horizon Telescope