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Astronomy

Closest black hole to Earth could be visible in the skies of nearby planets

Jonathan O'Callaghan

THE closest known black hole may have been found a cosmic stone's throw from Earth, just 1500 light years away. Called Gaia BH1, it is estimated to be about 10 times the mass of our sun.

Although it can't be seen directly because it emits no light, data from the European Space Agency's Gaia space telescope revealed the gravitational tug the black hole exerts on its orbiting companion star, which is similar in age and mass to our own sun.

Several candidates for nearby black holes have been found before, but most haven't stood up to scrutiny. However, Kareem El-Badry at the Harvard-Smithsonian Center for Astrophysics in Massachusetts and his colleagues say their discovery is the best candidate yet for such an object (arxiv.org/abs/2209.06833).

"This one is solid," says team member Tsvei Mazeh at Tel Aviv University in Israel.

PANSTARRS/EL-BADRY ET AL

Gaia BH1 is invisible but located at the centre of this image

"I'm ready to bet my life on it."

Many black holes have been discovered before, such as merging black holes seen by the gravitational waves they produce, and others eating stars in binary systems, making them shine brightly in X-rays. Astronomers using the Event Horizon Telescope have also directly imaged two of these cosmic behemoths.

Dormant black holes like Gaia BH1 have been harder to find, due to their near invisibility. "These black holes are far from any source of food," says Lukasz Wyrzykowski at the University of Warsaw in Poland – Gaia BH1's star orbits the black hole at about the same distance Earth orbits the sun.

It isn't clear how this system formed. One possibility is that the black hole was originally a much more massive star that expanded into a red supergiant and then collapsed, perhaps with an accompanying supernova, although it is unlikely that its companion star would have survived. Another scenario is that the black hole could actually be two black holes, making this originally a triple-star system. Alternatively, the companion star could have been captured by the black hole when passing.

El-Badry hopes to find out with observations using other telescopes, looking for evidence of a binary black hole or even planets orbiting the star, which could suggest a lack of an explosive event. "It could definitely have planets," he says. "If you lived on a planet around the star, the black hole would be as bright as Jupiter", as it eats a small amount of the star's solar wind, he says.

In a few billion years, the black hole's companion star is expected to expand into a red giant, like our sun, which will massively increase the fuel going into the black hole and make it far brighter in any nearby planet's sky. "One hundred thousand times brighter than the sun," says El-Badry.

1500
Distance to the black hole from Earth, in light years

Gaia should find dozens more of these dormant black holes in our galaxy, of which there could be tens of thousands. Systems like Gaia BH1 would be prime targets for learning more about black holes. "We don't normally get chances to study these extremes of physics," says Wyrzykowski.

Environment

Urban trees are threatened by climate change

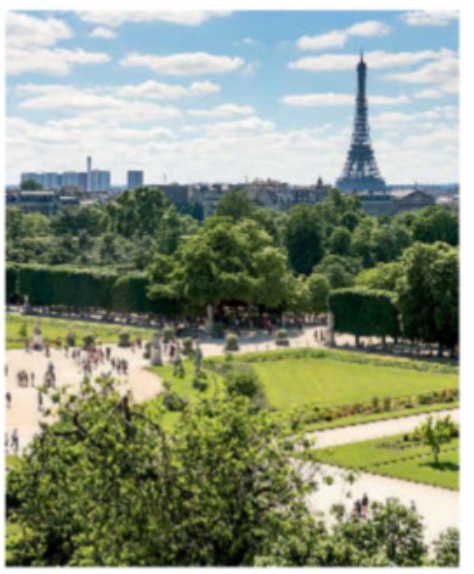
CITIES around the world may need to start planting different types of trees and shrubs that can tolerate warmer and drier conditions. By 2050, about three-quarters of the species currently grown in urban environments will be at risk as a result of climate change, a study has found.

"By 'at risk', we mean these species might be experiencing stressful climatic conditions," says Manuel Esperon-Rodriguez at Western Sydney University in Australia. "Those trees are likely to die."

City trees have many benefits, from making urban spaces look beautiful and providing a refuge for wildlife to keeping places up to 12°C cooler than they would otherwise be in summer. Losing tree cover would lead to cities becoming even hotter as the planet heats up.

To assess the threat, Esperon-Rodriguez and his colleagues used a database called the Global Urban Tree Inventory to work out the conditions required by 3100 tree and shrub species currently grown in 164 cities worldwide. The researchers then looked at how these conditions would be affected by climate change under a medium-emissions scenario known as RCP6.0.

By 2050, 76 per cent of these species will be at risk from rising average temperatures and 70 per cent from decreasing rainfall, the team concludes (*Nature Climate Change*, doi.org/jcz9).



SHUTTERSTOCK/LENA IVANOVA

The Tuileries Garden in Paris is being restored with a wide variety of tree species

The study doesn't take account of continued urban growth, which could warm cities even faster. Nor does it take account of greater weather extremes caused by climate change, or the effects of pests and diseases. Warmer conditions are allowing more pests, such as bark beetles, to survive winters as well as to reproduce faster in summer, greatly increasing their impact. "Our estimates are conservative," says Esperon-Rodriguez.

There are some things that can be done to help trees survive. The best strategy is to choose resilient species when replacing trees or planting new ones, the team concludes.

Michael Le Page

Physics

Einstein's gravity principle holds up after the most precise test yet

Karmela Padavic-Callaghan

THE most precise test yet of one of Albert Einstein's ideas about gravity has once again shown he was right. Physicists may need experiments that are even more accurate to figure out where his general theory of relativity breaks down and potential new forces and phenomena kick in.

"General relativity is a very good theory that works very well, but it doesn't explain all the observations in our universe," says Manuel Rodrigues at the French aerospace lab ONERA. Physicists have long looked for violations in general relativity that hint at phenomena missing from Einstein's theory, such as dark matter, and that could lead to a theory of gravity that includes quantum effects.

One area of focus is a pillar of general relativity called the weak equivalence principle. It states that all objects, regardless of their shape or material, fall with the same acceleration when gravity is the only force acting on them. It has been tested many times and has always held up.

Rodrigues and his colleagues launched a small satellite into space to test it with greater accuracy. On board were two devices known as electrostatic accelerometers that measure how objects experience gravity. Inside each device was a pair of nested cylinders. One device contained cylinders made of the same material and the other held cylinders of different materials. The weak equivalence principle says gravity should act the same on both regardless of these differences. However, if for some reason it didn't, the electrostatic accelerometers would pick it up.

A satellite experiment tested part of general relativity for 2.5 years

CNES

The experiment orbited 710 kilometres above Earth for two-and-a-half years, and didn't spot any gravitational differences. The set-up was sensitive enough to detect changes as small as a hundredth of a trillionth of a per cent, making it the most precise measurement of the weak equivalence principle ever carried out (*Physical Review Letters*, doi.org/jcpw).

Rodrigues says that the new measurement is 100 times more precise than previous tests, most of which were on Earth.

Philippe Bouyer at the French National Centre for Scientific Research says it will help justify future tests of fundamental physics theories in space. The project involved controlling a satellite extremely precisely and developing analysis techniques that account for even the smallest disturbances, such as friction between the satellite and space dust. It could become a foundation for future satellite-based experiments that are 10 or 100 times more precise, he says. He and his collaborators are planning such a mission that would use a quantum device instead of an electrostatic accelerometer.

Physicists will continue looking for violations of the equivalence principle, says Eric Adelberger at the University of Washington in Seattle. "There's more to physics than we understand, that's pretty clear. And this is a pretty likely place to look [for something new]." ▮

Medicine

Drug derived from tree sap could treat chronic wounds

AN antimicrobial drug derived from the sap of an Australian tree has shown promise for treating chronic wounds in animal tests.

Chronic wounds are common in people with diabetes, because poor circulation and other symptoms slow down healing. Such wounds are painful and have a high risk of infection.

Doctors increasingly want to curb the use of antibiotics in order to minimise the evolution of antibiotic-resistant bacteria. To look for alternatives, David Thomas at Cardiff University in the UK and his colleagues investigated compounds derived from the sap of the blushwood tree (*Fontainea picrosperma*), which grows in Australia.

They tested a gel containing a promising compound called EBC-1013 in two animals: mice used to model diabetes, with chronic wounds, and dairy calves. All dairy calves have their horns taken off, so the researchers applied the treatment to this wound.

In the calves treated with EBC-1013, 75 per cent of the wounds healed after 28 days, compared with just 25 per cent of untreated wounds. In the mice, complete wound healing was observed in five of the seven animals studied, whereas none of the seven wounds healed in the control group (*Science Translational Medicine*, doi.org/gqtds7).

Bacteria in chronic wounds are more likely to form a sticky mesh called a biofilm. These aggregations are resistant to antibiotics, making such wounds difficult to treat. The new drug appears to disrupt the structure of biofilms and induce the production of inflammatory cells and proteins that promote healing.

"The next challenge will be to show that these preclinical findings translate into the clinic"

"The next challenge will be to show that these preclinical findings translate into the clinic and that they can be developed into a safe and cost-effective treatment for chronic, non-healing wounds," says Matthew Hardman at the University of Hull, UK. ▮

Jason Arunn Murugesu