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Physics

A sea of gravitational waves?

We have found hints that the whole cosmos may be awash with strange ripples

Leah Crane

EVERYTHING in the universe is constantly being stretched and squeezed by disturbances in space-time that are caused by the movements of massive objects.

Now, astronomers may have caught the first glimpse of this sea of gravitational waves permeating the entire cosmos, known as the gravitational wave background.

It is the result of work by the North American Nanohertz Observatory for Gravitational Waves (NANOGrav) consortium, which used a so-called pulsar timing array to attempt to build a sort of map of gravitational waves.

The NANOGrav researchers analysed data gathered on 45 pulsars over the course of 13 years and found a gravitational wave signal that was identical across multiple pulsars. This strange, low-frequency hum could be the first evidence of the gravitational wave background.

Pulsars are neutron stars that rotate extremely rapidly and regularly, sending out beams of light that act as "ticks" in extremely precise cosmic clocks.

When a gravitational wave passes through the same region of space-time as those beams of light are travelling through, it makes the light appear to take slightly more or less time to reach us, meaning the "ticks" from a pulsar seem irregular. Using pulsar timing arrays requires radio telescopes to observe the signals from many pulsars simultaneously.

"These pulsars are spinning with millisecond periods and we are able to detect changes in the time of arrival [of signals]… at the hundreds of nanosecond level," said Joe Simon at the University of Colorado, Boulder. He presented the new work at a virtual meeting of the American Astronomical Society on 11 January.

"We are seeing incredibly significant evidence for this signal," said Simon.

However, to prove that this is coming from the gravitational wave background, we would need to see a distinctive pattern in the gravitational waves affecting each pulsar. Gathering the additional data necessary to find that pattern should only take about a year, Simon said, although analysing it may take longer.

"This will tell us more about black holes in the universe, especially supermassive ones in galactic centres"

If the signal is in fact the gravitational wave background, it will be a useful tool for understanding the most massive objects in the universe.

"This will tell us more about black holes in the universe, and especially the supermassive black holes in galactic centres," says Nelson Christensen, who is at the Observatory of Nice in France. "This NANOGrav signal is likely from [black hole] binaries with billions of solar masses," he says. As these enormous pairs of black holes merge, they emit thrums of gravitational waves powerful enough to persist throughout space-time.

The latest research will build a bridge between the gravitational waves we have already spotted coming from smaller black holes with the Laser Interferometer Gravitational-Wave Observatory (LIGO) and Virgo detectors, and those from supermassive black holes, says Christensen.

Such a bridge will help us understand how different types of black holes form, how galaxies evolve with the black holes within them, and maybe even to comprehend the larger mysterious forces at work in our universe like dark matter and dark energy. ▮

Machine learning

AI dog-trainer could teach your pooch how to sit

ARTIFICIAL intelligence could train your dog for you while you are out at work. A prototype device can issue basic commands to your pet, recognise if they are carried out and provide a treat if they are.

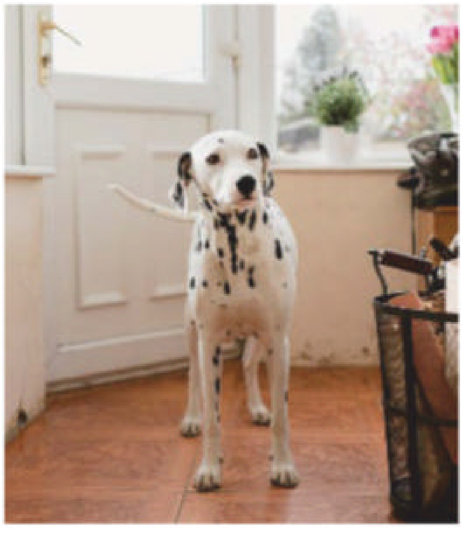
Jason Stock and Tom Cavey at Colorado State University used more than 20,000 images showing a range of breeds to train an AI to identify when dogs were sitting, standing or lying down.

The AI is a convolutional neural network – a type of algorithm often used in image processing that can break down pictures into smaller component parts to help it classify what is shown. Overall, the algorithm managed to achieve 92 per cent accuracy.

The AI was then combined with a moveable camera, a speaker for issuing instructions and a dog treat delivery tube to create an automated trainer (arXiv, arxiv.org/abs/2101.02380).

How the system did in telling a prone dog from a standing one varied depending on what part of the image it looked at. "If the AI was looking at the legs, for instance, it would do better, as opposed to looking at the shape of the back or some other feature," says Cavey.

Cavey says his motivation for the project came from finding it hard to keep his hyperactive Australian shepherd dog entertained while he was out at work.



SOLSTOCK/GETTY IMAGES

Dogs could be given treats for obedience by an AI when left at home

"It is a step forward and an exciting area," says Ilyena Hirskyj-Douglas at Aalto University, Finland, who has a PhD in dog-computer interaction. "Yet it is also ethically precarious as computers are not able to recognise the welfare of dogs as effectively as humans."

Dirk van der Linden at Northumbria University in the UK also praises the tech while having some qualms about it. "It's the automating of the human-dog relationship that I think is increasingly problematic, because it is using a technological fix for a very valuable interspecies relationship that caregivers ought to keep working on," he says.

That is something Cavey is aware of. "Our future work would be to look and see what is a good emotional state, rather than good behaviour," he says. ▮

Chris Stokel-Walker