

New Scientist

WEEKLY May 22-28, 2021

**THE EARLIEST
BLACK HOLES**

WHAT EXACTLY IS A
CHEMICAL BOND?

**NEW HOPE FOR
LIFE ON EUROPA**

CUBA'S HOME-GROWN
COVID-19 JAB



MOVE YOUR MIND

How the way you exercise
changes how you think

SHARING THE VACCINES

The path to a fair and global solution

**PLUS HAS SCI-FI GOT TOO BLEAK? / NEGATIVE-CALORIE FOOD /
SPOTTING PARKINSON'S IN THE NOSE / RECTAL BREATHING**

Science and technology news www.newscientist.com

No3335 US\$6.99 CAN\$9.99



Physics

Searching for the earliest black holes

Some black holes may have formed just after the big bang – have we detected them?

Leah Crane

WE MAY have already seen black holes from the dawn of the universe, known as primordial black holes. The Laser Interferometer Gravitational-Wave Observatory (LIGO) in the US and the Virgo observatory in Italy have detected 47 pairs of black holes slamming into one another, and a statistical study suggests that nearly one-third of them may be primordial.

Black holes are thought to form via several mechanisms. The main way is by a huge star collapsing in on itself, forming what is called an astrophysical black hole. Some black holes are too large to have formed that way, so they probably come from the mergers of smaller black holes. And primordial black holes may have formed in the early universe from dense clouds of plasma, but as yet we have no direct evidence for their existence.

“When we get a black hole observation from LIGO, it does not come with a label that tells us how it was formed, it just comes with a mass and a spin,” says Salvatore Vitale at the Massachusetts Institute of Technology. Vitale

and his colleagues have done a statistical analysis of data from LIGO and Virgo that was informed by data from three leading models for the formation of astrophysical black holes, as well as a model of primordial black hole formation.

Their analysis concluded that the observatories have collected so much gravitational wave data that all of the formation models are likely to be correct. This includes the idea that some observations are from primordial black holes (arxiv.org/abs/2105.03349).

“Typically in this kind of analysis, you’re punished because of Occam’s razor for making things more complex and adding more models,” says Nelson Christensen at the Nice Observatory in France. “So the fact that they added primordial black holes and that had the highest probability is interesting.”

The analysis suggests that about 27 per cent of the LIGO and Virgo black holes could be primordial. “When I started this, I was expecting we would not find any significant level of support for primordial black holes,”

says Vitale. “I got surprised.”

However, because this result relies on theoretical models, it isn’t proof that primordial black holes exist. Those models are the best we have right now, but they aren’t guaranteed to be correct.

“The result is not definitive: it is not a ‘hard proof’, it is more of a change in our expectations in light of the new data,” says Francesca Vidotto at the

One of LIGO’s gravitational wave observatories is in Livingston, Louisiana



CALTECH/MIT/LIGO LAB

University of Western Ontario in Canada. “But such a change is important.” It could lead astrophysicists and cosmologists to build more sophisticated models for black hole formation, both for astrophysical and primordial black holes, she says.

If some of these black holes are primordial, they could be a crucial window into our early universe and may even make up part of the mysterious dark matter that holds galaxies together. But either way, this result is a hint that our understanding of black holes is incomplete. “Even if these are only astrophysical black holes, there’s clearly something involved in their formation beyond what has been assumed so far,” says Jane MacGibbon at the University of North Florida.

The next step is to build better models and get more data from LIGO and Virgo. The observatories, along with the Kamioka Gravitational Wave Detector in Japan, are expected to turn on again in 2022. “We need more [data], and we will get more,” says Christensen. ■

Internet culture

Emoji meanings may morph as time goes by

THE meaning of emojis can change depending on the context in which they are used and when they have been posted, according to the first study of their use over time.

Alexander Robertson at the University of Edinburgh, UK, and his colleagues tracked how emojis were used on Twitter between 2012 and 2018. They checked 1.7 billion tweets to see if they contained an emoji, with duplicate content and

non-English tweets filtered out. They analysed them with models that recognise the semantics of how words are used based on others around them. This allowed them to attribute meanings to emojis and note changes to those meanings.

“We found patterns we would also find in words,” says Robertson. Just as words change meaning through usage, so do emojis. “You have seasonality in emojis,” he says. For instance, the maple leaf emoji was most used in exchanges about autumn during those months, while for the rest of the year it became a substitute for mentions of cannabis.

The four emojis that changed meaning most over the study period were fingers pointing left, right and down, and a fist bump. For example, the fist bump changed from signifying a willingness to fight to expressing support for movements such as Black Lives Matter (arxiv.org/abs/2105.00846).

Effie Le Moignan at Newcastle University, UK, says the work is a valuable contribution, but that the

“Language use online is flexible and evolving. ‘Tea’ has changed to mean gossip in online vernacular”

findings have limitations. She says this doesn’t generalise beyond Twitter, and says social media and linguistic experts could help parse the data in more detail.

“If you map to closest words, the pairings may remain matched, but language use online is also flexible and evolving,” she says. For example, “tea” has evolved to mean gossip in online vernacular. Seeing a word next to an emoji “does not guarantee in the weird world of the internet the meaning didn’t alter over the time you collected data”, she says. ■

Chris Stokel-Walker