# Astronomers may have found black holes that formed soon after big bang

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By **Leah Crane**

**When two black holes collide, the event can release gravitational waves**
MARK GARLICK/SCIENCE PHOTO LIBRARY

We may have already seen black holes from the dawn of the universe, called 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 can form through several different 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 directly, 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 performed a statistical analysis of the data from LIGO and Virgo that was informed by data from three of the leading formation models for astrophysical black holes, as well as a model of primordial black holes.

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 of the data comes from primordial black holes.

“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 suggested that about 27 per cent of the LIGO and Virgo black holes could be primordial. “When I started this, I was expecting that we would not find any significant level of support for primordial black holes, and instead I got surprised,” says Vitale.

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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 University of the Basque Country in Spain. “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’ll potentially be getting a new binary black

hole every day for 18 months," says Christensen. "We need more, and we will get more."

Read more: https://www.newscientist.com/article/2277681-astronomers-may-have-found-black-holes-that-formed-soon-after-big-bang/#ixzz6v0TlnCdK