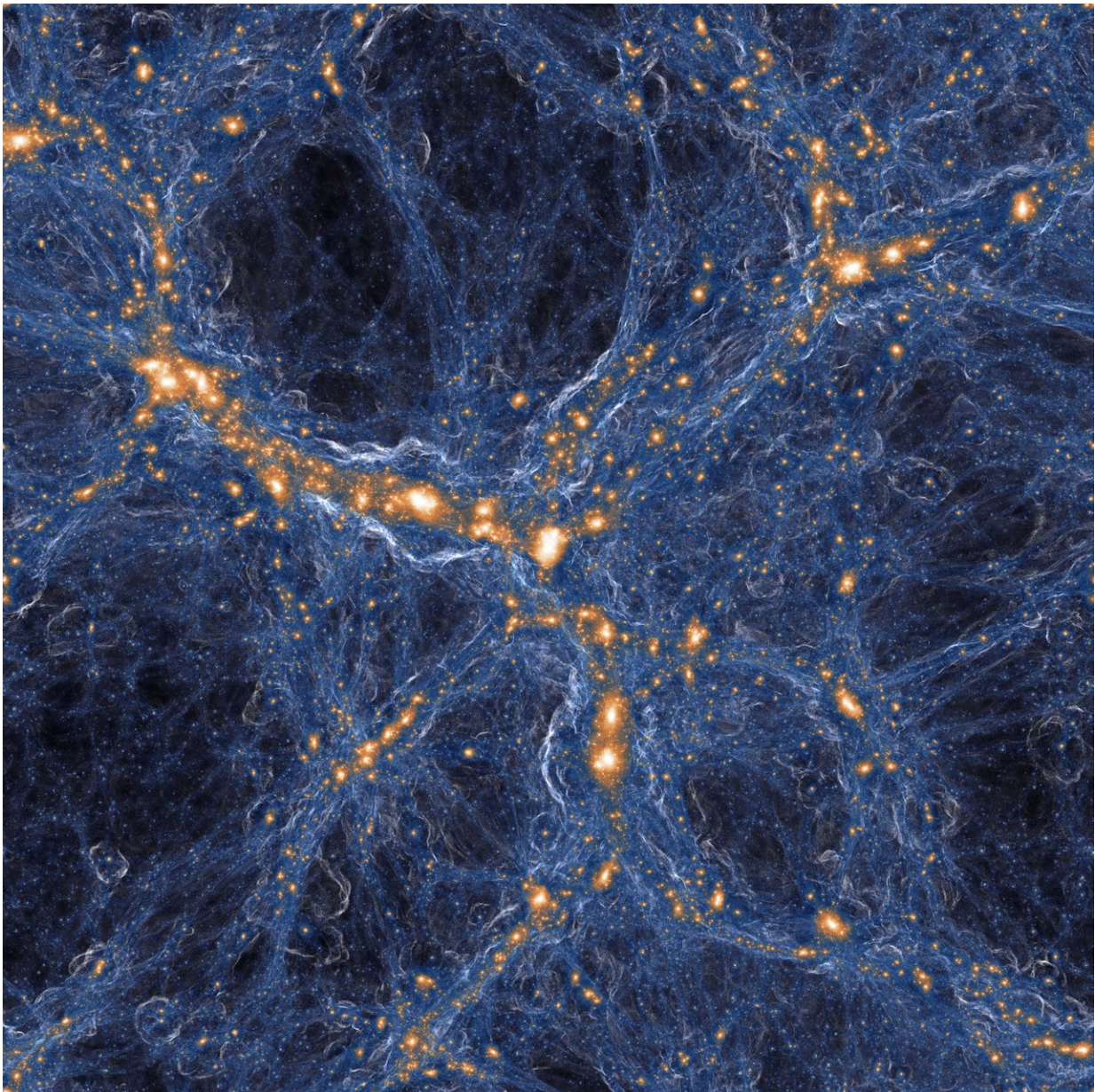


Rare relic is one of only three fossil clouds known in the universe

December 18 2018



Within the gas in the (blue) filaments connecting the (orange) galaxies lurk rare pockets of pristine gas -- vestiges of the Big Bang that have somehow been orphaned from the explosive, polluting deaths of stars, seen here as circular shock waves around some orange points. Credit: TNG COLLABORATION

A relic cloud of gas, orphaned after the Big Bang, has been discovered in the distant universe by astronomers using the world's most powerful optical telescope, the W. M. Keck Observatory on Maunakea, Hawaii.

The discovery of such a rare fossil, led by PhD student Fred Robert and Professor Michael Murphy at Swinburne University of Technology, offers new information about how the first galaxies in the universe formed.

"Everywhere we look, the gas in the universe is polluted by waste [heavy elements](#) from exploding stars," says Robert. "But this particular cloud seems pristine, unpolluted by stars even 1.5 billion years after the Big Bang."

"If it has any heavy elements at all, it must be less than 1/10,000th of the proportion we see in our Sun. This is extremely low; the most compelling explanation is that it's a true relic of the Big Bang."

The results will be published in the journal *Monthly Notices of the Royal Astronomical Society*. A preprint of the paper, "Exploring the origins of a new, apparently metal-free gas cloud at $z = 4.4$," is available online at arxiv.org/abs/1812.05098.

Robert and his team used two of Keck Observatory's instruments – the Echellette Spectrograph and Imager (ESI) and the High-Resolution Echelle Spectrometer (HIRES) – to observe the spectrum of a quasar

behind the gas cloud.

The quasar, which emits a bright glow of material falling into a [supermassive black hole](#), provides a [light source](#) against which the spectral shadows of the hydrogen in the gas cloud can be seen.

"We targeted quasars where previous researchers had only seen shadows from hydrogen and not from heavy elements in lower-quality spectra," says Robert. "This allowed us to discover such a rare fossil quickly with the precious time on Keck Observatory's twin telescopes."

The only two other fossil [clouds](#) known were discovered in 2011 by Professor Michele Fumagalli of Durham University, John O'Meara, formerly a professor at St. Michael's College and now the new Chief Scientist at Keck Observatory, and Professor J. Xavier Prochaska of the University of California, Santa Cruz; both Fumagalli and O'Meara are co-authors of this new research on the third fossil cloud.

"The first two were serendipitous discoveries, and we thought they were the tip of the iceberg. But no one has discovered anything similar – they are clearly very rare and difficult to see. It's fantastic to finally discover one systematically," says O'Meara.

"It's now possible to survey for these fossil relics of the Big Bang," says Murphy. "That will tell us exactly how rare they are and help us understand how some gas formed stars and galaxies in the early universe, and why some didn't."

More information: "Exploring the origins of a new, apparently metal-free gas cloud at $z = 4.4$," arxiv.org/abs/1812.05098

Provided by W. M. Keck Observatory

Citation: Rare relic is one of only three fossil clouds known in the universe (2018, December 18)
retrieved 19 April 2024 from

<https://phys.org/news/2018-12-rare-relic-fossil-clouds-universe.html>

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