A missing part of the universe has been found

By Kevin Wheeler

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Do magnetic fields that hold the universe together exist? An answer might be close. (Unsplash/Tengyart)

About half of the relatively small portion of the universe that is not dark matter or energy is in fact a mixture of gases that may connect galaxies in a kind of loose cosmic web, according to new research illuminating vast areas that were previously unknown.

Until now, this sizable chunk of "baryonic matter," which makes up 5% of the universe, had been unaccounted for. Researchers from institutions in Spain and the Argonne National Laboratory in Illinois detailed their findings in a study published March 25 in *Monthly Notices of the Royal Astronomical Society*.

While the other 95% of the universe is made up of dark matter and dark energy, baryonic matter comprises stars, planets, galaxies and everything they contain

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knew it was there, but didn't know if it was more stars, planets or anything else that wasn't dark matter or energy.

"You just assume that this was known and say, 'I can see this, it's not like dark matter, not dark energy,' we know that," said lead author Jonás Chaves-Montero, who completed most of this work as a postdoctoral researcher at the Argonne National Laboratory."But then you start to look around and find that half this matter is missing, and we didn't know where it was, and we realized, OK, the things you take for granted are sometimes not well-detected or well-understood."

To identify the true content of baryonic matter, Chaves-Montero and his colleagues devised a new method of analyzing the cosmological microwave background of the universe, which is the energy that was released by the Big Bang about 14 billion years ago, and is still moving today. As this energy moves through matter, it distorts.

"By detecting those distortions, we were able to infer the amount of matter that was causing them," Chaves-Montero said in an interview with *The Academic Times*. "In that way, we were detecting matter, not only at a certain distance, but all the matter that was intervening and creating this distortion across the whole history of the universe."

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This new technique combines different maps of photons coming from the beginning of the universe, along with maps of galaxy redshifts, which are shifts in the radiation wavelength emitted by celestial bodies. Chaves-Montero and his colleagues created the former using radio observation from the European Space Agency's Planck satellite, and the latter by analyzing the redshifts of hundreds of thousands of galaxies observed by optical telescopes in Australia and the United States.

Combining these maps, the researchers were able to detect the distortion signals of the matter that was interacting with these waves. It turned out to be primordial gas, according to the Chaves-Montero, 25% helium and 75% hydrogen.

These gases are floating well outside the gravitational pull of galaxies, according to cosmological simulations. Chaves-Montero hypothesizes that they could be forming galaxy filaments, large structures that connect galaxies like nodes on a three-dimensional spider web.

This hypothesis remains unproven, Chaves-Montero acknowledges, because he and his colleagues were not able to measure this gas with enough precision at this time. Still, with this discovery, he hopes to have made the map of the universe a little clearer.

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"Now that we know this is there, we can use this matter and these types of detections in order to set constraints in cosmology," said Chaves-Montero, who is now affiliated with the Donostia International Physics Center in Spain. "We can use this information to better understand the matter content of the universe, how it evolves, how it changes in time. We can use these measurements to set constraints on that."

In future research, Chaves-Montero says he would like to keep improving the technique his team developed, because it can be used to measure more not only baryonic matter, but gravity, as well. The colleagues are focused on using this technique to learn more about the universe and its history, and they plan to keep using it as new data from cosmological surveys becomes available in the coming years.

The study,"Measuring the evolution of intergalactic gas from ***z*** *= 0 to 5 using the kinematic Sunyaev–Zel'dovich effect." published March 25 in Monthly Notices of the Royal Astronomical Society, was authored by Jonás Chaves-Montero, Donostia International Physics Center; Carlos Hernández–Monteagudo, Centro de Estudios de Física del Cosmos de Aragón, Instituto de Astrofísica de Canarias and Universidad de La Laguna; Raúl E. Angulo, Donostia International*

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Correction: An incorrect title for the cited paper was given in the original version of the story. Also, J.D. Emberson was omitted from the original list of citations. Also, this story originally misstated the time when the Big Bang occurred. These have been corrected.