Scientists release new map of all the matter in the universe

January 31 2023

Scientists have released a new survey of all the matter in the universe, using data taken by the Dark Energy Survey in Chile and the South Pole Telescope. Credit: Andreas Papadopoulos

Sometimes to know what the matter is, you have to find it first.

When the universe began, matter was flung outward and gradually formed the planets, stars and galaxies that we know and love today. By carefully assembling a map of that matter today, scientists can try to understand the forces that shaped the evolution of the universe.

A group of scientists, including several with the University of Chicago and Fermi National Accelerator Laboratory, have released one of the most precise measurements ever made of how matter is distributed across the universe today.

Combining data from two major telescope surveys of the universe, the Dark Energy Survey and the South Pole Telescope, the analysis involved more than 150 researchers and is published as a set of three articles Jan. 31 in *Physical Review D*.

Among other findings, the analysis indicates that matter is not as "clumpy" as we would expect based on our current best model of the universe, which adds to a body of evidence that there may be something missing from our existing standard model of the universe.

Cooling and clumps

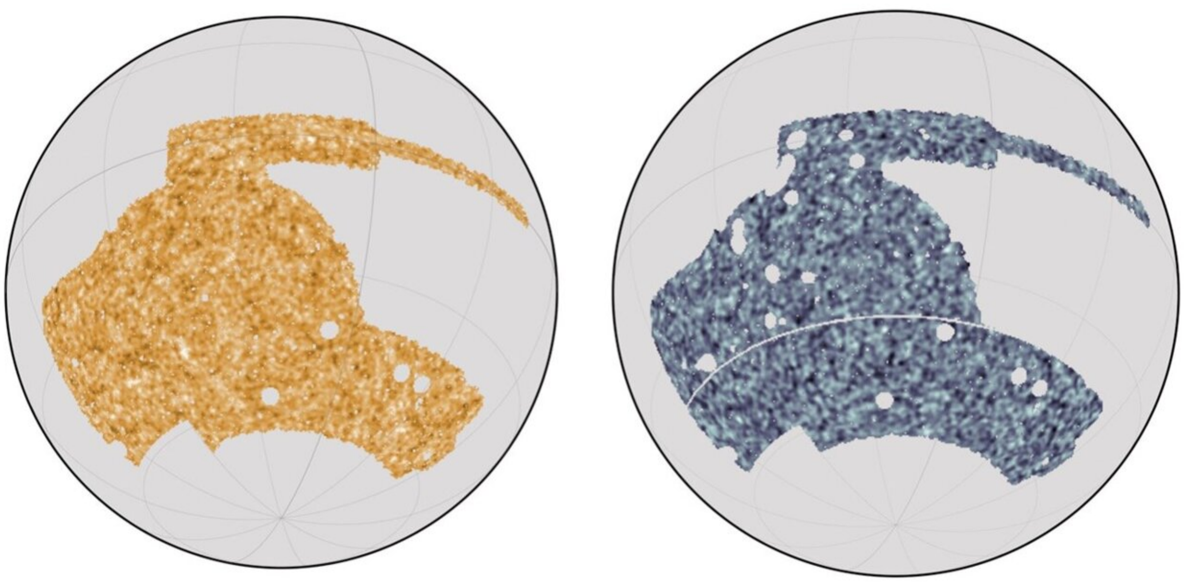
After the Big Bang created all the matter in the universe in a very hot, intense few moments about 13 billion years ago, this matter has been spreading outward, cooling and clumping as it goes. Scientists are very interested in tracing the path of this matter; by seeing where all the matter ended up, they can try to recreate what happened and what forces would have had to have been in play.

The first step is collecting enormous amounts of data with telescopes.

In this study, scientists combined data from two very different telescope surveys: The Dark Energy Survey, which surveyed the sky over six years from a mountaintop in Chile, and the South Pole Telescope, which looks for the faint traces of radiation that are still traveling across the sky from the first few moments of the universe.

Combining two different methods of looking at the sky reduces the chance that the results are thrown off by an error in one of the forms of measurement. "It functions like a cross-check, so it becomes a much more robust measurement than if you just used one or the other," said UChicago astrophysicist Chihway Chang, one of the lead authors of the studies.

In both cases, the analysis looked at a phenomenon called "gravitational lensing." As light travels across the universe, it can be slightly bent as it passes objects with lots of gravity, like galaxies.



By overlaying maps of the sky from the Dark Energy Survey telescope (at left) and the South Pole Telescope (at right), the team could assemble a map of how the matter is distributed—crucial to understand the forces that shape the universe. Credit: Yuuki Omori

This method catches both regular matter and dark matter—the mysterious form of matter that we have only detected due to its effects on regular matter—because both regular and dark matter exert gravity.

By rigorously analyzing these two sets of data, the scientists could infer where all the matter ended up in the universe. It is more precise than previous measurements—that is, it narrows down the possibilities for where this matter wound up—compared to previous analyses, the authors said.

The majority of the results fit perfectly with the currently accepted best theory of the universe.

But there are also signs of a crack—one that has been suggested in the past by other analyses, too.

"It seems like there are slightly less fluctuations in the current universe, than we would predict assuming our standard cosmological model anchored to the early universe," said analysis co-author and University of Hawaii astrophysicist Eric Baxter (UChicago Ph.D.'14).

That is, if you make a model incorporating all the currently accepted physical laws, then take the readings from the beginning of the universe and extrapolate it forward through time, the results look slightly different from what we actually measure around us today.

Specifically, today's readings find the universe is less "clumpy"—clustering in certain areas rather than evenly spread out—than the model would predict.

If other studies continue to find the same results, scientists say, it may mean there is something missing from our existing model of the universe, but the results are not yet to the statistical level that scientists consider to be ironclad. That will take further study.

However, the analysis is a landmark as it yielded useful information from two very different telescope surveys. This is a much-anticipated strategy for the future of astrophysics, as more large telescopes come online in the next decades, but few had actually been carried out yet.

"I think this exercise showed both the challenges and benefits of doing these kinds of analyses," Chang said. "There's a lot of new things you can do when you combine these different angles of looking at the universe."

University of Chicago Kavli Associate Fellow Yuuki Omori was also a lead co-author for the papers.

More information: Y. Omori et al, Joint analysis of Dark Energy Survey Year 3 data and CMB lensing from SPT and Planck . I. Construction of CMB lensing maps and modeling choices, *Physical Review D* (2023). DOI: 10.1103/PhysRevD.107.023529

C. Chang et al, Joint analysis of Dark Energy Survey Year 3 data and CMB lensing from SPT and Planck . II. Cross-correlation measurements and cosmological constraints, *Physical Review D* (2023). DOI: 10.1103/PhysRevD.107.023530

T. M. C. Abbott et al, Joint analysis of Dark Energy Survey Year 3 data and CMB lensing from SPT and Planck . III. Combined cosmological constraints, *Physical Review D* (2023). DOI: 10.1103/PhysRevD.107.023531

Provided by University of Chicago

Citation: Scientists release new map of all the matter in the universe (2023, January 31) retrieved 26 April 2024 from https://phys.org/news/2023-01-scientists-universe.html