

Physicists consider implications of recent revelations about the universe's first light

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In this 2007 photo provided by Steffen Richter, the sun sets behind the BICEP2 telescope, foreground, and the South Pole Telescope in Antarctica. Credit: Steffen Richter

Last month, scientists announced the [first hard evidence for cosmic inflation](#), the process by which the infant universe swelled from microscopic to cosmic size in an instant. This almost unimaginably fast expansion was first theorized more than three decades ago, yet only now has "smoking gun" proof emerged.

What is this result and what does it mean for our understanding of the universe? Late last week, two members of the discovery team discussed the finding and its implications with two of the field's preeminent thought leaders.

Walter Ogburn is a postdoctoral researcher at the Kavli Institute for Particle Astrophysics and Cosmology at Stanford University, and a member of the discovery team. For him, the exciting thing "is not just confirming that inflation happened—many of us already had a pretty good idea that was likely to be the case—but having a chance to figure out exactly how it happened, what it was that drove it, whether there are new particles and new fields that participated in it, and which of the many models could be correct."

That's made possible by the strength of the detected signal. Far from the quiet whisper that many expected, the signal turned out to be a relatively loud drone. That brings with it many implications.

"The theoretical community is abuzz," says theorist Michael S. Turner, Director of the Kavli Institute for Cosmological Physics (KICP) and the Bruce V. and Diana M. Rauner Distinguished Service Professor at the University of Chicago. Turner, who was not involved in the experiment, continues: "We got the signal we were looking for—that's good—but we shouldn't have gotten one according to the highbrow theorists because they said it should be too small. So we also got a surprise. And often in science, that's the case. We like to the experimenters to find what we predict, but we also like surprises."

This surprise is still so new that additional implications keep coming to light each week. It's already clear that the result rules out many theoretical models of inflation—most of them, in fact—because they predict a signal much weaker than the one detected. In addition, the discovery also seems to disprove a theory that says that the universe

expands, collapses and expands again in an ongoing cycle.

More than that, the result could very well be what Turner calls a "crack in the cosmic egg," offering clues that even the most accepted theoretical assumptions contain inaccuracies.

"There have been hints for a while now that maybe something else is going on," says KICP Deputy Director John Carlstrom, who leads two other experiments that study the universe's first light. "Maybe we need to... allow some new physics in there. Maybe there are more neutrinos. Maybe they're more massive than we thought. Or maybe it's something none of us have thought of yet."

Theorists will carefully consider these ideas and their implications over the coming months and years. Meanwhile, the signal still needs to be experimentally confirmed. Results from other telescopes, including the Planck satellite and the South Pole Telescope, are expected in the coming year. After that, the next step will be to measure more carefully the characteristics of the signal, searching for evidence of how inflation took place and how exactly the universe worked in its high-energy infancy. Those results may shed light on some of our biggest questions about how the universe began and how the forces of nature are unified.

But for now, the community is still buzzing with this first evidence of [cosmic inflation](#).

"It's a funny thing when you're on the inside of a discovery like this," says Abigail Vieregg, an active member the discovery team and a professor at the University of Chicago and KICP. "It's only when you release the results to the world and watch the reaction of the community that, at least for me, it really hits home how important it is. If this is what we think it is, it's a very big deal."

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