Ripples in space-time detected, astronomers say

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Courtesy of the Harvard-Smithsonian
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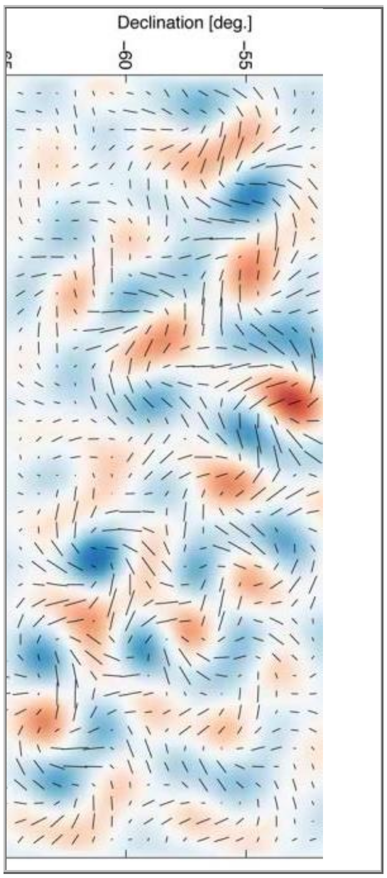
Astronomers say they have detected "ripples" in space and time caused by a process in which our universe expanded out of control during its first fleeting fraction of a second.

The process is said to have begun almost 14 billion years ago during the Big Bang, an explosive event that gave birth to the universe. In an unimaginably small amount of time, the theory goes, the universe stretched to be far bigger than what our best telescopes would be able to see.



The B-mode or "twisty" pattern seen in the cosmic background light. The lines show the polarization strength and orientation at different spots on the sky. The red and blue shading shows the degree of clockwise and anti-clockwise twisting of this B-mode pattern. (Courtesy BICEP2 Collaboration)

This version of the Big Bang theory is known as "inflation."

Scientists from a research collaboration called BICEP2 announced on Monday what they called the first direct evidence for this cosmic inflation. Their data also represent the first images of gravitational waves, or ripples in space-time. These waves have been described as the "first tremors of the Big Bang."

Finally, they said, the data confirm a deep connection between quantum mechanics, the prevailing theory that describes the realm of subatomic particles, and general relativity, which describes events on cosmic scales.

"Detecting this signal is one of the most important goals in cosmology today. A lot of work by a lot of people has led up to this point," said John Kovac of the Harvard-Smithsonian Center for Astrophysics, leader of the BICEP2 collaboration.

The findings came from observations by the BICEP2 telescope of the cosmic microwave background—a faint glow left over from the Big Bang. Tiny fluctuations in this afterglow provide clues to conditions in the early universe. For example, small differences in temperature across the sky show where parts of the universe had thicker consistency, material that would later condense into galaxies.

The cosmic microwave background is a form of light, and light can be "polarized," meaning many waves vibrate in similar directions. This can occur after light scatters off atoms or other particles; on Earth, sunlight becomes polarized after hitting the atmosphere.

"Our team hunted for a special type of polarization called 'B-modes,' which represents a twisting or 'curl' pattern in the polarized orientations," said study co-leader Jamie Bock of the California Institute of Technology.

Gravitational waves squeeze space as they travel, and this squeezing produces a distinct pattern in the cosmic microwave background, the scientists explained. Gravitational waves have a "handedness," much like light waves, and can have left- and right-handed polarizations.

"The swirly B-mode pattern is a unique signature of gravitational waves because of their handedness. This is the first direct image of gravitational waves across the primordial sky," said co-leader Chao-Lin Kuo of Stanford University in California.

The team examined spatial scales on the sky spanning about one to five degrees, two to ten times the width of the full Moon. To do this, they traveled to the South Pole, where the views are clearer, and said they were surprised to detect a B-mode polarization signal considerably stronger than many expected. "This has been like looking for a needle in a haystack, but instead we found a crowbar," said co-leader Clem Pryke of the University of Minnesota.