The cosmic confusion of the microwave background

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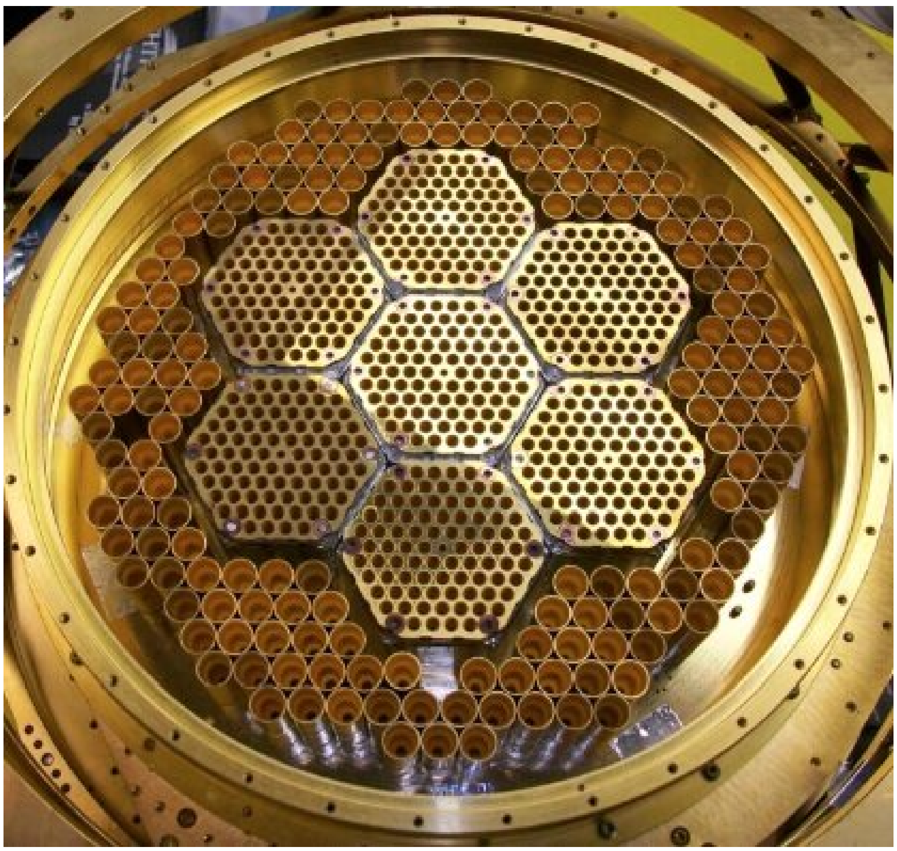

An image of the South Pole Telescope's "SPTpol" instruments core, containing 768 pixels and 1536 detectors capable of measuring the polarization of incoming millimeter radiation. The SPT team used SPTpol to determine that the combined polarized radiation from distant galaxies is not strong enough to obscure the search for polarization effects in the cosmic microwave background radiation. Credit: SPT collaboration; DOE

Roughly 380,000 years after the Big Bang, about 13.7 billion years ago, matter (mostly hydrogen) cooled enough for neutral atoms to form, and light was able to traverse space freely. That light, the cosmic microwave background radiation (CMBR), comes to us from every direction in the sky, uniform except for faint ripples and bumps at brightness levels of only a few part in one hundred thousand, the seeds of future structures like galaxies.

Astronomers have conjectured that these ripples also contain traces of an initial burst of expansion—the so-called inflation—which swelled the new universe by thirty-three orders of magnitude in a mere ten-to-the-power-minus-thirty-three seconds. Clues about the inflation should be faintly present in the way the cosmic ripples are curled, an effect that is expected to be perhaps one hundred times fainter than the ripples themselves. CfA astronomers and their colleagues, working at the South Pole, have been working to find evidence for such curling, the "B-mode polarization."

Traces of this tiny effect are not only difficult to measure, they may be obscured by unrelated phenomena that can confuse or even mask it. CfA astronomer Tony Stark is a member of the large South Pole Telescope (SPT) consortium, a collaboration that has been studying galaxies and galaxy clusters in the distant universe at microwave wavelengths. Individual cosmic sources are in general dominated either by active supermassive black hole nuclei and emit radiation from the charged particle jets ejected from the regions around them, or by star formation whose radiation comes from warm dust. The emission is also probably polarized and could complicate the positive identification of CMBR B-mode radiation signals. The SPT team used a new analysis method to study the combined polarization strength of all the millimeter emission sources they find in a 500 square degree field in the sky, about four thousand objects. They conclude—good news for CMBR researchers—that the extragalactic foreground effects should be smaller than any expected B-mode signals, at least over a wide range of spatial scales.

More information: N Gupta et al. Fractional polarization of extragalactic sources in the 500 deg2 SPTpol survey, *Monthly Notices of the Royal Astronomical Society* (2019). DOI: 10.1093/mnras/stz2905

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