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Cosmologically complicating dust

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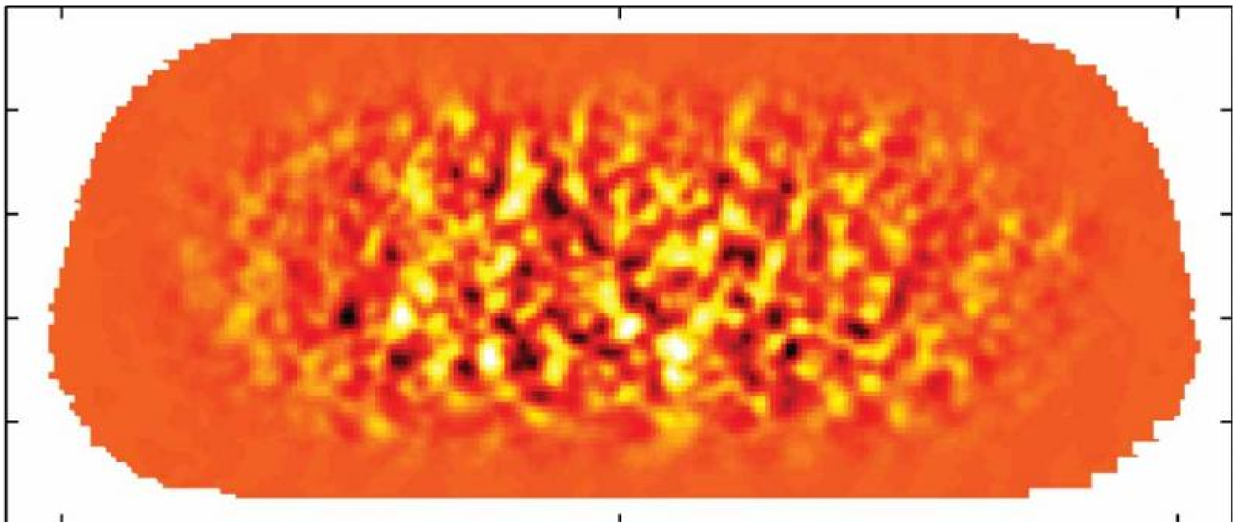

The Planck astronomy satellite's new submillimeter wavelength image of ripples in the cosmic background, as refined with data taken with the South Pole BICEP2/Keck Array facilities. Scientists from the two teams combined their data to conclude that previously reported measurements attributed to the effects of cosmic inflation are instead almost certainly due to the effects of galactic dust. Credit: ESA, NASA, Planck/BICEP

The universe was created 13.7 billion years ago in a blaze of light: the big bang. Roughly 380,000 years later, after matter (mostly hydrogen) had cooled enough for neutral atoms to form, light was able to traverse space freely. That light, the cosmic microwave background radiation (CMBR), comes to us from every direction in the sky uniformly ... or so it first seemed. In the last decades, astronomers discovered that the radiation actually has very faint ripples and bumps in it at a level of brightness of only a part in one hundred thousand – the seeds for 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-33 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. One year ago, CfA astronomers working at the South Pole amazed the world by reporting evidence for such curling, the "B-mode polarization," and cautiously calculated that the measured strength supported the simplest models of inflation.

Other exotic processes are at work in the universe to make this daunting measurement even more challenging. The principal one is the scattering of light by dust particles in the galaxy that have been aligned by magnetic fields; the light is polarized and twisted in a way that emulates the curling effects of inflation. In 2009, the European Space Agency, with NASA as a partner, launched the Planck satellite to study the CMBR. The first papers from Planck substantially refined the values of key cosmological parameters. In the course of studying the cosmic light, it unavoidably encountered emission from dust grains.

Writing in the latest issue of *Physical Review Letters*, CfA astronomers K.D. Alexander, C.A. Bischoff, I. Buder, J. Connors, C. Dvorkin, K.S. Karkare, J. Kovac, S. Richter, and C.L. Wong joined over one hundred colleagues in reporting their analysis of the galactic dust contribution to the curled CMBR signature using data from both South Pole and Planck experiments.

The scientists conclude that the previously reported curl signal is genuine, but almost certainly due to galactic dust, whose effect turned out to be considerably stronger than had been previously expected, swamping the cosmological signal. The new paper provides much more sensitive limits to cosmological effects, however, and notes that several next-generation experiments at the South Pole and elsewhere are continuing to probe even more deeply. In the next few years, they predict, substantial progress towards finding the faint traces of inflation will be made, and the improved results used to refine the details of cosmic inflation.

More information: "A Joint Analysis of BICEP2/Keck Array and Planck Data," P.A.R. Ade et al. (BICEP2/Keck and Planck Collaborations, *Physical Review Letters* 114, DOI: 10.1103/PhysRevLett.114.101301

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