Star dust casts doubt on recent big bang wave result

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An imprint left on ancient cosmic light that was attributed to ripples in spacetime – and hailed by some as the discovery of the century – may have been caused by ashes from an exploding star.

In the most extreme scenario, the finding could suggest that what looked like a groundbreaking result was only a false alarm. Another possibility is that the stellar ashes could help bring the result in line with other cosmic observations. We should know which it is later this year, when researchers report new results from the European Space Agency's Planck satellite.

On 17 March, researchers led by John Kovac of Harvard University announced that gravitational waves from the early universe had been found by a telescope called BICEP2 at the South Pole.

The waves were said to be the "smoking gun" evidence for the theory of inflation, which suggests that space expanded faster than the speed of light in the first moments after the universe's birth. The announcement sent shock waves through the physics world. "I was so excited," recalls Philipp Mertsch of Stanford University in California.

Dust damper

But soon it dawned on him that his own research on galactic dust might put a damper on the result. That is because BICEP2 identified the waves based on how they appeared to polarise, or align, the electromagnetic fields of photons they came into contact with in the infant universe.

Those photons, which have been travelling through space ever since, appear in every direction in the sky as the cosmic microwave background (CMB) radiation. But other things apart from gravitational waves, such as dust, can emit polarised photons.

To minimise the chances of this effect causing a false signal, the BICEP 2 team pointed their telescope at a patch of sky far away from the Milky Way's dusty disc. Then they used models of the dust in that part of the sky to estimate its effect on the polarisation. They found that this could account for no more than about 20 per cent of the signal that they attributed to gravitational waves last month.

Giant loops

But Mertsch says the models they used didn't account for dust shells produced as the expanding remnants of supernovae slam into surrounding gas and dust. Magnetic field lines threading through those shells should get compressed and aligned, causing some of the material to line up as well. If the aligned dust contains iron, the particles' slight vibrations due to their own heat would produce polarised microwave radiation, says Mertsch.

A handful of nearby dust shells can be seen by radio telescopes, appearing as giant loops looming above the Milky Way's galactic disc. Mertsch and his colleagues, led by Hao Liu at the University of Copenhagen in Denmark, plotted the positions of these loops. They found that one "goes right through the BICEP field", Mertsch says. This plot shows the patch of the sky that BICEP2 observed (multicolored patch) and the giant loops detected by radio telescopes (blue lines).

The effect of this finding on the BICEP2 result is not clear, because no thorough measurements have yet been made of how much polarised light the dust in our galaxy produces. But David Spergel of Princeton University says that if you take the dust into account, along with emissions from charged particles in the galaxy – which he says the BICEP2 team probably underestimated – it might make the gravitational wave signal disappear entirely.

"It is important to explore the possibility that the galactic signal could account for all of the signal seen by BICEP," he says. "Given its importance, the BICEP2 team needs to make a more convincing case."

Pressure on Planck

Another upshot of the finding could be that dust doesn't account for all of the polarisation that BICEP2 attributed to gravitational waves – just some of it. That would help bring the BICEP2 result in line with more preliminary measurements taken by the Planck satellite last year, which hinted at weaker ripples than BICEP2 reported.

The BICEP2 team leaders did not respond to requests for comment on the new research, but upcoming observations by Planck should help settle the matter. The Planck team is currently measuring the polarisation of the CMB and is expected to report its findings in October. Unlike BICEP2, Planck observes at a range of different wavelengths. Because emissions from dust vary with wavelength, this should allow researchers to better separate out the contributions to polarised light from dust.

"For sure, this BICEP2 result will put even more pressure on Planck's next release," says Fabio Finelli, a Planck team leader at Italy's National Institute for Astrophysics in Bologna.

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