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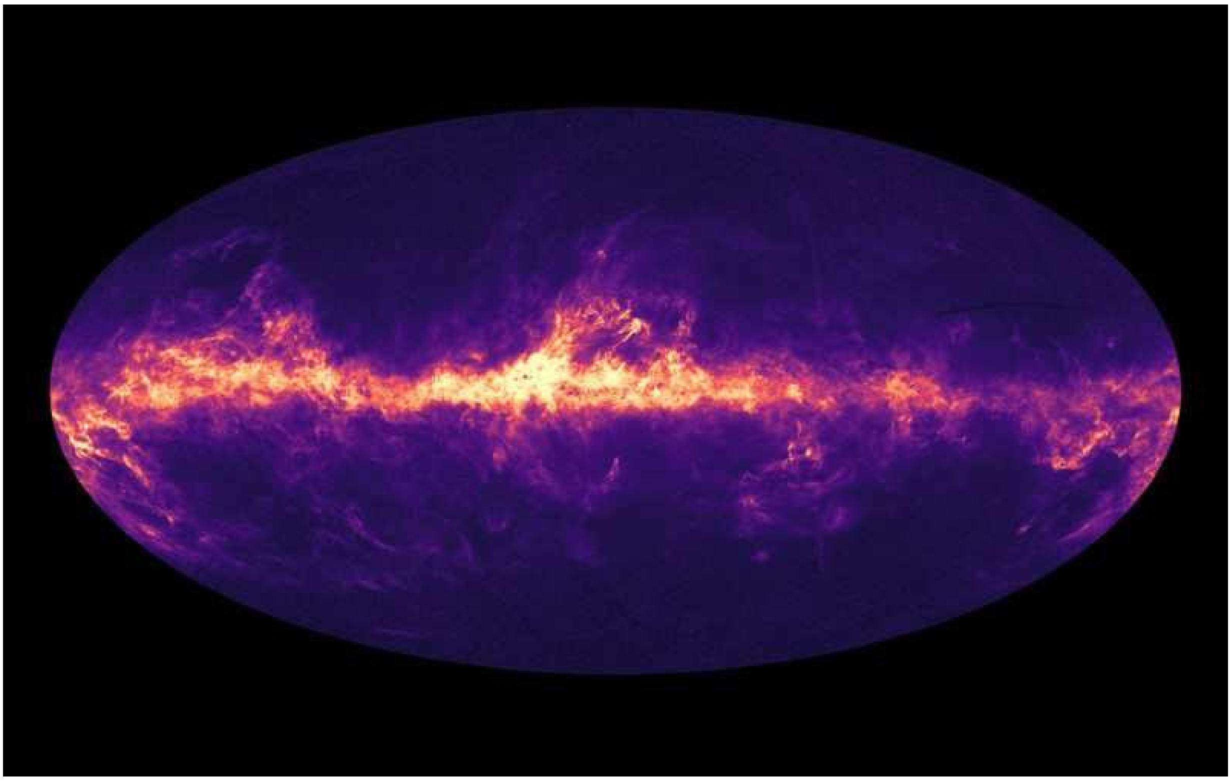
Our understanding of the universe's expansion is really wrong



Gaia measured the dimming and reddening of 87 million stars to construct this image
ESA/Gaia/DPAC

By **Leah Crane**

The universe just got even more confusing. Last week, the biggest ever 3D map of our galaxy was released as part of the second batch of data from the European Space Agency's Gaia satellite. The long-awaited data dump revealed the location and brightness of some 1.7 billion stars in the Milky Way.

Now the first analysis of the data has crystallised our confusion about the rate at which the universe is expanding.

We have two ways to determine the speed of the universe's inflation, and they have always returned different values. Some researchers hoped that the data released on April 25 from the Gaia spacecraft might lessen the conflict, but they've only made it worse.

One of our determinations of this so-called Hubble constant comes from the cosmic microwave background (CMB), a relic of the first light in the cosmos after the big bang. Researchers have used the Planck space observatory to examine this light and figure out how fast the universe was expanding back then. Those values can then be plugged into models of how the cosmos has evolved to predict how fast it should be expanding today.

The other method involves directly measuring the distances to stars called Cepheid variables, to figure out how quickly objects in the local universe are moving away from us. This more direct method has come up with a value more than 9 per cent higher than the CMB method.

Cosmic confusion

In the past, we've only been able to measure a few Cepheids at a time, but Gaia pinpointed 50 of them. Adam Riess at the Space Telescope Science Institute in Baltimore, Maryland and his colleagues analysed Gaia's Cepheid data to see how it would affect the Hubble constant discrepancy.

"Not only is it confirmed, but it's actually reinforced," Riess says. Prior to this analysis, he says, there was a one in 1000 chance that the apparent discrepancy was just a fluke – now, there's only a one in 7000 chance it's not real.

If the discrepancy is real, it means that something is wrong with our models of the universe's evolution. And it's looking more and more real.

Reiss says there may be more particles out there that we've never detected, or maybe our guesses about the natures of dark matter and dark energy are wrong.

"When we say the Hubble constant should be lower, that's with models using the most vanilla, least interesting versions of dark matter and dark energy," says Riess. "But maybe there's a wrinkle. Maybe it's much weirder."

Galactic scars

Closer to home, the Gaia data have also revealed a disturbance in the Milky Way. Our galaxy doesn't float alone in space; it is surrounded by smaller satellite galaxies. These are gravitationally bound to our own galaxy, so astronomers agree it is likely that some of them interacted with the Milky Way in the past, perhaps by smashing through the galaxy's disc.

Thanks to Gaia, we now have evidence that another galaxy perturbed the Milky Way's disc relatively recently. Teresa Antoja at the University of Barcelona in Spain and her colleagues analysed the motions of more than 6 million stars from the Gaia dataset, and found patterns we've never seen before.

Plots of these stars' velocities have swoops, arches and spirals indicating patches of stars that are moving together. If the Milky Way were in equilibrium, and hadn't been recently perturbed, those patterns wouldn't appear. That they do indicates that something has shaken up the stars recently enough that their orbits haven't relaxed back to a stable state yet.

The researchers' analysis found that the Milky Way was likely perturbed between 300 and 900 million years ago, which corresponds to the last time the Sagittarius dwarf galaxy is estimated to have made a close pass.

“This is just the beginning for Gaia,” says Riess. “Gaia should be delivering data that’s five or six times more precise than this in a few years.” And even for now, analysis of the deluge of data we just received is nowhere near complete.

Reference: arxiv.org/abs/1804.10196

Read more: When will the universe end? Not for at least 2.8 billion years