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Repulsive Astronomy: Strengthening the case for dark energy

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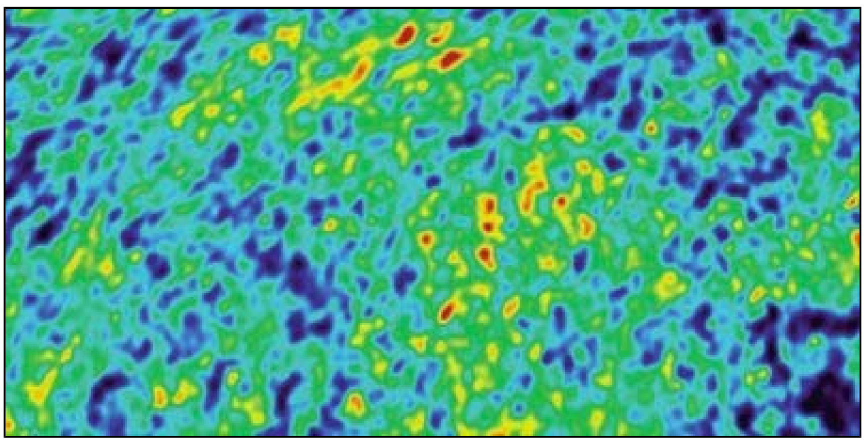
Astronomers have found new evidence for one of the strangest properties of the universe. A mysterious substance, dubbed dark energy, appears to be ripping the cosmos apart, causing the universe to expand at an ever-faster rate.



DARK FINGERPRINT. Some of the color differences in this temperature map of the cosmic microwave background, researchers say, result from a mysterious substance called dark energy.
NASA/WMAP

The wrenching findings come from a correlation between two kinds of sky maps—one that denotes the positions of large numbers of galaxies and another, a snapshot of the cosmic microwave background, which is the remnant radiation from the Big Bang.

By comparing the maps, astronomers have found the imprint of dark energy, which pushes objects apart and thus counters gravity's familiar tug. Previous support for dark energy has been based on the brightness of distant stellar explosions known as supernovas (SN: 3/31/01, p. 196: Available to subscribers at http://www.sciencenews.org/20010331/fob1.asp). With only one line of evidence, however, some researchers weren't convinced.

"Since the implications of dark energy are so profound for physics, having multiple, independent lines of evidence for its existence is absolutely essential," says Joshua A. Frieman of the Fermi National Accelerator Laboratory in Batavia, Ill., a coauthor of one of four dark-energy studies recently posted online. Each study uses data from the Wilkinson Microwave Anisotropy Probe (WMAP), a satellite that is generating detailed maps of the cosmic microwave background (SN:

2/15/03, p. 99: http://www.sciencenews.org/20030215/fob1.asp).

This remnant radiation is riddled with hot and cold spots, most of which reflect the lumpiness of the infant universe, from which galaxies grew. But some of the energy in the hot spots may have been acquired later, as light traveled for billions of years to reach Earth.

During their long journey, photons from the microwave background encounter huge concentrations of matter, such as superclusters of galaxies. As the photons fall into these clouds of matter, they gain energy, like a marble that speeds up as it rolls downhill. As the photons climb out of these areas, they lose energy.

If the universe were flat—so that parallel lines never meet—and contained no dark energy, photons traversing matter-filled regions would gain exactly as much energy as they lose. But in a flat universe containing dark energy, there would be no such cancellation, says Frieman.

Dark energy would spread matter out during the period in which photons traverse a supercluster or other large clump. The photons would therefore expend less energy leaving a supercluster than the amount they gained when they entered. So, wherever the universe harbors lots of matter, the microwave-background photons ought to be slightly more energetic than those in less-dense areas. This would be indicated by a shift of the photons toward bluer wavelengths.

That's exactly what Frieman, Ryan Scranton of the University of Pittsburgh, and their collaborators found when they compared data from WMAP with the positions of several million galaxies mapped by the Sloan Digital Sky Survey, a vast, visible-light survey of the heavens (SN: 5/31/03, p. 341: http://www.sciencenews.org/20030531/fob6.asp). The blue shift was discernible on scales of 100 million light-years, or roughly one-hundredth the scale of previous studies. The scientists recently posted their findings online (http://xxx.lanl.gov/abs/astro-ph/0307335).

Using a smaller sample from the same visible-light survey, Pablo Fosalba of the Institut d'Astrophysique de Paris and his collaborators observed a similar correlation (http://xxx.lanl.gov/abs/astro-ph/0307249). Relying on galaxies mapped at X-ray and radio wavelengths, Steven Boughn of Haverford (Pa.) College and Robert Crittenden of the Institute of Cosmology and Gravitation in Portsmouth, England, found the same blue-shifting effect (http://xxx.lanl.gov/abs/astro-ph/0305001). The same goes for Michael R. Nolta of Princeton University and his collaborators, who also worked with the radio-wavelength map (http://xxx.lanl.gov/abs/astro-ph/0305097).

"It is exciting that all these teams find the same correlation," says Wayne Hu of the University of Chicago.

Further studies with the Sloan data may help pin down the physical traits of the still-elusive dark energy, Frieman notes.

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Further Readings:

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