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Astronomers find evidence of a 'dark' force in the universe

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By Byron Spice, Post-Gazette Science Editor

Astrophysicists led by a core of Pittsburgh researchers yesterday said they have found new evidence for "dark energy," the mysterious, repulsive force that appears to be speeding up the expansion of the universe.

By combining and analyzing two huge astronomical databases, the international team was able to detect dark energy's "shadow" as it appears against the cosmic microwave background, the remnants of the Big Bang that backlight the universe.

But in the topsy turvy world of dark energy, this shadow is actually brighter than its surroundings, suggesting that dark energy is so weird that it may have finally outstripped scientists' capacity for analogy.

"It's very encouraging that we came up with such a result," said Andrew Connolly, an astrophysicist at the University of Pittsburgh. Previous evidence of dark energy has been based on measurements of distances to supernovae and on temperature variations in the cosmic microwave background. This new evidence, by contrast, is based on physical processes that act on light particles as they travel through galaxies and thus complements the earlier findings.

The researchers, headed by Ryan Scranton, a Pitt post-doctoral fellow, found that cosmic radiation actually picks up energy as it passes through the gravitational fields of galaxies, suggesting that some force -- dark energy -- is acting in opposition to gravity.

The findings were posted online late Sunday on a physics Web site run by Los Alamos National Laboratory and a research paper has been submitted for publication in the journal Physical Review Letters.

"It's always good to have independent confirmation of dark energy," said Lawrence Krauss, chairman of physics at Case Western Reserve

University, who was not involved in the study. Given the growing evidence for dark energy, however, it would have been more surprising if the researchers had failed to find support.

Talk about dark energy has been building over the past five years, ever since astronomers began making measurements suggesting that the expansion of the universe is speeding up. Albert Einstein had theorized about a force that would cause objects to repulse each other, which he termed the cosmological constant, but he later repudiated his idea. As evidence has grown that such a force does indeed exist, it has come to be known as dark energy.

Work on the latest findings began in February with the release of a detailed map of the cosmological microwave background made by a satellite called the Wilkinson Microwave Anisotropy Probe. Researchers compared the map of that radiation, which made its appearance 380,000 years after the Big Bang, with the position of millions of galaxies charted by the Sloan Digital Sky Survey, an ongoing effort to map everything in one-fourth of the sky.

Robert Nichol, an astrophysicist at Carnegie Mellon University who has worked on the Sloan team for more than a decade, said combining the two databases allowed him and his colleagues to compare the energy of microwaves that flew through regions of space where lots of galaxies exist with those that encountered mostly empty space.

Gravity in a dense region such as a galaxy can act on light particles as they pass through, a physical phenomenon called the Sachs-Wolfe effect. Physicists talk of a light particle entering a "gravitational well" as it enters a galaxy, picking up energy as it falls into the well, like a ball rolling down a hill. As the particle leaves the galaxy, it climbs back out of the well and gives up the energy it gains, Nichol explained.

But if dark energy also is exerting itself in opposition to gravity, the galaxy is "puffing" up and losing some gravitational oomph during the millions of years it takes the particle to travel through a galaxy. So the size of the gravitational well that the particle climbs out of isn't quite as deep as the one it fell into. The result is that the light particle has a little more energy when it leaves than it had originally.

It's a very subtle effect, however. Albert Stebbins, a collaborator at the NASA/Fermilab Astrophysics Center, said the amount of energy change is less than one part in a million.

So researchers had to look at millions of galaxies if they had any hope of finding such a small change, Nichol said. That's possible to do now that the Sloan has surveyed about a third of the northern sky, he added.

Large datasets come with lots of co-investigators, however, so the new paper includes a list of 38 authors. "When you look at the list of authors, it looks more like a high-energy physics paper than an astronomy paper," Krauss said, referring to the hundreds of co-authors who typically are involved in experiments with atom smashers. "Astronomy used to be done by one person looking through a telescope. Now we're moving into the era of Big Astronomy."

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