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Dark Energy's Demise? New Theory Doesn't Use the Force

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Dark energy, a mysterious force proposed more than a decade ago to explain why the universe is flying apart at an increasingly faster clip, is no longer necessary.

That's the conclusion of a controversial new theory that shows how the accelerated expansion of the universe could be just an illusion.

In a new study, two mathematicians present their solutions to Einstein's field equations of general relativity, which describe the relationship between gravity and matter.

The work suggests that our home galaxy sits inside a vast region of space in which there's an unusually low density of matter due to a post-big bang wave that swept through the universe.

From our viewpoint, other galaxies outside this region appear to have moved farther away than expected, when really they're right where they should be.

"If correct, these solutions can account for the anomalous accelerated expansion of galaxies without dark energy," said study team member Blake Temple of the University of California, Davis.

Other experts call the attempt to excise dark energy from models of the universe "commendable." But the same scientists note that the new theory could violate a cornerstone of modern cosmology, which would make dark energy's demise very hard for astronomers to accept.

Dark Energy Alternative

Until 1998 astronomers had thought that gravity should be slowing down the cosmic expansion triggered by the big bang.

That year two independent teams announced data showing that the universe's expansion is speeding up.

Both teams saw that light from distant supernovae appears much fainter than expected—suggesting that the explosions are farther away than they should be if the universe is being driven by the pull of gravity alone.

To explain this observation, astronomers started to entertain the idea of dark energy, a universal repulsive force that is pushing apart the very fabric of space-time.

Still, more than ten years later, no one is sure what dark energy is—or if it really exists.

To find a dark-energy alternative, other scientists have proposed versions of the newly supported theory that our galaxy sits inside an expansion wave, a ripple of space with low density.

Ripple Effect

Temple and his colleague, Joel Smoller of the University of Michigan, are the first to provide a possible mechanism for how such a ripple formed.

Their solutions, described this week in the *Proceedings of the National Academy of Sciences,* show how the big bang might have created a large-scale wave in space-time called a density wave.

As this primordial wave moved through the universe, it left behind a low-density ripple several tens of millions of light-years across, which now envelops the Milky Way.

Meanwhile, matter trapped in front of the wave got pushed outward, shifted from its original location like pebbles on a beach shore.

This displaced matter later formed distant stars and galaxies.

When light from these objects eventually reaches Earth, it appears dimmer than expected, because the objects are farther away from us than they would have been if the density wave had never washed over them.

This would explain why the supernovae described in 1998 are so far away *without* an accelerated universe.

Even Mix

Such a model, however, could violate a widely held tenant of cosmology known as the Copernican principle.

This theory states that the universe is homogenous—when viewed on a very large scale, different parts of the universe look essentially the same.

The Copernican principle is a built-in assumption of the current favored solutions to Einstein's equations, called the Friedmann-Robertson-Walker space-times.

"We want homogeneity in the equations, because that's what we observe in the sky," said Dragan Huterer, an astrophysicist also at the University of Michigan who was not involved in the new study.

By contrast, Smoller and Temple's solutions don't use the Copernican principle, since matter inside the ripple would be significantly less dense than matter outside.

The study authors note that there is a way their theory might not violate the Copernican principle: If the big bang's density wave gave rise to multiple ripples.

In this case, space would still retain its uniform appearance when viewed from a far enough vantage point.

Hard Pill to Swallow

For astronomers to take the idea seriously, the new model will need to account for the growing number of observations that have accumulated in favor of dark energy, the University of Michigan's Huterer said.

(Related: "Most Direct Evidence of Dark Energy Detected.")

"It's not clear at all that this model will fit the data," Huterer added. "Right now, all the claims they can make have the word 'may' in them. It 'may' explain cosmic acceleration."

But even if the wave theory withstands experimental testing, dismissing the idea of a homogenous universe would be a hard pill for many astronomers to swallow.

"The price that has to be paid is a violation of the Copernican principle, and also a very special setup of the

initial conditions [of the universe]," said Alexey Vikhlinin of Harvard-Smithsonian Center for Astrophysics in Massachusetts.

"Many cosmologists therefore consider such proposals unlikely to be realized in nature."

And in some ways, the new work raises as many troubling questions as the concept of dark energy itself, Huterer added.

"You have to wonder why we are in the middle of this [ripple]?" he said. "Why not somebody else?"
