Dark energy may be changing, and it could rewrite the universe’s fate

Story by Cassian Holt

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For a generation, cosmologists have treated dark energy as a fixed backdrop, a steady pressure stretching space faster and faster forever. Now a wave of new measurements suggests that this invisible component of the cosmos may itself be changing over time, raising the possibility that the long term story of the Universe is far more complicated than an endless, featureless expansion. If the signal holds, it would force me, and everyone who works with the standard model of cosmology, to rethink how the Universe began, how it is evolving, and how it might ultimately end.

From Einstein’s “constant” to a moving target

When Albert Einstein added the cosmological constant to his equations of general relativity more than 100 years ago, he imagined a static cosmos held in balance by a fixed term in the math. That idea was reborn in the late 1990s as dark energy, the name given to the mysterious effect that makes the expansion of the Universe accelerate rather than slow down under gravity. In the standard ΛCDM picture, that dark energy behaves exactly like Einstein's constant, with a strength that never changes in space or time.

That simple assumption is now under direct pressure. Researchers at the University of Chicago describe how new observations of distant galaxies and the large scale structure of space provide "our first indication that dark energy is not the cosmological constant introduced by Einstein over 100 years ago," arguing that the data fit better if this component evolves rather than stays fixed, a point they highlight while reconsidering the cosmological constant. Parallel work summarized later in Nov reports that astronomers are rethinking one of cosmology's biggest mysteries, with new evidence that dark energy may be evolving and that Einstein's cosmic constant might not be the final word, a shift that could shape the universe's next great revelation and is captured in fresh dark energy evidence.

DESI's precision map of the cosmos

The most disruptive clues come from the Dark Energy Spectroscopic Instrument, or DESI, which has spent years measuring the three dimensional positions of tens of millions of galaxies. By tracking how clusters of galaxies clump and how that pattern changes with distance, the project can reconstruct the expansion history of the Universe with unprecedented precision. In Mar, the DESI collaboration released an extensive analysis of their first three years of observations, using the evolving pattern of galaxies to test whether dark energy really behaves like a constant or whether it shifts over time in unexpected ways, a result they describe in new DESI analysis.

Scientists involved in this effort emphasize that the project's strength lies in its ability to follow the expansion over roughly the past 11 billion years, rather than just taking a snapshot of the nearby cosmos. In Mar, researchers at the Center for Astrophysics reported that this global collaboration, which includes CfA astronomers, used DESI to probe both dark energy and matter, finding that the data raise pointed questions about the future of the Universe and how its acceleration has changed over that 11 billion year window, a concern they detail in their DESI dark energy analysis. Earlier work already hinted at this shift, with Apr coverage noting that 2024 was DESI's year and that the first year of Dark Ene data delivered some of the strongest early signs that the ΛCDM model might need revision, a point underscored in a look back at how DESI and Dark Ene reshaped the conversation.

Hints that dark energy is weakening

What makes these measurements so provocative is the emerging pattern: several independent analyses now suggest that dark energy may be getting weaker with time rather than staying perfectly steady. In Mar, scientists working with New DESI data reported that the Universe might be changing in exactly this way, with the strength of dark energy appearing to evolve over cosmic history instead of remaining locked at a single value, a possibility they highlight in their description of how New DESI results show dark energy may evolve over time. A separate Apr summary of a Major survey of galaxies and quasars likewise notes that new findings suggest dark energy may be changing over time, hinting that it is not constant and that cosmologists will need more data to pin down dark energy's nature, a conclusion drawn from these New Major findings.

Other teams are reaching similar conclusions with different tools. An Apr report on a New survey of the sky explains that fresh DESI data provide hints that dark energy is evolving and weakening over time, based on how the expansion rate inferred from distant galaxies deviates from the expectations of a perfectly constant Λ, a pattern described in the New DESI survey. A detailed Mar analysis in Nature adds that by tracking the evolving size of baryon acoustic oscillations, the ripples in the distribution of galaxies, researchers can reconstruct how the expansion of the Universe has changed since it was 4.5 billion years old, and that this reconstruction appears to favor a scenario in which dark energy's influence is not perfectly steady, a conclusion they draw from the Mar Universe analysis.

From endless expansion to a possible Big Crunch

If dark energy is indeed fading, the stakes are enormous, because the long term fate of the cosmos depends on how this component behaves. Under the classic ΛCDM picture, a constant dark energy drives an ever faster expansion, leaving galaxies to drift apart until distant systems slip permanently beyond our horizon. But if the repulsive effect that powers this acceleration weakens, gravity could eventually regain the upper hand, slowing the expansion and perhaps reversing it. In Mar, one widely discussed interpretation of the DESI results suggested that if the first year of DESI findings are correct, the accelerated expansion of the Universe will cease and the cosmos could ultimately collapse in a “Big Crunch” scenario, an outcome framed explicitly in an Apr discussion of how Apr DESI results challenge the cosmological constant.

Other commentators have picked up the same thread, sometimes in starker language. A Mar report from NPR notes that dark energy is weakening and that the Universe could eventually collapse, describing dark energy as a mysterious force that appears to be losing strength and raising the possibility that space might one day pull back in on itself according to new research, a scenario they outline in their Mar Dark NPR coverage. In Dec, another study went further, arguing that Our universe is heading for gravitational collapse known as the Big Crunch as dark matter is rapidly changing, a claim that ties the ultimate fate of the cosmos to shifting properties of both dark matter and dark energy and that is described in detail in a report on how Our Big Crunch might unfold. While these scenarios remain speculative, they illustrate how quickly the conversation shifts once dark energy is allowed to change.

Why cosmologists are cautious but excited

For all the drama of a possible cosmic collapse, most cosmologists I speak with are careful to stress that the evidence for evolving dark energy is still emerging and that the current signals are not yet definitive. A Mar overview of the DESI findings notes that if dark energy ebbs with time, which now seems plausible, the Universe could one day stop expanding and then eventually contract, but it also emphasizes that the current measurements are early steps and that more data will be needed to confirm whether the trend is real or a statistical fluke, a balance captured in a report on how Mar observations could rewrite our understanding of the Universe’s fate. At the same time, the Chicago team’s argument that dark energy may fit the data better if it is not the simple cosmological constant introduced by Einstein over 100 years ago shows why theorists are already sketching out new models that allow this component to evolve, building on the Sep Einstein rethink of the cosmological constant.

What makes this moment so compelling is that the tools now in hand are finally precise enough to test ideas that were purely theoretical a decade ago. DESI's detailed map of galaxies, the New survey results pointing to a weakening dark energy signal, and the broader effort to reconcile these findings with Einstein's century old equations all point in the same direction: the Universe may be more dynamic at the deepest level than the tidy ΛCDM model suggests. If that is true, then the question of whether we live in a cosmos that expands forever, coasts to a halt, or ends in a Big Crunch is no longer a matter of philosophical taste, but a measurable property of nature that instruments like DESI, and the next generation of surveys that will follow it, are finally starting to pin down, a shift that began when 2024 was DESI's year and the first wave of Dark Ene data hinted that we were only just starting to understand Dec DESI Dark Ene at all.

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