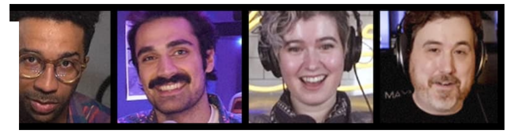

sing the Universe's Growth, Scientists Say

The unexplained cause of the slowed growth of the cosmic web that connects galaxies could hint at new physics.

By Becky Ferreira

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ARTIST'S DEPICTION OF THE COSMIC WEB. IMAGE: ANDRIY ONUFRIYENKO VIA GETTY IMAGES

Something unknown appears to be suppressing the growth of the gargantuan structures that connect the universe in a cosmic web, a finding that challenges our current understanding of physics, according to a new study.

Scientists have presented new observational evidence that large-scale structures, which are enormous filaments and nodes made of gas and dark matter, are growing at a slower rate than predicted by the standard model of cosmology. The growth of these structures—meaning the rate at which they clump d help to explain a

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The cosmic web is a network of large-scale structures that stretch for hundreds of millions of light years and intersect at points called nodes. These structures are primarily made of dark matter, an unidentified substance that accounts for most of the mass of the universe. The cosmic web influences the distribution of matter in the universe; gas and galaxies travel along the filaments and accumulate into dense regions, such as galaxy clusters, at the nodes.

The standard model, also known as the Lambda cold dark matter model (ΛCDM), offers predictions about the long-scale evolution of these structures, which have mostly been validated by observations. However, some observations seem to defy the model, such as the value of sigma-8, which is a term used to describe the distribution of matter in the universe.

Now, scientists led by Minh Nguyen, an astrophysicist and cosmologist at the University of Michigan, suggest that the growth of large-scale structures has been suppressed in the modern universe, even as the overall expansion of the universe has accelerated over time due to a mysterious force known as dark energy. The researchers concluded that some “cosmological tensions can be interpreted as evidence of growth suppression” and that the sigma-8 tension could be effectively resolved by their hypothesis, according to a new study published in *Physical Review Letters*.

“We did not set out to look for evidence of a late-time suppression specifically,” said Nguyen in an email to Motherboard. “Our original intention was to see whether the history of the cosmic background expansion is consistent with the history of cosmic structure growth.”

“The universe has always been expanding, and lately the expansion has accelerated,” he continued. “This expansion has always acted as a ‘friction’ against the growth of cosmic structures (while gravity has the opposite effect to growth). Therefore—even

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es over the course of the universe's 13.8-billion-year lifetime. The oldest light in the universe, known as the cosmic microwave background (CMB), reveals insights about the cosmic web in the deep past. Scientists also use a cosmic effect called gravitational lensing, in which light is warped and brightened by massive objects as it moves through space, to map out the distribution of matter in the more recent "dark-energy-dominated" universe, which began about four billion years ago.

Nguyen and his colleagues created a timeline of large-scale structure evolution that incorporates both of these techniques, as well as movements of local galaxies to help fill in more recent growth patterns. The new study is the first to show that these different datasets from various probes—each of which reveal distinct cosmic eras and spatial scales—appear to "separately and jointly prefer a late-time growth suppression," Nguyen said.

"Seeing that different data sets are in tension in the standard model, yet are consistent within an alternative where growth has been suppressed recently, we were then motivated to investigate and able to show that many other current cosmological tensions can be related to this growth anomaly," he explained. "I think we're also the first to do this."

If future studies were to corroborate the findings, scientists could potentially resolve the finicky sigma-8 tension. This cosmological problem arises from the fact that measurements using the CMB, gravitational lensing, and other techniques return different values of sigma-8. Nguyen and his colleagues suggest this is because the growth, or "clumpiness," of large-scale structures is actually quite different over the course of the universe's lifetime relative to the predictions of the standard model. To that end, the team's new constraints on this late-stage growth suppression turned out to be statistically strong, reaching a high confidence level known as "4-sigma."

"It's definitely surprising and interesting given the ~4-sigma significance we achieved," Nguyen said. "We're more surprised by the statistical significance of the finding. In fact, we went back and forth for a long time to see if we had missed something. The actual analysis and writing took much less time than all the testing and checking, hunting for a computer bug or assumption error that's never there."

findings, and figure out exactly what it

ematic-driven 'discovery,' Nguyen said.
experiments" and "examine data of
and scales since at the end of the day,
or growth (and expansion) at all times and

"We think the universe is trying to tell us something," he concluded. "We're not sure yet what it really means, but we will keep listening and report back!"

Update: *This article has been updated to include comments from lead author Minh Nguyen.*

TAGGED: SPACE, UNIVERSE, PHYSICS, NEW PHYSICS, ASTRONOMY, COSMIC WEB, ABSTRACT