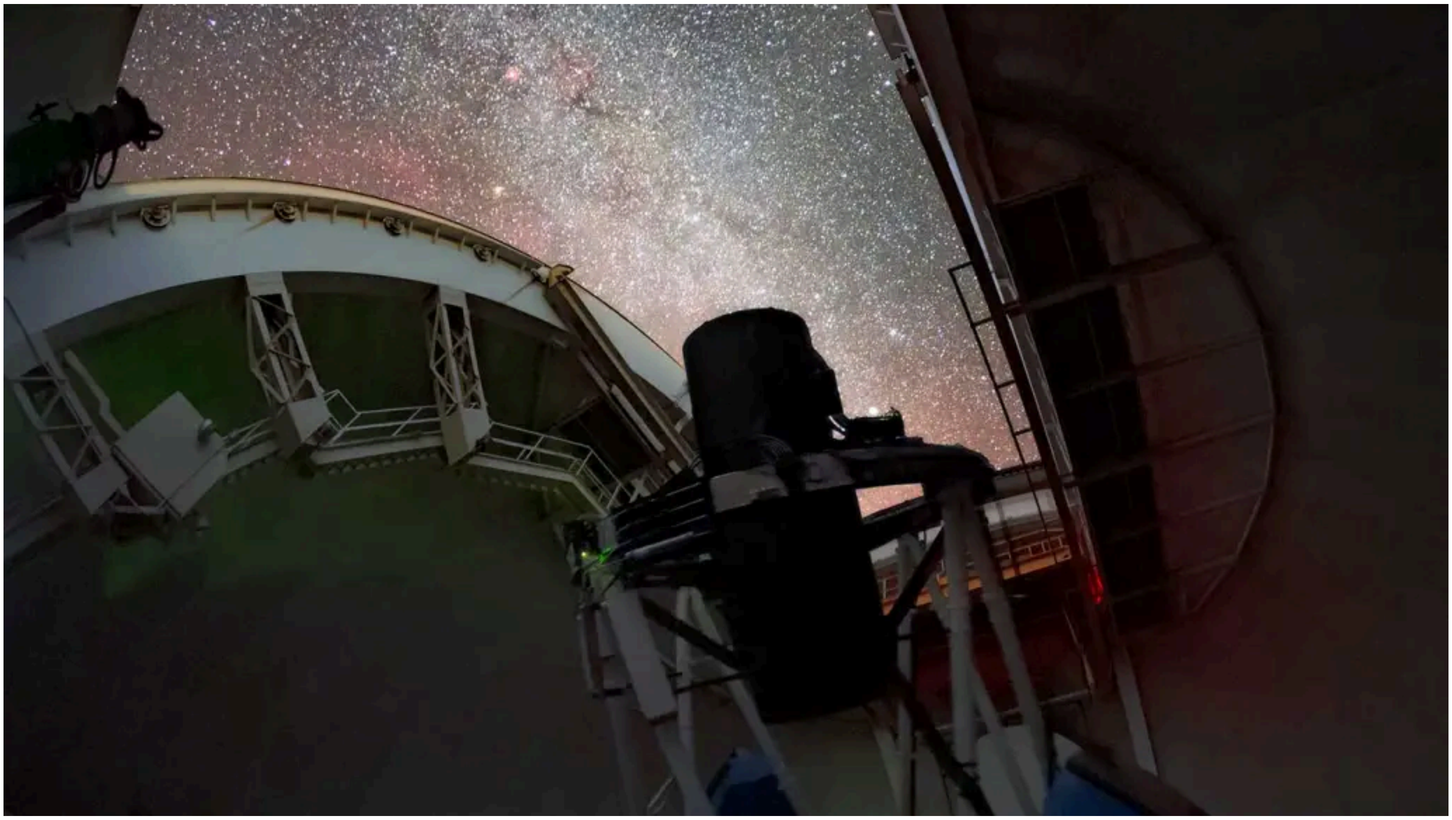
ScienceNews SIGN IN

NEWS COSMOLOGY

Einstein's gravity endures despite a dark energy puzzle

An analysis upholds general relativity but hints dark energy may vary over time



Scientists mapped galaxies with the Dark Energy Spectroscopic Instrument at the Mayall telescope (shown) at Kitt Peak National Observatory in Arizona.
T. SLOVINSKÝ, KPNO/AURA/NSF, NOIRLAB

By Emily Conover

15 HOURS AGO

Scientists could be wrong about dark energy. But they're right about gravity, a new study suggests.

Dark energy, the mysterious phenomenon that causes the expansion of the cosmos to accelerate, is widely thought to have had a constant density throughout the history of the universe. But dark energy may instead be waning, researchers from the Dark Energy Spectroscopic Instrument, or DESI, collaboration report November 19 in a batch of papers posted to the project's website and arXiv.org.

thorough look at the same data used in the earlier report — confirms that the DESI data agree with general relativity, Albert Einstein’s theory of gravity, with no evidence for alternative, “modified gravity” theories.

DESI makes a 3-D map of galaxies throughout the cosmos. The project’s previous analysis focused only on one type of information gleaned from that map: baryon acoustic oscillations, sound waves in the early universe that left imprints on the cosmos that are visible today (*SN: 3/4/19*).

The new analysis adds information on how galaxies and other structures evolve over cosmic history. “This is the first time we are sensitive to how structure grows with time,” says cosmologist Dragan Huterer of the University of Michigan in Ann Arbor. “This is significant because the growth of structure is well known to be very sensitive to dark energy and modified gravity.”

In both analyses, the researchers found signs of a variation in dark energy’s equation of state, the relationship between its pressure and density over time. “We are pointing at the same conclusion, and this is … completely reassuring,” says cosmologist Pauline Zarrouk of CNRS and the Laboratoire de Physique Nucléaire et de Hautes Énergies in Paris. Because the two analyses are based on the same data, “if we were not seeing the same [conclusion], that would really be an issue.” (In both cases, the team combined DESI’s data with other cosmological data, including data on the cosmic microwave background, the oldest light in the universe.)

With the first result, DESI researchers were sticking their necks out, says physicist Daniel Scolnic of Duke University. “They’re not backing away from that. A lot of times when there’s some big result in cosmology, it feels like a month later — it’s gone.” But with DESI, “their neck’s still out. I really respect

If dark energy is confirmed to vary, it would send a jolt through cosmology, overthrowing scientists' accepted theory, the standard cosmological model. That theory has been extremely successful at describing the cosmos, but it includes poorly understood components, like dark energy and the likewise unidentified source of mass called dark matter (*SN: 8/26/24*).

In an attempt at a more satisfying explanation of the cosmos, some scientists are tweaking general relativity, which describes gravity as a result of mass warping spacetime. Modified gravity theories could potentially do away with the need for dark matter or dark energy (*SN: 7/5/24*). But the structure formation that DESI observed was consistent with that predicted by general relativity. And there's no evidence for modified gravity, although the theories are not fully ruled out.

In the new study, a puzzle persists about the masses of neutrinos, lightweight subatomic particles that are plentiful in the cosmos. Like DESI's first analysis, the new findings indicate that the sum of the masses of the three types of neutrinos is smaller than expected, at least by some accounts (*SN: 9/20/24*). That could hint that cosmologists have misunderstood something about the nature of the cosmos or about neutrinos themselves.

In 2025, the DESI collaboration plans to release results based on the project's first three years of data. That will be a true test of how robust the results are, including whether dark energy indeed changes over time.

Scolnic envisions the standard cosmological model as a bonfire. While scientists had been enjoying sitting around the warm glow, with the DESI results, sparks have begun to fly. "This is when you tell everyone, 'Let's just take a step back from the bonfire, just to be safe. … We're not throwing water on the whole thing, but definitely just one step back.'"

CITATIONS

DESI Collaboration. DESI 2024 VII: cosmological constraints from the full-shape modeling of clustering measurements. Published online November 19, 2024.

M. Ishak *et al*. Modified gravity constraints from the full shape modeling of clustering measurements from DESI 2024. Published online November 19, 2024.