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▲ Based on analysis of 300 galaxies, South Korean scientists say supernovae brightness varies strongly with the age of stars

NASA, ESA, THE HUBBLE KEY PROJECT TEAM, AND THE HIGH-Z SUPERNOVA SEARCH TEAM | © 2025 BLUE ORIGIN | CALTECH, R. HURT (IPAC)

The Universe's expansion may be slowing down

New study suggests current theories of dark energy could be wrong

The prevailing Nobel Prize-winning theory that the Universe is expanding at an ever-accelerating rate due to the unseen influence of dark energy has been called into question by a new study.

Astronomers at Yonsei University in South Korea found evidence that the 'standard candles' used to measure cosmic distances and calculate how fast the Universe is expanding may not be as standard as thought. These 'candles' are Type Ia supernovae, exploding stars that all reach a consistent, well-known peak of brightness, meaning the dimmer the Type Ia supernova, the farther away it is.

However, by measuring a larger sample of 300 galaxies, the team found evidence that these supernovae are strongly affected by the age of their progenitor stars and are less reliable as brightness benchmarks. They declared a high statistical confidence – 99.99 per cent – in this age–brightness relation.

When the team corrected for the age of the supernovae, the data showed that the Universe was still expanding, but that expansion was already slowing down. Lead researcher Professor Young-Wook Lee explains: "Our study shows that the Universe has already entered a phase of decelerated expansion at the present epoch and that dark energy evolves with time much more rapidly than previously thought. If these results are confirmed, it would mark a major paradigm shift in cosmology since the discovery of dark energy 27 years ago."

This view is likely to prove controversial, as the results conflict with the current standard model of Big Bang cosmology, the Lambda-CDM (ΛCDM) model. Instead, they align more with a new model favoured by the Dark Energy Spectroscopic Instrument (DESI) project, derived from baryonic acoustic oscillations (BAO) – essentially, the sound of the Big Bang – and cosmic microwave background (CMB) data.

With theories of the Universe's future now in question, it's likely to take more evidence for this theory to be proved correct – but it's coming. As the paper's co-lead author Professor Chul Chung explains: "Within the next five years, with the Vera C Rubin Observatory discovering more than 20,000 new supernova host galaxies, precise age measurements will allow for a far more robust and definitive test of supernova cosmology."
www.yonsei.ac.kr

▶ **Read our interview with Professor Young-Wook Lee on page 98**

Anita Chandran talks to Professor Young-Wook Lee

Q&A WITH A GALAXY EVOLUTION EXPERT

Fresh evidence shows supernovae aren't the trusty yardsticks we thought, putting the standard model of an accelerating, expanding Universe in doubt

▲ Astronomers rely on the consistent brightness of dying stars to judge the expansion of space – but now research suggests it may not be constant at all

MARK GARLICK, SCIENCE PHOTO LIBRARY, ALAMY

How do astronomers currently think the Universe is expanding?
Astronomers have long believed the Universe is expanding at an accelerating rate, driven by what we call 'dark energy'. This led to a model known as Lambda cold dark matter (ΛCDM), in which the density of dark energy doesn't vary with time. Then, 27 years ago, a group of scientists observed distant supernovae – specifically Type Ia supernovae – and found they were dimmer than expected. This fitted the predictions of ΛCDM very well, which is how we got the model of the Universe we have today.

What did your team discover instead?
Type Ia supernovae were used to test ΛCDM because they were thought to explode with an almost identical intrinsic brightness, making them good reference objects. Instead, we found that the brightness of Type Ia supernovae is strongly affected by the age of the stars they come from.

After taking account of their age, supernovae from younger populations of stars appear fainter and those from older stars appear brighter. We found an extremely high significance rate for our findings (over 99.9999999 per cent confidence) in a sample of over 300 galaxies. This means that the dimming of supernovae does not just arise from cosmological effects like the acceleration of the Universe, but also from stellar astrophysics. As a result, the data we collected no longer matches the ΛCDM model.

What kind of alternative model of the Universe does this point to?
Our data points to a model of the Universe based on 'time-varying dark energy', where instead of dark energy acting in a fixed, constant way, its impacts vary with time. These models are also supported by data from other projects, like the Dark Energy Spectroscopic Instrument (DESI).

How did you make this discovery?
We started this project in 2010, when South Korea lacked its own telescope. We sent two students to Chile and Arizona to collect extremely high-quality spectral data of 60 galaxies. Our project has since been extended to 300 host galaxies by employing photometric age measurements. This data is like a fingerprint, giving astronomers an accurate idea of the properties of an astronomical object, including its composition.

It was from this data, and the well-established DESI model, that we found that the age of the host galaxy impacts the brightness of supernovae within it.

What are the implications if the ΛCDM model of expansion is wrong?
The history of the Universe will change. Even the age of the Universe will change slightly. Interestingly, the future of the Universe will change too. It could potentially lead to a 'big crunch' scenario – which some cosmologists have discussed based on our result – where the Universe collapses back down to a singularity after finishing its expansion. We cannot say for certain at this stage, but it's certain that the Universe's story will be rewritten.

Why do you think this correction wasn't made earlier?
In most previous studies concerning these supernovae, the ages of the host galaxies were not directly measured. Instead, they were inferred indirectly from the mass of the host galaxy. This practice has become routine, but we've found that mass is not a reliable proxy for age, because galaxies evolve very differently with redshift (or cosmic time). By applying a correction based on directly measured ages, rather than on a proxy, we have been able to show a dramatically different result for cosmology.

What's next for your discovery?
We have a bright future ahead, with the launch of telescopes like the Vera Rubin Observatory, which South Korean astronomers are also members of. It will discover more than 20,000 new supernovae host galaxies, and precise measurements will enable a more definitive test of supernova cosmology.

Young-Wook Lee is the director of the Centre for Galaxy Evolution Research at Yonsei University, Seoul, South Korea