Einstein Proven Right again—Theory of General Relativity Confirmed to Work in Distant Galaxy

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Astronomers Complete Most Precise Test Of Einstein's General Relativity

Tech & Science Albert Einstein Physics general relativity

In 1915, Albert Einstein outlined his general theory of relativity (GR) in which he described the nature of gravity and transformed our understanding of the universe.

In the years since, scientists have confirmed that the theory works within our solar system, but not beyond the Milky Way—until now.

According to a study published in the journal *Science*, an international team of researchers led by Thomas Collett from the Institute of Cosmology and Gravitation at the University of Portsmouth has made the most precise test of GR outside of the Milky Way,

"GR has been tested very precisely inside the solar system, originally by [Arthur] Eddington using the eclipse of 1919 to measure the curvature of space near the sun," Collett told *Newsweek*. "[But] outside the solar system GR hasn't been tested anything like so well."

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The scientists used data from NASA's Hubble Space Telescope and the European Southern Observatory's Very Large Telescope (VLT) to show that gravity in a distant galaxy behaves as GR predicts, confirming the theory's validity.

To precisely test gravity at this scale, the team harnessed an effect known as gravitational lensing created by a nearby galaxy known as ESO 325-G004. This galaxy distorts light travelling towards Earth from a more distant galaxy that lies directly behind it.

"General Relativity predicts that massive objects deform space-time, this means that when light passes near another galaxy the light's path is deflected," Collett said in a statement.

"If two galaxies are aligned along our line of sight this can give rise to a phenomenon, called strong gravitational lensing, where we see multiple images of the background galaxy. If we know the mass of the foreground galaxy, then the amount of separation between the multiple images tells us if General Relativity is the correct theory of gravity on galactic scales."

To find out the mass of ESO 325-G004 the team measured the movement of stars within it using VLT, enabling them to infer how much mass there must be in the galaxy to hold all of its stars in orbit.

They then compared this mass to ESO 325-G004's gravitational lensing effect, as seen by Hubble, to measure the strength of gravity, giving a result which is in line with GR.

In the known universe, scientists know of a few hundred strong gravitational lenses, but most of them are too distant to precisely measure their mass. ESO 325-G004 is one of the closest lenses, located just 450 million light-years from Earth.

This image from the NASA/ESA Hubble Space Telescope shows the diverse collection of galaxies in the cluster Abell S0740 that is over 450 million light-years away in the direction of the constellation Centaurus. The giant elliptical ESO 325-G004 looms large at the cluster's centre. NASA, ESA, and The Hubble Heritage Team (STScI/AURA)

Testing the long-range properties of gravity is crucial to validating current scientific models of the universe. The latest findings, for example, could have implications for alternative theories of gravity, according to the researchers. These theories predict that gravity behaves differently at astronomical scales to how it does on the smaller scale of the Solar System.

"Our result validates GR on scales up to 6000 light years," Collett said. "The expansion of the Universe is speeding up. Assuming GR is correct, we interpret this as evidence for a mysterious dark energy that is driving this acceleration."

"Alternatives to GR have been proposed that can have accelerated expansion without dark energy," he added. "These theories predict deviations from GR over large distances. We see no evidence of this, so either dark energy is real or GR breaks down on scales larger than 6000 light years."