Astrophysicists spy ultra-distant galaxy amidst cosmic 'dark ages'

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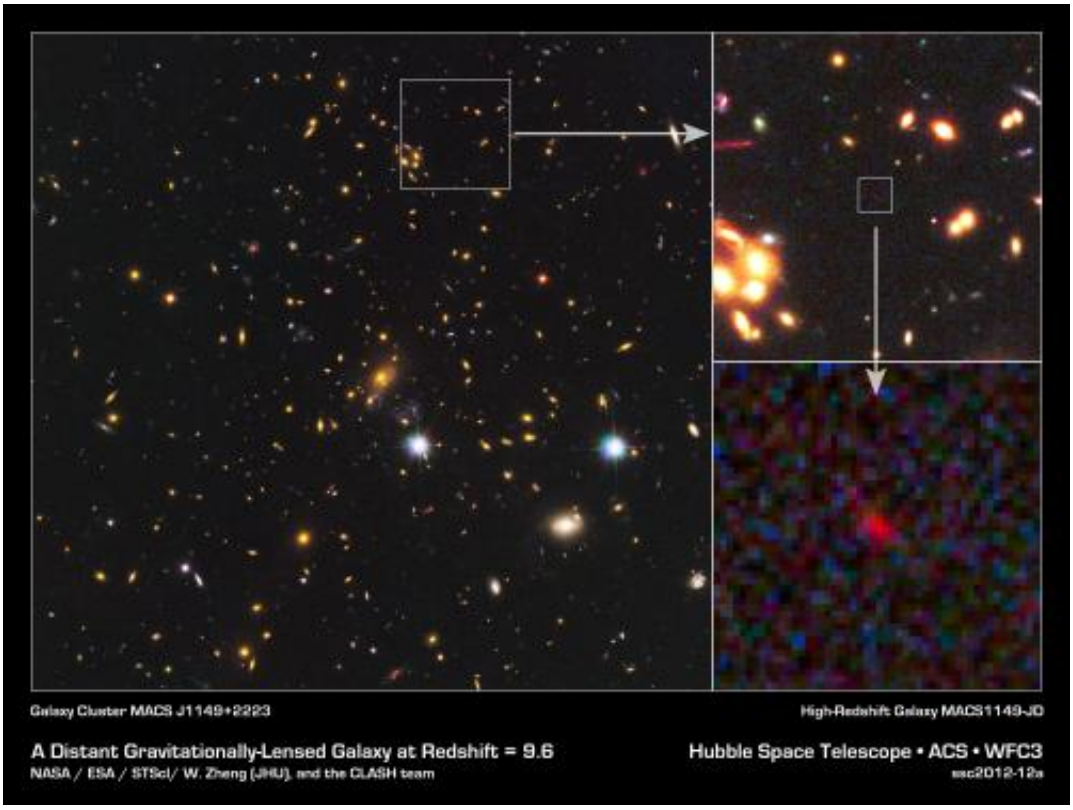

In the big image at left, the many galaxies of a massive cluster called MACS J1149+2223 dominate the scene. Gravitational lensing by the giant cluster brightened the light from the newfound galaxy, known as MACS 1149-JD, some 15 times. At upper right, a partial zoom-in shows MACS 1149-JD in more detail, and a deeper zoom appears to the lower right. Credit: NASA/ESA/STScI/JHU

With the combined power of NASA's Spitzer and Hubble space

telescopes as well as a cosmic magnification effect, a team of astronomers led by Wei Zheng of The Johns Hopkins University has spotted what could be the most distant galaxy ever detected.

Light from the young galaxy captured by the orbiting observatories shone forth when the 13.7-billion-year-old universe was just 500 million years old.

The far-off galaxy existed within an important era when the universe began to transit from the so-called "Dark Ages." During this period, the universe went from a dark, starless expanse to a recognizable cosmos full of galaxies. The discovery of the faint, small galaxy accordingly opens up a window into the deepest, remotest epochs of cosmic history.

"This galaxy is the most distant object we have ever observed with high confidence," said Zheng, a principal research scientist in The Henry A. Rowland Department of Physics and Astronomy at Johns Hopkins' Krieger School of Arts and Sciences and lead author of a paper appearing in *Nature* on Sept. 20. "Future work involving this galaxy—as well as others like it that we hope to find—will allow us to study the universe's earliest objects and how the Dark Ages ended."

Light from the primordial galaxy traveled approximately 13.2 billion light-years before reaching NASA's telescopes. In other words, the starlight snagged by Spitzer and Hubble left the galaxy when the universe was just 3.6 percent of its present age. Technically speaking, the galaxy has a redshift, or "z," of 9.6. The term "redshift" refers to how much an object's light has shifted into longer wavelengths as a result of the expansion of the universe. Astronomers use "redshift" to describe cosmic distances.

Unlike previous detections of galaxy candidates in this age range, which were only glimpsed in a single color, or waveband, this newfound galaxy

has been seen in five different wavebands. As part of the Cluster Lensing and Supernova Survey with Hubble program (CLASH), the Hubble Space Telescope registered the newly described far-flung galaxy in four wavelength bands. Spitzer located it in a fifth band with its Infrared Array Camera (IRAC), placing the discovery on firmer ground.

Objects at these extreme distances are mostly beyond the detection sensitivity of today's largest telescopes. To catch sight of these early, distant galaxies, astronomers rely on "gravitational lensing." In this phenomenon—predicted by Albert Einstein a century ago—the gravity of foreground objects warps and magnifies the light from background objects. A massive galaxy cluster situated between our galaxy and the early galaxy magnified the latter's light, brightening the remote object some 15 times and bringing it into view.

Based on the Spitzer and Hubble observations, astronomers think the distant galaxy was spied at a time when it was less than 200 million years old. It also is small and compact, containing only about 1 percent of the Milky Way's mass. According to leading cosmological theories, the first galaxies should indeed have started out tiny. They then progressively merged, eventually accumulating into the sizable galaxies of the more modern universe.

These first galaxies likely played the dominant role in the epoch of reionization, the event that signaled the demise of the universe's Dark Ages. About 400,000 years after the Big Bang, neutral hydrogen gas formed from cooling particles. The first luminous stars and their host galaxies, however, did not emerge until a few hundred million years later. The energy released by these earliest galaxies is thought to have caused the neutral hydrogen strewn throughout the universe to ionize, or lose an electron, the state in which the gas has remained since that time.

"In essence, during the epoch of reionization, the lights came on in the

universe," said paper co-author Leonidas Moustakas, a research scientist at NASA's Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, Calif.

Astronomers plan to study the rise of the first stars and galaxies and the epoch of reionization with the successor to both Spitzer and Hubble—NASA's James Webb Telescope, slated for launch in 2018. The newly described distant galaxy will likely be a prime target.

Holland Ford, one of Zheng's colleagues and a co-author on the paper, commented on the findings.

"Science is very exciting when we explore the frontiers of knowledge," said Ford, a physics and astronomy professor at Johns Hopkins. "One of these frontiers is the first few hundred million years after the birth of our universe. Dr. Zheng's many years of searching for quasars and galaxies in the dawn of the universe has paid off with his discovery of a galaxy that we see as it was when the universe was less than 500 million years old.

"With his discovery, we are seeing a galaxy when it was not even a toddler," Ford said. "But this infant galaxy will in its future grow to be a galaxy like our own, hopefully hosting planetary systems with astronomers who will look back in time and see our galaxy in its infancy."

Provided by Johns Hopkins University