

# Astronomers spot distant galaxy group driving ancient cosmic makeover

January 6 2020, by Francis Reddy

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This composite of archival Hubble Space Telescope visible and near-infrared images shows a part of the Extended Groth Strip, a well-studied area located between the constellations Ursa Major and Boötes. The three galaxies of the EGS77 galaxy group, shown in the green circles, lie at a redshift of 7.7, which means we're seeing the galaxies as they were when the universe was just 680 million years old. The image is 3.2 arcminutes across. Credit: NASA, ESA and V. Tilvi (ASU)

An international team of astronomers funded in part by NASA has found the farthest galaxy group identified to date. Called EGS77, the trio of galaxies dates to a time when the universe was only 680 million years old, or less than 5% of its current age of 13.8 billion years.

More significantly, observations show the galaxies are participants in a sweeping cosmic makeover called reionization. The era began when [light](#) from the [first stars](#) changed the nature of hydrogen throughout the universe in a manner akin to a frozen lake melting in the spring. This transformed the dark, light-quenching early cosmos into the one we see around us today.

"The young universe was filled with [hydrogen atoms](#), which so attenuate [ultraviolet light](#) that they block our view of early galaxies," said James Rhoads at NASA's Goddard Space Flight Center in Greenbelt, Maryland, who presented the findings on Jan. 5 at the 235th meeting of the American Astronomical Society in Honolulu. "EGS77 is the first galaxy group caught in the act of clearing out this cosmic fog."

While more distant individual galaxies have been observed, EGS77 is the farthest galaxy group to date showing the specific wavelengths of far-ultraviolet light revealed by reionization. This emission, called Lyman alpha light, is prominent in all members of EGS77.

In its earliest phase, the universe was a glowing plasma of particles, including electrons, protons, atomic nuclei, and light. Atoms could not yet exist. The universe was in an ionized state, similar to the gas inside a lighted neon sign or fluorescent tube.

After the universe expanded and cooled for about 380,000 years, electrons and protons combined into the first atoms—more than 90% of them hydrogen. Hundreds of millions of years later, this gas formed the first stars and galaxies. But the very presence of this abundant gas poses challenges for spotting galaxies in the early universe.

Hydrogen atoms readily absorb and quickly re-emit far-ultraviolet light known as Lyman alpha emission, which has a wavelength of 121.6 nanometers. When the first stars formed, some of the light they

produced matched this wavelength. Because Lyman alpha light easily interacted with hydrogen atoms, it couldn't travel far before the gas scattered it in random directions.

"Intense light from galaxies can ionize the surrounding hydrogen gas, forming bubbles that allow starlight to travel freely," said team member Vithal Tilvi, a researcher at Arizona State University in Tempe. "EGS77 has formed a large bubble that allows its light to travel to Earth without much attenuation. Eventually, bubbles like these grew around all galaxies and filled intergalactic space, reionizing the universe and clearing the way for light to travel across the cosmos."

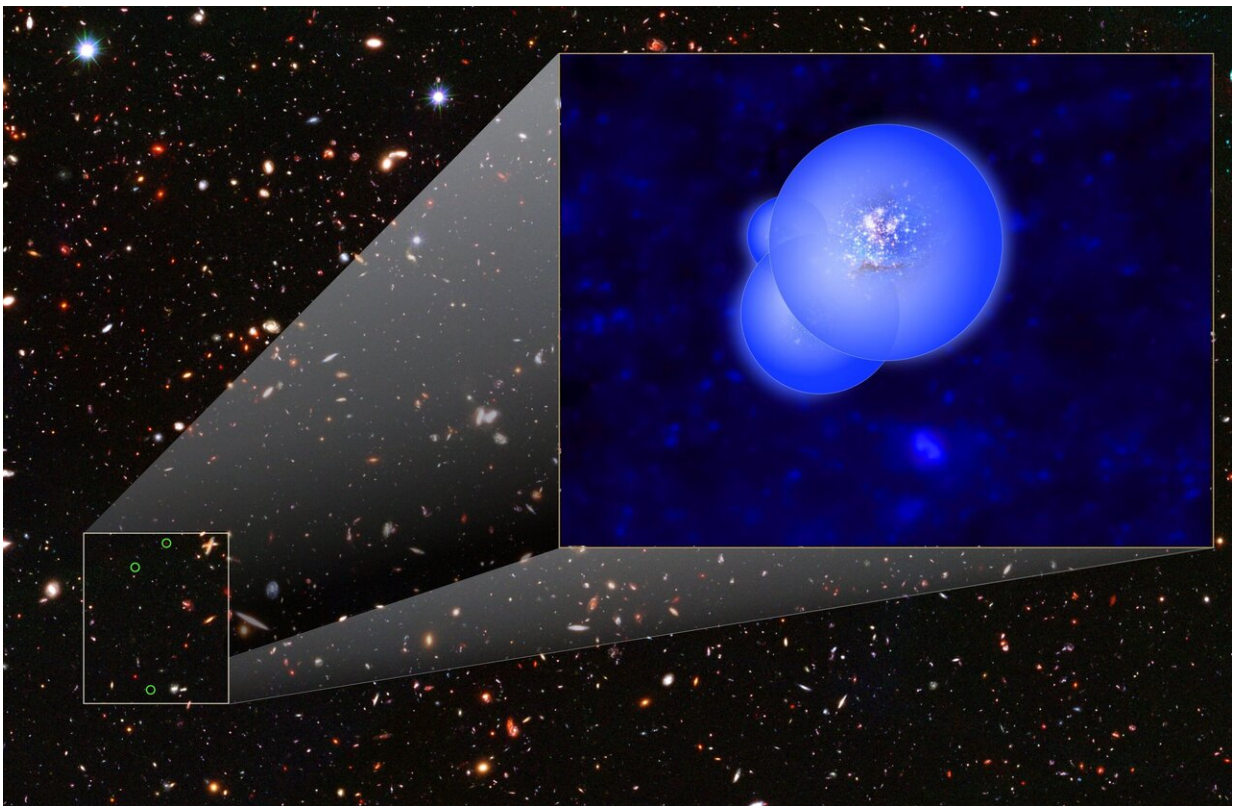
EGS77 was discovered as part of the Cosmic Deep And Wide Narrowband (Cosmic DAWN) survey, for which Rhoads serves as principal investigator. The team imaged a small area in the constellation Boötes using a custom-built filter on the National Optical Astronomy Observatory's Extremely Wide-Field InfraRed Imager (NEWFIRM), which was attached to the 4-meter Mayall telescope at Kitt Peak National Observatory near Tucson, Arizona.

Because the [universe](#) is expanding, Lyman alpha light from EGS77 has been stretched out during its travels, so astronomers actually detect it at near-infrared wavelengths. We can't see these galaxies in visible light now because that light started out at shorter wavelengths than Lyman alpha and was scattered by the fog of hydrogen atoms.

To help select distant candidates, the researchers compared their images with publicly available data of the same region taken by NASA's Hubble and Spitzer space telescopes. Galaxies appearing brightly in near-infrared images were tagged as possibilities, while those appearing in visible light were rejected as being too close.

The team confirmed the distances to EGS77's galaxies by using the

Multi-Object Spectrometer for Infra-Red Exploration (MOSFIRE) on the Keck I telescope at the W. M. Keck Observatory on Maunakea, Hawaii. The three galaxies all show Lyman alpha emission lines at slightly different wavelengths, reflecting slightly different distances. The separation between adjacent galaxies is about 2.3 million light-years, or slightly closer than the distance between the Andromeda galaxy and our own Milky Way.



Inset: This illustration of the EGS77 galaxy group shows the galaxies surrounded by overlapping bubbles of ionized hydrogen. By transforming light-quenching hydrogen atoms to ionized gas, ultraviolet starlight is thought to have formed such bubbles throughout the early universe, gradually transitioning it from opaque to completely transparent. Background: This composite of archival Hubble Space Telescope visible and near-infrared images includes the three galaxies of EGS77 (green circles). Credit: NASA, ESA and V. Tilvi (ASU)



A paper describing the findings, led by Tilvi, has been submitted to *The Astrophysical Journal*.

"While this is the first galaxy group identified as being responsible for cosmic reionization, future NASA missions will tell us much more," said co-author Sangeeta Malhotra at Goddard. "The upcoming James Webb Space Telescope is sensitive to Lyman alpha emission from even fainter galaxies at these distances and may find more [galaxies](#) within EGS77."

Astronomers expect that similar reionization bubbles from this era will be rare and hard to find. NASA's planned Wide Field Infrared Survey Telescope (WFIRST) may be able to uncover additional examples, further illuminating this important transition in cosmic history.

Provided by NASA

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