ASU astronomers discover faintest distant galaxy

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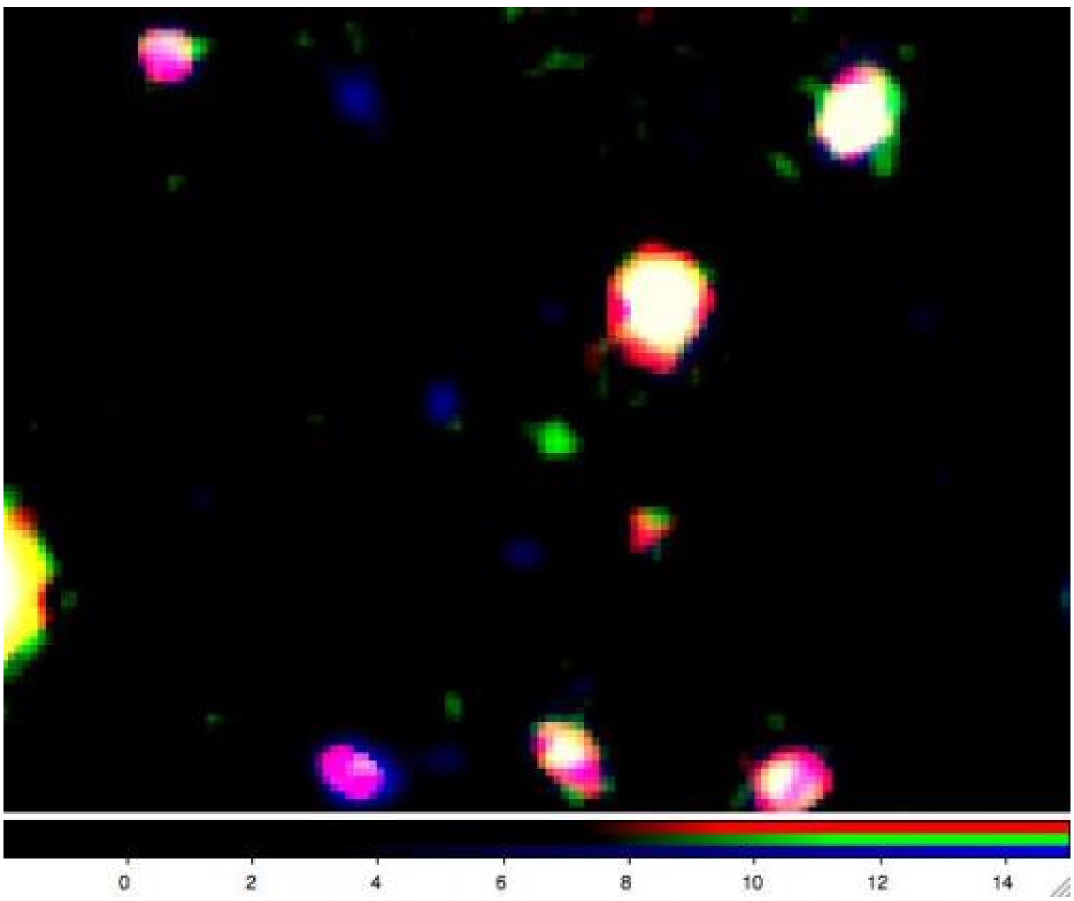

This is a false color image of the galaxy LAEJ095950.99+021219.1 . In this image, blue corresponds to optical light (wavelength near 500 nm), red to near-infrared light (wavelength near 920 nm), and green to the narrow range of wavelengths admitted by the narrow bandpass filter (around 968 nm). LAEJ095950.99+021219.1 appears as the green source near the center of the image cutout. The image shows about 1/6000 of the area that was surveyed. Credit: James Rhoads

Astronomers at Arizona State University have found an exceptionally distant galaxy, ranked among the top 10 most distant objects currently known in space. Light from the recently detected galaxy left the object about 800 million years after the beginning of the universe, when the universe was in its infancy.

A team of astronomers, led by James Rhoads, Sangeeta Malhotra, and Pascale Hibon of the School of Earth and Space Exploration at ASU, identified the remote galaxy after scanning a moon-sized patch of sky with the IMACS instrument on the Magellan Telescopes at the Carnegie Institution's Las Campanas Observatory in Chile.

The observational data reveal a faint infant galaxy, located 13 billion light-years away. "This galaxy is being observed at a young age. We are seeing it as it was in the very distant past, when the universe was a mere 800 million years old," says Rhoads, an associate professor in the school. "This image is like a baby picture of this galaxy, taken when the universe was only 5 percent of its current age. Studying these very early galaxies is important because it helps us understand how galaxies form and grow."

The galaxy, designated LAEJ095950.99+021219.1, was first spotted in summer 2011. The find is a rare example of a galaxy from that early epoch, and will help astronomers make progress in understanding the process of galaxy formation. The find was enabled by the combination of the Magellan telescopes' tremendous light gathering capability and exquisite image quality, thanks to the mirrors built in Arizona's Steward Observatory; and by the unique ability of the IMACS instrument to obtain either images or spectra across a very wide field of view. The research, published in the June 1 issue of The Astrophysical Journal Letters, was supported by the National Science Foundation (NSF).

The recently discovered LAEJ095950.99+021219.1 galaxy is extremely faint and was detected by the light emitted by ionized hydrogen. The search employed a technique ASU professors James Rhoads and Sangeeta Malhotra pioneered that uses special narrowband filters that allow a small wavelength range of light through. In this photo, a narrowband filter is being mounted in a filter holder for use in the instrument IMACS (the Inamori-Magellan Areal Camera & Spectrograph). IMACS was built by a team at the Observatories of the Carnegie Institute of Washington, led by Alan Dressler. Credit: James Rhoads

This galaxy, like the others that Malhotra, Rhoads, and their team seek, is extremely faint and was detected by the light emitted by ionized hydrogen. The object was first identified as a candidate early-universe galaxy in a paper led by team member and former ASU postdoctoral researcher Hibon. The search employed a unique technique they pioneered that uses special narrow-band filters that allow a small wavelength range of light through.

A special filter fitted to the telescope camera was designed to catch light of narrow wavelength ranges, allowing the astronomers to conduct a very sensitive search in the infrared wavelength range. "We have been using this technique since 1998 and pushing it to ever-greater distances and sensitivities in our search for the first galaxies at the edge of the universe," says Malhotra, an associate professor in the school. "Young galaxies must be observed at infrared wavelengths and this is not easy to do using ground-based telescopes, since the Earth's atmosphere itself glows and large detectors are hard to make."

To be able to detect these very distant objects which were forming near the beginning of the universe, astronomers look for sources which have very high redshifts. Astronomers refer to an object's distance by a number called its "redshift," which relates to how much its light has stretched to longer, redder wavelengths due to the expansion of the universe. Objects with larger redshifts are farther away and are seen further back in time. LAEJ095950.99+021219.1 has a redshift of 7. Only a handful of galaxies have confirmed redshifts greater than 7, and none of the others is as faint as LAEJ095950.99+021219.1.

A team of astronomers led by ASU professors James Rhoads and Sangeeta Malhotra identified a remote galaxy after scanning a large patch of sky with the Magellan Telescopes in the southern reaches of Chile's Atacama Desert, which are among Arizona's telescope resources. Visible in this photo are both Magellan telescopes in the late afternoon, as seen from the path up to the telescopes. The Arizona telescope system provides access to the Large Binocular Telescope on Mt. Graham, the 6.5 meter MMT on Mt. Hopkins, the 2.2 meter Bok telescope on Kitt Peak (all in Arizona), and the twin 6.5 meter Magellan telescopes at Las Campanas Observatories in Chile, along with several smaller telescopes. The Magellan telescopes were built by the Carnegie Institution of Washington on behalf of the Magellan Project, a collaborative effort by the Carnegie Institution, University of Arizona, Harvard University, University of Michigan, and the Massachusetts Institute of Technology. Credit: James Rhoads

"We have used this search to find hundreds of objects at somewhat smaller distances. We have found several hundred galaxies at redshift 4.5, several at redshift 6.5, and now at redshift 7 we have found one," explains Rhoads. "We've pushed the experiment's design to a redshift of 7 – it's the most distant we can do with well-established, mature technology, and it's about the most distant where people have been finding objects successfully up to now."

Malhotra adds, "With this search, we've not only found one of the furthest galaxies known, but also the faintest confirmed at that distance. Up to now, the redshift 7 galaxies we know about are literally the top one percent of galaxies. What we're doing here is to start examining some of the fainter ones – thing that may better represent the other 99 percent."

Resolving the details of objects that are far away is challenging, which is why images of distant young galaxies such as this one appear small, faint, and blurry.

"As time goes by, these small blobs which are forming stars, they'll dance around each other, merge with each other and form bigger and bigger galaxies. Somewhere halfway through the age of the universe they start looking like the galaxies we see today – and not before. Why, how, when, where that happens is a fairly active area of research," explains

Malhotra.

In addition to Hibon, Malhotra, and Rhoads, the paper's authors include Michael Cooper of the University of California at Irvine, and Benjamin Weiner of the University of Arizona.

Provided by Arizona State University