First Detailed Look at a Normal Galaxy in the Very Early Universe

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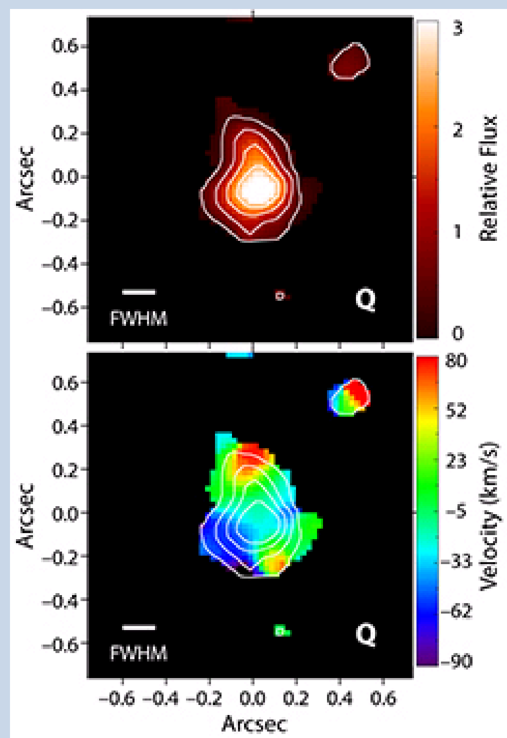
University of Hawaii at Manoa astronomer Regina Jorgenson has obtained the first image that shows the structure of a normal galaxy in the early universe. The results were presented at the winter American Astronomical Society meeting being held this week near Washington, DC.



The galaxy, called

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Higher-Resolution Image

Top: A map of the hydrogen emission from DLA2222-0946. The mapped region, which covers only a portion of the galaxy, is about 5,000 parsecs (or 16,300 light-years) across. The position of the background quasar is marked by a "Q". Bottom: The corresponding map of the movement of the gas in the galaxy. Red means moving away from us; blue is moving towards us. Credit: R. Jorgenson

DLA2222-0946, is so faint that it is virtually invisible at all but a few specific wavelengths. It is a member of a class of galaxies thought to be the progenitors of spiral galaxies like our own Milky Way.

These galaxies are known to contain most of the neutral gas that is the fuel for star formation, so they are an important tool for understanding star and galaxy formation and evolution. Discovered and classified over 30 years ago, they have been notoriously difficult to see directly.

Dr. Jorgenson, an NSF Astronomy and Astrophysics Postdoctoral Fellow at the UHM's Institute for Astronomy, worked with Dr. Arthur Wolfe of the University of California, San Diego. They used the advanced technologies of the W. M. Keck Observatory on Mauna Kea to obtain the first-ever spatially resolved images of a galaxy of this type.

DLA2222-0946 was initially detected not by its own light, but by absorbing some of the light of an even more distant quasar. Galaxies detected in this way are called damped Lyman-alpha systems, or DLAs, based on the specific color of light they absorb due to their copious reservoirs of hydrogen gas.

While thousands of DLAs are now known thanks to the large Sloan Digitized Sky Survey (SDSS), their detection in absorption tells us only about the small part of the galaxy pierced by the background quasar's light.

This is akin to trying to map a fog bank from a single headlight shining through it.

A full understanding of the distant galaxy requires a direct detection, which had eluded astronomers until now.

“These galaxies are extraordinary for being ordinary—they represent normal types of galaxies, rather than the brightest, extreme, and most rapidly star-forming galaxies that are typically observed at these redshifts,” Dr. Jorgenson explained. “But this normalcy makes them nearly impossible to detect directly from the light they give off because first, that emission is relatively weak, and second, the bright background quasar used to find the galaxy hampers the detection of fainter foreground emission from the galaxy itself.”

The galaxy is located at a redshift of 2.354, which corresponds to a time when the universe was about 20 percent of its current age, about 10.8 billion years ago. This time in the universe’s history was a key period of galaxy formation, and hence observing typical galaxies from this time will potentially provide great insight into the relevant physical processes.

Determining exactly how galaxies such as these, which are essentially massive reservoirs of neutral gas, turn that gas into stars is a key missing piece of the star and galaxy formation puzzle.

A preprint of the paper, which will be published in the Astrophysical Journal, can be found at the arXiv website at http://arxiv.org/abs/1311.0045.

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Dr. Jorgenson explained this work at a AAS press conference on January 9, 2014. She was the first speaker.

Founded in 1967, the Institute for Astronomy at the University of Hawaii at Manoa conducts research into galaxies, cosmology, stars, planets, and the sun. Its faculty and staff are also involved in astronomy education, deep space missions, and in the development and management of the observatories on Haleakala and Mauna Kea. The Institute operates facilities on the islands of Oahu, Maui, and Hawaii.