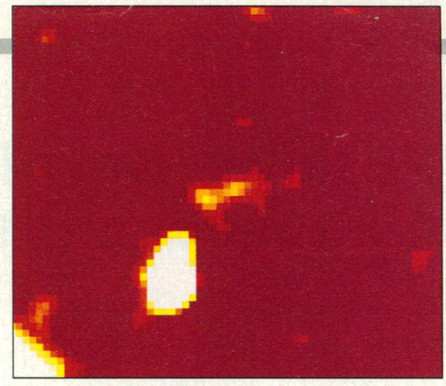
ASTRONOMY

Finding the Most Distant Galaxies

Until recently, the only objects that provided astronomers with a glimpse of the most distant reaches of the universe were quasars—pointlike sources of light that send out enormous amounts of energy. Since the 1980s, however, researchers have found galaxies—just as distant—which emit faint radio signals. And in the 15 November *Monthly Notices of the Royal Astronomical Society*, British, Dutch, and U.S. astronomers report spotting the most distant galaxy yet, which, they say, lies more than 12 billion light-years from Earth.

The galaxy, known by its catalog number 8C1435+635, is more than just an astronomical record breaker. By definition, light and radio emissions from the galaxy have taken some 12 billion years to reach Earth—which means the astronomers are seeing a snapshot of the galaxy's appearance when the universe was one-tenth its present age. Because cosmologists believe most galaxies were formed at around this time, 8C1435+635 represents an important natural laboratory for studying the early stages of galactic evolution. "It tells us that galaxies were forming in the first one or two billion years of the universe," says Roger Taylor of the University of Sussex.

George Miley of Leiden Observatory in the Netherlands explains that identifying 8C1435+635 involved a process of elimination. "It's like trying to find a needle in a haystack," he says. "If you know where to look, you are more likely to find the needle." Starting with catalogs containing almost 10,000 radio sources, Miley's team first narrowed the search down to 33 candidate distant galaxies. This narrowing was carried out on the basis of their previous work, which showed that fainter—and therefore more distant—galaxies have radio spectra dominated by low-frequency emissions. Detailed observations at three radio frequencies by a group led by Mark Lacy of the University of Oxford then revealed 8C1435+635 as the most promising candidate among the 33.



MARK DICKINSON AND CHARLES STEIDEL

A galaxy far, far away. The faint object in the center of this picture is 12 billion light-years away.

To estimate the galaxy's distance from Earth, the researchers turned to the Anglo-Dutch William Herschel Telescope at La Palma, the Canary Islands. This instrument turned up a faint smudge, from which the astronomers recorded an optical spectrum showing two "emission lines," corresponding to radiation emitted by ionized carbon and hydrogen. For nearby objects, these lines appear in the ultraviolet; but for more distant sources, which are moving rapidly away from Earth, they are shifted to longer wavelengths. Galaxy 8C1435+635, with a redshift of 4.25, easily beats the previous record: 3.8. While the relationship between redshift and distance is uncertain, the researchers were able to estimate that the galaxy lies between 12 and 15 billion light-years away.

In addition to the emission lines, the spectrum of 8C1435+635 also contains a continuum of light at different wavelengths—and the origin of this continuum is the galaxy's biggest mystery. "One might guess that this is starlight," says Mark Dickinson of the Space Telescope Science Institute in Baltimore, who took part in the search for 8C1435+635. Observations of other redshifted galaxies with continuous spectra, however, have shown that their light is polarized—which should not be the case if it comes from young stars, such as those that would likely be present in a newly forming galaxy. This, says Dickinson, could indicate that the light is in fact scattered from a quasar hidden in the heart of the galaxy.

Lacy, Miley, and their colleagues hope this riddle—and other mysteries of early galactic evolution—can be solved by further detailed observations of 8C1435+635 and other distant galaxies. The good news is that some six other galaxies with redshifts greater than 3 have been found in the past few years. "[B]y having a sample of such galaxies," says Miley, "you can hope to learn about [their] formation."

–Alexander Hellemans

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Mapping Our Galactic Neighborhood

While some astronomers are catching faint glimmers of galaxies at the farthest edge of the known universe, other researchers are finding new galaxies in previously hidden regions right under our noses. In last week's issue of *Nature*, a team of astronomers announced the discovery of a galaxy (shown in the image below) near our Milky Way, previously hidden in what astronomers ominously call "the zone of avoidance." Their find may eventually allow researchers to get a better grip on the amount of matter in the universe.

The zone of avoidance got its name early in this century, when researchers thought stellar material somehow stayed out of it; they later realized the apparent void was an artifact and they simply couldn't see this 15% of the universe because their vision was blocked by the Milky Way's dense stars and dust. Today's radio telescopes can peer through the fog, however, and an international team led by Harry Ferguson of the Space Telescope Science Institute in Baltimore used one to detect this cosmic neighbor. Dubbed Dwingeloo 1, after the Dutch radio telescope used to find it, the spiral galaxy lies only 10 million light-years away—about 8 million light-years beyond our nearest neighbor, Andromeda. The sighting was also confirmed by an optical scope in the Canary Islands used to make the image shown here.

Ferguson says his team is continuing to survey the zone of avoidance, and they expect to find more galaxies. And that bit of close-to-home cartography has universal implications, says astronomer David Burstein of Arizona State University, because these obscured galaxies will help astronomers map distribution of the invisible "dark matter" in the universe. He and other astronomers are attempting to find this dark matter by measuring its gravitational pull on visible stars and galaxies. "If we are to understand the amount of dark matter, the only way is to measure the motions of galaxies near us," he says. But to do that you need to find all the visible galaxies, he says, and that includes the 15% lying behind our milky veil.

DWINGELOO OBSCURED GALAXY SURVEY/RGO

Hidden neighbor. Newly noticed galaxy Dwingeloo 1 *(center)* is just 10 milion light-years from Earth.

–Faye Flam