Galaxy evolution: A multiwavelength view

When were galaxies born and when did stars set them aglow? Recording the whispers of radiation from distant galaxies may help solve this cosmic mystery.

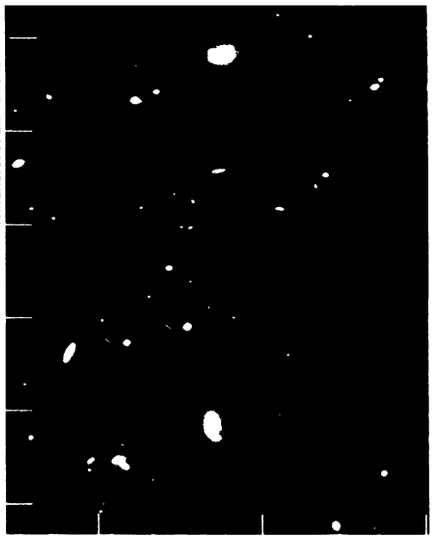
Although the emissions from distant galaxies span a broad range of wavelengths, astronomers don't usually conduct detailed observations of a single patch of sky with more than one instrument. Thus they often lack a complete, multiwavelength portrait of any particular region of the universe.

Now, a team has combined a deep radio map of a selected patch of sky with a highly sensitive visible-light and near-infrared survey of the same region. Rogier A. Windhorst of Arizona State University in Tempe and his colleagues report their work in the June 6 NATURE. Their results indicate that an intriguing set of faint radio emissions comes from a group of distant disk-shaped galaxies, probably spirals, undergoing a burst of star formation.

More than half the galaxies have at least one companion. The researchers suspect that some of these galaxies are merging or colliding with their neighbors. Such violence could trigger waves of star birth. It also suggests that the distant galaxies, some of which were observed as they appeared when the universe was just over half its current age, are still in the process of forming.

In an accompanying commentary, George Helou of the California Institute of Technology in Pasadena notes that beginning a decade ago, as radio surveys detected weaker and weaker emissions at centimeter wavelengths, the number of signals increased beyond what astronomers expected. Scientists think the bright emissions arise from activity powered by black holes at the hearts of large galaxies. In contrast, the faint sources correspond to routine activity, such as radiation from supernovas and hot gas, in distant disk-shaped galaxies.

"The study conclusively identifies faint radio sources as a population of disk galaxies," says Helou. That's no surprise, Windhorst notes. But it's intriguing, he adds, that so many of the galaxies reside in pairs or groups and that a substantial number appear distorted, as if they were undergoing violent interactions with their neighbors. The study suggests that the distant galaxies, midway in size between the Milky Way and dwarf galaxies such as the Magellanic clouds, "are still under construction," says Windhorst.



Windhorst *et al.*/ NATURE

False-color Hubble image at visible and infrared wavelengths reveals distant disk-shaped galaxies. Contours show Very Large Array radio map.

The findings fit an emerging picture of galaxy evolution, says study collaborator Richard E. Griffiths of Johns Hopkins University in Baltimore. Large galaxies formed in the very distant past, perhaps less than a billion years after the Big Bang; small galaxies were still forming or merging considerably later; and galaxies of intermediate size took their final form sometime in between. Astronomers conjecture that larger galaxies took shape first because their greater mass hastened their gravitational collapse.

In 1992, the astronomers used the unrepaired Hubble Space Telescope to record faint emissions from a tiny region of sky. Between late 1993 and early 1995, they probed the same region with the Very Large Array radio telescope near Socorro, N.M. The team's radio map represents one of the most sensitive surveys ever made at a wavelength of 3.5 centimeters, notes Helou.

He adds that enhanced sensitivity—the ability to detect fainter objects—must go hand in hand with higher spatial resolution, the ability to separate neighboring objects. "Matching exactly both sensitivity and resolution of instruments operating at very different wavelengths is nearly impossible," notes Helou, "and one of the technical achievements . . . is that [the study] edges sufficiently close to such a match to make the comparison fruitful." —*R. Cowen*

Alzheimer's mice betray cognitive drop

For some Alzheimer's disease researchers, the immediate goal is not to prevent the deadly neurodegenerative disorder, but to create it. They're the ones seeking to craft a mouse model of the disease. With such an animal stand-in, they would have an inexpensive, well-understood organism in which to test drugs and hypotheses about the causes of the affliction.

Making an Alzheimer's mouse isn't easy, however. A number of mouse models have skyrocketed into prominence, only to fizzle under close examination. Now, an older model, unveiled 4 years ago, may be making a comeback.

This genetically engineered strain of mice experiences a decline in learning and memory skills as it ages, researchers report in the June 6 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

"That is the cardinal feature [of the disease] in humans, and we have replicated it in mice," says Barbara Cordell of Scios Nova, a biotechnology company in Mountain View, Calif.

In 1991, Cordell led a team that created mice whose brains generate larger than normal concentrations of a beta amyloid precursor protein. Many researchers believe that an abnormal buildup of beta amyloid causes the brain cell degeneration characteristic of Alzheimer's disease. To evaluate the behavior of these mice, Scios Nova then collaborated with the Marion Merrell Dow Research Institute in Strasbourg, France.

Their results mark the first time investigators have shown that mice which overproduce beta amyloid suffer cognitive difficulties analogous to those of affected humans.

Ironically, some researchers had dismissed the Scios Nova mice as a model for Alzheimer's. Although diffuse deposits of beta amyloid build up in the brains of these animals, they do not form the dense plaques found in Alzheimer's patients. So researchers continued the search for a mouse model, lately favoring one in which plaques are present (SN: 2/11/95, p.84).

Cordell and her colleagues subjected their mice to more than a dozen different behavioral tests, including some that examined general activity, anxiety, and motor skills. In two of the tests, one of which relies on learning skills and the other on short-term memory, 9- to 12-month-old Alzheimer's mice performed significantly worse than both normal mice and 6-month-old Alzheimer's mice.

The group plans further tests of learning and memory skills, adds Paula M. Moran of Marion Merrell Dow.

Researchers caution, however, that it may prove impossible to create a perfect mouse model. Some crucial areas of the brain that degenerate in Alzheimer's—regions involved in higher learning—do not even exist in the simpler brains of mice, notes Creighton Phelps, director of the Alzheimer's Disease Research Centers at the National Institute of Aging. "Alzheimer's is a human disease. You can only model aspects of it," he says. —*J. Travis*