Hubble offers clues to galaxy evolution

Peering deep into space and far back in time, the Hubble Space Telescope has found evidence that fully formed elliptical galaxies already existed during the universe's youth — at one-tenth its current age — but spiral galaxies were still forming.

The observations suggest that elliptical galaxies, which take shape over about 1 billion years, formed soon after the Big Bang. In these studies, Hubble researchers assumed an age of 14 billion years for the cosmos.

The findings may pose problems for some cosmologists. Models that give a relatively young age for the universe "leave little time for these [ellipticals] to form and evolve to the maturity we're seeing," says Mark Dickinson of the Space Telescope Science Institute (STScI) in Baltimore.

He and other astronomers presented their findings this week at a NASA press briefing in Greenbelt, Md. The observations, which may only apply to galaxies in clusters, rank among the first clues to galaxy evolution provided by Hubble since its repair a year ago.

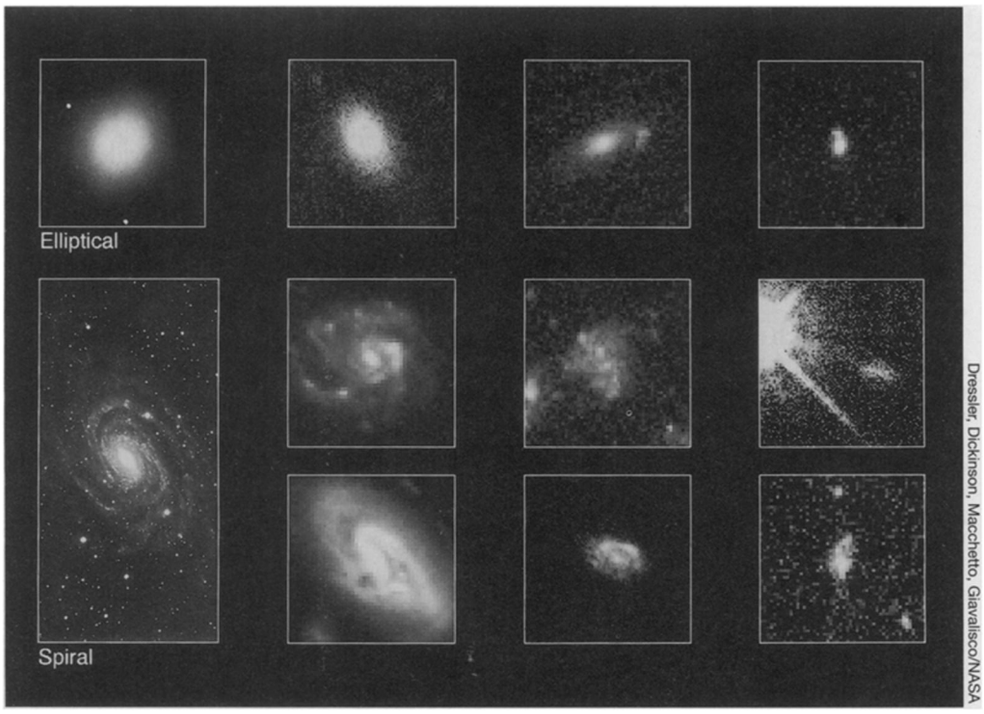
In studying galaxy clusters that existed when the universe was 5 billion years old, Alan Dressler of the Carnegie Observatories in Pasadena, Calif., found a higher proportion of spiral galaxies, many in fragments. Ellipticals were identical to those in today's cosmos.

To find a cluster of more distant galaxies, Dickinson's team looked for objects grouped around the radio galaxy 3C324, observed as it appeared when the cosmos was one-third its current age. Using ground-based telescopes, the team found 20 galaxies in the same patch of sky as 3C324. Two of the galaxies lie near the radio galaxy, and the team inferred that the other 18 might lie at the same distance.

Orbiting above Earth's wavering atmosphere, Hubble determined the shapes of these galaxies and found that most of the reddest ones were ellipticals. The red color suggests that the galaxies contain lots of old stars. Ellipticals in the nearby, present-day universe appear old and red, and "these galaxies look just the same," Dickinson says. The irregular bluish fragments his team also observed could be the building blocks of spiral galaxies that hadn't yet formed, he adds.

Using Hubble to observe the shapes of galaxies as they appeared even further back in time, F. Duccio Macchetto of the European Space Agency and the STScI and Mauro Giavalisco of the STScI found 16 objects that existed some 12 billion years ago. One of them has a pattern of light emission remarkably similar to today's ellipticals. The object could be a primeval elliptical galaxy; if it already has the reddish hue of a galaxy with elderly stars, it might rewrite theories on cosmology.

— R. Cowen



Far left: An elliptical (top) and spiral galaxy today. Center left: Elliptical galaxy appears fully grown at 9 billion years, but some spirals are less defined. Center right: The spirals in this earlier era had a fuzzier structure than those today, but ellipticals still had a clearly recognizable pattern. Far right: Top body, seen as it existed 2 billion years after the Big Bang, emits light in the same pattern as an elliptical today. Bottom images may be spiral fragments.

Acoustic snapshots: Images from noise

Researchers often use sound waves to probe the murky depths of the ocean. With sonar, they can detect underwater objects by looking for reflected signals. With submerged microphones, they can listen for the sounds emitted by an object.

Now, a team of researchers is developing a new way of using sound to detect and image things underwater. Their approach exploits the fact that the ocean is filled with sound. Underwater bodies scatter this naturally occurring random noise in much the same way that visible objects scatter ambient light. Thus, by using the acoustic equivalent of a camera, it's possible to take a "snapshot" of a submarine, whale, or shipwreck.

The concept of using "acoustic daylight" to image submerged entities was first introduced 2 years ago by Michael J. Buckingham of the Scripps Institution of Oceanography in La Jolla, Calif., and his collaborators. Last summer, John R. Potter and his coworkers, also at Scripps, tested a prototype imaging system that produced color images of moving targets placed in San Diego Bay.

"This is the first-ever device capable of acoustically imaging silent objects underwater without making any sound of its own," the team reports. Preliminary results of the tests were presented at an Acoustical Society of America meeting held last week in Austin, Texas.

Resting on the seabed, the "acoustic daylight ocean noise imaging system" (ADONIS) focuses and detects sound waves ranging in frequency from 8 to 80 kilohertz. An underwater electronics package processes these signals, then transmits them to special high-performance computer hardware and software to produce a sequence of images.

In its first tests, the system detected targets 3 meters by 1 m in size at a range of 38 m, generating crude but recognizable images on a computer monitor. The color and intensity of each of the 126 picture elements (pixels) on the screen correspond to the frequencies and intensities of the received signals. The test targets, deployed in a variety of configurations, were constructed from a layer of neoprene foam mounted on an aluminum backing plate.

These tests open the way for developing practical systems for underwater imaging. "This successful demonstration has profound ramifications both for future ocean development, which is largely constrained by our ability to 'see' underwater, and [for] our understanding of the way in which marine animals use sound to hunt, avoid predators, and navigate," the researchers conclude.

— I. Peterson