

Slew of distant galaxies tells a cosmic tale

On images packed with celestial objects, distant galaxies look no different from the faint smudge of common, nearby galaxies. Yet these bodies lie several billion light-years from Earth and reveal what the universe was like at a much earlier age.

As recently as a year ago, astronomers had no proven method of picking out distant galaxies from the crowd. Now, researchers have spied a flood of far-away objects, a set of findings that could revolutionize cosmology.

Using a criterion based on an object's color, researchers early this year announced that they had identified 23 galaxies so distant from Earth that their light has taken 85 percent of the age of the universe to reach us (SN: 2/24/96, p. 120). Since then, the same team, which includes Charles C. Steidel of the California Institute of Technology in Pasadena and Mark E. Dickinson of the Space Telescope Science Institute in Baltimore, has established that at least 47 more galaxies are just as distant.

Using a similar technique, another group, which includes James D. Lowenthal and Sandra M. Faber of the University of California, Santa Cruz, has found an additional 12 objects at similar distances. Thus, in a single year astronomers have detected about 80 galaxies that date from an extremely ancient era.

Astronomers estimate a galaxy's distance by using spectroscopy to measure its redshift, the amount by which the expansion of the universe shifts light to longer, or redder, wavelengths. The 80 galaxies have redshifts of about 3. Another 400 galaxies have colors that make them likely candidates, although researchers have yet to measure their redshifts.

Piero Madau of the Space Telescope Science Institute and his collaborators, including Dickinson, have now gone a step further. Adapting their color criterion to find objects that are even more distant, the team has identified 14 galaxies seen by the Hubble Space Telescope that may have redshifts around 4. This redshift corresponds to an era when the

universe was only 9 percent of its present age.

Dickinson reported the findings last month at a conference in Baltimore. Madau's team provides further details in an article accepted for publication in the MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY. Dickinson cautions that because all 14 objects are extremely faint, recent observations have succeeded in collecting the necessary spectral data for only one of the galaxies, which appears to have a redshift of 4.02.

Nonetheless, the findings help lay down rules about star formation and the evolution of galaxies, says Madau. "It's

no longer [just] a case of finding more and more distant galaxies," adds Dickinson. "We can now use the objects to make meaningful statements about physical processes in the cosmos."

In comparing the density and luminosity of galaxies at different times in the cosmos, Madau's team finds that star formation proceeded slowly. The researchers see no evidence that a wave of star birth set all the earliest galaxies ablaze at once. They also confirm earlier evidence that star formation peaked when the universe was one-third of its present age. As the astronomers look at progressively earlier times, they find fewer galaxies, suggesting that they may soon encounter the epoch when the first galaxies assembled. — R. Cowen

El Niño is bashful about revealing its age

Thoroughly sated and ready for sleep, a resident of coastal Peru hoisted himself from his campsite and dumped a pile of empty scallop shells onto a nearby trash heap. Six thousand years later, archaeologists digging through the leftovers of that meal report that they have discovered the origin of the climate feature called El Niño.

Known for its feverish warming of the central and eastern equatorial Pacific Ocean, El Niño strikes once every 4 to 7 years, disrupting weather around the world. Geoscientists have tried tracking its history using coral and other evidence, but their studies have failed to pinpoint when the pattern of warmings begins.

Archaeologist Daniel H. Sandweiss of the University of Maine in Orono and his colleagues began studying the problem when they noticed the wrong kind of mollusk shells in prehistoric garbage deposits, or middens. Modern species living along the shores of Peru are adapted to the cool waters of the Humboldt Current, which skirts the coastline. Middens dating to 5,000 years ago contain these same cool-water species, but middens going back 5,000 to 8,000 years have warm-water species, the researchers report in the Sept. 13 SCIENCE.

These unusual mollusks help date the onset of the modern El Niño pattern, says Sandweiss, because they reveal that warm waters continually bathed coastal Peru prior to 5,000 years ago. "El Niño is an occasional incursion of warm water along the coast of Peru, which is normally cool. If we see conditions in which there were permanently warm waters along the coast, then by definition there couldn't have been the El Niño pattern we know today," Sandweiss says.

The archaeologists first uncovered hints that the climate had shifted from warm to cool in the 1980s, while studying a site called Ostra. Last year, they documented a similar mollusk transition 400 kilometers north of the site. In support of



Remains of an ancient scallop dinner.

their interpretation, Sandweiss notes that recent pollen studies from northern Australia also point to the initiation of El Niño warmings 5,000 years ago.

"The archaeological evidence is very compelling," comments Richard L. Burger of Yale University.

The shift toward cooler and more variable conditions may have played some role in fostering the development of more complex Peruvian societies, which appeared at roughly the same time. "Just after 5,000 years ago, the people began to build monumental structures in coastal Peru. How these [events] are linked needs to be looked at more closely," says Sandweiss.

The idea of a climate shift at that time gets a chilly reception from some other researchers who study coastal Peru. Geologist Lisa Wells of Vanderbilt University in Nashville traces the climate history of the region by examining deposits of giant floods, which occur when particularly intense El Niños deluge the coastal desert with rains. Wells sees evidence of the El Niño-style floods going back to 7,000 to 8,000 years ago.

To explain the presence of warm-water mollusks off Peru more than 5,000 years ago, Wells suggests that they lived in shallow lagoons protected from the cooler ocean. She has documented a relict lagoon from this period at the Ostra site. — R. Monastersky



Galaxy (arrow) may date to when the universe was 9 percent of its current age.