Astronomy

Ron Cowen reports from Berkeley, Calif., at the Texas Symposium on Relativistic Astrophysics and Symposium on Particles, Strings, and Cosmology

Tracking the evolution of galaxies

Using telescopes to peer back in time at galaxies as they appeared billions of years ago, astronomers are documenting how the density of these bodies changes in the distant universe. One interpretation of the findings hints that researchers have glimpsed galaxies in their infancy, soon after they "switched on" and experienced the first glimmers of starbirth.

Nigel Metcalfe and Thomas Shanks of the University of Durham in England and their colleagues used the 2.5-meter Isaac Newton and 4-meter William Herschel telescopes in the Canary Islands, Spain, to study galaxies so faint and distant that the instruments could barely detect them. The team found that the faintest — and presumably most distant — galaxies in their survey had higher number densities than the brighter, nearer galaxies. However, the rate at which the faint galaxies increased in density seemed to begin tapering off at about 10 billion light-years from Earth.

Metcalfe suggests two explanations for the findings. The more mundane scenario relies on the phenomenon of redshift and the fact that galaxies absorb ultraviolet light shorter than the far ultraviolet wavelength known as the Lyman-alpha limit. Thus, galaxies appear dark at shorter ultraviolet wavelengths. And because light from distant galaxies gets shifted to the redder end of the spectrum, the galaxies appear dark when viewed from Earth at some visible-light wavelengths. So although the galaxies actually exist, a typical visible-light survey would fail to count them.

Alternatively, notes Metcalfe, the density of faint galaxies may increase more slowly with distance from Earth because astronomers are finally looking back far enough to see some galaxies that are still dim and haven't yet begun forming many stars. To decide between the two explanations, Metcalfe's team plans eventually to conduct their faint, visible-light survey at bluer, shorter wavelengths. If the density increase also tapers off at shorter wavelengths, then researchers may truly be viewing an important, early epoch in galaxy evolution, he says.

Metcalfe adds that the total number of galaxies detected in his team's survey — about 1 million galaxies per square degree — seems too big for the volume of space available in a model of the universe favored by many cosmologists. In this model, the cosmos is poised between expanding forever and having enough mass to gravitationally collapse in on itself. Metcalfe notes that the high number count would still be consistent with such a universe if many of the more distant, younger galaxies in the survey actually represent fragments that later merged to form groups of bigger galaxies.

ROSAT makes classy finding

ROSAT, the German-U.S.-British satellite, has used its X-ray eyes to detect a new class of star, reports Joachim Trümper of the Max Planck Institute for Extraterrestrial Physics in Garching, Germany. Dubbed supersoft sources, these stars — about 15 of which ROSAT has detected in Andromeda and other nearby galaxies — appear unusually bright in the light of very low energy X-rays, yet appear dim at higher energies.

Trümper and others suggest that the stars are a type of white dwarf — long sought, yet never before detected — that radiates low-energy X-rays 1,000 times more intensely than any other known white dwarf with a stellar partner. He speculates that the partners continuously feed just enough mass to the dwarfs to trigger a slow, steady nuclear burning characteristic of the radiation detected by ROSAT. With too little mass, the dwarfs would undergo a series of staccato, high-energy surface explosions; too much mass, and the dwarfs would evolve into puffed-up stars called red giants, which also don't emit many low-energy X-rays.

Earth Science

Richard Monastersky reports from San Francisco at a meeting of the American Geophysical Union

Chaotic tremors within a computer

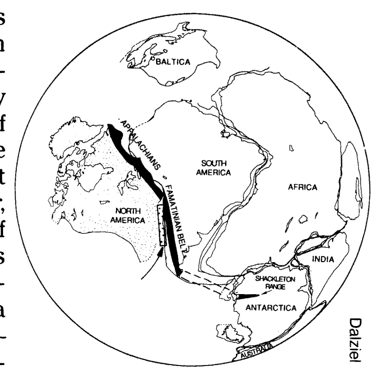
Experiments with synthetic earthquakes created in a computer suggest that the San Andreas fault behaves much less predictably than previously thought — a finding that carries both good and bad implications for residents living nearby.

Steven Ward and Saskia Goes at the University of California, Santa Cruz, made their discovery with a computer model that mimics earthquake recurrence over thousands of years, something researchers cannot determine from examining the relatively short historic quake record in California. The model works by gradually increasing stress on the San Andreas, which is divided into several segments that have different propensities for producing quakes. When the crustal stress reaches a critical value for a given fault segment, that part of the San Andreas slips, generating an earthquake that transfers stress onto adjoining segments.

By watching the model simulate 100,000 years, Ward and Goes see that each segment behaves irregularly. After one large tremor on a patch of fault, the next one in that same spot could come as soon as 50 years later or wait as long as 450 years. Ward believes the model presents an accurate picture of quake behavior because it does well at simulating the record of smaller, more numerous earthquakes within this century.

The finding raises questions about seismic hazard studies, notably a 1988 report by a panel of scientists that estimated the probability of earthquakes along each segment of the San Andreas for the next 30 years. To do this, the panel relied heavily on calculations of the average interval between the last few earthquakes on each segment. But the computer simulations by Ward's group show that intervals can vary substantially — so records from the last few earthquakes cannot provide a true estimate of the probability that another will strike in the next few decades. Indeed, the Santa Cruz researchers calculate that the 1988 panel overestimated the long-term risks along each segment of the fault. That might seem like good news. But the work also indicates that scientists face a much more difficult task estimating seismic hazard.

Appalachians with a South American flavor



Dalziel

The Appalachian mountains of the modern Earth run from Newfoundland along the eastern United States until they disappear in the deep south of Georgia and Alabama. But the present range may represent only a small stretch of a former, glorious incarnation. A team of geologists suggests that pieces of the earlier Appalachians exist in southern South America and perhaps Antarctica — leftovers from a time 500 million years ago when the three continents may have abutted one another.

Ian W.D. Dalziel of the University of Texas at Austin and his colleagues note that a limestone formation in Argentina has a distinctive form of trilobite typical of ancestral North America rather than South America. The researchers suggest that these two continents collided a half billion years ago and then rifted apart, transferring a sliver of land (arrow) from North to South America. By this theory, the crash created an ancestral Appalachian range that continued into western South America long before the Andes formed. The early mountains may have extended even further, to Antarctica's Shackleton Range, speculate the researchers. They discussed their work at the meeting and in the December GEOLOGY.