Astronomy

Ron Cowen reports from Arlington, Va., at a meeting of the American Astronomical Society

Evidence for a distant galaxy cluster

Astronomers say they may have found the most distant cluster of galaxies ever observed in the universe. Because a telescope acts like a time machine, detecting distant objects as they appeared when the universe was young, the researchers could see what these faraway galaxies looked like when the universe was roughly one-tenth its present age.

The tentative finding has profound implications for theories about the evolution of the universe. If galaxy clusters did exist in the infant universe, then galactic structure may have begun developing earlier and matured over a longer period than some popular models suggest. Instead of assembling galaxies and galaxy clusters from small, primordial subunits, the universe may have evolved from the breakup of immense, pancake-like structures a thousand trillion times the mass of the sun. And astronomers might have to revise their notion of dark matter — hypothetical, invisible material that makes its presence known through its gravitational tug.

Two teams of scientists contributed to the new report. With the 4-meter telescope at Cerro Tololo Inter-American Observatory in La Serena, Chile, one team used light from the distant quasar QSO 0000-263 as a beacon to search for primeval galaxies. In analyzing the spectrum of the quasar light, Charles C. Steidel of the Massachusetts Institute of Technology and Donald Hamilton, then at the California Institute of Technology in Pasadena, found that an object in front of the quasar — a candidate primeval galaxy — absorbed particular wavelengths of the light. The absorption pattern indicated that this foreground galaxy has a redshift of 3.4. This means that the galaxy — according to one cosmological model — lies more than 14 billion light-years from Earth.

Using special color filters that reveal galaxies located 14 to 14.5 billion light-years from Earth, Steidel and Hamilton imaged the primeval galaxy. The filters also enabled them to find 15 other galaxies residing somewhere in the same distance range. If these galaxies actually lie close to one another, rather than at varying distances in the same patch of sky, then they form the most distant cluster ever found, Steidel says.

In an independent study, F. Duccio Macchetto and Mauro Giavalisco of the Space Telescope Science Institute in Baltimore examined the vicinity of the same quasar with the European Southern Observatory's 3.6-meter telescope in La Serena. Rather than look for absorption features, this team searched for a telltale hydrogen emission from a galaxy near the quasar. They found one such galaxy. In recording the galaxy's emission spectra, Macchetto and Giavalisco discovered that it is distinct from, but has the same redshift as, the light-absorbing galaxy found by Steidel and Hamilton.

These two galaxies thus lie at the same distance from Earth and in the same patch of sky, proving that they are closely associated. But two galaxies do not a cluster make. It remains uncertain whether the other galaxies found by Steidel and Hamilton are part of the same grouping. Borrowing a statistical technique developed by Alexander S. Szalay of Johns Hopkins University in Baltimore, Macchetto and Giavalisco calculate that there is only a 1.2 percent chance that the other galaxies could occupy the same patch of sky without being in close proximity.

However, Stanislav G. Djorgovski of the California Institute of Technology notes that the astronomers have only measured the exact redshifts, and thus the actual distances, of two galaxies. The filters used to estimate the distance of the other 14 galaxies allow too much leeway to even suggest that these galaxies are associated, he adds. "I personally tend to think there is a cluster there, but there's no evidence [right now] to support this," he says. Steidel says the findings, though tentative, "are certainly intriguing enough to alert astronomers."

Earth Science

Getting the drift on continental shifts

It doesn't take great detective skills to notice that the coastlines of South America and Africa would fit nicely together if the two sat side by side. This observation, followed by others, led German meteorologist Alfred Wegener in 1912 to propose the theory of continental drift, which holds that the landmasses migrate around the planet, sometimes colliding and other times rifting. Although scientists give Wegener and others of his time credit for formulating the drift hypothesis, a researcher has now traced elements of the idea back three centuries earlier, to a Dutch cartographer named Abraham Ortelius.

James Romm, a professor of classics at Bard College in Annandale-on-Hudson, N.Y., reports in the Feb. 3 NATURE that Ortelius in 1596 suggested the continents once were joined but later separated. In his work *Thesaurus Geographicus,* Ortelius postulated that earthquakes and floods tore America from Africa and Europe: "The vestiges of the rupture reveal themselves, if someone brings forward a map of the world and considers carefully the coasts of the three [continents]."

Romm happened upon Ortelius' theory while researching the history of the Atlantis myth. As was common in Ortelius' day, the cartographer equated the Americas with the lost city of Atlantis. But he went beyond others by suggesting that Atlantis moved away from the other continents instead of sinking, as had been suggested. Romm speculates that Ortelius' contribution went unnoticed for so long because it appears only once in the middle of his long volume.

Ortelius supplants a long line of other philosophers credited with formulating the idea of continental drift. While Wegener was one of the first to present a fleshed-out scientific theory of drift, historians until recently viewed a book written by Francis Bacon in 1620 as the first to mention that the continents could fit together. Yet Bacon missed the entire point, says Romm. Instead of recognizing that the continents had complementary coastlines, he suggested that some landmasses had similar shapes, as if cut by the same mold. After severing Bacon's hold on the honor, historians have since named an 18th century theologian and a 19th century geologist as potential originators of the continental drift theory.

Although people today might find it obvious that the continents could fit together like pieces in a jigsaw puzzle, Romm says the match became self-evident only after the theory of continental drift gained widespread circulation. "Without an explanation of what that might mean, it was very hard to see the phenomenon itself."

Bacteria steal oxygen from Biosphere 2

Geoscientists have fingered microbes as the culprits in the case of the missing oxygen within Biosphere 2, the sealed experimental ecosystem in southern Arizona. The concentration of oxygen in the enclosure's atmosphere dropped from 21 percent to 14 percent during the first 16 months of operation, causing residents inside to suffer symptoms of high-altitude sickness.

When they first looked into the problem, Jeffrey P. Severinghaus of the Lamont-Doherty Earth Observatory in Palisades, N.Y., and his colleagues suspected that microbes in the extra rich Biosphere 2 soils were consuming oxygen faster than plants in the facility could replace the gas through photosynthesis. But if bacterial respiration had removed the oxygen, then carbon dioxide concentrations in the ecosystem's air should have risen to 80,000 parts per million, roughly 300 times normal. Instead, levels were 10 times normal.

The researchers discovered that concrete within Biosphere 2 had absorbed the extra carbon dioxide through reactions that formed calcium carbonate. That process masked the bacteria's role, they report in the Jan. 18 EOS. To combat the problem, Biosphere 2 now receives occasional oxygen injections.