Astronomy

Ron Cowen reports from Victoria, British Columbia, at the Workshop on the Space Distribution of Quasars

Giant cluster confounds cosmology

Astronomers have discovered a cluster of 10 quasars that may represent the largest structure ever found in the universe — as well as one of the most distant. Covering a swath at least 650 million light-years long and 100 million light-years wide in the northern celestial hemisphere, this quasar cluster is only the third identified so far. Its discovery adds to a growing body of evidence challenging several theories commonly invoked to explain the evolution of the universe.

Roger G. Clowes of the Royal Observatory in Edinburgh, Scotland, and Luis E. Campusano of the University of Chile in Santiago used two telescopes to detect the quasars. About five years ago, Clowes and Campusano began using an automated scanning machine to examine and digitize tens of thousands of images from a photographic plate taken by the U.K. Schmidt Telescope in Epping, Australia. Keying in on such features as the brightness and color of the imaged objects, special software then selected about 200 likely candidates for quasars from among the myriad galaxies and stars depicted on the plate.

Two years ago, guided by their list of quasar candidates, the researchers made high-resolution observations of the same sky region using the 4-meter telescope at the Cerro Tololo Inter-American Observatory in Chile. The study confirmed about 20 of the 200 objects as quasars, based on their redshifts and spectra. Moreover, 10 of these turned out to be astronomical neighbors. Their redshifts all fell within the range of about 1.1 to 1.3, indicating that they sit relatively close together at a distance of perhaps 8 billion light-years from Earth, Clowes says. Three quasars identified in a nearby sky region in the 1980s may belong to the same group, he adds.

Clowes notes that the cluster appears to exceed the dimensions of the two other known quasar groups, discovered in 1982 and 1989. But because the newly identified cluster — as well as the one found in 1989 — may stretch beyond the boundaries of the photographic plates, their relative sizes remain unclear, he says.

Nonetheless, the average redshift of quasars in the newly found cluster indicates that Earth-based observers are seeing this structure as it existed when the universe was only one-third its current age. The discovery that a quasar group existed in such an early era confounds the standard assumption that the universe could not have grown so lumpy so soon after the smooth, uniform beginning of the Big Bang. Clowes and Campusano plan to examine photographic plates from other sky regions to find out whether other such clusters may have existed in the early universe.

Distant galaxy looks strangely normal

David J. Thompson and Stanislav Djorgovski recently launched a search for protogalaxies — distant, primeval galaxies undergoing their first major burst of star formation — by analyzing light emitted from high-redshift objects illuminated by quasars behind them. Although the spectroscopic survey has revealed only a few potential candidates so far, it has turned up an unexpected bonus: a previously unseen object that appears to be one of the most distant "normal" galaxies known.

To qualify as "normal," a galaxy must undergo relatively mild evolution and must lack a quasar, or "active nucleus," at its heart. Most faraway galaxies don't fit that description.

Thompson and Djorgovski, both from the California Institute of Technology in Pasadena, made their finding with the 5-meter telescope at Mount Palomar Observatory near Escondido, Calif. Thompson says the object, dubbed G033+3208, has a redshift just beyond 1, which dates it back to when the universe was only half its present age. This may be just one of many faint, "ordinary" galaxies that go undetected at great distances yet contribute a substantial portion of the energy generated in the universe, Thompson suggests.

Radio waves may trace distant clustering

Determining whether galaxies and quasars formed clusters early in the history of the universe can tell astronomers much about the distribution of matter and the evolution of structures in the cosmos. By focusing on distant and intense radio-wave sources, an astrophysicist has found evidence for large-scale clustering when the universe was less than half its current age.

Brilliant visible-light emissions from relatively nearby galaxies — ones less than about 1 billion light-years from Earth — permit astronomers to discern not only whether these celestial objects cluster, but also whether groups of these galaxies congregate in superclusters. In contrast, the faintness of more distant galaxies and quasars makes it all but impossible for astronomers to assess large-scale clustering far beyond the Milky Way — at least when using visible light.

However, many distant galaxies and quasars *do* emit intense radio waves. Michael J. West at the Canadian Institute for Theoretical Astrophysics in Toronto, Ontario, took a cue from the behavior of nearby galactic clusters, called Abell clusters. About 20 percent of them contain a large, elliptical and bright galaxy at their center, called a "cD" galaxy, he notes. Other researchers had previously established that a cD galaxy tends to emit visible light pointing toward another cD galaxy — if the neighboring galaxy resides within 150 million light-years. Astronomers had also found that the parent Abell cluster housing the cD galaxy exhibits a similar behavior — it tends to emit light toward a neighboring cluster located no more than 150 million light-years away.

Notes West: "It is certainly remarkable that the structure and orientation of cD galaxies, just a few thousand light-years in diameter, should somehow reflect the presence of large-scale clustering of matter on scales of millions of light-years."

He wondered if the orientation of radio-emissions from distant galaxies could play a role similar to that of visible-light emissions from cD galaxies. If the analogy held, then such distant radio emissions could literally point to superclustering that occurred when the universe was much younger.

To more completely examine his hypothesis, West reviewed radio-wave surveys of nearby cD galaxies. And "sure enough, in almost every case," he says, "the radio emission from the [nearby] cD galaxy was indeed strongly aligned with [visible-light emissions] and the cluster in which it was located."

Other researchers had investigated whether radio emissions from distant galaxies aligned with the direction of the fainter, visible-light radiation from these objects. A wide variety of surveys indicated that distant galaxies — those 5 billion to 16 billion light-years away — indeed emitted both types of radiation along roughly the same direction.

Then came the finding that helped clinch his argument, West says. An analysis of 600 distant galaxies revealed that 38 had neighboring quasars located within 150 million light-years. Radio emissions from all 38 pointed toward the quasars. West observes that such alignment appears highly similar to the clustering that takes place among nearer cD galaxies and Abell clusters.

"It's a leap of faith," admits West, to extrapolate from what's known about nearby galactic clusters to more distant ones "where all we can see is the radio emissions." But, he adds, "The most natural interpretation of these results would seem to be that they indicate a well-organized pattern of superclustering [among distant galactic groups] when the universe was less than half its present age."