Astronomy

Ivars Peterson reports from Arlington, Va., at the meeting of the American Astronomical Society

The source of a great attraction

The Milky Way and its galactic neighbors appear caught up in the irresistible gravitational pull of a vast agglomeration of matter whose center lies about 150 million light-years away. Known as the Great Attractor, the concentration of mass significantly alters the rate at which these galaxies spread apart as the universe expands. Alan M. Dressler of the Pasadena, Calif.-based Observatories of the Carnegie Institution of Washington and Sandra M. Faber of the University of California, Santa Cruz, have now amassed sufficient data to confirm the Great Attractor's existence and to define its extent. Working independently, Robert A. Schommer of Rutgers University in New Brunswick, N.J., and his colleagues have obtained similar results.

Dressler and Faber were members of the international team of astronomers that first identified a strong local perturbation in the smooth outward flow of matter associated with the universe's expansion (SN: 3/22/86, p.182). Galaxies in a large region of space seemed to be streaming in the general direction of a collection of galaxies known as the Hydra-Centaurus supercluster. The entire region was expanding less rapidly than the universe as a whole, suggesting the presence of an unidentified center of attraction somewhere beyond the Hydra-Centaurus galaxies.

But the original measurements of galactic distances and velocities did not extend as far as the postulated attractor's center, where gravity would pull equally in all directions and any galaxies present would have no motion beyond that associated with the expansion of space. "We had walked on the side of a [cloud-enshrouded] mountain and inferred its presence without seeing its peak," Dressler says. The new measurements by the two research groups include galaxies that appear to lie near the attractor's center. A few of the galaxies even seem to be falling toward Earth, indicating they sit on the attractor's far side. These data enable astronomers to establish the attractor's sphere of influence.

By almost any measure, the Great Attractor represents the dominant structure in our part of the universe. Roughly spherical, it stretches 300 million light-years across the sky and contains a mass equivalent to tens of thousands of galaxies. But its enormous gravitational influence results not so much from its large mass density as from its vast extent. Compared with some galactic superclusters, "it's not a particularly dense structure," Dressler says. "It's just very big." The Milky Way itself is actually inside but on the edge of the Great Attractor.

The new data also seem to rule out the presence of an even stronger attractor just beyond the Great Attractor. Astronomers have detected concentrations of galaxies that lie farther out (SN: 4/15/89, p.230), but these concentrations don't appear to influence galactic motion in the vicinity of the Great Attractor. Nevertheless, astronomers suspect that features on the scale of the Great Attractor are common in the universe. "We found one . . . after sampling only a small fraction of the universe," Dressler notes.

An X-ray background for star formation

A group of astrophysicists has discovered a type of faint galaxy only a few billion light-years from Earth that may generate much of the bright glow of X-rays that appears to fill the sky. First observed during a rocket experiment in 1962, this X-ray background has long puzzled astronomers. A variety of individual objects, including quasars and hot clouds of intergalactic gas, produce significant amounts of X-rays, but their total output is insufficient to explain both the brightness and the slight graininess of the X-ray sky. Now, David J. Helfand and Thomas Hamilton of Columbia University in New York City and their colleagues have identified a special group of faint, red galaxies that appear to generate X-rays and that may be numerous enough to account for the X-ray background.

To pinpoint these sources, the researchers compared X-ray, radio-wave and visible-light observations of one particular region of the sky. They found more than 100 faint radio sources in a region roughly the size of the full moon as it appears from Earth. A significant number of these coincided with bright points in the X-ray map. "We found to our delight and somewhat to our surprise that the faintest radio sources lined up with the bumps in the X-ray field," Helfand says. Subsequent optical telescope observations revealed an unexpected abundance of large but faint galaxies in the vicinity of the radio sources. "We see only the nearest neighbors, but these are probably representative of even more such galaxies farther away, to make up the full X-ray background," Hamilton says.

A close look at seven of the faint galaxies shows them to be within a few billion light-years of Earth. Hamilton and Helfand speculate that such galaxies are in a relatively early stage of their evolution, when large numbers of massive stars form and then explode to produce supernovas, neutron stars and possibly black holes — all of which are associated with intense radio-wave and X-ray emissions. The X-ray background "doesn't tell us about the formation of galaxies, but it may be a key link in studies of the evolution of galaxies," Helfand says.

The birth of twin quasars

Astronomers have resolved a distant, fuzzy patch of light designated PHL 1222 into two separate objects that may represent a pair of quasars less than 100,000 light-years apart. Quasars, thought to be the active cores of certain types of galaxies, are extraordinarily bright but relatively small objects that greatly outshine the "host" galaxies enveloping them. The discovery of two so close together indicates the host galaxies may have a strong gravitational influence on each other. That could have been responsible for turning on both quasars, says Georges Meylan of the Space Telescope Science Institute in Baltimore, who led the team making the discovery.

Astronomers have detected apparent quasar pairs in the past, but those images instead represented light from a single, distant quasar split into two components by the gravitational effects of an intervening galaxy between the quasar and the Earth-based observers. In such gravitationally lensed quasars, both components have identical spectra, confirming that the light comes from the same source. In contrast, the two quasars that make up PHL 1222 have slightly different spectra.

The newly identified quasars also appear to be approaching each other with velocities typical of galaxies in a cluster, and they have a spectral redshift of 1.91, indicating that the light seen was emitted as much as 12 billion years ago. These observations suggest that rich clusters of galaxies may have existed early in the history of the universe, putting a significant constraint on theories attempting to explain the formation of large-scale structure in the early universe.

The discovery of the twin quasars in PHL 1222 also provides evidence that close encounters between galaxies may be responsible for turning on many quasars. Computer simulations show that encounters between galaxies can cause gravitational effects capable of driving huge amounts of gas into the inner regions of the galaxies. Such a mass concentration could develop into a black hole, and matter swirling into the hole would generate prodigious amounts of radiation.

Galactic near-collisions would have been much more common 12 billion years ago, when the universe was smaller and galaxies closer together, the researchers say. That would help explain why the majority of quasars emerged billions of years ago and are now seen at such great distances.