Lumps, clumps and jumps in the universe

Astronomers have already discovered lumps, motion and structure never suspected in a universe once considered smooth and expanding uniformly in all directions (SN: 3/22/86, p. 182). Two researchers now say the universe is even lumpier, has faster relative motion and shows larger structures than previously believed.

Neta Bahcall of the Space Telescope Science Institute in Baltimore and Raymond Soneira, previously of the Institute for Advanced Study in Princeton, N.J., searched for large-scale structures in the universe by tracing superclusters — clusters of clusters of galaxies, each containing hundreds of billions of stars. The astronomers looked at the light spectra emitted by 175 galaxy clusters. As the clusters speed away from earth, their spectral emissions shift toward the infrared region of the spectrum; the amount of shift indicates the speed of movement away.

The researchers then used three statistical methods to interpret the cluster velocities. They established that clustering occurs, determined the spatial relationships between clusters in a supercluster and showed how the superclusters actually look. Says Soneira, "All three methods produced the same results."

But those results — to be published in the ASTROPHYSICAL JOURNAL later this year — were unexpected, says Bahcall, and "very exciting. . . . Our whole view of the universe is changing right in front of us." The new view includes:

- Much more extensive clumping of galaxy clusters, and much larger clumps, than had been expected. It now appears that superclusters can extend as far as 500 million light-years, about 1 percent of the known universe.
- Relative motion within superclusters of 2,000 kilometers per second more than the speed accounted for by the general expansion of the universe, and about 5 times more than the speed expected as a result of gravitational motion.

These discoveries are the latest in a series of findings defying the theory that the universe is expanding smoothly and uniformly. Forces other than the Big Bang may cause the clumpiness and the motion. "Probably the same force that created the superclusters is the force that propels them," says Bahcall, but she adds that "we have no good model at the moment" to explain the existence or the motion of the clusters.

Three main theories make the attempt. One proposes that superclusters emerged soon after the Big Bang as results of large fluctuations in the overall smoothness of the primordial universe. Over time, the superclusters fragmented to form galaxy clusters and galaxies. Another theory suggests that early galaxies exploded, propelling clusters at the high speeds observed.

An equally promising theory, according to Bahcall, postulates that small fluctuations in the smooth early universe coalesced into galaxies under their own gravitational pull; later, gravity pulled galaxies together into clusters and superclusters. Not enough time has passed, however, for gravity alone to have formed the large structures now seen, says Bahcall. This leads to speculation that huge clumps of dark matter (black holes, neutrinos or other invisible matter) may help pull the galaxy clusters along.

Perhaps the real answer incorporates a little of each approach. Says Bahcall, "We're trying to combine them in some physical way. I think it's probably more complicated than any one [explanation]."

Even more tantalizing for Bahcall is the possibility that the cigar-shaped superclusters are subsections of still larger, filamentlike structures extending across the entire universe. "My feeling," she says, "is the more we study large-scale structures, the more we'll see even larger structures." — *T. Kleist*

Par for radioastronomy

David Stichweh/Otterbein

The radiotelescope in Delaware, Ohio, that was threatened with destruction by the expansion of a golf course (SN: 2/12/83, p. 101) has now definitely been saved, Phillip E. Barnhart of Otterbein College in Westerville, Ohio, reported at the meeting of the American Astronomical Society in Ames, Iowa, last week. Four institutions have formed the North American Astro-Physical Observatory to operate the telescope and have negotiated a 10-year renewable ground lease with the owners of the golf course. Built by Ohio State University at Columbus and Ohio Wesleyan University in Delaware, Ohio, the instrument was threatened when Ohio Wesleyan sold the ground on which it stands to the owners of the golf course. □

'Apparent' gravitational lens questioned

Two quasars very close together in the sky, catalogued as 1146+111B,C, may be a double image of a single quasar formed by the largest gravitational lens yet discovered (SN: 5/17/86, p. 310), or they may not be. Observations are now causing some astronomers to question the suggestion of a gravitational lens, but according to Bernard Burke of Massachusetts Institute of Technology, one of the group that first called these images an "apparent gravitational lens," the proponents of a gravitational lens are not giving up. Burke spoke in Ames, Iowa, at last week's meeting of the American Astronomical Society.

The two images lie 157 seconds of arc apart on the sky, and to Edwin L. Turner of Princeton (N.J.) University and his collaborators (including Burke), their spectra looked identical enough to be the same quasar. If that were so, the two images would be formed by bending of light around some very dense, massive object between us and them. One of the astrophysically exciting suggestions about the identity of that object is that it is a cosmic string, a kind of kink in space-time that is left over from an extremely early stage of the existence of the universe. Turner's group reported its conclusions in the May 8 NATURE.

Less than a month later, in the June 5 NATURE, P. A. Shaver and S. Christiani of the European Southern Observatory (ESO) headquarters in Garching bei München, West Germany, reported observations of the spectra of 1146+111B,C in a range not covered by Turner's group. The work was done at the ESO at Cerro La Silla, Chile, and it seems to show that the spectra are not identical. In particular, certain lines that astrophysicists would expect in that range from a quasar of that particular class do not appear in one of the spectra. Shaver and Christiani suggest that the images are two different quasars very close to one another. (Both images are at virtually the same distance from earth, so if they are not a double image, they must be close together.)

Also in the June 5 NATURE, under the rubric "scientific correspondence," E. S. Phinney and Roger D. Blandford of Caltech in Pasadena make a statistical argument for this to be two quasars close together and take it as evidence that quasars cluster as galaxies do. They call for a reexamination of the arguments on which other instances of alleged gravitational lensing are based.

Burke concedes that the finding of Shaver and Christiani is disturbing, but says "the issue is not settled." Further, "careful, quantitative spectroscopy" of the two images and everything near them is needed, he says. That should start in October, when that part of the sky comes out from behind the sun.

— *D. E. Thomsen*