Sound waves may drive cosmic structure

The melody lingers on. Sound waves generated in the early universe may have helped orchestrate the striking pattern of galaxy clusters and huge voids seen in the sky today.

Many sky surveys have shown that galaxies and clusters of galaxies form a web stretching across hundreds of millions of light-years. In the Jan. 9 NATURE, Jaan Einasto of the Tartu Observatory in Tõravere, Estonia, and his colleagues provide new support for this picture. Analyzing a collection of data on galaxy clusters, they find evidence of a three-dimensional pattern of rich clusters and intervening voids with a nearly periodic spacing of about 390 million light-years.

These results, cautions Robert P. Kirshner of Harvard University, are open to question. The data are sketchy and the interpretation depends on details of how the galaxy clusters were selected for the analysis, he notes. Yet this and similar findings, including those from the detailed Los Campanas sky survey, clearly hint at the presence of structures as large as a few hundred million light-years, Kirshner adds.

Such architecture spells trouble for a popular theory of the growth of structure in the universe. Relying on a hypothetical, fast-moving type of invisible material known as cold dark matter, the theory predicts that the distribution of galaxies on large scales should be entirely random and so have no discernible pattern.

Without that theory, two possibilities remain, says Kirshner. Cosmologists might invoke some new type of physics, perhaps with a new type of subatomic particle, to explain how tiny fluctuations in the density of matter in the early universe developed into the cosmic architecture seen today. A simpler and less daring strategy, however, has been proposed by several researchers, including Alexander S. Szalay of Johns Hopkins University in Baltimore. These scientists suggest that acoustic oscillations—sound waves—generated when the universe was still a hot soup of protons and electrons left their imprint on ordinary matter, helping to determine its later structure.

Stephen D. Landy *et al.*

Slice of sky from the Los Campanas survey shows clusters and voids among 3,540 galaxies.

Szalay explained the theory in Chicago last month at the Texas Symposium on Relativistic Astrophysics. During the first 300,000 years or so after the Big Bang, the cosmos was in a fog. Radiation and matter were strongly coupled, and the interaction between light and charged particles formed a dense medium through which acoustic waves traveled just as sound waves travel through the air.

Then came the dawn of a new era. The cosmos cooled, and electrons and protons combined to form hydrogen atoms. Because radiation isn't easily scattered by neutral atoms, light traveled unimpeded and the fog lifted. That light, which today provides an early snapshot of the distribution of matter, is known as the cosmic microwave background. At the time the atoms first formed, acoustic oscillations could no longer travel freely but imparted their energy into density fluctuations that later developed into galaxies and galaxy clusters.

Szalay and the other scientists propose that only acoustic waves with certain frequencies became part of galactic structure. In the same way that a guitar string's length and density allow sound waves of only certain frequencies to travel along it, the size and density of the cosmos permitted only some acoustic waves to propagate.

Szalay proposes that the characteristic sizes of structures seen in the cosmos today were imparted by acoustic waves of particular frequencies that reflect the size and density of the early universe. Today's galactic architecture, says Szalay, is consistent with a low-density universe—one that expands forever—containing a relatively high proportion of ordinary matter to dark matter.

If Szalay is right, the same size scale observed in galactic surveys should be apparent in the cosmic microwave background. Two satellites now under construction have the resolution to detect such a signature. In addition, researchers have begun larger, more detailed sky surveys that over the next few years should provide a more accurate picture of large-scale galactic structure.

"The exciting thing is that in a few years, we should know the answer," says Kirshner. —*R. Cowen*

Uncovering traits of effective therapists

Psychotherapy consists of a welter of competing techniques, each touted as a means of achieving better mental health. Yet clinicians and researchers have long noted that some therapists are more helpful than others, regardless of what techniques they employ.

A new analysis of data from an 8-year-old federal study of depression treatments underscores that observation and promises to shed some light on the personal approaches to treatment that make for outstanding psychotherapists.

"Significant differences exist in therapeutic efficacy among therapists, even the experienced and well-trained therapists in [this study]," write psychologist Sidney J. Blatt of Yale University School of Medicine and his coworkers.

The therapists who facilitated the greatest improvement in depressed clients said that they focus on psychological factors, such as distorted thinking and feelings of helplessness, rather than biological disturbances, Blatt's group reports in the December 1996 JOURNAL OF CONSULTING AND CLINICAL PSYCHOLOGY. In addition, superior therapists generally used psychotherapy alone, rather than in combination with psychoactive drugs, in their practices. They also expected treatment for depression to take longer than less effective therapists did.

Clinicians who created a strong therapeutic alliance, a measure of the collaborative bond between therapist and client, were most successful, the scientists argue. One therapist was especially effective even when she simply offered support and advice in brief weekly sessions to clients who received placebo pills, suggesting that a talented clinician needs no formal techniques to exploit the therapeutic alliance.

Moreover, clients who perceived their therapists as empathic and caring responded best to antidepressant drugs.

The new report derives from a study funded by the National Institute of Mental Health (NIMH) in Bethesda, Md., that uncovered few differences in the effectiveness of four treatments—two forms of psychotherapy, an antidepressant drug, and placebo pills—given over 16 weeks to 250 depressed people (SN: 12/2/89, p. 365). Drug and placebo clients received support and advice but no formal therapy.

Nine of the 28 therapists in the NIMH study elicited marked improvement from clients, regardless of the treatment to which they were assigned, Blatt's group notes. Another 9 therapists fostered moderate improvement, and 10 fell within a lower range of effectiveness.

"The NIMH study indicates that the therapeutic alliance is more critical than the techniques a therapist employs or the drugs that may be prescribed," says psychologist Hans H. Strupp of Vanderbilt University in Nashville. "This is currently not a popular view among many researchers, and it isn't what health care insurers want to hear either."

Elements of the therapeutic alliance are poorly understood, Strupp states. As in any profession, he adds, psychotherapy has small cadres of excellent practitioners and of poor ones. —*B. Bower*