PHYSICAL SCIENCES

Making it sound Gothic

Protestant religious services depend heavily on the spoken word. There is usually a 45-minute sermon, Scripture readings and spoken prayers. Singing and instrumental music play a minor role. But the use of music is growing and as it does, churches with acoustics designed for speech are found inhospitable to the sound of music.

Such was the case with the Duke University chapel, which had finished over half its interior with Akoustolith, a porous substance developed in 1916 that reduces reverberation time to about half that of a stone surface. Akoustolith was widely used in surfacing the interiors of churches where speech was to be favored. But now a large donor toward a new organ for the Duke chapel stipulated that the surfaces should be treated so as to increase their reverberation time to something appropriate to organ music.

Robert B. Newman of Bolt Beranek and Newman Inc. of Cambridge, Mass., and James G. Ferguson Jr. of Chapel Hill, N.C., addressed the problem. After some experimentation, as they told last week's meeting of the Acoustical Society of America in Salt Lake City, they found a sealer that closes the pores in Akoustolith and makes it as sound reflecting as stone without changing its appearance. With a 7-second reverberation time, the chapel now sounds as Gothic as it looks. So, presumably, could other churches. Provision for the spoken word is made with a sound reproduction system that involves speakers mounted on the pillars of the chapel's interior.

The tau and the unified theory

The tau lepton, a heavier relative of the electron and the muon, was a difficult particle for physicists to find, but find it they had to if efforts at a unified theory of particle physics were to continue in their present course. They require its existence. They also specify how it shall decay, and in the Nov. 19 PHYSICAL REVIEW LETTERS G. S. Abrams and 54 others working at the SPEAR storage ring of the Stanford Linear Accelerator Center report a measurement of the decay of the tau into a rho meson and a neutrino. This decay tests several important determinations of the new theory, and so far the measurement shows it happening in the expected proportions.

A cold big bang?

For years the generally accepted model of how the universe began has been a gigantic "big bang" involving temperatures so "hot" that they can meaningfully be discussed only in terms of relativistic energies of individual particles. Presumably such a state involved physical principles that only become evident on earth during experiments in high-energy particle accelerators. But as these experiments have proceeded, they have produced evidence for another sort of initial event.

At the recent meeting in Palo Alto, Calif., of the Council for the Advancement of Science Writing, IBM physicist Gordon Lasher described a model for the origin of the universe that involves a lot of "little bangs" occurring spontaneously in a cold, dense fluid of free quarks. Although quarks are now generally accepted as the most fundamental known constituents of matter, none has ever been observed in the free state. This discovery is key to Lasher's theory, for, he says, as the primordial fluid expanded, its density fell below a critical level, thus causing the free quarks to coalesce into the matter we see today.

The situation is somewhat analogous to opening a bottle of soda pop. Once pressure is released and gas dissolved in the liquid is allowed to expand, bubbles form spontaneously and randomly. As the proposed quark fluid expanded, however, the formation of nucleon "bubbles" was accompanied by the release of vast quantities of energy. These tiny explosions sent out shock waves that eventually collided with each other, so that within a half hour or so after the cold quark fluid began expanding, all the quarks had united to form protons, neutrons and so forth. By then the temperature of the universe had heated up to the level predicted by the big bang theory and the universe was rapidly expanding as we observe it today.

Not only does Lasher's theory take into account the principles of quark interactions ("chromodynamics") emerging from high-energy physics, it also offers a solution to a long-standing problem facing big bang proponents. In order for galaxies to form, the early universe needed to have an uneven distribution of matter. A perfectly uniform hot gas would have gone on expanding forever. To get around this problem, some theorists have just *assumed* that the necessary density variations (on the order of 2 percent) were present. But because of the turbulence caused by bubble formation and shock waves, Lasher's theory contains a simple explanation for the density fluctuations that eventually led to the formation of galaxies.

A hint of quarks and such to come

Just as the emerging principles of chromodynamics derived from earth-bound experiments are illuminating some of the deepest mysteries of outer space, some current observations of processes related to the universe at large are providing hints on the nature of the subatomic world. Some of these were discussed by physicists Sidney D. Drell and William M. Fairbank of Stanford at the CASW meeting.

With the construction of accelerator rings in which two beams of high-energy particles collide, the energy available to break up particles into their constituents is now measured in tens to hundreds of Gev's. Experiments in this energetic region are expected to fill in the remaining gaps in the predicted family of six quarks from which all known particles of matter could theoretically be constructed.

However, the question remains: Is there something even smaller and more fundamental than a quark? Drell thinks there may be. "Nature has always surprised us" at each new energy frontier, he says. Already two naturally occurring particle collisions, caused by the impact of cosmic rays, have been observed at energies more than 10,000 times greater than those yet available in accelerators. The results, Drell says, are "very weird," and he predicts that new surprises continue to lie in store for high-energy experimenters.

At the opposite end of the energy spectrum, involving gravitational processes so weak that any changes on an earthly scale would simply escape detection, another set of cosmic events may soon yield data bearing on the theory of elementary particles and forces. According to present understanding, William Fairbank says, previous experiments that failed to find evidence of gravity waves did so because they were so insensitive that only a nearby star explosion would have been detected. Now, however, a new instrument called SQUID (Superconducting QUantum Interference Device) may make it possible to detect gravity waves from catastrophic stellar events anywhere in our galaxy.

Other, more ambitious methods may also eventually be used to measure gravity waves. These include the use of satellites and beams of light traveling along evacuated tubes 20 kilometers or more in length. Besides confirming the prediction that such waves do exist, such experiments may offer enough data to address an important cosmological question: Is enough energy present in gravity waves to account for the "missing mass" needed to keep the universe from expanding and dissipating itself forever?