Subatomic Particles Make A Noise

Fourteen years ago in their book *Elementary Particles,* David H. Frisch and Alan M. Thorndike listed neutrinos under the heading "Particles We Might Do Without." One would hesitate to make such an entry today, if not for the sake of the economy of the universe (Frisch and Thorndike concluded that neutrinos are, after all, needed), certainly for the sake of the economy of particle physics for which neutrinos have done so many useful things.

Historically neutrinos have been the first to show physicists several important effects. Having revolutionized physical theory they seem now to be ready to be the instrument of a radical change in physics technology: the implementation of particle detection by acoustical means. At the meeting in Honolulu of the Acoustical Society of America and the Acoustical Society of Japan, L.R. Sulak of Harvard University reported that moving beams of charged particles such as might be produced by interaction between neutrinos and other matter do indeed produce detectable sound signals in water. This, he says, is the first successful detection of acoustic waves generated by charged particles.

One primary interest in this activity is what can be done to extend the use of neutrinos as probes of subatomic structures. "High energy neutrino reactions provide the finest resolution microscope known to man," says Sulak. "This microscope can effectively split the diameter of the proton into 100 slices." The next step would be a resolution sufficient to poke around in the inside of the quark.

Physicists don't know how to build accelerators to make neutrinos with that kind of energy, but they do exist in the cosmic rays. Particle physicists have an old habit of using cosmic rays for energies not otherwise available, and as soon as they suggest studying cosmic ray neutrinos, they meet an equally fervent interest from astrophysicists, who see neutrinos as bringers of information from the deepest cores of stars and other astronomical bodies.

But to study cosmic ray neutrinos means to solve a problem of how to detect their interactions in sufficient numbers. Particle interactions are usually detected by visible means: flashes in a scintillation counter, trails of bubbles in a liquid or sparks between a series of charged plates. In the first place, neutrinos (like all electrically neutral particles) do not make such tracks. Their appearance can be deduced by gaps in the tracks and by the tracks of the charged debris they set in motion when they hit something. But neutrinos don't hit often. A neutrino can go through the solid earth without hitting anything. In even the biggest bubble chambers with the densest beams of accelerator produced neutrinos, neutrino hits are few.

Cosmic ray neutrinos are rarer, and to get a sufficient number of hits from them, Sulak estimates a cubic mile of material will be necessary as target and detector. The only thing cheap enough is seawater, and that is precisely what is proposed. The proposal is entitled DUMAND (Deep Underwater Muon and Neutrino Detection), and it would instrument a piece of the ocean for recording such cosmic ray neutrino events.

Such a thing depends on the success of experiments like the one Sulak describes. Visible signals won't carry far enough in the ocean; only sound will. B.A. Dolgoshein of the Moscow Physical Engineering Institute and T.A. Bowen of the University of Arizona had suggested listening for acoustical pulses produced by the interaction debris as it instantaneously heats the water. The experiments were done at Brookhaven National Laboratory and the Harvard Cyclotron Laboratory and consisted of leading beams of charged particles (simulating the shower of debris from neutrino interactions) into a tank of water, where hydrophones recorded the sound. "The acoustic information seems sufficient to give an accurate measure of the shower position, direction, diameter and energy. The lowest energy shower that can be observed coincides with the highest energy showers accessible at currently planned accelerators," Sulak concludes.

Thus, if it continues to work, physicists may not have to abandon neutrino physics and all its glories after the next generation of accelerators. Meanwhile, there are possible laboratory applications using other liquids (for example, nitrogen) for detecting ordinary particles or possibly for the mapping of radiation dosage in proton radiotherapy. □

Chemical dumps: A growing problem

In the latest stage of what appears to be a growing chemical nightmare, the Environmental Protection Agency's administrator, Douglas M. Costle, announced last week than an estimated 32,254 potentially dangerous chemical dumps exist throughout the country, containing hazardous wastes in quantities that could prove harmful to humans and the environment. Of them, an estimated 638 may contain "significant" quantities of wastes "which could cause *significant* imminent hazard to public health," the agency said.

The numbers, culled from data filed with EPA's 10 regional offices are not hard figures but only the "best professional estimates" the agency can offer. They are based on what is known about present and past industrial activities and disposal practices. EPA says the sites were not identified by inspection teams nor does EPA have a list naming specific suspect sites. In announcing the figures, Costle noted that 80 to 90 percent of the 30 to 40 million tons of hazardous waste generated annually is being disposed of in ways that will not meet forthcoming standards.

The agency estimates that 20,000 *active,* private sites are being used to store, treat and dispose of the hazardous wastes generated by approximately 400,000 national producers. However, the agency had no idea how many thousands of *inactive* sites may exist.

In October, congressional hearings by the House Commerce Subcommittee on Oversight and Investigations probed just that issue. "Hazardous waste may be the single most significant environmental-health issue of this decade," a real "sleeping giant," according to subcommittee chairman Albert Gore (D-Tenn.).

The Love Canal incident in Niagara Falls, N.Y., brought the sleeping giant to light. From 1947 to 1952 the Hooker Chemical and Plastics Corp. buried drums of chemical wastes at the canal landfill. Although the company is believed to have complied with existing regulations and to have used state-of-the-art technology, years later a rising water table leached chemicals from their graves and carried them to the surface. Actual chemical pools formed in the backyards of some neighboring homes. So far, 80 highly toxic organic hydrocarbons and other chemicals —including at least 10 known carcinogens —have been found in tests at the site.

An unusually high incidence of birth defects, miscarriages, retardation and blood abnormalities has appeared in local residents and is now attributed to the chemicals. In August, President Jimmy Carter designated the Love Canal area an emergency qualifying for federal relief. The state recommended that pregnant women and small children evacuate; as of last week, all but 11 families had been relocated with millions in government aid.

What is EPA doing to identify other potential Love canals? Not much, according to those who testified before the subcommittee. Hugh B. Kaufman, manager of EPA's hazardous-waste-assessment program, told the subcommittee his was to be the lead EPA office for that, except that he had