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

EPA/Documerica

Hazardous wastes accumulating at Ville Platte, La., present a problem of safe disposal.

no budget, only one employee and in June was ordered flatly to stop looking for imminent hazards. A June 16 memo told Kaufman's boss to "put a hold on all imminent-hazard efforts" because work on writing hazardous-waste regulations has higher priority "at this time."

Kaufman also claims that when he was able to uncover potentially threatening situations, "trying to get the appropriate EPA regional office to take action against these facilities proved to be an almost insurmountable obstacle." In one such case involving a Deerfield, Ohio, site, the regional office refused to visit — or let headquarters personnel visit — the site. "When I discussed this case with regional officials," Kaufman testified, "I was told that they have in their files other cases that are even worse than [the Deerfield one] and... that they didn't plan to investigate any... let alone take action against them."

According to the Nov. 17 ENVIRONMENTAL REPORTER, a recent EPA study shows hazardous constituents are entering the groundwater — often in concentrations greater than permitted by drinking-water standards — at 43 of the 50 industrial-waste lagoons and landfills studied. In each case, there had been no prior documented or suspected problem.

The basis of EPA's authority to regulate the management of hazardous wastes comes from the Resource Conservation and Recovery Act of 1976. A set of seven regulations is required; three have been proposed, the rest will be ready within weeks. EPA estimates it will promulgate final standards in January of 1980. But the agency says its authority over abandoned or closed disposal sites rests mainly in enforcing action against the site owner if and when a particular site represents an imminent and substantial public-health hazard. If the owner lacks money to remedy the situation, EPA can't do much, Costle says, because it, too, lacks funds.

EPA hopes a national inventory by the states of open chemical dumps, due to begin next summer, will help at least to define the magnitude of the growing hazardous-waste problem. □

Estrogens and cancer: More questions

During the past three years, studies by five different groups of investigators have found that menopausal women who take estrogens run a considerably greater risk of getting uterine cancer than do women who do not take estrogens. Five separate studies confirming each other constitute scientific proof, right? Wrong! Reproducibility does not necessarily establish validity because the initial studies contained a serious methodological flaw. Or so argue two Yale University School of Medicine researchers in the Nov. 16 NEW ENGLAND JOURNAL OF MEDICINE.

And to further heat the controversy, two Harvard University School of Public Health scientists counter the Yale researchers' conclusions in an accompanying editorial. In fact, they claim that the Yale researchers' findings substantiate, rather than detract from, the initial five studies showing that menopausal estrogens increase the risk of uterine cancer.

Now for the details. All five groups of scientists who found a link between estrogens and uterine cancer used a retrospective case control study. That is, they selected women who had been diagnosed for uterine cancer, matched them against women with other kinds of cancer or no cancer and asked both groups whether they had been using menopausal estrogens. All five groups found that those women with uterine cancer had been using estrogens to a considerably greater degree than had women with other kinds of cancer or no cancer. They concluded, on the basis of their particular findings, that women who use menopausal estrogens are anywhere from three to eight times more at risk for uterine cancer than are women who don't use estrogens.

Ralph I. Horwitz and Alvan R. Feinstein of Yale, however, believed that the methodology used in the above five studies was faulty. Specifically, because uterine bleeding is a well-established side effect from estrogen use, they suspected that far more women using estrogens would come to physicians fearing uterine cancer than would women not using estrogens. As a result, many more cases of uterine cancer would be detected among estrogen users than among nonusers, thus suggesting that estrogens cause uterine cancer. The only unbiased way to determine whether estrogens really cause uterine cancer, they reasoned, would be to match women diagnosed for uterine cancer against women who had come to physicians because of uterine bleeding, but who had not been found to have cancer, and to see whether the women with uterine cancer had used estrogens considerably more than had the women without it.

Horwitz and Feinstein then conducted two studies — one comparable to the five that had established a link between estrogens and uterine cancer and one in which they matched women diagnosed for uterine cancer against women not so diagnosed, but who had come to doctors because of uterine bleeding. The results of the first study, they report, were close to what the five previous studies had found — in fact, even a bit higher; that is, women who use menopausal estrogens run a *twelve* times greater risk of getting uterine cancer than do women who do not use estrogens. The results of the second study, however, found that women with uterine cancer had not used estrogens to any significantly greater degree than had women without uterine cancer. So Horwitz and Feinstein conclude: "The magnitude of the association between estrogens and endometrial [uterine] cancer has been greatly overestimated because of detection bias; when an appropriate compensation for the bias is introduced, the odds ratio approaches a value much closer to one."

In the accompanying editorial, however, George B. Hutchison and Kenneth J. Rothman disagree with Horwitz and Feinstein's conclusions. They contend that women with uterine cancer will eventually have the problem diagnosed whether they had early uterine bleeding from estrogens or not, and thus estrogen use "will have little effect on the total number of uterine cancer cases ultimately found. Therefore estrogen users, especially long-term users, would be very little overrepresented among a series of women with endometrial cancer." On the other hand, Rothman and Hutchison assert, many of the noncancerous conditions detected by estrogen-induced uterine bleeding probably would not be detected if women weren't estrogen takers. Therefore, using women with such conditions as controls tends to "yield falsely high estimates of estrogen use, as compared with what would be obtained from a valid control series. Thus the analysis recommended by Horwitz and Feinstein compares a case series that has minimal selection bias with a control series that has a bias in the direction of exaggerating the frequency of estrogen use. The net effect is to underestimate the estrogen-cancer association."

Horwitz and Feinstein's second study, then, is not valid, but their first study is, Rothman and Hutchison conclude. And the data from their first study "only add to the... evidence that exogenous estrogens induce endometrial cancer." □