Neutral weak currents: The other shoe

It frequently happens in science that two or more experimental groups are working on the same subject. One of them comes up with a new and startling result. In confident hope of confirmation, the scientific public stands around waiting for the other shoe to fall. Sometimes it falls with a bang; sometimes it never falls at all, and once in a while it is set down very gently. The last alternative is what has now happened in the case of the so-called neutral weak currents.

Two groups, one at the CERN laboratory in Geneva, the other at the National Accelerator Laboratory in Batavia, Ill., have been studying the physics of neutrinos with very high energies, hoping among other things to find out something about the workings of the weak interaction. Last year the CERN group reported that it had found a phenomenon called neutral weak currents, a particular process in the collision of two particles under the influence of the weak interaction that is predicted by newer theories of the interaction but forbidden by older ones. The effect of the discovery, if it were confirmed, would be to overthrow the older theories and pave the way for the acceptance of the new ones. The new ones are more exciting to many theorists because they go beyond the weak force alone and make attempts to unite it theoretically with other classes of force. Everyone waited for the NAL result.

The weak interaction is one of the four classes of force that physicists recognize in nature. It comes into play in the domain of particle physics, where it governs a number of the ways certain particles decay radioactively (and also the beta decay of atomic nuclei). The older theory had said—and it was upheld experimentally until the CERN result—that when two particles collide under the governance of the weak interaction, they must exchange a unit of electric charge. That is, a particle that goes in uncharged comes out charged, while one that goes in charged comes out neutral. The newer theories, which seek to unite the weak interaction with other classes of force (the electromagnetic or the strong interaction or sometimes both), demand the possibility of a weak-interaction collision without charge exchange. This is called a neutral weak current, a term taken from the branch of mathematics used to describe these events.

The CERN group found evidence for a collision in which no exchange of charge occurred, and they published bubble-chamber pictures to prove it. Interested people then turned to NAL and inquired after their results. At first the talk among informed sources was that a confirmation was in the offing, but one was warned not to write anything pending publication or public announcement of the results. The physicists were not through with their analysis. Gradually the talk became more and more equivocal.

Now the NAL group (A. Benvenuti et al) has finally published a report, in the April 8 PHYSICAL REVIEW LETTERS. It sets down the other shoe with a certain tentativeness.

The NAL result concerns collisions of neutrinos with neutrons or protons. One of the things that is supposed to come out of such a collision is a muon. The NAL group has found numbers of such collisions in which muons do not come out. Their conclusion: "A possible, but by no means unique, interpretation of this effect is the existence of a neutral weak current."

They also mention that the numerical data assembled in their experiment tend to fall into the range predicted by one of the new theoretical models, that of Steven Weinberg of Massachusetts Institute of Technology.

But the NAL physicists caution that the nonproduction of muons could have other causes, contamination of the beam of muon neutrinos that they were using with the other type of neutrino, electron neutrinos, or the existence or production of a new particle. For the moment these cannot be ruled out. They have an improved version of the experiment running and promise results soon.

Quantum electrodynamics: A first kick

Quantum electrodynamics, the theory of electromagnetic phenomena on the subatomic level, has been one of the big success stories in particle physics. A great body of experimental evidence can be cited in its favor. As experiments have gone to higher and higher energy, thus probing shorter and shorter distances, the theory has continued to apply very satisfactorily. Physicists wonder how far quantum electrodynamics will hold out. Will it work in the new energy domain now opening up?

The availability of beams of protons with 200 billion electron-volts energy at the National Accelerator Laboratory made it possible for a group from the State University of New York at Buffalo (P. L. Jain et al) to do an experiment probing the theory at very high energy. The experimental mode they chose is one in which some hints of conflicts have appeared at lower energies: the production of electron-positron pairs by a swiftly moving particle as it interacts with the electric field of an atomic nucleus.

The results of their experiment disagree with theory. The Buffalo group concludes: "We feel that the present . . . observations will be useful to the theorists who wish to look into these discrepancies very seriously." In the past when there has been trouble in this domain modifications of the theory to fit experiment were possible. Whether that will happen in this case is in the laps of the theorists. □

Margarine and your heart

Hardening of the arteries causes 90 percent of all heart disease. Evidence has indicated that the hardening results from high amounts of cholesterol and saturated fatty acids in the blood. So the medical community has encouraged people to eat foods with less cholesterol and with polyunsaturated fatty acids rather than saturated fatty acids. Down with eggs and butter, up with polyunsaturated vegetable oils and margarine! This has become the credo of millions.

Now margarine is being accused of being a worse villain in hardening of the arteries than butter or eggs. The unorthodox indictment, by Fred A. Kummerow, professor of food chemistry at the University of Illinois, and his team, was made last week at the annual meeting of Federation of Societies for Experimental Biology in Atlantic City.

The problem, Kummerow explains, is that although margarine consists of polyunsaturated acids, many of these acids change from their natural form to an altered form during the hydrogenation process. The altered form of fatty acids appears to be more damaging to arteries than even saturated fatty acids or cholesterol.

Kummerow and his colleagues fed 10 groups of 12 pigs each a basic diet. Five of the groups received a supplement of one of the following: beef tallow, corn oil, butterfat, fat free of altered fatty acids, or hydrogenated soybean oil (margarine base stock containing 50 percent altered fatty acids). One group received a supplement of fat and sugar. One group was supplemented with a mixture of used fat and sugar. Three groups received egg yolk, whole egg powder or crystalline cholesterol

equivalent to two eggs a day. The remaining group did not receive supplements.

The pigs were fed these diets with or without supplements for eight months, then were slaughtered. The levels of cholesterol in their blood and the amount of cholesterol in their aortas (the artery that takes blood from the heart and distributes it throughout the body) were measured. The degree of hardening of the arteries was also determined.

The pigs fed the margarine fat had the highest cholesterol levels and the greatest degree of hardening of the arteries. The aortas of seven out of twelve (58.3 percent) of the pigs fed the oil had bumps in their arteries (the first symptoms of hardening of the arteries); bumps for the rest of the pigs appeared in only 14 percent of them. The next group with the most hardening of the arteries were pigs fed the mixture of fat and sugar, but the figures dropped markedly. Only three out of twelve had aortas that showed hardening. No elevation in total blood levels of fat or cholesterol was noted in the pigs fed the basic diet or the basic diet supplemented with crystalline cholesterol, powdered egg yolk or powdered whole egg. Aorta damage was also less than for the other groups.

"No explanation," Kummerow admits, "is presently apparent for the observation that a significantly higher percentage of raised lesions was noted in the aorta from swine fed trans [altered] fat as compared to those fed saturated fats or a dietary source of cholesterol. That the addition of cholesterol to the diet of rabbits increases their plasma cholesterol level is well known. However, such an elevated effect has not been observed in swine. Therefore, swine seem closer than rabbits to human subjects in their response to a source of dietary cholesterol."

What these findings mean for the public, Kummerow says, is that margarine that contains trans-fatty acids is more likely to cause hardening of the arteries than are cholesterol-rich animal fats, such as butter, or cholesterol-rich foods, such as eggs. Some American margarines have been found to contain as much as 36 percent trans-fatty acids. Canadian and European margarines prepared from hydrogenated fish oil and rapeseed oil contain an even higher level of trans fats.

"We can't say which margarines are worse and which are better because the trans content is varied from time to time," he says. "However it is possible to provide trans-free margarine to American consumers. One large international firm is providing such a margarine to their customers in Europe; they should also do so for their customers in the United States." □

Blow up: Removing the people mover

Such a deal! For only $13.4 million I can get you the perfect people mover. It will have 3.2 miles of elevated guideway on which 90 fully computerized, 21-passenger capsules will efficiently whisk people to and from their destinations at the push of a button.

The Federal Urban Mass Transportation Administration (UMTA) bought this spiel in 1969 when enthusiasm ran high for alternate modes of mass transportation. It proceeded to spend $57 million on a prototype people mover.

Where was the money spent? In New York where construction of the Second Avenue subway could serve millions of people? No. The people mover was built in Morgantown, W. Va., on the campus of West Virginia University. This happens to be in the home district of Rep. Harley O. Staggers (D-W. Va.) who, as chairman of the House Commerce Committee, has a lot to say about the Department of Transportation's budget.

After five years of engineering delays, cost overruns, politicking and assorted red tape, all the Transportation Administration has to show for its money is 2.2 miles of track, five test vehicles and three, instead of six, stations. Now, the Government is thinking about blowing up the whole mess.

Why does anyone want to dynamite the people mover? Because it will cost at least another $50 million to complete the system that was supposed to be carrying passengers in 1972. Three weeks before the 1972 election, Mrs. Edward F. Cox, the President's daughter, dedicated the system with much fanfare as a shining example of the Administration's progress in mass transportation. Shortly thereafter, the Administration imposed a one-year moratorium on major work on the system.

UMTA has recently tried to divest itself of this white elephant. It tried to give it to the University of West Virginia but the university doesn't want it. As it stands, the people mover has too little track and too few stations and cars to be of any practical use on the campus. The portion that is completed probably will not work properly because of engineering short cuts and, even if it does, the university does not have the money to operate it.

Engineers are now trying to properly estimate the cost of destroying the people mover. □

Mercury: Revising the textbooks?

Just as Jupiter seems to provide back-looking planetologists with an atmosphere that reflects the earliest days of the solar system, Mercury may be offering them a surface that still shows traces of its formative years. If this is true, there is just a chance that Mercury may rewrite the textbooks on the way in which the planets were born.

From the reams of data collected by Mariner 10, two findings are the keys to what could be one of the most important discoveries since earth-spawned space probes began visiting other worlds. One is the observation that Mercury has an outer layer of lightweight, moonlike material, which, because of the planet's high overall density, argues for a heavy iron core (SN: 4/6/74, p. 220). The other is the possibility, suggested by Bruce Murray of the California Institute of Technology, that much of Mercury's original surface is still showing.

The ranking theory of how planets evolve has long been that they condensed from concentrations in a primordial gas cloud. Then, once they had accreted, or come together, but while still in a largely liquid state, the heavy elements such as iron sank to the center while lighter ones rose to the top. This sorting process is known as differentiation.

The alternative posed by Mercury is iffy at best, but it contradicts such a fundamental part of planetology that it could be foolhardy to reject it out of hand, though even Murray points out that Mariner 10's data merely provide some justification for considering the alternative.

The idea is beguilingly simple: If Mercury is a differentiated planet with its original surface still on top, perhaps the differentiation took place as it formed instead of afterward. Otherwise the original surface would presumably have been plowed under.

The critical factor is whether much of the surface photographed by Mariner 10 is indeed original. There are definite signs of lava flows suggesting volcanic activity, and long, not-too-twisted cliffs and fissures pointing to a planet with at least a somewhat active history. But, says Murray, there are no signs of substantial atmospheric erosion or of worldwide crustal shifts like the plate tectonics of earth. Perhaps some original surface does remain. In fact, because the radioactive elements that provide much of a planet's internal heating are more likely to end up among the rocks at the top than among