Ripples in Physics: Apparent Failure of Muon Conservation

Conservation laws are one of the chief weapons that physicists use in attempting to impose some intellectual order on the fast-changing world of subatomic particles. Conservation laws impose limits on the sorts of particle transmutations that may take place by decreeing that, whatever happens, certain properties possessed by the particles must be conserved. Conservation of electric charge is an example: If a positively charged particle decays, among the decay products there must be a net electric charge of one positive unit.

Conservation laws are usually empirically determined: In millions of different particle activities, experimenters note that a certain quality is conserved, so they propose an appropriate conservation law. It becomes one of the tasks of theory to explain the existence of the conservation laws either prospectively, by prediction, or retrospectively, by "retrodiction," as Steven Weinberg of Harvard University put it in a talk at the meeting of the American Physical Society in Chicago last week. Conservation laws occasionally break, and when they do, theorists must readjust or repredict. In his talk, Weinberg made public a rumor that had been going around the meeting about such a violation, mentioning an experiment that seems to violate the law of muon conservation. The rumor has been causing quite a ferment among theorists.

Muons are among the very small class of particles called leptons. There are only four leptons whose existence has been thoroughly confirmed: the muon, the muon neutrino, the electron and the electron neutrino. (There is strong evidence for the existence of more leptons, but it is indirect and not yet entirely satisfying.) Small as is the group of known leptons, it appears to be divided into a muon "family" and an electron "family" by separate conservation laws. It has appeared that there were separate qualities of muonness or "muon number" and electronness or "electron number" that were separately conserved. Electron number belongs to the electron and the electron neutrino, muon number to the muon and the muon neutrino. What the conservation law for muon number means in practice is that when a muon decays, there must be a muon neutrino among the decay products. The observation cited by Weinberg amounts to a very few examples of muon decay that does not include the muon neutrino among its products.

The experiment took place at the Swiss Institute for Nuclear Research near Zurich, and it seems to have shown six examples of a process in which the muon decays into an electron and a gamma ray, rather than the more common result of electron, muon neutrino and electron antineutrino. In response to a query from SCIENCE NEWS, J. P. Blaser of SIN replied with the following quasiconfirmation:

"In a preliminary experiment at SIN on the gamma decay of the muon (authors W. Dey, R. Engfer, W. Eichenberger, C. Petitjean, H. P. Povel, A. van der Schaaf and H. K. Walter) six events were observed which cannot easily be explained by radiative muon decay or other known backgrounds. However, there is no sufficiently significant proof at this stage that these events really originate from gamma decay of the muon. The experiment will be continued with an improved setup." Radiative decay is the kind allowed by the conservation law; gamma decay is the forbidden kind.

If this appearance should be confirmed and the rate of conservation-violating decays remains what it now appears to be, the law will be violated by one muon decay in a billion according to figures cited by Weinberg. Thus it becomes a law that holds in most cases but is "weakly violated." In theoretical terms this demotes muon conservation from an "exact symmetry of nature" to an "approximate" one. As Weinberg points out, the unified field theory of subatomic particles that he and others have been working on for years has been quite successful in explaining several previously discovered weak or partial violations of conservation laws. These are among the retrodictions he cites. ("I think that's a real word," he says.) If the experimental evidence for violation of muon conservation becomes compelling enough, theory might deal with it by postulating a new, very weak, class of force in nature, or by adjusting the number of leptons theoretically allowed to exist.

Of course, as Weinberg stresses, physicists should always keep in the back of their minds the possibility that a given conservation law may break. There never was any evidence *for* muon conservation, he reminds us; there was only no evidence *against* it. That is the status of most conservation laws. □

Viking's search for life: Another mystery

The two Viking landing craft on the surface of Mars are continuing to seek answers to the towering question of life on that surprising planet, and answers they are getting—of a sort. But what are they answering? The latest test has seemingly tilted the scales away from biology, yet at the same time it may have knocked out the supports from beneath one of the few nearly accepted parts of a nonbiological explanation for the tantalizing results of past tests.

One of Viking's three kinds of biological experiments is a "pyrolytic-release" device, which exposes a Martian soil sample to a radioactively tagged atmosphere and then incinerates it to see if the gases given off show that any of the tagged carbon compounds have been assimilated. Previous runs with the instrument have shown that premoistening the sample with water produces a lower response in the data, as does heating the soil (to well below incineration temperatures) beforehand. If Martian microorganisms are present, the inference went, their lack of response after such treatment suggests that they were either drowned or cooked. Alternatively, nonbiologic chemical reactions were "deactivated."

In the latest run, performed with Viking lander 1, team leader Norman Horowitz of the California Institute of Technology decided to use a soil sample that was first moistened, then heated to drive off the added water. With both of the response-lowering techniques in use, he reasoned, the data should almost surely yield a zero. Instead, the instrument showed a "first peak" radioactivity count of about 2,200 and a significant second peak of 32. "As far as we're concerned," says Frederick Brown of TRW, Inc., "that's a positive response."

Combined with past runs, says Brown, the result shows that "if you add water, the response goes away; if you remove the water, it returns." More important, he says, is that it seems to be a vote against biology, since the preheating would presumably have "deactivated its response" more readily than it would have affected a nonbiologic reaction.

These same results, however, raise a serious problem, according to Gilbert Levin of Biospherics, Inc., another of Viking's chief biologists. The "gas-exchange" experiment in Viking's biology package showed early in the mission that exposing a soil sample to moisture (in the form of water vapor given off by a nutrient solution) produced a rapid release of oxygen that suggested to some observers the presence of substantial amounts of peroxide or superoxide adsorbed or otherwise trapped on the soil grains. The release was so complete, in fact, that adding more water a few days later (by bringing the sample into physical contact with the nutrient) produced no more oxygen. The possibility of such volatile oxides, while by no means proven,

has been almost a cornerstone in many attempts to account for the instruments' responses by nonbiologic means.

Yet the latest PR results, says Levin, throw the whole peroxide model into question, suggesting that more exotic chemistries must be postulated if biology is to be explained away. Horowitz, he points out, has stated that Viking's labeled-release and gas-exchange data represent oxidative reactions, while the PR indicates a reduction. "However," says Levin, "those proposing the single-cause theory—peroxide—to explain all three instrument results had theorized that the peroxide reacted to produce intermediates or free radicals, which, in turn, were responsible for the reductions observed in PR." The water added to the latest PR sample, even though it was boiled off later, ought to have driven off the oxygen from the peroxides on the soil. This precludes the peroxide-produced intermediates or free radicals from being available to reduce the carbon dioxide or carbon monoxide to form the "organic matter" detected by the experiment.

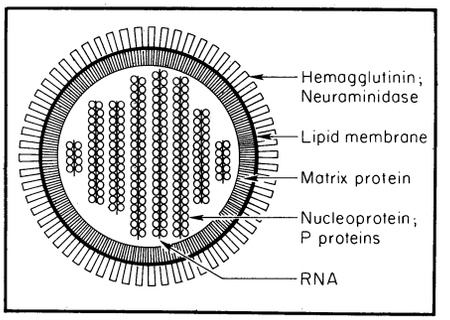
An alternative theory may be that the water merely reduces superoxides down to peroxides, leaving the reaction potential relatively intact. Gas-exchange experimenter Vance Oyama of the NASA Ames Research Center proposes this idea as part of a detailed model of Martian surface chemistry (NATURE, Jan. 13). But the case is far from closed. □

Soyuz 24 crew aboard Salyut 5

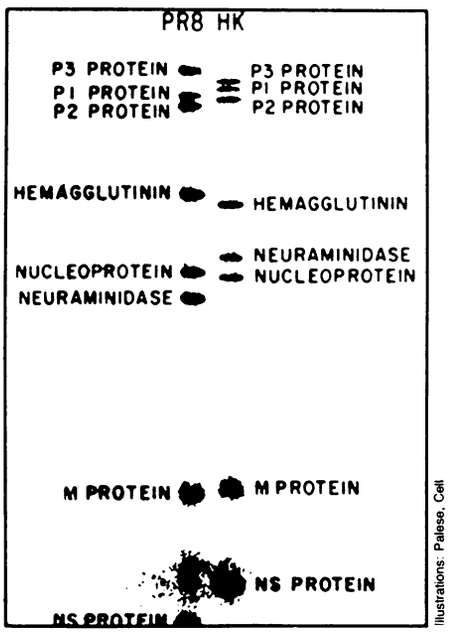
The Soviet Salyut 5 space station was successfully boarded last week by a second crew of cosmonauts—the third to make the attempt. Both of the previous attempts, last autumn, suffered considerable difficulties: The Soyuz 21 crew was forced to leave the station and return to earth prematurely because of difficulties with their spacecraft, and Soyuz 23 was unable even to dock with the station at all due to a malfunction of the Soyuz portion of the rendezvous system.

Soyuz 24 was launched on Feb. 7, carrying cosmonauts Victor Gorbatko and Yuri Glazkov, who had also been the backup crew for Soyuz 23. (Gorbatko had been in space once before, aboard Soyuz 7 in 1969.) The rendezvous and docking with Salyut 5 took place on Feb. 8, and the cosmonauts entered the station a day later. The goals of the mission have not been publicized beyond general references to biomedical experiments, earth-resources studies and the like. It has been reported, however, that both crewmen have been trained in extravehicular activity, and that in fact Gorbatko was a backup crewman for two earlier missions (Voskhod 2 in 1965 and Soyuz 5 in 1969) that included such "spacewalks." □

Fine dissection of virus: No pandemic



Influenza A virus: Sphere with spikes



Separation of genes from flu viruses

The New Jersey swine flu virus is unlikely to cause the next influenza pandemic, say reseachers at Mt. Sinai Medical School. Their prediction is not based on the epidemiology of influenza, but on the exact composition of the swine flu virus.

At the Gustav Stern Symposium on Perspectives in Virology last week in New York, Peter Palese described techniques, developed with Jerome L. Schulman and Mary B. Ritchey, that allow a close look at the genes and proteins of influenza viruses. The influenza genes are separate segments of RNA. When the researchers compared the eight genes of different flu viruses, they found that the New Jersey influenza closely resembled the influenza that infects swine. None of the genes appeared to be from the type A influenza virus that most commonly infects humans. The New Jersey virus thus does not fit the current theory that pandemic strains of influenza result from new combinations of flu genes from animal and human viruses. "It is therefore most probable that the occurrence of New Jersey swine virus in humans in Fort Dix represents an isolated event without serious consequences," Palese writes in an article that will appear in CELL.

Separation of the eight genes of the influenza virus has made it possible for researchers to determine the genes that code for each protein in the virus and to begin clarifying the role each protein plays in infection. Two human viruses—PR8, which was prevalent before 1947, and HK, the current A-Hong Kong strain—have genes with different separation characteristics (see figure). The researchers detected the protein message of each gene by infecting a cell with different viruses and analyzing resultant viruses that included new combinations of genes. Palese and co-workers compared the proteins present in each new virus with the RNA segments and with any altered characteristics of the virus. They found, for example, that P1 and P3 proteins are necessary for synthesis of intermediate RNA strands, and P2 and nucleoprotein are probably necessary for synthesis of the RNA that goes into the final virus particles. They have also learned that not only surface proteins but also some internal proteins influence whether a virus can evade a host's immune system and infect cells.

"Clearly we are now in a position to ask which gene(s) is involved during different replication steps and to identify genes contributing to virulence in a particular host system," Palese writes in his paper. "RNA analysis of different influenza viruses and their recombinants will open new avenues of investigation into the capricious nature of influenza virus."

The new methods of analysis may also lead to a more rational approach to selection of vaccines. "It is extremely important that any virus given to man today be completely genotyped so we know the origin of every gene. Before this, we could only identify two genes," Palese says. □

Limited use of flu shots resumed

An outbreak of A-Victoria flu in a Miami nursing home and cases scattered across the United States and Canada has prompted the Department of Health, Education and Welfare to partially lift its ban on flu immunizations. Secretary Joseph A. Califano Jr. recommended doctors vaccinate elderly and high-risk persons with the combined vaccine that protects against both A-Victoria and swine flu viruses. Although an epidemic of swine flu remains unlikely, the combination shots will be given because no single-purpose vaccine against A-Victoria influenza was manufactured this year.

Doctors may also resume immunization against B-Hong Kong flu, a milder strain that commonly attacks children. Only the