Science News of the Week

Still another (possibly) new particle

And then there were (possibly) four new ultraheavy particles. In addition to the two or three psi or J particles previously reported, the Fermi National Accelerator Laboratory now reports another new particle. Evidence for the existence of such a particle with a mass somewhere between two and four billion electron-volts is reported in the Feb. 17 PHYSICAL REVIEW LETTERS by Alberto Benvenuti and 12 others.

The evidence appeared in the FermiLab experiment that works with high energy neutrino beams. The experiment, a collaboration of Harvard University, the University of Pennsylvania, the University of Wisconsin and FermiLab, has already done much to revolutionize physicists' ideas of the physics of neutrinos and of the weak interaction, the class of force responsible for their behavior. This is its first venture into the new heavy particle business.

What indicates the existence of such a new particle is 14 events in which the neutrino beam, as it interacts with matter, produces pairs of muons, one with positive electric charge, the other with negative charge. The rate of muon pair production, the oppositeness of their charges and the way they behave are the factors that convince the experimenters that a new particle has been present.

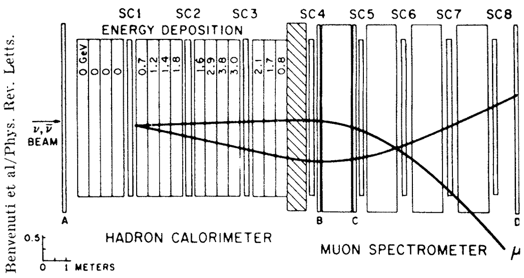
One possible interpretation is that the new particle is a hadron, a particle that responds to the so-called strong interaction, the class of force that holds atomic nuclei together. This characteristic might relate it to the psi or J particles seen in other experiments. Another possibility the experimenters mention is that it is a heavy lepton, one of the class of particles closely associated with the weak interaction. The experimenters propose to call their discovery a *y* particle.

Theorist Benjamin W. Lee of FermiLab calls the result "a very important finding" but points out that the evidence is still somewhat circumstantial and not a "smoking-gun proof" because the experiment tells little yet about the detailed characteristics of the new particle. Theoretical interpretation is thus not unique, and a number of options are open.

One possible explanation, according to Lee, is that this is a so-called charmed particle, a possessor of a new and theoretically important property not heretofore experimentally demonstrated. A good deal of the theoretical speculation about the psi-J particles sees them as composites of charmed particles, mesons (mesons are a subclass of hadrons) composed of a charmed quark and a charmed antiquark. The psi-J's thus would not exhibit charm themselves since charm and anticharm would cancel out. But the *y*, Lee says, might. It could be made of a charmed quark and a not charmed antiquark and so carry a unit of charm itself. On this interpretation the experimental happening is explained by saying that the neutrino comes in and produces the charmed meson and a muon. The charmed meson then decays into another muon.

Lee finds that interpretation logically compelling but in view of the experimental ambiguities concedes that others are possible including the view that the *y* is a quite ordinary heavy particle not involved with charm or charmed quarks

Benvenuti et al/Phys. Rev. Letts.



Muon pairs are evidence for y *particle.*

at all that happens to decay into muon pairs. But he contends that this possibility is not likely.

It seems thus that something new and interesting is happening, but further work is required to pin down its nature unambiguously. For now, Lee says, it is not conclusive that they are producing charmed mesons. □

Nitrogen fixing the synthetic way

After years of difficult research, chemists from England and the United States have devised synthetic reactions approximating a process that some bacteria and algae have carried on for millions of years. The process is the fixing of atmospheric nitrogen (N_2) into ammonia (NH_3) at mild temperature and pressures.

Chemists now convert N_2 into NH_3 for use in fertilizers mainly by the Haber process, a complicated series of steps which consume copious amounts of energy. Several groups have been studying the nitrogen-fixing ability of certain bacteria and blue-green algae and attempting to duplicate it in the laboratory. Until now, however, experimental yields of NH_3 have been unimpressive.

The two teams published within a few weeks of each other; Joseph Chatt, A. J. Pearman and R. L. Richards of the University of Sussex in the Jan. 3 NATURE and Stanford chemists Crista R. Brûlet and Eugene E. van Tamelen in the Feb. 17 JOURNAL OF THE AMERICAN CHEMICAL SOCIETY. Both teams were able to get NH_3 yields as high as 90 percent with a system of organometallic complexes and acids at normal pressures and temperatures. Both groups report that the reduction (the addition of hydrogen) of N_2 may have occurred at a single metallic site rather than at dimetal sites as proposed previously.

To review the research effort briefly, chemists isolated the enzyme responsible for natural nitrogen fixation, nitrogenase, several years ago. The enzyme has two protein components, one containing an atom of molybdenum and about 15 atoms of iron, and the other containing two atoms of iron and some sulphide. It is suspected that N_2 is bound to the molybdenum or a molybdenum-iron complex, then hydrogen is added to reduce it to NH_3. Several groups have devised synthetic schemes in which metal complexes pick up N_2, but reducing it with high yields under atmospheric temperatures and pressure has been accomplished only by the Chatt and van Tamelen teams. Both teams used slightly different metal complexes, solvents and acids in their reactions.

The two studies are not significantly different, have comparable results and tend to confirm each other, Brûlet told SCIENCE NEWS. Both indicate that single metal sites are involved, although more work is needed to eliminate the possibility that two metals, such as molybdenum and iron, might be complexing during the nitrogen fixation, Brûlet says. This work does not signify that a new industrial process is right around the corner, she says, but it does clarify the natural mechanism. And this understanding is needed before a catalytic, energy-efficient process can be devised for producing large amounts of ammonia without massive energy input. □