Physical Sciences

Leptons with size proposed

Current physical theory tends to treat the leptons, the class of particles that respond to the so-called weak force, as if they had no spatial extent. The electron, the positron, the muon are treated as if they were geometric points. The idea causes some serious conceptual difficulties, but the difficulties have usually been overridden by the consideration that the theory works.

But not quite any more. A shadow has fallen, cast by the results of certain experiments in which electrons and positrons collide. The cross sections for the production of certain kinds of particles (hadrons) in those collisions do not come out quite what theory says they ought to be.

One suggested solution to the difficulty is presented in the June 24 PHYSICAL REVIEW LETTERS by O. W. Greenberg and G. B. Yodh of the University of Maryland. They suggest that leptons, after all, have a finite size. The dimension would be on the order of 6×10^{-17} centimeter. Greenberg and Yodh present an argument to show that the existence of such a size would add a certain component to the interaction that takes place between two leptons as they approach each other and that this component makes the cross sections for hadron production come out to the experimental value.

And still no heavy leptons

Another problem involving leptons is that there are only four of them (eight if you count antileptons). The electron, the muon and two kinds of neutrino are all. Newly proposed theories, which are attractive to many physicists because they present a treatment that tends to unify the phenomena under control of the weak forces with those under control of electromagnetism (SN: 5/25/74, p. 340), predict the existence of more leptons, heavier than the known ones.

Up to now experiment has consistently failed to find any. A new experiment, done at the Fermi National Accelerator Laboratory in Batavia, Ill., extends the range of masses searched for and still comes up negative. As B. C. Barish of California Institute of Technology and seven collaborators put it in the June 17 PHYSICAL REVIEW LETTERS, previous experiments searched for leptons with masses up to 2.5 billion electron-volts. (This is about ten times as heavy as the muon, the heaviest known lepton.) But some theoretical models allow lepton masses up to seven billion electron-volts, so the experiment of Barish et al was designed to search the range between two and seven.

They report finding no such leptons with masses in this range, and they conclude that any heavy leptons must have masses greater than 8.4 billion electron-volts.

A fast flying pulsar

Theories of what pulsars are tend to regard them as fast moving objects. Pulsars are supposed to be the remnants of supernova explosions, and the explosion could blow the remnant off position with quite a high speed.

If pulsars are moving fast, they should show appreciable proper motion (motion across the line of sight) in only a few years' observation. In a recent ASTROPHYSICAL JOURNAL LETTERS (Vol. 189, p. L119) R. N. Manchester, J. H. Taylor and Y. Y. Van of the University of Massachusetts report such a motion for the pulsar PSR 1133 +16. If the pulsar is 130 parsecs away, as believed, the velocity across the line of sight is 380 kilometers per second.

Chemistry

Hot diamonds melt an old theory

The question of how diamonds are formed has always intrigued man. Besides his basic curiosity, if he knew how they were formed in nature, perhaps he could find them more accurately or produce more perfect ones himself.

An old theory may go by the wayside as a result of research reported in the June 14 NATURE by two chemists, R. E. Langford and Charles E. Melton, and a geologist, A. A. Giardini of the University of Georgia at Athens.

It had been proposed that diamonds were formed by the reduction of carbon dioxide to pure carbon. Pyrrhotite, an iron-and-sulfur-containing mineral occasionally found in diamonds, was thought to be active in the reduction process. Iron could accept the liberated oxygen, sulfur gas would be formed and carbon would be crystallized.

The Georgia team reasoned that if this was the diamond-forming process, then sulfur inclusions should be found in diamonds. To test this, they heated diamond fragments in the presence of pure oxygen. Any included sulfur would then form sulfur monoxide or dioxide and could be detected.

No sulfur compounds appeared. This suggests, the team said, that pyrrhotite was not involved in diamond formation, except perhaps in isolated circumstances.

So for geochemists, it's back to the laboratory and the half a dozen other theories of diamond formation.

Chloro-organics and fish hatching

The treatment of municipal sewage with chlorine before it reaches rivers and lakes has increased during the last decade. More than 100,000 tons are added annually. Unfortunately, the chlorine forms many stable organic compounds after reaching the surface water, and scientists know very little about their effects on animal and plant life.

Four Oak Ridge National Laboratory scientists, C. W. Gehrs, L. D. Eyman, R. J. Jolley and J. E. Thompson, report in the June 14 NATURE on the effects of two of these compounds on the hatching success of carp eggs. They added 4-chlororesorcinol and 5-chlorouracil to newly fertilized carp eggs. Some of the eggs were "water-hardened," or left undisturbed for 30 minutes before addition of the chemicals, and some were "nonwater-hardened," or fertilized right in the test solutions. (The latter more closely duplicates conditions in natural waterways.)

The team found that the hatchability of the nonwater-hardened eggs was "significantly decreased" by doses of the toxins as low as .001 milligrams per 100 milliliters of water. That level is below the estimated concentrations in sewage treatment plant effluents.

The results are an important first source of data on the toxicity of stable chlorine-containing organic compounds and should be considered when judgments are made on the potential toxicity of chlorine, the team says.

Noble-gas compounds

Xenon, a noble gas, was once thought to be totally inert. Experiments with the highly electronegative element fluorine disproved this, and xenon-fluorine bonds were formed. Now, two Kansas State University chemists, Darryl D. DesMarteau and Robert D. LeBlond, have succeeded in synthesizing a compound with a xenon-nitrogen bond. Through a complicated series of reactions that take four days to complete, a compound called fluoroxenonimidobis (sulfuryl fluoride) is formed. They will also try for xenon-carbon bonds in their study of unusual compounds.