physical sciences

Gathered at Boulder Conference on High-Energy Physics held last week at the University of Colorado

PROTON STRUCTURE

Partons

One of the ways in which physicists try to discover how protons are constructed is to bombard them with other particles. Experimental evidence now indicates that in some kinds of collisions, the impinging particles interact with only a part of the proton.

Such parts of a proton, called partons, appear to have the characteristics of particles, and the characteristics of the partons are not necessarily those of the whole proton. In other words it seems as if the proton, instead of being a simple particle, is actually more like an atom, being composed of a number of subsidiary entities whose properties add up to make those of the proton.

Since physicists already have a theory in which protons, like all other particles, are made up of ultraelementary objects called quarks, some theorists, says Dr. Emmanuel Paschos of the Stanford Linear Acceleration Center, have applied the quark theory to the parton situation to see whether the partons could be quarks.

The evidence is still inconclusive, he says, but if partons were quarks, the quark theory would have to be modified a little to fit. Ordinary quark theory sees the proton as made of three quarks, but, says Dr. Paschos, the parton situation might do better if there were five. To make the interactions come out right, this proton core, whether comprising three or more quarks, would also have to be surrounded by a cloud of quark-antiquark pairs, something not provided in quark theory.

PHOTONS

Vector meson dominance

When a photon, or gamma ray particle, approaches a collision with particles of the class called strongly interacting, or with an atomic nucleus, it appears to turn into one of another class of particles, the so-called vector mesons, before it strikes. This is a hypothesis drawn from experimental evidence that shows similar results from collisions involving photons and those involving vector mesons.

The theory is important, says Dr. Robert E. Diebold of the Stanford Linear Accelerator Center, because the vector mesons are related to the pi meson, the particle that carries the strong nuclear forces from place to place. Since the photon carries the electromagnetic force, the theory, called vector meson dominance, gives physicists a much desired link between the two classes of forces.

But detailed consideration of the evidence in photon collisions seems to show that other heavier vector mesons should exist besides the three already known. There is now some evidence that these may exist, but other experiments designed to check predictions regarding photon collisions with atomic nuclei have shown discrepancies.

The situation leads some participants in the conference to question the correctness of the vector meson dominance hypothesis, and to suggest that something else may be needed to explain photon collisions with strongly interacting particles.

PROTON STRUCTURE

Repulsive core

Atomic nuclei stick together because there is a force, the so-called strong interaction, by which protons and neutrons attract each other. Study indicates that there must be a so-called repulsive core to the strong interaction, that is, there must be a minimum distance between a proton and neutron for example, below which the attraction becomes a repulsion, or neutrons and protons in a nucleus would melt into each other.

Now a computation by Dr. Leona Marshall Libby of the University of Colorado and the Rand Corp. indicates that the repulsive core does show itself in collisions involving two protons. The repulsion becomes strong at distances of about 0.3 Fermi, she finds, and on the average two protons do not approach closer to each other than about 0.75 Fermi.

QUARKS

Magnetic loops

For several years physicists have worked with a theory that regards all the so-called elementary particles as made up of units called quarks.

Some have been led to suppose that quarks are not real entities at all.

Now Dr. Herbert Jehle of George Washington University suggests that quarks may really be a kind of magnetic loop. This would render them unobservable as particles and yet preserve them as building blocks of the theory.

Dr. Jehle hypothesizes that quarks are loops of magnetic force lines similar to those that surround a bar magnet. Such loops, he says, could be combined in different ways to give the known particles. "The concept of individual independent quarks has no meaning in terms of such a definition," says Dr. Jehle. "If a loop unlinks, it behaves as whatever it becomes." The quarks that have been postulated, might have the form of a simple loop, a figure eight and a trefoil.

SYMMETRIES

No evidence against time reversal

Physicists have believed that an antiparticle can be regarded as if it were its conjugate particle moving backward in time. This is the principle of time-reversal symmetry.

In recent years some doubt has been cast on this principle (SN: 6/28, p. 616) because of the failure of a related spatial symmetry principle that says nature does not prefer left-handed objects to right-handed ones.

Attempts to find evidence for failure of time-reversal symmetry have not succeeded, including one by Drs. R. G. Glasser, M. J. Baggett and B. Kehoe of the University of Maryland, who report that they have looked for a failure of the principle in the decay of sigma-zero mesons and found none.