physical sciences

Gathered at the Coral Gables Conference on Fundamental Interactions at High Energy at the University of Miami last week

RESONANCES

A complex situation

Resonances are a class of extremely short-lived subatomic particles. They often appear as a kind of intermediary state in collisions of other particles: The colliding particles form the resonance, which then very quickly turns itself into the particles that actually come out of the collision.

Resonances are important both for the light they can shed on the mechanics of particle collisions and because their spectroscopy can be a test of the current theory that tries to relate all the subatomic particles to one another, the so-called SU_3 symmetry.

The SU_3 symmetry takes the particles and tries to arrange them in geometrical patterns from which their various properties can be predicted. The spectroscopy of resonances consists in arranging them according to their masses to see if patterns show up that fit SU_3.

The present situation is complicated, says Dr. Nicholas P. Samios of Brookhaven National Laboratory, because all the known resonances do not show up equally well in the different experiments used to produce them.

PROTONS

An optical model

The way a light beam behaves when it encounters a piece of matter has provided a theory that is used by analogy in other branches of physics. For example, it has been found that in certain cases, when a beam of particles strikes an atomic nucleus, it is absorbed, scattered and bent the same way a light beam is on encountering solid matter. The same mathematics can be used to describe both cases.

Dr. David Weingarten of the National Accelerator Laboratory at Batavia, Ill., suggests that a beam of protons encountering a proton may also behave like a light beam. Assuming this, he says, will explain the complexities observed in the way the incident beam is scattered, without having to hypothesize complicated internal structures for the proton as other theories do.

TACHYONS

Action at a distance

An imaginary number is defined by mathematicians as the square root of a negative number. Such a number cannot be written in terms of ordinary real numbers, but since the product of two imaginary numbers is a real number mathematicians have invented symbols for them and manipulate them arithmetically.

Dr. E. C. G. Sudarshan of the University of Texas suggests that imaginary numbers can sometimes represent the masses of physical particles.

Such particles are called tachyons (SN: 2/22/69, p. 196); he finds them useful in solving the problem of action at a distance, that is, how a body can exert a force on another without touching it.

Particle physics turns action at a distance into contact by hypothesizing intermediary particles to carry such forces from one body to another.

This works well enough when the distance is microscopic, but when it is astronomical, the difficulty arises that the intermediaries needs a measurable time to cross, while the forces in fact seem to appear instantaneously.

But tachyons, says Dr. Sudarshan, if they can exist, can go faster than light. They can go at any speed up to infinity and thus carry forces across any distance as fast as need be.

FIELD THEORY

Gravity and particles

More and more theoretical physicists are trying to include gravitational effects in their treatments of subatomic particles. This was not done in the past because gravitational effects of particles on one another are experimentally negligible, and things that were experimentally important were crying for attention.

The best-accepted theory of gravity at present is Einstein's general relativity. If it is a good universal theory it should apply in the subatomic domain as well as in the astronomical one, for which it was made.

In the subatomic domain, however, particles travel at speeds near that of light, and therefore masses and lengths change, the so-called special relativistic contraction and mass increase. Length and mass are crucial to the determination of gravitational forces, and the question arises whether gravitational theory can be worked out to provide for these relativistic changes.

It can be done, say Drs. Murray Gell-Mann of California Institute of Technology and Sidney Coleman of Harvard University, and the result, says Dr. Coleman, is consistent with gravitational theory for bodies that don't have to take special relativity into account.

PARTICLES

Hydrogen atom model

All magnets that have ever been seen possess both north and south poles. Cutting a magnet in half produces two magnets, not a north and a south pole separated.

Theoretical physics, however, contains predictions of bodies that have only one kind of magnetic charge. And Dr. A. O. Barut of the University of Colorado suggests that bodies of this sort, possessing a single magnetic pole and an electric charge, may be the interior components of currently known subatomic particles. He sees a proton, for example, as made of two such bodies orbiting around each other.

He develops the physics of a proton of this composition as an analogy to the physics of a hydrogen atom and suggests that the strong nuclear force that binds protons and neutrons together in nuclei is analogous to the chemical bonds that hold hydrogen atoms together.

Dr. Barut's particles are not the traditional magnetic monopoles (SN: 2/22/69, p. 127) since they have electric charge as well as magnetic.