SCIENCE NEWS OF THE WEEK

Physics is an Abstract Art

The physics of subatomic particles today is like a jigsaw puzzle in which not only is the appearance of the total picture unknown, it is not even known whether all the pieces are present. Physicists keep discovering new particles, some of which have new properties. The properties, which tend to get whimsical names, can be followed consistently through all the interactions and changes that the various particles undergo. But although Nobel prizes are given for the discovery of new particle properties (for example, the discovery of charm, which got the 1976 prize), the essential significance and interrelationships of the various properties is quite unclear. At last week's meeting of the American Physical Society in San Francisco, physicist Martin Perl of the Stanford Linear Accelerator Center suggested that what physics needs is a new Einstein to make sense of it all. Perhaps not a literal Einstein, since the actual Einstein strongly disliked the kind of physics involved in the particle game, but a mind as synthesizing and generalizing as his.

The actual Einstein to the contrary, God continues to throw dice, and the dice continue to land with new faces up. Vincent Vuillemin of the Lawrence Berkeley Laboratory and Stanley G. Wojcicki of Stanford University reported that two experiments running at SLAC's SPEAR storage ring, the one called the SLAC-LBL collaboration and the other called DELCO, have discovered what is being called a D meson factory, a point at which the collisions of electrons and positrons that take place in the storage ring produce copious amounts of the new D mesons in a particularly clean and easy-to-study way. The significance of this discovery to the over-all understanding of the particle physics puzzle is that the D mesons are particularly pure manifestations of the newly discovered property, charm.

The D's, which come in electrically negative and charged versions, are believed to consist of a charmed quark and a charmed antiquark. According to the theoretical models most widely applied at the moment, quarks are the fundamental entities out of which most of the known particles are built. Quarks are the ultimate carriers of the basic particle properties: old ones like electric charge and strangeness, new ones like charm. How the various quarks combine with each other to make a given particle determines the properties that particle will manifest. At first three quarks were enough. The discovery of charm provided a fourth, and a discovery made in the middle of 1977 (SN: 12/3/77, p. 372) seems to require a fifth.

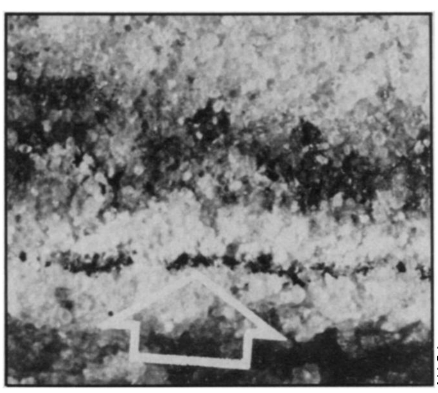
The D mesons, or charmed mesons, thus consist of charmed quarks only, without admixture of other things to complicate the picture. The D's appear as products of the radioactive decay of the particles that first manifested charm, the PSI particles. To the original PSI, which was discovered in November 1974 at both SLAC and the Brookhaven National Laboratory and which won the 1976 Nobel Prize for the leaders of the discovery teams, continuing work at SLAC has added the PSI-prime and the PSI-double-prime. The masses of the three are 3.1 billion electron-volts (3.1 gev), 3.68 gev and 3.77 gev, respectively. It is the mass of the latter, 3.772 gev, to add another significant figure, that is the "threshold" of the D meson factory. D mesons are produced at other energies, but along with a lot of other particles that complicate the interpretations of the data. At 3.772 there happens to be just enough energy to make a pair of D's, a D and an anti-D, so nothing else comes along to complicate the picture. Thus the masses of the D's can be determined, and the particles into which they decay can be studied. The mass of the electrically negative D comes out to 1.863 gev and that of the electrically charged D comes to 1.868 gev. Study of the ways D's can decay and the probability of each mode of decay will help elucidate the detailed behavior of charm.

A very recent piece of data from the SLAC-LBL experiment seems to indicate, Vuillemin says, the existence of a new kind of quark combination, that of a charmed quark and a strange quark. The name for this is F meson, and it could represent the first of a whole new family analogous to the D's.

DELCO has also added, or confirmed the addition of, another important new piece to the puzzle, a heavy lepton. The particles made up of quarks, of which there are more than 100, constitute a class called hadrons. In addition, there is another class called leptons. Leptons are not made of quarks, but seem to be as fundamental as quarks. Leptons and hadrons represent what physicists often refer to as two different kinds of matter. For reasons that rapidly get more profound than simple esthetics, theorists would like a symmetry between quarks and leptons, as many of one as there are of the other.

Although experimental evidence now shows up to five quarks, and some theorists postulate six, the number of known, confirmed and accepted leptons was only four—the electron, the muon, the electron neutrino and the muon neutrino. About two years ago an experimental group led by Perl reported the discovery of a new particle that they believed was a new lepton, one heavier than any of the other known leptons. But the mass of that particle was somewhere between 1.800 and 1.900 gev. This was somewhat suspicious, because the masses of the D mesons lie in that range, and it was possible that the discovery of Perl and company was really one of them. Wojcicki reports that studies by the DELCO experiment indicate that the new particle of Perl and co-workers appears when the storage ring is run at an energy of 1.860 gev, just below the threshold for D pair production. Furthermore, its behavior shows that it has nothing to do with charm but is a heavy lepton. It is being called TAU, comes in electrically positive and negative varieties and has a mass of 1.825 gev. □

A rocky niche in a harsh environment



NASA

Layer of life millimeters below surface.

The Dry Valleys of the Antarctic, frozen deserts as bare as Mars, were long considered lifeless. Then, E. Imre Friedmann and Roseli Ocampo-Friedmann of Florida State University discovered blue-green algae colonizing air spaces within a sample of rock (SN: 10/2/76, p. 218). Now the same researchers have identified a rich vegetation of bacteria, true algae and fungi within porous, semi-translucent rocks widespread throughout the frozen deserts. The organisms appear to take refuge from the climate by occupying a protective microscopic niche. "The porous rock acts as a moisture trap and also a heat and light trap," Friedmann says. When the outside air is $-10°$ C, a few millimeters within the rock the temperature may be a cozy 10° C. The investigators have discovered bacteria and blue-green algae, but not the higher organisms, similarly entrenched in hot deserts. Based on these findings, Richard S. Young of NASA says that future Mars landers may need to break open specific rock types in the search for life. □