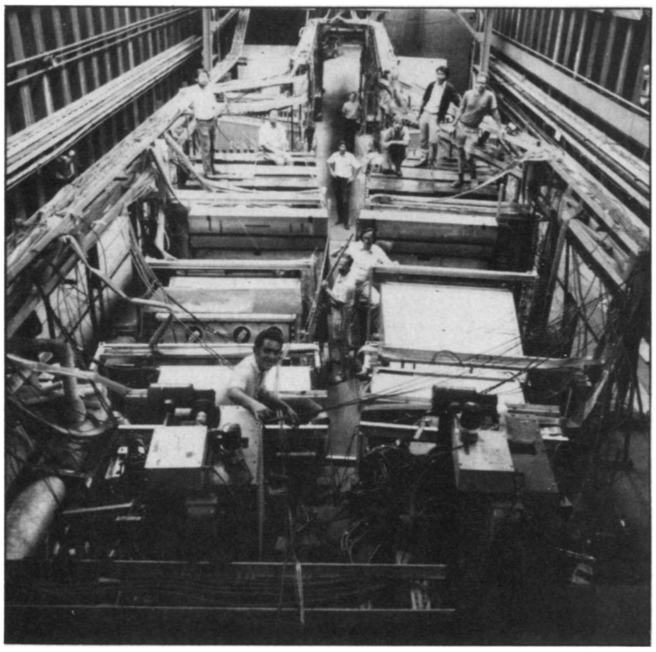
Upsilon and the Fifth Quark: A Heavy Resonance

And then there were five. Quarks that is. Or at least that appears to be the growing interpretation of the latest finding in particle physics at the Fermi National Accelerator Laboratory. In recent months, a group of 16 experimenters under the leadership of Leon G. Lederman of Columbia University has found evidence for the existence of a resonance with a mass of 9.5 billion electron-volts (9.5 GeV) (SN: 8/6/77, p. 87). Earlier, they were somewhat reticent about interpreting the significance of this resonance, but now they seem prepared to urge that it is a new particle—with a mass more than 9 times that of the proton it would be, by at least a factor of two, the most massive particle yet—and that it is evidence for the existence of a fifth quark. They propose calling it upsilon.

The current most widely accepted theory of particle physics started out with three quarks. Quarks are the subparticles from which, so the theory postulates, most of the known subatomic particles are built up. When the theory was first propounded, three quarks (and three corresponding antiquarks) sufficed to explain all the phenomena that had been observed up to then. Since then, the discovery of new sorts of particle behavior has led theorists to suggest the existence of more categories of quarks to explain the exotic behavior (SN: 6/26/76, p. 408). Theorists can now count at least as high as six.

The original three quarks are called up, down and strange (or proton, neutron and lambda). The up and down could deal with the properties of garden-variety particles such as protons, neutrons and their near congeners. The strange quark was necessary to explain the behavior of a group of particles that had been called "strange" because they do odd things. The discovery of behavior by the strange particles that was even stranger than strange seemed to require a fourth quark, which is generally called the charmed quark. Once the charmed quark was in the picture, symmetry principles and other considerations led to openings for a fifth and a sixth. The last two have been designated rather whimsically "truth" and "beauty" although in a recent statement Lederman names them more prosaically "top" and "bottom."

Experimentally, the evidence at hand when the quark theory was first elaborated sufficed to justify the existence of three quarks. The discovery of the psi particles, which took place simultaneously at the Stanford Linear Accelerator Center and Brookhaven National Laboratory in November 1974 (and for which the 1976 Nobel prize was given), is now generally taken as evidence for the existence of the charmed quark. The psi particles exhibit characteristics (among them an unexpectedly strong resistance to radioactive decay) that seem to be what charmed particles should have.



Fermilab

Wired together at Fermilab. Some of the experimenters pose on and around equipment used for data taking in the experiment that found upsilon.

In the present case, what the experimenters have found is a resonance at 9.5 GeV, a sudden enhancement in the production of pairs of muons by protons striking metal targets. This is at best secondary evidence of the possible existence of a new particle. (What one would wish is that the particle itself would make a spark or flash in the appropriate counter, but these untraheavy particles don't last long enough to tickle currently available counters.) In their published paper on the subject, the group, which includes physicists from Columbia University, Fermilab and the State University of New York at Stony Brook, are reticent about an interpretation, but since that was written, they have presented their findings at a meeting of the European Physical Society at Budapest, and the audience reaction there, they say, leads to a consensus that they do have a new particle, and that it represents a fifth quark. According to Lederman, the data fit well with an interpretation that the resonance is a particle made of a bottom quark and a bottom antiquark. □

PBBs: More effects and more exposure

New disorders are being detected among victims of the disasterous chemical mix-up in Michigan in 1973. "With chemical diseases, we have to look for unusual things," Irving J. Selikoff of Mt. Sinai School of Medicine told a House subcommittee last week.

The problem began when over a ton of flame retardant PBBS (polybrominated biphenyls) was accidently substituted for magnesium oxide in feed supplements for lactating cows. Hundreds of thousands of Michigan farm animals died or were slaughtered as a result, and much of the state's food supply was contaminated.

At first health officials contended the harm was limited to livestock. But last November Selikoff and colleagues examined over 1000 rural Michigan people and found a disturbing number with neurological symptoms, such as muscle weakness, memory loss, coordination difficulties and an excessive need for sleep. About a third reported that their health had deteriorated since the PBB contamination, but the researchers could not strictly prove that PBBS were the cause of the problems. "There were no proper controls in Michigan," Selikoff explains. "Almost everyone had some exposure by ingestion to PBB.

Now a control group has been analyzed. It consists of dairy-farm families in Marshfield, Wis. The Wisconsin group showed almost no neurological defects, Selikoff told the House subcommittee.

Both the pediatrician and the dermatologist on the investigating team report differences between the Wisconsin and Michigan farm samples. Joseph Chanda of the University of Michigan describes a skin disorder and unexplained hair loss among the Michigan subjects. They also report more skin dry-