

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



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

psi particles exhibit characteristics (among them an unexpectedly strong resistance to radioactive decay) that seem to be what charmed particles should have.

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 disastrous 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 accidentally 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-

ness, itching, sweating and peeling. Finally many Michigan subjects complained of a sudden increase in fingernail and toenail growth. Chanda points out that the stricken cattle showed marked growth of their hooves.

Mason Barr of the University of Michigan examined 415 farm children. Although, so far, no objective evidence of disease has been detected, Barr finds a broad spectrum of health problems in the Michigan group. While only one Wisconsin child experienced a sudden increase in symptoms, a third of the Michigan children developed more than ten new symptoms in a year. Thirty-five percent of the Michigan parents thought their children's health had declined over the past three years. But, Barr told the hearing, the Michigan children seem now to be getting better.

The most alarming result is the discovery of serious defects in the immune systems of Michigan, but not Wisconsin, farm residents. Forty percent of those tested had a substantial deficit in the number of cells called T-lymphocytes, which are responsible for rejecting bacteria, viruses and foreign tissues. Instead of normal T-cells, they have "null" cells that look like lymphocytes, but serve no health function whatsoever, reports J. George Bekesi of Mt. Sinai. Furthermore, even the normal lymphocytes function less effectively. John A. Moore of the National Institutes of Health reports that initial experiments on rats and mice also indicate a decreased function of T-cells. The full health effects of this abnormality are not yet known.

The PBB problem may not be limited to Michigan. Thirteen million pounds of the chemical was made between 1970 and 1976 and, being long-lived, may eventually appear in the environment. In February, the Environmental Protection Agency began investigating PBBs under the new Toxic Substances Control Act. Officials told the House subcommittee that an analysis last week showed "frightening" amounts of PBB in three catfish from the Ohio River, near a plant that used PBBs. Earlier this summer EPA scientists found PBB residues in human hair and fish samples near two New Jersey plants that manufactured PBBs and near a Staten Island company that used PBBs in making wire coating. EPA Administrator Douglas M. Costle has ordered development of rules for strict control of PBB production.

Another chemical-related health problem has been discovered in a California plant. No worker in the pesticide-producing unit has fathered a child recently. Medical tests on 15 men revealed that 10 have sperm counts so low as to make conception unlikely. Health officials suspect the culprit chemical is DBCP (dibromochloropropane), which produces sterility in rats. No one knows whether the human sterility is permanent. Occidental Chemical Co. has shut down that pesticide unit. □

Babies bottom out—a 'maybe boom'

The first substantial sign of a reversal in the declining birth rate—and a possible precursor to a new baby boom—has been reported by the National Center for Health Statistics. Figures show that a birth rise began last September and has continued through this April, the latest month for which statistics were analyzed. During the first third of this year, the marriage rate was also up and, for the first time in several years, there was no increase in the divorce rate.

After dropping to a post-World War II low in 1976, the United States birth rate climbed to 15.1 children born per 1,000 population for January through April of this year—an increase of 6 percent over the same period last year, according to the center. Should the trend continue through the entire year, nearly 3.4 million youngsters will be born in 1977, an increase of about 200,000 over what would have been expected at last year's rate.

An "echo" baby boom has been predicted by various demographers for several years (SN: 9/13/75, p. 167). Girls born in the post-war baby boom, which reached its height in 1957, are now passing through their prime years of fertility, researchers note. This trend, combined with signs of a philosophical return to the traditional marriage concept, make an upcoming birth increase inevitable, some researchers suggest.

In addition, the fertility rate for the first third of this year was 68.4 children per 1,000 women of child-bearing age (15 to 44). That is an increase of 5 percent over a comparable span in 1976. The "total fertility rate"—a figure calibrated to the average completed family size at current fertility rates—was also up about 5 percent above the first third of last year. However, the current rate of 1.84 children per woman is still below the "replacement level" of 2.1 children for American society.

While a birth-rate increase would be welcomed by those who fear that prolonged zero population growth would some day produce a geriatric society, there is at least one aspect of the rising trend that bothers even proponents: teenage pregnancies. That problem has been steadily growing during the last few years (SN: 8/14/76, p. 104), and the Planned Parenthood Federation reports that more than one million 15 to 19 year olds a year get pregnant in America. More than half the 21 million persons in that age range have sexual intercourse, the federation estimates. Of those who get pregnant, 28 percent are married before conception takes place, 21 percent give birth out of wedlock, 14 percent have miscarriages and 27 percent have abortions.

University of Michigan psychologist Sylvia S. Hacker traces much of the teenage problem to lack of proper use of contraceptives, caused ultimately by inade-

quate sex education, she says. In a study of teenage practices and attitudes toward sex, Hacker concludes that despite the advent of academic sex education, boys and girls remain "uneasy or uninformed about sex. Sex education classes in this country are a failure," she says. "The classes are dealing with anatomy and reproduction when what kids really want to know about are human relationships—'What will she think if I try something,' or 'How far should I let him go?'" The more uneasy or uninformed a boy or girl feels about sex, the less likely they are to use birth control, she says. "Sex and contraception are still relatively taboo subjects in our post-Puritanical culture," she says. "Even the most liberal parents tend to view sex as a private matter, and the schools treat it as a dry academic subject."

For whatever reasons, teenagers and adults alike are contributing to the current upswing in births. Whether or not this marks the start of a new baby boom remains to be seen. □

Seafarer: NAS sees no basic hazard

Project Seafarer, proposed underground antenna grid for communicating with submarines far below the ocean surface, has been controversial since its conception. Last week, developments moved it nearer to realization, although environmentalists worry that the huge project will upset health or ecology. President Carter described the submarine communications system as essential to national security. House and Senate conferees agreed on a compromise bill approving \$15 million to develop transmitters and receivers and to operate the existing test facility at Clam Lake, Wis. And the National Academy of Sciences issued its final report on Navy plans for a 4,000-square-mile radio antenna, probably to be built in Michigan's upper peninsula, giving it a predominantly clean bill of health on biological hazards (SN: 1/1/77, p. 5).

Concerns for long-term adverse effects on people living in the area were judged to be "invalid and unwarranted," Harvard physiologist J. Woodland Hastings, chairman of the NAS committee, told a press conference last Friday. "We have concluded that it is very unlikely that there will be any harmful effects."

The committee's major recommendations address the possibility that the grid of buried cables would give people electric shocks. The report recommends that at the ground terminals, uninsulated copper wires up to 4,000 feet long, the maximum electric field be reduced by a factor of 10. Although the limit specified by the Navy would not normally harm