The Upsilon: The Heaviest Particle Yet

The poker game in the saloon in the old-time western movie was always a focus of melodramatic tension. The participants kept raising each other's bets until, as a hush punctuated by the cocking of pistols settled over the barroom, the audience wondered when, if ever, the hand would be called and they would see who held what and know the pattern of the cards.

The particle physicists' current charmed-particle game seems to be getting like this. The energy stakes keep rising, and the speculations as to which cards are in what hand get more and more feverish. The latest raise, a new particle with a rest mass about six billion electron-volts, is reported from the Fermi National Accelerator Laboratory. The experiment that found it is a collaboration of physicists from Columbia University, Fermilab and the State University of New York at Stony Brook.

The new particle, designated upsilon, was reported at the meeting of the American Physical Society in New York by Leon Lederman of Columbia University. The upsilon particle is six times as heavy as a proton, three times as heavy as any known uncharmed particle, and one and a half times as heavy as any previously discovered charmed particle. Its lifetime may be less than 10^{-18} seconds.

The previous charmed particles have mostly been discovered in colliding-beam experiments that bang electrons and positrons together. Six billion electron-volts lifts the ante a bit above what these experiments can momentarily produce, and the Fermilab experiment uses the accelerator's highly energetic protons to make the upsilon. These protons are directed against targets of beryllium nuclei, and the result is a kind of matter-assisted materialization of energy. The presence of the beryllium helps the energy carried by the protons to materialize itself as new particles. The lifetime of the upsilons is too fleeting to be detected, and their properties are inferred from their decay products.

So new are the data that no hint of the discovery appeared in the abstract of Lederman's talk, which was published about six weeks before the meeting. The upsilons are also rare. A Fermilab spokesman indicates that the experiment has recorded only 11 upsilon events from the billions of protons fired. A confirming experiment will be necessary.

But, if confirmed, the upsilon may change the game somewhat. Some physicists have suggested it means the betting could go on forever—that there is a multitudinous if not perhaps infinite series of these particles. Upsilon may also indicate the need for another new quantum number. (A quantum number is a property of particles that helps determine their behavior.) The addition would raise the number of necessary quarks (the subparticles out of which particles are made according to theory) from the three contemplated when the theory was originally published to six. (Four- and five-quark theories have already been put forth in connection with other charm-particle developments.) The next question is where to go from here. Anybody want to bet? □

Laser uranium separation: A leap forward

The laser, with its emission of a precise frequency of light, has opened new possibilities in chemistry. It is possible to excite a single energy transition of an atom or molecule and use this excitation to effect chemical changes. One thing laser chemistry can sometimes do that other chemical methods cannot is to separate one isotope of a given element from another.

The isotopes of an element differ in nuclear structure and therefore in atomic weight. But their classical chemical properties are identical, so the older chemistry could not separate them. The new methods make use of the slight difference in light-absorption spectra between isotopes. The difference in weight shifts the spectrum of one isotope from that of another. If the shift is large enough, a given laser may be able to excite one isotope and make it chemically reactive while leaving others alone.

Isotope separation has many practical applications, but the most important now is the separation of fissionable uranium from nonfissionable uranium for the manufacture of reactor fuel and bomb charges. Both these uses require uranium samples richer in the fissionable isotope U-235 than are natural deposits. So it comes not so much as a surprise as a confirmation of suspicions to learn that the laser chemistry group at the Los Alamos Scientific Laboratory is working on laser-chemical methods to separate uranium.

This was admitted last week at the meeting of the American Physical Society in New York by C. Paul Robinson and Reed J. Jensen, leaders of the group. When Los Alamos first publicized its laser-chemical isotope-separation work in the spring of 1975, the talk was all about sulfur hexafluoride, and the separation of sulfur isotopes. Sulfur hexafluoride is a compound that seems very similar to uranium hexafluoride, the form in which natural uranium comes, and observers at the time immediately suspected that uranium hexafluoride might be in the background somewhere. At that time SCIENCE NEWS asked Robinson whether the separation method applied to uranium hexafluoride. "If it did," he replied, "nobody would be talking about it in public." The argument was that the spectrum of a heavy element like uranium is so complex that the isotope shift is not unambiguous enough for selective excitation.

Well, perhaps it is not the same method, but Robinson and Jensen now report that a method to simplify uranium hexafluoride's complex spectrum has been found. Furthermore, they admit that they were working on uranium even a year ago and that in some cases "sulfur hexafluoride" was indeed a cover for "uranium hexafluoride."

The method of simplifying the spectrum, which promises to open a large new field in pure and applied chemistry, is similar to the way gas-dynamic lasers are made. Uranium hexafluoride gas at room temperature (300 degrees K) is passed through a special nozzle that makes it expand adiabatically and cool. It gets down to 20 degrees K, and—what is important—it does not solidify; it remains a gas.

The big discovery is that at such low temperatures (this is about the temperature of liquid air), the complex spectra become simplified. The isotope shift works for uranium, and a laser beam can excite one isotope and not another.

What should follow is a chemical reaction to bring out the desired isotope. Asked what that was, Robinson refused to reply. "We come here as physicists, not chemists."

Questions about the technological steps that follow were parried with the explanation "classified." However, Robinson and Jensen did estimate that if the method works technologically, plants producing enriched uranium by laser could be in operation by the early 1980's. The method promises cheaper and more efficient uranium enrichment and conservation of uranium resources because it will get more fuel out of a given amount of natural uranium hexafluoride.

The next question was whether the literature of other countries, in particular the Soviet Union, shows evidence of being on the same track. It seems the Russian literature does show such indications.

While the hawks and doves will jump all over the uranium aspects of the report, each group from its own side, the most important part of the presentation should not be obscured. It is the method of producing supercooled gases and the finding that supercooling simplifies their spectra. Detailed study of the chemical physics of heavy atoms and complicated molecules (uranium hexafluoride is, after all, a seven-atom molecule) has languished because their complicated spectra seemed insuperably difficult to unravel. This method of simplification offers new hope of understanding their behavior, and from such data numerous practical advantages may someday flow. □

Insect resistance climbs, Academy says

Insects are gaining ground in the battle over food crops. Despite the arsenal of agricultural chemicals developed to destroy them, insects, with their remarkable ability to adapt, are growing increasingly resistant to chemical pest control. More effective methods are thus needed—and quickly—if the United States is to meet the growing demand on its food production.

This was the conclusion of a major study on pest control, just released by the National Academy of Sciences. Seventy scientists, headed by biologist Donald Kennedy of Stanford University, prepared more than 1,000 pages of detailed reports on present pest control techniques, and made recommendations on how they can be improved during the next decade.

Despite the value of agricultural chemicals, "their efficacy is decreasing alarmingly," Kennedy told reporters in Washington last week. A typical U.S. farmer probably gets a return of $4 on every dollar he invests in chemical pest control, he cited from the report, but more than 200 arthropod species have developed resistance to the chemicals during the last 50 years, and this dollar amount is decreasing. Besides genetic resistance in these "target species," nontarget species, often the natural predators of the targets, are killed inadvertently by broad spectrum pesticides. Cotton farmers in the San Joachin Valley have found, for example, that when they spray heavily against *Lygus* (a plant-feeding bug) in early- and mid-season, outbreaks of the bollworm *Heliothis* are much worse in late season. The *Lygus* spray, Kennedy explained, kills off the natural enemies of the bollworm and its populations build up rapidly.

The NAS committee also examined other impacts of agricultural chemicals: environmental effects of long-lived compounds, human health hazards (including residues in the human body and the threat of cancer that led to bans on several, such as chlordane, Dieldrin and DDT) and occupational hazards. "The statistics on occupational health of farm workers are so bad," Kennedy said, "that it is impossible to measure the occupational impact." But a recent California study indicates that agriculture is the most dangerous occupation in that state.

Statistics on production and use of agricultural chemicals are equally bad, he said. "The pest control enterprise places a billion pounds of toxic materials into the environment each year," the report states,

Philip S. Callahan/Univ. of Fla.

Boll weevil: Insects defeat pesticides.

"but it is 'normal' for us to have only the vaguest idea of how much of each compound was used and where, and even then only after half a decade's lag." The committee called for an overhaul of industry-reporting procedures.

The committee also recommended that government agencies (primarily the U.S. Department of Agriculture and the Environmental Protection Agency) give "high priority" to the development of alternative, integrated pest control technologies. These would use several techniques: 1) Chemicals that interfere with insect reproduction and development. These affect biochemical processes unique to insects and thus pose fewer hazards to workers and the environment than broadly toxic chemicals. 2) Control by insect viruses and bacteria that cannot affect other organisms. This week EPA cleared the first such virus, the nucleopolyhedrosis virus of the cotton bollworm and the tobacco budworm, for field use. 3) Genetic manipulation to give crop plants more resistance to pests and to sterilize insects for natural control. 4) The integration of all these methods into a scheme that makes the most use of natural control and the least use of harmful chemicals.

"We realize that there is no magic bullet for this problem," says Kennedy. "The most promising methods will involve a mixture of techniques and knowledge of the local situation and will need to be research- and people-intensive." He estimates that the Government needs to spend $10 million to $15 million during the next decade "if the United States is to hold to its planned increases in agricultural productivity of two percent per year." □

A weirdly jittery X-ray source

X-ray astronomy piles astrophysical mystery upon astrophysical mystery. The latest is reported by scientists from the Massachusetts Institute of Technology working with data from the Astronomical Netherlands Satellite. It involves a strange pattern of X-ray bursts or pulses coming apparently from a globular cluster of stars in the constellation Sagittarius.

This is another to add to the menagerie of pulsed signals, but it is an extremely weird one. The bursts rise to maximum in about half a second and take ten seconds to die down. They occur on the average of every 15,718 seconds, but the repetition is not exactly precise. There is a "phase jitter" of about 500 seconds one way or the other, the longest recorded discrepancy being about 1,000 seconds. The data were reported at the meeting of the High Energy Astrophysics Division of the American Astronomical Society held recently at MIT by graduate student Jesse G. Jernigan Jr. His collaborators were George W. Clark, Claude R. Canizares, Satio Hayakawa, a visiting professor from the University of Nagoya, and Fuk Kwok Li.

Such a difference between pulse length and repetition time is unique in pulsed X-ray phenomena. Normally, pulsed signals are attributed to pulsing or rotating bodies, but the difference in the numbers and the jitter make it hard to imagine what kind of body could produce these. If the source is indeed in the globular cluster in Sagittarius from the direction of which the bursts come, the intensity of a burst is a million times the intensity of all radiation from the sun. □

Science adviser act

Bills to create the post of science adviser to the President have now passed both the Senate and House and await action by a House-Senate conference committee. The Senate bill was passed Feb. 4. It is similar in purpose, but not in every detail, to one passed by the House in November. The Senate bill establishes in the White House an Office of Science, Engineering and Technology Policy to provide a continuing source of policy guidance to the President on those subjects. Its director would be the President's science adviser. The Senate bill makes him a member of the Domestic Council, an adviser to the National Security Council and an active participant in development of the Federal R&D budget.

Sen. Frank E. Moss (D-Utah), chairman of the Senate Committee on Aeronautical and Space Sciences, said he expects quick action by the conference panel. "If so, we could have a new law on national science policy by spring." □