News of Science

Discovery of the Antiproton

The discovery of the antiproton was announced recently by Ernest O. Lawrence, director of the University of California Radiation Laboratory in Berkeley. The new particles, also called negative protons, were produced and detected with the bevatron, the Atomic Energy Commission's accelerator at Berkeley.

The newly reported work was done by four physicists at the Radiation Laboratory—Owen Chamberlain, Emilio Segrè, Clyde Wiegand, and Thomas Ypsilantis. These four authors acknowledged the important cooperation of E. J. Lofgren, director of the bevatron, and the assistance of Herbert Steiner.

The existence of the antiproton had been suspected for many years by analogy with "antielectrons." Antielectrons were predicted by the Dirac theory of the electron, which was formulated in 1928. The antielectron was later discovered by C. D. Anderson of California Institute of Technology. It is a particle just like the electron, but it has the opposite electric charge. The antielectron is well known to nuclear physicists and is called the "positron." The question was soon raised whether or not the proton was a particle to which the Dirac theory also applied; if so, then antiprotons should be observable.

Until recent years, no accelerator has had sufficient energy to produce antiprotons. For this reason, attempts to see them were restricted to cosmic-ray investigations. In cosmic radiation there are particles of sufficient energy to make antiprotons. Although physicists have long looked for antiprotons in the cosmic rays, no antiprotons have thus far been positively identified.

The California physicists have identified the antiprotons by simultaneously measuring the momentum and velocity of the particles coming from a target in the bevatron. The target, which was made of copper, was struck by the proton beam of the bevatron, each proton having an energy of 6.2 Bev. This is enough energy to cause the production of a pair of particles (one proton and one antiproton), by the reaction proton + neutron + energy → proton + neutron + proton + antiproton.

Using analyzing magnets and magnetic lenses, the physicists extracted from the particles emerging from the bevatron target those that were negatively charged and had momentum 1.2 Bev/c. Pi-mesons of this momentum have an energy of 1060 Mev and a speed very nearly equal the speed of light, while antiprotons of the same momentum would have an energy of 570 Mev and a speed about three-quarters of the speed of light. The research group determined the speed of the particles by observing them in two counters placed 40 feet apart. By measuring the time of flight between these two counters, they determined the speeds of the various particles.

Since the time-of-flight apparatus was not regarded as completely reliable, the investigators confirmed their speed determinations with special Cerenkov counters that were designed to count only particles of a particular speed. This procedure showed that there was among the mesons a small fraction (one in 44,000) of particles with just the right speed for antiprotons.

The outcome of the new work is the discovery of a particle with the same mass (within 5 percent) as the proton, but with negative charge. This particle has been assumed to be the antiproton, the negative counterpart of the ordinary proton.

Theory predicts the properties of an antiproton in quite great detail. The mass must be the same as the proton mass, but the charge must be negative. The spin of the antiproton must be one-half unit, it must obey Fermi statistics, and its magnetic moment must be exactly opposite that of the ordinary proton. In vacuum, the antiproton is stable; it does not decay in any way.

Furthermore, when an antiproton comes in contact with an ordinary proton, it must be possible for an annihilation process to occur in which both the antiproton and the ordinary proton are destroyed. In such a process, the combined rest energy of the two particles will appear in a different form, very probably as a number of pi-mesons.

In the production process for antiprotons, another particle must also be produced at the same time, an ordinary proton. Thus, a pair of nucleons is made at the production process, and a pair of nucleons is destroyed at the death of the antiproton. In these two processes of production and annihilation, there is no net creation or destruction of nuclear matter.

It will presumably be many years before all the expected properties of the antiproton can be measured. Up to the present time, only the charge and mass are well known. While the discoverers of the new particles believe it is correct to assume that these particles are antiprotons, they are aware that the new particles might be some different but previously unknown type of particle. In the coming months, much effort will be put into the important determination of the amount of energy released at the annihilation process, and attempts will be made to observe the annihilation process in cloud chambers, bubble chambers, and photographic emulsions.

The existence of the antiproton virtually guarantees the existence of another particle, the antineutron, because neutrons and protons play very similar roles in high-energy physics. It is believed that antiprotons may become antineutrons in certain types of scattering processes; and vice versa, antineutrons may become antiprotons in scattering processes. Either of these interchange processes may be very useful in finding the antineutrons (which might otherwise be quite difficult to detect).

It seems clear that the discovery of the antiproton has opened a new and entrancing field of basic research. It is hoped that much new information about many of the fundamental particles of matter may be obtained through study of the antiprotons.

Hugo Theorell

Hugo Theorell, who has been awarded the 1955 Nobel prize in medicine, is a Swedish biochemist who is now the head of the biochemistry department of the Nobel Institute in Stockholm. The prize has been awarded to Theorell for his contributions to knowledge of the enzymes that catalyze oxidation-reduction reactions. He has carried out work on many of these enzymes, including yellow enzyme, lactoperoxidase, horse-radish peroxidase, lipoxidase, and cytochrome *c*. Perhaps of greatest importance among his researches was his study of "old" yellow enzyme ("yellow ferment") in 1934.

In 1925 Bleyer and Kallman had separated a yellow material from milk. Szent-Györgyi and his coworkers in 1932 obtained a yellow preparation from heart muscle and observed that the yellow color disappeared on reduction and reappeared on oxidation. In 1932 Warburg and Christian described a "yellow ferment" that they had separated from yeast. They and other investigators during the following few years were able to show that the yellow color was due to a substance of small molecular weight that could be separated from the remaining material. The constitution of this dye, riboflavin, was determined independently by Kuhn and coworkers and by Karrer and coworkers in 1935.

Warburg and Christian had thought that the dye was attached to a carbohydrate molecule with high molecular weight. The problem was attacked by Theorell in 1934. He built an apparatus by means of which the enzyme could be purified by electrophoresis and in this way obtained a homogeneous material, the pure enzyme.

He found that the prosthetic group could be separated from the remaining part of the molecule by dialysis in acid solution. The prosthetic group was found to be the monophosphate of riboflavin, the remainder of the molecule being a specific protein. Theorell was able to recombine the riboflavin phosphate with the specific protein to obtain the complete enzyme with its original enzymic activity. This was the first time that an enzyme had been reversibly separated into its prosthetic group and specific protein.

For many years, Theorell has carried out studies of the heme enzymes, including lactoperoxidase, horse-radish peroxidase, and especially cytochrome *c*. These studies have led to a deep understanding of the structure and mechanism of action of these oxidation-reduction enzymes. At first, the work on cytochrome *c* involved the investigation of physical-chemical properties such as absorption spectra and magnetic susceptibility. In connection with the studies of magnetic properties, he devised and constructed a magnetic apparatus with much greater sensitivity than those previously used.

In recent years, Theorell has carried out the peptic degradation of cytochome *c* and has made a study of the structure of the part of the protein that is connected to the heme group by bonds to the sulfur atoms of two cysteine residues. The study, completed by other investigators, showed that the peptide sequence is valine-glutamine-lysine-cysteine-alanine-glutamine-cysteine-histidine-threonine-valine-glutamic acid, and Theorell and Ehrenburg have proposed a detailed three-dimensional molecular structure for this part of the molecule, including the heme.

Theorell was stricken by poliomyelitis when he was a young man, and he then abandoned his career as a medical practitioner. He now walks with some difficulty, with the aid of canes.

He received the prize of $36,720, a medal, and a diploma on 10 Dec. from King Gustav Adolph of Sweden at a ceremony in Stockholm at which the prizes in chemistry, physics, and literature were also awarded.

LINUS PAULING
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News Briefs

■ Secretary of the Interior Douglas McKay has announced that his department has dropped the plan for a dam at Echo Park that would flood part of the Dinosaur National Monument from its program for developing the upper Colorado River Basin.

■ At the end of November, 14 leading physicians and surgeons from 13 countries completed a 38-day tour of the United States that was devoted to observations and to an exchange of views with American colleagues on developments in the field of atomic medicine. During the visit, the second such tour made under Government sponsorship, special emphasis was given to the application of new techniques in cancer treatment as well as to the general medical applications of atomic energy.

■ Thomas Alva Edison's laboratory at West Orange, N.J., center of his inventive work for the last 44 years of his life, has been given to the Government. It will become a National Monument. Simultaneously, Secretary of the Interior Douglas McKay designated Glenmont, the late inventor's home in West Orange, as a national historic site under non-Federal ownership. The deed to the Edison laboratory land and buildings, donated by Thomas A. Edison, Inc., was presented to McKay by Charles Edison and Mrs. John Eyre Sloane, son and daughter of the inventor.

■ The Atomic Energy Commission has established a 12-member Advisory Committee of State Officials to consult with the commission on regulations concerning health and safety aspects of private atomic energy activities. The first meeting of the committee will take place within 2 months.

The committee members represent state agencies such as health, labor, public utility, and legal departments. Some are from states already doing work in radiation protection. Among advantages expected from the consultative arrangement, the AEC cited the following:

Close cooperation between the AEC and the states should help in attaining uniformity in regulations. Some states have already issued, or are about to issue, codes and regulations on radiation protection; others are doing preliminary work.

Working through the advisory committee, the commission will keep informed of the needs of the states and will be better able to help states requesting technical guidance.

In general, the arrangement will provide for exchange of information that will be of aid to the commission in discharging its regulatory responsibilities and to the states in keeping themselves informed of the activities of the commission.

■ The first Swedish atomic fuel plant, a new unit near Stockholm, will be in full production toward the end of December. The plant, which is operated by the semipublic Atomic Energy Company, will provide 5 tons of highly refined uranium annually. An experimental reactor for the production of atomic fuel is planned; until it has been completed, the uranium produced will be stored.

■ The Clinic for Reconstructive Plastic Surgery of the Face, perhaps the first of its kind in the United States, is to be established at the Manhattan Eye, Ear and Throat Hospital, New York. John M. Converse of New York University College of Medicine and the Manhattan Eye, Ear and Throat Hospital is surgeon-director of the new clinic, which is being sponsored by the Society for the Rehabilitation of the Facially Disfigured. The clinic will not only treat a patient's physical defect, but it also will provide assistance in personality and vocational problems.

■ Waste heat generated by nuclear reactors is being used for large-scale space heating at the Atomic Energy Commission's Hanford plant, where General Electric Company scientists and engineers are transferring heat obtained from coolant water to air conditioners in various Hanford buildings.

Several buildings are heated by the system. About half goes into a single structure that houses a large reactor that produces plutonium. Equivalent heat would be sufficient to fill the needs of more than 1000 average-sized homes. The new heating system operates as follows:

The coolant water is pumped to a heat exchanger, where it gives up its heat to an ethylene glycol water solu-