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 $\rightarrow$ 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