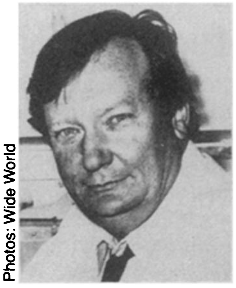
Throwing 'heavy light' on physics



Rubbia

van der Meer

Photos: Wide World

Discovery of the W and Z particles, also known as the intermediate vector bosons, which had eluded physicists for more than 40 years, won the 1984 Nobel Prize in physics for Carlo Rubbia of the CERN laboratory in Geneva and Harvard University and Simon van der Meer of CERN. Rubbia led the group of more than 100 experimenters who found the particles. Van der Meer developed an antiproton-manipulating method, without which the experiment could not have been done. The discovery was announced less than two years ago (SN: 2/5/83, p. 84; 6/18/83, p. 388).

The W and Z particles are intermediary particles. They carry from place to place the forces and influences of the weak interaction. The weak interaction, which can be sensed only at subatomic distances, is responsible for a large number of radioactive decays. Modern theory, the Glashow-Weinberg-Salam theory, unites the weak interaction with that of electromagnetism. This means that the electrically neutral photon, or particle of light, which carries electric and magnetic forces from place to place, and the positive and negative Ws and the neutral Z form a symmetric set. However, the Ws have rest masses of 82 billion electron-volts each, and the Z has a rest-mass of 93 billion electron-volts. The photon, so far as anybody knows, has exactly zero rest mass. Therefore CERN likes to call the Ws and Zs "heavy light."

The Ws and Z were produced in the annihilation reaction that takes place when high-energy beams of protons collide head-on with high-energy beams of antiprotons. Rubbia is credited with being the driving force behind the conversion of CERN's Super Proton Synchrotron into a machine that accelerates both protons and antiprotons and collides them. Antiprotons, when they are made, come out with a wide range of energies and momenta. The accelerator will not accept them in this state; the range of energies and momenta has to be sharply narrowed, a process called "beam cooling." Van der Meer developed the method known as stochastic cooling.

Rubbia is a native of Gorizia, Italy. He was educated at the University of Pisa and at Columbia University in New York. For more than a decade he has divided his time between CERN and Harvard. Van der Meer was born in The Hague, Netherlands, and educated at the Technical University of Delft.

—D.E. Thomsen

Chemistry Nobel for protein synthesis

A novel laboratory method developed 25 years ago for creating peptides and proteins has been recognized with the 1984 Nobel Prize in chemistry. R. Bruce Merrifield of Rockefeller University in New York is the only U.S. scientist to win a Nobel Prize this year.

The key to the success of Merrifield's method, which is called "simple and ingenius" in the Nobel Prize announcement, is the binding of the first subunit of the intended product to a solid support, a polymeric matrix. After each additional amino acid subunit is added, simple filtration and washing are used to isolate the growing product from raw materials and by-products. Only when the entire synthesis is completed is the product freed from its support.

"Merrifield's methodology has brought about a revolution in peptide and protein chemistry, and thousands of different peptides have now been synthesized using this approach," says the Royal Swedish Academy of Sciences. "Such a synthesis is more rapid than those achieved with earlier methods and the quantity of final product obtained is considerably greater."

An increased yield after each step allows the synthesis of longer proteins than would be possible with earlier methods. Merrifield has put together chains of more than 100 amino acids with his technique. In addition, the method is suitable for automation, and automatic synthesizers are now in use in many research laboratories.

Wide World

Merrifield

Scientists working on nucleic acids, rather than peptides, have also benefited from Merrifield's idea. Automated apparatuses — sometimes called "gene machines" — are programmed to synthesize chains of nucleic acids attached to solid supports. These nucleotide chains are an important tool in genetic engineering.

The Academy concludes, "[Merrifield's methodology] has greatly stimulated progress in biochemistry, molecular biology, pharmacology and medicine."

Merrifield was born in Fort Worth, Tex., in 1921 and received a Ph.D. from the University of California at Los Angeles.

— J.A. Miller

Lighting the way to a stronger glow

How many researchers does it take to change a light bulb? At GTE Lighting Products in Danvers, Mass., a team of four scientists led by Jakob Maya has found a way to make fluorescent lamps more efficient simply by increasing the proportion of one mercury isotope within the gaseous mixture inside a typical tube. In the Oct. 26 SCIENCE, the researchers estimate that the potential energy savings for the United States could amount to more than $200 million per year if an efficient, inexpensive method can be found for raising the isotope's natural concentration.

In a fluorescent lamp, high-speed electrons bombard a low-pressure mixture of mercury atoms and rare gases. Excited mercury atoms, in turn, emit ultraviolet light. This radiation strikes phosphors coating the inside of a glass tube, which convert the ultraviolet light into visible light. However, radiation from the excited mercury atoms is absorbed and reemitted many times by neutral mercury atoms during its escape to the walls of the tube. This "trapping" increases the chance of excited atoms losing their energy by collisions with other atoms, which helps limit energy conversion efficiency to less than 65 percent.

The GTE project began several years ago with the discovery that natural mercury contained a trace of the isotope mercury-196 — in an amount so small that until then no one in the lighting industry had noticed its presence. The researchers found that mercury-196 atoms reduce radiation trapping by offering a new, preferred path for escaping photons. Increasing the proportion of mercury-196 from its naturally occurring concentration of 0.146 percent to about 3 percent raises the energy efficiency of the process by about 5 percent.

"You would save a few watts on all the fluorescent lamps on the market," says Maya, "and there's something like 100 million of them in operation."

After the initial discovery and patent filing, the project was delayed because of the difficulty in obtaining mercury enriched with mercury-196. "Then we came to realize that there are technologies for enriching uranium," says Maya, "and we started wondering whether these could be applied to mercury." At GTE, Maya's group is testing photochemical separation, while the Department of Energy is beginning to take an interest in studying how uranium isotope separation techniques may be adapted for mercury enrichment.

Says Maya, "Because discharges have been thought to be optimized for a very long time and most of the research in fluorescent lighting has been in phosphors, this opens up a totally new area of activity."

—I. Peterson