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Nobel Prize in Physics 1976

Burton Richter

Samuel Chao Chung Ting

The Nobel Prize in Physics 1976 was awarded jointly to Burton Richter and Samuel Chao Chung Ting *"for their pioneering work in the discovery of a heavy elementary particle of a new kind"*

Information about winners:

Burton Richter,

Stanford Linear Accelerator Center, USA,

Samuel C.C. Ting,

Massachusetts Institute of Technology, Cambridge, USA,

RESEARCH INFORMATION:

Shared Physics prize for elementary particle

The prize is awarded for discoveries in the exploration of the smallest components of matter, smaller than atoms and their nuclei. According to Einstein's well-known law of energy and mass, $E=mc^2$, large amounts of kinetic energy are required to create a heavy particle. In addition the energy must be concentrated. The two prize experiments were made independently of one another at two of the world's largest particle accelerators. Ting and his associates have constructed their equipment in connection with the proton

machine at the Brookhaven National Laboratory. The accelerator is a device with a diameter of some 200 metres and the measurement equipment of the Ting team is close on 15 metres in length. Richter and his co-workers have their equipment connected to the 3 km long, linear electron accelerator at the Stanford Linear Accelerator Center. The Richter equipment is of such a size that it cannot be kept indoors. When exploring small object large microscopes are necessary and cannot be avoided. For the smallest bits of matter the largest installations are required.

The Richter equipment is a sort of carousel (storage ring) where a stream of electrons and a stream of positrons go round in opposite directions at very high speeds, which may be adjusted exactly. In head-on collisions, all the energy of an electron and a colliding positron may in principle give rise to a motionless very heavy particle, which is expected to turn into several other particles by decay in a very short space of time. It had not been forecast that anything like that could possibly happen other than at lower energies where the known, lighter elementary particles exist. The research programme therefore concentrated on following up in a specially built magnetic detector a very interesting and significant line initiated at Frascati, Italy, and continued at Cambridge, USA. The discovery of the new particle was sudden and dramatic, although preceded by years of planning and preparations. The speed at the head-on collisions may be adjusted to more than a thousand different values. The new particle appears at only one of these. About November 10, 1974, the Richter team set the correct speed and found that an enormous number of collisions gave the new particle, christened psi. What was most remarkable was that the psi particle was transformed unexpectedly sluggishly, or in other words, it lived about a thousand times as long as it reasonably should.

Ting's experiment took place quite differently. High-speed protons - the direction of the firing is here more important than the speed setting - are allowed to collide with a motionless target area of beryllium. The Ting team was hoping to find new heavy particles, which are transformed into two others an electron and a positron. Ting and his associates had for many years achieved a world championship in this field, closely studying how

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lighter, better known parent particles give rise to electron and positron daughter pairs. From measurements of the fast-flying daughters, the properties of the parent particle may be calculated. The difficulty was sorting out a very small number of daughter pairs from a horde of millions of other particles streaming forth, in this context undesirable but unavoidable. It was like hearing a cricket close to a jumbo jet taking off. The equipment was therefore large, provide, with many refinements and embedded in tons of radiation protection. In time it became clear that a new, heavy parent particle was formed every now and then in the collisions. It was christened the J particle.

On November 11, 1974, Richter and Ting met at the Stanford Linear Accelerator Center and found that the two research teams had discovered the same particle. The announcement appeared at once and the scientific publications within a week. A short time after the discovery was confirmed, first at Frascati, Italy, and then at the Deutsches Electronen Synchrotron in Hamburg, West Germany.

During the last 16 years many new elementary particles have been discovered, which show kinship with one another in groups or families. The new particle is something separate and new and it has formed the beginning of a new family of its own. A new field of research has been opened. Is there anything further in these particles, thought to be the smallest building blocks of matter? For centuries physicists and chemists have devoted much of their efforts to a search for the smallest components of matter. The limit of the smallest has slowly been moved from atoms via atomic nuclei to what are known as elementary particles. For some years now the physicists have had to move this limit downwards, and the signs are that the elementary particles, too, consist of yet smaller units, quarks. It was assumed that three quarks, in some respects having different properties, would be enough. But to understand the structure of the new psi particle a fourth quark is very likely necessary, in the opinion of many researchers.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1976/press.html