METHODS OF USING THEORETICAL TEACHING MATERIALS ON THE DISCOVERY OF PARTICLES IN THE TEACHING OF ATOMIC NUCLEUS AND ELEMENTARY PARTICLE PHYSICS

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ABSTRACT

The article provides basic training materials on the history of the discovery of elementary particles and their physical and chemical properties. Students are given the opportunity to develop sufficient knowledge and skills about the physical nature of elementary particles.

Keywords: Learning process, elementary particles, criteria, neutrino.

INTRODUCTION, LITERATURE REVIEW AND DISCUSSION

It is known that in recent years, unprecedented discoveries and innovations have been made in the field of elementary particle physics. These studies are aimed, firstly, at creating a complete picture of the universe and the natural processes that take place in it, and secondly, at transmitting and preserving the integrity of the natural entity to future generations. In this regard, the study of physical processes occurring in elementary particles remains relevant. This article provides theoretical information about some of these elementary particles, the history of the discovery of particles and some information about their physicochemical properties. First of all, let's look at the "Criteria" that scientists pay a lot of attention to.

Criteria. In contrast to the discovery of the positron, the discovery of the criterion occurred not as a result of individual observations, but as the result of a large number of experimental and theoretical studies. Using the method of matching proposed by Rossi, Bote, and Colcherster in 1932, he showed us that a certain proportion of cosmic rays observed at sea level consist of particles capable of passing through a lead plate up to 1 m thick. After that, he soon turned his attention to the presence of two different components in the composition of the cosmic rays.

Since a component of a type of particles (transient component) can easily pass through substances of very large thickness, their absorption rate in these substances is approximately proportional to the mass of the substance. Another type of particle component (particle flow-generating component) is rapidly absorbed mainly in heavy elements, resulting in the formation of a large number of secondary particles (flow) [1-3].

Experiments conducted by A. Anderson and S. Neudermeyer in Wilson's chamber to study the passage of particles of cosmic rays through lead plates also showed that there are two different components of cosmic rays. These experiments show that, on average, the energy lost in the cosmic rays corresponds to the decimal point by the calculated theoretical values of the energy expended by the particles to collide with the environment. Some of these particles caused very large energy losses.

In 1934, Bete and Geitler published a theory of radiant energies lost by the formation of electron-positron pairs by electrons and photons. The properties of the low-permeability components observed by Anderson and Neudermeyer are consistent with the properties of the electrons described in Bete and Geitler's theory; the large energy losses encountered are explained by radiation processes. The properties of the radiation generated by the particle stream recorded by Rossi can be explained by the assumption that this radiation consists of high-energy electrons and photons. On the other hand, while acknowledging the validity of Bete and Geitler's theory, it can be concluded that the "permeable" particles in Rossi's experiments and the less permeable particles in the experiments of A. Anderson and S. Neudermeyer are different from electrons. It has to be assumed that transient particles are heavier than electrons because, according to theory, the energy lost in radiant radiation is inversely proportional to the square of the mass. After that, speculations began to be made about the possibility that the theory of radiation at high energies would turn out to be wrong. As a counter-argument, in 1934, Williams hypothesized that transient particles in cosmic rays could have a proton mass. Another difficulty associated with this hypothesis was that in addition to positive protons, there was also a need for negatively charged protons, as experiments with the Wilson camera showed that transient particles of cosmic rays had both signaling charges. In addition, some of the photographs taken by A. Anderson and S. Neudermeyer in Wilson's camera showed particles that did not radiate like electrons, but were not as heavy as protons.

Thus, by the end of 1936, it was almost certain that in addition to electrons, the cosmic rays contained particles that were hitherto unknown, with masses between electron and proton masses. It should be noted that in 1935, H. Yukawa, relying only on theoretical considerations, hypothesized the existence of such particles.

By 1937, experiments by S. Neudermeyer and A. Anderson, Street and Stevenson had directly confirmed the existence of particles whose masses were between the masses of electrons and protons. The experiments conducted by S. Neidermayer and A. Anderson were a continuation of the above-mentioned research (in an improved way) on the energy losses of particles of cosmic rays. These experiments were performed in a Wilson chamber divided into two with a platinum plate 1 cm thick and placed in a magnetic field. The pulse losses of some of the cosmic rays were determined by measuring the curvature of the particle traces before and after the plate. It was easy to see that the particles being absorbed were electrons. The fact that the absorbed particles are electrons can also be confirmed by the fact that these particles, unlike transient particles, undergo secondary processes in the platinum absorber, and often they occur in groups (two or more). This is exactly what was expected before, in the experiments observed by S. Neidermayer and A. Anderson, many electrons are part of the currents generated in the environment. Conclusions about the nature of transient particles became clearer on the basis of the following two results obtained in the experiments observed by S. Neidermayer and A. Anderson [4-5]:
1). Although the absorbed particles are relatively large at small values of the pulses, while the transient particles, on the contrary (mostly in large value pulses) meet, there is a noticeable pulse range for both the absorbed particles and the transient particles. Thus, the difference in the behavior of these two types of particles cannot be considered as a difference in energies. This result explains the failure of the theory of radiation at high energies by their behavior by denying the perception of transient particles as electrons.
2). Near the minimum of the ionization curve, there is a small amount of transient particles with a momentum of less than 200 MeV / s that performs ionization with no more than the ionization of a single charged particle. This means that transient particles of cosmic rays are much lighter than protons because protons smaller than a pulse of 200 MeV / s perform a specific ionization that is about 10 times larger than the minimum ionization.

Street and Stephen tried to directly estimate the mass of cosmic ray particles by simultaneously measuring their momentum and specific ionization. They used a Wilson camera controlled by a Geiger-Müller counter system connected to a reverse fit. In this way, the particles that had completed their treadmill were selected. The Wilson camera was placed in a magnetic field with a voltage of 3500 Gs. The camera starts running 1 s late to allow you to count the drops. Street and Stephen found one of the most important of the many photographic images. In this photograph, a trace of a particle with a pulse of 29 MeV / s, the ionization capacity of which is about six times greater than the minimum value, was visible. As this particle moves downwards, its electric charge has a negative sign. Depending on the pulse and specific ionization, it can be said that its mass is about 175 electrons; the probability error in determining the mass is 25%, which is due to the uncertainty in the measurement of specific ionization. It should be noted that an electron with a pulse of 29 MeV / s has almost minimal ionization capacity. On the other hand, particles with such a pulse and proton mass (a simple proton moving upwards or a proton with a negative sign moving downwards) have a specific ionization of about 2,000 times the minimum value. In addition, the trajectory of such a proton in the chamber gas must be less than 1 cm. However, the trace of the particle in question in the photograph was 7 cm, after which it went beyond the illuminated volume.

Thus, in 1936, A. Anderson and S. Neudermeyer were the first to discover the muon. This particle differs from an electron only by about 200 times its mass.

Neutrino. The discovery of a neutrino, a particle that is virtually unaffected by matter, began in 1930 with V. Pauli's theoretical hypothesis that "such a particle must also have formed" in order to avoid violating the law of conservation of energy during the beta decay of radioactive nuclei. The existence of neutrinos was confirmed experimentally only in 1955 (F. Reynes and K. Cohen, USA).

In the beta decay of radioactive nuclei, as mentioned above, in addition to electrons, neutrinos also fly out. Previously, this particle was theoretically "included". Initially, W. Pauli called this neutral particle, which is formed in the beta decay of nuclei, a neutron (this was before Chedwick's discovery) and hypothesized that it is part of the nucleus [6-8].

It was much more difficult to come to the neutrino hypothesis that is formed in the decay of a neutron. Prior to Fermi's fundamental article on the properties of weak interactions, Pauli used the term "neutron" to describe two particles, now called neutrons and neutrinos, when he gave a lecture on the current state of the atomic nucleus. "For example, according to Pauli's hypothesis," Fermi writes, "there may be neutrons inside the atomic nucleus, and they will leave the nucleus at the same time as the v-particles." These neutrons can easily pass through very large thicknesses of matter, and in doing so they lose almost no energy, so they are almost invisible. The presence of a neutrino would, of course, explain some unanswered questions, such as the statistics of the atomic nucleus, the anomalous specific moments of some nuclei, and the nature of the transmitted radiation. In fact, when it comes to a particle that comes out with v-electrons and is poorly absorbed in matter, it is necessary to consider a neutrino.

It can be concluded that in 1932 the neutron and neutrino problems were in a rather confusing state. After a year of rigorous scientific research by experimenters and theorists, it became possible to solve both the fundamental and terminological difficulties of these problems. After the discovery of the neutron, recalls W. Pauli, at seminars in Rome, E. Fermi began to call my new particle, which appears in v-decay, a "neutrino" in order to distinguish it from a heavy neutron. This Italian name has become a generic name. ”

In the 1930s, E. Fermi's theory was generalized to positron decay (Vin, 1934) and transitions that occur with changes in the angular momentum of the nucleus (Gamov and Teller, 1937). The "fate" of a neutrino can be compared to the "fate" of an electron. Both particles were initially hypothetical (appearing at the tip of the pen) - an electron was introduced to adapt the atomic structure of matter to the law of electrolysis, while a neutrino was introduced to protect the law of conservation of energy during v-decay from impulses. And it was only a long time later that they were discovered as real, existing particles.

In 1962, it was discovered that there are two types of neutrinos: electron and muon. Currently, there are three types of neutrinos: electron, muon, and taon.

Thus, in the years since the discovery of the electron, a large number of different microparticles of matter have been identified. Very small dimensions are characteristic for all elementary particles: the linear dimensions of the nucleon and the peony are approximately equal, ranging from 10-15 m. Theoretical data show that the size of the electron should be in the order of 10-19 m. The mass of many particles is comparable to the mass of a proton, and its value is close to 1 GeV in energy units.

The world of elementary particles has a sufficiently complex structure. The properties of some elementary particles turned out to be unexpected in many respects. In describing them, in addition to the characteristics of classical physics: electric charge, mass, moments of momentum, there are many new special characteristics, in particular, for the description of strange elementary particles - "wonder" (K. Nishidjima, M. Gell-Mann, 1953), elementary to describe the attractiveness of particles, characteristics such as “attractiveness” (American physicists D. Bjorken, S. Gleshow, 1964) were introduced. The nomenclature of the introduced characteristics also indicates that the properties of the elementary particles are unusual.

Introducing students to the history of the discovery of elementary particles inspires a deep sense of respect and esteem for their physics, its history, the international community of scientists, who have made great contributions to the development of physics. It also instills in students a sense of pride, curiosity, a desire to do great creative work, and a sense of confidence and hope for the future.

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