STUDY OF THE CONTRIBUTION OF NOBEL PRIZE WINNERS TO THE DEVELOPMENT OF ATOMIC AND NUCLEAR PHYSICS IN PEDAGOGICAL UNIVERSITIES

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Abstract

The article is devoted to the importance of the study of the contribution of Nobel Prize winners to the development of Atomic and Nuclear physics in the pedagogical universities. The article describes the advances that have been nominated in the Atomic and Nuclear physics and provides basic information about the Nobel Prize winners. In the article the biographical method of teaching Physics in the future teacher training has been used. Using this method allows to 'humanize' the Physics course and wider reveal the context of Physics inventions. This method also promotes training of a Physics teacher not only as a professional, but also as a developed personality, as it allows significantly expanding the students' outlook, add some variety in the content of the Physics course, as well as to prepare creative teachers.

Keywords: history of science, culture, atom, nucleus, structure

1. Introduction

In the modern conditions of the process of training a future teacher it is necessary not only to train his/her main profession, but also to develop his/her general culture and involve him/her in the expansion of the outlook. One of the sources of cultural and intellectual development is the study of the History of science, which not only contributes to the deepening of knowledge on the subject, conscious and mastering acquisition of this knowledge, but also to the formation of general cultural competences. The study of any science, including Physics, is inextricably linked with the study of the history of this science, which contributes not only to the deepening of the knowledge on the studied subject, but also to the preparation for future career.

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2. The Nobel Prize

The Nobel Prize is one of the most prestigious international prizes, awarded annually for outstanding scientific research, revolutionary inventions or major contribution to the culture or society development. The Nobel Prize has been awarded since 1901 for works in Physics, Chemistry, Physiology or Medicine, literature and 'for Peace' (Nobel Prize for Peace) [1]. The prize founder Alfred Nobel put Physics in the first place, and it was not by accident: in the nineteenth century Physics was regarded as the most developed part of Natural science, which reflected to the greatest extent all the main features of this phenomenon that nowadays we regard as modern science. In the twentieth century the following discoveries that have radically changed the physical picture of the world have been made: the Quantum mechanics and Quantum field theory, Special and General relativity were established, the atom theory was constructed, models of the structure of the atomic nucleus and elementary particles were created. The discovery of radioactivity and nuclear fission, the implementation of the fission chain reaction had a significant impact on the image of technical and technological world image. Many physical discoveries and fundamental physical ideas were appreciated by the Nobel Prizes in Physics [2, 3]. On one hand, they promoted and still promote the development of experimental Physics and other fields of scientific research. On the other hand, they led to revolutionary changes in the technological position of the society [4]. That is why the study of the history of these discoveries by students of pedagogical universities plays an important role in increasing students' interest in the studied disciplines, broadening their outlook and better understanding of many physical processes and phenomena associated with the structure of the elements of the microcosm. The biographical method, which allows to consider the discoveries and achievements in the context of the era and human life, has an important role in the acquisition of this material [5-7]. The experience has shown that information on the Nobel Prize winners and their contribution to the development of a certain branch of Physics can be included in the content of the studied course of Physics [8]. The best opportunities to explore the information on the Nobel Prize winners and their discoveries in the Atomic and Nuclear physics can be revealed in the study of the 'History of Physics', 'History of Science and Technology', which are provided in the programs for training of pedagogic education bachelors.

3. The Nobel Prize on Atomic and Nuclear physics

Atomic and nuclear physics is a branch of Physics devoted to the study of the structure of the atomic nucleus, radioactive decay processes and the mechanism of nuclear reactions. Atomic physics emerged in the late nineteenth – early twentieth centuries. In the first decade of the twentieth century it was found that the atom consists of a nucleus and electrons bound by electric forces. In the first stage of its development, Atomic physics also covered issues related

to the structure of the atomic nucleus. In the thirties, it became clear that the nature of the interactions within the atomic nucleus is different from one in the outer membrane of the atom, and in the forties Nuclear physics became a separate science. In the fifties the Physics of elementary particles separated from Nuclear physics. The present article describes the structure of Atomic and Nuclear physics, a reliable foundation of Physics, and the achievements of scientists in this area, which were awarded Nobel prizes. This information has been provided not chronologically, but namely in accordance with the specified logic of the development of Atomic and Nuclear physics. This is due to the fact that discoveries made in this field of Physics, were often awarded the prestigious Nobel Prizes decades later, only after they had received wide recognition.

3.1. The atomic structure

In 1922, Niels Henrik David Bohr, a Danish physicist, was awarded the Nobel Prize in Physics for theoretical research in the field of atomic structure [9]. During his internship at Rutherford in 1911-1912 Bohr became interested in the problematic model of the atomic structure together with Rutherford. As a result, by 1913 he developed a planetary model of the atom in which the electron orbits the atom were only allowed stable orbits (‘Bohr atom’). He showed that the spectral lines emitted by atoms can be explained by the fact that when moving from one allowed orbit to another, the electron gains or loses energy proportional to hv and equal to the difference between the energy states of the allowed levels, and emits a frequency v. Although the Bohr model could explain only the simplest features of optical spectra, it has become an essential step in the development of quantum theory of the atom and the quantum theory as a whole. In particular, this model gave a theoretical justification of the Mendeleev periodic law. On the basis of this model, Bohr predicted the existence of a new chemical element – hafnium, discovered in 1923 by David Coster and Hevesy György.

Interesting facts from the life of scientists: studying these discoveries, the students also learn about features of Bohr’s bright personality. For example, Niels Bohr was the founder of the vast theoretical school, most representatives of which became Nobel Prize winners (F. Bloch, A. Bohr, W. Heisenberg, P. Dirac, H. Jensen, L.D. Landau, N. Mott, W. Pauli, I. Rabi, H. Yurey) and three scientists – I. Rabi, J. Slater and J. Wheeler – created their own Physics schools. Experience has shown that the students get interested in the information about citizenship and the scientists’ hobbies. For example, such interesting facts: before the Second World War, at the end of the thirties the Bohr’s laboratory became a refuge for scientists who were persecuted by the Nazi regime [4, p. 321], or that Niels Bohr was a member of the Danish national football team.

In 1925 the German physicists James Franck and Gustav Ludwig Hertz were awarded the Nobel Prize [*The Nobel Prize in Physics. 1925*, Official web site of the Nobel Prize, May 25, 2015, http://www.nobelprize.org/nobel_ prizes/physics/laureates/1925/] for experiments on collisions of electrons with

atoms. Major studies have been associated with the excitation and ionization of mercury vapours by strokes of electrons, which formed the content of 'Franck-Hertz experiment' (1913). In the experiment between the cathode and the grid they applied potential difference that accelerated electrons colliding with atoms of mercury vapours. Then the electrons were moving into the area where between the second grid and the anode a small potential difference was attached in the opposite direction, and the anode current dependence on the potential removed. It has been shown that when the values of the potential are greater than the critical value, electrons experiencing inelastic collisions with the atoms lose all the energy, whereby the current decreases sharply, indicating that the electron energy goes into the internal energy of the atoms, and the internal energy of the atom does not change continuously and takes only certain discrete values - it means it quantizes. This experience played an important role in the confirmation of the Bohr's quantum theory.

Let us provide some interesting facts from the life of scientists: Frank's scientific activity began in the first third of the twentieth century, when he made a discovery in cooperation with Hertz and headed the Department of Experimental Physics of the Gottingen University in 1920. At that time the department was the centre of modern Physics, where a future Nobel Prize winner P.M. Blackett and other prominent physicists worked. After Hitler came to power in Germany in 1933, Jews began to be removed from academic positions. Before leaving Germany, Frank could find a job abroad for each member of his staff [4, p. 342]. The German physicist Gustav Hertz was the nephew of Heinrich Hertz, one of the founders of Electrodynamics who experimentally proved the existence of electromagnetic waves. He was convinced that he may be useful to the Soviet Union in the development of Physics research, and after the Second World War Hertz spent 10 years in the Soviet Union, heading the research on atomic energy and radars in the laboratory in Sukhumi.

3.2. The radioactivity

In 1903, the French physicist Antoine Henri Becquerel was awarded the Nobel Prize for the discovery of spontaneous radioactivity of uranium salts [10], which was no less surprising than the discovery of X-rays. The scientist studied the effect of different luminescent substances on a photographic plate through the partition opaque for visible light, and found that uranium salts have an impact on the photographic plate even if they have not previously been exposed to X-rays or visible light. On the image of the Becquerel's photographic plate, which was illuminated by radiation of uranium salts, we can see the shadow of a metallic Maltese cross, placed between the plate and the uranium salt. After a series of control experiments he found that the radiation of uranium salts is an atomic property of uranium and it is not related to the luminescence.

Here are some interesting facts from the life of scientists: Antoine Henri Becquerel was the successor of a dynasty of physicists. His father, Alexander Edmond, and his grandfather, Antoine César, were well-known experts in the

field of phosphorescence, members of the Paris Academy of Sciences, and his son Jean also became a member of the Paris Academy of Sciences and an expert on magnetism.

In 1903 the French physicists Marie Sklodowska-Curie and Pierre Curie received the Nobel Prize for studying the phenomenon of radioactivity [*The Nobel Prize in Physics. 1903*, Official web site of the Nobel Prize, May 25, 2015, http://www.nobelprize.org/nobel_prizes/physics/laureates/1903/]. They became interested in the discovery of Becquerel and began to study the minerals containing uranium or thorium. They found that these minerals have radioactivity (they were the first to use this term), and the greater radioactivity is, the more uranium or thorium they contain. This made them to conclude that there is a chemical element responsible for radioactivity. Conducting a thorough chemical analysis of uranium ore, in 1898 they discovered the highly radioactive substances called polonium and radium. In 1902 the use of the original method of processing of uranium ore waste allowed them to receive one-tenth of a gram of radium chloride and further determine its atomic weight, the exact place in the periodic table of chemical elements, its ability to continuously emit large amounts of heat, as well as to develop quantitative methods for measuring radioactivity. In 1899-1900, they have found that radioactive rays cause changes in the cells of living organisms, resulting in paralysis and death under prolonged exposure.

Here are some interesting facts from the life of scientists: the Curies supported a healthy lifestyle, they devoted much time to cycling. Marie Curie was the only female scientist who was twice awarded the prestigious prize: she won the second prize in 1911 for "outstanding achievements in the development of Chemistry: the discovery of radium and polonium, radium desorbing and the study of the nature and compounds of this remarkable element" [4, vol. 2, p. 1119]. This discovery led to the creation of a new field of Science – Radiology. During the First World War, Marie Curie trained military doctors to use radiology, such as X-ray detection of the shrapnel in the body of the wounded [4, p. 194].

It should be noted that a large number of Nobel Prizes in Chemistry were ideologically close to the works that have been awarded the Nobel Prizes in Physics. Moreover, in some cases they represent such sections of Chemistry (Nuclear chemistry, in particular), which might be equally regarded as sections of Physics. For this reason, we shall provide the information on the Nobel Prizes in Chemistry.

In 1908 Ernest Rutherford was awarded the Nobel Prize in Chemistry [The Nobel Prize in Chemistry. 1908, Official web site of the Nobel Prize, May 25, 2015, http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1908/]. Investigating the behaviour of the rays emitted by radioactive elements, the scientist has established the existence of three types of radioactive rays: the rays of alpha-, beta- and gamma- radiation. Using alpha particles that represent the nuclei of helium atoms, Rutherford discovered the atomic nucleus, and thus founded a new science – Nuclear physics.

Here are some interesting facts from the life of scientists: Rutherford managed to bring up many independent researchers who have made a great contribution to the development of Physics and created their own groups of students. Nine of his students – P. Blackett, N. Bohr, O. Hahn, P.L. Kapitsa, J. Cockcroft, C. Powell, E. Walton, G. Hevesy and J. Chadwick won the Nobel Prize. Furthermore, Bohr, Blackett and Powell founded their own scientific schools. The work of several generations of his students had a tremendous impact not only on the development of Science and technology, but also on the lives of millions of people.

3.3. The discovery of isotopes and the structure of the atomic nucleus

In 1921, the English radiochemist Frederick Soddy was awarded the Nobel Prize in Chemistry for studying the origin and nature of isotopes [The Nobel Prize in Chemistry. 1921, Official web site of the Nobel Prize, May 25, 2015, http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1921/]. Since 1900 he worked on the problem of radioactivity together with Rutherford. Rutherford and Soddy have jointly developed the theory of the decay of radioactive elements (1903). In accordance with this theory, some of the heaviest elements acquire resistance, throwing small but sufficiently scattered units of mass, charge and energy out of their nuclei in the form of alpha-, beta- and gamma-radiation. The other elements are formed in the process of radioactive decay. In 1913 Soddy formulated the law of radioactive displacement, which states that under the emission of alpha particles occurs the transformation of one element into an isotope of another element located two places lower in the periodic table, while beta radiation causes displacement per one place higher. The law of displacement made it possible to predict the sequence of decay of many radioactive elements, determining the generated elements on the basis of a certain type of radiation, and including them in the periodic table. Soddy proved the existence of new radioactive elements in decay products, and found that the nuclei belonging to the same chemical element can have different masses (on Soddy's proposal they were called 'isotopes'). He proposed to use the isotopes to determine the geological age of rocks and fossils, using knowledge of the half-life period. Currently, there are over 1,900 isotopes of 107 chemical elements.

Here are some interesting facts from the life of scientists: after receiving the Nobel Prize, Soddy gradually departed from research in Physics and Chemistry and turned his attention to the economic, social and political theory, including Mathematics.

In 1934, the American chemist Harold Clayton Urey was awarded the Nobel Prize in chemistry for his discovery of heavy hydrogen [The Nobel Prize in Chemistry. 1934, Official web site of the Nobel Prize, May 25, 2015, http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1934/]. Deuterium (heavy hydrogen) is one of the two stable isotopes of hydrogen, whose nucleus consists of one proton and one neutron. Deuterium occurs in nature at a ratio of

1/5000 to the standard hydrogen. Urey has developed a process of distillation of liquid hydrogen, in which molecules of a lighter isotope evaporate faster than molecules of a heavy isotope. The scientist calculated the spectral line of a heavy element and found these lines, analyzing more concentrated hydrogen. Thus he was the first to use physical methods (spectral analysis) in Chemistry. Heavy water (deuterium oxide) is an isotope variation of water. Later it became clear that the most important feature of heavy hydrogen water is that it almost does not absorb neutrons (neutrons together with protons form the atomic nucleus), and therefore it is used in nuclear reactors as a coolant.

Here are some interesting facts from the life of scientists: during the Second World War, Urey took part in the Manhattan Project (a secret program on the creation of the atomic bomb). In peacetime, Urey applied his knowledge of the isotope chemistry to the other fields of Science such as Palaeontology, Cosmology. In the sixties he persuaded the government to combine scientific research with the American space program. The scientist was fond of growing orchids.

In 1935, the English physicist James Chadwick was awarded the Nobel Prize in Physics for the discovery of the neutron [11]. In 1920, he completed the work on scattering of α-particles by nuclei of different metals, measured the nuclear charges and gave a final confirmation of Rutherford's atomic theory. In 1932 the scientist explored the radiation, produced by the irradiation of beryllium with the stream of α-particles, and the study has shown that it is not a special kind of electromagnetic radiation, but a stream of electrically neutral particles – neutrons, with a mass close to the mass of the proton, the existence of which was predicted by Ernest Rutherford in 1920. In addition, he managed to determine the most accurate value of the neutron mass.

Here are some interesting facts from the life of scientists: Chadwick coordinated the efforts of British scientists working on the Manhattan Project. The scientist was fond of fishing and gardening.

In 1935, the French physicists Frederic Joliot and Irene Joliot-Curie received the Nobel Prize in chemistry for the synthesis of a number of new elements [The Nobel Prize in Chemistry. 1935, Official web site of the Nobel Prize, May 25, 2015, http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1935/]. In 1934 they made one of the biggest discoveries in Nuclear physics – they discovered the phenomenon of artificial radioactivity. In the study of products of nuclear reactions that occurred as a result of the bombardment of aluminium with alpha particles, the scientists found that this reaction produces radioactive phosphorus, which emits a positron when decaying and turns into a stable silicon-30. Soon they discovered that radioactive nitrogen and silicon are obtained as a result of bombarding boron and magnesium. The feature of the obtained radioactive isotopes consisted in the fact that they emitted positrons, which were the antiparticles of electrons.

Here are some interesting facts from the life of scientists: Frederic Joliot was a striker of the French youth football team, and during the Second World War he was an active anti-fascist taking part in the French Resistance, along

with other well-known scientists-physicists – P. Langevin, A. Abragam and E. Cotton.

Continuing the research of Joliot-Curie, the Italian physicist Enrico Fermi showed that neutron bombardment causes artificial radioactivity in heavy metals. In 1938 he was awarded the Nobel Prize in Physics for the discovery of artificial radioactivity caused by slow neutrons [12]. In the years 1934-1938 he was first to discover artificial radioactivity caused by neutron bombardment of a number of elements, including uranium, discovered the phenomenon of neutron moderation in matter and created a detailed theory of this phenomenon. By bombarding aluminium and fluoride, the scientist got isotopes of sodium and nitrogen emitting electrons. He showed that the probability of nuclear reactions induced by neutrons (in which there is a transformation of elements) increases when the neutrons slow down, and this is true both for light and heavy elements. In his theory of beta decay, Enrico Fermi put forward the idea of the existence of the neutrino. In 1942 he constructed the first nuclear reactor, which used uranium and uranium oxide as fuel, and graphite as a moderator, and implemented the first self-sustaining nuclear chain reaction in this reactor.

Otto Stern received his Nobel Prize one year later, in 1944. During the selection process in 1943, the Nobel Committee for Physics decided that none of the years nominations met the criteria as outlined in the will of Alfred Nobel. According to the Nobel Foundation's statutes, the Nobel Prize can in such a case be reserved until the following year, and this statute was then applied. Otto Stern therefore received his Nobel Prize for 1943 one year later, in 1944 [The Nobel Prize in Physics. 1943, Official web site of the Nobel Prize, May 25, 2015, http://www.nobelprize.org/nobel_prizes/physics/laureates/1943/]. Due to the war it was not a standard award ceremony – the Prize was presented during the breakfast organized by the American-Scandinavian Foundation in New York.

Together with colleagues he developed experimental method of molecular beams – directed flows of molecules moving in a vacuum with virtually no collisions with each other and the residual gas molecules. This method allowed to efficiently investigate the phenomena caused by the electron spins and nuclear magnetic moments. In 1921 the scientist pointed out the possibility to experimentally prove the fact that the projection of the atom magnetic moment on the direction of the external magnetic field takes discrete values (spatial quantization). In 1922 together with Walter Gerlach, Otto Stern conducted a relevant experiment for the passage of silver atoms in the magnetic field strongly inhomogeneous along the z-axis (‘Stern-Gerlach experiment’). In 1933, together with Otto Frisch, the scientist was first to measure the proton magnetic moment in the hydrogen molecule.

3.4. The discovery of nuclear fission of heavy atoms

In 1944, the German physicist Otto Hahn received the Nobel Prize in Chemistry for the discovery of nuclear fission of heavy atoms. But just as in the case of the Prize for Physics from 1943, during the selection process in 1944, the

Nobel Committee for Chemistry decided that none of the year's nominations met the criteria as outlined in the will of Alfred Nobel. According to the Nobel Foundation's statutes, the Nobel Prize can in such a case be reserved until the following year, and this statute was then applied. Otto Hahn therefore received his Nobel Prize for 1944 one year later, in 1945. [The Nobel Prize in Chemistry. 1944, Official web site of the Nobel Prize, May 25, 2015, http://www.nobelprize.org/nobel_prizes/chemistry/ laureates/1944/].

In the Nobel Prize statute, based on the Nobel's will, it was said that those people "who have managed to bring the greatest benefit to mankind" can be awarded the Nobel Prize. But in those times only uranium and plutonium atomic bombs were operated on the 'splitting principle' ('Little Boy' and 'Fat Man'), that struck Hiroshima and Nagasaki just three months before that. Together with Fritz Strassmann and Lise Meitner, Hahn discovered that the neutron bombardment of uranium leads to the formation of radioactive substances and realized that neutron irradiation splits uranium into two nuclei. Otto Hahn, without Lisa Meitner, received the Nobel Prize for fundamental discovery in this area. Lise Meitner, an Austrian Jew, had to flee to Sweden. There she and her nephew, the physicist Otto Frisch, continued the research. She also continued her cooperation with Otto Hahn: they kept in touch by mail. After receiving new data of the study of the neutron bombardment of uranium nuclei, Meitner discovered that this bombardment leads to the formation of radioactive substances, which are chemically identical to barium and lanthanum. As barium and lanthanum have less atomic weight than half the original uranium, it became clear that the neutron irradiation splits uranium nuclei, and with the release of huge amounts of energy. The subsequent history of the creation and use of a nuclear bomb is well known. However, justice has been partially served. In 1959, for the 80th anniversary of Otto Hahn the Institute for Nuclear Research in Berlin was renamed 'Hahn-Meitner Institute'.

In 1948, the English physicist Patrick Maynard Stuart Blackett was awarded the Nobel Prize for improving the cloud chamber and works in Nuclear physics performed with it. He fitted the cloud chamber with Geiger counters as a particle detector (1931), that allowed to automate the registration process, and put it into a refrigerated coil with high magnetic field strength. In 1932, together with G. Occhialini, the scientist discovered the electron-positron pairs, which were created by high-energy cosmic rays with energy of 1 MeV. In 1934, together with Chadwick and Occhialini, he found the creation of electron-positron pairs when the substance absorbs gamma rays from radioactive sources and investigated their annihilation. Thus, he was first to demonstrate the transformation of the radiation into the substance and vice versa.

Here are some interesting facts from the life of scientists: Blackett was aware of the dangerous consequences of using nuclear energy for military purposes. In 1948 Blackett published a book titled 'Fear, war and the bomb: military and political consequences of atomic energy' [14].

In 1951, the English physicist John Douglas Cockcroft and the Irish physicist Ernest Thomas Sinton Walton received the Nobel Prize for their works on transmutation of atomic nuclei by nuclear particles artificially accelerated by high voltage. Cockcroft and Walton were the first who made nuclear reaction on the accelerator: they constructed the first high-voltage capacity series-fed cascade generator ('Cockcroft-Walter generator'), developed a method of accelerating the hydrogen ions and, irradiating the lithium target by artificially accelerated protons, turned lithium into helium, i.e. carried out the first splitting of the atom (1932).

In 1963, the American physicist Maria Göppert-Mayer and the German physicist Johannes Hans Daniel Jensen won the Nobel Prize for the creation of nuclear shell structure. According to this model (1949-1950), a nucleon in a nucleus moves independently in some potential well, which is the result of a joint impact of all the other nucleons on the studied nucleon. This model introduced the concept of nuclear shells, similar to the electron atomic shells. Maria Göppert-Mayer explained the existence of 'magic nuclei', in which the number of protons or number of neutrons is equal to one of the 'magic numbers'.

In 1975, the Danish physicists Aage Niels Bohr and Ben Roy Mottelson and the American physicist Leo James Rainwater received the Nobel Prize for their research of the connection between collective and individual movement of particles in the atomic nucleus and the development of a generalized nuclear model on this basis. They developed a nuclear model, in which the fluid-like nuclear behaviour, described by Bohr's droplet model, and the shell model, proposed by Göppert-Mayer and Jensen, had been synthesized. According to this model the nuclear surface behaves like the surface of the liquid drop, while the orbital nuclear structure allows deformations, leading to vibration and rotation of the surface. If the outer shell of the nucleus has a full set of nucleons, the nucleus has a symmetrical shape, in case when the outer shell is not full, it takes the form similar to the ellipsoid of revolution. This model allowed to describe a number of essential properties of heavy nuclei, including their ability to divide.

Here are some interesting facts from the life of scientists: Aage Bohr was the son of Niels Bohr, his assistant, and during the Second World War together with his father he was involved in the work on the atomic project at Los-Alamos National Laboratory [15].

On the basis of the mentioned discoveries and names of scientists who made them, we can conclude about significant contribution of the Nobel Prize winners to the development of the study of the atom and atomic nucleus. All these discoveries and inventions were appreciated by the highest scientific prize – the Nobel Prize in Physics.

4. Conclusions

Studying the history of discoveries made by Nobel Prize winners plays an important role in training of students of pedagogical universities, as it allows to 'revive' the learning process of many disciplines, as well as to enhance the

educational and cognitive activity of future teachers. In addition, it contributes to the formation of a school graduate both as a qualified professional and an educated, intelligent personality. In the present article we reviewed the achievements of Nobel Prize winners in the field of Atomic and Nuclear physics, the branches of Physics studied by pedagogical education bachelors in the Physics course. Among the winners of this prestigious award there are outstanding theorists and experimentalists, who formed new physical theories, developed fundamentally new technologies and radically transformed the physical picture of the world, as well as people who have become classics of Physical science. The history of Atomic and Nuclear physics cannot be presented, studied and understood without mentioning these scientists. Nowadays the highest authority of the Nobel Prizes can be explained by the achievements of brilliant personalities, whose intellectual influence goes beyond the Natural sciences.

The information on discoveries and inventions that have been honoured with this prestigious award can be used in the study of Physics course (in such branches as 'Optics', 'Quantum physics', 'Atomic and Nuclear physics'). Teaching experience has shown that it is more appropriate to study this topic in the courses 'History of physics' or 'History of science and technology', in the sub-discipline devoted to the latest achievements of Physical science, as well as in the organization of students' independent work using the Internet, the result of which can be the preparation of an essay or a report for the student conference.

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