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Research Article

METHODS OF DEVELOPING THE SCIENTIFIC COMPETENCE OF PHYSICS STUDENTS IN TEACHING NUCLEAR PHYSICS

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ABSTRACT

The article analyzes the methodology for the development of scientific competence of future physics teachers in practical, laboratory and theoretical classes, as well as in the performance of independent work on nuclear physics.

KEYWORDS

Nuclear physics, integration of science and education, scientific projects, nuclear research, isomeric nuclei, beta stability, online experiments, spectrometer, Gerholm, gamma spectrometer, scientific competence.

INTRODUCTION

As you know, the training of specialists for all areas of production technology and the social sphere is based on knowledge and skills acquired in secondary schools. This circumstance imposes a great responsibility on pedagogical universities that train future teachers. In this regard, the training of highly competent physics teachers is also an urgent task of the modern education system. Taking into account the fact that physics as a science studies the patterns of industrial and technical processes, when teaching physics, it is important to integrate education with production and science. Therefore, it is important to develop students' creative, scientific and heuristic thinking through a scientifically practical approach to the study of knowledge provided by the curriculum.

This paper describes the methodology for the development of scientific thinking of physics students in teaching atomic and nuclear physics.

Literature review.

Teaching the section "Physics of the atom, nucleus and elementary particles occupies a special place as the final stage of general physics. This is due to the fact that when studying this section, internal integration with knowledge gained in other sections of general physics deepens, mathematical concepts and elements of dialectical thinking are more clearly revealed. In addition, when studying this section, ideas about a unified physical picture of the world are formed by generalizing knowledge about the general course of physics. Therefore, for an in-depth study of nuclear physics, it is advisable to use an integrated learning approach [1]. When implementing an integrated approach, one should not forget that the development of students' scientific competence is in itself a complex process and that this process is carried out in certain stages.

RESEARCH METHODS AND RESULTS

The stages of development of scientific competence of future teachers are schematically depicted in Fig.1.

At the first stage of the development of scientific competence, it is envisaged to use interesting facts from the history of science, facts from the life of scientists, etc., which contribute to the formation of motivation, as well as the formation of human qualities characteristic of great scientists. On the other hand, a consistent presentation of the history of solving a physical problem in chronological order contributes to the formation of scientific competence of students, turning them into accomplices of this event [2].

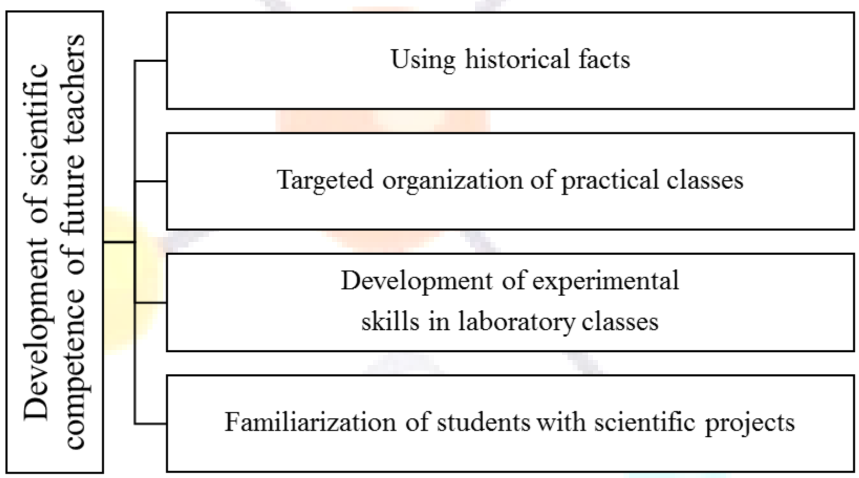

Fig.1. Stages of development of students' scientific competence

The second stage of the formation of a scientific worldview consists of the targeted organization of practical classes for in-depth study of theoretical materials. In this case, the main criterion is the correspondence of the calculation results of complex scientific problems with experimental results. This correspondence strengthens students' confidence in their knowledge potential. When conducting practical classes, it is necessary to meet the requirements such as: presenting the tasks being solved as a problem situation; ensuring continuity between theory and practice; preparing students for the next topic, etc. The problematic tasks include computational and graphic works designed for independent work of students [3] When performing computational and graphic works, interdisciplinary integration between physics, mathematics, chemistry, biology, computer science, etc., as well as integration between theoretical, practical and laboratory classes is carried out simultaneously. The scientific analysis of the obtained graphs contributes to an in-depth study of the laws of the physical process, thereby forming and developing the scientific competence of future physicists.

The formation of scientific and experimental competence is carried out by the development of experimental skills of students. At the same time, based on the physical quantities measured in each experiment, it is advisable to start classes with an introduction to the principle of operation and devices, the accuracy class or the reduced error of measuring instruments. At this stage, it is important to indicate the role of measuring instruments as a means of controlling technological processes. When studying nuclear radiation detectors, it is necessary to pay attention to their purpose, energy and time resolution, based on which types of detectors are selected for specific studies. When performing laboratory work on nuclear physics, in addition to the rules of electrical and technical safety, compliance with the rules of radiation safety is also required. This feature must be taken into account when creating virtual laboratory work on nuclear physics [4].

Familiarization with scientific projects carried out at leading scientific centers is the best way to develop the scientific competence of future physics teachers. To do this, it is necessary to familiarize students with the purpose and objectives of the scientific project. For example, let's give the YASNAPP research project (Proton Beam Nuclear Spectroscopy) (Dubna, Russia), carried out at the Joint Institute for Nuclear Research, with the direct participation of the author of this article [5]. This scientific project has been completed in two stages. The first stage of the YASNAPP-1 scientific project was carried out offline, that is, isotopes obtained by bombarding a tantalum target with protons with an energy of 680 MeV and isolated in a mass separator were brought to the radiochemical laboratory. During transportation, the short-lived isotopes almost completely disintegrated. In this way, the properties of nuclei with a half-life of more than one minute have been studied. At the second stage of the YASNAPP-2 project, experiments are planned to be conducted online. In this case, isotopes from the mass separator are transmitted via an ion conduit to the source holders of the recording detectors. The diagram of the YASNAPP-2 complex is shown in Fig.2.

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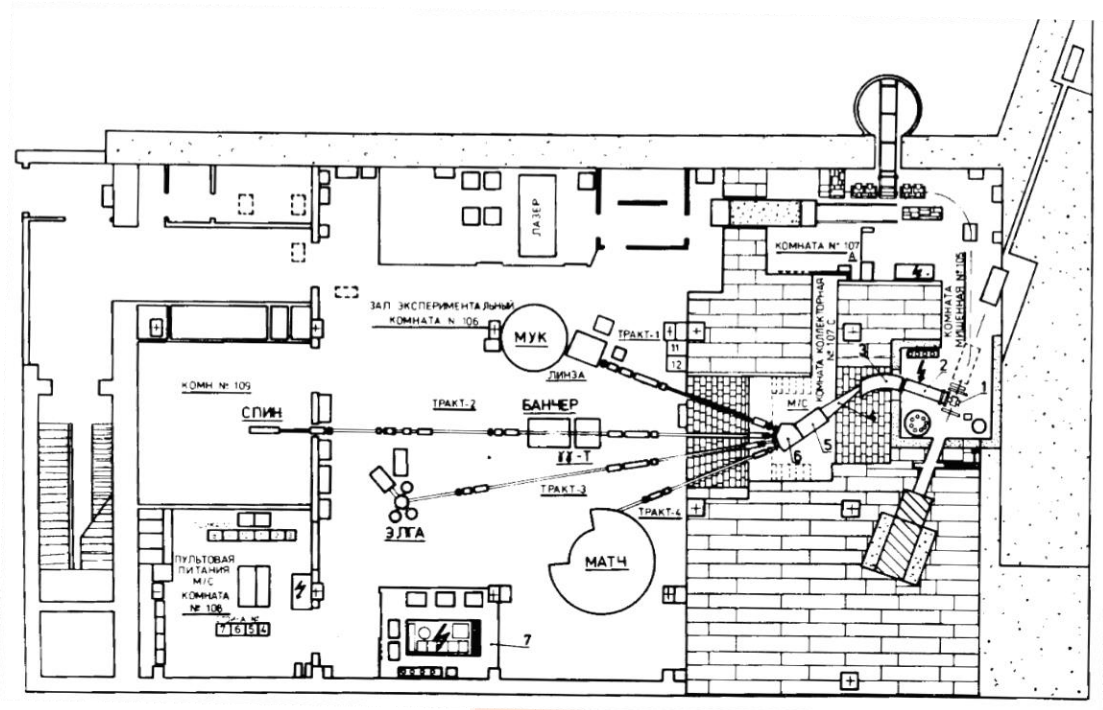

Fig. 2. The scheme of the YASNAPP-2 complex

In this complex, along with other tasks, it is possible to study the properties of short-lived isotopes with a half-life of less than one minute. One of the scientific objectives of the project is to study the isomeric (metastable) states of neutron-deficient nuclei far from the beta stability band [6]. The totality of isomeric nuclei, according to the definition of academician G.N.Flerov, is called "islands of stability", and the scientific project YASNAPP-2 is "a journey in search of islands of stability" [7].

The lifetimes of the isomeric states of the studied nuclides are measured using a magnetic lens beta spectrometer and a semiconductor gamma spectrometer connected according to the e-gamma coincidence scheme (Fig.3.).

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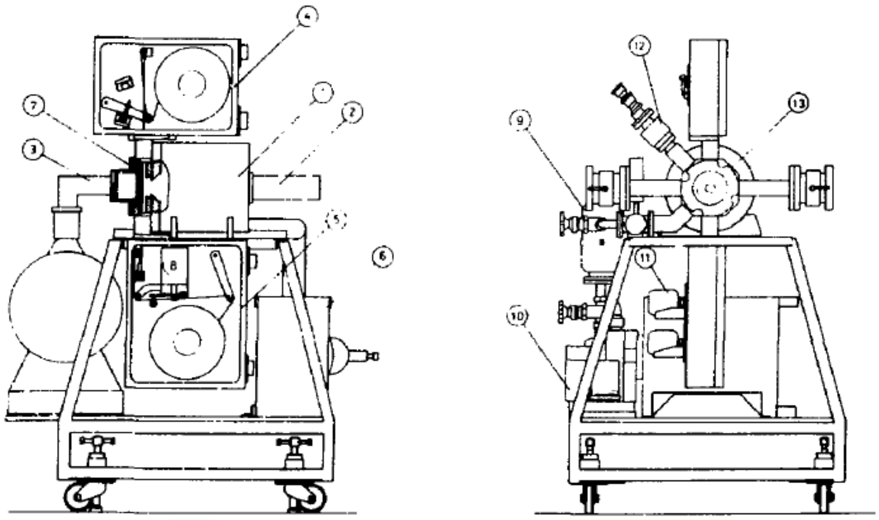

Fig.3. Installation of e-gamma matches for measuring the lifetime of isomeric states of short-lived nuclei based on a magnetic lens beta spectrometer and a semiconductor gamma spectrometer

In this experimental setup, the Geerholm magnetic lens beta spectrometer (Fig. 4, 5) registers electrons charging or defusing the studied level.

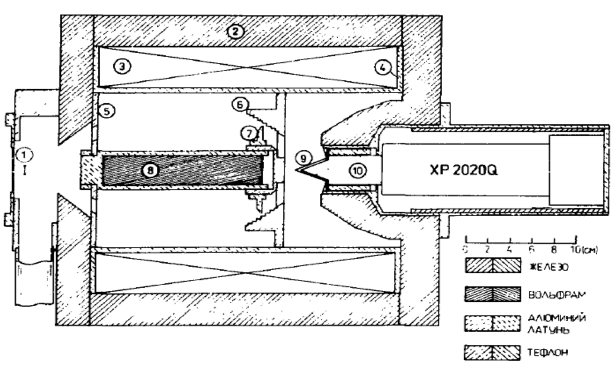

Fig.4. Section of the Girholm magnetic lens beta spectrometer

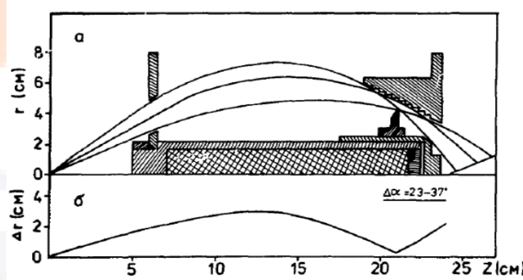

Fig.5. Projection of the electron trajectory in a magnetic lens beta spectrometer

In the beta spectrometer, gamma rays from the source are held by a lead rod mounted on the axis of the magnetic lens. Positrons can also be emitted from a radioactive source along with electrons, which, moving in the same plane with the electrons, fall on the beta detector. To remove positrons, a screw diaphragm is used, made based on the results of calculating the trajectory of electrons in the magnetic field of a magnetic lens. To do this, first of all, it is necessary to determine the distribution of the magnetic field in the spectrometer, taking into account the shape of the magnetic core, the number of turns and the magnitude of the current in the winding (Fig.6.a).

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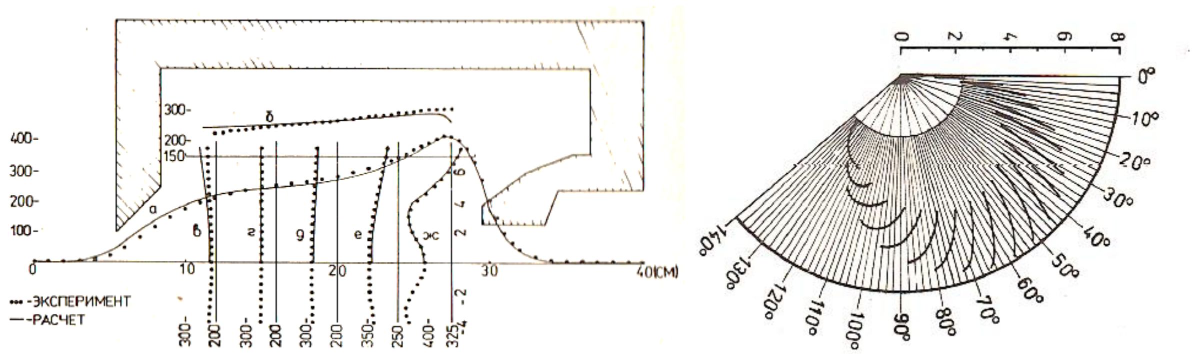

а) б)

Fig.6. Spatial distribution of the magnetic field (a), shape and angle of rotation of the electron trajectory in the beta spectrometer (b)

Next, calculations of the trajectory and the angle of rotation of the electron trajectory are carried out (Fig.6.). According to the calculated data, a screw diaphragm is made. Since positrons rotate in the opposite direction in a magnetic field, they are completely absorbed in a screw diaphragm made of aluminum. A general view of the screw diaphragm for separating electrons from positrons is shown in Fig.7. Electrons passing through the diaphragm are recorded on a scintillation detector made of NaI(Tl).

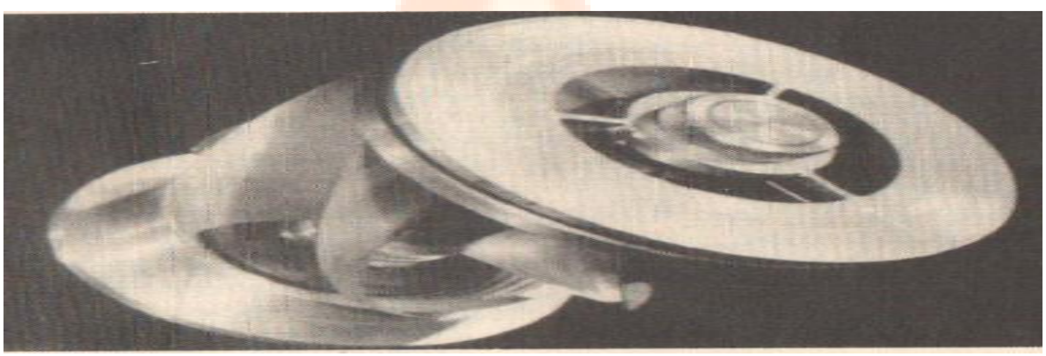

Fig.7. General view of the screw diaphragm separating electrons from positrons

The e-gamma coincidence facility installed on the first path of the YASNAPP-2 complex has been successfully used to study the half-lives of isomeric states of neutron-deficient nuclei remote from the beta stability band. To explain the principle of operation of the e-gamma coincidence setup, imagine that some excited state is formed by beta decay and discharged through gamma radiation (Fig.8.a).

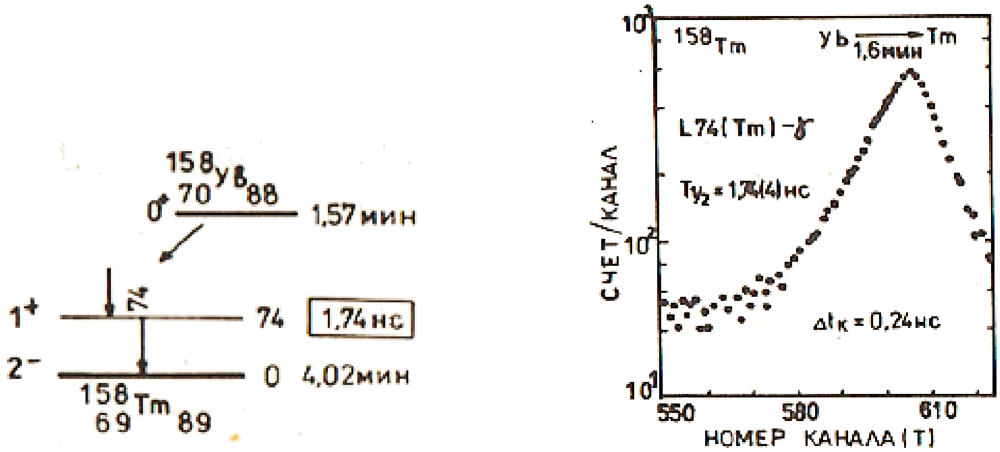

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Fig.8. The discharge scheme of the isomeric state of the isotope ${}^{158}_{69}Tm$ (a) and the time spectrum of the isomeric state of the 1+ isotope ${}^{158}_{69}Tm$

At the e-gamma coincidence facility, the delay time of the pulse from the gamma spectrometer is measured relative to the pulse from the electrons in the beta spectrometer (Fig.8 b.). The delay time between pulses is equal to the lifetime of the excited isomeric state of the nucleus (Fig.9).

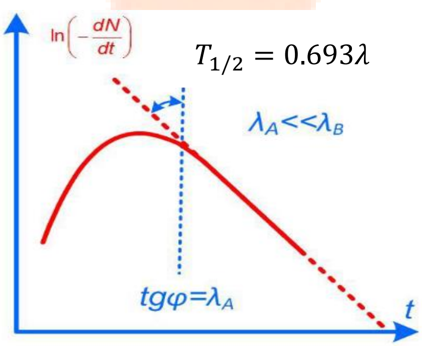

Fig.9. On determining the lifetime of the excited state from the time spectrum

CONCLUSION

In the process of familiarization with the above-mentioned scientific project, students are faced with the application of knowledge gained in previous sections of physics (intra-subject communication), as well as the application of knowledge in mathematics, software for mathematical calculations (interdisciplinary communication), etc. (Fig.10).

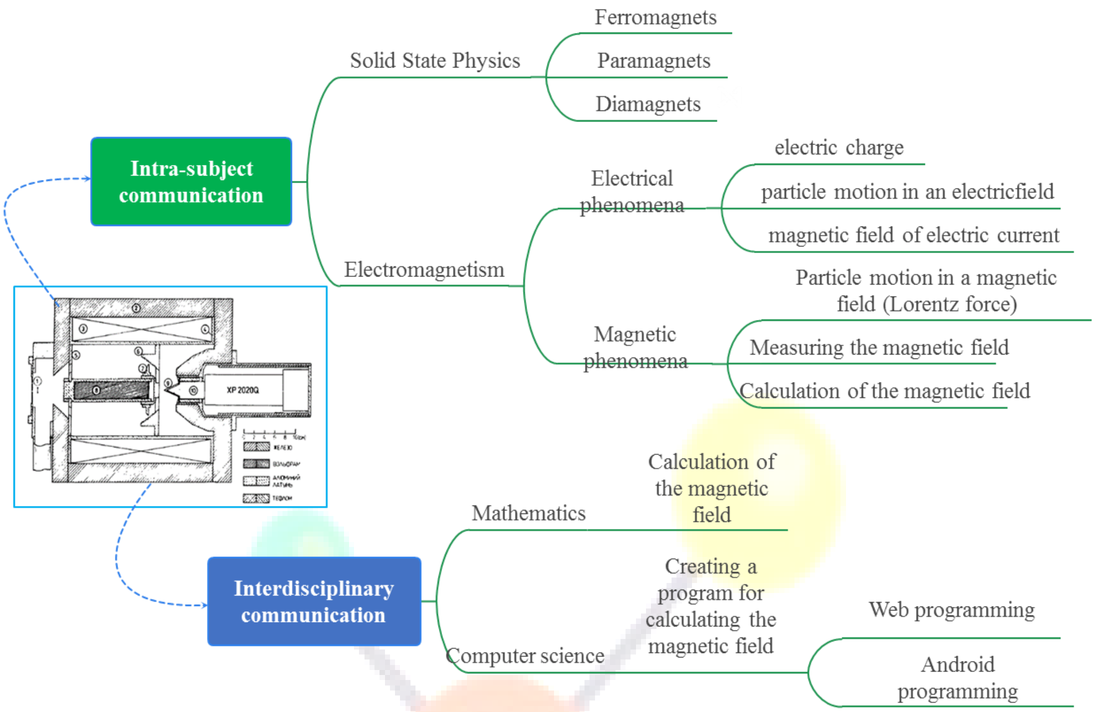

Fig.10. Intellectual map of intrasubject and intersubject integration in the development of students' scientific competence through communication with scientific projects

Thus, familiarization of students with scientific projects contributes to the simultaneous solution of several tasks:

an in-depth study of the laws of physical processes,

the formation of motivation to study the subject;

the development of students' scientific thinking;

training of highly qualified specialists based on the integration of education, science and production.

REFERENCES

1. Xudayberdiyev E.N. Improving the methodology of an integrated approach to improving efficiency in teaching nuclear physics. International Journal of Early Childhood Special Education. Vol 14, Issue 08 2022. – p. 177-183.
2. Худайбердиев Э.Н. Насриддинов К.Р., Самандаров Л.Қ. Повышение эффективности преподавания ядерной физики использованием принципа историчности. International Scientific Journal Theoretical & Applied Science. - Филадельфия, США 2020 Issue: 11 Vol: 91. –Б. 383-390.
3. Худайбердиев Э.Н., Насриддинов К.Р., Самандаров Л.Қ., Қосимжонов Р.В. Умумий физика атом ва ядро физикасидан масалалар тўплами. Ўқув қўлланма. – Тошкент.: Малик принт со, 2022. -226 б.
4. Худайбердиев Э.Н., Насриддинов К.Р., Самандаров Л.Қ. Умумий физика (атом, ядро ва элементар зарралар физикаси)дан лаборатория ишлари. -Тошкент Malik print co, 2022. –196 б.
5. Худайбердыев Э.Н. Развитие методики поиска изомерных состояний короткоживущих ядер в

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on-line экспериментах. Автореферат дисс. на соиск.ученой степени к.ф.-м.н. Москва 1990, 36 с.

6. Калинников В.Г. и др. Экспериментальный комплекс для изучения ядер, удаленных от полосы β-стабильности - ЯСНАПП-2. Сообщения ОИЯИ Д13-90-183, Дубна, 1990 – с. 21.
7. Флёров Г.Н., Петржак К.А. Путешествие в поисках острова стабильности. –М.: Наука, 1984.