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# ACTIVATION OF EDUCATIONAL AND COGNITIVE ACTIVITY IN THE PROCESS OF STUDYING ELECTRODYNAMICS IN THE GENERAL PHYSICS COURSE FOR STUDENTS

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**Abstract:** In the article expedience of introduction of method of teaching of flat rate of physics is examined in the process of study of fundamental concept of symmetry in higher educational establishments for the students of unphysical specialities, that allows to activate cognitive searching activity of students in the process of study of physics.

**Keywords:** general course of physics; symmetry; electrodynamics; circulating of processes; intensification of educational and informative activities.

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**Introduction.** Fundamental theoretical and practical training expands the professional horizons of students, allows them to see any educational or scientific problem holistically, to find its optimal solution. Thorough knowledge from the theory of teaching physics helps the student to determine the strategy and tactics of practical actions when solving professional tasks, translate theoretical ideas into practical actions, equip with effective ways of self–preparation and self–control in the educational process.

However, in modern conditions of reducing classroom hours and increasing the volume of independent work of a student, in our opinion, it is the activation of educational and cognitive activity of students that plays a decisive role in ensuring the quality of the educational process.

In this regard, there is a problem of developing a methodology for teaching a general course of physics for higher educational institutions, in which fundamental physical concepts, in particular symmetry, would occupy an important place in the educational process in physics in various physical theories.

The fundamental concept (from Lat. fundamentum is a category of science that has been proven experimentally and theoretically, and on the basis of which new directions in science are developing, in particular in physics.

**Discussion.** The concepts of symmetry were considered in the works of B.S. Gott, ideological issues in the context of the theory of symmetry were considered by B.S. Bloom [1]. The problem of symmetry in physics is devoted to the work of J.

Elliott, J.Piaget [2]. J. Douglas C. Giancoli[3] considered the spatial symmetry and optical properties of solids. G.L. Beer and G.E. Pikus highlighted in the monograph [4] symmetry in deformation effects in semiconductors. K. Sh. Tursunov [5,6] noted in his works the most important problems of a philosophical and natural scientific nature related to symmetry and group theory. M.I. Sadovyi [7] considered the symmetries of elementary particles.

The purpose of the article is to reveal the features of the study of electrodynamics using the fundamental concept of symmetry in the study of the general course of physics by students of non–physical specialties for the activation of educational and cognitive activity.

The section "Fundamentals of Electrodynamics" studies the most common type of interaction between bodies and particles. An important result of this study is the establishment of the existence of two interrelated and mutually reversible types of matter – matter and field. But physical fields, including electric and magnetic fields, are special fields. This is a new kind of matter that students met with while studying physics in the 8th grade of high school.

The main task of the section is to formulate clear ideas about the electric and magnetic fields as a form of matter, and their relationship. The study of the electromagnetic field begins with its simplest form – the electrostatic field. The source of this field is charged bodies. The main characteristics of which are tension, potential, energy density, are determined by the distribution of charged bodies, as well as the medium in which the field is created. To establish such a connection between the distribution of charges and the nature of the fields, we will use the position of the doctrine of symmetry.

To establish the symmetry of the field of fixed charges, use a graphical description of the field (lines of tension, equipotential surfaces). They explain to students beforehand that the picture of the field, its symmetry is determined by such factors: 1) the values and mutual placement of charges; 2) the properties of the medium in which the field is created.

Then we formulate the principle of symmetry for an electrostatic field: the totality of the elements of symmetry of an electrostatic field necessarily includes those common elements of symmetry that the charge system and the medium have separately. This symmetry of the field is minimal.

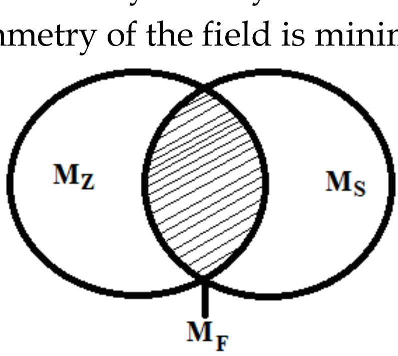

Fig. 1. Euler diagram.

Using the concepts of the theory of multiple numbers, we show the transition from the symmetry of causes to the symmetry of consequences. When the plural of the symmetry elements of the charge system is Mz, and the plural of the symmetry elements of the medium is Ms, then the plural of the symmetry elements of the electrostatic field of this charge system is a cut of these two sets, that is, $M_F = M_S \cap M_Z$. Geometrically, this fact can be represented by an Euler diagram (Fig. 1).

Now we consider the fields of simple systems of electric charges.

***Point charge.*** This charge has the following symmetry elements: the center of symmetry, a set of axes and planes of symmetry. The medium is homogeneous, and therefore in it all directions are symmetrical.

Such an environment has the same multiple symmetry elements. Therefore, the medium does not change the symmetry of the charge. Consequently, the field of a point charge has the following symmetry elements (Fig. 2, a): the center of symmetry (coincides with the charge), an infinite number of axes of infinite order (intersect in the center), a set of planes of symmetry (intersect in the center). Such a field is called centrally symmetric.

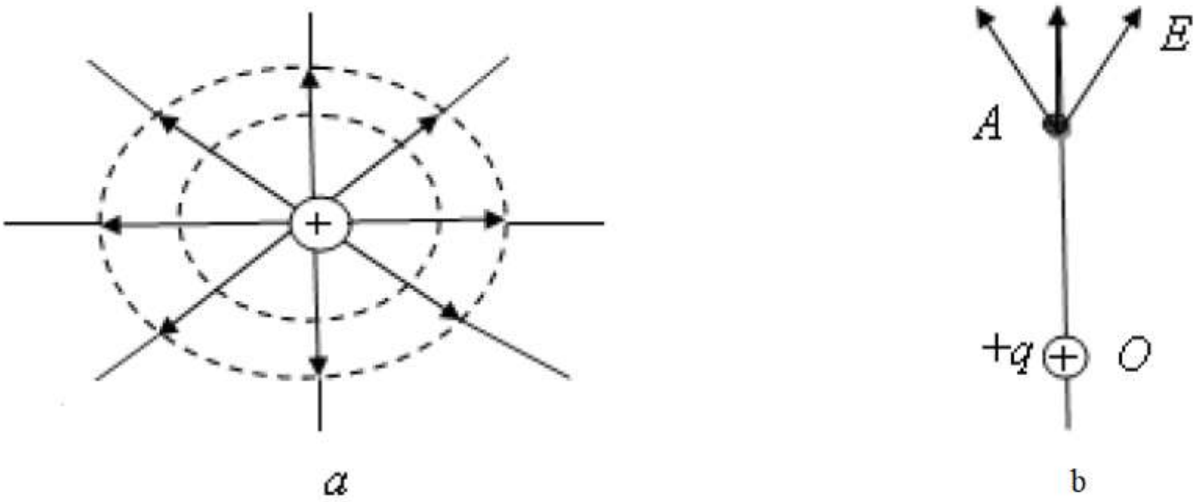


Fig.2. Elements of the symmetry of the electrostatic field.

Such an environment has the same multiple symmetry elements. Therefore, the medium does not change the symmetry of the charge. Consequently, the field of a point charge has the following symmetry elements (Fig. 2, a): the center of symmetry (coincides with the charge), an infinite number of axes of infinite order (intersect in the center), a set of planes of symmetry (intersect in the center). Such a field is called centrally symmetric.

Summing up the results: 1) the lines of tension begin or end at a point charge, because otherwise it will not be the center of symmetry; 2) the field strength at an arbitrary point is directed to or from the charge for the same reasons (Fig. 2, b); 3) the charge is the center of symmetry of the field. Therefore, at points that lie at the same distance from the charge, the magnitude of the tension and potential are the same, because these points are physically symmetrical.

***Two point charges.*** Students easily draw conclusions that when another point charge is introduced into the field of a given charge, the symmetry of this field is violated. Such a system has no center of symmetry at all. It has an axis of symmetry of infinite order, that is, a conical symmetry is observed. Next, the properties of the field of such a system are set.

***A homogeneous electric field*** is a field that is created between two infinite parallel metal plates that are charged with equal–sized charges of different names. Students independently establish that this system of charges has: 1)the axis of symmetry of infinite order, perpendicular to the plane of the surface of the plate; 2)the set of planes of symmetry that pass through this axis; 3) the plates are infinite, so there are many axes of symmetry and they are all parallel to each other. From here we get conclusions about the properties of a homogeneous electrostatic field, determine the direction of the field strength lines, their density, the magnitude of the field strength at each point.

**The field of a charged metal ball or a uniformly charged dielectric ball.** First, we determine the symmetry of the charges of this system. Then we determine the symmetry of the field, the picture of the field is determined by it, this field is compared with the field of a point charge, the magnitude and sign of which coincides with the magnitude and sign of the charge of the ball. Accordingly, in the area outside the ball, these fields completely coincide, since here the symmetry of the fields is the same. Hence, a formula is obtained for calculating the field strength of a metal charged ball or an arbitrary uniformly charged ball.

**A uniformly charged infinite thin plate.** The field of this system of charges is studied according to the same scheme as the previously considered fields. Students conduct this study independently, draw conclusions based on the previously mentioned about the properties of the field of such a plane.

All the features of the symmetry of the fields of different charge systems, which were discussed above, can be illustrated by the example of the spectra of electric fields.

For a deep study of electric and magnetic fields, we use the method of comparing their properties. By defining common features and highlighting different sides of these fields, students develop the ability to compare, which is an important operation of thinking.

Studying the topic "Magnetic field" we set a goal: to form students' clear ideas about the nature of the magnetic field, that the magnetic field it can be created by mobile electric charges, enter the characteristics of the magnetic field. Although the magnetic field can exist independently, it should still be noted that the electric current is the cause, and the magnetic field is the effect.

Then we formulate the principle of symmetry – this is a set of common symmetry elements of a system of conductors with a current. We begin to study the symmetry of the magnetic field with a homogeneous field (the field of a chain current in its center is considered). It is necessary to show the spectrum of this field and draw a picture of the lines of magnetic induction. Then we establish the basic elements of the symmetry of the field of this current, based on the principle of symmetry: 1)the axis of symmetry of infinite order, which coincides with the axis of the ring; 2) the plane of symmetry that passes through the chain current; 3) the center of symmetry is the center of the chain current.

It should be noted that there are no planes of symmetry that pass through the axis. This is due to the fact that the chain current does not have such planes of symmetry, because it flows in a certain direction.

Demonstrating the spectrum of the field of a solenoid with a current, we determine the symmetry of a homogeneous magnetic field (this field has the same symmetry as the field of a chain current). We draw the students' attention to the fact that the presence of a plane of symmetry perpendicular to the induction of the field is a feature of the magnetic field.

We explain this feature of the magnetic field by the fact that it is created by chain currents that have such a plane of symmetry. Magnetic field induction is an axial vector, the direction of which is determined by agreement.

After the Ampere hypothesis about chain molecular currents is considered, we compare once again the properties of electric and magnetic fields, as well as their differences. These force fields transmit the force interaction between electric charges. Their power characteristics are the inductance vectors of the magnetic field and electric tension.

Lines of electric field intensity begin and end at charges, sometimes go to infinity. Magnetic field induction lines are closed. This is because the first field is static and the second is dynamic.

The fields differ in symmetries. To show this difference, we consider the fields of a cylindrical magnet and a cylindrical polarizable dielectric. It should be shown that a cylindrical magnet, together with the field that surrounds it, has the symmetry of a revolving cylinder. A cylindrical polarized dielectric, together with the field that surrounds it, has the symmetry of a stationary cone.

Students are convinced that the magnetic field does not have longitudinal planes of symmetry, but has a transverse plane of symmetry.

The electrostatic field does not have a transverse plane, but has many longitudinal planes of symmetry.

Special attention should be paid to the fact that the closed currents at both poles of the magnet flow in the same direction, only they are observed from different sides. After that, we bring the students to the conclusion that the rotation of electric charges is both right and left at the same time, that is, the right rotation is the same as the left, and vice versa.

Students are convinced that the north pole of a magnet cannot be distinguished from the south and vice versa, that these poles cannot be separated from one another, and therefore there are no magnetic poles, magnetic masses. The magnetic field is created only by mobile electric charges and an alternating electric field.

In the process of repeating the training material, we consider the connection and similarity of magnetic and electric fields. We remind students that Faraday's law of induction shows the relationship between an alternating electric field and an alternating magnetic field, with the former being the effect and the latter the cause.

This relationship is one–way. To eliminate this asymmetry between the fields, Maxwell formulated the law of magnetoelectric induction: every electric field variable in time creates a magnetic field in the surrounding space.

We compare both induction laws, indicating the presence of symmetry of the connection between the fields. We pay attention to the types of symmetry of this connection: each of the two laws of induction is a mirror preservation of the other with simultaneous replacement of the electric field by the magnetic field and vice versa. For example, when mirrored, the "left screw" of Faraday's law turns into the "right screw" of Maxwell's law. This symmetry also indicates that in reality there is a single electromagnetic field.

Next, we study the principle of turnover. To do this, we show that the movement of a charge in an electric field is a reverse motion, because the force that acts on the charge in this field does not change when the time sign is replaced. By studying the motion of charges in a magnetic field, we show that the equation of motion does not change. It is only necessary to emphasize that when performing this transformation, the direction of the particle velocity changes, as well as the direction of magnetic field induction. We conclude that with the help of electric and magnetic fields it is impossible to determine the sign of time, that is, T–symmetry is considered.

**Conclusion.** Thus, we see ways to improve the quality of knowledge in physics in the development and implementation of pedagogical technologies and the activation of educational and cognitive activity, which should be reflected in curricula, programs and textbooks. The educational and pedagogical process should contain, first of all, the problematic structure of educational information in physics. The expediency of subordinating the content of the educational material in the general course of physics is based on fundamental concepts, one of which is symmetry. Accordingly, familiarization and study of this concept by students will contribute to the formation of modern scientific thinking, and will also ensure the systematization of knowledge from the general course of physics at the university and the formation of a scientific worldview.

The prospects for further research in the direction of research consist in a detailed analysis of the concept of symmetry in the process of studying the general course of physics by students in higher educational institutions and the development of a methodology for teaching the general course of physics using this concept.

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