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Issue Article

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IDEOLOGICAL ASPECTS OF THE PRINCIPLES OF SYMMETRY AND DISSYMETRY IN MOLECULAR PHYSICS

Abstract*: The article considers the principles of symmetry and dissymmetry in molecular physics on the basis of ideas about the universal nature, recommends three main components in the formation of a scientific worldview in the process of teaching physics, comparative examples of the aggregate state of substances having different natures, preservation of their structure and behavior, as well as criteria for the emergence of qualitatively new formations, conditions for the emergence of self-organization and the development of systems under the influence of symmetry and dissymmetry. It is conditioned that any geometric symmetry is associated with the movement and interaction of material objects, and any dynamic symmetry is associated with the properties of space and time.*

Key words*: scientific worldview, molecular system, symmetry, dissymetry, conservation, invariance, aggregate states of matter, entropy.*

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Introduction

In the conditions of economic and social transformations in our country, the value aspects of modern physics (the use of solar, wind, nuclear energy, the fight against atmospheric pollution and the solution of other environmental problems, etc.) are of particular importance, the role and responsibility of representatives of physical science to society are immeasurably increasing. Physics plays a special role in the formation of students' scientific worldview, as it reveals the most general laws of nature and its content considers general philosophical categories (matter and motion, space and time, cause and effect, etc.) For this reason, it must be understood that the scientific worldview of teachers can only act as a result of the entire educational process in educational institutions.

Worldviews are a system of generalized views, ideas about the world and its laws, about the phenomena of nature and society surrounding a person. According to its content and orientation, a holistic worldview can be philosophical, scientific, mythological, religious. It should be said that when analyzing any type of worldview, the characteristic of its relationship with scientific knowledge is of great importance, since this determines the degree of scientific validity of each of the possible varieties of worldview [1].

The foundation of the worldview is a system of generalized knowledge, which is an important component of the personality structure and is formed under the influence of a large number of factors practically throughout a person's life. The analysis of educational and methodological approaches (V.G. Ivanov, G.M. Golin, V.F. Efimenko, J. Tulenov, V.N. Moshansky, V.V. Multanovsky, etc.) to the formation of a worldview in the process of teaching physics allowed us to identify three of its main components:

- formation of a system of knowledge about the basic concepts, laws and principles of physics that contribute to the creation of an idea of the scientific picture of the world and the process of scientific cognition;
- formation of views and beliefs corresponding to the dialectical understanding of nature and the process of its cognition;
- development of a dialectical style of thinking.

One of the activities of a physics teacher is to communicate knowledge about the basic concepts, laws and principles of physics. The concepts of symmetry and their principles make a significant contribution to the formation of a scientific worldview. However, the most general principles are those of symmetry or invariance, which permeate all modern physical theories.

In teaching physics, it is important to take into account and stimulate the desire of students in the process of cognition to restore symmetry. Because the idea of symmetry in the development of physics determined the path to the ideal of a unified picture of the world, since the original meanings of the concept of symmetry correspond to the laws of the physical world, which are characterized by: order, harmony, rhythm, similarity, similarity, proportionality, coordination of parts in a holistic structure. There is every reason to consider the concept of symmetry expressing the relationship of the integral structure of cognizable matter and is accepted as a discussion of the main issue of philosophy in the school physics course. On the symmetry function of J. Newman writes: “Symmetry establishes a funny and surprising affinity between objects, phenomena and creations seemingly unrelated: terrestrial magnetism, female veil, polarized light, natural selection, group theory, invariants and transformations, working habits of bees in the hive, the structure of space, vase drawings, quantum mechanics, petals colors, interference pattern of X-rays, cell division, equilibrium crystal configurations, snowflakes, music, relativity theory...”[2, p.261].

In modern science and philosophy, symmetry means cooperative community, compromise, alternative, invariance, fractality, and asymmetry is considered as the opposite of the above. In modern science, the analysis of the processes of transition from symmetry to asymmetry and vice versa leads to the emergence of the concept of dissymmetry and this concept makes it possible to objectively know the laws of the processes of formation of the opposite sides of being [3, p.31].

We emphasize that invariance does not exist by itself, not in general, but only with respect to certain transformations. On the other hand, a change (transformation) is of interest insofar as something is preserved at the same time. In other words, without changes (movement), it makes no sense to consider preservation (rest), just as without preservation, interest in changes disappears. Symmetry expresses the preservation of something with some changes, or, in other words, the preservation of something despite changes. Thus, the concept of symmetry is based on the dialectic of conservation (rest) and change (movement).

In the middle of the XIX century, science turned to the principles of symmetry and conservation as the basic basis of the laws of physics. Thus, the law of conservation and transformation of energy reveals Yu. Mayer. The idea of symmetry in the concept of symmetry of electric and magnetic fields was applied by P. Curie outside the framework of crystal physics. The works of A. Einstein, V. de Sitter, A.A. Friedman have become classic in the development of physical cognition. The principle of symmetry has now become the conceptual means through which the unity of the laws of quantum behavior of matter is ensured and the construction of a fundamental quantum theory that reveals the deep semantic unity of all nature.

In physics, it is generally accepted to distinguish two forms of symmetry: geometric and dynamic.

Symmetries expressing the property of space and time are referred to the geometric form of symmetry. Examples of geometric symmetries are: uniformity of space and time, isotropy of space, spatial parity, equivalence of inertial reference frames.

Symmetries that are not directly related to the properties of space and time expressing the properties of certain physical interactions are referred to the dynamic form of symmetry. An example of dynamic symmetry is the symmetry of electric charge.

Generally speaking, dynamic symmetries include symmetries of internal properties of objects and processes. So geometric and dynamic symmetries can be considered as external and internal symmetries. Thus, any geometric symmetry is associated with the movement and interaction of material objects, and any dynamic symmetry is associated with the properties of space and time.

Here are a number of examples of geometric symmetry. Suppose that all the electrons of one atom have swapped with the electrons of another atom. Since the electrons are identical (any randomly selected electron is no different from myriads of other electrons), no changes in the atoms will occur from the exchange of electrons. This is symmetry.

Let's take the aggregate states of matter known to everyone from school - solid, liquid, gaseous. For certainty, as a solid, consider an ideal infinite crystal. There is a certain so-called discrete symmetry with respect to the transfer. This means that if you move the crystal lattice by a distance equal to the interval between two atoms, nothing will change in it - the crystal will coincide with itself. If the crystal is melted, then the symmetry of the resulting liquid will be different: it will increase. In the crystal, only points that were distant from each other at certain distances, the so-called nodes of the crystal lattice, in which the same atoms were located, were equivalent.

The liquid is homogeneous throughout the volume, all its points are indistinguishable from one another. This means that liquids can be displaced by any arbitrary distance (and not just by some discrete ones, as in a crystal) or rotated by any arbitrary angles (which cannot be done in crystals at all) and it will coincide with itself. The degree of its symmetry is higher.

The gas is even more symmetrical: the liquid occupies a certain volume in the vessel and there is an asymmetry inside the vessel, where the liquid is, and the points where it is not. The gas occupies the entire volume provided to it, and in this sense all its points are indistinguishable from one another. Nevertheless, it would be more correct to speak here not about points, but about small, but macroscopic elements, because there are differences at the microscopic level. At some points at a given time there are atoms or molecules, and at others there are not. Symmetry is observed only on average, either by some macroscopic volume parameters, or by time. But there is still no instantaneous symmetry at the microscopic level here. If the substance is compressed very strongly, to pressures that are unacceptable in everyday life, compressed so that the atoms were crushed, their shells penetrated into each other, and the nuclei began to touch, symmetry arises at the microscopic level. All nuclei are the same and pressed against each other, there are not only interatomic, but also internuclear distances and the substance becomes homogeneous.

But, there is also a submicroscopic level. Nuclei consist of protons and neutrons, which both move inside the nucleus. There is also some space between them. If you continue to compress so that the nuclei will also be crushed, the nucleons will press tightly against each other. Then, at the submicroscopic level, symmetry will appear, which does not exist even inside ordinary nuclei. It is in this state that the substance is inside the so-called neutron stars. From what has been said, we can see a very definite trend: the higher the temperature and the greater the pressure, the more symmetrical the substance becomes. This tendency turned out to be an extremely general law.

With complete and quite unambiguous certainty of the laws and uncertainty of the initial and boundary conditions, we get the whole diverse range of physical phenomena and processes. However, the most general principles are those of symmetry or invariance, which permeate all modern physical theories. Symmetry is a fundamental methodological principle of scientific and, especially, physical cognition, a conceptual form of the philosophical way of thinking. Therefore, the philosophical and methodological understanding of the formation and development of the principle of symmetry in the context of the development of science, philosophy and, in general, the entire spiritual culture, the identification of its role in the evolution of scientific ideas, the formation of scientific theories, the synthesis of scientific knowledge is of paramount importance [4].

Between symmetry and its negation – asymmetry, there is an important concept – dissymmetry. In addition to dialectics, dissymmetry correlates with synergetics. This relationship is expressed both in the involvement of dissymmetric development in the equilibrium and nonequilibrium states of the system (considered in synergetics), and in the explicit manifestation of dissymmetry found in the main provisions of the synergetic paradigm [5, p.182-187]. In connection with the worldview aspect, attention is drawn to the congruence of another worldview conclusion, characteristic of synergetic constructions and constructions based on dissymmetry. Both points of view recognize the material unity of the world at its various structural levels. And if in synergetics in this connection the emphasis is placed on the idea of the Universe as an “integral system” (N.N. Moisov), then the view of this problem from the standpoint of dissymmetry was expressed by Louis Pasteur, and for the first time introducing the concept of "dissymmetry" into scientific circulation, who considered the world as a "dissymmetric ensemble", explaining this by the fact that "... the properties of certain figures are not combined by simple superimposition with their mirror image" [6, p. 383]. Continuing the theory of L. Pasteur, P. Curie, in the logic of his scientific research on the influence of the environment on the bodies in it, determined that, "... they retain mainly those elements of their own symmetry that coincide with the symmetry of the environment." According to the principle of dialectical unity of symmetry and dissymetry, every living object has one or another form of this unity [7, p. 74].

V. I. Vernadsky also noted that “there is a dissymmetry in the world, manifested in the existence of entropy in it” [8, p. 350]. From the standpoint of the dissymmetric concept of transformation, entropy is a measure of the degree of dissymmetrization of a system, [9, p. 114] i.e., the growth of entropy in a system depends on the degree of its dissymmetrization.

There are at least four forms of entropy in the literature today:

First, entropy as a measure of the uncertainty of the state of any completely ordered physical system, or the behavior of any system, including living and inanimate objects and their functions. Physical entropy is a measure of the energy ordering of an object and is a function of the number of their possible states. Any increase in the ordering of objects leads to a decrease in their total entropy, and vice versa.

Secondly, the thermodynamic entropy of microparticles, or a molecular (microscopic) set. Thermodynamic entropy is a measure of the disorder (or disorder) of microparticles, then entropy in a broad sense is a measure of the disorder (or disorder) of an object by any signs. The value of entropy measures the degree of homogeneity of the structure of an object, has the dimension of the unit entropy –Joule per Kelvin (SI system).

Thirdly, information entropy, or uncertainty of information, i.e. information about some information system, has the dimension of a unit of time (seconds).

Fourth, entropy, or uncertainty of behavior, of any system that is not completely ordered, up to macroscopic sets. For example, biological, political, ecological, social, historical, etc.

The physical and thermodynamic entropy and the information entropy of the system are fundamentally different. If the physical and thermodynamic entropy for closed systems does not decrease with time, but increases in accordance with the second principle of thermodynamics, then the information entropy may decrease with time for any systems instead of increasing [10, p.18].

The history of science shows that symmetry and dissymmetry can explain many phenomena and predict the existence of new properties of Nature. At the same time, one should take into account the fact that "there is a fundamental, deep difference between the symmetry of crystal polyhedra and the symmetry of living organisms. In the first case, we are dealing with the expression of the atomic structure of a solid substance, in the second – with the desire for the organization of living matter that exists separately and separately in the stagnant environment of the biosphere alien to it" [11, p.58].

The principles of symmetry allow us to discover new laws and in this sense are correlations between laws. "If laws govern phenomena, then the principle of symmetry governs laws" [12, p.39]

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