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Historical-methodological foundation, mental-model representation, physical theory and ideal experiment

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Abstract: In the history of the formation and development of scientific thought in the study of natural phenomena and objects, theoretical and experimental approaches remain the main research methods. In this case, the process of knowledge (scientific) priority belongs to the experimental method. As you know, a real experiment “is a matter of decrees before nature” and nature itself answers it.

Generalization of experimental data is empirical knowledge - the foundation of natural sciences [2].

Keywords: Experimental data, empirical knowledge, natural sciences.

Introduction: The essence of the theoretical method is that on the basis of scientific and logical, generalized, mastered knowledge is a condition for the formation of elements of new knowledge about physical phenomena and objects of the surrounding reality.

It should be noted that with a theoretical approach to the study of natural phenomena, the researcher finds answers to the questions posed on the basis of formed knowledge. In the theoretical method of research, the main tool for the scientific and logical construction of physical phenomena is various forms of theoretical thinking?

As you know, one of the forms of theoretical thinking is a thought experiment. To reveal the essence of a thought experiment, an example proposed by Maxwell, known in physics as “Maxwell's demon”, is given. This thought experiment was put forward by Maxwell as a possible objection to the second law of

thermodynamics, according to which heat itself cannot pass from bodies a with a lower temperature to a body with a higher temperature. " Maxwell's Demon " could sort gas molecules according to speeds without energy supply. The experiment showed that the entropy of the system decreases, which contradicts the second law of thermodynamics. A discussion of this thought experiment showed that the existence of a "Maxwell demon" that does not consume energy contradicts the laws of thermodynamics. The most convincing proof of the impracticability of Maxwell's demon has been provided by quantum mechanics. The demon must measure both the speed and position of the molecule in space with high accuracy, which contradicts the Heisenberg uncertainty principle [6].

A thought experiment is a special theoretical procedure that consists in obtaining new or testing existing knowledge by constructing idealized objects and manipulating them in artificially (conditionally) specified situations [7].

As the author of [6] notes and we fully support that the purpose of setting up such thought experiments may be to prove the fallacy of the hypotheses put forward. For example, Galileo was mistaken, believing that by inertia a body can not only move uniformly and rectilinearly, but also move uniformly in a circle (the latter is incorrect!), His idea allowed Newton to correctly formulate the law (principle) of inertia, which he calls Newton's first laws [4]. Therefore, if the results of a thought experiment contradict common sense or known scientific principles, then the hypothesis was recognized as erroneous. Unlike a physical experiment, in a thought experiment, the interpretation of its results is very important.

Subsequent studies of this issue by a number of scientists (Silard, Lewis, Slater, Brillouin, Wiener) showed that in the "Maxwell demon" reasoning was based on the use of incorrect premises ...., it was only a theoretical reasoning, it was carried out in the form of an analysis of a certain situation, which basically impossible to do. This form of theoretical thinking was called a "thought experiment" [2].

As you know, Maxwell is not the first who turned to a thought experiment to describe idealized physical phenomena, objects. Thus, Galileo first used the idea of a thought experiment. with the help of which he proved that the time of free fall of bodies from a given height with different masses is the same. Indeed, in any real experiment on earth, we cannot free the body from the action of gravity and friction. However, we can put the question this way: what will happen if we gradually reduce these forces, at least mentally ..... This is the idea of a mental experiment in which the body is free from any external influences led Galileo to the idea of inertial motion of the body [4]. As Einstein himself said: "... the phenomena that we want to observe cause some changes in our measuring device, as a result of which some processes begin to occur in it ..... affecting our sensations and leading to fixing the results in our minds. If we want to claim that we have observed something, we need to know how nature functions all the way from the observed phenomenon to fixing its results in our minds. We must at least have a practical knowledge of the laws of nature" [5]. This understanding of Einstein contains the meaning of understanding the function of a thought experiment.

Physical science, as the oldest in the study of (nature) of the surrounding reality, was one of the first to turn from descriptive to exact. The world around us is infinite and limitless in its manifestations. In this regard, each stage of the study and forecasting of natural phenomena is a process of approaching the truth of the origin and development of the world around us (nature).

It should be noted that, based on the foregoing, it is not necessary to take into account all factors of natural phenomena, without exception, when solving various physical problems. In this regard, the model representation of physical phenomena and objects in an ideal experiment is most often used.

In our understanding, an ideal experiment is a process of mental and model representation of objects and phenomena of reality, which form the basis of a thought experiment with certain limits of their application in scientific research.

For example, the author of [2] notes that in a thought experiment, the objects of study are replaced by certain idealized ideas about the original. At the same time, a mental experiment is presented as an ideal form of a real experiment.

It must be emphasized that thought experiments are "carried out" not only with idealized representations, but also with idealized models of the original.

From all the variety, causes and consequences of the analyzed physical phenomena and objects, the mental-model representation highlights the main (essential) properties and connections that most clearly approximate the structure and content of the model to the original.

Thus, the purpose of the mental-model representation, i.e. creating a model - the original, is to identify cause-and-effect relationships between specific variables of certain natural or social processes, in particular physical phenomena or objects. The implementation of such a task is facilitated by the smaller the number of variables.

Depending on the content and object of the task-

execution, the models are conditionally divided into fundamental and private. Many examples of such models can be cited in the development of physics. Thus, the fundamental scientific model is

Newtonian mechanics, which uses the concepts of a material point. The fundamental model is Maxwell's electrodynamics, it served basis (condition) for the emergence of new fundamental models (generalization of Newtonian mechanics and electrodynamics). Another fundamental model is Einstein's special and general theory of relativity. This list goes on.

A private model is the concept of an ideal incompressible fluid (it does not depend on pressure and internal friction). In the nature of such media there are no effects, within the framework of these representations qualitatively different from real phenomena. So, with a disappearing low viscosity, the resistance of a real medium to the movement of bodies with a bad streamlined shape is all the same great. Despite this, the use of the model of an ideal incompressible fluid in scientific research gives valuable results and is effectively used [1].

The concept of an ideal gas is a particular model where the volume of a molecule and their interactions are neglected.

Thus, from the foregoing, it can be seen that before talking about a thought experiment in the study of natural phenomena, in particular physical ones, it is necessary to reveal the mental-model representation, with the gradual formation of (mental) mental actions to reveal the basic properties, essential links between the model and the original and their relationship with the performer (trainee, teacher, students, etc.).

It should be emphasized that the development of modern physics has led to the impossibility of understanding and perception by the human senses (registered only by instruments) of phenomena based on the existing systems of visual-figurative representations, analogies and mechanical models that make up the classical picture of the world according to Newtonian mechanics. In physics, a crisis of “visibility” arose with the advent of quantum mechanics. However, further development of science itself showed that the use of mental-model representations made it possible to penetrate into the microcosm of elementary particles and the macrocosm of cosmic processes. On this basis, it is necessary to pay attention to the mental-model representation, which unites and synthesizes the conceptual-sign and object-sensory reflections of objective reality, becomes essential in the cardinal, key and critical stages of the development of physics (Newton's dynamics - mechanics and the creation of Einstein's theory of relativity and quantum mechanics).

It should be noted that the opposition mental-model representation of the experiment to sensory-conceptual forms of cognition are incompatible, since both forms of cognition are united by their common, objective content. In this sense, the imagery mental-model representation is a necessary, main component of the process of scientific knowledge, complementing the world of abstract-logical constructions, in the form of a model - the original.

As A. Einstein wrote, “In my life, the view of the world through the eyes of an artist played a big role. After all, the work of scientific research develops on the basis of the imagination. Just as an artist creates his images partly intuitively, so a scientist must have a great deal of intuition” [8].

As the author notes [2], the main means of uniting conceptual-sign and subject-sensory forms of reflection of real phenomena and objects is a mental experiment. However, in our understanding, this process is theoretically based on a mental-model representation and the gradual formation of mental (mental) actions of realization in an ideal, abstract experiment.

As you know, a thought experiment in scientific knowledge is not directly related to the possibility of its implementation in a material-objective form.

However, on this basis, one should not completely separate the thought experiment from those stages of research activities that are directly related to the development and planning of laboratory experiments. This activity, to a large extent, is also associated with a thought experiment, representing a "playing in the mind" of some idealized situations [2].

In line with the foregoing, mental-model representation as the main component of a thought experiment is an effective means of implementing the prognostic function of scientific research on phenomena and objects of reality.

Thus, the mental-model representation as a component of a thought experiment complements the process of constructing an abstract reflection of the main properties of the connections of their relations between the model, the original and the performer (researcher, teacher, student, etc.).

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