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THE ROLE OF CONCEPTUAL SITUATIONS AND THE PRINCIPLE OF GAUGE INVARIANCE IN THE DEVELOPMENT OF SCIENCE

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ABSTRACT

In this article is considered role of model "conceptual situations" and principle colebric invariance in developing of a science, as they opened the mechanism and reason of dialectic transitions of scientific progress. There is the wide argument in the decision of the equations theory which relativity and theoretical of quantum mechanics.

В статье предлагается модель «понятийных отношений» как механизма и причины возникновения научно-технических проблем в развитии науки. Были сделаны научные выводы, доказывающие, что уравнения теории относительности откалиброваны инвариантными тамогаипипшг и сильно приближаются к натриевому решению задач квантовой механики.

INTRODUCTION

Quantum mechanical relativity acts as a relativity to the type of transition or to the type of interaction, since each transition is carried out in one interaction or another.

Such an understanding of quantum mechanical relativity, in our opinion, is very promising. At the same time, I would like to note that, claiming to generalize the content of the historically preceding principles of relativity to the means of observation, to the macroenvironment, the classical level, the observer, etc., the new understanding of the principle of relativity being developed at the present time should not simply discard. It should, in our opinion, in a certain way include them in its content as special cases, determined by the presence of one or another specific conceptual situation.

And this conceptual situation can be different depending on whether we are talking, for example, about the problems of quantum cosmology or quantum radiophysics, or, say, about the quantum theory of dissipative structures. A logically and philosophically consistent system of ideas about the content of the physical picture of the quantum world can be obtained only if it is clearly recognized that quantum objects are real, regardless of their observation, two modes of existence and two modes of change (methods of interaction) are inherent. In the first mode of existence, external physical influences or internal processes change only the potentialities that are objectively inherent in a quantum object. At the same time, the quantum object itself actually exists, as it were, in the form of a carrier of potentialities. Such a mode of existence and a mode of change (interaction) is not directly observable, is not recorded by instruments, but is cognizable. It is he who is reflected in the formal apparatus of quantum mechanics in the form of a wave function that changes according to the Schrödinger equation.

As for the second mode of existence (and change) of quantum transitions (in the form of quantum events), it cannot be described by the Schrödinger equation. At the same time, based on its solutions, it is possible to determine the probability of discrete transitions-events, which are actually recorded by the measuring equipment.

We have no serious grounds for considering the entire problem of quantum mechanical relativity only from the point of view of the two named types of interactions, because they do not exhaust the possible variety of conceptual situations. In any case, the possibility of new types of physical relativity should not be ruled out in advance. It is this point of view that A.M. Mostepanenko and V.M. Mostepanenko adhere to, noting in their philosophical and methodological works that the development of the idea of relativity, the expansion and deepening of our ideas about reality are, in fact, two dialectically interconnected sides of one process.

They consider the whole question of the possibility of new types of physical relativity and their classification within the framework of the general methodological problem of reality and existence in physical cognition. In this context, the central question is the question of the criteria for the existence of both new and already tested in physical cognition. Among these criteria, we should first of all mention the principles of observability and invariance.

As for the principle of invariance, it is often associated with the fact that real objects must be invariants with respect to a certain class of practical transformations (transformations of observation conditions, empirical situations, frames of reference, etc.), and the constructs that display them must be invariants of the corresponding classes of mathematical transformations.

These criteria (principles) of existence are necessary but not sufficient. We can speak of two types of relativity: relativity to the frame of reference and relativity to the means of observation.

Here, it is more significant for us that in modern physics, in connection with the joint consideration of GR (general relativity) and relativistic quantum field theory, new conceptual situations arise that are not related to traditional ideas about relativity within the framework of GR (special relativity), GR and quantum mechanics separately.

We are talking about the emergence of a conceptual situation in the context of which it becomes possible to speak of a new type of relativity. A similar situation arises, for example, when we encounter the phenomenon of the birth of particles from vacuum in a strong gravitational field. We are talking about the fact that previously considered absolute concepts, such as the concept of “particles” and “number of particles”, turn out to be non-invariant, depending on the frame of reference.

Thus, the idea of a physical particle as an element of physical reality turns out to be relative to a specific conceptual situation as a specific unity of ontological and epistemological ideas that exists at a particular historical stage in the development of scientific knowledge.

Speaking about the conceptual situation that is emerging in a particular area of scientific and, 'first of all, physical knowledge, we mean that with the help of this concept, it is possible to identify, first of all, the dynamic aspect of its development, formation,' i.e. fix with its help the characteristic moments of dialectical transitions in the dynamics of scientific development.

Currently, the problem of scientific revolutions and changes is relevant. It involves the consideration of scientific knowledge in dynamics, in the process, taking into account all significant - external and internal factors that in one way or another determine its development. This also means that from considering knowledge primarily from the point of view of its finished results (a complete theory, a set of established methodological principles, each of which can be considered separately, etc.), it is necessary to move on to considering knowledge in unity with the methods and means of its receipt. Note that it is this approach to the consideration of scientific knowledge that is most consistent with the new way of thinking, which is assumed by the general methodological content of the principle of relativity, in its most developed form, represented by the principle of quantum mechanical relativity to the means of observation.

The problem of scientific changes and scientific revolutions includes an extensive list of very diverse issues. A lot of works are devoted to this problem both in our country and abroad. Without pretending to be complete, in this connection we will name such well-known Western historians and methodologists of science as B. Cohen, T. Kuhn, K. Popper, I. Lakatos, P. Feyerabend, W. Stegmaller, D. Shaigshr and a number of others authors who have made a great contribution to the development of these problems. It was also successfully developed in the works of Russian scientists: B.M. Kedrov, M.E. Omelyanovsky, V.S. Stepin, M.D. Akhundov, L.B. Bazhenov, E.A. , V.V. Kazyutinsky, P.S. Dyshlevy and others.

In this work, general methodological issues of changes in the system of scientific knowledge are not the subject of direct consideration. But this, of course, does not mean that in this case all questions arising in connection with the fundamental problem of the dialectical transition in the development of science are left aside. On the contrary, the problem of dialectical transition as a qualitative transformation in the system of scientific knowledge is directly related to our topic, as long as we are talking about the formation and development of the content of such a fundamental principle of knowledge, which, obviously, is the principle of relativity.

The realization and creation of the principle of relativity, as well as the problems of interpreting quantum mechanics, predetermined the revolutionary transition from the classical way of thinking, characteristic of the natural sciences of past centuries, to the modern, non-classical, quantum-relativistic worldview.

In general terms, our point of view on the problem of qualitative transformations in the development of science coincides with the general approach outlined in the work of V.G. Chernik in his book “The Dialectical Transition in the Development of Science”, which emphasizes the need for its differentiated, consideration in a broad sociocultural context. From our point of view, in order to characterize qualitative transformations in the system of methodological principles of physical cognition, it would be better to speak not about a “dialectical transition”, retaining this term for a general description of qualitative changes in science, but to speak about a change in the “conceptual situation”, meaning specific changes in methodological principles and related changes in the totality of ontological and epistemological prerequisites for the cognitive activity of scientists.

Therefore, further, when we touch upon the issues of the development of modern physics, we mean some of its “aspects” in the context of a certain conceptual situation, characterized primarily by the specifics of the evolution of the principle of relativity as a methodological principle. At the same time, we emphasize once again what was already said above: an isolated consideration of one single principle, abstracted from its connection with another methodological principle, such as, for example, the principle of observability, the principle of invariance or the principle of correspondence, is in fact a kind of idealization, which , like any idealization, implies a certain simplification of the real state of things, and therefore has its own limits. Unfortunately, this circumstance is rarely given proper attention in our methodological literature, and even more rarely the necessary conclusions are drawn from it.

So, for example, in the conclusion of the book "Methodological principles of physics", the following is said on this subject: "The methodological nature of the principles ... first of all consists in the fact that each of them represents a specific requirement for a physical theory (and sometimes even for physics in as a whole) to which it must satisfy. By setting a certain characteristic of the ideal of physical knowledge, each of the methodological principles of physics in its own way determines the research process, directing it towards a clearly defined goal, i.e. methodologically regulating it"[1;506].

We do not set ourselves the task of considering the principle of gauge invariance. However, it should be mentioned. Without taking into account the internal interconnection of these principles, it is impossible to fully understand many features of the development of physical cognition in our day. And the most important among these features is the strengthening of integrative tendencies, in the ever-increasing interaction of such sections of physical knowledge as cosmology, elementary particle physics, solid state physics, etc.

Today, physics is on the verge of acquiring a qualitatively new unity, the contours of which are beginning to emerge more and more clearly. We will talk about this in more detail below, but for now we will continue our remarks on the principle of gauge invariance and its connection with the principle of relativity.

Historically, the idea of gauge invariance is a rather old idea, the emergence of which is directly related to the emergence of Faraday-Maxwell's theory of electromagnetism. The mention of Faraday in this context is not accidental: for it is from Faraday, from his ideas, that modern field theory originates. "Faraday saw lines of force penetrating all space, where mathematicians saw centers of forces attracting at a distance; Faraday saw the medium where they saw nothing but distance. Faraday assumed the source and cause of the phenomenon in real actions occurring in the environment, they were satisfied that they found them in the force of action at a distance attributed to electric fluids" [2;382].

At the same time, Faraday was guided by a deep conviction of a metaphysical nature, which was formed largely under the influence of Schelling's natural-philosophical ideas about the unity of all the forces of nature, a conviction that was the initial principle of his scientific worldview. We note in parentheses that later, already in the postwar years, dealing with these issues, according to the testimony of a prominent Japanese physicist R. Uchiyama, meant doing something reprehensible for a serious scientist [3; 200-208]. The exception was A. Einstein and W. Heisenberg, but in this case it could be considered as a whim of the great scientist.

However, not only the successes of SRT and GR weakened interest in the search for unified theories, but also the failures of the attempts made in the 1920s to unify gravity and electromagnetism, among which the most famous and far-reaching was the attempt of G.

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Weyl, which was based on the principle of gauge invariance. Initially, Weyl was looking for geometric principles that could be used to reformulate classical electrodynamics in order to make the latter more conceptually compatible with SRT and, especially, with GRT. “Weil's theory,” writes V.P. Vizgni, “still amazes with the depth of its conception, mathematical simplicity and elegance of its implementation”[4;73].

But this characterization of Vizgin concerns the mathematical aspect of Weyl's theory. As for the physical side, here Weyl's theory encountered serious difficulties, which were immediately pointed out by Einstein, as well as by Pauli.

Then there was a long lull in the development of the concept of gauge invariance, until in 1954 the works of Yang and Mills, as well as Uchiyama, failed to spread the principles of gauge invariance in the field of quantum field theory and elementary particle physics, naturally generalizing them at the same time in an appropriate way. On this path, the technical details of which we will not touch upon here, referring for this purpose to the review by V.N. symmetries. Almost all modern theoretical physicists, and not only those who are directly involved in the construction of unified theories of fundamental interactions, but also those who are engaged in research in such traditionally considered applied areas as, for example, solid state physics, they all agree on opinion that the main successes of theoretical physics of the last 10-15 years are connected with the development of the ideas of gauge symmetry.

There is still a lot of methodological work to be done on a comprehensive understanding of these ideas, including from the point of view of further development and generalization of the content of the principle of relativity. It seems that the experience of past discussions on the foundations of quantum mechanics, in particular discussions around the quantum mechanical principle of relativity to means of observation in its various versions, including the version defended by B. Ya. Pakhomov, is called upon to play the experience of past discussions on the foundations of quantum mechanics. In order to make what has been said more convincing, let us conclude with one more excerpt from V.N. Pervushin’s review already cited by us: which makes objective assessments almost impossible. We will try to characterize modern research, revealing only the trends of their further development. The first of these tendencies is the tendency of a vacuum. Its essence can be briefly expressed as follows: an explanation of the observed world of phenomena directly unobservable physical objects or their properties... There are two types of vacuum in electrodynamics: a) virtual creation and annihilation of particles, and b) a gas of photons whose energy is less than the energy resolution of the device. These photons really exist, but are practically not observable at a given resolution of instruments, and therefore they can be called a vacuum.

We cannot build a device that measures energy as accurately as we like, and from this point of view, our world is energetically open from below ... We are beginning to understand more and more that in the relativistic field theory, the properties of a physical object as a whole determine the local structure to no lesser extent than local properties determine the behavior of the object as a whole. Such a trend could be called the trend of the Whole... We see how quantum concepts are gradually changing the very logic of physical research: the classical explanation using the logic of cause is supplemented in the spirit of Bohr by the logic of purpose (teleology). This trend could be called the tendency of Man.

So, we have before us three trends in the development of modern theoretical physics, presented in a brief metaphorical form by V.N. Pervushin: the trends of vacuum, the whole and man. Of course, it is not at all necessary to agree with him entirely with regard to which particular trends in the development of modern theoretical physics should be considered the most characteristic, and also what particular expression these trends receive, but anyway, the cited statement well captures the current state of knowledge in physical cognition. conceptual situation. It should be noted that the trends identified by Pervushin are not isolated from each other - there is a certain internal unity between them, which can be comprehended from different positions, for example, by appealing to such concepts as the style of thinking and its evolution, paradigm change, the beginning of a “new dialogue between man and nature ”, the revival of the ideas of cosmism and anthropocentrism, etc.
And this understanding of the prospects for the future development of science, based on the trends emerging in the present, is an extremely important and urgent task. However, in order for this forecasting task to have real chances for a successful solution, it is necessary to adequately fix the current state in which scientific knowledge is actually located today. But, as we have seen from our consideration of the principle of quantum mechanical relativity to the means of observation, the concept of "real" includes not only the actual, which has become real, but also the real potential.
Drawing an analogy here with quantum problems, we believe that the reality of the current state of cognition of our days is the reality of not only the actual, which has become knowledge, but also the reality of potential knowledge, which is becoming. It is for this purpose that we have proposed the term "conceptual situation", designed to represent (model) in a certain way the process of the formation of knowledge at critical points of its growth, in the unity of its ontological and epistemological characteristics. According to our model, at different stages of the development of science, there are conceptual situations that determine the course of the next progress of science. These conceptual conditions are purely specific depending on the level of development of science in the context of its history: features of the dynamics and trends in the development of science. And scientific revolutions or processes of dialectical transition in the development of science are the results of conceptual situations.

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