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# THE CONCEPT OF ELEMENTARITY IN THE MODERN SCIENCE

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## ABSTRACT

*A new, process-oriented picture of the world assumes the integrity and unity of all its parts. The refusal to describe all aspects of the behavior of natural systems by the parameters isolated from each other and characterizing the object only, and the transition to parameters that characterize processes and relations became a general methodological moment for the theory of relativity and quantum mechanics. Elementary material processes started being considered as the simplest elements of the physical world. The procedural approach to the study of phenomena reveals the concept of the integrity of material phenomena, allows us to comprehend the significance of the interconnection and development of processes at various levels, differing in the complexity of the organization and the qualitative diversity of the laws that operate within them. The procedural vision does not allow identification of the studied reality with any particular private connection or with the usual amount of all individual connections, in the abstraction from the process of their general interconnection and their interconversions. Thus, the world is viewed not as something completed in space and time, but as an unfolding process. At the same time, the procedural vision of reality makes it possible to better reveal the regular connection between the chain of conditions and the chain of events. It captures and establishes an integral character of development, represents a developing system as a specific set of events. This approach embodies simultaneously the idea of the matter, movement in space and time, and is associated with the recognition of the finite speed of any interaction.*

**Keywords**: *Classical and Modern Science, the Development of Elementary In Physics, Elementarity as a Thing, Event and Process.*

## INTRODUCTION

When considering the meaning of the idea of elementarity for modern science, we proceed from the fact that its constructive solution is ultimately connected with the analysis of the structure of the modern physical knowledge. Since physical theory is considered to be the most perfect and leading form of knowledge expression in physics, it is first of all necessary to consider how elementarity is interpreted within the framework of individual theories and what changes occur in this process during the development of new, more generalized theories in modern science.

In classical physics, the notion of elementarity was mainly associated with the image of the material object (particle, atom) as some initial simplest composite element of all physical bodies in the Universe. In modern physics (in the theory of relativity and in quantum theory) elementarity is primarily a kind of the simplest "indivisible" event (process) (Roberts et al., 2007). This transition from the "language of objects" to the "language of events" means the formation of the procedural aspect of the idea of elementarity and has the most important

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meaning for the understanding of the modern formulation of the elementality in science (see: B.Y. Pakhomov, 1985). This article makes an attempt to consider the methodological significance of the procedural aspect of elementarity in the history of the formation and development of the modern scientific knowledge.

In Newtonian mechanics, the concepts of elementarity were directly associated with the simplest material object and were expressed in an idealized way of a material point. These ideas were based on the atomism that originated in antiquity (Mechanics, 1994). The material point means an idealized object of infinitesimal dimensions, but possessing mass as a mandatory. Mass in general was considered as the main characteristic of this object, which determines its materiality. The position of the material point in space is described as the position of the geometrical point, which allowed materialistic development of the original section of classical mechanics - the dynamical point of the material point.

The dynamics of the material point was considered as the simplest direct mechanical movement in human practice. The higher sections of mechanics were developed on the basis of the dynamics of the point in the future – the mechanics of the systems of material points, the mechanics of an absolutely rigid body and the mechanics of continuous media. Both the structure of the ordinary mechanics in general, and the ways and methods of developing its higher sections clearly indicate that all concepts of elementarity were directly associated with the image of the material point (A. Craifaleanu, 2015). It is important for us to emphasize that the material point is fundamentally structureless. It is the rejection of any idea of the structure that made it possible to create the very image of a material point.

With the development of classical physics, the insufficiency of these concepts of elementarity became more and more clear. Classical physics began with the study of properties and laws of behavior of discrete material formations, and the discrete aspect of the structure of matter. As the research tasks became more complicated - the transition to the study of increasingly complex mechanical systems - a theoretical apparatus was developed, on the basis of which it became possible to map the continuous aspect of the structure of matter.

The idea of pure continuity in the fundamentals itself denies the mechanical notions of atoms as elementary objects of matter. At the same time, the most complete demonstration of the properties and laws of the wave aspect of the structure of matter began to be associated with the existence of a special kind of matter - at first hypothetical ether and then a field. In classical physics, the doctrine of continuity is represented, first of all, by Maxwell's theory. As A. Einstein notes, "a consistent field theory requires the continuity of all the elements of the theory, and not only in time, but also in space, and at all its points. Consequently, the material point as a fundamental concept has no place in the field theory "(A. Einstein, 1966, p. 722).

How is the question of elementarity solved in the framework of classical electrodynamics? Classical electrodynamics is a physical theory of the electromagnetic field, it expresses the laws of electromagnetic phenomena. In this theory, the state of the physical system is an electromagnetic field, is characterized by vectors of electric and magnetic strengths E and H. The simplest elementary representation in the system of electrodynamics is the state of the electromagnetic field at a point characterized by a given vector of electric and magnetic tension at some point in time. It is clear that elementarity cannot be expressed here on the basis of ideas about some simplest material object (Landau & Lifschitz, 1975). Accordingly, for the expression of elementarity, the concept of an event is increasingly used as an expression of

the instantaneous state of the field at a point. The change in the sign of the state of the field during the transition from point to point also began to be interpreted in the language of events.

Elementarity begins to act not in the form of the (simplest) object, but in the form of the simplest acts of manifestation of the properties of physical bodies. Thus, elementary processes of change became the simplest element of the emerging new picture of the world. In this connection, in the structure of physical knowledge for the characterization of elementarity, the concept of an event begins to become more and more definite.

By (elementary) event in the general case is understood the simplest act of interaction of physical objects (bodies, systems) or the simplest change in a physical process that can be registered. The concept of an event is directly characterized through categories of interaction and change, and this determines the breadth of its use. It characterizes some physical essence from its manifestations, from the side of phenomena. Any physical object is characterized by its properties, based on which, the image of the object is recreated. In other words, the essence is always manifested through a mass of phenomena and is determined by the establishment of laws in this number of phenomena. The simplest and further indissoluble phenomenon is an elementary event. The leading modern physical theories are presented in the language of events – the theory of relativity and quantum mechanics.

## METHODS

In this article we have set the goal to reveal the modern content of the concept of elementarity in accordance with the categorical structure of the interconnected notions: *concept-thing-event-phenomenon-state-relationship-process,* and also to explore the types and functions of the elementary components of the world of matter in the system of modern scientific theories. The study of the nature of matter within the framework of elementarity from the point of view of the procedural approach was previously carried out in the philosophical literature. However, the given approach is supplemented by an analysis of the latest achievements of natural and social sciences. The analysis of the category of elementarity proposed by us from the point of view of the triad of notions of thing-event-process makes it possible to more accurately elucidate the details of the problem and to reveal the points in which the analysis performed by other authors becomes insufficient. A new approach to the concept of elementarity which we have proposed, includes such a new element as development. This hypothesis also justifies itself from the point of view of modern synergetics and achievements in the field of natural sciences, such as physics, chemistry and biology.

The article widely uses the modern publications of researchers on the current philosophical problems of modern scientific knowledge, as well as the research in the field of basic sciences. This is a theoretical study, on the basis of which we will try to determine the methodological role of the concept of elementarity in scientific cognition, as a factor of its integration and unity. The study of the procedural aspect of the idea of elementarity will make it possible to reveal the dialectic of the elementary and complex in the scientific knowledge, and will allow us to make fuller use of the systemic approach in the formation of a modern scientific picture of the world.

## RESULTS

### *On the general theory of space and time*

The theory of relativity is a modern physical theory of space and time. Spatial and temporal relationships are determined by the nature of the material links between the objects and processes. At the same time, the general theory of space and time is abstracted from the specific properties of physical objects and systems, for only on this path can one discover the general laws and properties of space-time relations. Accordingly, the laws and properties of the general structure of material connections of objects and systems are expressed in the theory of relativity. "The simplest element of the world is what is called an event. The event is analogous to a point in geometry, and by imitating the definition of a point given by Euclid, one can say that an event is a phenomenon, part of which is nothing, it is an "atomic" phenomenon. Every phenomenon, every process is represented as some set of events. From this point of view, the entire world is regarded as a multitude of events "(A.D. Aleksandrov, 1969, p. 226).

The transition to the language of events (see: L.B. Bazhenov, V.I. Kremen- sky, 1984) is essentially connected with the fact that the theory of relativity uses Minkowski's concepts of the four-dimensional world-space (the world of events) to adequately formulate its content (P.L. Galison, 1979). Defining the event as an image of the material process and as an elementary image of a new picture of the world, it is important to note that it is the concept of the event that embodies both the idea of matter and motion, space and time, and reveals the dynamics of material education.

Despite the fundamental nature of space-time representations, some of them are not enough for the analysis of the real physical processes. They do not grasp the inner physical essence of these processes. This allows us to conclude that one language of events is not enough to describe real physical processes. Such a description should be supplemented by a language of concepts expressing the inner essence of the corresponding material processes with which the ideas about the physical objects themselves are usually associated.

### *Peculiarities of the quantum-mechanical approach to the mapping of reality*

The peculiarities of the quantum-mechanical approach to the mapping of reality are often associated with the principle of complementarity, which opposes the classical understanding of reality. The significance of this principle lies, first of all, in the fact that the characteristics of micro objects depend on macro conditions, and the latter can be fundamentally different (E.H. Walker, 2000). With this, there are significant changes in our understanding of the category of the event.

A feature of the quantum-mechanical description of reality is that the corresponding concepts are divided into classes, to levels that have a different relation to the characteristic of the inner essence of quantum objects (see: Y.V. Sachkov, 1971, p. 128-136, 164-167). The category of the event is related to the characteristics of the first, initial level of our knowledge of micro objects.

The transition to a higher level of information coding is characterized by the allocation of a certain order in the systems of quantum events. This orderliness, the structure in a set of events, is expressed through the probabilistic distributions (via wave functions). The characteristics of a higher level of information coding determine the structure in the systems of events, are the parameters of probability distributions. The quantum level of cognition is

associated with the disclosure of a deeper interpretation of the nature of probability, with a more accurate presentation of the potential and actual (J. Busemeyer, 2012).

Quantum events are processes in which potential opportunities are realized. "Events that realize quantum mechanical possibilities are short-term jump-like quantum transitions, such as the emission of a light atom, the decay of a particle, the collision of the particles without their transformation into others... Thus, the quantum-mechanical state characterizes the quantum state inherent in the given physical conditions, the potential to realize this or that kind of quantum transition (event). Quantum mechanics relativity, therefore, appears as relativity to the form of transition or to the form of interaction, so each transition is realized in one or another interaction. This allows us to propose that many quantum-mechanical quantities reflect not the properties of the microobject itself prior to the interaction under consideration, but the characteristics of the transition itself (event) "(B.Y. Pakhomov, 1985, p. 190-191).

From what has been said, it follows that in quantum theory, the elementarity acts as a separate act of interaction of the microobject, in which its property manifests itself, and it can be registered. Such simple acts of interaction are called elementary quantum events. These events bear the point character - they do not have any components. A quantum event is the simplest act of manifesting the properties of a microobject (interaction, observation, measurement), which can be compared to a certain probability. In this case, quantum mechanics can be defined as a theory of quantum events. More precisely, quantum theory builds its conclusions on the existence of certain regularities in the world of quantum events; it essentially began to use the language of events.

It is also necessary to note the following: the presence of this orderliness and regularity in the world of quantum events means that the "language of objects" is also essential in the structure of quantum mechanics. To understand the nature of elementary particles, the main points are the interconversion of particles and the interdependence of their properties and very existence, the widespread use of methods of group theory and symmetry ideas for understanding their fundamental properties and structure.

The solution of the question of elementarity in elementary particle physics is built not only on the basis of the concept of a separate, further "indivisible" material object. The nature of elementary particles is inseparable from their interactions and mutual transformations.

A free interacting particle is only a mathematical abstraction. A dynamic cloud of the emitted and absorbed virtual particles always exists around each "elementary particle". Thus, objects are inseparable from the processes of transformation, the latter enter the objects themselves. Modern "atoms" can not be imagined outside the bonds and the events that occur with them, the event is the immanent way of their existence. In other words, certain states characterized by numerous acts of interaction act as objects (see: M.A. Smondyrev, 1985, p. 95-98, see also V.S. Barashenkov, 1977. p. 222-246). These elementary acts of endless transformations and radiations create an image of a particle that is associated with a procedural vision.

Recently, there have been significant changes in the physics of elementary particles. In experimental studies on large accelerators, a large number of "elementary particles" have been discovered and studied. A relatively strict classification of "elementary particles" and their interaction, and quantum chromodynamics, which is based on the modern quantum theory of

non-Abelian gauge fields, has become the basis for specific calculations of observed phenomena in the physics of elementary particles (J. Busemeyer, 2012).

Exciting is the idea of a super-string picture of the world (see: D.I. Kazakov, 1986), which has appeared in recent years and with which has great expectations in the construction of a unified theory of all fundamental interactions.

The properties of relativistic strings themselves were so rich and attractive to theoretical physicists that recently this new object of relativistic mechanics has been studied outside the framework of the idea of quark confinement in a hadron. Therefore, gravity (the theory of gravitation) is also included in this most general scheme of the theory of all possible interactions. Unlike local quantum field theory, in which each field describes the dynamics of only one type of particles, the superstring carries in itself an infinite number of multiplets of particles corresponding to the excitation of the string. Interaction and inter-transformation of elementary particles is described in the new theory as an interaction between superstrings (K. Becker, 2007).

Accordingly, the concept of the event is also used here in an original way. The states of the process, different excitations of the string correspond to different elementary particles.

## DISCUSSIONS

### *Objective existence of an event*

The theoretical structure of modern (logically closed) physical theories includes the concept of an event. The event acts as the simplest element of the corresponding theoretical constructions. Physical regularities in these cases express the presence of certain regularities in the space of elementary events. The interpretation of modern physical theories, their relation to experience, is also based on the consideration of events as some data given to us in the experience of elementalities.

The event is characterized by the same status of objective existence as the physical body previously characterized. Moreover, the physical object itself was theoretically reproduced as a system of events. The internal properties of objects are compared with the structure and with the presence of a certain orderliness in such systems of events. Consequently, in its theoretical reproduction, an object can be perceived as something derived from events.

From this we can conclude that only events truly exist, and objects represent certain complexes of such events. In any case, the development of modern physics posed the question of the relationship between the concepts of (physical) object and event, the relationship between the "world of objects" and the "world of events" and the connection with the problem of elementarity.

When considering the question of objective reality, it is inappropriate to oppose the world of events to the world of objects. We are given events (both atomic "directly data"), and objects that are characterized primarily through the essence. The language of events is quite simply entered into the philosophical and methodological literature, connected with the comprehension of content and the trend of development of modern natural science.

However, a special philosophical analysis of the category of events is clearly not enough. B.Rassel paid a lot of attention to it, and his book "Human knowledge" is practically based on the consideration of this category as a foundation of knowledge. Thus, Russell asserts: "... we have two different cases of the identity of the structure of groups of objects: in one case,

material objects are structural units, and in the other, events" (B. Russell, 1948, p. 497). However, only the latter are recognized as true. Stressing the fundamental status of the "language of events" in modern scientific knowledge, B. Russell writes: "Modern physics has moved farther from ordinary common sense than the physics of the XIX century. It parted with matter, replacing it with a succession of events "(B. Russell, 1948, p. 358).

Of course, such statements give grounds for criticism. However, it should be borne in mind that when talking about the fact that modern physics "broke up with matter", Russell has in mind the understatement of matter, which is characteristic of classical physics of the 19th century, which identified the matter with the substance. This is in the first place. Secondly, to challenge Russell's thesis about the role of the "language of events" in modern physics means not seeing that new understanding of the world that is associated with it. In general, in assessing the position of Russell on this issue should be careful. He was not, apparently, inclined to reduce the whole question of the relationship between the "language of things" and the "language of events" only to a purely pragmatic question, as is characteristic of the position of R. Carnap (R. Carnap, 1959, p. 302).

The language of science is thought of as a formal system, and the question of his choice, according to R. Carnap, is not a theoretical question, but a practical one - "rather a matter of choice than a statement." "Objects" and "events" are considered only as practical forms of expressing knowledge.

Often the procedural approach is absolutized by some authors who pursue the goal of considering any material formation and its structure in the form of "events" and "processes." From A. Whitehead's point of view, the reality is a "stream of events", and the real world consists of concrete individual, "actual essences", which they then define as "events". Therefore, "the fundamental concept of modern science is activity and process" (A.N. Whitehead, 1958. p. 191). According to his point of view, the task of philosophy is reduced to an analysis of the concept of the process and the identification of the hidden logical premises contained in it. The main components of knowledge are "actual events" (actual occosions) and "eternal objects". In this case, any act of cognition (or elementary experience) is an "actual event".

However, his attention is mainly drawn not so much to the relationship between the events as to the internal properties of the events themselves. Our entire universe must consist of such incidents. These actual events, or entities, are "those ultimate real things that make up the world" (A.N. Whitehead, 1929. p. 27). In other words, such events claim to be the ultimate building blocks of the universe.

The philosophical position of Whitehead as a whole is a bizarre combination of organicism and objective idealism. We did not set ourselves the task of giving a detailed critique of Whitehead's views. However, one cannot fail to see that for all its vulnerability and weakness in a number of important aspects, Whitehead's concept of nature represents a bold attempt to include the achievements of the natural sciences of the 20th century (first of all physics) within the broad framework of a new picture of nature and its cognition by the human being. From our point of view, the methodological preference of the "language of events" to "the language of things" consists in the fact that the ideas of becoming, development and qualitative change are naturally associated with the first.

It is for this reason that the Whitehead concept of the event and process finds a sympathetic response in the broad circles of the scientific community. And in order for this concept to receive its adequate assessment from the point of view of dialectical materialism, the latter must offer the key concept of its (not a declarative, but constructive) version of understanding the fundamental nature of the concept of event and process in the modern scientific knowledge.

Neither "objects" nor "events" can be regarded as something absolutely primary. The transition to a new language - the language of events is associated with a change in our ideas about elementary objects. Elementary objects of modern theories have become the most informative. The occurrence of the concept of the "event" in the structure of physical theory cannot be understood as a concession to idealism, for idealism is not manifested in the very fact of using the concept of an event, but in its definite interpretation with the denial of the objective reality of the world of objects or things.

## CONCLUSIONS

With the development of physics, her notion of elementarity has undergone profound changes. Modern physics for a long time does not connect these representations to the presence of some of the simplest structureless physical objects or particles. There are simply no such objects or particles. With the transition of physics to new objects of research, it was established that those "primary" material objects, of which physics "compose" the world, have a complex internal structure. Traditional notions of elementarity were transferred to the notion of an event. An elementary event is regarded as something point-like, then indivisible. Such an event acts as the simplest and initial element of theoretical systems of modern physics. At the same time, it may not be enough when solving the question of the materiality of the physical processes of ideas about individual events.

A meaningful analysis of the theoretical systems says that the basic physical statements are based on the analysis of certain systems of events, and a particular event is of interest only from the point of view of the structural connections and the conditions for its entry into systems. The event is viewed not as an "alienated" individuality, but as an element of the system. Elementarity began to act not in the form of a primary object, but as its aspect, which can only be understood in its relation to the original whole. The reality of such integral systems of events means that not only events are physically real, but also objects as carriers of these holes.

The presence of a structure and stability in the systems of events indicates the nature of the internal properties of the objects under study. In other words, the disclosure of the inner essence of material objects presupposes not only the knowledge of their internal properties and structure, but also is based on the analysis of the field of the possible and diverse manifestations of their inner essence. To characterize such manifestations, the language of events was developed, and the disclosure of certain regularities in the systems of events is a way of knowing the inner essence of material objects.

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