# METHODOLOGICAL ANALYSES OF THE SCIENTIFIC RESEARCH

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**ABSTRACT**

**The article addresses the structure of scientific research in the context of the methodology of science. This goal is realized through the concrete material of physical theory, detailing the structure of scientific research and its elements; its process and the laws it obeys; its results, which lead the process; its motives, e.g. the "driving forces" of research and the role of philosophy in the process.**

**The paper examines the theoretical phase of researches as a synthesis of the empirical and the speculative, in contrast to the existing literature that presents the opposition between theoretical and empirical research.**

**The steps of knowledge of the objective laws in a particular area are analysed: the *empirical* research, the *non-fundamental* theoretical, the *speculative*, and the *fundamental* theoretical; this analysis allows the generalization of the patterns of scientific research.**

**Particular attention is paid to the speculative research and its main elements. The "methodological mechanism" of formation of new fundamental conceptions in science is unravelled. The essence of this mechanism consists of some *non-logical cognitive operations* (idealization, choice of "Gestalt", substitution, generalization). The knowledge of corresponding combinations of these operations made by the investigator facilitates the process of research, decreases the probability of errors in the scientific cognition.**

**KEYWORDS: structure of scientific researches, domain and informational area, methodology of scientific research, measure of researches, non-fundamental theoretical research, speculative research, genesis of scientific ideas, novel knowledge, theoretical constructs.**

The history of data generalization in science shows that the major aspects of fundamental research are: the *structure*, namely, the elements it consists of and their co-operation; the *process* of this co-operation and those conformities to the laws it supports; the *results* this process finally arrives at; the *reasons*, i.e. the "motivating forces" of researches and the role of philosophy in this process.

## The structure of research

The scientific research in the widest sense of this word is such a type of activity at which a researcher subject co-operates with the studied object through the research facilities. The research *object* is a domain of topics, e.g., a totality of phenomena possessing similar signs. The scientific research always supposes that its object is an eventual fragment of the objective reality, i.e. that it exists not only outside but also regardless of the researcher's consciousness, as well as outside and regardless of any forms of his activity.

The *subject* of research is a research worker, a man possessing a set of certain "properties":

- normal and developed enough sense-organs, in order to be apt for the perceptive cognition of research object;
- a developed capacity for abstract thought, taking into account the laws of logic, and a good memory, providing him the necessary knowledge supply;
- creative imagination, allowing the throwing out of new ideas.

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In addition, a research worker must possess certain *methodological* rules and a philosophical outlook (even if not fully clear and systematized in a general cultural thesaurus).

The philosophers of the 16-17th centuries considered that a research structure is always binomial: it is a *direct* co-operation of subject with an object. But the development of sciences in the 19-20th centuries has shown, with all evidence, that a research structure, generally, is trinomial, the co-operation of subject with an object through the medium of *instruments* and *research terms* (new material and materially mediated objects of dual origin).

Measuring devices, computing and writing devices belong to the first; to the second are the scientific literature, the supervision protocols, photo, a tape recorder records etc.

The distinction between these two types of objects consists in that the first does not contain the supply of the old information fixed in some language, while the second does.

The domain of topics studied by means of certain sensitive devices gives what usually the research article names. This one is the form in which a research object shows itself in the material facilities used for its study. The research article can be neither identified with the research object on the whole nor does it match against it. The research article is one of the parts of research object.

The *content* of research object opens up as far as the research article develops. The information supply accumulated by preceding generations or researchers, contained in the research conditions and in its memory of topics, forms the so-called *informative area* of the researcher, determining his erudition degree: and he "looks" at the studied domain topic, from the beginning, through "the prism" of that degree.

**The research process**

The research consists of raw operations (*cognitive procedures*) as co-operation of the subject with the studied object through research facilities. *To find out the basic conformities to the laws these procedures submit to, is the main task of the methodology of scientific research.*

The study of the work of prominent researchers shows at first blush that the scientific activity of each of them is quite individual and *unique* (the same result often turns out in quite different ways, a great number of casual factors has influence on the research, a large role is played by unforeseeable emotions etc.). However, for the analysis of the scientific activity from the viewpoint of the principle of development it is necessary to catch the basic conformity to laws in the extraordinarily difficult picture of the activity of many thousand research workers. Applying this principle, it is possible to discover that the knowledge of objective laws of the domain takes place through the next basic stages: *the empiric research; the non-fundamental theoretical; the speculative; the fundamental theoretical***.**

The questions are: why such stages and exactly four, and why is their sequence exactly the above-mentioned one?

There are two different types of *theoretical* research:

- that which allows to achieve new empirical knowledge explanation by means of *old* theoretical knowledge (*non-fundamental theoretical research*);
- that which achieves this aim only by means of *new* theoretical knowledge (*fundamental theoretical research*).

Since fundamentally, theoretically new knowledge cannot be obtained either by inductive generalization of data or by deductive reasoning from the old theoretical knowledge, it is necessary to use for its construction *creative imagination*, that is, speculative combinations (fantasy, guess work/conjecture, intuition etc.)

Consequently, first the studied subject domain is described and explained by the means of *old* theoretical knowledge (present in the information area of the researcher). This moment is the most simple and (according to the principle of development applied to the research process) it is necessary to be tested, before one arrives to more difficult steps.

For the fundamental research, to arrive at a dash to these steps would be similarly unreasonable as to apply the most drastic medicine for the treatment of the onset of an illness without trying preliminarily a weaker one. Only when one does not attain success using the first way it is necessary to call to the stronger remedies, i.e. to the search of fundamentally new ideas (*speculative* research).

In the history of the development of philosophical ideas, there were two approaches about the generation of the explanation of the new theory, incorporating the aspiration to create an "opening logic" in a counterbalance to the *proof logic* of the already obtained theoretical knowledge. The distinction between these two approaches consisted of new knowledge facilities: either by *generalization of details* arriving to the general concepts, as the only way to open the new (peculiar inductivism); or by concluding the new knowledge from the *general theories* (deductivism). The representatives of these two approaches [Francis Bacon (1561-1626), William Whewell (1794–1866), John Herschell (1792-1871) – on the one side; Aristotle, Descartes, Spinoza, Leibniz – on the other] criticized the views of each other.

The tasks of development of the problem of method were set by the productive necessities of the practice of the 17$^{th}$ century. The practice of scientific researches has dictated the necessity to elect the conception of such method, which is related to both the empirical analysis and the operations of generalization. An inductive ascent from single facts to general conclusion resulted in the successful opening in natural sciences. The new conclusions received, the concepts began to add more to the successful use of inductive method in empirical research, for the explanation of the origin of empirical concepts.

However, the scientific research is inevitably related to concepts of unempirical origin. But inherently, the inductivists of the century did not have correct classification of scientific concepts, did not dissociate empirical concepts from theoretical ones and conceived of the conclusions of relatively scientific concepts in general, essentially supposing empirical concepts.

The construction of fundamental theoretical concepts and presentations cannot be carried out by means of inductive generalization, and based on the choice of repetitive signs (as somehow tried Lullus, though he started from fundamental concepts – the features of God –). Whewell wished to realize this moment in scientific cognition near other inductivists, but neither he was able to explain the unempirical origin of fundamental scientific concepts consistently, he did not work out to a consistent conception of research where conjecture is only its first stage and related to the non-logical cognitive operations. The conjecture's mechanism remains obscure.

There is no doubt that some of the specific methods (*organon*) have played a methodological role in science, and this role is related to their applicability scope. Their value is determined by the fact that they expressed a dissected nature of human knowledge, available logical processing and analysis methods. But the differences between *generic* and *similar to* phenomena, so abstract, universal concepts are not yet carried out, so these concepts are considered theoretical concepts. On the other hand, the theoretical concepts would be superfluous, since the empirical concepts would reflect the deep essence and not the simple similarity to phenomena. A limited inductive methodology and emphasizing of the illegality of this induction as a method of new knowledge creation characterizes this distinction among the concepts and the lack of clear classification. Ignoring or weak taking into account the role of deduction have also testified that there was insufficient and one-sided: as only inductive methodology. But it is possible to apply the deductive method (something which was not understood by deductivists) at the level of empirical

researches. Deduction provides *non-fundamental* knowledge here (non-fundamental empirical laws, derived from fundamental empirical concepts and laws, deductively).

Fundamental scientific ideas cannot be inferred inductively; this was understood already by deductivists, but the method of problem solving they proposed was also limited. Theoretical concepts can be obtained only using deductive reasoning. *Deduction really leads to the new knowledge formation*, it can be used on both the levels of empirical and theoretical researches successfully, but the deductive elimination results will be non-fundamental knowledge. *New knowledge is dual in nature: it can be fundamental and non-fundamental*. We can see that the knowledge received on the stage of non-fundamental theoretical studies can explain old empirical laws and predict new ones; if we consider this new knowledge duality, then deduction is capable of producing new knowledge, but it is not new fundamentally. A method of producing the non-fundamental theoretical knowledge – the deductive reasoning, is selected from a plurality of possible evidence and mathematical axioms and theorems known as satisfactory. It is not enough to have systems of logical rules, it is necessary to know when and how to apply them to the original data (Branskij 1973: 37-38).

But those philosophers who accept deduction as a means of obtaining new knowledge, does not focus on the *non-fundamental* nature of this knowledge. Rationalists (deductivists) proceeded from the fact that the researcher uses the traditional rules of logic without error, and that these rules are always chosen correctly. There are misconceptions and errors only associated with the need to choose an adequate "algorithm", the output of non-fundamental consequences from fundamental knowledge in the course of the study. If the choice of the logical rules of the system is correct, then the result will display *non-fundamental* theoretical concept; in this sense, deduction allows obtaining novelty, but this means selection, made in a different way, and the corresponding results. So, it cannot be reduced only to the operations related to process of researching the outputs. Rationalists associated intellectual intuition[2] with mind's ability of focusing on and freedom of action (discretion), and considered imagination as a vague and inadequate view of cognition. They did not attach importance to the role of creative imagination in the research process. This role is not limited to the direct discretion/freedom of action (this is just one of the features of phenomenological intuition), moreover, the discretion is not impossible, but it is mediated by some cognitive operations, not reducible to formal logic output operations. Thus, neither inductivists nor deductivists could explain the fundamental theoretical knowledge formation. All claims of the "discovery logic" creation, a kind of "logic algorithm" production of new theoretical ideas, was doomed to failure, because *formal logic does not exhaust all the possible forms of new knowledge cognitive formation*.

[2] Kant characterizes the intellectual intuition as being meaningful, e.g. this concept does not receive formal logical definition, but contextual, as it often occurs in the humanities, including philosophy texts. Kant arguments in favor of this contextual content of intuition, showing that intuition is "prior to any knowledge about the subject as an intellectual form, and it is even a formal a priori knowledge of all objects at all, because they are thought" (Kant 1994: 719). Karmin A.S. recalls that, according to Kant, "in our mind's nature lies a priori, not mediated by either experience or model of logical proof of any object of knowledge. This is obviously the premise of some form of intuitive knowledge from which we proceed in the process of thinking about any subject. Consequently, we are talking about the presence of our special kind intellectual intuition, which could be called "categorical intuition" (Karmin 2011: 80), and according to which the sense of contemplation is systematized. Based on the Edmund Husserl's (2009), E. Cassirer's (Cassirer, 1998), Derrida's (Derrida 2000), L.A. Mikeshina's (Mikeshina 2010), N.S. Avtonomov's (Avtonomova 2011) and Karmin's works, his analysis of comprehensive intuition – we may state that the exercise of "researcher" addressing the issue of the creation of general concepts of human knowledge leads to speculation about a special role of intuition in this process and the limitations of its formal-logical construction. It is also clear that in the sphere of wider consciousness and knowledge, in particular the need to resort to intuition, this need as such exists as an independent epistemological problem of "birth" of general concepts and requires a special research.

At the present stage, the problem solving difficulties of the genesis of fundamental theoretical knowledge are mainly generated by the fact that the theoretical knowledge is related to objects which are not accessible to sensory contemplation/ not directly observable. Therefore, the task seems to be the proving of the speculative nature of such ideas and ways of their formation. *To ideal constructs (speculative concepts, which become later on theoretical) other analysis methods are necessary than those corresponding to empirical and non-fundamental theoretical concepts*. The process of the formation of such ideal concepts is associated with the stage of speculative research.

When the empirical and theoretical stages are separated, we cannot explain satisfactorily the fundamental ideas of the origin of scientific theory.

The *speculative* research explains how a transition from the empirical to the theoretical knowledge takes place. Concretely, speculative images (concepts, models) explain the old empirical knowledge and forecast the new, becoming theoretical knowledge as a result of contact with the empirical realm. *The stage of empirical research must not be opposed to a theoretical and speculative stage.*

We find confirmation of this in A.I. Herzen (1812-1870), who underlined that no empirical science remains in pure empiricism; that empiricism in its development must necessarily go to the speculation based on experience.

There is a rationale for the existence of speculative research as an *intermediate* step between the theoretical and empirical research stages in the philosophical literature (Branskij 1973: 40-45; Oganyan 1990).

The new concepts underlying the theory are not derived from experience and do not follow from old theoretical knowledge. The real essence of the *theoretical* knowledge is revealed in that it is such a kind of speculative knowledge that gives an *exhaustive explanation of some empirical knowledge and the prediction of new empirical knowledge*. Theoretical knowledge as *unity and synthesis of the empirical and speculative* is a qualitatively new knowledge, different from each of the opposites of this unity. Speculative research is associated with a number of cognitive operations (non-logical in character and characterizing the creative intuitive process of cognition). The analysis of these cognitive operations, functioning as a mechanism of imagination, allows us to talk about the *methodological concept of imagination* that pushes the possibility of a creative process of generating new ideas in the process of forming a scientific theory[3].

The authors of these works (mentioned obove) are considering the psychological aspect of the problem of intuition: the system settings formation, the role of emotion and e.g., along with the epistemological aspect, noting the characteristic feature of the creative intuition – the specific interaction between sensual images and concepts – the new relations between them and the establishment of their synthesis, all of which fundamentally create concepts and images with a new content.

The methodological concept of creative imagination allows distracting from the psychological, axiological, epistemological aspects of the problem of new ideas genesis for a fundamental scientific theory. Implementation of non-logical cognitive operations (idealization, replacement, selection, generalization) in the stage of speculative research allows us to formulate a number of *methodological guidelines* that have the character of *methodological regularities*, explaining the opportunity to pass from empiricism to theory at this level.

Let us consider the methodological mechanism of intuitive process functioning.

The implementation of all the above-mentioned operations is often not required in the

[3] Such an analysis of different aspects in the understanding of the mechanisms of intuition and its operations is described in: (Irina V.R.), (Novikov A.A 1978); (Karmin A.S. 1978); (Ohanyan K.M.1984; 1986-2016) et al.

process of new ideas discovering: it is enough to make the Gestalt's choice (the choice by the *whole* hypothesis / theory) and replace its elements by empirical or theoretical images of real objects or the corresponding models, without resorting to idealization surgery and formation of idealized presentation during the limiting process operation (Shtoff 1981).

At the same time, elements for the replacement can act as empirical images and idealized representations (ideal representations), models. A theoretical idea can be used as an idealized representation, but not all, and it is obtained in the process of creative imagination, i.e. in the implementation of non-logical cognitive operations (in particular, idealization).

*The model* – the result of *speculative* research, too – is a speculative idea, which *becomes theoretical after contact with empiricism*. Empirical submission elements selected as a Gestalt, replaced by ideals: this is a relatively complex cognitive situation that occurred, for example, during the formation of the idea of probability wave by Max Born (1882-1970). *Gestalt* (a whole hypothesis) in this situation may be a theoretical understanding of the field of wave, or an empirical understanding of the real cloud, or the theoretical idea of wave-pilot. A data structure element connects images: density of the substance at the point, electromagnetic field intensity; the idea of finding a particle probability in a final volume of space tending to infinity; as a result of this operation, passing to the limit we obtain the ideal (the probability of density), which are replaced by the elements of Gestalt. The idea of the "cloud of probability" was obtained in the process of substitution. The specificity of substitution in this case is that it is potentially infinite. It is possible to extend the analysis of substances, for density is distributed continuously, and substitution may be performed at each point; limiting the committed transition, substitutions are associated with idealization. Born replaces tension force field (or the matter waves density) in the wave of de Broglie, a leading particle probability density. If the de Broglie wave sought to link the pilot with separate electron, Born took a single electron "probability cloud" (model view) and got a construct of "probability waves" through generalization, e.g. all the electrons attribution of this model.

Empirically presented elements, selected as the Gestalt/whole structure of ideas, can be substituted with not only an ideal, as in the above case, but a model. This is one of the possible combinations when the empirical representation or model can be used as substitutes for the elements of Gestalt (instead of ideals). The situation in the creative process when choosing structural image is not unique, it is typical. There are several potential Gestalts, as a rule, from which the researcher chooses one. After all, as a Gestalt can be used any way through which the information is taken from the field arbitrarily distant from the study, e.g. can be used by any analogy, proposed model building, if there is a relation structures isomorphism of this information and the image of the object. The analogy used in the stage of speculative research, the distinction of reasoning by analogy, means creating speculative model of the phenomenon or process. The question is of what Gestalt preferences decided by the researcher on the basis of his worldview are connected with the level of scientific knowledge.

*Idealized* presentation (of the velocity field in a perfect fluid) and *empirical* presentation, reflecting the experimental research level (for example, of the conductor, along which metal sawdust's scattered), are equally Gestalts in the process of formation of "force field" construct by Faraday. The historical plausibility degree is more consistent, as we see it, the first Gestalt, but the most important issue is not the choice of the Gestalt's grounds (methodological aspect), but the possibility to choose it from several images of information.

A new form, a new mechanism of intuition, when replacing the idealized representation, selected as a Gestalt, realized as an idealized representation revealed during the force field idea formation by Faraday. Other forms of "methodological algorithm", theoretically, are possible. *By "methodological algorithm" we refer to an ordered, repeating sequence of non-logical cognitive*

*operations*.

A feature of the construction of Bohr's atom model is that it is the use of selected higher operations in non-logical plan: substitution of Gestalt's elements, idealization, etc. However, as Gestalt according to Bohr is not a simple structural way and model obtained, in turn, the creative imagination process begins in its theoretical precursor Rutherford. The electron with continuous beam energy – Gestalt elements (models) – is replaced by Bohr electron with discrete energy (model). Such a representation (the model) can also be obtained intuitively by non-logical way. Bohr has replaced the light's production with quantized energy of substance, with quantized energy to do this.

Thus, the elements of the original model (Rutherford's model) are replaced by another model that is used as an ideal, element of which, in turn, is replaced by model, and so on until infinity: that suggests the infinity of imagination of creative researchers, associated with substitutions on a higher level. It turns out, as it were, a new round of substitutions, where the model derived speculatively advocates elements for replacement and substitution/as surrogate.

The genesis of an idea can be made consistent with the substitution of several Gestalt elements (among them: models, empirical images), several models obtained also intuitively. Planck's quantum of action has born in such a complex cognitive situation.

It is not enough to show the concept's genesis as a result of (sensory and conceptual) combination of respective images as elements of the old knowledge: this aspect mainly draws attention of existing works to the scientific research methodology. Combination is an illogical cognitive operation, but it is preceded by a Gestalt's variety, by a stimulation of the structure's similarity with something that is supposed to be already known and what needs to be found. Elements of intuitively chosen Gestalt and ideal (in order to be performed an idealization of operation), or that way/model which act as a substitute of Gestalt's elements, combine. There is no combination when the created model is attributed to a particular field of phenomena. Specialization is defined clearly. Therefore, *the reduction of the birth of mechanism of new idea only to combinations narrows the representation of the actual mechanism of intuitive act*.

The new ideas formation, when a model is used as a Gestalt, its elements replacing idealized representations, is non-trivial. In the history of physics, there are examples of such a mechanism to obtain new ideas. For example, to form the concept of "bias current", Maxwell has invented a model that included idealized representations: space filled with imaginary liquid (radiant, incompressible), formed vortex tubes, between which there are balls that come into contact with the periphery vortices and propelling. The structure of Gestalt has so connected its elements; small volumes of liquids containing vortex tubes, between which there are balls. Maxwell has replaced vortex tubes with the lines of force (in the sense of the field) – an idealized view taken already by Faraday intuitively – but small balls replaced the electric particles, they moving under the influences of forces. So was with an electric current conductive medium. Maxwell received a construct of "electric current" by extending the resulting model to all conductive material. Particles are displaced in non-conductive medium; there is a bias current in dielectrics. He got a new construct (by volume) – bias current in vacuum, subjecting the model's generalization again and attributing it vacuum.

Maxwell used such a form of "methodological algorithm", when the replacement operation is associated with the model, taken as a Gestalt, ideal and empirical presentation adopted as substitute of the structural image: this is the peculiarity of creative process. Therefore, a multifunctional and complex model for the replacement of its elements needed not one ideal or what role it performs in each case, but two. This example is remarkable: the fact that the speculative model, obtained in the creative imagination process, is attributed to two different areas – conductors and dielectrics. The received concepts amount is different, since this model content is new.

The *replacement* operation of all present situations was the main feature of the above mechanisms of intuitive processes to obtaining new ideas. This allows us to say that there is a kind of *methodological pattern of the mechanism of new ideas formation*: *the structural elements of the image (Gestalt) are replaced by ideals or by which serves as an ideal*. But it turns out that in the history of physics a lot of new ideas, concepts formed intuitively, have avoided the replacement operation. The development of a new idea begins with the *idealization* operation, resulting generalizations of the exposed ideal.

Let us consider these cases.

The first of the possible combinations: generalization of empirical presentation, acting as the ideal, considered directly. Is this process intuitive? Obviously, it is not. This cognitive situation does not go beyond the inductive generalization scope. We just expand the scope of experience, the habitual scope of empirical concept or representation known to us, after attributing other area of phenomena to empirical representation. The volume change and content of such a subjective image remains the same. This process is well within the normal scope of traditional inference and not linked to speculative researches.

The second possible situation is connected with the ideal's generalization.

We know quite a few discoveries in the history of physics. Here are some of them: the concept of a reversible process, the Galileo's idea of inertia, the concept of "absolutely solid", the "black body".

A model can be subjected to generalization directly. For example, Bernoulli's ideal gas model can be attributed to the combination of real gases.

Thus, the genesis of new ideas in the scientific theory construction is associated with the intuition of the researcher, his creative imagination. If "the intuition work", the epistemological "mechanism" of the new ideas formation – that the researcher usually not recognizes – would have not been shown, the present statement would not be new, and it would remain a phenomenological ascertaining. *The "methodological algorithm", that includes some non-logical cognitive operations sequence, is involved in the creative process invisibly*. Its various forms, steps, cognitive situations peculiarities, identified and considered in this article, confirm the methodological regularity of the creative process.

The foreign "philosophy of science" (when it has appeared at the turn of 19$^{th}$ century into the 20$^{th}$ century) has considered only two stages, theoretical and empirical, of the research process. However, a deeper analysis of the history of science shows that this approach does not only mix two very different research types (theoretical non-fundamental and theoretical fundamental), but also looses the main intermediary between the empirical and theoretical research, the *speculative*: and thus the transition from the empirical research to the theoretical development becomes incomprehensible.

Not every act of creative imagination in science is speculative research, but only that which allows, of the many possible combinations created as a result of the spontaneous fantasy games of researchers, to select a subset of meaningful combinations (e.g. logically consistent). It is obvious that such speculation becomes the core of the new research and for this reason it should be the subject of special methodological analysis.

One cannot consider the same speculation as a part of the given theoretical research, because in such case the nature of the relationship between different stages of scientific research in general will remain incomprehensible:

- the purpose of empirical research is to giving an accurate description of the experimental data;
- the speculative research seeks to go beyond the known experimental data.

It's easy to note that the purpose of speculative research is exactly opposite to the purpose of empirical research.

The *fundamental* theoretical research aims to harmonize the results of both stages of research, e.g., to overcome the profound contradiction that might exist between them.

Therefore as showed above, the empirical research is not the opposite of the theoretical and speculative, as in a traditional image opposing the empirical and the theoretical.

*The empirical and the speculative research stages are preparatory for theoretical study*.

The *empirical* research level is characterized by: a consistent transition from observation to the intention, to statistical processing of the measurement results, induction, interpolation, analogies etc. until the use of trial and error method and the implementation of full systematization and facts classification relating to the studied subject area (this is the so-called phenomenological construction creation).

At the level of *non-fundamental* theoretical research:

- First examination of scientific texts (prepared by different generations of scientists);
- Derivation by deduction of new private theoretical laws from the old fundamental laws in order to explain new empirical knowledge (construction of theory fragments theory, e.g. the new sections of the old theory);
- Construction of complex theories of all sorts and, finally, the so-called hybrid theories, attempting to explain the new empirical knowledge through a set of old theories: but this leads to a special kind of internal contradictions (theoretical paradoxes).

The *speculative* research consists of the following moments of the process:

- The new idealized images creation in the information field of the researcher;
- Mental models construction ("modelling");
- Their generalization to the level of speculative concepts (constructs);
- Promotion of some principles on the basis of such constructs;
- Building of special deductive system of speculative concepts with the latest.

Speculative research ends with the comparative analysis of various speculative concepts created in the researcher's information field, in terms of their logical consistency, and the isolation of subsets of consistent "meaningful" concepts from the set of all possible concepts.

The *fundamental* theoretical research consists of:

- selecting a limited subset from a variety of speculative principles, as basic principles of the new fundamental theory: this is the theoretical program creation;
- a certain structure as a form of the expression of the new fundamental theoretical law – this is the theoretical framework – is created through selection from an iconic plurality of structures contained in the information field of the researcher, on the basis of theoretical principles;
- the deductive scheme development, e.g. the theory of particular laws of two kinds getting deductively from the general law: then, the beginning of explaining how are known empirical laws established at the level of the empirical researches and how may one predict new empirical laws.

Further development of fundamental theoretical research suggests:

- Implementation of semantic procedures, eidetic and empirical interpretation of theoretical new particular law;
- Thought experiments conducting and making the theoretical scheme in the theoretical hypothesis;
- A fundamental theoretical research: about the transition from a thought experiment to a real one, and concerning the comparing of new empirical laws, predicted by the theory, with the laws obtained as a result of the experiment;
- Hypothesis confirmation or refutation.

**Results of researches**

The overall result of scientific research is scientific knowledge. Knowledge types can not be divorced from the relevant procedures or identified with the latter. We classify the main types of scientific knowledge based on the research development logic: *empirical*; *non-fundamental theoretical*; *speculative* and *fundamental theoretical*.

The main types of *empirical* knowledge: empirical fact; empirical law; phenomenological construction.

Phenomenological structure is the highest form of empirical knowledge, which is a deductive system, created on the basis of the fundamental empirical law, giving natural systematization and classification of non-fundamental empirical laws.

The main development stages of *non-fundamental theoretical* knowledge: fragmented theory; comprehensive theory; hybrid theory.

The speculative idea ("model"), speculative concept ("construct"), speculative principle and speculative concept are the main forms of *speculative* knowledge.

At first glance, it seems "speculation" and "knowledge" are incompatible: knowledge is always about something, and speculation is as nothing. But they are dissipated, if we consider that speculative knowledge is also always knowledge of something, but that "something" in the examined domain area may or may not exist, or its existence can be problematic. If we examine the planets set in the vicinity of some distant star, for example, the concepts of sphinxes and centaurs living on some of these planets are, perhaps, speculative knowledge.

The main stages of *fundamental theoretical* knowledge development are:

- "Program" (the theoretical principles system);
- "Scheme" (the fundamental theoretical law);
- "Hypothesis" (deductive system, created on the basis of the fundamental theoretical law, explaining known empirical laws and predicting new ones);
- "Theory" (the same deductive system, after the testing of the experimental predictions).

Therefore, *real theory is not a purely deductive system*, since the formation of its structure involves not only deduction, but also selection (choice), interpretation and verification.

The scientific theory formation process allows us to understand its *dialectical* nature: *theoretical* knowledge is a kind of speculative knowledge which provides a comprehensive explanation of the well-known empirical knowledge and predicts new one.

Theoretical knowledge is a kind of "synthesis of opposites", i.e. empirical knowledge based on experience and speculative knowledge going beyond experience. On the other hand, the theory can also be seen as a kind of return to the phenomenological concept of speculative construction, but based on the first ("negation of the negation"): it is such a speculative concept that explains old phenomenological construction and predicts the new phenomenological construction.

All of the above leads to the conclusion:

- A new construction of fundamental theory is the end result of scientific research, which leads to the achievement of all other results;
- A prediction confirmed by experiments conducted in the studied subject area is always using a specific sensitivity toward certain devices.

Such a theory is true within the specified domain and fixed measurement accuracy, and no subsequent science development can change this result.

**The motives of research**

The term "motif" in the scientific research methodology is used to refer to the need to resolve some scientific problems. As a motivation we mean knowledge that is required to obtain a certain result which has not yet been received. In fact, the researcher is faced with three situations:

- one can have knowledge about some aspects of the study subject area (there is a solution to some problems);
- one can not have this knowledge and nor can one be aware of its absence (no decision, nor even the problem);
- one can not have this knowledge but one is aware of its absence (no decision, but there is a statement of problem).

The fundamental methodological paradoxes, which are regularly found at the *interface* between one stage of the fundamental research and the next, are the most pressing problems:

- The transition from empirical research to non-fundamental theoretical - "empirical paradox" associated with an attempt to explain the empirical knowledge with the empirical knowledge of the same;
- The transition from the theoretical to the non-fundamental speculative - "theoretical paradox", due to the desire to explain the new empirical knowledge using old theoretical knowledge;
- The transition from speculative to fundamental theoretical - "selective paradox", arising on the basis of trying to choose the theoretical principles from the speculative trial and error method;
- The transition from fundamental theory to empirical - "theoretical and empirical paradox", due to the interdependence of theoretical and empirical research.

These paradoxes are real contradictions that arise in the course of the research and are not related to the errors or imperfections used by the researcher. Nor are these contradictions of formal logic, since this level of formal logic has not a truly dialectical character. In this respect, the fundamental methodological paradoxes are somewhat similar to the Kantian antinomy. Thus, to overcome these contradictions gives "impetus" to the development of research.

Thus, to be aware of and overcome its inherent dialectical contradictions is the "driving force" of the scientific research. The basis of all other scientific problems solutions is resolution. At the same time, it should be noted that these differences arise and are overcome in the long run as a result of the theoretical and practical activities interaction.

**The role of philosophy in the scientific research**

The influence of philosophy on the scientific research is found (through the scientific interests and ideals formation) at all stages of the research. The construction of a new fundamental theory is, however, the most complex, difficult and fundamental problem of all the research problems. Therefore, the question of the role of philosophy in the scientific research is central in the question of the role of philosophy in the scientific theory formation.

This question deserves special consideration also because here we are faced with the unique situation where philosophy influences the reception of scientific results not only indirectly, but directly. If the indirect influence of philosophy takes place on a daily basis, its direct effect is manifested only in the scientific revolutions era, e.g. in abrupt breaking periods of fundamental theoretical concepts.

The question about the role of heuristic philosophical principles in the scientific theory formation is considered by philosophers as a natural one. This role, they say, consists in the opportunity to deduce the scientific theories basic principles from philosophical principles. This approach took place, most clearly, in the grand natural-philosophical systems of Schelling and Hegel, later. In the middle of the 19$^{th}$ century, a belief – that in our time is quite widespread – arose:

that philosophy can not plays heuristically, e.g. having role in the theory formation, but can only organize and interpret ready-made knowledge, because any new true scientific theory would have not been created as a result of philosophy (only speculative construction or false theory were results). Wittgenstein expressed the essence of the above belief the most clearly: the philosopher cannot be compared to the architect helping the mason to build a house, but to a scavenger, cleaning already built homes.

The analysis of history of the fundamental theories formation (for example, the general relativity theory, the personality theory, surplus value theory etc.) show that the outstanding scientists overcome the selective paradox.

Actually, the philosophical principles – or worldviews – shared, consciously or not, by researchers, are involved in their work. For example, in the transition from speculative to fundamental theoretical research the philosophical principles carry out a kind of selective function. The latter consists in the fact that the researcher realizes a plurality of speculative combinations only with those who agree with his outlook.

If the fundamental theoretical discovery is the result of the interaction of five main factors:

- Creative imagination (the creation of a variety of options),
- Philosophical principles (primary limit),
- Theoretical paradoxes (secondary limit),
- Mathematical axioms (final selection sorting),
- Experience (the final choice by searching),

from the above it is clear that the philosophical principles define the overall strategy of scientific research in this extremely complex and intricate interaction. Experience and only experience is the final arbiter in this "drama" research.

So, the heuristic function of philosophy in the fundamental theory formation is not deductive, and selective. The converse is not true, however: the selective function can be both heuristic and anti heuristic.

It all depends on what kind of philosophical principles are used for selection. It follows that philosophy can play both positive and negative role in the process of theory formation. Therefore, we both should not forget the relevance in our time of the old Newtonian warning: "Physics, beware of metaphysics!" and not ignore the heuristic value of philosophy in the theory formation as opposed to stressing positivism.

In conclusion it is useful to note that the role of philosophy in the research should be neither underestimated nor overestimated: there is always a relative independence of the scientific results from the outlook of those who receive them, whatever is the impact of philosophy on the researchers.

Therefore, the role of philosophy in the scientific research is masked by a number of "obscure" circumstances, and requires a fairly thin methodological analysis to uncover the role.

**References**

1. Avtonomova, N.S. (2011). *Jacques Derrida's philosophical language*. M .: ROSSPEN. – 510 p. (in Russian).
2. Asmus, V.F. (1965). *The problem of intuition in philosophy and mathematics*. M.: Publisher: Thought. – 312 p. (in Russian).
3. Branskij, V.P. (1973). *Philosophical foundations of quantum and relativistic principles synthesis problem*. AL: LSU. - 176 p. (in Russian).

4. Gevorgyan, A.A. (2010). *Philosophy. Science. Culture*. Yerevan: "Gitutyun" NAN RA. -527 p. (in Russian).
5. Hegel, G.F. (1974). *Encyclopaedia of the Philosophical Sciences*. V.1. M.: Thought. – 452 p. (in Russian).
6. Husserl, E. (2009). I*deas Pertaining to a Pure Phenomenology and to a Phenomenological Philosophy*. Volume I. General introduction to a Pure Phenomenology. M.: Academic Project. - 489 p. (in Russian).
7. Descartes, R. (1995). *Selected works*. - M.: University. – 701 p. (in Russian).
8. Derrida, J. (2000). *Grammatology* / Trans. and introd. article N.S. Avtonomova. M.: Ad Marginem. – 520 p. (in Russian).
9. Irina, V.R, Novikov, A.A. (1978). *In the world of scientific intuition*. M.: Nauka, -192 p. (in Russian).
10. Kant, I. (1994). *Critique of Pure Reason,* in Kant, *Works*, in 8 volumes, volume 3. Thought, - 591 p. (in Russian).
11. Karmin, A.S. (1977). *Intuition and its mechanisms* // In the book: *Methodology of Science and Problems of Scientific Creativity*, L .: Leningrad state university. – 262 p. (in Russian).
12. Karmin, A.S. (2011). *Intuition. Philosophical concepts and scientific research*. SPb .: Science. - 901 p. (in Russian).
13. Cassirer, E. (1998). *The Logic of the Cultural Sciences*. M.: "Canon +" ROOI "Rehabilitation" I.T. Kasavin. – 139 p. (in Russian).
14. Mikeshina, LA (2010). *Dialogue of cognitive practices. From the history of epistemology and philosophy of science*. M.: ROSSPEN. - 575 p. (in Russian).

Oganyan, K.M. (1990). *Genesis and development of the theoretical level of natural sciences*. Yerevan: Armenian Academy of Sciences. -221 p. (in Armenian); Oganyan, K.M (1984). "The nature and basic characteristics of scientific knowledge". *Journal of Social Sciences*, Armenian Academy of Sciences. Yerevan, -№ 11. P.123-131 (in Armenian); "The genesis of new ideas in the scientific work. "Dialectic problems. – L.: LGU, 1987. P. 13-19 (in Russian); "Some aspects of intuitivist representations of the relationship between the intuitive and logical in creativity". Problems of philosophical and psychological creativity. - Yerevan, 1987. P. 116-13 (in Armenian); "The role of research procedures in the genesis of social theory". Social cognition's determination. -Tartu, 1986. P. 11-16 (in Russian); "The role of non-logical procedures in the methodology of physical theories". *Youth and creativity (Social-philosophical problems)*. - M.: Academy of Sciences of the USSR, 1988. P. 82-87 (in Russian); "Scientific research in the formation of new ideas in creative thinking". *Management, creativity, development*. - Saratov, 1990. P. 115-124 (in Russian); "The speculative nature of new ideas (methodological analysis)". *Restructuring, theory, methodology, practice*. -Novosibirsk, 1989. P. 119-125 (in Russian); "Speculative research and genesis of types of knowledge". *Scientific and technological progress and creativity*. -M .: Academy of Sciences of the USSR, 1986. P. 119-126 (in Russian); "Scientific research (methodological analysis)". *Methodological concepts and schools in the USSR (1952-1991)*. -Novosibirsk, 1992. P. 195-215 (in Russian); *Modern philosophy and methodology of science*. SPb .: Publishing house SPbGIEU, 2016. – 166 p. (in Russian); "*The methodology of the scientific research*. SPb .: Publishing house SPbGIEU, 2016. – 158 p. (in Russian).

Stoff, V.A. (1981). "Methods of Analogy and Simulation". *Lenin's theory of reflection in the light of the development of science and practice*. V.1. Sofia. Publishing house "Science and Art". P. 414-425 (in Russian).