Scientific Worldview as an Essential Component of the Foundation of Science

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In philosophical and methodological literature of the last decades the fundamental ideas, notions and concepts more and often become the subjects of investigation, which form the relatively stable foundations on which the concrete empirical knowledge and theories, which explain them, develop.

Discovery and analysis of these foundations presupposes a consideration of scientific knowledge as an integrated developing system. In Western philosophy such vision of science became its forming relatively lately, for the most part in a post-positivistic period of its history. What's about the stage on which the concepts of science, developed in a framework of positivistic philosophy, dominated, the so-called standard conception of knowledge structure and growth was their most outstanding expression[1]. Separately taken theory and its interrelation with experience functioned as a unit of analysis in it. Scientific knowledge appeared in it as a set of theories and empirical knowledge considered as a basis on which theories develop. However it became clear insensibly that empirical basis of theory is not a pure theoretically neutral empirism, and that the facts, but not data of observation represent the empirical basis on which theories rely on. And facts are theoretically laiden because other theories take part in their formation. And then the problem of interaction between a separate theory and its empirical basis appears as problem of this theory correspondence with other theories have been formed before generating composition of theoretical knowledge of definite scientific discipline.

Somewhat from the other side this problem of theories interrelation was revealed when their dynamics had been investigated. It was revealed that the growth of theoretical knowledge was carried out not as just a generalization of experimental facts, but as usage in this process of theoretical notions and structures developed in previous theories and applied to generalize the experience. Thus theories of an appropriate science appeared as some dynamical network, an integrated system interacting with empirical facts. Systemic influence of the scientific discipline knowledge set a problem of backbone factors determining integrity of an appropriate knowledge system. In this way the problem of science foundations became to be visible due to which the different knowledge of scientific discipline is organized into systemic integrity at each stage of its historical development.

Finally, consideration of knowledge growth in its historical dynamics revealed particular states connected with crucial epochs of the science development when radical transformation of its most fundamental notions and concepts was going on. These states became called as scientific revolutions and they can be considered as the reconstruction of science foundations.

Thus the broadening of field of methodological problematic in post-positivistic philosophy of science put forward as the actual methodological problem the analysis of the foundations of science.

These foundations and their individual components were fixed and described in following terms: "paradigm" (T. Kuhn), "core of research program" (I. Lacatos), "ideals of natural order" (S. Toulmin), "major themates of science" (G. Holton), "research tradition" (L. Laudan).

In process of discussions between the followers of different conceptions the problem arose abruptly of a differentiated analysis of science foundations. The discussions around the key notion "paradigm" in Kuhn's conception are indicative in this respect. Its extreme polysemy and indistinctness was marked by a great number of Kuhn's opponents.

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1 On basic principles of this conception see Suppes (1977). An analysis of the standard conception is given in V. N. Sadovsky's works. See e.g. Sadovsky (1981, pp. 315-351).

Under influence of criticism Kuhn tried to analyze the paradigm structure. He singled out the following components: "symbolical generalizations" (mathematical formulations of the laws), examples of concrete tasks solutions, "metaphysical parts of paradigm" and values (value directions of science)[2]. This was a forward step in comparison with the first variant of conception. However, at this stage the structure of science foundations remained unclear. First of all, it was not shown in what relations the marked components of paradigm were located. This meant, strictly speaking, that its structure was not revealed. Second, according to Kuhn, as the components related with deep foundations of scientific search as the forms of knowledge which had been built on these foundations were included into paradigm. For example, mathematical formulations of local scientific laws (like the formulas expressing Joule-Lenz's law, the law of mechanical oscillations etc.) are included into the composition of "symbolical generalizations". But then it turns out that discovery of every new local law must mean a change of paradigm i.e., scientific revolution. Thus distinction between the "normal science" (the evolutionary stage of knowledge growth) and scientific revolution disappears. In third, marking such scientific components as "metaphysical parts of paradigm" and values, Kuhn fixed them ostensibly through the description of appropriate examples. It is seen from Kuhn's examples that he understood "metaphysical parts of paradigm" either as the philosophic ideas or as the principles of concrete scientific character (as like as a principle of short-range action in physics or principle of evolution in biology). What's about the values, their Kuhn's characteristic is also looks as only the first and extremely approximate draft. At an essence, here the ideals of science are intended at that taken in extremely limited range as ideals of explanation, prediction and application of knowledge.

In principle, it may be said that even in the most advanced investigations of the foundations of science, to which T. Kuhn's works can be attributed to, Western philosophy of science is insufficiently analytical. It has not established yet what are the fundamental components of science foundations and their links. The links between the science foundations and relying on them theories and empirical knowledge have not been clarified yet. This means that the problem of the foundations' structure, their place in a system of knowledge and their functions in its development requires further deeper discussion.

In current and developed system of disciplinary scientific knowledge the foundations of science are discovered, first, when analyzing the systemic relations between the theories of varying degree of generalization and their respect to different forms of empirical knowledge in a framework of some discipline (physics, chemistry, biology etc.). And second, when investigating interdisciplinary relations and interactions of different sciences.

As the most important components forming the foundations of science one may single out the following: 1) scientific picture of the world; 2) ideals and norms of scientific cognition; 3) philosophical foundations of science.

The mentioned components express general views on specificity of the scientific investigation's subject, on particularities of cognition activity setting this or that type of objects, and on character of relations between science and culture of appropriate historical epoch.

Analysis of the picture of the world as a particular component of scientific knowledge presupposes a preliminary clarification of meaning of the initial terms the "world" and the "picture of the world". It is ought to distinct the category the "world" in its philosophical sense, when it is spoken about the world as a whole, from those notions of the world that are formed and used in concrete sciences, when it is spoken about the "world of physics", the "world of biology", the "world of astronomy" etc, i.e. about the reality which makes up a

2 Kuhn (1962).

subject of investigation of appropriate concrete scientific discipline.

The picture of the world as like as any cognitive image simplifies and schematizes the reality. The world as endlessly complicated, developing reality is always greatly larger then the views on it formed at the definite stage of social an historical practice. Together with it, at the expense of simplifications and schematizations, the picture of the world singles out from endless variety of the real world just those its essential links, which perception makes the major purpose of science on this or that stage of its historical development.

When describing the picture of the world these links are fixed as a system of scientific principles, which the investigation relies on and which allow to it to construct actively the concrete theoretical models, to explain and predict empirical facts. In its turn, the practical application field of these moments contains the potentially possible spectrums of technical and technological phenomena which the human activity relying on theoretical knowledge is able to generate. This aspect of the picture of the world attitude towards the world itself requires a particular understanding. It is necessary to consider that owing to the human activity the lines of development are realized which are possible and are not contradictory to the nature laws, but at the same time are improbable for it. Overwhelming majority of objects and processes generated by the human activity belongs to area of artificial and not emerging in nature itself without humans (nature created neither a steamship, nor a car, a computer, the cities architecture). But as science creates preconditions for appearance in technical and technological supplements a wide spectrum of such "artificial" objects and processes, as one may guess the scientific picture of the world as an extremely abstract "matrix" of their outcome. In this sense one can say that scientific picture of the world, being a simplification, includes together with this includes a more reach content in comparison with actually existing world of natural processes because it opens the abilities to actualize the improbable for the nature itself (though not contradicting its laws) directions of evolution.

The further substantial explication of notion the "scientific picture of the world" presupposes clarification of the major meanings in which term "the picture of the world" is used taking into account its extreme polysemy.

In contemporary philosophical and special scientific literature it is applied, for example, for designation of worldview structures lying in a fundamental of culture of a definite historical epoch. In this meaning such terms as "image of the world", "model of the world", "vision of the world" characterizing the integrity of the worldview are used. The picture of the world's structure in such approach is given through the system of so-called categories of culture[3] (universalities of culture).

Broad interpretation of term the "picture of the world" gave reason to series of investigators to equate the notions of the worldview and the picture of the world. So, for example, A. Chanyshev had mentioned that "under the worldview we mean the general picture of the world i.e., more or less complicated and systematized aggregate of images, concepts and notions in which and through which the world is realized in its integrity and unity. And (what is the most important) the place of such most important (to us) part of the worldview as the humanity is also realized in this way"[4].

However in this case it is very important to bear in mind that the worldview image of the world is not only a comprehension of the world and the knowledge about it. But at the same time it is a system of values determining the character of the attitude, of human experience of the world and a defined evaluation of these or those its events and occurrences and, accordingly, active approach of a human to these events.

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3 See e.g. Gurevich (1972, pp.15-16).

4 Chanyshev (1982, pp. 38-43).

In A. Chanyshev's definition the accent is made on the cognitive aspects of the worldview and value and active aspects of the picture of the world as a worldview's image are not fixed in a clear form. If to take them into consideration, the notion the "picture of the world", used in meaning of the worldview as the image of the human's world, then acquires a more adequate determination.

Application of term the "picture of the world" in this meaning can be found not only in the Russian, but in the foreign investigations, including those dedicated to science philosophical problems.

One can mark that in Western philosophy of science in the 80s a rehabilitation of its kind was going on with the notions the “worldview” and the “picture of the world”. G. Holton paid attention to this aspect of the problem. He noted that philosophy of science was compelled to appeal to these phenomena when necessity of complication of science methodological analysis arose and accordingly the need in more delicate methodological toolkit appeared[5]. Together with this, it was practically identified with the worldview when there was a discourse about the picture of the world. Notion of the picture of the world as a synonymous of notion of the worldview exactly is used in the G. Holton’s conception. It appears in his works as a model of the world which “generalizes the experience and innermost human views, and plays a role of an original mental map with which a human checks his actions and orients among things and events of real life”[6]. Its main function is to be a connecting force directed to the human society consolidation.

Together with the picture of the world’s understanding as the worldview G. Holton uses the notion the “scientific picture of the world” too. It seems he is close to distinguish the picture of the world as the worldview and the scientific picture of the world. However, judging by a context, term the “scientific picture” of the world is also used by him in the meaning of the worldview. And the adjective “scientific” is used to underline that the human worldview must base on collection of received scientific results but not on every possible cults, astrological prophecies etc.

G. Holton does not only fixes the picture of the world presence but aims to discover its thematic core. He mentions that at center of each picture of the world, forming it’s the most important in epistemological sense cognitive structure, the collection of thematic categories and assumptions is situated. They bear a character of unconsciously accepted, non-checkable, quasi-axiomatic basis statements which became firmly established in practice of thinking as its guiding and supporting means[7]. Giving the examples of thematic preconditions, Holton have already spoken about the scientific picture of the world and have called it such its thematic categories as “hierarchy/reductionism – integrity/holism”, “vitality - materialism”, “evolution – statism – regress”.

One can evaluate as positive the striving of Western philosophy of science in the last years to include into the arsenal of methodological analysis the new categorical means. But together with this let’s note that the no clear differentiation between the notions the “picture of the world” and the “scientific picture of the world” has been made yet.

In Russian philosophical-methodological literature the term the “picture of the world” is applied not only for designation of the worldview, but in a more restricted sense, when talking about scientific ontology i.e., those conceptions of the world which are a particular type of scientific theoretical knowledge.

The scientific picture of the world appears in this meaning as a specific form of scientific

5 Holton (1992, pp. 38-39).
6 Ibid, p. 38.
7 Ibid, p.41.

knowledge's systematization, giving a vision of science's subject world accordingly to definite stage of its functioning and development.

This sense of notion the "picture of the world" was noted not right away. Only as philosophical-methodological reflexion on the scientific activity was developing, the ability appeared to fix some integrative system of conceptions of the world as a particular science's component. This system is worked out as a result of knowledge's synthesis, which had been obtained in different fields of scientific investigations, and afterwards this system acquired the name of the scientific picture of the world.

With appearance of science and gradual increase of its influence on social life the worldview meanings begin their forming in many respects under the scientific picture of the world's impact. This picture is beginning to appear as a component of the scientific worldview which in many aspects makes the investigator's activity purposeful. This component fixes only the one block in the worldview, which represents knowledge about the world's structure which were received at some stage of historical development of science. And as the scientific picture of the world appears only as the worldview component, there are no reasons in this sense to speak about coincidence of the worldview and the scientific picture of the world. But at the same time it is impossible to draw a tough demarcation line between them. It is better to talk about interrelation between the worldview and the scientific picture of the world. One may note that prominent naturalists, comprehending the science history, faced this problem. For example, V. Vernadsky paid a sufficiently great attention to analysis of interrelation between the scientific picture of the world and the scientific worldview. He underlined that scientific worldview, which certainly includes as a component the general-scientific picture of the world and also its philosophical foundations, was developing in a close interaction with all aspects of society spiritual life. The fruitful attempt was undertaken in Vernadsky's works to track the mutual influence of scientific world view and different forms of spiritual life which is necessary nutrient medium for developing science.

Enough stable dependence of scientific conceptions of the world (the scientific picture of the world) from wider field of culture, in which science functions, and backward influence of science on other spheres of contemporary culture have been noted by the other naturalists. So, E. Schrödinger carried out the analysis of interrelation between the picture of the world which was introduced in quantum-relativistic physics, and the culture of contemporary technical civilization. The latter appeared as tendency to purposefulness of subject forms, simplicity, "predilection to deliverance from traditions" as the expression of social life dynamism, "mass governance methodic oriented to search of the invariant within a set of possible decisions" etc[8].

This aspect of mutual influence of the scientific picture of the world and the worldview's structures, forming a fundament of technogenic culture, is extremely actual, because it allows to concretize the problem of internal and external scientific development's factor's correlation. And, what is especially important, not only in separately taken sciences but in a science as a whole, the periods of intensive reorganization of scientific worldview take place together with quiet states[9].

At least the following interrelated aspects may be distinguished in the worldview itself: axiological, epistemological and ontological.

Scientific picture of the world can make significant influence on formation of the worldview's ontological components. It is clear, this relates only to particular types of cultures and civilization development. In traditional civilizations science did not make significant

8 Schrödinger (1971, pp.38-42).
9 Vernadsky (1981, pp.229-232).

influence on dominated worldview structures. An influence like this is peculiar only to non-traditional societies that have started the way of technogenic development.

The scientific picture of the world interacts with the worldview structures, which are forming culture's fundament, both directly and indirectly through the system of philosophical ideas, which appear as a rational explication of corresponding worldview meanings.

Thus the problem of correlation between the scientific picture of the world and the worldview transforms into the problem of interrelations between scientific, philosophical picture of the world and basic worldview images of culture.

To discuss this problem it is necessary previously to specify the appropriate notions. In the beginning it is purposefully to concretize the notion of the worldview as an integral image of human world, and to clear up its correlation with the system of world's conceptions creating in philosophy. As this theme have been discussed intensively enough in our philosophical literature in the last years[10], I will only briefly reproduce the most important results which are related to the raised problem.

Categories the "world" and the "human" are the fundamental categories of the worldview. They can be concretized through the system of categorical meanings of other culture universalities expressing the human attitudes to nature, society, other people and to himself (meanings of categories "nature", "space", "thing", "attitude", "Myself", "others", "freedom", "conscience" and others). All these worldview categories always have the sociocultural dimension and in many aspects determine the character of human vital activity and consciousness at this or that historical stage of social development.

Categorical structures of the worldview determine the mode of the world comprehension and understanding by a human. They specify an integral image of human vivid world, a picture of this world. And if at the early stages this picture had the anthropomorphic, mythological character, the worldview along with emergency of philosophy acquired status of theoretical nature.

Philosophy exactly constitutes theoretical core of the worldview. Carrying out the reflection under the culture universalities, it reveals and expresses them in logical-conceptual form as philosophic categories. Operating them as with particular ideal objects, philosophy is able to construct the new meanings and thus the new categorical structures.

As the result of analysis of correlation between philosophy and the worldview the new meanings of notion the "picture of the world" are revealed. Philosophical cognition also strives to build such picture, explicating and developing senses of culture universalities in a form of philosophical categories. But the actual worldview structures represented with a network of culture's categories, and their philosophical explication are not identical. Philosophy as theoretical core of the worldview not only schematizes the images of the world represented by meanings of culture categories, but constantly invents the new non-standard conceptions going out of the framework of these images[11].

As a result the analytical differentiation of problem of interrelations between the worldview, philosophical world's images and the scientific picture of the world takes place.

Science experiences the influence of philosophical principles and regulations from the beginning of its formation and in its development. In our time the philosophers of different orientations recognize their value and heuristic amount for development of scientific knowledge.

Although the series of investigators in Western philosophy noted that the philosophical

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10 See e.g. Gurevich (1972), (1983); Stepin (1986).

11 More detailed about correlation of philosophical categories and universalities of culture in functions of philosophy in culture will be said below, in part "Philosophical foundations of science".

ideas productivity in development of scientific knowledge, nevertheless mechanism of this influence had not received sufficient basis in their investigations. In this respect the results obtained in Russian philosophical literature look more preferable. It is related in many aspects with revealing, on the one hand, of a particular layer connecting the worldview and philosophy, and concrete-scientific knowledge on the other one. The scientific picture of the world just appears as this layer in relation to the system of ontological conceptions. Yet in the 60s, investigating the mechanisms of philosophy influence on physical knowledge formation on the material of physics, M. Mostepanenko had emphasized that a particular intermediate existed between physical theory and philosophy. Through this intermediate, on the one hand, philosophy influenced on physics, and on the other hand, physics influences on philosophy. This intermediate is the "system of physical conceptions and notions called as the physical picture of the world"[12]. V. Chernovolenko developed the analogous point of view. To his opinion, the "scientific picture of the world is such horizon of knowledge systematization, where theoretical synthesis of results of concrete sciences' investigation with knowledge of the worldview character occurs. The latter represent integral generalization of aggregate practical and cognitive experience of humanity. The scientific picture of the world is joint both with theoretical systems of lesser generality extent (concrete sciences, generalizing theories of natural science etc.) and with maximally wide form knowledge and experience systematization which is called as the worldview"[13].

The scientific picture of the world always bases on definite philosophical principles. But they are itself do not give and replace it yet. The mode of generalization and synthesis of most significant scientific achievements form this picture inside of science. Philosophical principles orient this synthesis process and substantiate the results obtained in it.

The scientific picture of the world can be viewed as a form of theoretical knowledge, representing the science subject of investigation accordingly to definite historical stage of its development. The concrete knowledge obtained in different fields of scientific search are integrated and systematized by means of this form.

As the different levels of knowledge systematization exist in a framework of the scientific picture of the world, three major types of its are distinguished. Accordingly, one can point at three major meanings in which notion the "scientific picture of the world" is applied when characterizing the processes of science's structure and dynamics. First of all, it designates the particular horizon of systematization of knowledge obtained in different sciences. In this meaning they talk about general scientific picture of the world which appears as an integral image of the world including the conceptions as of nature as of society. Secondly, term the "scientific picture of the world" is applied to designate the system of conceptions of nature, which are formed as result of the synthesis of achievements of natural science's disciplines. In analogous way this notion may denote an aggregate of knowledge obtained from humanitarian and social sciences. Thirdly, the horizon of knowledge systematization in a separate science is denoted by it, fixing an integral vision of the given science's subject. This vision forms at definite stage of this science history and changes when transitioning from one stage to another. In accordance with the noted meanings the notion the "scientific picture of the world" is splintered in the raw of interrelated notions. Each of these notions means a particular type of the scientific picture of the world as a specific level of scientific knowledge's systematization. These are the notions of general scientific, natural scientific, social, and, finally, local (special) picture of the world.

In the latter case term the "world" is applied in particular, narrow sense as the world of a

12 Mostepanenko (1969, p.5).
13 Chernovolenko (1970. p.122).

separate science ("world of physics", "biological world" etc.). In this connection the term "picture of the reality under consideration" is also applied in Russian literature to designate the disciplinary ontology. Under the "reality under consideration" a universal set fragment or aspect is understood which is studied by methods of corresponding science and which forms a subject of its investigation.

Each of these types of scientific picture of the world experienced the impact of the worldview structures at the different stages of science functioning, and together with this made its contribution in their formation and development.

The worldview can influence on the "scientific picture of the world" development both directly and indirectly through the philosophy which subjects the worldview categories to reflexion.

Interrelation between the worldview, philosophy and the "scientific picture of the world" fixes the infrastructure of developing knowledge system, which determines strategy of investigations and including their results into culture. At the same time the scientific picture of the world belongs to the inner structure of science represented by the interrelations between theoretical and empirical knowledge.

Historical evolution of notion of the "scientific picture of the world"

Notion of scientific picture of the world was introduced into the composition of conceptual apparatus of philosophy and methodology of science in many respects due to investigation of mechanisms of formation of scientific theories and empirical facts, taking into account the processes of scientific knowledge differentiation and integration. Scientists-naturalists and philosophers made their contribution into this notion elaboration.

The important incentive to the analyzing of the scientific picture of the world's place and functions were the revolutionary improvements of natural science on the boundary of 19-20th centuries, when the problem of choice and justification of physics' ontological postulates was set enough keenly. As the one of this problem's aspect, the question of ontological status of fundamental abstractions arose. Investigators perceived the latter as adequate reflection of the objective reality's fragments. The whole raw of such abstractions (indivisible atom, world's ether, absolute space and time) turned out to idealizations that had a limited field of application. So it was necessary to clarify in what extent do the physical notions express the essence of investigated objects and processes.

Different approaches have existed to considering the problem of notion's ontological status and scientific conceptions. In a classical epoch the majority of naturalists shared the point of view accordingly to which the complete correspondence of fundamental notions confirmed by experience to the external world's elements had existed. Supposed that experimental confirmation of fundamental abstractions allowed to discover all attributes of these abstraction in reality itself, that guaranteed exact and exhaustive reflection of essence of the investigated processes in science. But yet in the second half of 19th century this position had been undermined by a series of facts. It became clear, for example, that abstractions of phlogiston and thermogen, allowed for the time being to describe and to explain the experience, did not had correlates in nature, though earlier they had been identified with particular substances. Revolution in science in 19-20th revealed limitation of mode of thought at which fundamental scientific abstractions appeared as definitive and invariable and demonstrated flexibility and variability of scientific notions.

Discussion of problem of correlation between the science's fundamental notions with the investigated reality led to discovery of important characteristics of scientific picture of the world. So, M. Planck insisted on that the objective picture of the world construction was an ideal of natural science, and set a question: what is that we call the physical picture of the world? Is the picture of the world only more or less spontaneous creation of our mind, or, vice

versa, are we obliged to admit that it reflects the real, absolutely not depending from us natural phenomena?[14] From its point of view, the striving to find a constant scheme, not depending from the change of times, is characteristic for the natural scientific investigation. And in this sense yet the contemporary picture of the world, although is glittering with different colors depending on investigator personality, nevertheless contains in itself some features which none revolution in nature or in the world of human thought can erase anymore. This constant element, not depending on any human or even on any thinking individuality, constitutes what we call the reality[15].

Planck emphasized that change and development of the scientific picture of the world did not abolish these constant elements but preserves them adding the new elements to the existing ones. By this way the succession in development of scientific picture of the world and the more and more detailed reflection of the world in scientific cognition are carried out.

The presence of elements in every picture of the world corresponding to objective reality allows identifying this picture with the world itself at once. Ontologization of the picture of the world, accordingly to Planck, has the vital importance in a process of scientific creative work. He mentioned that outstanding investigators (Copernicus, Kepler, Newton, Huygens, Faraday) had made their discoveries, only due to that the basis of all their activity was stable confidence in actuality of their picture of the world[16].

Together with this the change of physical pictures of the world shows that not all their elements may be compared with objective reality. In this relation the new questions arose: what were the arguments to ontologize our conceptions of the physical world, how did the ascription of the picture of the world elements to objective reality carries out? Planck did not formulate these questions in an explicit view, but the determined preconditions for their setting were laid in his works. Further discussion of given problematic required consideration of physical knowledge in a particular aspect. This aspect was from the point of historical development of conceptual scientific means and their role in empirical and theoretical investigation of physical objects. A great work in this direction was made by A. Einstein in connection with the notion the "physical reality". Term the "physical reality" introduced by Einstein into physics methodology for designation of physical cognition basis, had several meanings. As a minimum, one can point at two main Einstein's interpretation of this term. In the first meaning he used term the "reality" to characterize an objective world existing outside and independently from human consciousness. Einstein mentioned that trust in the external world existence that is independent from perceptive subject, lies in foundation of all the natural science[17]. However the way we perceive the world under investigation and how the structure of this world is seen by us depends on the level of cognition and practice development and from the system of conceptual means applied when describing the world.

With their assistance we as if single out some aspects and structural characteristics of objective world and built a theoretical conception in which the world is reflected simplified and schematized. In such approach at the different stages of science development, investigators may uncritically identify the conceptions of the world with the world itself. So when analyzing the physical theory it is necessary to take into consideration the distinction between objective reality, which does not depend on any theory, and those physical notions that the theory operates with. These notions are introduced as the elements which must correspond to objective reality and with assistance of these notions we imagine this reality[18].

14 Planck (1958).
15 Ibid.
16 Ibid.
17 Einstein (1931).
18 Einstein, Podolsky and Rosen (1935).

Here Einstein came to the second aspect of the physical reality consideration. Term the "physical reality" is used in this meaning for "consideration of theorized world as an aggregate of theoretical objects representing the properties of the real world in a framework of given physical theory"[19]. In this plan the "physical reality" is given by means of scientific language with assistance of which a physician comprehends the essence of investigated objects. But the same reality can be described with assistance of different language means.

Einstein considered this circumstance and fixed the difference in reality description on empirical and theoretical levels of scientific cognition. Correspondingly to that he noted the distinction in vision of the physical world at the different levels of its cognition. Einstein talked about the different pictures of physical world: the picture of physicist-experimentalist's world and the picture of the physicist-theorist's world.

Making a comparison of these pictures of the world, he gave preference to the picture of the physicist-theorist's world. He did so on this foundation that “due to the usage of mathematics this picture satisfies the highest requirements with respect to strictness and accuracy of expression of interrelations”[20] and that this picture exposes the regularities of the physical world. But, talking about the picture of the physicist-theorist's world, Einstein did not make detailed analysis of theoretical language itself. In a framework of this language's system he did not mark those statements, which could represent the picture of the world, in distinction from separate theories which were connected with it. And he did not set a question about distinction between theory and the picture of the world in this system. Einstein applied the notion itself the "physical picture of the world" in different senses. Together with the senses have yet been noted, he talked about the picture of the world as "a minimum of primary notions and correlation of physics which provide its unity". Evidently, this sense is closer to characteristic of the physical picture of the world as a particular component of scientific knowledge, which differs from concrete physical theories and at the same time unifies them providing their synthesis. However, we don't find in Einstein's works the more strict definition of the physical picture of the world taken in this meaning. He distinguished the picture of the world from theory, most likely, at the level of methodological intuition.

On the heels of Planck Einstein emphasized that every picture of the world simplifies and schematizes the reality. But at the same time it reveals some essential features of reality. It allows identifying the picture of the world with the world itself to the definite moment (till investigator discovers the new, earlier unknown aspects of reality). "A human strives to create by a some adequate mode the simple and clear picture of the world within himself to try fairly to replace this world by the picture created by this mode"[21].

The ideas of schematizing role of the physical picture of the world were noted by many creators of contemporary physics (N. Bohr, M. Born, W.Heisenberg). They considered the physical picture of the world development as a result of discovery in a cognitive process the new properties and aspects of nature, which had not been considered in previous physical picture of the world. In this case insufficiency and sketchiness of previous conceptions of nature discovered clearly, and they were reconstructed into the new physical picture of the world. N. Bohr had written that Planck’s discovery, which was speaking that all physical processes were characterized by unusual for the mechanic picture of nature discontinuity features, revealed the fact that the laws of theoretical physics were the idealizations. And these idealizations were applicable to the event descriptions only when the magnitudes of action dimension participating in them were sufficiently large to neglect the quantum's value. At the

19 Chudinov (1976, p.33).
20 Einstein (1967, p.40)
21 Ibid, p.40.

time when this condition is performed with a large reserve in events of usual scale, we face the regularities of quite another type in atomic processes[22]. Exactly this circumstance required the rejection from the mechanical picture of the world. M. Born, generalizing the experience of physics historical development, noted that every physical picture of the world has its limits but till the consciousness has not faced the outside world obstacles, these borders can not be seen. They are discovered by physic's development itself, by revealing the new facts displaying the action of the new natural laws[23]. Discovery of such borders of the previous picture of the world leads to widening and deepening of knowledge and opens the new ways to the Nature's studying[24].

Classics of contemporary natural science showed that to create the every new picture of the world, as a rule, the elaboration of definite categorical apparatus is required. This categorical apparatus acts as a base of its kind on which the scientific picture of the world is created. So, N. Bohr, A. Einstein emphasized that mechanical picture of nature was based on notions of indivisible corpuscle, absolute space and time, Laplacian causality. And the physical reality was imagined, after Maxwell, as continuous fields which cannot be explained from mechanical point of view[25].

Further physics development, as N. Bohr mentioned, led to the classical pictures modifications. Specifically, general theory of relativity elaborated the new notions, widened our scope with their assistance and gave to our picture of the world the unity which could not had even been imagined before[26]. It led to absolutely new picture of the world, modifying its Newton's construction[27].

Classics of natural science fixed the circumstance that the great revolutions in physics had always been related with reconstruction of the picture of the world. Noting that mechanics creation was a revolution in science, many of them evaluated Newton's conception of nature as the first scientific picture of the world28.

Revolution during which the transition from classical physics to contemporary one was carried out was also related with radical reconstruction of picture of the world. Creators of quantum relativistic physics paid much attention to analysis of preconditions which provided the reconstruction like this. In this analysis they picked out the extremely important circumstance that transition to the new vision of the physical world required the changes of deep orientations of physical investigation.

The understanding of dependence of our conceptions about the physical world from the position of cognizing subject at the Universe and from the specifics of its cognitive means, due to which it marks in nature these or those its objects and links, is expressed clearly in works of A. Einstein, M. Born, W. Heisenberg and particularly of N. Bohr.

This new mode of thinking appeared as condition for building the new, adequate to nature, picture of physical reality.

In works of contemporary physics creators the point of view is expressed clearly that changes, which occurred in our understanding of the world owing to theory of relativity and quantum mechanics, did not mean the introduction of some subjective element into science and refusal from building of adequate picture of nature. They meant only collapse of the picture of the world and creation of another one representing more thorough understanding of

22 Bohr (1963).
23 Born (1956).
24 Ibid.
25 Bohr (1971, p.505), Einstein (1967a).
26 Bohr (1963).
27 Vernadsky (1981, p.237).
28 Einstein (1945), Wiener (1948), Vernadsky (1977, p.84).

"reality" nature[29].

Evaluating the statement of contemporary physics from these positions, prominent naturalists pointed that it represented only one of all steps of evolution of our nature picture and it is necessary to wait that this evolution would not stop[30].

Selection and investigation by natural science classics of different aspects of complex and many-sided problem of scientific picture of the world were related in general with analysis of physical picture of the world. By virtue of prolonged leading position of physics in natural science and owing to fundamental nature of knowledge received in this science, the attempts were made repeatedly to explain from positions of existing physical picture of the world such appearances, which did not relate to the subject of physical science. But the physical picture of the world did not contain in itself all the knowledge about the world. So it could not give the adequate interpretation of all natural phenomena. Situation like this required the introduction of another world vision, a particular picture of it (irreducible to the physical one), which contained the conception of those objects too, which did not included into physics subject of investigation.

This aspect of the problem was analyzed sufficiently in details by V. Vernadsky, N. Wiener, M. Born.

So, Vernadsky considered the physical picture of Cosmos only as the one of ways of the world's description. Investigator deals in it only with conceptions of ether, quanta, electrons, lines of force, curls, corpuscles[31]. But knowledge about the world must not be confined only by the knowledge about fragments obtained with assistance of these physical notions. The world around us is the huge variety of appearances and an important place in it belongs to the particular element. This element is the element of natural which the physical picture of the world does not describes. So, accordingly to V. Vernadsky's opinion, together with the physical, the "naturalistic" conception of the world exists ("the naturalist's picture of the world"), which is "more complicated and closer and actual to us, that is still associated not with the whole Cosmos, but with its part that is our planet, the conception of environment which every naturalist, studying the describing sciences, possesses. The new element, which is absent in constructions of cosmogonies, theoretical physics or mechanics, is always included in this conception. This is the element of living substance"[32]. Actually, Vernadsky enough clearly fixed one of the types of scientific picture of the world – the natural science picture of the world – as a particular form of systematization and synthesis of knowledge obtained in sciences of natural-science cycle.

One can find in his statements such important idea that there are the foundations about the general scientific picture of the world too, which organically joins the conceptions of inorganic matter's development and the conceptions of biological and social evolutions[33]. This arterial way of science's development must provide in future the construction of unite picture of the world in which "separate local events are combined together as the parts of a whole. And in the end the one picture of the Universe, Cosmos, in which the motions of celestial bodies and the structure of smallest organisms, and the human societies' transformations are included"[34].

The same ideas were expressed by the other prominent naturalists of 20th century too. So,

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29 Born (1956).

30 Dirac (1963), (1963a).

31 Vernadsky (1978, p.13).

32 Ibid.

33 In essence, it is talked about the ideas of global evolutionism which will find their realization in the modern scientific picture of the world. It will be discussed below.

34 Vernadsky (1981, p.43).

N. Wiener wrote about necessity of such picture of the world building, which would join together the achievements of physics, biology and other sciences[35].

This integrative picture of the Universe (general scientific picture of the world) was considered by naturalists as the scheme of the world.

"In the 20th century a human tried again, basing on data which natural science had accumulated by our epoch, to create the general picture of the world, but of the extremely schematized and simplified world"[36]. Thus, idea that our picture of reality was only approximation to the objective world and that this picture contains relatively true conceptions about it, was developed by the classics of natural science not only in relation to the physical picture of the world but to the general scientific one too.

Considering general picture of the world as the reality's schematization, eminent naturalists noticed that together with facts of science, some other extraneous features, which certainly could not be referred to scientific facts, might be included in it. These extraneous features "sometimes represent the real "fictions" and simple "prejudices" which disappear from scientific picture of the world as time goes by. But at the definite stage they can assist to science's development because they stimulate setting of such tasks and questions, which serve as of their kind the scaffoldings of scientific building. They are necessary and inevitable when this building is being created, but then they disappear without a trace"[37].

So, the methodological analysis of science history during the period of transition from the classical natural science to the contemporary one, carried out by eminent naturalists of the 20th century, revealed series of important characteristics of picture of the world as a particular form of knowledge, which brings together variety of the most important facts and most significant theoretical results of science. First of all, it was fixed that fundamental notions and fundamental scientific principles generate the picture of the world. Their system introduces an integral image of the world in its main aspects (objects and processes, nature of interrelation, spatial-temporal structures).

Secondly, the important characteristic of picture of the world is its ontological status. The composing it idealizations (notions) are identified with reality. The true knowledge moment containing in these notions is a base for this. Together with this such identification has its limits which are revealed when science discovers objects and processes not beyond the frameworks of idealized admissions implicitly containing in the picture of the world. In this case science creates the new picture of the world considering the particularities of new types of objects and interrelations.

Thirdly, in classics' methodological generalizations the important question was set about correlation between disciplinary ontology such as physical picture of the world with general scientific picture of the world elaborating as a result of interdisciplinary synthesis of knowledge.

Unfortunately all these important methodological results were not assimilated by Western philosophy of science for a sufficiently long time. The cause of this was dominance of positivistic attitudes of methodological analysis. These attitudes entered extremely narrow idealization of scientific knowledge considering it outside of links with practical activity and culture. Knowledge was analyzed outside consideration of historical development of means and modes of scientific investigation too. The separately taken scientific theory and its correlation with experience, but not the system of scientific theories and disciplines interrelating in a process of science historical development, were selected as a primary unit of

35 Wiener (1948).
36 Friedman (1965, p.5).
37 Vernadsky(1981, pp.62-63).

methodological analysis. At such approach it was extremely difficult to fix the scientific picture of the world as a specific form of knowledge because it is discovering just when analyzing the processes of intra-disciplinary and interdisciplinary synthesis of knowledge, knowledge relation to the reality under consideration (the ontological capacity problem), links of empirical and theoretical knowledge with philosophy, the worldview and culture.

Only after collapse of positivism and critical overcoming of its principles the definite preconditions were created in Western philosophy of science for investigation of scientific picture of the world. Those preconditions were the sufficiently substantiated refusal from positivistic requirement to eliminate the "metaphysical principles" from science language and the recognition of philosophy's heuristic role in development of scientific knowledge; the knowledge analysis taking into account its history, refusal to consider knowledge only from the side of its formal structure and of its substantial aspects studying including general cultural and philosophical determinants; choice of series of scientific theories in their relation to metaphysical statements as a primary unit of methodological analysis. As a result of this the means of methodological analysis were significantly broadened and certain steps were made towards the studying of superior forms of systematization of knowledge to which scientific picture of the world belonged also.

The most significant improvements in investigation of highest norms of knowledge's systematization forming deep scientific structures were established in conceptions of T. Kuhn, I. Lacatos, G. Holton, L. Laudan. The truth is that scientific picture of the world as a particular form of knowledge was not fixed evidently in any of these conceptions. But some elements of science's foundations, functionally coinciding with this form of knowledge were described in postpositivistic researches. So, in Kuhn's conceptions the key notion of paradigm was determined in the beginning as "…some accepted examples of actual scientific practice – examples which … provide models from which spring particular coherent tradition of scientific research"[38]. Subsequent attempts to concretize this notion led to fixation of a particular block marked by Kuhn as "metaphysical parts of paradigm"[39]. He understood them at least in two senses: as philosophical ideas participating in forming of scientific knowledge and as principles having a concrete-scientific character and lying in foundations of scientific theories. In the latter case the matter is, in essence, about the system of ontological postulates constituting the scientific picture of the world.

If to take into consideration that "metaphysical parts of paradigm" really belong to deep structures of science and its foundations, even their preliminary fixation could stimulate the new task setting which is more detailed analysis of science's foundations. If one differentiates the knowledge block which Kuhn marked as "metaphysical parts of paradigm" and singles out the scientific picture of the world distinguishing it from philosophical foundations of science, the paradigm's functions fixed by Kuhn should be referred also to the scientific picture of the world. Scientific picture of the world appears as such vision of investigated reality, which determines a set of admissible tasks and orients when choosing the modes to solve it.

The idea of anomalies and crisis as the preconditions to change the paradigm is very important to Kuhn. If to consider the development of scientific picture of the world in concordance with this idea, the problem arises of mechanisms of correlation between empirical facts and concrete theories and distinguishing of two types of situations: when facts and new theoretical corollaries are coordinated with picture of the world and when mismatch arises between them expressed in accumulation of inexplicable facts and appearance of paradoxes.

38 Kuhn (1962, p.10).
39 Ibid.

Thus, in spite of insufficient preciseness and insufficient differentiation capacity of Kuhn's analysis of knowledge dynamics, there was in it the hidden positive content which was necessary to assimilate when investigating structure and dynamics of science's foundations and scientific picture of the world as their most important component.

Analogously it is ought to regard to conception of "research programs" by Lacatos. The main notion of his conception was polysemantic as the notion of paradigm. Under "research program" Lacatos, for example, appreciated a concrete theory as like as Sommerfeld's theory of atom. He also talked about the Cartesian and Newtonian metaphysics as two alternative programs of mechanics construction. Finally, he wrote about the science as a whole like the global research program[40]. However at the same time the problem of revealing the hierarchy of research programs of science was hidden in polysemy and uncertainty of initial term. But to do this the more greatly differentiated analysis of scientific knowledge structure was necessary than the one had been represented in Western philosophy of science.

If to apply the characteristics of research programs marked by Lacatos to analysis of scientific picture of the world, they would allow the revealing of its new functions in dynamics of science. Firstly, the consideration itself of picture of the world as a research program includes a specific content (which was noted also in Kuhn's conception) which means that picture of the world must determine the frame of admissible theoretical and empirical tasks and the choice of means for their solution.

Secondly, the specific feature of rigid program's core to preserve oneself at the expense of protective hypothesis's belt even in conditions of its mismatch with facts was noted in Lacatos's conception. This circumstance throws light on well-known situations when even the appearance of paradoxes to explain the new facts does not bring about to refusal from the previous picture of the world, but stimulates the attempts to explain facts at the expense of engaging additional hypothesis.

Thirdly, the specific feature, marked by Lacatos, of majority of research programs' development presupposing its competition allows to clarify the important aspects concerning with reconstruction of pictures of reality under consideration (special scientific pictures of the world). It requires to pay attention to existence of pictures of reality that are often alternative to each other. Their competition characterizes development of science at the stage of scientific revolutions.

When investigating the transformation processes of scientific picture of the world, the problem of succession in development becomes important. This problem was not considered by I. Lacatos and, in essence, was eliminated by T. Kuhn, who interpreted the paradigms changing as Gestalt-switching.

G. Holton made the significant contribution in solution of this problem. He considered history of science as translation and meeting of different thematic ideas (themes), which were realized through the categorical structures, principles and concrete knowledge about the appropriate subject area and the methods of its investigation[41.]

In content of these themes G. Holton separately noted the fundamental ideas of structure of investigated reality as like as ideas of atomism, conceptions of space and time, principles of Laplacian and quantum mechanical determinism, principles of evolution of organisms and species[42] etc. Taking into consideration that ideas, principles and conceptions like these constitute the scientific picture of the world, in Holton's conception, in essence, the succession was revealed accompanying the change of scientific pictures of the world. In this

40 Lacatos (1970, pp.127-128, 132-133).
41 Holton (1988).
42 Ibid.

point Holton's conception had something in common with ideas expressed by classics of natural science, which noted the assimilation of elements belonged to objective content in process of historical evolution of scientific picture of the world.

Series of interesting ideas regarding to dynamics of deep research traditions of science can be found in L. Laudan's conception.

Analyzing a science as a historically evolving process, he consecutively developed the idea of theoretical weight of scientific problems. Their field is determined by theoretical vision of the world which, accordingly to Laudan, represents the most important aspect of research tradition.

From his point of view, the history appears as the history of becoming, functioning and changing of research traditions.

The notion of research tradition in its semantic content is close to Kuhn's "paradigm", Lacatos's "research program", Holton's "theme". Laudan noted the ontological admissions as the essential component of scientific tradition. This is the particular layer of knowledge which in many aspects coincides in its functions with characteristics of scientific picture of the world.

According to Laudan, science in a greater extent deals not with facts, but with problems which solution depends on accepted methodological and ontological norms. They are formed basing on the theoretical vision of the world and are the assumptions as about an essence of reality under consideration as about the methods of theories' construction and checking. These assumptions form a definite research tradition which represents a "series of ontological and methodological "permissions" and "prohibitions"[43].

If to differentiate the methodological and ontological norms, which conceptions Laudan developed, in their system the collection of ontological principles may be singled out which sets a conception of reality under consideration (the picture of reality under consideration).

From these position many characteristics of research traditions considered by Laudan can be applied to analyzing the scientific picture of the world.

So, to Laudan's opinion, a some stable invariant presents in research traditions which does not permit the varying principles to modify the previous tradition. Together with this Laudan noted that "there was no such a research tradition in history of scientific reflection which had been characterized by permanent series of principles during all its evolution"[44].

These ideas become important when understanding the particularities of the scientific picture of the world's evolution. Their changing is a condition of the scientific progress, but in their content some objective knowledge can always be found which can not be eliminated on the next stages of its historical evolution.

Further Laudan noted a particular role of anomalies in rational assessment of a theory and besides, from his point of view, anomalies are not reduced only to contradictions between theoretical knowledge and its empirical foundation.

Extending the class of anomalies he introduced the notions of a conceptual anomaly and of a conceptual problem, which was formed, on the one hand, between knowledge and methodological attitudes, and on the other hand, between knowledge and the worldview. And in the latter case this contradiction existed not as much within "a framework of science as between science and extra-scientific views"[45].

These ideas of Laudan permit to consider the functioning of the scientific picture of the world in a broad context of its sociocultural determination, when its evolution may be

43 Laudan (1977, p.24).
44 Ibid, p.97.
45 Ibid, pp.24, 61.

represented as the one implementing not only at the expense of interaction between theoretical knowledge and newly discovered facts, but also at the expense of links with worldview structures dominating in culture of this or that historical epoch.

All these results obtained within a framework of Western philosophy of the latest decades, pertinent to science's structure and historical dynamics, were assimilated and developed in Russian methodological investigations. And moreover, many ideas here were formulated independently and got a more detailed elaboration.

The studying of scientific knowledge structure and dynamics in Soviet methodological literature of the 70-80s led to revealing the series of components and structures which had not been analyzed in Western philosophy. Precisely in those investigations framework the question about position and functions of the scientific picture of the world in a system of theoretical and empirical knowledge and about its role in forming the new knowledge[46].

After the scientific picture of the world was fixed as the such form of knowledge's systematization, which mediated the influence of philosophical categories and principles on concrete scientific theories, the question had arisen about its relation to theory and experience and the mechanisms with which the scientific picture of the world influenced on their formation.

Originally these mechanisms were considered basing on the material of history of the physics. The following scheme of interactions between picture of the world and theories and experience was offered (the works by M.V.Mostepanenko). Basing on the productive philosophical ideas and the new facts considering the picture of the world was created in science (in the considered case the physical one), which represented the "ideal model of nature including the most general notions, principles and hypotheses of physics and those ones characterizing a definite historical stage of its evolution"[47]. This picture sets the targets to the construction of theories. Each new theory is based on the corresponding to it picture of the world. For example, the mechanics building was preceded by appearance of series of the mechanical picture of the world's fundamental notions, like force, gravitation, inertia, mass, etc. Under pressure of new facts and theoretical results the created picture of the world may be longer built and broadened. However the such situation is possible when the limits of broadening will be exhausted and then the old picture of the world begins to hinder the evolution of science. In this case the necessity arises to reconstruct the existing picture of the world itself. And here the philosophical ideas and principles are starting to play the active heuristic role.

Some real specific features of physical knowledge's dynamics found their reflection in described methodological scheme but there were many weak spots in it. Their discovering in a process of critical analysis brought about to the shift of problems and to setting the new research tasks. By this way the limitation of conceptions that scientific picture of the world always forewent the theories and was a condition of their forming had been fixed. This situation was endorsed only by classical physics material. But in an evolution process in contemporary physics the situations occur when theory starting its creation before the construction of adequate to it picture of the world. And only then the building of the new picture of the world is starting as the final stage of formation of a theory. For the first time P. Dishlevy paid attention on this specific feature. In his works the other important problem was

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46 In methodology of science in that period several schools emerged. Each of them made its contribution in elaboration of structure and functions of scientific picture of the world. The works are meant of Leningrad philosophers (M. Mostepanenko, A. Mostepanenko and others), philosophers of Kiev school (V. Chernovolenko, P. Dishlevy, S. Krimsky, V. Kuznetsov and others), Moscow philosophers (I. Alexeyev, L. Bazhenov, L. Kosareva, L. Mikeshina, B. Pahomov, V. Shvirev, L. Yatsenko and others), Minsk methodological school.

47 Mostepanenko (1969, p.71).

also set. This was the problem of distinction between picture of the world and theory. He proposed to distinct the physical picture of the world and theory by the following attributes. First, by the notions which the physical picture of the world and the physical theory operate with. To his opinion, the notions of picture of the world are modified substantive order philosophical categories (movement, interaction, causality etc.), which are transformed into the fundamental physical notions characterizing the physical objects independently from conditions of cognition (substance, particle, field, vacuum). What's about the physical theories, they are based on another conceptual structure. They consist along with the means for explanation of behavior of definite systems of physical objects the such means using which the description of experimental investigations' procedures and results is provided[48].

Second, the physical picture of the world, when representing the physical world, is distracted from the process of knowledge obtaining; the physical theory includes logical means providing as getting of these knowledge as verification of their objective character. And finally, third, one of distinctions between the physical picture of the world and a theory is in their different historical destinies. If the appearance of each new theory brings about only to specifying the scope of the "old" theories application, the appearance of the new physical picture of the world is linked either with negation of relevancy of the previous picture of the world or with attempts to unite somehow these pictures into a whole[49].

The mentioned attributes contained the series of constructive moments making clear the correlation between a theory and the scientific picture of the world, but together with this they needed some correction.

First of all this concerns with the problem of historical destinies of picture of the world and theory. The formed fundamental theories are actually preserved as the new fundamental theories appear, but they do not only specify their application field, but, as a rule, change their primary form, are reformulated many times in a process of science evolution.

What's about the process of picture of the world changing, the definite succession always exists between old and new systems of conceptions of reality under consideration. Thus, breaking of the mechanical picture of the world did not cancel the idea itself of atomistic structure of a substance, though it changed the old conceptions of atom as indivisible corpuscles. When transitioning from the mechanical picture of the physical world to the electrodynamic one, the conceptions about the interactions (the idea of short-range action became firmly established) were radically modified. But at the same time the conceptions of absolute space and time remained. In the contemporary physical picture of the world the conceptions of the physical objects typology became significantly broadened, but the conceptions that the specific aggregative states of a matter existed have been preserved also at the contemporary stage. Later the idea of succession in evolution of the scientific picture of the world was tracked not only on the physical material but on the material of the other sciences too, and thus it was substantiated in general[50].

The distinction between picture of the world and theory on the assumption of their conceptual structure's particularities also required the serious specifications. The greatest degree of generality of conceptual structure of picture of the world in comparison with concrete theories is expressed in its direct closeness with philosophical categories though in a definite sense (if to take into consideration that philosophical categories express the universal forms of thinking) any scientific notions function as specific concretizing of philosophical categories. But the major difficulty is that on the notion's level it is impossible to distinguish

48 Dishlevy (1973, p.118).
49 Ibid.
50 See: Zelenkov and Vodopianov (1987), Stepin (1987), Kuznetsova (1984).

clearly where the notions of picture of the world begin and where the notions of theory end, because the conceptual structure of theory always includes some determined notions characterizing the picture of the world. In other words theory may not be considered outside of relation to the picture of the world because it can not be formed without using the language which describes the picture of the world.

The picture of the world in a system of scientific knowledge

The new opportunities for resolving the question of correlation between the scientific picture of the world and a theory were being discovered in a process of analyzing the structure of science at the angle of the ideal objects organization which formed meaning of different types of statements of its language[51]. In this approach the scientific language was often considered as heterogeneous hierarchically organized system where the statements were directly formed in respect to the ideal objects representing inside of cognition the real objects, their properties, links and relations. Then the different types of ideal objects which appear as the abstractions characterizing the reality under consideration must correspond to different layers of empirical and theoretical language. All these ideal objects are organized into systems: they form complicated hierarchical system tracing one's roots back to practice.

At the empirical level the subject area under consideration is primarily represented with the structure of real experiments and observation situations which implicitly single out the separate links being the subject of investigation from the mixed up multiplicity of connections and relations of reality. Then the same links are fixed by the empirical scheme by means of relations between the empirical objects and the fact-fixing statements formulated relatively to these objects.

The same links are represented in theoretical language by relations of the constructs of local and fundamental theoretical schemes and the formulations of appropriate symbols.

It is turned out that the same reality appears in qualitatively specific images and forms of description at the different levels of investigation.

Farther cognition moves from the real experiments and observations to their theoretical descriptions, the language of these descriptions becomes more complicated and specific.

And here the important epistemological and methodological problem arises: what allows to correlate these different descriptions and models with the same reality under consideration? What does connect all these languages of description into an integral system of science language?

The answer to these questions just leads to discovering in a system of scientific knowledge the particular subsystem of the ideal objects forming in their relations the disciplinary ontology (the special scientific picture of the world).

It introduces conceptions about the major systemic and structural characteristics of a subject belonging to an appropriate science. Representation on it as of the empirical schemes as of the theoretical ones provides the connection of different patterns of reality represented in these schemes and their attribution to the unified object region.

The most studied pattern of picture of the reality under consideration is the physical picture of the world. But the pictures like these present in any science as soon as it is constituted as an independent field of scientific knowledge.

The generalized characteristic of investigated subject is introduced in a picture of reality by means of the following conceptions: 1) about the fundamental objects on which all the rest objects investigated in a framework of another science are supposed to be built upon; 2) about typology of the objects under consideration; 3) about the general regularities of their

51 This approach was realized in investigations of author and his followers representing in the 70-80s Minsk school of methodologists. See, for example, Stepin (1976), (1979), (1981).

interactions 4) about the space-time structure of reality. All these conceptions can be described in a framework of system of ontological principles by means of which the picture of reality under investigation is explicated and which appear as a basis of scientific theories that belong to an appropriate discipline. For example, the principles: the world consists of indivisible corpuscles; their interaction is performed as the momentary translation of forces along the straight line; corpuscles and bodies formed form them are moving in the absolute space during the absolute time – describe the picture of the physical world which was formed at the second half of the 17th century and subsequently acquired the name of the mechanical picture of the world.

Analogously, when after successes of Maxwell's theory the electrodynamic picture of the world had strengthened oneself in physics and had replaced the mechanical one dominating in science for more than two and a half of centuries, all natural processes in it were described by means of introduction of a particular system of abstractions (the ideal objects). The following elements appeared as these abstractions: indivisible atoms and electrons (atoms of electricity); the world ether, which states were considered as electrical, magnetic and gravity forces extending from one point to another in accordance with principle of short-range activity; absolute space and time.

This picture can be considered as the extremely generalized model of those natural objects and processes, which were the subjects of physical investigation in the last third of the 19th century.

At the expense of attribution to this picture of empirical and theoretical schemes of classical electrodynamics, they acquired an objective status and were perceived as the reflection of nature's characteristics.

The transition from the mechanical to the electrodynamic (the last quarter of the 19th century) and then to the quantum-relativistic picture of the physical reality (the first half of the 20th century) was accompanied with changing of physics' ontological principles. It was being more than ever radical during the becoming period of the quantum relativistic physics (revision of principles of indivisibility of atoms, of the absolute space-time existence, of Laplacian determination of physical processes).

By analogy with the physical picture of the world one can single out the pictures of reality in the other sciences too (chemistry, biology etc). Among them the types of pictures of the world exist historically changing one another. This is revealed when analyzing the history of science. For example, image of the world of chemical processes accepted by chemists in Lavoisier's time had little in common with the contemporary one. Only few of nowadays known chemical elements were supposed as the fundamental objects. The series of complicated combinations (for example, the lime) which had been attributed to the "simple chemical substances" was added to them. After the appearance of Lavoisier's works the phlogiston had been eliminated from the raw of substances like these but the thermogen had yet been reckoned in this raw. It was considered that interaction of all these "simple substances" and elements, expanding in the absolute space and time, gave birth to all known types of complicated chemical compounds.

Such picture of the reality under consideration at the definite stage of history of science seemed true to the most of chemists. It set purposes as to the search of the new facts as to the construction of theoretical models explaining these facts.

Each of concrete-historical forms of the picture of reality under investigation may be realized in a series of modifications expressing the main evolution stages of scientific knowledge. The lines of succession in evolution of this or that type of picture of reality (for example, evolution of Newtonian conceptions of the physical world by Euler, evolution of electrodynamic picture of the world by Faraday, Maxwell, Hertz, Lorentz, when each of them

introduced new elements into this picture) can be among modifications like these. But the other situations are possible. Those are when the same type of picture of the world is realized in a form of competing and alternative to each other conceptions of the physical world, and when one of them wins as a "true" physical picture of the world (the samples of this may be the struggle between Newtonian and Cartesian conceptions of nature as two alternative variants of the mechanical picture of the world, and the competition of two main directions in development of the electrodynamic picture of the world – Ampere-Weber's program on the one hand, and Faraday-Maxwell's program on the other one).

Revealing complicated and historically developing organization of the ideal objects of science language allows to formulate the problem of correlation between theory and the scientific picture of the world in a new fashion. Nowadays it is concretized as the questions about distinction between picture of the world and theoretical schemes as the core of theory, and the specific features of their interaction.

One may point at two major attributes by which this distinction is fulfilled. Firstly, by the character of ideal objects forming picture of the world and theoretical schemes, and consequently, by the specifics of language means used when describing the same reality. Secondly, by the scope of envelopment and the character of generalization of the events under consideration.

Theoretical schemes abstract objects and constructs of picture of the world are the different types of the ideal objects. If the laws are formulated relatively to the first of them, the principles are formulated relatively to the second ones. Theoretical schemes' abstract objects represent the idealizations and their inequality is obvious, whereas constructs of picture of the world, being also the idealizations, are ontologized and identified with reality. Every physicist understands that material point is an idealization because nature has no bodies without dimensions. But physicists of the 17-19th centuries, who accepted the mechanical picture of the world, supposed that indivisible atom actually existed in nature and was its first fundamental building block.

Analogously the abstractions of a point charge and of vectors of electrical and magnetic strength at a point quite clearly appear as idealizations. But electron (atom of electricity) represented in the electrodynamic picture of the world as a very little charged spherical body, and the electromagnetic field as a state of ether - all these objects were perceived by majority of physicians in the end of the 19th century as the real substances, the fragments of nature itself existing independently from the human cognition.

Meanwhile these abstractions, functioning as the elements of the physical picture of the world in the last third of the 19th century, also represented the idealizations not identical to reality but schematizing it. Their borders were discovered in the becoming process of quantum and relativistic physics. It was revealed that the world ether, as physicists of the end of the 19th century conceived it, was the same invented essence as thermogen or phlogiston. The conception about the pure continuity of electromagnetic field and about the pure discontinuity of electrons had also underwent changes - the ideas of corpuscular-wave dualism of as particles as fields were included into the physical picture of the world.

Theoretical schemes, although distinguished from picture of the world, at the same time are always linked with it. These links are provided by the particular mapping procedures. In process of these procedures the correspondence is established between the attributes belonging to the ideal objects of theoretical schemes and those ones belonging to picture of the world. One can illustrate the correspondence like this on example of correlation between the core of classical theory of electromagnetic field with the electrodynamic picture of the world.

ABSTRACT OBJECTS OF A THEORETICAL SCHEME OF MAXWELL-LORENTZ'S ELECTRODYNAMICS	THE CONSTRUCTS OF THE ELECTRODYNAMIC PICTURE OF THE WORLD
Vector of the electric strength in a point	Electrical field as a state of the world ether
Vector of magnetic strength in a point	Magnetic field as a state of the world ether
Vector of current density in a point	Movement of electrons
Spatial-temporal frame of reference	Absolute space and time

Owing to links between the constructs of picture of the world and the theoretical schemes abstract objects, they can often be named by one term which acquired different senses in different contexts.

For example, term "electron" in laws of Maxwell-Lorentz's electrodynamics denoted an elementary point electrical charge. But as a description of appropriate element of the physical picture of the world it was entered on the basis of "to be an extremely little electrically charged particle which presents in all bodies"[52], "to be a spherical body on the volume of which the electrical charge is assigned uniformly"[53], "to interact with ether in the way that ether remains immovable when electrons are moving"[54]. Images of electron as of the point charge and of the little spherical charged particle ("atom of electricity") corresponded to different ideal objects and different senses of term "electron".

Description of links between the attributes of theoretical schemes abstract objects and of the ideal objects, forming picture of the world, is included into the scientific notions' content as the one type of definitions. The example of this can be definition of the mass as the quantity of matter in Newtonian physics, because it was supposed that in the indivisible corpuscles (atoms), of what the bodies were built, the matter quantity was preserved in accordance with the attribute of atoms indivisibility and indestructibility. Scientific notions include the multiplicity of notions and their development is fulfilled as interaction of all types of definitions including those ones emerging when theoretical schemes are brought into correlation with the scientific picture of the world.[55]

That is why on the notions level one can not make a clear distinction between picture of the world and theory. But it can be made taking into consideration the specifics of ideal objects of theoretical schemes and picture of the world which interrelations between themselves and with experience influence the development of scientific cognitive apparatus by the crucial way.

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52 Lorentz (1953, p.29).

53 Ibid, p.33.

54 Ibid, pp.32-33.

55 Along with determining the attributes of abstract objects of theoretical scheme in terms of picture of the world, notions also include the operational definitions and also the definitions fixing relations between the attributes of abstract objects of theoretical scheme which are revealed through the formulation of appropriate theoretical law. The example of this can be determining a mass as magnitude directly proportional to force and inversely proportional to acceleration. This expresses those major relations between the attributes of a material point, force and spatial-temporal frame of reference, which are expressed in the second law of Newton.

Procedures of mapping of theoretical schemes on picture of the world are the obligatory condition of theory building and provide its further functioning, its application to explanation and prediction of the new facts. In the case when theory laws are formulated on mathematical language, the mapping of theoretical schemes on picture of the world provides their semantic (conceptual) interpretation, and the mapping on situations of actual experience provides empirical interpretation of equations.

Empirical interpretation sets the compounding of links with the experience of magnitudes appearing in equations. But this interpretation alone is not sufficient for theory recognition. It is considered to be incomplete without conceptual interpretation of its mathematical apparatus.

In classical physics these two types of interpretation emerged together because theory was created basing on previously introduced and substantiated picture of the world. In contemporary physics they can be divided in time. This happened, for example, when the quantum mechanics was being constructed. The fundamental construct of its theoretical scheme a "state vector" (ψ-function) had no empirical interpretation for some time, which later was found by M. Born. But exactly after this the discussions had become keener in which the problems of corpuscular-wave dualism, of electron's nature and the questions of what did the ψ-function reflected in physical reality were discussed. All of them concerned with problematic of conceptual interpretation and stimulated the evolution of the quantum-relativistic picture of the physical world.

Picture of the world is always characterized with a wider scope of envelopment of investigated events than any separately taken theory. Thus several theoretical schemes constituting the cores of different theories including the fundamental ones may be mapped on the same picture of the world.

So, the fundamental theoretical schemes lying in foundations of Newtonian mechanics, electrodynamics, thermodynamics, Ampere's electrodynamics were related with the mechanical picture of the world. Theoretical schemes of Maxwell-Lorentz's electrodynamics and Hertz’s mechanics were correlated with electrodynamic picture of the physical world. The contemporary quantum-relativistic picture of the world unifies all accumulated variety of the fundamental physical theories, classical and quantum mechanics, special and general theories of relativity, thermodynamics, classical and quantum electrodynamics.

Special scientific picture of the world (the disciplinary ontology) is indirectly related with experience through the theoretical schemes. But it also has the direct links with the empirical level of knowledge.

The situations of experiment in which these or those events are discovered and studied represent the sorts of human activity. To interpret this activity in terms of natural process it is necessary to be viewed as the interaction of natural objects existing independently from a human. Exactly the vision like this the picture of reality under consideration adjusts. Through relation to it the situations of real experiment and their empirical schemes acquire an objective status. And when, for example, Biot and Savart discovered in experiments with a magnetic needle and rectilinear conductors with current that magnetic needle reacts to current, they interpreted this phenomenon as generating the magnetic forces by current. Thereby when interpreting the results of experiment they applied the conception of the physical picture of the world on existence of electrical and magnetic forces and their propagation in space.

Links with relations that the picture of reality under consideration possessed consist not only in interpreting and explaining the results of experience, but also in that this picture is directly substantiated with the experimental facts.

The main attributes of its ideal objects must necessarily get an experimental confirmation and this is the one of conditions of their ontological capacity. Even if there is a discourse

about the indivisible attributes, for example, about the indivisibility of atom, or about the absolute space and time in mechanical picture of the world, one can in principle discover some conditions of experience in which these assumptions have a sense. Over the range of the mechanical influence energies, which the physics of the 17-19th centuries operated with, it was really impossible to discover the divisibility of atom.

As regards to the conceptions of absolute space and time, they had foundations in numerous observed facts of studying the mechanical motion being evidence of preservation of space and time intervals when passaging from the one inertial frame of reference to another. Later it was determined that measuring procedures with help of clocks and rulers, in framework of which the characteristics of space and time intervals were fixed, were based on the idealizing assumption of momentary translation of a signal applied by observers when synchronizing the clocks. Such assumption was an idealization which had its foundation in that the speed of passing mechanical processes was significantly lesser than the speed of light, which was applied implicitly as a signal carrying to observers the information about the clock swing in different frames of references. Owing to this one could neglect the finite velocity of spreading interaction[56].

The clarification of place of the special scientific picture of the world (the disciplinary ontology) in the structure of scientific knowledge (its relation with theories and experience) introduces the conception of integral knowledge system in scientific discipline. The special picture of the world appears as a particular link forming the system in multiplicity of theoretical and empirical knowledge which compose this or that discipline (field of science). Just the links of picture of the world with all types of this knowledge allow the considering it as a particular form of their systematization.

Pictures of reality, which are being developed in different scientific disciplines, are not isolated from each other. They interact between themselves. In this connection the question arises: do the wider horizons of knowledge systematization and this knowledge systematization's forms integrative regarding to the special pictures of reality (the disciplinary ontology) exist? In methodological investigations such forms have already been fixed and described. The general picture of the world which appears as a specific form of theoretical knowledge belongs to them. It integrates the most significant achievements in natural, humanitarian and technical sciences. These achievements are such the conceptions of the non-stationary Universe and the Big Bang, about quarks and synergetic processes, genes, ecosystems and biosphere, about the society as an integral system, about formations and civilizations etc. In the beginning they are developing as fundamental ideas and conceptions of corresponding disciplinary ontology and then are included into the general scientific picture of the world.

And if the disciplinary ontology (special scientific pictures of the world) represent the objects of every separate science (physics, biology, social sciences etc.), the most important systemic-structural characteristics of subject area of scientific cognition as a whole, taken at the definite stage of its historical evolution, are represented in the general scientific picture of the world.

Revolutions in different sciences (physics, chemistry, biology etc.), changing the vision of the corresponding science's subject area, permanently give birth to the mutations of natural scientific and general scientific pictures of the world, and result to revision of conceptions of reality which were formed in science earlier. However the link between changes in pictures of

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56 This assumption, however, was found as incorrect when investigating electromagnetic processes. It was needed here to introduce another understanding of experimental-measuring procedures that in the end led to replacement of Newtonian conceptions about space and time by conceptions of relativistic theory (see Mandelstam (1972, pp.160-161, 181-185), Tomilchick and Fyodorov (1987, pp.144-145)).

the world and cardinal reconstruction of natural scientific and general scientific pictures of the world is ambiguous. It is necessary to take into consideration that the new pictures of reality in the beginnings are laid down as the hypotheses. Hypothetical picture passes the substantiation stage and may for a very long time co-exist side by side with the previous picture of reality. Most often it is strengthened not only as a result of the prolonged verification of its principles by the experience, but also owing to that these principles serve as a base for the new fundamental theories.

Entering of new conceptions of the world elaborated in this or that field of knowledge into the general picture of the world does not eliminate but presupposes a competition between the different conceptions of reality under consideration.

The conceptions of the world which are introduced in the pictures of reality under investigation always experience the definite impact of analogies and associations gathered from the different spheres of cultural creative work, including the ordinary consciousness and the factory floor experience of a definite historical epoch.

It is not difficult, for example, to discover that the conceptions of electrical fluid and thermogen, included into the mechanical picture of the world in the 18th century, were being formed in many aspects under the influence of subject images gathered from the sphere of everyday experience and production of an appropriate epoch. It was easier for the common sense of the 18th century to agree with existence of non-mechanical forces, conceiving them in the image and likeness of the mechanical ones (for example, conceiving the flow of heat as the flow of weightless liquid – thermogen falling like a water flow from one level to another and making at the expense of this the work as like as water does in the hydraulic units). But together with this the introduction into the mechanical picture of the world of conceptions about different substances – carriers of forces – contained also the moment of objective knowledge. The idea of qualitative different types of forces was the first step on the way to acknowledgement of irreducibility of all types of interaction to the mechanical one. It contributed to the formation of the particular, different from the mechanical, conceptions of structure of each type of interaction like that.

Forming the pictures of reality under consideration in every field of science always proceeds not only as a process having the scientific character, but also as the interaction between science and the other fields of culture.

Science always draws these or those fragments, which are entering into the substance of its pictures of investigated reality, from the field of significant obvious images elaborated in different cultural spheres. The images of the Universe as of simple machine dominated in development of the mechanical picture of the world in the 17-18th centuries (the world as clocks, the world as mechanism) having something in common with usual conceptions of object structures of techniques in the epoch of the first industrial revolution.

In contemporary scientific pictures of the world the images emerge more and more often of the self-organizing automatic machine, which appear as a specific appellation to obviousness of technical devices that are the complicated self-organizing systems which are applied in different fields of techniques in the second half of the 20th century.

The combination of heterogeneous, but along with that inter-consistent substantiation (empirical, theoretical, philosophical, worldview) determines the admission of the special scientific pictures of the world by culture of an appropriate historical epoch and their functioning as the scientific ontology.

The obviousness of conceptions of scientific pictures of the world provides their comprehension not only by specialists in a given field of knowledge, but also by scientists specializing in other sciences and even by the widely-educated people who are not concerned directly with the scientific activity. When it is spoken about the scientific achievements

influences on the culture of an epoch, first of all the talk is not about the special results of theoretical and empirical investigations, but about their accumulation in conceptions of the scientific picture of the world. Only in the form like this they can acquire the general cultural, worldview meaning.

Even if taking the ideas which the historical retrospection allows to fix as significant to the worldview, many of them in their primary formulation emerged as the specialized theses understood only in the narrow circle of scientists.

Let's take, for example, an assertion: in the formula $ds^2 = \Sigma g_{mn} dx_m dx_n$ the magnitudes g_{mn}, representing the continuous functions of coordinates and determining the metrics of four-dimensional manifold (space-time), at the same time describe the field of gravitation too[57]. This assertion expresses the major physical idea of the general theory of relativity (GTR). But if formulated like this, it will not arise the broad human interest those ones who are not concerned with theoretical physics. Only the translation of this statement on the language of the physical picture of the world and its further philosophical interpretation discover the deep worldview senses contained in Einsteinian discovery. Joining the scientific picture of the world and getting the philosophical interpretation, the conceptions of GTR about the mutual correlations between the geometry of the physical space-time and the character of gravitation field begin to confront with peculiar to common sense comprehension of the spatial-temporal structure of the world. They require the reconstruction of the deep-rooted from the conceptions belonging to Galileo's and Newton's times ideas of the homogeneous, infinite Euclidean space and the homogeneous quasi-Euclidean time of the Universe. These are conceptions which turned into an original worldview postulate of ordinary consciousness through the system of education and training.

Special scientific notions and conceptions can acquire the worldview status and then resonate in the other cultural spheres only through the procedures of their correlation with the scientific picture of the world, at the same time resulting in its reconstruction.

Thus it was not only with the theory of relativity but also with all other scientific discoveries which modified the scientific picture of the world and influenced through it on the system of worldview attitudes orienting the human vital functions.

General cultural meaning of special scientific pictures of the world and possibilities of their understanding by investigators working with the different sciences appear as the condition of their synthesis into the whole general scientific picture of the world.

As a result of conducted analysis the foundations of science appear as a particular link which at the same time belongs to internal structure of science and its infrastructure determining the connection of science with culture. The structure of scientific knowledge, determined by links between foundations of science, theories and experience, can be visually depicted in the following scheme (see fig. 1).

57 Einstein (1965-67, vol. 2, p.125).

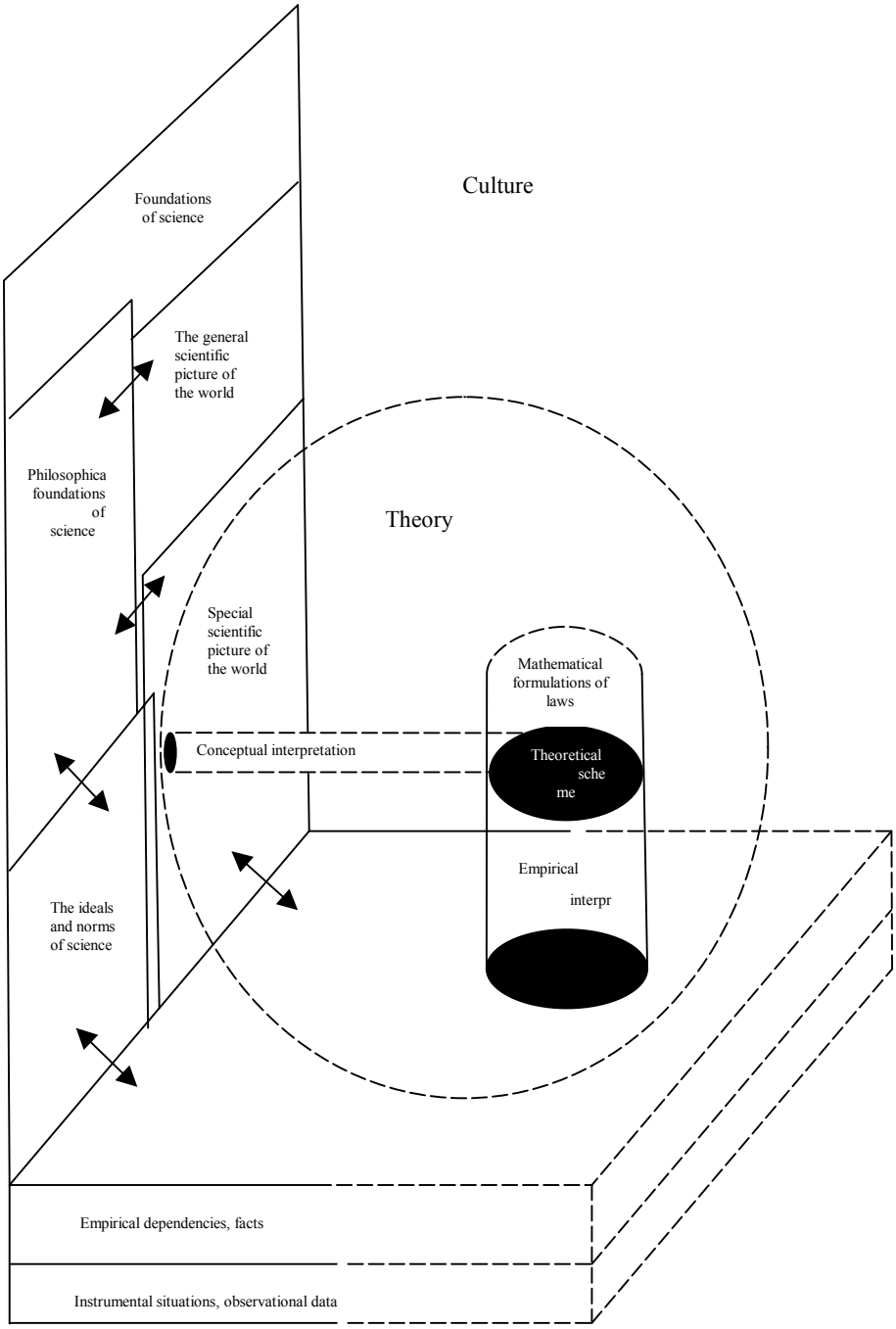
Culture
Foundations of science
The general scientific picture of the world
Philosophica foundations of science
Theory
Special scientific picture of the world
Mathematical formulations of laws
Conceptual interpretation
Theoretical sche me
Empirical interpr
The ideals and norms of science
Empirical dependencies, facts
Instrumental situations, observational data

Fig. 1