Published on *Metanexus* (http://www.metanexus.net)

Question of Methodology of Scientific Theories of Complex Reality

May 28, 2009
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Introduction

Einstein told Heisenberg that o*nly theory decides what can be measured*. Every scientific theory is an entity of logically compact generalizations deduced from established scientific facts, the generalizations being connected with the contemporary state of science. The purpose of such a theory is to explain the cause or the system of causes, conditions and circumstances of the original phenomena of interest to us. *The complexity is a scientific theory [2] which asserts that some systems display behavioral phenomena that are completely inexplicable by any conventional analysis of the systems' constituent parts. These phenomena, commonly referred to as emergent behaviours, seem to occur in many complex systems involving living organisms, such as a stock market [3] or the human brain (…). Precisely how to model such emergence—that is, to devise mathematical laws that will allow emergent behaviour to be explained and even predicted—is a major problem that has yet to be solved by complexity theorists.*[1]

Apart from the definitions of complexity, some of them being mathematical while others-informal, there exist also different methods of investigation and description of complexity. Although the sciences of complexity explore relatively new theoretical field, we already, at this stage, find a whole spectrum of approaches to the complexity issue lying *between computational approaches to complexity in the tradition of information theory and cybernetics and the more conceptual approaches that we find in organicism, emergentism and systems theory* [2]*.* In the present paper, I am going to concentrate on scientific theories of the real-world complexity.

In the sensible efforts which are being made to develop the contemporaneous methodology of the natural sciences, the following principle can be perceived as the direction for activities in this domain: through logic to physics and to biology. It can be expressed in other words that the conception of performing physical measurements must be preceded by taking into consideration and theoretically analyzing the concepts of the respective physical phenomena and the definitions of the respective physical quantities. Shortly, theory precedes measuring and suggests what can be measured. Therefore, Kant's undertaking of investigating the metaphysical foundations of the natural sciences is not obsolete, as the empiricist philosophy of science would have stated. Moreover, the empiricism of the twentieth century did not succeed in its efforts to establish the demarcation between empirical science and metaphysics. One purpose of my paper is exploring and considering the genesis and development of theories of complex reality, in which the aspects of usefulness of the theories to describing and understanding the real-world are included.

1. On scientific theories of the natural sciences: between possibilities and limitations

The investigation of both the philosophical bases and the methods of science is of interest for the philosophy of science. The philosophy of the natural sciences of contemporaneous century can be considered to be intentionally retrospective philosophy. The question on the foundations of the knowledge of the natural sciences remains of great meaning. The exact sciences are fascinated by reality and they rest on that knowing all about reality from experience. In the phases of normal science philosophy is not necessary for the factual progress, even impedes that. Pragmatic attitude of normal science stimulates its progress and the science progresses rapidly as it is making the effort to understand the reason for its own success.

In the scientific approach to describing reality building, the methodology of sciences is recognized as justified since the methodology is a formal theory of rational scientific investigation. However, we may meet often the opinion that there is a lack of adequate criteria for rationality. The reason for the lack is that the complex problems, which are characteristic for a scientific method, are being approached often in different ways. Moreover, in investigations of the method, the proportion of formal and empiric elements is also composed differently. Therefore, the logical reconstruction of really applied methods remains continually as open postulate. The reconstruction would enable us to create the hypothetical methodological model which eventually may be changed into a normative one. Kazimierz Ajdukiewicz, a representative of the Lwow-Warsaw philosophical school, pointed out both investigating the evolution of the scientific conceptual apparatus and considering the factors causing the evolution – as superior tasks of the theory of science [3]. He postulated the understanding methodology should be dealing not so much with description and theory of the applied methods, as with proving the correctness of applying these methods.

1.1 Depedence of the quality of a scientific theory on formulating the relationships between elements composing the theory

It is commonly taken that one determines to a high degree the nature of scientific cognition by pointing out the object, purpose and method of the cognition while knowing which elements and in which manner they create a scientific theory we are able to understand as the base of science. Each scientific theory is a deductive system (for the most part if its rules are made on a priori grounds) or has a form approximating to the deductive system. In the empirical disciplines, a theory is a system of theses which are logically and factually connected to each other, i. e., the theory is the system of the most general principles and hypotheses, rules and definitions explaining the scientific discipline which is uniquely pointed out. As this development was characterized by Stanislaw Kaminski, it had happened that the relationships between the elements of the theory had been differently defined. After Aristotle, the ideal form of scientific theory had been seen in the structure of a pyramid (strictly, of a trapezium). The analogy with trapezium is referring to the situation where from not numerous assumptions (associated with the lesser base of the trapezium) all the scientific theorems lesser and lesser general are being deduced gradually by employing more and more assumptions and premises (associated with displacement in the direction to the greater base of the trapezium). Later only the way of acceptation of central premises was modified. When it comes to that, the premises may be of such forms as the most general principles read with intellectual evidence in given examples (peripatetic). In another cases they are of the form of rational hypothetical assumptions or of analytical real definitions, or of definitions obtained through gradually generalizing (by the so called *axiomata media*) observable opinions.

Since the parallelism between the causal and ontological relations (causal relations correspond to resulting) was admitted, the theory was simultaneously ordered logically and factually. In XVIII century (mainly due to the influence of Hume's epistemological conceptions) the encyclopedic form of presenting the results of scientific activity was appreciated by theoreticians of science. Here it may be mentioned also something about an antisystem as an obligatory structure of science. Previously dominated the conviction that science consists in describing the scientific experiments grouped thematically as well as in considering the possibility and conditions of occurring in nature and in experiments phenomena in which are involved regularities of events. Contrary to that, in positivism the scientific observational opinions resulting from the observations of the phenomena, which are occurring in nature and in experiments under definite conditions and revealing some regularietes, becomes the main premises enabling us to induce such laws of nature which, in turn, enable us to deduce scientific predictions. Therefore, it may be said that the positivists inverted the Aristotle trapezium [4].

1.2 The complex reality as the conception delivering new possibilities in development of scientific theories of the natural sciences

Complexity research can have methodological significance for the natural sciences, as well as for the humanities and theology [5]. The scientific theories of real-world complexity imply a view of the world as largely unpredictable and open to surprising change. The works of Kepler in the domain of astronomy, Newton in the area of mechanics and Einstein in the range of relativity theories strengthened the general belief that simplicity mirrored a beautiful unity and harmony in the inner workings of nature, and that these features of the existence of nature should hold true for both physical and biological world [6]. However this thesis postulating the faith in the basic simplicity of nature faced some limitations and doubts. For example, even within physics, not all fields and theories could yet be united but, contrary to that, there exists separate fields such as thermodynamic and physics.

The opposition to the simplicity is complexity. It is a truism the statement when the complexity of an object grows its simplicity diminishes. A common understanding of complexity in contemporary physics is as follows:

- complexity of the object (system) with emergent properties was generated during long and complicated history of the object. Thefore,
- complexity in nature must be considered in the context of processes generating the systems, their parts of various kind and the relations between the parts;
- processes of forming systems (structures) must be described on several distinct levels of the organization of the structures and through correlative functions involving in the process all what contributes to and essentially influences on the processes.

Claus Emmeche who is dealing with the evolution of complexity put the questions about the influence (implications) of the science on our ability to perceive the natural world and its conditioning, among other, its relation to other domain [7]. Considering the problems he stated that the distinction between simple and complex is relative since our ability to distinguishbetween our picture of the world as created by our immediate experiences and the structure of the world as describedby science plays very important role in perceiving the world.

As we recognize complexity through descriptive frames, then we are

- committed to a specific scientific paradigm which *implies willingness to try to extend the explanatory power of that paradigm, that is, to explore science at its utmost frontiers, in order to see how far one can go in successfully applying its principles* [8];
- not entitled to decide a priori whether descriptive complexity entails ontological complexity;
- allowed to base our interpretation of the situation on either realism, in which case the decision is affirmative, or an instrumentalism, in which case 'ontological complexity' is simply a metaphysical limit concept that cannot be justified within science.

However, whether we chose the realism or instrumentalism as possible interpretation, different notions of complexity give rise to special methodological problems [9].

2. Selected issues of the development of methodology of scientific theories of the natural sciences: between continuity and discontinuity.

The seminal question how scientific revolutions are possible is very important. These problems are better understood in the context of comparison with biological evolution. According to Konrad Lorenz, there occur *fulgurations*, flash-like mergers of other structures into a more complex new structure which accomplishes a new simplicity of performance at a higher level of integration, the new level from the previously mentioned structures being unpredictable. Therefore, from the philosophical point of view most important in science are not the always and everywhere applicable methods of science but its unique factual problems and results. At first sight we suppose that a closed theory will appear to be both the more amenable to a fundamental explanation and the more generally valid the later it occurs in the succession of theories. In particular, this may lead us to quantum theory. In this case we suspect that nowadays the best criterion for acceptance of a philosophy of science is whether it can make quantum theory understandable.

The above question on the possibility of constructing closed theories has the same epistemological structure as Kant's question: how is experience possible at all? As regards content, in accordance with our understanding of theory; both questions are synonymous. Experience in the Kant's sense can be expressed conceptually. We have learned above that scientific concepts obtain a precise meaning only in the context of a closed theory. However, in a scientific theory there exist the concepts which imply the meaning of measurements. They always come with preconceptions, in terms of which they must be initially formulated.

2.1 A question of the methodological universalism in creating the scientific theories

Scientists would agree that all living phenomena are complex. *General concepts about life, organization and complexity have a peculiar status within science. In a sense, they reveal that one cannot draw clear lines of demarcation between natural science and metaphysics in the sense of general ontological assumptions about our world* [10]. Both the earlier approaches to complex phenomena and the sciences of complexity are interesting in themselves, because they enhance our understanding of the natural and social world. An attempt to create a conception of universal methodology of scientific theories of complex natural and social world with employing the Comte's positivism and empiric inductive logic was undertaken by Herbert Spencer.

Spencer asserted that in culture there appeared first definite and specific experiences, and afterwards the respective general theses. In the treatise entitled *Genesis of Science* Spencer deprecated the trials of distracting theory and thinking abstractively from empirical experiment. In accordance with him, every scientific theory is supplying only relative truths: *We have seen how in the very assertion that all our knowledge, properly so called, is Relative, there is involved the assertion that there exists a Non-relative. We have seen how, in each step of the argument by which this doctrine is established, the same assumption is made. We have seen how, from the very necessity of thinking in relations, it follows that the Relative is itself inconceivable, except as related to a Real Non-relative. We have seen that unless a Real Non-relative or Absolute be postulated, the Relative itself becomes absolute; and so brings the argument to a contradiction. And on contemplating the process of thought, we have equally seen how impossible it is to get rid of the consciousness of an actuality lying behind appearances; and how, from this impossibility, results our indestructible belief in that actuality*[11].

According to Spencer, convincing explanation and complete description of the simplest fact are not feasible. Here his views and cognitive agnosticism of Kant are convergent. The Spencer's cognitive views may be summarized as follows: It is impossible to acquire by cognition full cognizance of the world understood whether as an entity or as its individual (specific) part. In other words, we are not able to explain the world not only because of its ontological nature, diversity of forms and relations, but also because of the manner of our investigating the world consisting in formulating continuously new questions and general theses. We recognize reality only in its reveals, partially, but not such as it is. The deepest mystery of existence remains non-reachable for human mind, however not for this reason, that existence is of supernatural character [12].

The fundamental concepts of ontology such as space, time, matter and motion are non-recognizable and for this reason cannot be sufficiently clearly defined by science. Nor space and time are objective features of substance, since we are not knowing their limitations; neither they are the forms of intellect, since they are not able to think belonging to spatial and temporal objects and events. Matter should be divisible, but to some limited extent. However, a non-divisible matter particle of the smallest sizes is a spatial one and hence it is divisible. Equally mysterious is the concept of motion, since motion is described by us with using concepts whose nature is unknown to us. Therefore, according to Spencer, the functioning concepts of ontology lead our mind to a non-transient lane [13].

In accordance with Spencer conception, philosophy is to be the ultimate synthesis of particular disciplines of science, since it is performing the highest and most general synthesis of the achievements of the scientific disciplines. Reality as a whole considered in all its bearings and continuous development is the object of the synthesis. The ground of the process is matter which in its development is passing through the following three stages:

- from the state of feeling loose to that of greater consistence (compactness);
- from inhomogeneity to heterogeneity;
- from indefiniteness to definiteness.

In the Spencer's conception the development means ordering and determining the system of the world of reality. The law of development acts everywhere and always, in the organic and inorganic worlds, in the worlds of matter and spirit, in nature and in the human life of every both individual and social group existing as a single entity. As consequences of acting of the law of development it may be observed, too:

All living species (entities) are undergoing evolutionary changes which consist in effective influence of random environmental circumstances on the genetic biological structure of every individual. The changes are of the form of the mutation of features, the strongest mutants initiating a new consecutive way of species development while the degenerated individuals dying.

In a similar manner is developing the human species. All the consequences and circumstances of the human existence are positively or negatively influencing on the human biological development. As an inteligent being, a human is eliminating consciously the negative circumstances and due to that is developing more fast than the individual belonging to the all the other species. All the conquests of culture, spirit and material have the value this much, that they contribute to growing stronger the condition of human species.

The selection of information on what is useful for human species is performed on the following three levels:

a. current, arbitrary and chaotic;
b. scientific which is integrating the current knowledge into the law enabling us to act consequently and purposely, however within the compass of particular human groups or groups of people with common interests;
c. philosophical which determine such rules of behaviour which seems to be the most useful for all humanity. We are provided with that only by philosophy since
   - philosophy reduces the whole human knowledge to some fundamental principles describing the energetical and biological homogeneity of the world;
   - philosophy disposes of the tools enabling that to determine the theses and to supply in this way the other sciences with possibility of building – respectively to the homogeneous structure of the world despite the differentiated structure forms - uniform methodology. Despite different objects of each particular science.

Spencer's contribution to development of knowledge of real-world complexity constitute his attempts for delivering the methodology for describing the complex reality. It seems also that Spencer’s question of methodology of complex world stimulated the development of scientific approaches to real-world complexity, which are nowadays developed by whole spectrum of the sciences of complexity. *The pure Spencerian view of the world, therefore, is that inceased complexity is an inevitable manifestation of the system and is driven by the internal dynamics of complex systems: heterogeneity from homogeneity, order out of chaos. The pure Darwinian view is that complexity is built solely by natural selection, a blind, nondirectional force, and there is no inevitable rise in complexity. The new science of Complexity combines elements of both: internal and external forces apply, and increased complexity is to be expected as a fundamental property of complex adaptative systems* [14].

2.2 A question of the possibility of the methodological continuity in science

It happens that contemporary theorists formulate the question whether the innovative character of the modern science was connected with introducing the new investigative method basing by a prevailing degree on experiments and observations, and, therefore, being opposite to the speculative method originated with Aristotle.

Such researchers in history of science as G. Sarton and A. C. Crombie were expressing the view that the philosophers of XIII century reached the conception of science and scientific method which, due to his fundamental aspects, was identical with the conception of XVII century, especially in the range of applying the mathematics to formulating theories and verifying that by recalling the respective experiments. In this way, they created science of the same type as that of Galileo Galilei, R. Descartes and I. Newton.

Alexandre Koyre, historian and theorist of science, referred to the matter in the article „Les Origines de la science moderne. Une interpretation nouvelle". He expressed the view that there do not exist premises bringing us to accept the opinion that the appearance and development of contemporary science may be explained by changing the scientific leading interests from theory to practice. He also took to be misunderstanding all the trials of searching the origins of the methodological tools applied to the contemporary science before XVII century [15].

The Koyre's main thesis is the conviction that methodology is not able to initiate science, but methodology is within the compass of science and often is codified just lately ex post. The progress in the science does not consist in applying an elaborated theoretically method such as that of Bacon or Descartes. If it were so then we would have to recognize Aristotle science as borned by anti-Aristotle methodology.

According to Koyre, great scientific revolutions of XVII, XIX and XX centuries were in reality *theoretical revolutions, the result of which was not better connection of „experimental data", but new deep conception of reality being the basis of the data* [16](Koyre, op.cit., p.89). The epistemological view taken by Koyre is closed in the conviction that the accumulation of pure facts revealed by experiment does not create science. The facts need to be completely ordered and explained, thus they need theory [17].

Approving the above reasons, Koyre defined and accepted a view on the dependence of the development of a scientific theory on the methodology of the theory, the view being as follows: In the history of science it is necessary to consider connected with each other spheres of theory and experiment. However, it should be remember that the way of performing experiments and even the whole character of the objects being observed as well as the ability to extract information from the reality with saving all details which are essential and neglecting all what should be disregarded and filter out as being non-essential - requires the respective transformations in the frame of wide theoretical structure in the situations where the transformations may not base only on creating the methodological program.

3. Searching for the methodology of scientific theories of complex reality

To consider the methodology of scientific theories of real-world complexity, I am dealing with the aspects of complexity research, whichare epistemological and ontological: *One question is whether, at least in principle, it is possible to reduce different descriptions of complex phenomenon to one fundamental (for instance, physical) description. Another question is whether complexity is merely a subjective human construction or has an ontological bearing, in the sense that it refers to a quality, or certain qualities, of the world* (…). *Second, in so far as theories of complexity are assigned an ontological bearing, these theories raise questions regarding the fundamental' nature of the world'. Do they not imply a view of the world as largely unpredictable and open to surprising change, at least in the long term* [18]

It may be said that in searching for the methodology of scientific theories of complex reality the key problem is contained in the question: What stand, realism or idealism, should be taken (is proper) in searching for the way of the existence of the object of physics?

The most prominent feature of science is objectivity. Let me remind here Heisenberg opinion: *Every scientists who does research work feels that he is looking for something that is objectively true. His* *statements are not meant to depend upon the conditions under which they can be verified. Especially in physics the fact that we can explain nature by simple mathematical laws tells us that here we have met some genuine feature of reality, not something that we have-in any meaning of the world-invented ourselves*. A second major feature of science is understanding. While objectivity refers to the reliability of the information obtained, *understanding refers to the penetration of the mind into the structure of the object one has been informed about*.

3.1 Towards the objectivity in scientific description of complex reality

For our purposes it seems to be worth considering the conventional stand of Poincare and Duhem because one of the elements of the fundamentals of the philosophical stand is the conviction that the character of the natural regularities is objective and that there exist infinite possibilities of having rich cognizance of natural regularities. For Poincare the evolution theory is a container (hinterland) of the solutions of the majority of epistemological problems. He supplemented the biological evolution adding some metaphysical propositions concerning the character of reality in which the evolution takes place.

Poincare supposed that human was also formed by evolutionary mechanisms. The world which is perceived and described by us in the context of cognition process is the world of ours. The human perceptive apparatus obtained its human form during millions years due to the process of evolution. Although the evolution was an objective process, since it consists in interaction of material environment, human and all the biological organisms, one of the effects of the evolution was mentioned apparatus obtained by human and giving him the ability both to perceive the world, which is independent of human, and to think about the world in one of the hipothetically possible ways.

Poincare considered three different concepts of reality:

- primary reality being the sphere in which the evolution takes place;
- reality perceived by human species;
- separating in the frame of the human perspective the subjective elements from the objective ones, we obtain the structure built of the objective elements in the form of relations.

The structure built of the objective relations is just the reality in the third meaning which was used by Poincare. The reality in the third meaning is the product of scientific cognition where it is visualized in the most perfect form of mathematical relations.

The Poincare's second and third conceptions of reality presented above do not have any independent ontologically existence; such that has the primary reality. Poincare stated that opposing radically to each other the distinguished above types of realities is without any sense. In his works Poincare many times revealed that it is his conviction that the richness of the primary reality does not deplete in the world which is recognized experimentally.

Passing into characterizing shortly the different types of reality from the point of view of the laws governing the reality, let me mention that according to Poincare these laws are deterministic and may be expressed in the form of differential equations. He was convicted that the laws of the statistical physics apparantly break out of the picture of the world proposed by Laplace because the systems described as a whole by statitical laws are governed on the level of elements of their statistical ensembles by deterministic laws.

It seems to be worth to focus our attention on the Poincare's view that the relation between the primary and natural realities is analogous to the relation between the natural and theoretical realities, the constructions of the last being aways insufficient for approaching the complexity of the real natural structures. Although Laplace inclined to the deterministic picture of the world, he also saw the philosophical simplifications in the picture of the world generated by the determinism. Finally, Poincare prefer the view that the world is inifitely rich in laws and we will never be able to construct the matrix describing completely the world.

3.2 Towards understanding the base of the complexity of the world

In XX century in the picture of the world there came into sight the feature of the openness of the world. The feature of the openness came into sight in the situation when the mechanistic view of the world and universe appeared to be non-effective as a basis for interpretation the results of the experiments concerning a wide class of physical phenomena of such domains as, for example physics of atoms, their nuclei and particles. For these reasons, the mechanistic determinism had to be replaced in such places by the probabilistic (statistical) indeterminism lying at the root of quantum mechanics. Moreover, the discoveries about dynamic chaos indicated that also in the area of classical physics there exist places where the conviction of the possibility that stiff precise forecast may be replaced by a new view. Passing from the strictly deterministic picture of the world towards its openness also may be observed in philosophy [19]. *Philosophical positions in current debate on scientific realism fall short of the quantum structure of subatomic physics. The question is: in terms of which concepts can we conceive of subatomic reality? Modern science rests on a sophisticated interplay between theory and experiment. The way in which this interplay extends physical reality beyond the observable realism gave rise to the conflict between Galileo and Aristotelian opennens* [20].

We are able to observe only such a world in which is possible life. In accordance with the so called anthropical principles there came into sight the idea of numerous universes. The anthropical principles in different way formulated data concerning the dependence of the existence of living organisms on the initial conditions and on another parameters characterizing the universe. In turn, not large change in the conditions causes essential changes in the evolution of the world providing facilities for initiating an evolution. One may reflect upon what causes that the universe is friendly towards life. Michal Heller answered the question in the following way: *The thought on purposefully projecting the universe is intruded oneself. However such a thought is strange to the rule „explaining the universe with the help of the universe itself". To neutralize the thought, the following argument was used: Assume that there exist (infinitely) many universes, in which are realized all the possibility combinations of initial conditions and other parameters characterizing each universe. Only a few universes are friendly towards life and we are living in one of the universes since in all the other universes we could not live. Among the debaters at once were found such ones who the hypothesis of numerous word recognized as more rational than the hypothesis of God, and another ones who state 'it is not necessary to multiply beings without any need' once is enough one God* [21].

Resume

Aristotle divided science into two main categories: cognition of the *what* and cognition of the *why*. Throughout history the first category of cognition was capable of empirical or merely factual novelty, very often without attaining to the essence of things. The *what* of thing is encumbered with the inability to go beyond factual knowledge of things. Contrary to that, the second kind of cognition (the *why* of thing) stimulates us to reach the *why* of things, i.e., to discover the intrinsic reasons why things were as they were. The great revolutions in science originate from just the query *why* about the reason. In these revolutions both philosophy is not dispensable, and science and philosophy are not separable. Moreover, a philosophy of science which describes only normal science or at most bygones, becomes itself normal science with the fate of being overtaken in the next scientific revolution.

Greek philosophy was developing simultaneously and in interaction with the deductive form of mathematics. For this reason it led to the expectation that philosophy is also a deductive science and as such is the basis of the other sciences. However, the specific philosophical process is the Socratic retrospective query*: Do you really know what you are doing?* It is the aspiration of philosophers to understand the structure of every object, understanding being referred to the penetration of the mind with this retrospective query to the unshakable foundation of a deductive reconstruction. Philosophy is contained in such a reconstruction of physics, the reconstruction being performed in accordance with the following scheme: from temporal logic to physics, from physics to the evolution of life, from the modes of cognition of life to the preliminaries of logic. Consequently, according to

Weizsacker, we arrive at the following methodological figures of this reflection:

- temporal logic is the basis of physics;
- physics is the foundation of biology;
- and methodology arising from biology teaches us to see structures of animal and human behavior which ultimately permit the interpretation of logic itself as a system of behavioral rules.

The modern science was beginning when it was succeeded in proving that the same physical laws are governing the planet Earth and the universe as a whole. Cosmological models are solving the problem of genesis of the universe shifting in time its beginning to minus infinity. The approach is based on the assumption that if the world does not have any time of origin then there does not exist anything what need to be explained. An another approach to the problem of the genesis of the universe is applied in the trials of constructing a models presenting a way in which the cosmos could arise from nothing, for example the model proposed by Jim Hartle and Stephen W. Hawking [22].

Physics supplies a description of complex reality unifying that in the total cosmos in the range of the physical laws. Each of the elements of the universe is additionally described in detail, even in the range transcending its physical properties, in the situations when the considered elements are involved in the analysis of the evolution of biological life. The activity led to a particular contact between the observing and being observed. In turn, the contact is an encouragement to widen the view on biological reality, even with transcending the physical laws. Then we begin perceiving the kind of the logic of the existence of the world. In the causal-resulting sequence the logic leads from and to the First Cause. Thus, for scientific considerations the defined logic of the existence of the world may be both the point of the purpose when we are passing biology through physics to the logic or the point of the start when we are interested, in the first place, in the ontological structure of the world (in the ontological dimension of the complexity) as well as next successively in the physical laws governing the complexity and in the biological complexity of surrounding complex reality. With respect to rationality and objectivity, the approach through logic to physics to biology seems to be the well justified methodology of scientific theories of complex reality.

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Endnotes

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7 see, Ibidem, p. 23.

8 Ibidem, p. 21.

9 see, Ibidem, p. 29.

10 see, Ibidem, op.cit., p. 23.

11Spencer, H., First Principles, New York, 1898, p.99.

12 Mackiewicz, W., Filozofia wspolczesna w zarysie, Warszawa, 1991, p. 30-32.

13 see, Ibidem, p. 32.

14 Lewin, R., Complexity. Life at the Edge of Chaos, Chicago, 1999, p. 149.

15 see, Koyre, A., An experiment in measurement, Proceedings of the American Philosophical Society 2 (97), 1953, p. 76-77.

16 Ibidem, p.89.

17 Ibidem.

18 Niekerk, K., Buhl, H., Introduction: Comprehending Complexity, in: Niekerk, K., Buhl, H. (eds.), op. cit., p.11.

19 see, Heller, M., Czy fizyka jest nauka humanistyczna, Tarnow, 1998, p.152.

20 Falkenburg, B., Particle Metaphysics. A Critical Account of Subatomic Reality, Berlin, 2007, p.41.

21 Heller, M., Ostateczne wyjasnienie wszechswiata, Krakow, 2008, p. 20.

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