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Studia Philosophiae Christianae 47/3, 19-36

2011

Studia Philosophiae Christianae
UKSW
47(2011)3

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AN ATTEMPT AT THE CATEGORIZATION OF THE LIMITS OF SCIENCE

Key words: philosophy of science, methodology, science, limits of science, empirical knowledge

1. INTRODUCTION

In this paper I would like to make an attempt at indicating various categories of science limits. As I will try to demonstrate further on, an analysis of the identified limit categories may help to better understand the specifics of science as such.

Science is a phenomenon of culture, which we create but the substance of which we are unable to fully describe and understand. What does ignorance with regard to science consist of?

Although in specific cases it is not difficult to define what kinds of predictions or explanations are a part of science and which aren't (e.g. cosmology is a scientific theory while forecasts of the fate of the world made by clairvoyants are not), we still fail to capture the essence of

methods applied in science or provide a universal and sufficient criterion of appurtenance of a theory to science.

The philosophical disputes surrounding science, such as the dispute concerning the demarcation criterion, rationality of science, its empirical nature etc., reveal the scope of ignorance about science itself. This lack of philosophical knowledge does not preclude pursuance and development of science. Scientists create science by applying methods acknowledged by the scientific community. They present theories, justify, check and develop or reject them. But explanation of the substance of the phenomenon of science, determination of what the meaning of the rationality or truthfulness assigned to it is, location of its role in culture e.g. in relation to common cognition, ethics or religion, is the task of philosophers and, eventually, of the recipients of science. Owing to the importance and universality of science, an understanding of the aforementioned issues is relevant.

To obtain knowledge about science, scientific theories were investigated, and their content and methods analyzed. This paper will make an (non-exhaustive) attempt at indicating various categories of limits faced by science. It will be also demonstrated that investigation of these limits may be an additional source of knowledge about the essence of science. Each of the indicated limits tells us something about it, or about properties of the investigated phenomena.

2. TYPES OF THE LIMITS OF SCIENCE

The general question about "the limits of science" is ambiguous and we need to detail what limits are concerned. Science encounters several limits. Some mark the boundaries of its capabilities, while others determine its character. One may ask, what the limit of the current science is, or ask whether there is a domain of phenomena which by its own internal rule science will never be able to investigate. Yet another question is how far we can change the present research methods to still be able to clasify the results attained through them as scientific ones? These are the questions about the limits of science as a whole. Philosophy has frequently attempted at identifying and sometimes at demarcating those science limits.

The question of limits of a specific theory has a different frame of reference. It concerns the issue of how adequate the laws of a particular scientific theory are, e.g. the classical gravity theory, biological brain's neuronal theory etc. Those limits on science are not set by philosophy or culture, but are defined by science itself.

3. THE PROPOSAL TO IDENTIFY THE TYPES OF THE LIMITS OF SCIENCE IN THE CONTEXT OF QUESTIONING THE ESSENCE OF SCIENCE

I. Limits of science taken as a whole:
   1. methodological:
      - limitations of empiricism,
      - limitations of logical uniformity,
      - limitations of methodological unity of science,
   2. epistemological:
      - limits of the realism of scientific cognition,
      - limits of scientific truth,
      - limits of scientific rationality,
   3. ontological:
      - limits of the scope of science.

II. Limits of particular scientific theories:
   1. Limits of the scope of particular scientific theories,
   2. Intra-theoretical limits:
      - Limitations concerning the phenomena from the scope of theory,
      - Limitations concerning cognition of events postulated by the theory,
      - Factual limitations of calculation technique and acquisition of information about complex systems,
   3. Ethical,
   4. Economic.

4. AN ANALYSIS OF SELECTED TYPES OF LIMITS

4.1. LIMITS OF SCIENCE AS A WHOLE

4.1.1. Methodological limitations

Identification of the indicated types of limits follows from the types of postulates set for the ideal of science. Each specified type of limit is related to some philosophical dispute, which indicates that science transcends those limits and any model of science, which does not account for this and imposes strict limitations, is inadequate. What methodological limits are actually transgressed by the science pursued?

Scientists create and intuitively apply the research methods which seem to them appropriate to a given phenomenon domain. They consider some methods as scientific, while they reject others as inadmissible in science. Despite the efforts of philosophers concerned with scientific cognition (and scientists themselves) it is impossible to define what a scientific method really consists of. Paul Feyerabend claims that there is no criterion of scientific method, no method can be forbidden in science and none is universally good. Science keeps transcending the existing methodological limits, just as it does with any other limits and its progress consists precisely in transcending those limits.

However, in practice a methodological limit exists; we think that astronomy is science while astrology is not, exactly owing to how their theorems are justified; we differentiate between scientific medicine and non-scientific beliefs about health, basing on the methods of knowledge acquisition in both fields etc. Where does the limit between scientific and non-scientific methods actually run? Generally speaking, a scientific method is an empirical and mathematical method. Since the times of the Vienna Circle, non-empirical theories (except mathematics and logic) have been recognized as non-scientific.

4.1.1.1. The limits of empiricism – the dispute concerning the role of experience

We owe to the idealistic image of early 20th century science an assumption that uninterpreted, "pure" facts are the foundation of scien-

ce and the proper point of reference for scientific theories. The search for facts completely independent of theories revealed the limits of science empiricism. Attempts to face the „problem of finding protocolar statements" undertaken by representatives of the Vienna Circle: Carnap, Neurath and Shlick demonstrated borderline examples of possible statements reflecting pure empirical facts. What facts might they be? Subjective experiences of sensory qualities devoid of any objective and quantitative interpretation. Such cognition may not be the beginning of science. Objective interpretation of the experienced qualities requires conceptualization, a conceptual schema being the tool for understanding perception as experiencing the world. Does science reach as far as this pure experience? Schlick tried to demonstrate that it does but such experience does not constitute science beginning but may appear as a final confirmation of a theory. Sentences concerning qualitative sensory experience derived from theory may serve the purpose of confronting the theory with the world. Results of such experience make sense only in the context of a verified hypothesis. Attempts to reach the borderline ideal situation showed that there is no pure experience as a reference point for theory and there is only experience in the light of a tested hypothesis.

According to Kuhn, the theoretical component of experience is fundamental. It is the paradigm that defines the ontology of experience and methodology of scientific theory. A hypothesis is a prerequisite of experience. To understand the significance of an image captured in a telescopic lens and on its basis e.g. to estimate the size of the observed object, one needs to know the optical theory underlying the workings of a telescope. To understand the meaning of bursts of light on the scintillator screen, one needs to have a hypothesis of the impact of matter particles. Only in the view of such hypothesis do those bursts signal appearance of specified objects. Only in connection with a hypothesis interpreting it, the result of the measurement becomes a comprehensible experience result. This hypothesis allows one to define the observed phenomena as expected and comprehensible cases of regularities or surprising anomalies.

So how shall we understand the confrontation of a hypothesis with the world? A hypothesis defines what shall be and what it shall be like,

e.g. if neutrinos exist then the outcomes of their interaction with matter will be such and such. If something interacts in a hypothetically assumed manner, we ascertain that those are neutrinos. But if objects that emerge interact differently, then the hypothesis is in conflict with experience. Although incomprehensible in the light of the hypothesis, such result can be observed and formulated in its conceptual schema. It indicates anomalies, which play an important role in the process of theory development and modification.

Transcendence of the limits of narrowly defined empirical method, understood as a confrontation of theory with pure experience, reveals the nature of scientific method, where theory and experience mutually intermingle. The a-prior, linguistic, theoretical component is an element of each experience. A scientific experiment is not passive observation; it rather consists in provoking certain phenomena in specified conditions so as to bring about defined, postulated by the hypothesis, phenomena. Focusing such research on a defined cognitive objective requires that they be theoretically conditioned. Explaining science in opposition between facts and experiences and theoretical interpretation is oversimplified. Empirical method is a multi-stage process of mutual inspiration and perfection of the hypothesis and experiment.

4.1.1.2. The dispute concerning the logic of justification of scientific theories

As has been postulated on many occasions, (the Vienna Circle, Popper) on the basis of the applied method one can perform a strict division of knowledge (demarcation) into science and non-science. The line of this division delineates the limits defining science.

The issue of demarcation was one of central issues of the philosophy in the first half of the 20th century and has not be finally solved. It provided attempts at characterizing science on the methodological plane. The positivists of the Vienna Circle claimed that a scientific method is a method for empirical confirmation of hypotheses, which was combined with the method of inductive recognition of the truthfulness of general statements on the basis of a finite number of cases confirming them. K. Popper pointed out the shortcomings of such criterion of scientific viability, arguing that it eliminates from science all funda-

mental laws, which – owing to their general nature – cannot be conclusively confirmed empirically. By rejecting induction he assumed that a scientific method, and consequently a demarcation criterion, is comprised by empirical falsification of hypotheses connected with the deductive method.

Prior to that, the deductive method was combined with formal, rather than with empirical systems. Science limits (except mathematics and logic) were defined by the induction method. Popper demonstrated that the induction logic does not define science limits. Those limits are defined by the deductive structure of empirical theory enabling falsifying reasoning. The deductive method proposed by Popper does not fully solve the problem. Firstly, as shown by Lakatos, owing to *ceteris paribus* clause it is impossible in scientific practice to falsify any theory, and secondly, it is scientific practice to confirm the selected, relevant test cases of the theory rather than to look for falsifying cases. Therefore the general laws are legitimized on the basis of individual cases – which corresponds more to the inductive than deductive method.

It is also impossible to obtain starting hypotheses that might be falsified with the use of deduction. Popper ignored the issue of scientific discovery, of postulating hypotheses recognizing, it as a psychological and irrational process. It is true that scientific hypotheses are not simple generalizations of empirical facts and in their time they are recognized as daring hypotheses. But it is their aim to explain a certain group of experiences whose results were not accordant with an earlier theory. The context of those experiences and prior attempts at their comprehension provide heuristics for introduction of new hypotheses. Investigation of the transcendence of the limit of deduction and entering the area of induction prohibited by Popper, may shed new light on the conditions of scientific discovery. This limit is reflected in the dispute concerning rationality of scientific discovery and indicates that scientific method combines both those paths in a way of its own.

Having at its disposal results of a small number of experiences, science formulates general laws, which it confirms *via* selected individual experiments. It also neither proposes nor tests an unlimited num-

ber of random hypotheses. On the contrary, it offers single proposals, which are developed into mature theories via successive corrections.

So perhaps there is some different type of interdependence between a specific case and the general law under which it falls. If we assume rationality of nature or occurrence of phenomena in accordance with unchanging laws, then those laws may be seen in specific events. This is not an easy task, but still a possible one. Scientists do not treat the world of nature as a set of incidental events not governed by laws. Therefore they do not make inductive generalizations on a set of incidental events nor do they adopt as a starting point a whole chain of daring and unjustified by experience hypotheses. They try to guess general laws on the basis of their realization in a small number of similar cases, which proved relevant in view of the prior knowledge.

4.1.1.3. The dispute concerning science unity

According to the positivist model, scientific theories are those using only empirical and mathematical methods modeled on physics. The dispute concerning the unity of science contradicts the view that all areas of nature, and also the human brain and society, should be investigated using the same methods as those applied by physics. Science investigates material reality, whose most fundamental level is described by physics. Since the laws of physics are the most fundamental ones for the entire material world, an explanation making reference to them is the basic and final method to explain all phenomena. The reductionism connected with this conviction proved very useful. It contributed to many achievements, e.g. in biology, medicine, psychology, sociology etc. But can it be used without any limitations? Isn't it a limitation for science in itself?

Opponents of reductionism point out that at each more complex level of the organization of nature, certain laws emerge which cannot be derived from regularities taking place at a lower tier. Biology, psychology, sociology formulate their own laws which cannot be reduced to laws of physics. At a higher level of organization, a factor emerges which integrates objects into more complex entities of specific structure and functions. Reduction removes this most significant element

from the scope of research. Therefore reductionism imposes excessive limitations on the scientific method. Currently this problem is clearly visible in cognitive sciences. The undertaken attempts at explaining the essence of human cognition demonstrate that reduction of the occurrence of the content of consciousness to emergence of representations understood as material information carriers in the brain fails to reflect the essence of the issue. The relationship between the brain and mind still fails to subdue to reductionist methodology. It seems that its resolution exceeds the limits of reductionism. If this succeeds we will also know more about scientific method itself. If this method is able to make reference to those qualitative differences between sciences, it will lead to a change in the concept of the unity of science.

In recapitulation: the idealized model of science set out the goal of methodological efforts. According to it, science was supposed to provide complete, genuine and justified cognition. Science was supposed to fulfill its task via empirical method of hypotheses formulation or their confrontation with pure experiencing of reality preceding all theoretical interpretations. The empirical method was to be combined with the inductive method, and in the successive model with the deductive method, for justification of hypotheses. This method was to be universal for cognition of the entire reality available to science. This utopian methodology set too narrow limits on science. In scientific practice they are permanently transcended and this transcendence reveals the true nature of methods actually applied in science. Their adequate description requires breaking through the two aforesaid oppositions. It demonstrates that science cannot be understood by defining it as a set of theorems and a set of cognitive methods. A separate treatment of methods and contents obscures the fact that the content of hypotheses and the methods applied to check them are mutually conditional upon each other.

4.1.2. Epistemological limits

The expectation set on science to provide a true and adequate image of reality, which will serve as a basis for prediction of future events, also encounters several practical and theoretical limitations, with the

latter ones being a subject of many centuries of epistemological discussions. They follow from general properties of human cognition. The questions regarding the limits of any cognition concern also scientific cognition.

4.1.2.1. Limits of the scientific realism

The most important of them concerns the nature of what we get to know. Is this the very material reality or just constructs of human mind? Both parties to the dispute have arguments of their own. The arguments supporting constructivism are presently very convincing. It claims that science creates the objects of its theories and formulates the laws which govern them. The very conceptual definition of experience in itself bears elements of abstraction, idealization and construct. It is also aspectual and goal-oriented. We attach greater weight to those components of experiencing which correspond to the set research or practical goals, while we ignore or even fail to perceive others. Therefore the experiencing of reality itself, which is supposed to inspire and initiate the research process in science, performs – decisive for a further cognition – **selection and idealization of the features of the experienced phenomenon**. To explain the experienced – and consequently also selected and idealized – phenomena, objects meeting experience conditions are postulated. Such objects have properties defined by theories within the frames of which their existence makes only sense. For example: constant lengths of bars independent of their movement in relation to the observer making measurements do not make sense in relativist physics, but they are well defined in Newton physics. Objects having simultaneously properties of a particle and wave are impossible and incomprehensible for classical physics but are typical for quantum physics.

Within this meaning the objects of science are not real object but only postulates of a theory. Such theories provide models of phenomena which are used to predict events. If such prediction takes place within a satisfactory scope, such theory and the related image of reality will be universally recognized.

According to Kuhn, scientific theories of such order as classical or quantum mechanics, theory of evolution, chemical theory of oxidation have the character of a paradigm, i.e. by supplying a solution to a problem they also determine its ontology and admissible methodology. Paradigms are historically and culturally, not just empirically, determined. Therefore the generally understood culture, as a set of beliefs and life styles and organizations, language, and history, determine the scientific models of the world.

On the other hand, however, science continues to experience the limits of the reality models it designs. The possibility to discover their limits points out to their relationship with the world. Science is able more and more precisely to point out the limits of adequacy of its models. Therefore it is aware of its constraints and looks for ways to break through them. Science supplies various aspective images of reality, applies models that idealize phenomena at various levels, but it also provides methods for testing those models in experiences. The tests eliminate some models while preferring other ones. This helps make successive models closer and closer to the defined aspects of the phenomena. It also helps to get to know through them the phenomena actually taking place in the world.

The development of empirical science is a response in the dispute concerning realism of scientific theories. In the scope of phenomena available to its research methods, science gets to know the world via models it constructs. A science fact verifies our understanding of cognitive realism, according to which the world may be available to science beyond any conceptual apparatus, with aspective selection of data and the necessity to create many descriptions and models regarding a given selection and conceptual apparatus. The multitude of descriptions defining various aspects of reality does not mean, however, that the properties reflected in the model do not accrue to real objects. The analysis of relationship of scientific theories to reality points out to the need to verify the understanding of scientific realism. One of such attempts was presented by e.g. H. Putnam, who called his view the internal realism.

4.1.2.2. Limits of scientific truth

Similarly, the question of truthfulness of scientific cognition gave rise to beginnings of reflection concerning the criteria of truthfulness of scientific theories. Basing on classical theory of truth, logical atomism proved to be a utopian model for truthfulness of scientific theories. Scientific theories constitute systems of statements which as a whole face the judgment of experience. Only certain, specially formulated for that purpose, statements are confronted with experiences, other are legitimized on the basis of the image of cohesion of the entirety of the system.

Truth is not assigned to scientific theories in uncontested manner. Scientific revolutions demonstrated that scientific theories are transient and revocable. But what is revocable? Have the predictions of Newton's mechanics as regards small speeds and classical objects proven false? It turned out that the calculation rules of Newton's physics cannot be applied without limitation. But the fact that one can point out the limits of their application makes those rules correct for their proper scope of phenomena. By indicating the limits of the applicability of particular theories and related phenomena models, science corrects its own errors. The analysis of the limits of truthfulness encountered and transcended in science, similarly to other types of limitations, provokes a reflection on the issue of scientific truth and the search for solutions which take into account the fact that science does not make statements as absolute copies of reality, but instead it interprets reality from a certain point of view and in the form of abstract models. Its theorems are not simply untrue for that reason. They are true in a given aspect and the scope of the description of reality.

4.1.3. Ontological limitation. The limits of scientific scope

The limits of the application of research methods adopted in science demarcate the scope of issues which science may sensibly address. Ethical, religious and aesthetic matters used to be excluded from the scope of those issues. But scientific limits have also shifted in this respect. In the modern meaning of the word, science began with Newton's

physics. Initially the scope of science so understood – with physics being a model example – was limited to physical objects having mass and interacting gravitationally and mechanically. This method began to be successfully applied also to other phenomena. Gradually the empirical method combined with the quantitative characteristics of phenomena expanded to the field of chemistry, biology, sociology and economics. Science therefore successively transcended the limits set upon its scope. Currently science faces the challenge of breaking through yet another barrier, namely the area of the human mind. The mind model, as a system processing information about the environment and neuronal states as a representation of the world, allows for application of scientific, empirical and calculating methods to the areas of consciousness, which used to be set against the physical world. Present methods of research into the consciousness do not allow us to get to know the content of thoughts. What we have managed to do has been to largely recognize which areas of the brain are responsible for various functions, e.g. cognitive, emotional etc., as well as what information transmission within the nervous system consists in. But we cannot state that this limit will not be transcended. As this analysis shows, development of science has consisted in perception, in a successively expanding scope of phenomena, of the possibility of their empirical and quantitative or calculating (algorithmic) characterization and finding proper methodological tools for it.

Still much remains outside the limits of science. For example the very process of scientific discovery, philosophical reflection over science, or the issue addressed herein, namely what is truth in science, and in the fields of religion, values and culture.

Transgression of successive limitations by factual science demonstrates how inadequate the very ideal image of early 20th century science was. The entire century of search was marked by building opposition to this ideal. This analysis demonstrates that those oppositions need to be defied too.

The table below shows the connection between categories of the limits of science and philosophical discussion about nature of science.

Category of limits		Philosophical dispute	Main oppositions	Source of limitations	Comments
Methodological limits		the dispute concerning scientific methods	Philosophical model/ scientific practice	postulated by idealistic model of scientific method	science reveals its nature which cannot be captured using one of the indicated oppositions.
1	limits of empiricism	the problem of the role of experience in science	theory-independent experience/ theory-driven experience (the conceptual schema)		
2	limits of logical uniformity	the problem of demarcation	inductive/deductive methods		
3	Limits of methodological unity of science	the problem of unity of scientific methods	reductionism / mutual unverifiability of the theories at various levels of elementariness.		
Epistemological limits				demarcated by a utopian image of the properties of scientific cognition	
1	**limits of the scientific realism**	The problem of realistic nature of the objects, laws and theories of science	opposition between scientific realism/ antirealism		
2	**limits of scientific truth**	the problem of the criterion of truthfulness in science	classical theory of truth/coherent theory of truth		
ontological limits				Limits defining the scope of phenomena available to science	
1	**Limits of the scope of science.**	The problem of transcending by science of the limits of the physical domain.	scope of science unlimited as a rule, limited only factually and by time / the scope of science limited as a rule.		

4.2. THE LIMITS OF PARTICULAR SCIENTIFIC THEORIES

Particular scientific theories face various types of limits.

4.2.1. Limits of the theory scope

The scientific revolution of the early 20th century uncovered the limited scope of the applicability of scientific theories. There are two reasons for this. The first is that phenomena models adopted in a given theory reveal their limitations, e.g. models of a body and actions in classical physics. Scientists realize those limits when they encoun-

ter difficulties in understanding the results of experiences incompatible with scientific predictions. Factual development of science takes place in contact with those limits. An attempt to overcome difficulties leads to the emergence of new, frequently paradigmatic theories supplying other phenomena models and new research methods. But those new theories concern a new area of phenomena, e.g. quantum theory concerns microscopic phenomena and the General Theory of Relativity concerns phenomena of a cosmic scale. New emerging theories only set limits on old theories, which frequently prove to be borderline cases of new ones, for example when we treat the speed of light as one approaching infinity, or the value of Planck's constant approaching zero.

The second reason is that the scope of scientific theories is expanded by the attempt at modelling phenomena from the proper scope of a given theory, so as one could apply to them the existing theories and methods. For example, the application of neuro-biological and computer methods in investigating the human mind is an attempt at expanding the scope of theories of natural sciences onto the area of consciousness phenomena. Application of reductionist methods in biology and medicine is another example of such an expansion of limits. Such procedures let one keep expanding the scope of phenomena covered by research and consequently leads to development of a method proper for those phenomena and emergence of further, more mature hypotheses.

One can say that almost the entire creative effort of science is devoted to discovering, attempting at understanding and transcending those limits. Development of science consists in a continuous transcending beyond the scope of current knowledge.

4.2.2. Intratheoretical limits

4.2.2.1. The limitations concerning phenomena from the scope of theories

They follow from the content of theories and concern the nature of investigated phenomena, their properties and cognitive capacities. Each scientific theory formulates limitations for nature. Its laws state which events may not occur. However, certain limitations proved surprising.

The most frequently discussed limits of that kind are the limits pointed out by Quantum Theory and the Theory of Relativity. Both those theories pointed out that there are limits of applicability of conceptions of the world developed in contact with phenomena described by classical physics. The concept, that the laws and models of such physics can be extrapolated onto any phenomenon, was proven false.

Quantum physics deals with objects on an atomic and nuclear scale; wave effects of material objects are manifested in this range of sizes. The wavelength is inversely proportional to its size. When a wavelength assigned to an object exceeds its size, then wave effects can be observed. At atom size and smaller, this effect becomes significant. Quantum physics states that for quantum objects it is impossible to measure simultaneously their position and momentum with any precision. Imprecision of measurements has to comply with the Heisenberg principle. This is surprising only due to incompatibility with expectations formulated on the basis of classical theory. The notions of position and momentum are classical values and their applicability has limitations. A full image of the properties of quantum objects does not include the necessity or need for precise, simultaneous measurement of both values. However, this limitation points out to the existence of such pairs of values, so-called complementary ones, which are governed by the same restriction as momentum and position (e.g. time and energy). It states that in the micro-world not all measurable values accrued to classical objects can be simultaneously precisely defined.

The second limitation concerns the maximum speed of propagation of interactions and transmission of information in the world, which must not exceed speed of light in vacuum. This bears consequences for our cognition of remote areas of space. One is unable to know the events taking place in them presently, only those adequately remote in time. Owing to this, we are properly isolated in the universe. This limitation is so coherent with our present image of the world that the information which surfaced this autumn, to the effect that some movement of neutrinos violating this principle can be observed, sent shock-waves throughout the physics community.

4.2.2.2. Limitations concerning cognition of events postulated by theory

Cosmology also points out limits concerning the nature of the world and the possibility of getting to know it. It indicates the existence of idiosyncrasies. It deprives science of the possibility to have knowledge about the beginnings of universe and phenomena taking place within the event horizon in black holes. However, there is hope to explain the processes taking place inside black holes, or immediately after the Big Bang when the quantum theory of Gravity is formulated. Limitations of this kind are closely related to specific cosmological hypotheses. At this stage of science it is difficult to define their objectivity or answer the question whether this is a property of nature or an effect of the adopted model.

Still another type of limit concerns **physical costs** of the acquisition of information about a complex system and the **actual possibility to calculate**, with the use of the fastest computers, some theoretically available predictions. In this sense, despite a lack of theoretical limitations, the effects of applications of known laws to some factual situations cannot be predicted.

5. RECAPITULATION

The image of science revealed through this analysis demonstrates that it is a certain dynamic entirety of theories and methods, constantly evolving and developing in accordance with its internal laws. It is not completely homogenous in terms of methodology or scope, it has some kind of hierarchical structure, but there is a certain kind of internal non-contradiction between theories of various levels. Various areas of knowledge in the scope of the entirety of science interact and inspire each other. As I tried to demonstrate, getting to know the limitations of science is a way to lead to a better understanding of its nature.

PRÓBA KATEGORYZACJI GRANIC NAUKI

Streszczenie

W artykule podjęto próbę (niewyczerpującą), wskazania różnych kategorii granic, z jakimi mierzy się nauka. Pokazano też, że badanie granic może być dodatkowym źródłem poznania istoty nauki.

Ogólne pytanie o „granice nauki" jest wieloznaczne i potrzebuje doprecyzowania o jakie granice chodzi. Nauka napotyka bowiem na cały szereg ograniczeń. Jedne wyznaczają kres jej możliwości, inne natomiast determinują jej charakter. Można pytać jaki jest kres nauki aktualnej lub pytać czy istnieje jakaś dziedzina zjawisk, których nauka ze swej wewnętrznej zasady nigdy nie będzie w stanie zbadać. Innym pytaniem jest, jak dalece można zmienić obecne metody badawcze aby wyniki uzyskane za ich pomocą określać jeszcze mianem naukowych? Są to pytania o granice nauki ujętej jako całość. Te granice nauki często próbowała rozpoznać a czasem wytyczyć filozofia.

Inne odniesienie ma pytanie o granice konkretnej teorii. Dotyczy ono problemu jak daleko adekwatne są prawa określonej teorii naukowej, np. klasycznej teorii grawitacji, biologicznej teorii neuronalnej mózgu itd. Tych granic nie stawia nauce filozofia czy kultura ale wyznacza je sama nauka. W tym artykule tylko krótko wspomina się o tym rodzaju ograniczeń ale nie przeprowadza się ich głębszej analizy.

W artykule skoncentrowano się szczególnie na tym rodzaju ograniczeń, jakie charakteryzują nauką jako całość. Wyodrębnienie wskazanych typów granic wynika z rodzaju postulatów stawianych ideałowi nauki. Z każdym określonym rodzajem granic łączy się jakiś spór filozoficzny, który wskazuje, że nauka przekracza te granice a model nauki który tego nie uwzględnia i narzuca ścisłe ograniczenia jest nieadekwatny.

Głównym przedmiotem artykułu jest pokazanie, że filozofia próbowała odkryć naturę nauki przez wyznaczanie granic, których wiedza, aby być naukowa, nie może naruszyć. Konfrontacja oczekiwań filozofów i realnej nauki prowadzi do rozwoju wiedzy na temat nauki jako takiej.

Obraz nauki jaki wyłania się z przeprowadzonej analizy ukazuje, że jest ona pewną dynamiczną całością teorii i metod, ciągle ewoluującą i rozwijającą się według swoich wewnętrznych praw. Nie jest ona do końca jednorodna ani metodologicznie ani zakresowo, przejawia pewien rodzaj struktury hierarchicznej, istnieje jednak wysoki stopień wewnętrznej niesprzeczności pomiędzy teoriami różnych poziomów. Różne obszary wiedzy oddziałują na siebie i się inspirują. Poznanie ograniczeń nauki jest droga prowadzącą do lepszego zrozumienia jej natury.

Słowa kluczowe: filozofia nauki, metodologia, nauka, granice nauki, wiedza empiryczna