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Polish Contemporary Philosophy and Philosophical Humanities

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Preface

Lively discussions about developing a general theory of reality are magnified at the time of the emergence of new scientific theories. This situation occurred in the first half of the 20th century: in the natural sciences there appeared two fundamental theories of macro- and microcosmos: theory of relativity and quantum mechanics; whereas, in the formal sciences, a breakthrough was to be observed – among others manyvalued logic systems and the so-called limitation theorems were elaborated. Groundbreaking achievements in detailed sciences have changed the view of the world of natural phenomena. The mechanic image of reality was removed and in its place new insights into traditional problems that carried a philosophical charge began to be introduced. What we are referring here to is not only the change in the understanding of space, time or matter, the principles of causality, but also the development of systems distant from thermodynamic equilibrium and basic natural sciences research.

The testimonies of the philosophical struggle with the development of specific sciences and new concepts appearing in them can be, developed by Zygmunt Zawirski and Benedykt Bornstein, two different concepts of scientific metaphysics.

The subject matter of this monograph is the presentation, discussion and critical analysis of two selected paths leading to the development of scientific metaphysics, which deserve special attention due to the still valid research programs presented by Zawirski and Bornstein. Both studies meet very high standards of methodological development of a general theory of reality referring to the development of specific sciences, and in this respect can be considered as a model test for contemporary studies of this type.

In philosophical and methodological studies, Zawirski and Bornstein attributed a special role to mathematical and logical methods. They stood in the position of scientific approach to practicing philosophy, where there is no place to unjustified speculations and irrational elements. Both Zawirski and Bornstein, however, did not avoid pointing out the place for metaphysical considerations in the world-dominated science. However, they did it with great caution and responsibility for the results of their searches. With such caution and diligence in practicing philosophical considerations, we have to deal with almost the entire period of Polish philosophy in the first half of the 20th century. An illustration of this situation in philosophy is Zawirski's statement: "[…] work was done with great effort and success on displaying a whole array of detailed matters, but no great scientific synthesis took place, no one was in a hurry feeling that it was still too early."[1] Although there was an awareness of the completion of a thorough preparatory work, i.e. the work at the basis of the philosophical understanding of reality, there were attempts to formulate a full approach to behold the world around us.

Polish philosophers of the early 20th century were aware of the goals that philosophy has to achieve, so that the world inhabited by man would become better known and understood[2]. The specific goals that philosophy has to achieve were formulated by Władysław Heinrich in the pages of the quarterly "Kwartalnik Filozoficzny" [The Philosophical Quarterly]. Zygmunt Zawirski, agreeing with the understanding of philosophy given by Heinrich, brings a new aspect in the elaboration of philosophical synthesis concerning reality. The axiomatic method, which was only sporadically used in philosophy, was acquired in a significant way for the purpose of philosophical reflection on reality. All considerations in the field of natural sciences and ontologies should, according to Zawirski and Bornstein, take into account certain axioms adopted within these disciplines and thus be enriched by the possibility of using the axiomatic method in these studies, and what naturally comes from it, be able to appropriately use the results of the work of mathematicians and logicians.

The issue of the amazing effectiveness of mathematics in the description of natural phenomena has its extensive literature. The issue of mathematical natural science is one of the fundamental problems of the philosophy

1 Zygmunt Zawirski, *O współczesnych kierunkach filozofii* [On the Contemporary Trends in Philosophy] (Kraków: Wiedza-Zawód-Kultura, 1947), pp. 9–10.

2 Władysław Heinrich, "Filozofia i jej zadania [Philosophy and its Tasks]," *Kwartalnik Filozoficzny* [The Philosophical Quarterly], Vol. 1 (1922), pp. 1–18; as well as Władysław Heinrich, "O zagadnieniach podstawowych filozofji [On the Basic Philosophical Terms]," *Kwartalnik Filozoficzny*, Vol. 2 (1924), pp. 269–302.

of science. Generally speaking, the issue of mathematical natural science is closely related to the philosophical problem of intelligibility of being (*intelligibilitatis entis*). In medieval philosophy, the dominant function in the cognition of nature was attributed to philosophy, in particular paying special attention to accepted philosophical and theological assumptions, from the perspective of which attempts were made to evaluate natural theories. In the era of modern rationalism, the situation has changed, and it was striving to practice philosophy in the way similar to the exact sciences.

In the 19th century, the development of modern science led to attempts to completely subordinate philosophy to science, which contributed to the frequent reduction of philosophy to the analysis of the language of science and scientific research methods. The emerging extreme epistemological isolationism between philosophical and natural cognition resulted in a neo-positivist division of opinions into scientific and metaphysical. Both for Zygmunt Zawirski and Benedykt Borsntein, the epistemological and ontological studies concerning the natural reality conducted by each of them, not taking into account new facts and scientific theories, lead to a characteristic style of philosophizing, in which commonsense intuitions are valued higher than the philosophical implications of scientific theories. In their opinion, on the one hand, the new physical theories, developed at the beginning of the 20th century, deserved special attention, which contributed to the mathematical and logical studies of the foundations of natural science; and on the other hand, the study of the foundations of mathematics and logic contributed to a fuller understanding of the surrounding reality and led to the possibilities to develop a scientific metaphysics. In this type of research, however, the epistemological difference between philosophy and natural sciences should not be blurred. Both types of cognition have different research methods and a separate language[3]. This situation, that methodologically orders the research, does not negate the perception of reality in terms of its ontological unity.

3 Zygmunt Zawirski, "*O stosunku metafizyki do nauki. Próba wytyczenia nowych dróg filozofii teoretycznej* [On the Relation between Metaphysics and Science]" (the critical edition of the 1919 manuscript was prepared by Michał Sepioło), (Warszawa: Faculty of Philosophy and Sociology at the University of Warsaw, 2003).

Zawirski and Bornstein, while discussing the genesis, essence and benefits of using the axiomatic method in deductive theories, at the same time present attempts to apply the axiomatic method in the study of real and philosophical sciences. Zawirski focuses on the introduction of the axiomatic method to contemporary physical theories, which through ontological generalization lead to a comprehensive approach to reality and describing it in the scientific perspective of metaphysics. In turn, for Bornstein, axiomatization can be subjected to the qualitative area of the natural reality and thus, thanks to ontological generalizations, to develop a general theory of being. Nevertheless, there are differences in both perspectives of reaching the concept of scientific metaphysics. Ontological generalizations, which we are dealing with in Zawirski's works, are the approach to reality in the perspective of quantitative categories. At the same time, Bornstein carried out ontological studies based on qualitative categories.

The results that both philosophers reach – on the one hand, on the path of logical-natural research, and on the other hand, logical-ontological one – are two scientific concepts of the metaphysical image of reality, the theories of a generally perceived being.

The development of scientific metaphysics, proposed by Zawirski and Bornstein is a testimony to the struggle of native thought with fundamental philosophical problems concerning the scientific relationship of metaphysics to particular sciences and the classically understood metaphysics, as well as the problems of the so-called unity of the world. This monography is to show that both paths leading to the development of scientific metaphysics are still current research programs that bring tangible benefits in the natural and philosophical understanding of reality. In both cases, the development of scientific metaphysics was associated with the development of such a general and critical science that would give a unified theory of reality.

This study also shows the need to build a general theory of reality, but not on intuitively accepted assumptions, but on the basis of scientific assumptions, which will be discussed in more detail later. The development of two concepts of scientific metaphysics is intended to give new arguments in the debate between supporters and opponents of metaphysics. One of the main arguments of supporters of metaphysics is the strongly accentuated need to capture the totality of human knowledge in one system, which none of the particular sciences gives. Opponents, although many times strive for a synthesis of particular sciences and do not give up certain generalizations, do not go as far as metaphysical syntheses. However, they fight off the existence of separate methods of metaphysical research; they are also against certain hypotheses or assumptions of metaphysics that result from certain specific definitions of its subject, in particular regarding the principles of being as such. Another noteworthy issue is the fact that the opponents of metaphysics do not exclude hypotheses from science. While in science these hypotheses are a means of cognition, in metaphysics they function as the main goal of cognition. In spite of this significant difference regarding the role and significance of hypothetical factors in cognitive processes, there is a common area for both such opposite directions of thought, which will be illuminated after hearing the proposals of the scientific metaphysics of Zawirski and Bornstein that strongly refer to the development of particular sciences.

The work *Towards Scientific Metaphysics* consists of two volumes. The first one is devoted to the philosophy of Zygmunt Zawirski and the second, to Benedykt Bornstein. Before I go to the elaboration and critical comments of both concepts of scientific metaphysics, I will outline the discourse regarding the legitimacy of metaphysical research that took place in the native academic milieu of the turn of the 19th and 20th centuries. In my opinion, the presentation of this issue will outline the intellectual background on which Zawirski's and Bornstein's concepts of scientific metaphysics will turn out to become philosophically original shots of reality. This presentation will also make it possible to compare these two concepts with other attempts made at the time to frame a framework for metaphysical research.

Outline of metaphysical research in Polish academic circles at the turn of the 19th and 20th centuries

At the turn of the 19th and 20th centuries, the main centers of philosophical research were the universities in Lvov, Krakow and Warsaw. The diverse approaches of the partitioning powers defined the framework in which the intellectual life of these scientific institutions could develop. In terms of freedom of practicing science in the Polish language, the best was undoubtedly the Austrian partition, with the main centers of Lvov and Krakow.

While discussing metaphysical research programs in the above-mentioned creative environments, I do not strive to fully implement this objective, which, however, would require separate studies. Presentation of even selected and developed metaphysical conceptions of the studied period is a good testimony that presents the maximalist aspirations to define the tasks and purpose of philosophy by native philosophers. It is only in this context that the critical analyses of the two paths leading to a new concept of metaphysics referring to newly developed scientific methods, such as mathematical logic or methodological principles in the field of natural sciences, show the implementation of expectations for scientific philosophy, aiming at the development of a general theory of reality.

a) Criticism of positivism as the basis for restoring metaphysical issues

In the second half of the 19th century, Polish philosophy remained under the influence of the so-called Warsaw positivists. The growing awareness of the unreality of the idea of Polish romanticism, nurturing sentimentality, individualism, the cult of talents and the reluctance to the program of "organic work", which – in the opinion of many of the people became the sources of the defeat of both the November and January Uprisings – contributed to the development of this philosophy[4]. It was realized that after gaining the country's independence, well-educated staff must be found to be able to lead the nation. The positivists proposed a scientistic orientation in philosophical research that refused, *inter alia*, the sense of metaphysical inquiries and eliminated value-related judgements when establishing empirical facts. The proposed new program of philosophy, however, was not devoid of critical analyses.

One of the first attempts to criticize positivist concepts was made by Henryk Struve (1840–1912). The criticism also took place in the very center of positivism itself. Aleksander Świętochowski (1849–1938), generally

4 There are other opinions regarding the importance of the philosophy of Polish Romanticism, emphasizing its positive elements, such as, for example, its mysticism and rationalism. Without going into the polemics of valuing romantic philosophy, it should only be noted that it is, among others, Bolesław Józef Gawecki who boldly stands in the defense of the national philosophy created between the November Revolution and the January Uprising. See: Bolesław Józef Gawecki, *Polscy myśliciele romantyczni* (Warszawa: PAX Publishing Institute, 1972).

recognized as one of the most eminent representatives of Warsaw positivists, who formulated the program of organic work and offered its theoretical justification, among others in the papers such as *My i Wy* (1871 – work is a positivistic manifesto program) and *Praca u podstaw* (1873), criticized the concept of positivism in 1876. Henryk Struve noticed that the dispute over the existence or lack of scientific concepts does not boil down to whether we objectify them or not, whether they are transcendental or not, because the concepts we use are common for science and metaphysics. The dispute is about providing such objectification to mental products that fulfill the conditions determined by logic or by scientific methodology[5]. At the same time, Świętochowski, in one of the papers from the *Dumania pessymisty* series, presented in the "Przegląd Tygodniowy" of 1876, showed the powerlessness of empiricism, which initiated a gradual rebirth of metaphysical problems. Świętochowski has shown that human knowledge based on experience, which is illusory and not subject to verification, has dubious value. Empirical knowledge closes man in the circle of his own sensory experiences and does not allow him to reach an objectively existing world. In subsequent articles, he pointed to the limited scientific knowledge, which does not answer any of the relevant questions about the existence of the world, matter, man or consciousness. He also presented the problem of human alienation, its deepening loneliness as a result of the development of a civilization functioning based on specific mechanisms that prevent the authenticity of contacts between people.

According to Julian Ochorowicz (1850–1917), philosophy, while generalizing data of particular sciences, at the same time unites them and protects them from far-reaching specialization and one-sidedness, which could be the cause of distortion of the real world image. Philosophy clearly shows that the world is a unity in diversity. Everything that exists is part of nature governed by general laws. The sciences investigating these issues should use methods of observation and experiment, appropriate for natural science. Ochorowicz did not accept the existence of boundaries for human cognition, he believed that the use of natural science methods would help

5 Henryk Struve, *Pozytywizm i zadania krytyczne filozofii*, in: *Filozofia i myśl społeczna w latach 1865–1895: Part. 2*, ed. Anna Hochfeldowa and Barbara Skarga (Warszawa: Państwowe Wydawnictwo Naukowe, 1980), pp. 178–181.

one solve the problems that – at the given stage of knowledge – seem to be insoluble. Being a positivist, he did not accept Comte's development of knowledge, that splits itself into the theological, metaphysical and positive phases, but he supported the abrasion of opposites, the existence of the dialectical right to develop reality. He believed that the binding of certain ideas should be associated with better adaptation to a given situation, which would be subject to change, causing a change in the validity of certain ideas. He also rejected the possibility of a philosophical synthesis of the knowledge of abolishing adversity. He believed that human thought oscillates between realism and idealism, empiricism and mysticism, and materialism and spiritualism. In the process of developing thoughts, these positions become more critical, but their inclusion in a synthesis is impossible.

By accepting a reductionist position in philosophy, Ochorowicz pointed to the power subordinated to the law of evolution as the principle of unity in nature. Due to the fact that evolution shows the irreversibility of phenomena, and the motion of matter can be reversible, therefore the world should not be perceived mechanically but dynamically, in this way being equated to the body. Without accepting mechanistic theories and not advocating materialism, Ochorowicz points to a dynamic principle that unites all reality in its diversity. He advocates dynamic monism. In the work *Siła jako ruch*[6], he pointed to the discovered general law of the inverse: if force A transforms into force B, the reverse force B transforms into force A. On this law he based his research on parapsychology and used it in numerous inventive works[7].

It should be noted that not all representatives of positivism were able to accept the rebirth of metaphysics. An example of this can be the

6 Julian Ochorowicz, "Siła jako ruch. Studium z filozofji fizyki," *Ateneum*, Vol. 3–4 (1879), pp. 538–564.

7 Ochorowicz was quite close to the discovery of radio and television. With the help of the transmitters and receivers constructed by him, he transmitted long-distance voice waves, converting them into electromagnetic waves. His spectacular success was the message of the instrumental performance of the *Marseillaise*, played at the Opera in Paris, to the exhibition of the Electricity Exhibition in Paris in 1885. His other ideas were a harbinger of modern ecology and bioelectronics. See: S. Borzym, H. Floryńska, B. Skarga, A. Walicki, *Zarys dziejów filozofii polskiej 1815–1918* (Warszawa: PWN, 1983), pp. 154–155.

representative of the Lvov scientific community, Władysław Kozłowski (1832–1912), who openly advocated Comte's views. Being also a supporter of Spencer's evolution, he praised his agnosticism. At the end of the 19th century, he argued with Jan Władysław Dawid and Adam Mahrburg about the importance of psychophysical parallelism, in which he saw the danger of the return of metaphysics to philosophical decisions.

The scientific significance of metaphysics was also rejected by representatives of neo-criticism[8]: Adam Mahrburg (1855–1913), Henryk Goldberg (1845–1915) and Marian Massonius (1862–1941)[9]. Henryk Goldberg in his work *Filozofia i Wiedza* (1877) refused the notion of scientific value in philosophy. Its meaning consists mainly in creating a synthesis of all skills – it organizes human experience and corresponds to the aspirations of human reason for synthesis in which the imagination plays a huge role. From this understanding of philosophy, he excluded the theory of cognition and logic, which he acknowledged as possessing full scientific value. Adam Mahrburg, on the other hand, combined the philosophical position with critical neo-Kantianism, thus being an attempt to analyze the assumptions that science takes. The results of such an analysis have contributed to the deepening of the positivist doctrine expressed in the cult of science and the naturalistic view of the world. Mahrburg adopted a position of extreme scientism that criticizes all the presence of metaphysical ideas in science[10]. He believed, however, that metaphysics is of great importance in expressing the spiritual and intellectual problems of a given epoch, creating a world

8 In the eighties, the growing interest in Kant (neo-Kantianism) in Poland became a reaction to the epistemological care of the positivists and their attempts to disregard the subject in cognitive acts. The result was a reformulation and deepening of the positivist doctrine referring to the exact sciences, and Kant was treated as a modern philosopher boldly putting important and current questions about the boundaries of cognition, the nature of *a priori* elements and the legitimacy of metaphysics.

9 Anna Hochfeldowa, Barbara Skarga, *Filozofia i myśl społeczna w latach 1865–1895* (Warszawa: PWN, 1980), pp. 410–505.

10 Władysław Spasowski, *Adam Mahrburg i jego poglądy na naukę i filozofię: analiza porównawcza* (Warszawa: Skład Główny w Księgarni Gebethnera i Wolffa, 1913).

of ideals that are neither subject to theoretical nor empirical verification, but which guide the progress of humanity.

Mahrburg, being an empiricist, rejected the concepts of taking on the path of their hypostasis. His positivist position, however, is not uncritical. He states that positivism without criticism is blind. He also rightly departs from the concept of science as a faithful reflection of the world along with its regularities, which opens up the prospect of developing the theory of science. He does not accept the existence of "naked facts" considering that we come to the concept of the object of cognition as a result of the rational organization of the experimental material. Scientific knowledge for him was only an intellectual construction giving a systematic and economical description of the experience. In his opinion, the worked out constructions must not contain any contradictions between accepted assumptions and empirical facts. If there are contradictions, they are usually either the result of far-reaching specializations and lack of criticism in scientists inclined to absolutize the conclusions they draw; or they are caused by insufficient development of scientific knowledge. Mahrburg believes that constructions are used to explore the real world, not the invented one. Constructions must therefore be in accordance with experience data and allow for the prediction of possible effects. Each structure remains hypothetical and open, and is able to operate only with probable assumptions. Only formal sciences are systems of truths whose negation is unacceptable. In the real sciences one should accept a relative truth that amounts to conformity with other theses of a given discipline of knowledge. The intersubjective assessment of the results of experiments becomes important for the development of science[11].

According to Marhburg, positivism was a way of thinking constantly present in science, but only Kant made a critical ordering of scientific thinking. Marhburg critically refers to the introduction of metaphysics in the form of practical reason, to the *noumenu* of metaphysical content and the dogmatic adoption of *a priori* forms of cognition, without a critical reference to their actual sources. He claimed that Kant had artificially divided man's mental powers into forms of sensuality, intellect and reason. In turn, rational knowledge in the form of pure natural science, in the understanding

11 Józef F. Chwal, *Metafilozofia Adama Mahrburga* (Warszawa: Wydawnictwo IFiS PAN, 1998), pp. 23–40.

of Kant, was detached from empirical sources, which, in the opinion of Mahrburg, let it acquire a metaphysical character.

In order to build general systems of concepts and judgments that cover all empirical data, Mahrburg worked out the pattern of "perfect" (i.e. excellent) science, based on empirical facts and methodically developed concepts. Such excellent science, according to Mahrburg, is freed from all imposed practical and utilitarian goals. Science deals only with real things without evaluating them, and when it treats values, it captures them as facts present in human culture. He was in favor of pure scientism. He created an image of science that offers a systemic and coherent set of concepts and natural laws. There are evolutionary threads in his analyses that are not elements of the world image inductively derived from the observed facts of objective reality, as Ochorowicz did, but constitute an evolution theory treated as a heuristic principle that allows the explanation of natural phenomena.

Mahrburg warned against treating philosophy as a general system of human knowledge, as a synthesis of the results of research of individual scientific disciplines. He believed that philosophy cannot be defined because it depends on changes in science. However, he saw in philosophy the ever-present problem of the theory of knowledge. He defended scientific thinking, arguing that there are no metaphysical elements in it. Concepts such as atom, energy, force, time or space, considered metaphysical, are only theoretical constructs that organize the material of experience[12]. The task of philosophy is to critically and methodically develop the terms used in science and to study their scientific value[13]. At the same time, he refused to build scientific metaphysics. He also strongly opposed any whatsoever teleological explanation in science. The use of the concept of purpose makes sense to him only in the actions taken by man, which consist of imagining a specific goal and striving for it with appropriately selected means[14]. He

12 Adam Mahrburg, "Filozofia i metafizyka," in: *Poradnik dla samouków*, part. IV (Warszawa: 1902), pp. 109–199.

13 Adam Mahrburg, "W sprawie naukowości metafizyki," in: *Pisma filozoficzne*: *Vol. II*, ed. Władysław Spasowski (Warszawa: 1914), pp. 206–269.

14 Adam Mahrburg, "Teoria celowości ze stanowiska naukowego. Studium filozoficzne," in: *Pisma filozoficzne*: *Vol. I*, ed. Władysław Spasowski (Warszawa: 1914), pp. 1–208.

noticed that the concept of natural selection, which was adopted in science, is a teleological concept that facilitates explanation of biological phenomena. In turn, monistic positions were accused of the abuse of the data of natural sciences for purely speculative purposes, in this way showing the contradictions inherent in these positions, which testify to their metaphysics. Although he criticized these positions, he himself opted for the position of psychophysical parallelism, treating it as a purely empirical principle.

b) The possibilities and the necessity of metaphysics

At the beginning of the 20th century, in metaphysical inquiries, recognized as part of a professionally practiced philosophy, he tried to use the German tradition of inductive metaphysics by Gustav Fechner, Hermann Lotze, Eduard von Hartmann and Wilhelm Wundt, as well as neo-scholasticism initiated by Pope Leo XIII with the encyclical *Asterni Patris* from 1979. At this time in Poland we have already had a lively reflection on the essence and properties of being, made by Henryk Struve, Stefan Pawlicki (1839–1916), Maurycy Straszewski, Wincenty Lutosławski and Franciszek Gabryl. To a large extent, with the exclusion of Lutosławski and Gabryel, the other philosophers sought to agree on the requirements of empiricism with the search for answers to fundamental philosophical questions.

According to Henryk Struve it was the method of psychological and metaphysical studies he had developed for the purpose of releasing science to metaphysics. Struve identified logic with the theory of cognition, claiming that the forms of logical thinking cannot be abstracted from their content. Opposing pure formalism, he sought a theoretic cognitive solution to the problem of human abilities and ways of learning things. He sought solutions through experimental and rational analysis of the facts of internal and external experience, which he called the psychological-and-metaphysical method. According to Struve, when we penetrate psychological processes, we reveal general laws of thinking and recognize the relationships between these processes and the outside world. In this way, combining the subjective and the objective, basing upon the psychological and metaphysical method, we come to the scientific theory of being as the most important subject of philosophy.

Struve accepted the existence of absolute conformity and parallel laws of thinking and the laws of nature, in which he saw the sources of truth for our judgments about the world[15]. Thus he was in favor of monism.

On the other hand, Stefan Pawlicki, resolving the issue of metaphysics for science, favored the total autonomy of metaphysics, believing that we do not need natural sciences to determine its laws. In every situation where metaphysics begins to use scientific data, one turns deduction into an induction, and thus metaphysics becomes physics. Moreover, the metaphysics of specific sciences is a completely different cognition, and therefore cannot settle the truth of scientific claims. Pawlicki, however, allows the possibility of mutual control of the results obtained by natural sciences and metaphysics in these matters, where the objects of the both sciences are mutually converging. Such mutual control protects naturalists against false hypotheses and metaphysicists against unnecessary speculation[16].

In turn, for Maurycy Straszewski, metaphysics is a philosophical synthesis of human knowledge[17]. Natural sciences, included in the spirit of empirical criticism, in a methodical but simplified way, reveal the real course of phenomena and the regularities that occur between them. He found it impossible for people to penetrate the principles of the discovered order and the realities inherent in the natural sciences[18]. Man, however, naturally strives to synthesize knowledge, which is why philosophy becomes for him a discipline that not only examines the theoretical foundations of particular sciences, but also links their results by building a synthetic image of the world.

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15 Stanisław Borzym, *Poglądy filozoficzne Henryka Struvego* (Wrocław: Zakład Naukowy im. Ossolińskich, 1974); See also: "Struve Henryk," in: *Filozofia i myśl społeczna w latach 1865–1895*, ed. Anna Hochfeldowa and Barbara Skarga (Warszawa: PWN, 1980), pp. 148–182.

16 "Stefan Pawlicki," in: *Filozofia i myśl społeczna w latach 1865–1895*, pp. 262–288; See also: Bronisław Dembowski, *Spór o metafizykę. Główne poglądy na metafizykę w Polsce na przełomie XIX i XX wieku*, (Warszawa: 1969).

17 Maurycy Straszewski, "Pomysły do ujęcia dziejów filozofii w całości," *Roczniki Historii Filozofii Polskiej*, Vol. 1 (2008), pp. 203–242.

18 Barbara Skarga, "Antypozytywizm i obrona metafizyki," in: *Zarys dziejów filozofii polskiej 1815–1918*, ed. Andrzej Walicki (Warszawa: PWN, 1983), pp. 247–248.

Similarly for Wincenty Lutosławski, metaphysics was a postulate of the unity of knowledge, but the knowledge organized in a deductive system of concepts. Such developed metaphysical system is intended to have had a structured and internally consistent united scientific knowledge, while philosophical certainties and hypotheses fill in the areas of cognition that are not yet available to science.

Regardless of the approaches observed in professional philosophy, interest in various forms of metaphysics was also observed in literary and artistic circles. The idea of a return to metaphysics, accentuated by many representatives of modernism, was associated with the devaluation of the positivist scientist myth. Intellectual cognition, ordering the sense of experience, was treated only as part of the cognition that is available to man. However, among the philosophers of modernism there were also those who advocated the possibility of synthesis of science and metaphysics. These philosophers include Edward Abramowski with his experimental metaphysics and Stanisław Ignacy Witkiewicz.

Witkiewicz advocates the symbiosis of metaphysics and science. Defending the science of metaphysics, he took as a starting point a description of the necessary laws of material existence, a problem that combines science and metaphysics. In the work *Pojęcia i twierdzenia implikowane przez pojęcie istnienia*[19], he presented a method of practicing metaphysics that is neither extremely pure speculation nor extremely empirical science. On the one hand, the scientific practice of metaphysics is not deprived of the possibility of metaphysical speculation, and he solicited this opportunity by opposing Carnap and Russell, representatives of scientific philosophy, and on the other hand, he criticized speculative philosophers for too much departure from science[20]. In the work *Zagadnienia psychofizyczne*, he described himself as a scientific metaphysician who, by reaching to

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19 Stanisław Ignacy Witkiewicz, *Pisma filozoficzne i estetyczne. O idealizmie i realizmie: "Pojęcia i twierdzenia implikowane przez pojęcie istnienia" i inne prace filozoficzne*, Vol. III, ed. Bohdan Michalski (Warszawa: Państwowy Instytut Wydawniczy, 1977).

20 Krzysztof Kościuszko, *Stanisława Ignacego Witkiewicza spór o naukową metafizykę* (Olsztyn: Wyd. Wyższa Szkoła Pedagogiczna, 1998), pp. 132–180.

empiricism, tries to interpret the achievements of modern physics with the help of the assumptions of biological monadology.

Witkiewicz spoke in favor of using the axiomatic method in metaphysics, resulting in a real description of the world. Considering material existence, we recognize, in Witkiewicz's opinion, a reality disintegrating into two kinds of existence: soul and body, consciousness and matter. This duality is an expression of the duality of worldviews: idealism and materialism. The proper task of metaphysics is to try to understand the relation of consciousness to nature, therefore by eliminating the impossible assumptions, we come to the necessary basic notions and theorems. On the basis of these concepts and theorems, we determine the necessary primary views and their mutual relations, and strive to capture these views into a consistent and unified system that preserves the recognized duality of existence.

On the other hand, Mścisław Wartenberg and Witold Rubczyński are among the professional philosophers who deal with metaphysics and defend its scientific character. Mścisław Wartenberg, in his work *Obrona metafizyki*[21], while making an attempt to critically approach the Kantian impossibility of practicing metaphysics and carrying out the analysis of the concept of causality, worked out the so-called hypothetical metaphysics. Wartenberg noted that the opponents of metaphysics accept the non-verifiability of metaphysical sentences. On the other hand, those who deal with science strive to concentrate their research on the so-called pure experience. According to Wartenberg, this procedure is not correct, since neither, as demonstrated by metaphysics, it is a collection of only our beliefs, i.e. it does not only refer to the achievements of particular sciences, nor there is any possibility of such experience that would be free of non-empirical elements.

While presenting the question of the relationship between science and philosophy, Wartenberg notes that science cannot free itself from metaphysical assertions, which should be treated as legitimate hypotheses as long as they remain consistent with reality and contribute to its explanation. What is more, scientific hypotheses are not different from metaphysical hypotheses,

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21 Mścisław Wartenberg, *Obrona metafizyki. Krytyczny wstęp do metafizyki* (Kraków: Friedlein, Warszawa: Wende, 1902).

because in both cases their validity cannot be resolved by the so-called pure experience, but by what he defines as the "tribunal of reason". In Wartenberg, metaphysics is to closely correspond with the beings of a truly existing reality, and although metaphysical claims are accepted at a higher level of abstraction, they should always refer to science and to empiricism.

In turn, according to Witold Rubczyński, there existed and will always exist mutual relations between the detailed sciences and philosophy, which is why on the basis of the results of scientific research, it is possible to build a properly ordered whole of all things[22]. The synthesis of the whole of the universe, the general view of the world, cannot, however, be supported by the theoretical achievements of specific sciences only, but must reach for elements that do have their practical character, in this way justifying the existence of a world of values.

The presentation, the outline of the discussion on the legitimacy of metaphysical research, allows us to note that in the national philosophy of the turn of the 19th and 20th centuries the attempts on the construction of such metaphysics was undertaken, as well as that the assumptions of scientific metaphysics were pointed out which, during a period of turbulent scientific progress and the creation of a number of new physical theories, would satisfy the nascent expectations for getting a full and comprehensive understanding of reality. In this context, in my opinion, it was Zygmunt Zawirski and Benedykt Bornstein who took the most prominent positions, able to fulfil these expectations. The choice is dictated here to show how Zawirski, in accordance with the program of the Lvov-Warsaw School, developed the concept of scientific metaphysics in the context of research on the philosophy of nature and natural sciences. In turn, Bornstein, who did not belong to this school, while applying high standards of ontological research methodology in the context of algebraic logic and quality geometry, developed ontological theory of reality, a general theory of being, i.e. scientific metaphysics.

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22 Witold Rubczyński, *Stosunek filozofii do nauk szczegółowych* (Kraków; Towarzystwo Filozoficzne w Krakowie, 1911); See also, by the same author: "Walka o wszechstronny pogląd na świat," *Przegląd Polski*, Vol. 179, (1911), pp. 18–41.

Contents

Introduction

The works undertaken in the field of logic, methodology and philosophy of science, and in particular the philosophy of nature and natural science testify to a solid preparation for the fundamental task of developing contemporary scientific philosophy. The emerging mathematical natural science did not have those possibilities that emerged in the 20th century and which Zawirski used. In the development of scientific metaphysics, he took into account both the achievements of modern logic and mathematics as well as physics. Zawirski builds scientific metaphysics by referring to empiricism, to broadly understood experience. Modern metaphysics should meet high standards of precision and uniqueness, which is why Zawirski attempts to apply the axiomatic method to both the analysis of the theory of physics and the scientific metaphysics.

The study of the concept of scientific metaphysics aims not only to show the historical importance of the achievements of native philosophy, but above all to pay attention to their timeliness. Conducted research on philosophy and the general theory of reality developed within its framework are to show how this project proposed by Zawirski was implemented by him, and to what extent it is still valid, due to the continuous development of natural science.

The first volume consists of three parts. In the first one, I discuss the most important areas of Zawirski's colloquial research, highlighting many detailed issues that particularly demonstrate a very good knowledge of not only the ongoing methodological discussion outside of Poland, but also a very good knowledge of physical theories: relativity theory and quantum mechanics. Reflecting on the second law of thermodynamics, Zawirski developed the concept of time cycles, which is now one of the basic concepts of understanding the history of the Universe. Zawirski also notices that the content of new physical theories changes the understanding of many scientific concepts such as: causality principle, space, time, irreversibility of natural phenomena, etc. The leading issue, which Zawirski studies, is the possibility of applying the axiomatic method to the analyses of particular sciences. Zawirski was undoubtedly the first philosopher who used the axiomatic method in physics.

When presenting the first part one cannot forget about Zawirski's important achievements in the field of logical and methodological research. Zawirski developed many-valued logic, which he tried to use to develop quantum mechanics. In turn, the analysis of the results of methodological research is important because they have become recognized as permanently useful for the achievements of the philosophy of science. At the end of the first part we will go to the central issue of the two-volume monograph – the scientific metaphysics developed by Zawirski. At this point, I will discuss Zawirski's views on the relation of scientific metaphysics to particular sciences and classical metaphysics and his position on the possibility of developing a synthesis of particular sciences.

In the second part, the previously discussed detailed problems of Zawirski's philosophy will be subjected to critical analysis, taking into account parallel discussions in Polish academic circles. Confronting the results of Zawirski's research with other methodological proposals and positions in the field of the possibility of synthesis of particular sciences and the development of scientific metaphysics, it will be possible to evaluate all of his scientific achievements and show them significantly for contemporary research. In this part we put a lot of questions-problems for which we will seek answers. We will be interested in the following issues: how and – if yes – whether all the results of Zawirski's research in logic and methodology are in line with important scientific achievements? Is and – if yes – to what extent the building of scientific metaphysics can be recognized as a current research program? How much is the axiomatization of scientific theories still an important research venture? To what extent is it possible to build scientific metaphysics as a deductive system? Answers to the above questions will serve to compare the scientific results and scientific conception of metaphysics worked out by Zawirski with the results of scientific research of Benedykt Bornstein in the quest for the elaboration of an algebraic and geometric concept of scientific metaphysics.

In the third part, so as to document Zawirski's research route, I will present some of his works from the most interesting areas of logic, methodology and meta-philosophy.

When analyzing Zawirski's results of scientific research, it should be stated that he was a philosopher with a broad spectrum of interests in the philosophical assumptions and consequences resulting from the development of natural sciences. So as to arrive at a more complete illustration of his scientific involvement, I have made up my mind to present his biographical data below. This is important because it allows me to show – in the form of a critical analysis – many of his achievements and stages of the research carried out by him.

From the biography of Zygmunt Zawirski

Zygmunt Michał Zawirski was born on September 29, 1882 in Podolia in Berezowica Mała next to Zbaraż and died on April 2 in Końskie[23]. He was a son of Józef and Kamila Zawirska. Zygmunt Zawirski was a better than average learner[24] in the 3rd Gymnasium in Lvov from 1893 till 1901. From 1901 till 1906 he studied at the Philosophical Faculty of Jan Kazimierz University in Lvov, his mentor being Professor Kazimierz Twardowski (1866–1938). During his studies he also attended other lectures delivered, among others, by Mścisław Wartenberg (1868–1938) on issues concerning metaphysics after Kant and Witold Rubczyński (1864–1938) on history of Greek philosophy. He also studied mathematics, physics and philosophy in Berlin (1910) and in Paris (1910). During his Berlin studies he attended the lectures delivered by Carl Stumpf, Georg Simmel and Alois Adolf Riehl.

In 1904 Zygmunt Zawirski became one of the founder members of the Polish Philosophical Society, originally founded by Kazimierz Twardowski in Lvov. He was granted the PhD degree in philosophy in July 1906 on the basis of his work entitled *O modalności sądów*, which was written under Professor Twardowski's supervision. Zawirski belonged to the

23 Zygmunt's father, Józef Zawirski (actually Jan Gieysztor-Buchowiecki) after the collapse of January Uprising hid himself under the assumed name in the Austria-Hungarian Part of the partitioned country. Zygmunt's mother née Strońska got married to Józef Zawirski in 1869. They had 10 children. Zygmunt was their seventh child. Zygmunt's nephew was Jerzy Kalinowski (1916–2000), a professor of philosophy at the Catholic University in Lublin.

24 See: Michał Sepioło: *Zygmunt Zawirski (1882–1948). Bibliografia*, in: Zygmunt Zawirski, *O stosunku metafizyki do nauki*, (Warszawa: Wydział Filozofii i Socjologii Uniwersytetu Warszawskiego, 2003), pp. 253–265.

first generation of Twardowski's students. Therefore, he is recognized by historians of philosophy as a co-founder of the famous The Lvov-Warsaw School (LWS).

After his graduation, he first (up till Septemebr 1906) began to work in the 4th Gymnasium[25] in Lvov: since 1907 commenced his career as a teacher of philosophy, mathematics and physics in Gymnasium no.2 in Rzeszów. In January 1911, having completed his studies in Berlin and Paris, he started teaching in Gymnasium no.3 in Lvov. He also started to cooperate with a journal titled "Ruch Filozoficzny" and wrote many reports on books and reviews appearing in renowned French and German philosophical magazines such as "Revue Philosophique de la France et de L'étrange", "Revue de Métaphysique et de Moral" and "Archiv für Geschichte der Philosophie". Apart from his reporting activities, he participated actively in the meetings of the Polish Philosophical Society in Lvov, presenting many papers developed in the form of scientific articles or more advanced writings. Zawirski achieved the first prize in the 3rd competition of "Przegląd Filozoficzny" in 1912 on the basis of his work entitled *Przyczynowość a stosunek funkcjonalny. Studium z zakresu teorii poznania*. In this work he demonstrated that it is impossible to reduce completely the notion of causality to the notion of functionality.

The period of the World War I resulted in a one-year-long gap in the scientific activity of Polish researchers. At that time Zawirski had left Lvov and returned in 1915 only to intensify his scientific activity. The subject of his interest included the following problems: hypothesis of constant returns of all-matters, inductive metaphysics, relations between metaphysics and science, detailed issues from logic and their significance in mathematical and natural research. The research conducted by him had an impact on the development of his opinions that were later expressed in the paper entitled *Refleksja filozoficzna nad teorią względności* (1920), and the following treaties: *Relatywizm filozoficzny i fizykalna teoria względności* (1921) and *Metoda aksjomatyczna a przyrodoznawstwo* (1923), which were the

25 A gymnasium was at that time a type of school with a strong emphasis on academic learning, and providing advanced secondary education.

products of earlier written, but unpublished, writings such as *O stosunku metafizyki do nauki* (1919) and *Nauka i metafizyka* (1920).

Since 1922, till 1928, he used to be lecturing at Politechnika Lwowska, leading courses in logic, logic basis of mathematics as well as the courses dealing with natural history, theory of deduction, history of philosophy and psychology. One year later he also started delivering lectures at the National School of Pedagogy, improving his educational experience and skills as an academic teacher. He combined his didactic with his scientific activity.

During the 1st Polish Philosophical Convention (Lvov 1923), so as to share the research he used to carry out as well as the results concerning the implementation of axiomatic method applied in the history of nature, he presented a paper entitled *Współczesne próby aksjomatyzacji przyrodoznawstwa matematycznego i ich znaczenie filozoficzne*. In the same year he wrote a thesis entitled *Metoda aksjomatyczna a przyrodoznawstwo* and presented it to Władysław Heinrich (1869–1957). This work became the basis to initiate the proceedings for the qualification as a university professor at the Jagiellonian University, which was completed in 1924 with the defence of his postdoctoral thesis entitled *The Relations between Many-valued Logic and Probability Calculus* (*A Habilitation Lecture*).

In the period between 1928 and 1936, Zawirski began to cooperate with the University of Poznań. Professor Władysław Mieczysław Kozłowski (1858–1935) had retired and Zawirski was appointed a lecturer for the courses in the theory and methodology of sciences at the Humanistic Faculty; since August 1, 1929, he began his work as an associate professor at the Faculty of Mathematics and the History of Science. The classes led by Zawirski had a good reputation among students. He was interested in students' access to the basic philosophical works which were the subjects of his lectures and seminars. Then, he gathered valuable literature in his department, which was destroyed by the Nazis during the World War II. During his seminars, his students read such seminal works as Hume's *Badania dotyczące rozumu ludzkiego* [*Research Concerning Human Mind*] or Hilbert's *Theoretische Logik*. During his lectures, Zawirski focused on the philosophical problems of the history of nature, basic problems of mathematics, issues of epistemology as well as the theory of classes and oncoming relations.

Zawirski got in close touch with his master, Kazimierz Twardowski, in the period of his activity at the University of Poznań. He used to send him his reports and/or reviews of books for the periodical "Ruch Filozoficzny" edited by Twardowski. He also gave lectures during the meetings of the Poznań Society of Friends of Sciences, which were later summarized in the *PTPN Summaries*. He participated in the 7th International Congress of Philosophers in September 1930 in Oxford where he presented his paper entitled *On Indeterminism in Quantum Physics*, published in the *PTF Visitor's Book* (1931).

The period of work for the University of Poznań is the most important stage in his scientific life. His work entitled *L'évolution de la notion du temps* was awarded the first and very prestigious prize in the Rignan's competition in 1933, announced by the Italian magazine "Scientia". This report was published only in 1936 by the Publishing House of the Polish Academy of Skills and Sciences, but earlier it had been summarized in the magazine "Scientia". His work was not translated into Polish in 1936. Therefore, its Polish summary entitled *Rozwój pojęcia czasu* was published in "Kwartalnik Filozoficzny" in the same year.

Zawirski was nominated as a full professor in 1934. He stayed two years more at the Faculty of Mathematics and Natural Sciences where he was the Dean and the Chair of the Department of Theory and Methodological Sciences, being an active member of scientific life internationally. He participated in the 8th International Philosophical Congress in Prague (1934) and presented a paper entitled *Znaczenie logiki wielowartościowej dla poznania i związki jej z rachunkiem prawdopodobieństwa*. He also participated in the 9th Congress in Paris in 1934 and presented a paper entitled *O stosunku logiki wielowartościowej do rachunku prawdopodobieństwa*. In the same year he welcomed members of the International Convention of Thomistic Philosophy held in Poznań instead of absent Michał Sobecki, the President of the Poznań Philosophical Society. Zawirski also participated in the 1st (Paris, 1935) and the 2nd (Kopenhagen, 1936) Congress of Scientific Philosophy where he presented a paper entitled *O zastosowaniach logiki wielowartościowej w przyrodoznawstwie*. He participated in the 3rd Polish Philosophical Convention in Cracow in 1936, where he presented a paper entitled *W sprawie syntezy naukowej*.

Nearby the end of his scientific work at the University in Poznań, he was awarded an honorary doctorate by the University of Poznań and the Faculty of Mathematics and Natural Sciences on November 12, 1936 and accepted it on November 18, 1936 from President Ignacy Mościcki.

He was asked by Władysław Heinrich in 1935 to chair the faculty after Tadeusz Grabowski (1869–1940). Zawirski accepted it and as a full professor he started his work since January 1, 1937 at the Philosophical Faculty. Later, after its division, he worked at the Faculty of Mathematics and Natural Sciences. In the period between 1938 and 1939 as well as between 1945 and 1946 he was the Dean of this Faculty.

He took over the editorial office of the "Kwartalnik Filozoficzny" after Władysław Heinrich in 1936. In the period between 1938 and 1945, he was the President of Cracow Philosophical Society and gave papers entitled, among others, *O działalności naukowej prof. Kazimierza Twardowskiego* (1938) and *Materializm dialektyczny a logika matematyczna* (1947). He gave two lectures at the University in Bucharest in 1938 entitled *Science and Philosophy* and *On the Notion of Time*. In the period between 1938 and 1941 he worked on *Słownik filozoficzny*, following the model presented in Schmidt's *Taschenbuch der Begriff und Denker* (1934) and Thormeyer's *Teubners kleine Fachwörterbücher* – 1930. Unfortunately, the censorship stopped the printing of the dictionary copies in 1948. A manuscript of this dictionary survived in the Polish Academy of Sciences Archives and only some terms were published in "Przegląd Filozoficzny – Nowa Seria" (1993).

The Nazis pacifist action "Sonderaktion Krakau" against the Polish researchers and scientists took place on November 6, 1939. Zawirski was outside Cracow on this very day and due to it he barely avoided transportation to the Nazi concentration camp in Sachsenhausen. During the World War II he participated in the clandestine academic teaching. After World War II he was a full professor at the Jagiellonian University. He was appointed a chairperson of the Cracow Philosophical Society since 1945.

Zawirski was very active in the scientific life in the period between 1945 and 1948. At that time his works were published as the result of his long standing research. Some of them were, for example: *Geneza i rozwój logiki intuicjonistycznej* (1946), *O współczesnych kierunkach filozofii* (1947). When traveling to Zakopane to take part in the Philosophical Conference in winter 1947, a luggage with two manuscripts: O *metodzie naukowej* and manuscript of Patristic Monography[26] were stolen from him.

Zawirski prepared a written speech for the 10th International Philosophical Congress in Amsterdam in 1948, but unfortunately he did not manage to present it. First of all the works of the manuscript reconstruction, and the work undertaken that year, overstrained his organism, moving toward an unexpected catastrophe. Zawirski died suddenly at his son Kazimierz's home in Końskie.

Zawirski's students

Zygmunt Zawirski by his didactic and scientific work inspired many Polish logicians and philosophers. The following students, among others, wrote their diploma works under his guidance or worked in these fields: Józef Maria Bocheński (1902–1995), Andrzej Grzegorczyk (1922–2014), Zygmunt Spira (1911–1942?) and Roman Suszko (1919–1979) and he was closest to the last two ones.

Admittedly, Józef Bocheński, listed above, did not write any work under Zawirski's supervision. However, being a student in Gymnasium no. 4 in Lvov, before he graduated from it in 1910, he had participated in Zawirski's maths lessons. Bocheński describes Zawirski in *Wspomnienia* as a passionate teacher, who can be easily put into contemplative reflections. It can be assumed that Bocheński's interests into mathematics and logics were born during Zawirski's lessons. The second student, mentioned above, Andrzej Grzegorczyk, studied at clandestine classes at the University of Warsaw. He completed his studies in 1945 at the Jagiellonian University achieving an MA degree in philosophy and defending his work on Leśniewski's ontology and Kotarbiński's reizm under Zawirski's supervision. However, in the following years, in the period between 1946 and 1948, Grzegorczyk was Władysław Tatarkiewicz's assistant and secretary of "Przegląd Filozoficzny".

Zygmunt Spira was interested in the natural history sciences, methodology and metaphysics. As a twenty-year-old student of the Jagiellonian

26 Roman Ingarden in the work *Wspomnienia o prof. Zawirskim* (1948) wrote that the author managed to reconstruct his stolen works.

University, he wrote a letter to Albert Einstein in 1931, asking him about the relations between the theory of relativity and some of Berkeley's and Kant's concepts. When answering the question, Einstein explained that the notion of relativity got the physical meanings only when, after one's having sought philosophical inspirations, one could find them in Leibniz's or Mach's works. Spira wrote his PhD dissertation at the Faculty of Philosophy at the Jagiellonian University under Zawirski's supervision. He published his first article entitled *Mechanistyka ewolucyjna Kanta w świetle jego przedkrytycznej metafizyki* in "Kwartalnik Filozoficzny" 14(1937). He was interested in methodology and theory of learning presented in Carl Popper's work titled *Logik der Forschung*. A result of the research done by Spira was a work entitled *Uwagi nad metodologią i teorią poznania Poppera* unpublished during his life time. The first part of this work was published in 1946 in "Kwartalnik Filozoficzny". The second part vanished in the backstreets of the Cracow ghetto in 1942. Spira was a well-promising philosopher; however, the events of World War II made him share the fate of the Cracow Jews – he found himself in the ghetto where he died.

Roman Suszko is one of the most outstanding professionals of Polish logics. He began his studies in Poznań in 1937 and completed them at the clandestine classes in Cracow in 1945 under the direction of Zygmunt Zawirski. He wrote his MA work entitled *Dorobek logiki polskiej* on logics, and became Zawirski's youngest assistant running Zawirski's designed seminars in philosophy at the Jagiellonian University. He arrived in Poznań in 1946 and worked for the Department of Theory and Methodology of Sciences led at that time by Kazimierz Ajdukiewicz. He gave lectures on mathematical logics. He defended his PhD work in 1948 based on the systems of axioms and the theory of definitions written under the supervision of Ajdukiewicz and published in "Kwartalnik Filozoficzny" in a series of two papers. The first one was entitled *O analitycznych aksjomatach i logicznych regułach* and the second one had the title *Z teorii definicji* (both parts, when translated into English, appeared in the book entitled: *On Analytical Axioms and Logical Principles. From Theory of Definition* published by Polskie Towarzystwo Przyjaciół Nauk, Poznań 1949). In this dissertation he offered a general theory of definitions for elementary systems. He also defended his post-doctoral thesis entitled *Canonic axiomatic system*, which appeared in "Studia Philosophica" 4(1949/1950) in 1951.

He has worked at the Faculty of Philosophy at the University of Warsaw where he achieved a degree of associate professor in 1959. His important scientific achievements include works from such areas as the theory of models and the theory of consequences, which appeared in the volume entitled *Sentential Logics* (1958), and which had an impact on the development of the paradigm that created one's possibility to enter the realm of metalogic. He was one of the first logicians in the world who used the theory of models to investigate problems beyond mathematics. Suszko used this theory in the analysis of the development of cognition and the formal logics used in this research named diachronic formal logics.

The most important Suszko's achievement was the form of logics developed by him, later named *non-Fregean Logic*. The logic is a generalization of the classical logics. Its particular example is the classical calculation of sentences and predicates, valued completion of Łukasiewicz's logics and some modal logics. Considering its extensionality and dual value, it should be stated that *non-Fregean* logics is the weakest one, while the classical logics is the strongest one.

* * *

Zawirski left behind a rich philosophical heritage, which until now have not been fully critically examined. Without undertaking such a maximal task, I will only pay attention to his attempts to develop scientific metaphysics, referring to the results of scientific research obtained in the first half of the 20th century, which remains a valid and important contribution to the understanding of the natural reality we are surrounded by.

Part One: The philosophy of Zygmunt Zawirski

1 Philosophy of natural science and the philosophy of nature

Zawirski was interested in the development of natural sciences and modern mathematics. While trying to answer the questions stated and/or the philosophical matters discussed at that time, he has left many original works in some ways connected to one of these theories. In his numerous works, Zawirski presented new philosophical implications derived from these theories.

1.1 Axiomatization of deductive theories

The axiomatization of deductive theory is the last stage of its development[27]. The axiomatic method does not increase the content of theory. For deductive reasoning, it is completely out-of-question whether what you deduce from is something obvious or not. Whether or not a given assertion is an axiom is determined by whether it can be proved by other existing axioms. Deductive reasoning based on principles which often obviously contradict one another may turn out to be an extremely important scientific achievement, as evidenced by the existence of non-Euclidean geometries[28]. It is also

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27 According to Kazimierz Ajdukiewicz, each deductive science goes through three stages in its development: the stage of preaxial intuition, axiomatic intuition and the stage of axiomatic abstraction. See: Ajdukiewicz Kazimierz, *Logika pragmatyczna* (Warszawa: PWN, 1975), pp. 181–192. By deductive theory, Ajdukiewicz understands the deductive system of sentences *A* as "[an] ordered set of sentences *Z*, which except sentences *A* contain only sentences *T*, deductively derived from sentences earlier in this set *Z*, and sentences *D* being definitions". See: Kazimierz Ajdukiewicz, "Metodologiczne typy nauk," in: *Język i poznanie, Vol. I*, ed. Kazimierz Ajdukiewicz (Warszawa: PWN, 1985), p. 292.

28 Studies of the basics of non-Euclidean geometries were exhaustively carried out in 1899 by Hilbert in *Grundlagen der Geometrie*. The main merit of Hilbert's work is that for the first time in the construction of the axiomatic system he was able to distinguish the mathematical and logical aspect from the epistemological foundations of geometry (demonstrative-spatial views). By the axiomatic method, Hilbert understands research activities aimed at separating certain objects, establishing relations between these objects in sentences named axioms

not unusual that science often deviates from the ordinary meaning of colloquial speech, creating its own language and its own symbolism.[29] According to Zawirski, some extreme formalizations of deductive theories may lead to absurdity, when it is demanded not only to forget what the individual symbols mean and remember only about the rules of the existing counting procedures, but also when it is declared that the symbols we operate have no meaning. In such situations, we have to do with misunderstandings, because by appropriate selection of axioms we create a certain type of objects that we deal with in a given deductive theory, and the meaning of the symbols we use each time boils down to existing axiomatic relations[30].

Understanding the essence of the axiomatic method in the theory of deduction can be expressed in three important areas of its application. First of all, the set of basic concepts and principles must be complete, which means that it cannot lack anything that would be needed to derive theorems of the theory and at the same time there cannot be anything that would have an effect on the theorems of a given theory. Only the set of axioms with the basic concepts introduced in them should define the subject of a given deductive theory. Second, the axioms do not have to be obvious; on the contrary, they can express something incompatible with the segment of obviousness. Thirdly, the terms or symbols we use do not have to have an understandable intuitive sense[31].

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and showing that the system of axioms, because of any sentences about the objects of a given deductive theory, is complete and non-contradictory. Such determination of the axiomatic method, according to Zbigniew Jordan, remains true to the ancient understanding of Plato's axiomatic method. See: Zygmunt Jordan, *O matematycznych podstawach system Platona. Z historii racjonalizmu* (Poznań: Poznań Society of Friends of Sciences, 1937), pp. 180–183.

29 This is the situation we had at the beginning of the formation of European science at the moment of the demythologization of nature made by ancient Greeks. See, for example: Olaf Pedersen, *Konflikt czy symbioza? Z dziejów relacji między nauką a teologią*. Trans. Wodzimierz Skoczny (Tarnów: Publisher Biblos, 1997), pp. 32–37.

30 Zygmunt Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," *Kwartalnik Filozoficzny* [The Philosophical Quarterly], Vol. 1, No. 4 (1923/1924), p. 514.

31 Similar to Zawirski, Russell also accepts the meaning of the axiomatic method; moreover, while characterizing pure mathematics, Russell states: "Thus mathematics may be defined as the subject in which we never know what we are talking

According to Zawirski, the axiomatic method leads to the demarcation of the formal and logical side of cognition from the overall epistemological basis. The use of the axiomatic method is not strictly connected either with the obviousness of the adopted principles or with the intuitive meaning of the terms used. In Zawirski's opinion[32], the use of the axiomatic method is not at the same time a symptom of disregarding the intuitive sources of our cognition, without which science would not have arisen at all. What's more, the results that this method leads to cannot be affected by some epistemological issues, such as the nature of the courts of mathematics.

The axiomatization of deductive theories brings definite benefits[33]. One of them is the search for an arrangement of axioms, which remains related to the search for those properties of objects on which the deductive theory really rests. These searches lead to a deeper penetration into the essence of a given theory. Another advantage of using the axiomatic method remains its role as an economic measure in our thinking[34]. The axiomatic method makes it possible to transfer whole theories from one domain to another, if both these theories have the same group of axioms. We save the time needed to carry out the evidence of the theorems of the second theory[35]. Moreover, axioms of a certain deductive theory can be used to obtain the axioms of a new theory, or by rejecting certain axioms, thus creating more general theories, or by denying certain axioms and introducing in their place axioms contrary to the first. An example of the first type can be projection geometry in relation to metric geometry, and an example of the second type – non-Euclidean geometries originating from Euclidean geometry[36].

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about, nor whether what we are saying is true". Quotation after: Zawirski, *Metoda aksjomatyczna a przyrodoznawstwo*, p. 513.

32 Zawirski, *Metoda aksjomatyczna a przyrodoznawstwo*, pp. 514–515.

33 Zawirski, *Metoda aksjomatyczna a przyrodoznawstwo*, pp. 515–521.

34 Joachim Metallmann, *Zasada ekonomii myślenia, jej historia i krytyka* (Warszawa: Towarzystwo Naukowe Warszawskie, 1914).

35 More on this subject, see Zygmunt Janiszewski, "Podstawy geometrii," in: *Poradnik dla samouków* (Warszawa: 1914).

36 The equations of non-Euclidean geometries approach asymptotically to the formulas of Euclidean geometry as some boundary values. The Euclidean space has a zero curvature, and the non-Euclidean curve has a curvature different from zero. It can, therefore, be assumed that Euclidean geometry is contained in non-Euclidean geometries as their common borderline case.

The axiomatic method can be used as a reliable heuristic agent in scientific research. An example of this can be the introduction of completely new concepts to the theory of deduction. Instead of looking for a set of axioms and concepts that are already ready for a given theory, one can look for new concepts that satisfy certain conditions, i.e. adopted axioms.

At the beginning of the 20th century, it became obvious that some of the natural sciences constitute the area of applied mathematics. If the methods of mathematical research are deepened by their axiomatization, it has to affect the natural sciences themselves. The axiomatic method, as Zawirski notes, is applicable to natural research, for which it is not indifferent what a reason is, or how to observe phenomena. The observation concerns an accurate quantitative measurement, and the reason is nothing more than an expression of certain solid quantitative relations between facts. The laws of nature, that express constant relationships of consequences and contemporaneity, must be checked if only they contain hypothetical elements. In addition, we strive to ensure that the laws of nature can be linked to a system free of contradictions, giving the opportunity to develop a unified scientific theory. In the natural sciences, therefore, attempts are made to link newly observed facts with existing ones.

Zawirski assumes that the inductive method of empirical sciences, constituting an inversion of deduction used by mathematics, has significance only for heuresis. In the natural sciences, we create a systematic system of acquired messages, which is based on a deductive course, as illustrated by a concrete empirical theory, in which general laws result in specific laws, and from them specific applications of them. It should be noted that physics, being the basis for mathematical natural science, uses seductive methods of its departments, although its laws have been acquired through the inductive method. The laws of physics can be expressed in mathematical symbols and usually take the form of differential equations. Mathematical symbols can be assigned to certain specific meanings, certain observed phenomena or certain quantities that can be measured. The same applies to the use of geometry in natural science. We apply this geometry, which is the geometry of a given area of reality, and as such must also be included in the natural sciences[37].

37 Zawirski, *Metoda aksjomatyczna a przyrodoznawstwo*, pp. 521–525.

Due to the fact that physics is not a closed science, and its development is not free of certain surprises, its axiomatization may be subject to constant changes. Each time the mathematical symbols of physics must be selected so that some empirical data can be subordinated to them, but this never interferes with the attempts of axiomatization of physics. By penetrating deeper and deeper into the accepted axioms, we gain an ever-more comprehensive understanding of the essence of scientific thinking and we are better aware of the unity of our knowledge.

Physics axioms, for many representatives of this science, can be considered sufficient to capture all physical phenomena, but they certainly cannot be regarded as a complete elaboration of the axioms of natural science. The change of the axioms of mathematical natural science proceeds in parallel with the development of theoretical physics and with the history of efforts to obtain the largest number of deduction-based detailed laws explaining natural phenomena and draw from them sets of the simplest ever rules, logically ordered and transparent[38].

The proper philosophical problem arises at the stage of axiomatization of natural science, where, apart from the axioms of physics, in which particular expressions applied to the experience are associated with mathematical symbols and, additionally, when the conditions and bases on which the use of these symbols for experience are to be based. According to Zawirski, it was assumed that the laws of logic and mathematical analysis exist alongside the general principles of cognition, which natural research must follow and on which only the application of mathematics to natural science can be based. Search for the so-called constitutive principles of mathematical natural science was one of the main goals of Kant's critique of pure reason. Immanuel Kant subjected the study to a sustainable framework, the principles on which all natural laws must be based. The research itself was based on the assumption that the distinguished constitutive principles must be obvious, intuitively certain and refer to the necessity of thought. Consequently, constitutive principles must be such *a priori* rules, which further nature research cannot in any way violate. Kant included to

38 Zawirski discusses in a very clear way the development of mathematical natural science axioms until the emergence of the theory of relativity. See: Zawirski, *Metoda aksjomatyczna a przyrodoznawstwo*, pp. 521–525.

the constitutive principles of natural sciences the assumptions about the Euclidean character of space and the absolute character of time, the lapse of which remained independent of the reference system. The emerging new axioms of natural science, transform Kantian aprioristic forms as the fundamental concepts of natural science. Naturally, the dynamic principles of natural science are also subject to change; and, together with them, the fundamental concept of the principle of causality[39] closely connected with the concept of time[40].

At the beginning of the 20th century, physicists were aware of the great transformations regarding the understanding of space, time and matter, but they were not able to cope with the problem of the relation of physics to geometry. Physics for Hilbert and Weyl, thanks to the axiomatic method, becomes a kind of geometry. The adoption of such an understanding of physics requires explanation, since it cannot be reduced only to an unambiguous assignment of the experience of certain mathematical symbols to the facts, which for Moritz Schlick is already a sufficient account of the essence of natural cognition[41]. In turn, for Albert Einstein and Max Born, the transformations in physics are regarded as evidence of a change in geometry into natural sciences.

In the natural science, there was a dispute over whether physics became geometry or geometry became physics[42]. According to Zawirski, the existing

39 Zygmunt Zawirski, "Teoria kwantów a zasada przyczynowości," *Przegląd Filozoficzny*, Vol. 33, No. 4 (1930), pp. 296–301.

40 Zygmunt Zawirski, "Rozwój pojęcia czasu," *Kwartalnik Filozoficzny*, Vol. 12, No. 1 (1935), pp. 48–80.

41 Moritz Schlick, *Allgemeine Erkenntnislehre* (Springer, Berlin: 1918), p. 56.

42 There is also a third position that Zawirski draws attention to; actually, for the opponent of Aloysi Müller's theory of relativity, both positions are absurd, because on the one hand we assume that geometry deals with ideal timeless objects, whereas physics focuses upon real, temporal objects, and on the other hand the relationship between matter and the metric of space has an empirical basis that cannot be axiomatic. For Müller, science of an authoritarian character and, at the same time, empirical nature is impossible. See: Zygmunt Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo: aksjomaty matematyczne fizyki wobec intuicyjnych zasad poznania [Axiomatic Method and Natural Science: Mathematical Axioms of Physics against Intuitive Principles of Cognition]," *Kwartalnik Filozoficzny*, Vol. 2, No. 1 (1923/1924), p. 3.

dissimilarity of physics and geometry can be reconciled with each other, despite the existing difference between their objects and the methods used there[43]. Geometry constructs its objects, regardless of the concrete reality, and justifies its claims by deduction. In turn, physics deals with data subjects found in experience and formulates laws mostly by induction. However, when we strive to build a unified theory of a certain group of physical phenomena, the difference in the method used disappears[44]. At the moment of creating the theory, the rights acquired in the way of experience can be justified by deduction, and unless they can be deduced from previously accepted assertions, then they must be accepted in a given theory as axioms. The above case concerns only the stage of systematization, not heuretics, where the significant difference between physics and geometry is still not questioned. In physics, theorems can occur only because they correspond to certain facts of the experiment, despite the fact that they cannot be related to any previously known laws. In geometry, however, as generally in mathematics, although certain ideas of laws can be born under the influence of experience[45], then such ideas cannot be introduced as geometrical assertions until they can be derived from the previously proven theorems.

According to Zawirski, the axiomatization of natural science is not an easy matter. After all, you cannot arbitrarily construct objects of physics, which are known to us only on the basis of descriptive features. According to Zawirski, we tend to assign univocally defined mathematical symbols to the objects of physics[46]. However, we act in such a way that first we consider the simplest, most typical and idealized phenomena and analyze the behavior of properly constructed objects only in terms of features strictly

43 Zawirski, Aksjomaty matematyczne fizyki wobec intuicyjnych zasad poznania, p. 5.

44 However, the difference in the subject does not disappear.

45 A useful example can be the generally known law about the area of the parabola section, which Archimedes fell on based on the weighting of properly cut plaques.

46 Kant in the *Critique of Pure Reason* posed the problem of how it is possible and on what terms it becomes possible to assign mathematical symbols in an unambiguous manner of reality. In Kant, the principles of assignment are then synthetic *a priori*. The main merit of Kant remains, not their formulation, but recognition of the existence of these principles of assignment.

defined in a given section of physics, abstracting from other features. In this way, the analysis starts with the phenomenon of motion, and therefore the mechanics obtained the status of a strict science very early. Then, taking mechanics analysis as a pattern, similar results were obtained in other branches of physics, and so, among other things, Maxwell's mathematical theory was created. In some cases, when attempts were made to combine several branches of physics into one theory, hypothetical factors were often referred to, specifying in advance their ownership and attitude to the characteristics of objects, or data assumed to be found in the description. This was the case in the case of the explanation of thermal phenomena by the movement of molecular particles in the kinetic theory of matter, or the reduction of light phenomena to electromagnetic phenomena. After completing these partial works, one could strive to create a unified scientific theory. However, as one can never have a guarantee that we will know all the properties of objects and their relations, and all possible ways of behaving in any conditions, therefore theoretical systematization is presented as a never-ending task, and thus the axiomatics to which such systematization leads, cannot have the character of eternal and inviolable truths[47]. Each time, in a system of mathematical laws created in the above manner, abstracted from the physical phenomena to which they can be assigned, we obtain the appropriate section of pure mathematics.

An important problem that attracted the attention of physicists was the geometry-based arrangement ("geometrization") of physics. The use of the name "geometrization of physics" remains justified by the need to treat the time coordinate in relation to spatial coordinates, which means that the concept of *change* is subject to geometrical treatment. It also turned out that the components of the metric tensor, determining the metric relations in the Riemannian four-dimensional continuum, turned out to be identical to the components of the gravitational potential. This means that not only spatio-temporal relations, but also dynamic relations can be treated in a geometric way. In the laws of physics, apart from the physical meaning of the respective symbols, we obtain the representation of relations in a kind of

47 Zawirski, Aksjomaty matematyczne fizyki wobec intuicyjnych zasad poznania, pp. 5–6.

four-dimensional continuum. It is worth noting that in differential geometry the same symbols were operated much earlier before it was noticed that they may also have physical meaning; later they were only identified with the components of gravitational potential.

Not only is it justified to talk about the geometry of physics, but also about treating geometry in a sense as a empirical science modeled on physics[48]. Geometry, only in the sense of researching the spatial properties of bodies, should be included in the natural sciences. The laws of geometry understood in this way must pass as a component of physics. There is close formal communication between the laws of body geometry and the laws of physics[49]. In Einstein's theory of gravity, the laws of body geometry cannot be strictly separated from the laws of physics. In this theory, mathematical laws expressing the metric of space, and laws expressing the nature of the gravitational field are the same[50]. In isolation from the physical meaning of the symbols used in Einstein's theory, the laws of geometry become nothing more than a branch of pure mathematics. According to Zawirski, if the laws of geometry are called laws of physics or laws of natural science, it is only because they are constructed so that natural phenomena can be unambiguously assigned to them. On the other hand, without natural research,

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48 The "in a sense" claim concerns the appropriate understanding of geometry. According to Janiszewski, the three meanings of the word geometry must be distinguished: geometry as a study of spatial properties of bodies; geometry as a study of empty, ideal space and geometry as a study of sets of ideal objects bound by axioms defined by them. Cf. Zygmunt Janiszewski, "Zagadnienia filozoficzne matematyki," *Poradnik dla samouków*, Vol. 1 (1915), p 462–489.

49 In 1872, Klein in his Erlangen program, pointed out that the laws of geometry can be regarded as a certain section of invariant theory for certain groups of transformations. For example, Riemann's geometry is a theory of invariants for all continuous coordinate transformations for which a certain square differential form passes into itself. In the theory of relativity, the laws of physics are nothing more than a part of the theory of invariants. The laws of relativity are invariance forms for the Lorentz transformation, whereas the laws of general relativity are invariance forms for all continuous transformations.

50 Moreover, in Weyl's theory, the dualism of physical-geometrical and purely physical laws disappears, which still exists at the stage of Hilbert's axioms. In Weyl's theory one cannot consider laws of body geometry as part of the laws of physics

we would never be able to choose the right geometry so that it would be suited to the sought-after, proper interpretation. The laws of axiomatically constructed geometry are at the same time the branch of natural sciences. Therefore, geometry becoming a natural science is a science in which laws are selected so as to express real relations in the existing world. However, claiming that physics is a science modeled on geometry, means that its laws, despite empirical origin, can be linked to axiomatically constructed deductive theory[51].

Zawirski notes that the contemporary axioms of physical theories replace the old, intuitive and certain axioms with the ones, where the spatial continuum depends on the time continuum on the one hand and on the masses disposed in it on the other. Zawirski, while not undermining the importance of intuitive sources of our cognition in the form of obvious principles, without which the emergence of mathematics and physics would be impossible, notes, however, that the results we reach using the axiomatic method are the further consequence of the path we follow in cognition of reality, where common sense criteria often fail.

1.2 Epistemological foundations of natural science

According to Zawirski, the axiomatic method, which was only sporadically used in philosophy, should be significantly acquired for the purpose of philosophical reflection on reality, similarly to the research in natural science. Thanks to this, natural science is enriched with the possibility of using the axiomatic method in its research.

According to Zawirski, nature remains the subject of natural science insofar as there is a specific material of empirical data that we obtain either by direct observation or by means of an account, in accordance with accepted axioms and based on measurements made[52]. Zawirski claims that the problem of the applicability of the set of axioms to the data of experience does not exist in the form in which it existed for Immanuel Kant,

51 Cf. Zawirski, Aksjomaty matematyczne fizyki wobec intuicyjnych zasad poznania, pp. 8–9;

52 Zygmunt Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," *Kwartalnik Filozoficzny*, Vol. 2, No. 4 (1923/1924), p. 129.

who selected axioms, so that empirical reality would apply to them. Kant accepted that forms of phenomena are something that our mind considers necessary, common and obvious. These forms are therefore subjective and therefore the universe considered in these forms is only a phenomenon. As Zawirski notes, the existence of the thing in itself is an assumption adopted by Kant, which he could not prove, but could not reject either. According to Zawirski, the space-time forms of phenomena, instead of becoming obvious to our mind, are mysterious to the mind and seem accidental to it. Therefore, there is no need to consider our mind as a co-creator of nature. The reality with which we are dealing, remains independent from a subject, not only as to its existence, but also as to its essence, which manifests itself in certain formal schemes.

Zawirski, however, does not consider, for example, that absolute realism should be attributed to the space-time continuum of general relativity theory, just as the quasi-spherical form of the world does not have such a reality, because the geometrical interpretation is obtained by appropriate mathematical formulas only by assigning empirical facts or results of certain measurements, and without this empirical content, mathematical formulas do not necessarily deserve their geometrical interpretation.

By rejecting apriorism and its phenomenalistic consequences in the Kantian sense, Zawirski does not reject the phenomenalistic consequences that contemporary physics comes to, regardless of philosophical considerations. The phenomenality of physics boils down to the claim that none of the attributes of material objects, including those of shape or body mass, can be attributed to existence in isolation from the conditions, in which an object reveals certain characteristics.

Some of the features revealed by objects can be included in such a general mathematical form that does not undergo any changes. Any mathematical form treated independently of these features, i.e. aspects of nature, can be given a different interpretation. However, the form that is the result of agreeing on all possible aspects of nature, presents itself as one of the possible constructions to which the sensual aspects of nature apply by accident, because this form does not seem to be of the shape necessary for the mind. Such a mathematical form, as long as it finds its reference to the adopted set of axioms in the field of natural sciences, should be regarded as something in which the nature of absolute reality is manifested[53]. The absolute reality can be treated here as an assumption adopted in many systems of natural philosophy which concerns one and the same world. All efforts of Copernicus, Galileo and Newton went in the same direction to capture this one, independent from our senses, reality. According to Zawirski, any allegations raised against such a determined striving to capture reality ultimately amount to misunderstandings[54].

If the set of axioms is treated as a kind of symbolic definition of absolute reality by enumerating symbols of essential features, then the formal-logical system of assertions resulting from axioms can be considered as symbols of derivatives of this absolute reality. Derivative symbols are symbols of everything that results from the nature of absolute reality, as indicated by symbols of axioms. The admission of absolute reality is attested by existing specific laws, which on the one hand result from accepted axioms, and on the other hand do not depend on their empirical interpretation. Therefore, without paying attention to the intuitive meaning of symbols used to formulate axioms, the axiomatic method of mathematics shows us how to build a deductive diagram of the whole theory of natural science.

Zawirski notes that natural cognition does not exclude the possibility of possession by objects experienced sensually, apart from the properties available to measurements, properties that cannot be determined experimentally. In addition, natural cognition does not exclude the possibility of the existence of knowledge, and even remains indifferent to this knowledge, whether there is a completely different, separate world outside the world of sense objects, whose logical and formal order is reflected in the accepted axioms of natural science[55]. The existence of a reality that goes beyond the world of sensory objects, however, does not remain indifferent to minds prone to metaphysical speculation. The metaphysical search is directed

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53 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," pp. 130–131

54 An example, of one of many misunderstandings, is the charges put forward by Planck towards Mach who, in Planck's opinion, reduces natural cognition to the adaptation of our thoughts to impressions and does not accept any other possibility. It turns out, however, that Mach, however, states that physical theories may come to assertions that "would be important and for beings with other senses, if they could translate them into their own sensory impressions" – quote after: Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," p. 131.

55 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," pp. 132–133.

toward the knowledge of the essence of being, and the sensual world often plays the role of a means leading to the discovery of the supersensitive world. The use of the axiomatic method in natural science indicates the possibility of building such a metaphysics that is based on experience and at the same time can preserve the nature of deductive theory.

For Zawirski, the application of the axiomatic method to solve metaphysical problems is the implementation of the old metaphysics' search, to bring the whole reality out of one or several of the highest principles. The principles adopted in metaphysics would be presented to the human mind in such a way that all the rich and varied content of the cognized reality can be deduced from them. However, the axiomatic method applied in natural science does not lead to the knowledge of the real essence of this reality, but it only gives the possibility of symbolic recognition of it. The axiomatic method makes it possible to develop a certain closed view of the world without resolving issues that have been subject to metaphysical disputes. Based on the subject of positivized natural sciences, we obtain that the axioms of this natural science do not exclude a different interpretation of them. On the other hand, how to find this "right" interpretation is always a matter of a given metaphysical system.

If two different theories have a strict dependence in formal and logical terms, both can be reduced to a common way of treating them. Assuming that there is a certain commonality of their logical-formal side between the sensual world and the post-emergent world, it means that the given order of the one side corresponds to the specific order of the other one. According to Zawirski, in this situation, all metaphysical issues boil down to the content of the logical-formal schemes of the natural order, in order to be able to read from them the laws of the extrasensory world[56].

Zygmunt Zawirski points out that every attempt to apply the axiomatic method to metaphysical cognition is usually supported on quite any assumption. In particular, he refers to the use of the axiomatic method in developing a scholarly picture of the world by Schlick and Eddington. For Schlick, cognition consists in assigning specific objects to the appropriate mathematical symbols, used in the axiomatic method, regardless of

56 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," p. 134.

whether these objects are the so-called phenomena, or things in themselves. According to Schlick, if, apart from the phenomena available for our cognition, there are things in themselves then, while making an attempt to know the phenomena, we also know things in themselves, because "the sign of the sign is after all the sign of the thing marked"[57]. Zawirski disagrees with such a view, believing that assigning objects to symbols each time produces a concrete cognition, expressed in sentences with a certain meaning. If we use symbols for phenomena, we always get a specific content that we associate with specific symbols. On the other hand, because specific things are rich in content, the use of symbols to mark them does not deprive us of any interpretation[58].

Eddington, in the work *Space, Time and Gravitation*[59], points out that the concepts of new physical theories are treated first as axiomatic defined symbols, and only then we assign a particular sense to them[60]. According to Eddington, objects or physical phenomena, in addition to the mathematical form that can be attributed to them, have a deeper meaning. On closer familiarization through experience, objects turn out to be complexes of some of the simplest elements that cannot be defined. Each time, by building complex concepts from these indefinite elements, we bring something that is undefined to these concepts. In this way, we come to a series of concepts that are defined in form, but are not defined as to the content, and which we use to explain all properties of matter. As an example, you can enter the concept of a point-event. Initially, such a "point event" is considered to be the name of something that cannot be determined in ordinary speech, the name signifying a certain moment in a certain place of space. We realize that the "point event" is something that is outside the realm of human reason. In turn, the set of point events begins to be called the world. Then, to express that this world is four-dimensional, one should first notice the

57 Quotation: Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," p. 134.
58 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," p. 138.
59 Arthur Eddington, *Space, Time and Gravitation: An Outline of the General Relativity Theory* (Cambridge: Cambridge University Press, 1921).
60 Eddington's use of the axiomatic-deductive model can be found in the work of Jerzy Witczak, *Eddington i teoria względności* (Tarnów: Biblos, 1999), pp. 152–164.

ordering of its elements, and this requires the use of the concept of interval, which, as the author notes, does not have to be treated as the equivalent of the real relationship between each of the two neighboring point events, but as something lying beyond the ability of our understanding. Finally, Eddington, arriving at the basic equations of the gravitational field without matter and with matter, allows himself to his own interpretation, in which he does not treat matter as a factor disturbing the gravitational field, but *vice versa* – he interprets the field disorder as matter[61].

In Eddington's interpretations of formal patterns, one can feel certain metaphysical tendencies that are very clearly related to the interpretation of the physiological processes of our brain. But does matter adopted in relativity by the coefficient $g_{\mu\nu}$ explain the processes of our thinking? Probably not. The coefficient $g_{\mu\nu}$, like the interval mentioned above, contains an undefined element, defined in form, but not specified in content. The matter of the brain in its physical aspect is only a form, but the reality of the brain contains a certain content. Therefore, one cannot expect the form to be sufficient to explain this content[62].

Zawirski, citing Schlick and Eddington, argues that the axiomatization of natural science can be used for metaphysical speculation. However, although he does not attach much importance to such attempts to use the axiomatic method for metaphysical purposes, he does not deny the validity of such attempts[63]. In terms of accepted physical theories, formulated mathematically, individual physics sections can be reduced to their common, mathematical treatment; in this way, for example, a vector algebra was created, allowing for the treatment of all directional quantities like force, speed or acceleration. The appropriate mathematical operations performed on vectors led physicists to formulate consecutive concepts such as gradient, potential or rotation. Further mathematical operations allowed to detect some invariant forms obtained from vector quantities and in this way a tensor account was created. It turns out that the search for mathematical laws of nature is a search for certain invariant forms.

61 Eddington, *Space, Time and Gravitation*, pp. 191–196.
62 Eddington, *Space, Time and Gravitation*, p. 191
63 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," pp. 141–142.

In physics, the same mathematical symbols subjected to an appropriate interpretation allow to define its individual sections. Metaphysical speculation in relation to the entirety of mathematical natural science attempts to behave similarly, but one should consider whether there is a key to the metaphysical interpretation of the basic concepts and principles of natural science. The applied axiomatic method in mathematical natural science can be used to more fully understand the existence of reality independent of our consciousness. There are, however, some reservations about this project, if we remain only in the area of knowledge in the field of physics. One should agree with Zawirski that due to the ignorance of the proper interpretation of these laws of nature, the mathematical form and the mathematical meaning of this form are of no interest to the physicist. Physical knowledge does not reveal absolute reality to us, it indicates it at most, and this is not the subject of physicists' knowledge. The mathematical form of the laws of nature determines the subject of physics as much as it is possible to assign to it some sensual or sensory elements, which can be reached through the performed account. Sensory phenomena are not a starting point in the knowledge of the laws of nature, but they provide specific content to the mathematical forms of the laws of nature.

It should be noted that Zawirski accepts two assumptions on which the possibility of using the axiomatic method for metaphysical issues is based. The first assumption concerns the existence of a reality independent of the human mind, and the second assumption is that not all metaphysical problems can be solved through a different interpretation of the laws of the phenomenal world.

Against Zawirski's acceptance of the existence of a reality independent of the mind, one can raise a charge of unlawful ontologies of concepts and violation of the intuitive meaning of names. The charge of formation of hypothetical notions remains valid, as long as it concerns those metaphysicists who, based on a simple analysis of concepts, without paying attention to experience, created any images of reality, while treating the concept of existence equally with other concepts at the same time. The solution to the problem of reality is also difficult when we develop conceptual constructions to interpret specific facts of the experience. The constructions we use have only a conventional value, they are only a useful fiction that we use for a specific cognitive purpose. However, the use of conceptual constructions leads to the breakdown of the unity of reality into the multitude of worlds. Zawirski notes that one cannot treat existence as a feature of any whatsoever concept, nor can one treat the notion of being as a qualitative sense inherent in sense qualities. In no way can it also be treated as a given quality[64].

In various philosophical systems, a different emphasis on the acceptance of the existence of external objects can be observed. At this point, one should ask the question whether in the sense of the existence of these objects we leave the intuitive meaning of the word "existence", or can the intuitive meaning of this word be maintained? For example, Berkeley's immaterialism is a departure from common sense, but also representatives of positivism, proclaiming the slogan of returning to naive realism, as well as representatives of metaphysical realism, advocating for the existence of the extrasensory world, change the intuitive sense of the word "existence". None of the positions mentioned retains some original, intuitive meaning of the word "existence".

Analyzing the problem of existence, one can recall the concept of Zawirski regarding the existence of absolute reality, which is a good justification of how the axiomatic method can be used to study metaphysical problems. Actually, a physicist considers as real only what can be measured. Undoubtedly, this is a symptom of their healthy scientific instinct, without which physics would lose the proper sense of learning about nature. The physicist also realizes that the results of his/her measurements in different conditions fall differently. In this way, the physicist creates the concept of the existence of relative features relative to a given system, but at the same time assumes the existence of properties independent of any system. The latter is achieved through an account based on the axiomatic method. According to Zawirski, both objects with variable features and certain unchanging forms, which can be achieved mathematically, have their deeper base in the sphere of absolute reality. A physicist who each time, on the basis of his/her professional knowledge, makes judgments about the dependence of the object of research on the whole of the cognized being, should

64 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," p. 152.

not forget about the existence of absolute reality, although the concept does not belong to physical concepts[65].

The second assumption, which Zawirski accepts regarding the applicability of the axiomatic method to metaphysical problems, boils down to the fact that not all metaphysical problems can be resolved by a different interpretation of the laws of the phenomenal world. In addition to the subject of mathematical natural science, the psychological world, the world of spiritual life, remains.

Zawirski assumes the existence of a reality independent of the human mind. This reality indicates the existence of absolute reality, the existence of a deeper unity of the world. Due to the fact that all of the properties and relations of the learned objects remain relative; the clearer, according to Zawirski, is the need to adopt a reality independent of the subjective and relative manifestations of the objects learned for the human mind. Otherwise, one would have to accept an infinite multitude of subjective worlds and one could not explain where the source the possibility of unambiguously assigning specific, subjective data to a specific object and on the basis of adjudging on the identity of an object comes from. The invariant form of the laws of nature indicates a real unity of the world. While not accepting the invariant nature of natural laws, which in the light of modern knowledge becomes impossible, the world would be strange and incomprehensible.

It must be said that the question still remains whether contemporary mathematical natural sciences reveal to us the nature of absolute reality. According to Zawirski, physical knowledge does not present absolute reality to us, but it indicates it at most. Both the objects with relative traits and invariant laws belonging to the world of phenomena must have their deeper base in the sphere of absolute reality.

1.3 Analysis of time, space and cosmology

Zawirski was interested in the development of natural sciences and, first of all, the theory of relativity and quantum mechanics. Constantly trying to answer the questions stated and the philosophical matters discussed at that time, he has left many original works linked with these theories. Zawirski

65 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," p. 153.

presented new philosophical implications derived from these theories in his numerous works and their impact on wider understanding of reality.

At the beginning of the 20th century, while conducting a research on the nature of time, space and cosmology, Zawirski was interested in the philosophical principles and implications linked with the general theory of relativity. Not much time behind, as it was only five years after Albert Einstein had presented his theory, Zawirski published his paper entitled *Refleksje filozoficzne nad teorią względności* which appeared in "Przegląd Filozoficzny" in 1920[66]. Not only did he notice crucial importance of Einstein's theory, but also made an attempt to explain the existence of absolute necessity to eliminate a number of philosophical premises out of science, especially the ones which had been accepted earlier by a number of physical theories and kept functioning in the notion of absolute time, space and movement. Zawirski paid close attention to, as well as followed the development of research undertaken within Einstein's theory. Such an approach is evidenced by his numerous reviews of books on this theory published at that time (10 reviews in total). However, first of all, it is evidenced by his work entitled *Relatywizm filozoficzny a fizykalna teoria względności*[67] published in 1921 in Lvov, as well as three smaller studies on this matter entitled respectively *Rzecz o 'obronie absolutu'*[68], *Czas i przestrzeń w przedstawieniu wielkich filozofów*[69] and *Fizykalna teoria względności a relatywizm filozoficzny*[70] having published them in the same year in *Słowo Polskie*.

66 Zygmunt Zawirski, "Refleksje filozoficzne nad teorią względności," in: *Przegląd Filozoficzny*, Vol. 23 (1920), pp. 343–366.

67 Zygmunt Zawirski, *Relatywizm filozoficzny i fizykalna teoria względności* (Lwów: Drukarnia Słowa Polskiego, 1921).

68 Zygmunt Zawirski, "Rzecz o 'obronie absolutu'," in: *Słowo Polskie*, Vol. 26, No. 19 (1921), p. 3, Vol. 26, No. 21 (1921), pp. 3–4.

69 Zygmunt Zawirski, "Czas i przestrzeń w przedstawieniu wielkich filozofów," *Słowo Polskie*, Vol. 26, No. 41 (1921), pp. 3–4; No. 43, pp. 3–4; No. 45, p. 3.

70 Zygmunt Zawirski, "Fizykalna teoria względności a relatywizm filozoficzny," Słowo Polskie, Vol. 26, No. 94 (1921), p. 3–4; No. 96, p. 3–4; No. 98, p. 3–4; No. 100, p. 3; No. 102, p. 3–4; No. 104, p. 3–4; No. 106, p. 5–6; No. 108, p. 3–4; No. 110, p. 3–4; No. 112, p. 3–4; No. 114, p. 3–4; No. 116, p. 3–4; No. 118, p. 3–4; No. 120, p. 3–4; No. 122, p. 3–4; No. 126, p. 3; No. 128, p. 3–4.

One of the first issues that did not directly relate to the philosophy of nature raised by Zawirski was a hypothesis on the so-called eternal returns of the worlds. He published a series of three papers on these matters in *Kwartalnik Filozoficzny* in the period between 1927 and 1928. He had already thought these problems over, studied them and was ready for the publication of the issues for the last fifteen years. The first drafted versions were presented on the May 27 and June 24, 1911 at the meetings of Polish Philosophical Society in Lvov, as well as during the Convention of Polish Medicals and Naturalists in Cracow in the same year.

Zawirski came back to this motive of "eternal returns" in his main work entitled *L'évolution de la notion du temps*, which was published in 1936[71]. His work is still worth considering due to the clear and deepened presentation of history linked with the notion of time; it starts with the Pythagoreans and ends with the modern philosophical concepts of his time, including the claims of H. Bergson and E. Husserl, and the latest relativists and researchers in quantum physics. *L'évolution de la notion du temps* is still a work worth reading and studying by anybody interested in philosophy.

Zawirski's most important achievements circulated around a number of issues related with time. He wrote many papers dealing with time and two books which we shall discuss later. The first book, *Wieczne powroty światów. Badania historczno-krytyczne nad doktryną 'wiecznego powrotu'*, was published in Cracow in 1927[72]. In this work, the issues of eternal return, involving a rather odd theory, were awakened in his mind as a profound interest in the problem of time which, as if shaped in the form of enigma, became his focus of investigation almost since.

Human curiosity about the eternal return of the world could be observed as vividly awakened in the earliest stages of culture. We have often to do is to think about the mystery of the past, the future and the present. The past has already ceased to exist but the future has not arrived yet. In addition, the only way present remains is a point of contact between the past and the

71 Zygmunt Zawirski, *L'évolution de la notion du temps* (Kraków: Librairie Gebethner et Wolff, 1936); Zygmunt Zawirski, "L'évolution de la notion du temps." *Scientia*, Vol. 28, No. 55 (1934), pp. 249–261.

72 Zygmunt Zawirski, *Wieczne powroty światów. Badania historyczno-krytyczne nad doktryną 'wiecznego powrotu'* (Kraków: Uniwersytet Jagielloński, 1927).

future. This problem can be found in the ancient philosophy and the ancient books, the Bible included. Many thinkers were fascinated by the mystery of time; it is enough to mention Anaximander, Plato, Aristotle, Augustine, Thomas Aquinas to Pascal, Leibniz and Bergson where the problem of time could be found to remain the center of philosophical and scientific discussions. In *Wieczne powroty światów,* Zawirski deals with the theory of eternal universe and the idea of cyclic time. Following Zawirski's concepts, it means that after a relatively long period, the universe returns to its initial point and from this point its old order is re-shifted, so as to begin a new history which is identical with the previous one. Zawirski's book consists of two parts. The first one is highly instructive and of the historical character. The second part is a critical analysis of the theory of cyclical time, adopting the issues observed in the light of contemporary science.

In Modern Times, we can observe that the discussion about the idea of returns was particularly favorable due to the laws of mechanics. These laws are recognized as symmetrical to the direction of time – all the phenomena may run from past to future and from future to past. Kant was also an adherent of the laws of mechanics and the theory of returns, which can be found in his work titled *Allgemeine Naturgeschichte* and *Theorie des Himmels* (1755). Other adherents of the idea of returns were: the author of a discourse *L'Eternité par les Astres*, Auguste Blanqui (1805–1885)[73], and Friedrich Nietzsche, the author of the seminal work *Also sprach Zarathustra*[74]. The idea of eternal return, as approached form the point of view of the direction of time was observed to be prevailing in science almost until the mid-19th century.

The situation radically changed in the second half of the 19th century, when in 1824 Nicolas L. Sadi Carnot discovered the Second Law of Thermodynamics. In the seventies of the 19th century Rudolf Clausius presented thermodynamic trans-formations, where thermal energy got transformed into mechanical work, currently known as the so-called law of

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73 Auguste Blanqui. *L'Eternité par les Astres*. Paris: Librairie Germer Baillière, 1872.

74 Friedrich Nietzsche, Also sprach Zarathustra, p. 182, "…dass alle Dinge ewig wiederkehren und wir selber mit, und dass wir schon ewige Male dagewesen sind, und alle Dinge mit uns." http://www.pileface.com/sollers/pdf/Zarathustra.pdf.

the increase of entropy. It means that, after we have applied the Second Law of Thermodynamics to the entire universe observed as an isolated system, the universe itself moves toward the state of maximum entropy, i.e. to thermal death. Zawirski, who clearly leans toward the cycles of time, extensively analyzed the theory of universal thermal death and drew a conclusion from the extrapolation of the second law. He began with the arguments which undermined the validity of universal thermal death (found in the philosophical approaches of Ernst Mach, Henri Poincaré and Ludwig Boltzmann).

The strongest arguments against the theory of the thermal death of the universe were suggested by Poincaré and Boltzmann. Poincaré, in the work *Le Mécanisme et l'Expérience* (1893), wrote that our observations can appear to be incompatible with mechanics and thus unable to formulate the differences between irreversible and reversible phenomena. Irreversible phenomena possess a relatively long period of return to the preceding state, while the time of return in respect to the reversible phenomena is relatively short. The time of all observation is too short, so our conclusions about the thermal death of the universe can be simply short-sighted. At the same time, Boltzmann suggests a statistical formulation of the second law and suggests an equal probability of all possible micro-states. This Boltzmann's idea of fluctuation connects the reversibility of the phenomena in the entire universe with the irreversibility of processes within the fluctuation range.

An experimental confirmation of the statistical interpretation of the second law was found within the micro-system. Marian Smoluchowski assumes that, where the number of particles is relatively small, that anti-entropy processes can be observed most easily. Up till now, the statistical character of the second law of thermodynamics had been confirmed experimentally by Böhi, Chaudesaigues, Dąbrowski, Perrin, Seddig, Svedberg and Zangger. Zawirski, on the basis of Poincaré's, Boltzmann's and Smoluchowski's theorems, adopts the concepts of quasi-return phenomena. In this way Zawirski, in *Wieczne powroty światów*, accepts the theory of eternal return of the universe only because it cannot be denied with complete certainty[75].

75 Zygmunt Zawirski, *Wieczne powroty światów. Badania historyczno-krytyczne nad doktryną 'wiecznego powrotu'* (Kraków: Uniwersytet Jagielloński, 1927), pp. 79–98.

Ten years after 1927, Zawirski decided to publish his new work titled *Rozwój pojęcia czasu*. It appeared to be his *opus magnum*. In an international competition under the auspices of Italian *Scientia* Zawirski was awarded the First Prize for it. No other publication known at that time was so up-to-date as Zawirski's book. Up till 1936, we knew only about Duhem's *Le temps selon les philosophes hellènes*[76] that was devoted to the ancient period only; Werner Gent's *Die Philosophie des Raumes und der Zeit*[77] included the period from Aristotle to the end of the 17th century, whereas Baumann's *Die Lehren von Raum, Zeit und Mathematik*[78] ends with Hume.

Zawirski's book contains the development of the idea of time up to the latest period and discusses the problems of time in relativistic physics and quantum mechanics. This work is semantically clear but its style is characteristic of the mental formation to which Zawirski belongs as a faithful disciple of Kazimierz Twardowski. *Rozwój pojęcia czasu* consists of two parts. The first contains the history of theories from the ancient philosophy up to Zawirski's period of time. The second one is critical in nature and devoted to the analysis of some *aporias* of the notion of time. We will confine ourselves to a very short review of these *aporias*.

The first group of *aporias* contains all the questions connected with problem of absolute time and – connected with that – the *a priori* or *a posteriori* elements naturally contained within the idea of time. Zawirski's answers to these problems are as follows: "[…] all the elements of the idea of time are of empirical origin, but the idea of time is nonetheless the product of our mental activity, because our mind's attitude in the formation of this idea cannot be a solely passive and receptive one. […] We reject the *a priori* idea as a blind and mysterious force which weighs heavily upon us, just as did the *fatum* of the Ancients. Such a conception of the *a priori* has nothing in common with science or with philosophy of science. It is

76 Pierre Duhem, "Le temps selon les philosophes hellènes. " *Revue de Philosophie*, Vol. 19, 1911, pp. 5–24, 128–145.

77 Werner Gent, *Die Philosophie des Raumes und der Zeit*. Bonn: Verlag Friedrich Cohen, 1926.

78 Julius Baumann, *Die Lehren von Raum, Zeit und Mathematik*. Berlin: Druck und Verlag von Georg Reimer, 1869.

the great merit of Husserl to have modified the sense of Kant's *a priori*, by limiting it to the consciousness of what is necessary and essential in the structure of an object. However, when penetrating the essence of objects, Husserl fell into the errors of the old metaphysics. Discrimination as to what is essential to, or accidental in, an object may change with the progress of science and, according to our opinion, it depends solely upon the definition of an object, which can also vary with experience. The point is that all *a priori* truths undergo a limitation of their application. Phenomenological investigations can in no way settle the problem of the reality of an object, or of its origin. The progress of sciences gives us the respective warning. It is from this point of view that the phenomenological axiomatization of time should be considered"[79].

The second group of *aporias* concerns the question of the psychological origin of the idea of time and relation between intuitive and physical time. This part includes the critique of Bergson and discusses the role of memory in the formation of the idea of time, temporal illusions and the relation between ideas such as the temporal order, the interval and the instant[80].

The third group of *aporias* concerns the problems raised by modern physics. All these *aporias* belong to the problem of the uniformity of the temporal flow and all those questions created by the theory of relativity. Zawirski concluded that metrical time and physical time are not identical notions. He concentrated upon these problems which led to two opposed orientations. One of them considers the ideas of the uniformity of time and the one of simultaneity as completely relative and conventional, while the other defends their intuitive and absolute character. Zawirski admitted that intuitionism found itself in a more difficult position after the advent of the theory of relativity. He does not exclude it, and indeed shall try to assume an intermediary position which takes into account the results of modern physics while not neglecting the data of intuition.

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79 Zygmunt Zawirski, "The Evolution of the Notion of Time," in: *Zygmunt Zawirski: His Life and Work. With Selected Writings on Time, Logic, and the Methodology of Science*, ed. Irena Szumilewicz-Lachman (Dordrecht-Boston-London: Kluwer Academic Publishers, 1994), pp. 277–279.

80 Zawirski, "The Evolution of the Notion of Time," pp. 279–307.

The truth is that the axioms are often used in modern theories. We can formulate a series or propositions wherein we find the primitive terms of the constructed theory, connected to each other by means of logical terms. The primitive terms are defined implicitly by the role they play in these axioms or primitive propositions. We know that this method of defining issues implicitly has been used by Peano, who defined the notion of the integer in this way by means of five axioms and three primitive terms, but it was Hilbert who applied this method to geometry. Zawirski, making an attempt to provide this third group of *aporias* an end, focused his attention upon the attempts of such philosophers like Carnap and Whitehead, for example, who sought to axiomatize the science of time. Carnap gives several examples of the application of the axiomatic method to the topology of space-time, according to the theory of relativity; whereas Whitehead adopts axiomatizing as the basis of his theory, not the points of the universe, but the natural elements which are the events, and constructs the geometry of the events[81].

The last group of *aporias* is devoted to problems of continuity, of the infinity of time and of its irreversibility. Zawirski has decisively solved none of these problems, since the state of modern science did not permit it. He said that the problem of continuity could be distinguished in future but now the result of quantum physics renders the mathematical continuity of time unverifiable; nevertheless, the intuitive notion of continuity should be maintained as different forms of atomism of time are not verifiable. The problem of the infinity and irreversibility of time provides the occasion for considering the value of the second law of thermodynamics and of other laws of physics. He suspected that by far modern physics did not reveal new possibilities which could be able to resolve the problem of determining the conditions and the direction of change[82].

2 Logic and methodology of science

2.1 Methodological problems in science

Zawirski developed many methodological problems such as causality, determinism, axiomatic method and *experimentum crucis*. He investigated

81 Zawirski, "The Evolution of the Notion of Time," pp. 307–347.
82 Zawirski, "The Evolution of the Notion of Time," pp. 347–365.

problems of casual relation from various perspectives during all his scientific research. He was certain about the importance of this principle for scientific research. In his work entitled *Przyczynowość a stosunek funkcjonalny*[83], published in Lvov in 1912, he demonstrated that the notions of "casual relation" and "functional relation" differ in terms of content. As casual relation is a real relation, considering the influence and time relations between reasons and consequences, it cannot be replaced with functional relation. In his paper entitled *Teoria kwantów a zasada przyczynowości*[84] from 1930, he presented an opinion clearly polemical to Heisenberg's theory claiming that the principle of uncertainty proves the falsity of the principle of causality.

Zawirski paid attention to any signal of philosophical thinking outside the borders of his mother country. He reacted violently to the methodological research included in Karl R. Popper's work entitled *Logik der Forschung. Zur Erkenntnisheorie der modernen Naturwissenschaft*, published in Vienna in 1934. Zawirski criticized Popper's falsificationism, which claimed that lack of agreement between some law and one of recognized and elementary opinions can be regarded as a sufficient reason for the rejection of this law. Zawirski notices that a single empirical law hardly ever is tested as perceived separately from the other laws. The whole system of opinions or theories is either tested or invalidated. Moreover, the number of laws and independent hypotheses becomes constantly smaller and smaller during such a test. Then, each general empirical task "becomes itself responsible" for the whole system to which it belongs. In this way, development of real sciences constitutes a continuation of the theory, which fight with each other and modify themselves constantly[85].

In an interesting paper *Doniosłość badań logicznych i semantycznych dla teorii fizyki współczesnej*[86] Zawirski was rather critical with Popper's

83 Zygmunt Zawirski, "Przyczynowość a stosunek funkcjonalny," *Przegląd Filozoficzny*, Vol. 15, No. 1 (1912), pp. 1–66.

84 Zygmunt Zawirski, "Teoria kwantów a zasada przyczynowości," *Przegląd Filozoficzny*, Vol. 33, No. 4 (1930), pp. 296–301.

85 Zygmunt Zawirski, "Doniosłość badań logicznych i semantycznych dla teoryj fizyki współczesnej," *Przegląd Filozoficzny*, Vol. 41, No.1 (1938), p. 26. This article was read out at the Paris Philosophical Congress in 1937

86 Zawirski, "Doniosłość badań logicznych i semantycznych dla teorii fizyki współczesnej," pp. 25–30.

concept of falsibility as the most important criterion of a scientific aspect in a theory, but he agrees with Popper as to the rejection of induction to be recognized as an appropriate method in science. Zawirski also states that there exists asymmetry in falsification on the one hand and verification on the other. The falsification of a theory is a proof, based on *modus tollendo ponens* that the theory is false, but empirical verification of a theory does not prove that the theory is a true one. Notwithstanding, Zawirski in his paper is openly critical to Popper's analysis and he expresses some arguments. Zawirski claims that induction and deduction are indispensable for science. Induction is important when a law or a theory is formulated *in statu nascendi*, but deduction plays its part during the processes aimed at testing any of them. He also states that falsification, like verification, is never of final character. We never test a singular theory, but always a group of theories or laws. We never know which theory has exactly been recognized as false, because falsification and verification are based on protocol sentences which do not form bottom of the rock. The protocol sentences depend on a number of factors: of theoretical, methodological or linguistic character. Summarizing, Zawirski concludes that "[…] a falsification by way of an experiment or an observation has the same relative character as verification […] so we shall find that between them no apparent asymmetry can exist"[87].

A problem of testing hypotheses in empirical sciences was also undertaken by Zawirski in the paper entitled *Uwagi o metodzie nauk przyrodniczych*[88]. In a way similar to Popper's, Zawirski assumes that we derive consequences

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87 Zawirski, "Doniosłość badań logicznych i semantycznych dla teorii fizyki współczesnej," p. 29.

88 Zygmunt Zawirski, "Uwagi o metodzie nauk przyrodniczych," *Przegląd Filozoficzny*, Vol. 44, No. 4 (1948), pp. 315–318. According to Jan Woleński, during one of Zawirski's tips in 1947, this manuscript containing a comprehensive academic textbook on the methodology of empirical sciences was stolen from Zawirski. One can only assume today that the monograph was a synthesis of many positions held by quite a number of methodologists, the ones presented by Polish methodologists included. For details, see Jan Woleński, *Filozoficzna Szkoła Lwowsko-Warszawska* (Warszawa: PWN, 1985), p. 268. Most probably, the paper that appeared in *Przegląd Filozoficzny* was a part of the monograph written some time earlier.

out of the accepted hypothesis. Then, we make an attempt to test it whether it agrees with the facts concerned with it. The hypothesis is found as correct when there is an agreement between the facts directly observed and the conclusions derived out of it. If there is found some form of disagreement, the hypothesis should be rejected due to its invalidation. In this paper, Zawirski does not mention the name of Popper, but still criticizes his concept of falsification and impossibility to achieve *experimentum crucis*. Currently, it can be stated that what he criticized was the so-called naive Popper's falsificationism.

Zawirski agrees with asymmetry to possibly appear between positive and negative result when testing a hypothesis. A question whether the negative result is to be considered as more serious than the positive one remained a problem for him. It is clear for Zawirski that the positive result still does not prove rightness of the particular hypothesis because it can always be changed in a minute; whereas, at the same time, the negative result does not always lead toward a complete withdrawal of the hypothesis. Invalidation of the hypothesis might be a decisive moment only when none of the notions describing an experiment remained unchanged. Every single change of meaning in the terms used leads to another undertaking of the particular hypothesis, in spite of the fact that it was invalidated. The example of such a situation can be earlier rejected by means of wave-particle theory of light that came out after Foucault's experiments and was later introduced with the help of the theory of quantum. A similar situation occurs in the experiments related to *experimentum crucis* and *instantia crucis* when we select the one which includes some newly-revealed fact out of two competing hypotheses or theories.

Zawirski notices an analogy between a verification of the particular hypothesis and acceptance of the one out of two competing hypotheses. As long as we expect a positive or negative answer in the first case, the positive answer linked with one of the hypotheses in the second case is simultaneously the negative answer for the other one. In the situation of *experimentum crucis* it rarely occurs that two competing hypotheses were of the opposite opinions. There are usually more complicated hypotheses. Therefore, logical conjunctions of sentences whose negation is their alternatives are often checked, Popper does not notice it in his concept of falsification. Zawirski agrees here with Duhem for whom *experimentum* *crucis* has never invalidated one isolated hypothesis but only the whole theory full of linked tasks.

The comments presented above refer only to the theoretical testing of hypothesis. In practice, the situation does not look to be complicated so much. Each theory, apart from the formulated laws, also includes numerous defined terms, as well as a number of agreements. The simplest way of testing a hypothesis is usually selected. However, more complicated cases occur and may trigger "[…] a revolution in science". "The cases occur when it is difficult to select which way is surely the simplest"[89]. Such a situation occurred during the development of the theory of relativity and quantum mechanics, when a number of negative experiences increased constantly together with the one of supporting hypotheses which explained these experiences. After some time, the edifice of classical physics had to be reconstructed, which appeared to be the best solution in this difficult situation[90].

2.2 Many-valued and intuitionistic logic and their applications in physics

After the end of the 19th and the beginning of the 20th centuries, the classical logic of Aristotle represented a small fraction of modern logics, whose basic part was the one of sentential calculus. The development of logic enabled the work of Aristotle to be understood better and more profoundly. The discovery of the structure and function of deductive systems was an inspiration for further impressive development of logic.

Jan Łukasiewicz devoted many years to study Aristotle's syllogisms. He started his studies on this problem with the publication of his monograph *On the Principle of Contradiction in Aristotle*. In this book, Łukasiewicz

89 Zawirski, "Uwagi o metodzie nauk przyrodniczych," pp. 317–318. Zawirski completed his research practice and historical analysis of the development of scientific theories with a logical analysis. In this way, he was the one who noticed the cumulative development of scientific theories, often taking place in the course of a scientific revolution, at a time when the number of negative experiences for the scientific theories in force at the given stage of knowledge development increases.

90 Zawirski, "Uwagi o metodzie nauk przyrodniczych," p. 318.

represented the first sustained questioning of the assumptions of traditional Aristotelian logic. The results of these studies were presented at the session of the Department of History and Philosophy of the Polish Academy of Sciences and Letters in 1939. Łukasiewicz demonstrated that Aristotle's syllogism is a deductive system constructed by the axiomatic method. He completed this system and accurately defined its theorems by using the modern formal method. His studies of Aristotle's original texts also made possible to discover new problems in the domain of modal sentences and the possibility of attributing a different value to some such sentences (Cf. *On three-valued logic*, 1920; *Two-valued logic*, 1921). He wrote about it in more detail in *Aristotle's Syllogistic from the Standpoint of Modern Formal Logic* (1951).

Zawirski followed the debate about a possibility of attributing a different value to sentences. In 1914 he published *O modalności sądów*[91] where he critically analyzed the said discussion of the modality of judgments starting his analysis from the ancient philosophers up to the ideas observed in the time of Sigwart's, Windelband's, Wundt's, Twardowski's and Husserl's philosophical activity. In this work Zawirski presents his own point of view, strongly speaking in favor of the two-valued logic. When Jan Łukasiewicz formulated the three-valued logics, where – in addition to true (1) and false (0) values, he introduced a third value (1/2) – Zawirski took part in the discussion of Łukasiewicz's bold new idea by publishing a series of papers in this field of logic. He was interested in the possibility of using the idea of manyvalue logic for solving numerous difficulties which appeared alongside the development of quantum mechanics and mathematics. Zawirski sees that Łukasiewicz's idea makes it possible to eliminate certain logical antinomies, and he believes that this idea is a better one for removing the said antinomies than Russell's theory of types.

The indeterminism of quantum mechanics appears to supply a field of applicability to the new logic, i.e. many-valued logic. In 1920, while discussing the notions of modality and, in particular, possibility, Jan Łukasiewicz introduced the third value in his first published paper titled *On the Concept of Possibility*. This paper was based on a talk given by him

91 Zygmunt Zawirski, *O modalności sądów* (Lwów: Polskie Towarzystwo Filozoficzne, 1914).

on June 5, 1920 in Lvov. Two weeks later, a second talk given by him (also in Lvov) was more transparently titled *On Three-valued Logic*.

Zawirski pointed at two potential uses of many-valued logic in 1932 in the paper entitled *Les logiques nouvelles et le champ de leur application* which appeared in "Revue de Métaphysique et de Morale"[92]. The first one focused on the link between the theory of probability and many-valued logic. The second one focused on the use of Łukasiewicz's three-valued logic in the analysis of wave-particle duality. Nevertheless, Zawirski admitted that this attempt was too early. In further works, Zawirski spoke in favor of the use of the theory of probability in the description of quantum phenomena. He stated that various degrees of probability can be assigned to such quantities of feedback as time, energy, position and momentum elemental particles.

Zawirski sees that three-valued logic provides better understanding of the complementary theory in micro-physics but he also notices the difficulties in the application of the notions of three-value logic to modern physics. The difficulties that are found in this application are compared with the traditional way of handling marks that are mainly associated with compound sentences. One problem that is concerned is that the negation of a sentence with a logical value of ½ can also obtain the same value of ½. Some other problem concerns the postulate of correspondence observed in the requirement that any later theories ought to be recognized as corresponding to the earlier theories. It means that the equations of the later theory should pass into equations of the earlier theory in the limited cases. In this time, scientists used to be convinced that this principle of correspondence provided a kind of guarantee that nothing will be lost from what is valuable in the achievement of the development of science. At the same time, this principle makes it possible to conduct a critical analysis from a new point of view. Zawirski writes that some time ago scientists simply adopted this postulate which was assumed to be intuitively certain, but now one ought to admit that such a new principle would be valid[93].

92 Zygmunt Zawirski, "Les logiques nouvelles et le champs de leur application," *Revue de Métaphysique et de Morale*, Vol. 39, No. 4 (1931), pp. 503–579.

93 Zygmunt Zawirski, "W sprawie indeterminizmu fizyki kwantowej," in: *Księga Pamiątkowa Polskiego Towarzystwa Filozoficznego we Lwowie* (Lwów: 1931), p. 25.

Tab. 1: Implication in Łukasiewicz's logic and Brouwer's logic

p	*Q*	*p*⊃*q* (Łukasiewicz)	*p*⊃*q* (Brouwer-Heyting)
1	1	1	1
0	0	1	1
0	1	1	1
1	0	0	0
0	½	1	1
½	½	1	1
1	½	½	½
½	0	½	0
½	1	1	1

Zawirski produces a table for the implication $p \supset q$ in Łukasiewicz's logic and Brouwer's logic (Tab. 1.)

One can see from the table (cf. position 8) that although ½ in Łukasiewicz's logic is possible, it turns to be false in Brouwer's logic. In intuitionist logic, when the antecedent has a higher value than the consequent, the implication is false. The same notion is observed in the traditional logic. So we can see that Brouwer's logic comes nearer to the traditional one. There are no propositions that the two-valued logic ought to reject the intuitionist logic as being false. The situations appears to be different in Łukasiewicz's logic, the law of negation of the equivalence of two contradictory sentences $\sim(p \equiv \sim p)$, for $p = 1/2$ and $\sim p = 1/2$, is false but in Brouwer-Heyting's logic this law continues to be true[94].

Łukasiewicz's logic had only three values and these were not enough for the interpretation of probabilistic laws observed in quantum mechanics, so Zawirski tries to form its alterations and works out his own variant of a many-valued logic which is to fulfill this interpretation. Zawirski deals with this problem in two works: *Znaczenie logiki wielowartościowej dla poznania i związki jej z rachunkiem prawdopodobieństwa* (1934)[95] and *Stosunek logiki wielowartościowej do rachunku prawdopodobieństwa*

94 Zygmunt Zawirski, "Geneza i rozwój logiki intuicjonistycznej," *Kwartalnik Filozoficzny*, Vol. 16, No. 2–4 (1946), pp. 199–202.

95 Zygmunt Zawirski, *Znaczenie logiki wielowartościowej dla poznania i związki jej z rachunkiem prawdopodobieństwa* (Warszawa: I. Pyz i S-ka, 1934).

(1934)[96]. He sees that as any connection of logic and probability calculus is impossible *a priori*, so he introduces new logical factors. He has increased the number of logical operators of the sum and of the product in such a way that only logical value corresponds to each of these factors; this can be, for example, the logic of five values, symbolized by the series of numbers 0, ¼, 2⁄4, ¾, 1. In this logic the different formulae of the sum are justified by the difference in the order in which the true propositions follow the false propositions in these classes. If the values of the arguments $v(p)$=2⁄4 and $v(q)$=2⁄4, the corresponding classes, containing two true propositions for four true or false ones, can have the form: p=(0,0,1,1), q=(0,0,1,1) or else p=(1,1,0,0), q=(0,0,1,1), or p=(0,0,1,1), q=(1,0,1,0). The logical sum p^q as a number of two-valued logical sums was formed by joining the first members of the first series with the first member of the second series, so in the first case p^q=(0^0, 0^0, 1^1, 1^1)=(0,0,1,1), the value of this sum will be 2⁄4[97]. Zawirski's results were presented at the Prague Conference in 1934 and at the First International Congress of Scientific Philosophy in Paris in 1935. During this Congress Hans Reichenbach, independently of Zawirski, spoke about the logic of probability. There are differences between Zawirski's and Reichenbach's conceptions of the calculus of probability and many-valued logic. Reinchenbach interpreted the probability calculus as a kind of generalized logic. At the same time, Zawirski underlined the importance of the notion of a parallelism between the formulae of the calculus of probability and Łukasiewicz's and Post's many-valued logic.

In 1938 Zawirski published *Doniosłość badań logicznych i semantycznych dla teorii fizyki współczesnej*[98]. In this paper, Zawirski analyzes the relationship between logic and science. The new developments in the field of deductive systems are of high importance for the understanding of the theories in science, but it is the new theories in physics, such as the theory

96 Zygmunt Zawirski, "Stosunek logiki wielowartościowej do rachunku prawdopodobieństwa," *Prace Komisji Filozoficznej Poznańskiego Towarzystwa Przyjaciół Nauk*, Vol. 4 (1934), pp. 155–240.

97 Zawirski, "Stosunek logiki wielowartościowej do rachunku prawdopodobieństwa," p. 4.

98 Zygmunt Zawirski, "Doniosłość badań logicznych i semantycznych dla teorii fizyki współczesnej," pp. 25–30.

of relativity and quantum mechanics, that contribute to the development of logico-semantical investigations. When Zawirski analyzed the status of physical theories, he concluded that they are based on both arithmetic and logic. Furthermore, the developments in many-valued and intuitionistic logic give rise to some important problems. In addition, the development of many-valued logic and intuitionistic logic leads to the emergence of certain problems relating to the legitimacy of applying the excluded measure rule or the existence of undecidable sentences in properly rich formal systems, which Kurt Gödel pointed out. [99].

3 Meta-philosophy

The scientific interests of Zawirski were also linked with more general problems of truth and being. The point of departure for his interests were the profound cognition of classical metaphysics and natural sciences within which more and more often the problems that previously had been reserved for philosophers only, were undertaken.

In the first decades of the 20th century, Zawirski witnessed an argument and a dispute concerned with the role of natural sciences in the development of general outlook on life. He noticed that both the metaphysicians and the opponents of metaphysics that took part in the said debate expressed a need to develop a scientific outlook on life. This fact made him ponder over a possibility to design metaphysics based on experience. He realized very quickly that metaphysics understood in this way would not be able to completely replace classical metaphysics perceived as *scientia entis*. It would not have been balanced only with the synthesis of natural sciences admitted by positivists. However, considering the mutual struggle of the most opposite reasoning movements, he undertook an attempt to develop a middle path leading toward the formation of the scientific metaphysics – both critical and open when using the results of the empirical experience. Zawirski presented his first ideas on the relations between metaphysics and science during a lecture given on May 5, 1917. His lecture, entitled *O stosunku*

99 Zawirski, "Doniosłość badań logicznych i semantycznych dla teorii fizyki współczesnej," pp. 26–27.

metafizyki do nauki, was presented at the meeting of the Philosophical Society in Lvov[100].

The issue concerning the relations between metaphysics and science on the one hand and possibilities of developing a general theory that would embrace the notion of reality dominated in Zawirski's research till 1923 when he published his post-doctoral thesis entitled *Metoda aksjomatyczna a przyrodoznawstwo*. The work was a summary of the research conducted earlier that focused on the possibility of axiomatization of metaphysical systems. Before 1923 Zawirski had also written two more works that discussed the said issues, entitled *O stosunki metafizyki do nauki* (1919)[101] and *Nauka i metafizyka* (1920). Both works remained in the manuscript form and only in the period between 1995 and 1996 *Nauka i metafizyka* was published in the periodical "*Filozofia Nauki*"[102]. Then, the second work *O stosunku metafizyki do nauki* waited for its publication till 2003.

3.1 Ontological structure of reality

Reflecting on an important ontological issue regarding the relationship between the sensual and extrasensory world, Zawirski developed the concept of three worlds. A sensual world that is given to us directly in the sensual experience and guarantees a permanent opportunity to experience sensory perceptions (we may call it the permanent possibility of sensation). This is a world that I would call – following Zawirski – a "mental world", the one that guarantees the permanent possibility of feelings. This world contains a permanent opportunity to experience and feel sentient beings;

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100 Zygmunt Zawirski, "O stosunku metafizyki do nauki," in: *O stosunku metafizyki do nauki. Próba wytyczenia nowych dróg filozofii teoretycznej*, ed. Michał Sepioło (Warszawa: Wydział Filozofii i Socjologii Uniwersytetu Warszawskiego, 2003), pp. 21–51.

101 Zawirski, "O stosunku metafizyki do nauki," in: *O stosunku metafizyki do nauki. Próba wytyczenia nowych dróg filozofii teoretycznej*, pp. 21–189.

102 Zygmunt Zawirski, "Nauka i metafizyka (I) [Science and Metaphysics]," *Filozofia Nauki*, Vol. 3, No. 3 (1995), pp. 104–135; and also: "Nauka i metafizyka (II) [Science and Metaphysics]." *Filozofia Nauki,* Vol. 4, No. 1 (1996), pp. 131–143.

this is the world of subjective experiences. In turn, the objective world is to some extent an imposed part of the subjective worlds.

Knowledge of the objective world is dealt with by the natural sciences, in this way providing more and more accurate messages about it, as well as more and more powerful tools for action to transform the world of sensory experiences and the real transformation of contemporary cultures. According to Zawirski, success in transforming our lives and providing powerful tools of action is primarily owed by the objective world to the fact that "theories and hypotheses submit to the constant control of experience; for each dispute, he (i.e. Zawirski) tries to detect any *experimentum crucis* that would tip the scales of victory in favor of one of the rival hypotheses; as soon as new facts become known, he improves his theories and in this way, thanks to the arduous work of tens and hundreds of minds, he constantly moves his work"[103].

It should be agreed with Zawirski that until today in natural science the issue of the essence of the objective world is still unresolved. Indeed, this unresolved issue continues to this day, some scholars point to the issue of mathematics of nature pointing to the objective nature of the world of mathematics (e.g. M. Heller, R. Penrose), others point to the objective existence of the field of rationality (e.g. J. Życiński), yet others strongly accept the original nature of God (Whitehead) or the so-called objective world 3 (K. Popper), etc.

Zawirski, however, approximates the understanding of the objective world he has selected to honor; in this way, for example, he draws the reader's attention onto the problem of apriority of the axioms of logic; he analyzes this issue by referring to the views presented by, among others, B. Russell and I. Kant. According to Russell, the axioms of logic exist independently of the human mind; they are endowed with an ideal, timeless and eternal being. In this case, we are dealing with a platonizing view, according to which Zawirski describes the objects of the objective world as *entia rationi*, which do not mean to reveal either potentiality or timeliness. Each transition from the potential to the current state occurs

103 Zawirski, "Nauka i metafizyka (I)," *Filozofia Nauki*, Vol. 3, No. 3 (1995), pp. 107–108.

only in the mind of the subject, as presented by Kant in the construction process.

Zawirski attempts to develop his own position, which would be somewhere between Russell's and Kant's. He speculates how the Platonic view of *entia rationis* can be reconciled with the idea of Kant, who conditions the apriority of knowledge with the forms of the mind. While reflecting on this issue, he believes that, for example, the Pythagorean Theorem did not change because it was formulated as a law, which means that the fact that the human mind knows the geometry's judgments does not affect the shape of these judgments. This, in turn, means that we do not establish the laws of geometry, but discover what occurs "in the womb of the All-Eternal" as an eternal opportunity. The world of eternal opportunity in the form of *entia rationis* is an infinite multitude of possibilities, of which only the selected ones are updated in the world of existence, described by Zawirski as *entia naturea*[104].

According to Zawirski, this *entia rationis* world is infinite and inexhaustible, and it is not limited by human thought. From this infinite field, human reason should, on the one hand, draw only as much as needed and necessary to understand this world of *entia nature*; but on the other hand, while being, for example, unable to predict what new areas of mathematics will be useful in understanding the world of existence, we should remove the nominalistic warning of Ockham – *entia non sunt multiplicand praeter necessitate* – which would then be the principle limiting scientific research. "We do not create the world of *enties*, but we recognize it and discover it as everything else; the newness is only its existence in our mind, and therefore its appearance in our mind in the forms of psychological existence, not as eternal timeless *entia*, in which the possibility is not different from the actuality in any way"[105].

Zawirski, while opposing the two worlds, labeled by him *entia rationis* and *entia naturae*, formulates his own definition of reality. In his opinion, reality, which is only one, can be described as something more than the world of existence, namely as the world of *entias* as well as the relations that take part between them. At the same time, however, the relationships

104 Zawirski, "O stosunku metafizyki do nauki," pp. 159–160.
105 Zawirski, "O stosunku metafizyki do nauki," p. 161.

in the world of enties are ideal, whereas these occurring in the world of existence are dynamic[106]. In the sense of these two worlds, it is also important that one cannot link truths about the world of *entia rationis* with the truths about *naturae*. There is only one truth, but the objects of this truth are many. The claim that is true about the object as *ens rationis* is not real about the object as *ens existens*. Not distinguishing *entia* from existence is the reason for, for example, accepting the ontological proof of God. One cannot, therefore, accept assertions that are right in the world of *entia*, to be absolutely true for the world of existence.

According to Zawirski, the existence of a cognizing subject causes a fuller understanding of the relationships occurring between the worlds of *entia rationis* and *entia naturae*, i.e. when the subjective psychic world is being formed. Then, it is the sense objects constructed by us that become the content of our consciousness. Zawirski, when speaking about objects, however, is aware of the ambiguity of this issue; this is because by agreeing in our statements about reality, we either show that we are dealing with something essentially one, or we succumb to the power of something that stands above us, some reality which is over-individual. This reality is presented as an absolute being, which is also *ens rationis*. This reality that we seek outside of nature, but also within us, is defined as the absolute reality by Zawirski. At the same time, by nature he understands events occurring in time in the world of existence, which are being related to the psychological order of time. In the world of existence, therefore, everything that takes place in time, enters into proper relations between each other, creating both certain interdependencies and order between empirical data, which is why these relations are dynamic in contrast to the ideal relations concerning the world of *entia*.

3.2 Relations between the theory of reality and metaphysics, and science

The relationship between metaphysics and science were presented by Zawirski in two areas, the relation of the theory of reality to particular sciences and the relation of the theory of reality to classical metaphysics.

106 Zawirski, "O stosunku metafizyki do nauki," p. 163.

Zawirski begins the analysis of the first area with the adoption of a strong assumption that there is an undeniable need to have a general theory of knowledge about reality, which cannot be squeezed down to the sum of the results of particular sciences. If such a situation did take place, the subject of the general theory of reality would not differ from the sum of subjects of particular sciences and one could not speak of the existence of a new science. Thus, all attempts to synthesize knowledge, when limited to storing the results of detailed science research do not deserve on the name of the new science. One cannot also accept a position proclaiming the impossibility of formulating such a new science about reality only on the basis of observation that the detailed sciences are still developing, what naturally makes it difficult to talk about permanent, unchangeable results of their research.

Zawirski, while making an attempt to avoid any misunderstandings that regard the possibility of building a general theory of reality, undertakes a variety of epistemological issues concerning psychology or the critique of cognition and focuses on the determination of such a part of general philosophy that does not only pursue the whole of knowledge, but also could be able to replace classical metaphysics. When talking about the whole of knowledge, one should not mean the never-to-be-achieved absolute whole of knowledge, but such a spectrum of the whole of knowledge that is actually achieved at a given stage of development. The search for such a striving to acquire the entirety of knowledge is also justified by the fact that absolutely isolated phenomena will nowhere be encountered; that is why, the division into particular sciences is largely an artificial procedure, justified by the necessity of division and the economics of research work. In conclusion, Zawirski states that the ratio of the theory of the whole of reality to particular sciences cannot be different than the ratio of one particular science to its individual sections[107].

The arguments supporting the need to build a general theory of reality remain in force. Taking into consideration the development of individual scientific disciplines, there is no doubt that specialists within a given science are not able to cover all its divisions evenly. Nevertheless, we cannot say

107 Zawirski, "O stosunku metafizyki do nauki," p. 26.

that specialists functioning within their sections do not observe the ways of functioning of other scholars in other sections. If this were the case, then in modern times (and nowadays) the progress of knowledge would not be what it is. In the scientific literature, we have many examples of how progress in one field revolutionizes, or modifies research in other fields, sometimes the ones that are far apart; for example, discoveries observed within the area of the science of electricity have changed the perception of optical and mechanical phenomena.

Zawirski also analyzes the relation that exists between his proposition of the general theory of reality and classical metaphysics. In his opinion, the theory of reality could be such metaphysics, only if it could do everything that was expected from classical metaphysics; i.e., if it could give a full answer to all questions of interest to humanity; the sense of existence of the world and man; the validity of the axiological order; the origin of evil; or the ultimate resolution of the mystery of being – why it is that there is a thing. However, as it happens, in vain would we be waiting for answers to these and similar questions from the science and theory of reality. This does not mean, however, that the theory of reality, which does not identify with classical metaphysics, is devoid of the *raison d'être*. In the era of modern natural science, the theory of reality can be a science coming out from the knowledge of the sensual world and striving to get to know the super-sensory world. In this theory, there is a fundamental difference between the science-derived meanings of the terms that relate to the world of phenomena, and those that we refer to the super-sensory world. According to Zawirski, the first concern and describe the patterns of possible experiences, whereas the second have the meaning of symbols created according to the analogy of something known to something completely unknown[108].

Zawirski notes that there are a number of misunderstandings between the positions of supporters and opponents of metaphysics. Opponents point to the alleged separation of metaphysics research methods and baseless conclusions from the metaphysics' acceptance of the principles of existence, or the formulation of the hypotheses that were not checked empirically. It should be noted that the opponents of metaphysics, while combating

108 Zawirski, "O stosunku metafizyki do nauki," p. 29.

the metaphysics conceived in this way, do not exclude hypotheses from science, accepting the fact that such hypotheses also often go beyond the sensual reality. Quite the contrary, such hypotheses are treated as a means to search for new facts.

Despite the different interpretation of the role and importance of hypothetical factors in cognitive processes, there can, however, be found a common ground for both opposite directions of thought. Both of them speak of a reality that is not invented arbitrarily, but that is studied and gained either on the direct or indirect path through a series of arguments. One should therefore, agree with Zawirski that opposing the extrasensory world with the sensory one remains a naive mindset which, following (and accepting) the philosophical divagations that result from the studies of Hume, Kant and Mill, remain unacceptable by many positivists.

Zawirski, pointing to the benefits of an inductive research method, based on experience, in the natural sciences, notices the process of gradual waking up in many minds of the belief in the possibility of basing metaphysics on scientific achievements and, in this way, building the so-called scientific view of the world; the view that appeals to experience and satisfies the results even if only they were thought of as probable ones. Such a construction of knowledge, in spite of the claims of positivism and neo-Kantianism of the late 19th century, was, among others, supported by Fechner, Hartmann, Lotze, Schopenhauer and Wundt. Their proposals for the construction of metaphysics based on experience, i.e. inductive metaphysics, accepting the existence of probabilities, the one that is led "from below", from experience, allow for gradual acquisition of general knowledge about reality. These proposals were also accompanied by the awareness that for metaphysical problems *experimentum crucis* is usually impossible, in contrast to – always admissible – a thought experiment. This experiment is also permissible when checking certain hypotheses in detailed sciences. On this basis, Zawirski confirms the correspondence between the particular sciences and metaphysics in areas that concern the subject and method of reality research[109].

109 Zawirski, "Nauka i metafizyka (I)," *Filozofia Nauki*, Vol. 3, No. 3 (1995), p. 110.

Seeing the above convergences between specific sciences and metaphysics prompted Zawirski to further research on this relationship. As Zawirski notes, the difference between inductive metaphysics and inductive sciences does not boil down to the criterion of generality, because the development of particular sciences in the 19th and 20th centuries showed that these sciences sometimes deal with very general issues that were previously classified as philosophical. Confirming Zawirski's thought, I have in mind the issue of time, space, matter, the issues of the continuity of macro- and micro-world processes, or the reversibility and irreversibility of certain processes. Such important and general issues studied in inductive sciences bring results that go far beyond the conclusions of classical metaphysics. It turns out that these issues do not disappear from science; but what changes is the way they are treated. What's more, agreeing with Zawirski, it should also be stated that philosophical issues are not only present in the study of particular sciences, but also often play an inspiring role in undertaking new research challenges. Still some general science is needed that would take into account the entire human experience; that is why despite the development of particular sciences, metaphysics, no matter how we specify it, be it "experimental", "scientific", "general", "synthetic" or "inductive", or other, has a legitimate right of existence to help develop general theories of reality.

Following Zawirski, scientific metaphysics that refers to experience uses the inductive method and feels satisfied with the results of probability. However, it is not strictly scientific because it does not use the theory of probability. At this point, it is difficult to agree with the scientific criterion accepted by Zawirski, reducing it to the applicability of the theory of probability, although, at the time, mostly due to the dominance of statistical studies in the mechanistic descriptions of many natural phenomena, the adoption of such a criterion was a kind of model of science. This fact is incomprehensible as, at the time, Zawirski knew the quantum theory and the theory of relativity; he was also convinced of the changing criteria in scientific research. Despite everything, he did not include that in the description of the general theory of reality sought by him.

According to Zawirski, the work concerning the development of a scientific pictures of reality should be developed according to the methods of specific sciences, maintaining such a relation to these sciences as to their respective sections. Such metaphysics should combine the results of these teachings in a system free of contradictions with the awareness that it is provisional and incomplete[110].

3.3 The problems of scientific metaphysics

While analyzing the relation of the general theory of reality to particular sciences and classical metaphysics, Zawirski added more detail to his theory, i.e. the theory of scientific metaphysics he kept elaborating for a number of years. Zawirski distinguished two areas of proper empirical sciencesand meta-empirical knowledge out of the field of metaphysical research, heading toward the general knowledge about the whole reality. The empirical sciences proper were for him the sciences not undertaking the main problems of classical metaphysics while meta-empirical knowledge was recognized as the science on of the principle of being. Assigning and giving priority to the empirical sciences proper in the research on the issues of reality, he did not discredit the need of going in for meta-empirical knowledge. He assumed that the notion of science observed in empirical sciences proper does not consist of a simple sum-up of the results from the detailed sciences and also is not their highest generalization. Its paragon is the transformation into the axiomatic and deductive system that ought to follow mathematics.

However, each system of axioms and statements that originates out of them ought to tolerate the possibility of many interpretations of their symbols. Then, many interpretations of the results are possible within empirical sciences proper, which occur in the process of meta-empirical knowledge. Although all the interpretations of science in meta-empirical knowledge that lead to various metaphysical systems possess the same learning value, Zawirski followed the idealistic concept criticizing the individual metaphysical system. The concept is worth attention and the most credible meta-empirical interpretation of the scientific results defined by the empirical sciences proper[111].

Both empirical sciences and meta-empirical knowledge were linked with the use of hypotheses which went beyond experience. These hypotheses in empirical sciences contributed to the development of science and served for

110 Zawirski, "Nauka i metafizyka (I)," p. 135.
111 Zawirski, "O stosunku metafizyki do nauki," p. 96.

simpler depiction of content in experience. These hypotheses in the meta-empirical knowledge are used in learning about objects and metaphysical problems linked with them, which do not belong to the experience such as the existence of the absolute and transcendent being, the issues connected with life after death or taking up decisions about the notions of learning about the world.

Zawirski notes that the development of scientific metaphysics, referring to experience, would solve numerous philosophical problems present in the natural sciences. He also noticed that scientific metaphysics, would never completely replace classical metaphysics. A possibility of numerous interpretations originates from the fact that universal science about reality is an instance of inductive theory. The authenticity of such a theory, or any other type of such a theory cannot be proved and its absolute reliability cannot be shown[112]. The symbols of induction theory allow for an unlimited number of their interpretations. However, none of these interpretations can be attributed to a greater or lesser probability. This means that inductive metaphysics should not refer to the calculation of raw similarities. It indicates that inductive metaphysics should not refer to the probability calculus. Taking it into consideration, Zawirski postulates in the studies on the universal theory of reality that the scientific face of empirical sciences should be linked with the results of detailed sciences into the system freed from contradictions and remain in such relation to these sciences in which detailed sciences remain in relation toward their particular areas and fields[113]. Empirical sciences, i.e. scientific (experiential) metaphysics, can in no way replace classical metaphysics. Statements formulated in empirical sciences have got the nature of temporary hypotheses and are constantly put to a test of arranging them into the previous experiences in the procedure of *experimentum crucis*. These hypotheses are important supplements of the scientific picture of the world in the empirical sciences, which is still not able to give us its complete picture. There are numerous and important issues for a human being, such as ethical postulates, outside the area of scientific metaphysics.

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112 Zawirski, "Nauka i metafizyka (I)," p. 113.
113 Zawirski, "Nauka i metafizyka (I)," p. 135.

In the definition of the universal opinion of reality within meta-empirical knowledge, Zawirski achieved an interesting differentiation between *entia rationis*, the world of ideal beings and *entia naturae,* the world of existence. *Entia rationis* exists independently of the learning subject. The world of these beings includes, among others, mathematical objects and the content of mathematical natural history. *Entia rationis* is not designed, but learned and discovered as everything else. Any novelty constitutes only their life in our mind as mental existences and as the defined content of our consciousness, but not as eternal existences beyond time. This world also includes figments of our thoughts; it embraces, among others, metaphysical systems as well as all sorts of logical mistakes having the ideal being and both true and false theories[114]. However, if these systems or mistakes exist only in our thoughts, they truly belong to the world of mental existence.

The world of senses is also an example of mental construction. Speaking about mental subjects, and/or producing similar statements about reality are possible because there is absolute being, above individual one that, following Zawirski's opinion, belongs both to the world of everlasting beings and to the world of existence.

The world of *entia rationis* is infinite and inexhaustible, beyond time and endless, unlimited by human thoughts. Human mind should, in Zawirski's opinion, following Ockham's principle, obtain out of this unlimited world of eternal beings only as much as it is necessary and indispensable to understand the world of existence[115]. Moreover, it is forbidden to make a mistake and come down to a blind transfer of relations linked with *entia rationis* into the relations linked with *entia naturae*. The relations among *entia rationis* are ideal, while the relations among various forms of existence are dynamic. Considering an argument that the world of eternal beings incorporates the world of various forms of existence, indicates that all possible relations belong to *entia rationis*. The difference between the one and another relation is that *entia naturae* relations refer to psychological and temporal orders, what cannot be stated about the relations occurring between eternal beings. Then the relations, which can be implemented in

114 Zawirski, "O stosunku metafizyki do nauki," p. 164.
115 Zawirski, "O stosunku metafizyki do nauki," pp. 159–164.

the sense picture of the world, define interdependence and temporal order among the empirical data.

Once again Zawirski referred to the problems presented in the post-doctoral thesis in 1936 during the session of the 3rd Polish Philosophical Convention when he presented the paper entitled *W sprawie syntezy naukowej*[116]. In this presentation he introduced different argumentation in the defence of scientific metaphysics than the one presented in the work entitled *Metoda aksjomatyczna a przyrodoznawstwo*. Following Gödel's statements on the incomplete systems, he argued that we should not refuse the sense of existence of metaphysical issues only because they are not subjected to empirical testing. He also pointed to the tasks of philosophy, stating that it should not undertake the issues for which it is not possible to find methods of their solution.

116 Zygmunt Zawirski, "W sprawie syntezy naukowej," *Droga*, Vol. 15, No. 12 (1937), pp. 974–996.

Part Two: Critical remarks and comments on the concept of the scientific metaphysics of Zygmunt Zawirski

We are now going through the critical analysis of the philosophical results of Zygmunt Zawirski's research. In the introduction to this work, I presented a discussion on the legitimacy of developing metaphysical issues, which were undertaken by native philosophers of the turn of the 19th and 20th centuries. This presentation is a kind of justification for the rationale for discussing two approximations of scientific metaphysics, showing the timelines of philosophical research problems undertaken by Zawirski and Bornstein in the context of the turbulent development of formal and natural sciences.

Critical analysis of Zawirski's philosophical achievements will be carried out by comparing the results of his research with other proposed results concerning the areas of research we are interested in at the time. In the analyses, I will pay special attention to the research of Polish philosophers of the first half of the 20th century.

1 On problem-rising axiomatization of mathematical natural science

Referring to the work *Metoda aksjomatyczna a przyrodoznawstwo*, it should be noted that among many analyses carried out by Zawirski, attention should be paid to the strong desire to indicate all the philosophical consequences resulting from the axiomatization of mathematical natural science. In the whole work, Zawirski is looking for basic principles for this kind of natural science, while critically referring to the solutions proposed, among others, by Kant. According to Zawirski, in mathematical natural sciences, one cannot rely on the principles perceived by the mind as necessary and common, to search for what Kant accepts as obvious and intuitively certain. In the era of the progress of particular sciences, the philosopher must be able to rely on the actual achievements of his natural science. In this respect, Zawirski aptly evaluates Kant's philosophical research. He notes that Kant, in search for the principles of natural science, has referred to the philosophical consequences of Newtonian mechanics: the absoluteness of time and Euclideanism of space, and not the actual empirical content of this theory. Zawirski proposes to look at the Kantian philosophy in the context of the theory of relativity in the similar way as Kant noticed the value of Hume's philosophy: "[…] if Kant said once, that Hume's philosophy has woken him up from his dogmatic nap, the theory of relativity should wake up some philosophers to stop dreaming about Kantian system, as well as to distract them from blind trust in the *a priori* truths […]"[117].

As Zawirski points out, the axiomatization of mathematical natural science does not make references to any of Kantian assumptions. Based on these assumptions, one can consider Zawirski's statement as consistent both with empiricism – since it makes references to experience – and apriorism, as it lacks any justification. Zawirski only ensures his readers that he makes references to mathematical axioms, but he neither formulates it anywhere, nor demonstrates the source of its origin. In his work, one can find only the observations that such axioms exist and that he "takes them into consideration". Nevertheless there are questions that still need to be answered: where do these axioms come from and what is their content? Zawirski does not answer these questions. In his work *Metoda aksjomatyczna a przyrodoznawstwo* one can only find statements that: "The axiomatisation of natural science is possible thanks to the fact that we attribute the compatible verbal or mathematical symbols to certain characteristics of the phenomena, which repeat themselves continually, aiming to achieve the complete unambiguousness through the smallest amount of these symbols"[118]. However, we cannot find there any formulation, discussion or identification of the source of origin of given axioms. What one can only find there are his claims that the fundamental axioms of the mathematical natural science are not obvious, and, moreover, they are very often inconsistent with or even contradictory to the intuitive obviousness[119].

117 Zygmunt Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," *Kwartalnik Filozoficzny*, Vol. 2, No. 1 (1923/1924), p. 44.
118 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," p. 55.
119 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," p. 26.

According to Zawirski, philosophers not only omitted this possibility, but even eliminated it. Therefore, Zawirski discusses extensively the argumentation that philosophical research should not only seek intuitively obvious assumptions.

Zawirski notices that while performing the research on the fundamentals of science and philosophy what one should do is to move away from their mind any assumptions that seem to be obvious and certain, as they were already taken into consideration in initial stage of the development of science. The progress in formal and natural sciences underlines unambiguously the fact of exceeding the intuitive obviousness in research. In order to make this question clearer, he formulates the postulate to gradually modify the principles, which in fact means that what matters is only the transmission of things which manifested themselves during the development of contemporary physics to the epistemology[120]. He claims that the significance of the fundamental concepts and principles of natural science, intuitively adopted in the past, should be rejected; otherwise, if we adopt them to describe our experience, we would not understand or interpret the mathematical axioms of the contemporary physics.

The formulation of the collection of axioms for given natural sciences and, even more, for scientific metaphysics is not an easy task to perform. On the ground of Polish philosophy such an endeavour was undertaken by Henryk Mehlberg, who strove to formalize the language of empirical science. Therefore, he suggested to translate a specific passage of the language of empirical science into a reistic language, namely such a structural language J_r, which would contain, apart from given logical constants, the individual names of material things and a certain number of constant name-forming functors. Reproducing in a structural language the division of sentences of the colloquial language into the ones that are directly finistically, inductively and probabilistically verifiable and unverifiable, Mehlberg introduced four kinds of constant name-forming functors: *P*, *Q*, *R* and *S*[121].

Without going into greater details regarding given kind of functors, which were described in two articles *Science et Positivisme*, published in

120 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," p. 45.
121 Henryk Mehlberg, "O niesprawdzalnych założeniach nauki," *Przegląd Filozoficzny*, Vol. 44 (1948), pp. 319–335; and pp. 327 –330

"Studia Philosophica"[122], one should notice the results of the operation of formalizing language of empirical sciences undertaken by the philosopher. Mehlberg did the analysis of the verifiable and unverifiable sentences construed of the four functors, which showed that the lack of unverifiable functors in the sentences of language J_r does not constitute either the sufficient or necessary condition for the verifiability of given sentences. It means that such a situation still remains independent from the specific structure of the language, which was used to characterize unverifiable sentences in J_r and, when translating the colloquial language into this language, it manifests the role of unverifiable sentences in the colloquial language. The results of the analyses are significant when it comes to the understanding of the postulate of verifiability of the theorems, underlined by the adherents of the neo-positivistic concepts of science, who bound the realization of this postulate with the construction of given language, in which it would not be possible to formulate any unverifiable sentence of the language of the empirical sciences. Rudolf Carnap in his works, i.e.: *Logische Syntax der Sprache*[123] as well as *Testability and Meaning*[124] did the research on the construction of verifiable language. The formalized language of empirical sciences presented by Carnap, corresponds to the part of language J_r described by Mehlberg, which does not contain functors of the group *R* and *S*.

The other important result of Mehlberg's analyses is the fact that the language possessing only the functors that are verifiable does not guarantee that the empirical science theorems formulated in this language are verifiable[125]. Moreover, the language that lacks unverifiable sentences would be too poor to formulate empirical theories, based on unverifiable assumptions, which play a vital role in contemporary science. Consequently, eliminating the metaphysical elements out of science during a process of implementation of the postulate of verifiability does not immediately remove the

122 Henryk Mehlberg, "Science et Positivisme," *Studia Philosophica*, Vol. 3 (1948), pp. 211–293.

123 Rudolf Carnap, *Logische Syntax der Sprache*, (Vien, Springer: 1934).

124 Rudolf Carnap, "Testability and Meaning," *Philosophy of Science*, Vol. 3 (1936).

125 The sentences which are construed of verifiable functors can be unverifiable, but also the functors, which contain unverifiable sentences can turn out to be verifiable, which was noticed by Prof. J. Słupecki.

unverified sentences out of the properly construed language of the science. Eliminating the metaphysical theses from science is merely possible thanks to the research on logical structures of the specific scientific theories that is a research which is related to the identification of the role of verifiable and unverifiable sentences in these theories. Mehlberg's analyses of the foundations of the nature of mathematical studies should be treated as the appropriate research on the logical structure regarding the present scientific theories[126].

When one expects a theory to be empirically verifiable, they encounter a possibility suggesting that the set of verifiable sentences, taken to constitute a given theory, may stem from a non-contradictory and finite subset of verifiable sentences, which belongs to this theory as well. Such a theory consists of a verifiable axiomatic basis and can be called a theory with an internal basis. When the theory does not have a verifiable axiomatic basis, which means that this theory can be formulated only with the help of unverifiable sentences, which can be used to derive all the verifiable consequences of this theory, then such theory should be called a verifiable theory with an external basis[127].

An example of such an empirical theory of an external base is Euclidean geometry, which is to be understood in a physical sense. In geometry, understood as empirical science, not all synthetic theorems are empirically verifiable. For example, the volume of a real solid remains a testable synthetic one. In turn, synthetic theorems are unprovable regarding the position of points on the straight line, because there is no such directly verifiable sentence by which it would be possible to justify or disprove the theorem that there is always a third point between the two points on the straight line. It should be remembered that every definition attached to the axioms of geometry, in order to give it the character of an empirical science, does not entitle us to treat the analyzed spatial compositions in an ideal manner. The straight line is not the same as the ray of light, which always remains a three-dimensional electromagnetic disorder in the physical space. Thus, the position of points on the straight line cannot be

126 Mehlberg, "O niesprawdzalnych założeniach nauki," pp. 330–331.
127 Mehlberg, "O niesprawdzalnych założeniach nauki," p. 332.

either confirmed or refuted. There is no doubt, however, that the axioms of geometry, supplemented by appropriate definitions, result in theorems, some of which remain empirically verifiable, and the whole theory becomes physical geometry.

According to Mehlberg, the role of unverifiable axioms in empirical geometry is typical for the whole mathematical nature studies. In this kind of natural science, one uses, for example, idealized notions of function: electric point charge, ideal gases or rigid bodies, which can be used to formulate unverifiable sentences, namely external basis of the individual empirical theories. Each of these bases contains verifiable consequences, which constitute the core of the given empirical theory[128].

The occurrence of unverified assumptions in empirical science is a fact; therefore the removal of unverified assumptions proposed by neo-positivists as devoid of meaningfulness by constructing such a language in which untoward sentences cannot be constructed is for Mehlberg a non-objective operation for at least two reasons. The first reason is that in properly constructed languages, neo-positivists would not be able to formulate theories about the external base, and yet such theories played and play a significant role in the development of science. The second reason is that neither mathematicians nor physicists, when using geometry based on unproven assumptions automatically become metaphysicists[129].

Physicists limit themselves to recognizing only empirically verifiable results that stem from given assumptions, but they do not assess them. Empirically unverifiable sentences in science have only an auxiliary role, which is simultaneously essential to verifiable scientific theories, not violating Mehlberg's postulate of verifiability[130].

Methodological studies of empirical theories by Mehlberg strengthen the natural science analysis of Zawirski. In modern scientific theories, we point not only to intuitively unobvious assumptions, but also assumptions that, without being verifiable, play a fundamental role in these theories, designating their so-called external database.

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128 Mehlberg, "O niesprawdzalnych założeniach nauki," pp. 333–334.
129 Mehlberg, "O niesprawdzalnych założeniach nauki," p. 334.
130 Mehlberg, "O niesprawdzalnych założeniach nauki," p. 335.

Returning, however, to the main question of the possible axiomatization of mathematical and scientific metaphysics, let us also pay attention to the attempts of the Polish philosophers to use the axiomatic method to systematize certain specific metaphysical issues undertaken in the 1930s. These studies also provide arguments regarding the possible building of metaphysics using the axiomatic method. Such research-based arguments, regarding the construction of metaphysics with the use of axiomatic method were offered by i.e. Jan Salamucha[131], Jan Franciszek Drewnowski[132] and Józef Maria Bocheński[133]. They were convinced that introducing this method into metaphysics could make it a deductive science based on mathematical logic. Such metaphysics could become a branch of logic, containing conditional claims that can be obtained from theorems of logic by substituting in them for variables of metaphysical terms. Metaphysics could also become a separate science with its own primary dates and axioms. Any introduction of a new date would be based on a definition that goes back to the original terms, and any new claim, when accepted, would be justified on the basis of accepted axioms.

The above-mentioned philosophers, using the method of axiomatization to study or construct a specific deductive system, draw attention to the difficulty of formulating a complete set of axioms sufficient for all scientific deduction. For example, Jan Salamucha, when studying the concept of deduction in Aristotle and St. Thomas states that these philosophers,

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131 Jan Salamucha, "Dowód ex motu na istnienie Boga. Analiza logiczna argumentacji św. Tomasza z Akwinu," in: Jan Salamucha, *Wiedza i wiara. Wybrane pisma filozoficzne*, ed. Jacek Juliusz Jadacki and Kordula Świętorzecka (Lublin: Towarzystwo Naukowe KUL, 1997), pp. 333–364. First printing: *Collectanea Theologica*, Vol. 15, No. 54 (1934), pp. 53–92.

132 Jan Franciszek Drewnowski, "Zarys programu filozoficznego," *Przegląd Filozoficzny*, Vol. 37 (1934); and idem, "O potrzebie ścisłości," *Verbum*, Vol. 3, No. 3 (1936), pp. 455–472.

133 Jan Maria Bocheński, "Zagadnienie przyczynowości u Neoscholastyków," *Przegląd Filozoficzny*, Vol. 38 (1935); and: Jan Maria Bocheński, "Tradycja myśli katolickiej a ścisłość," *Myśl katolicka wobec logiki współczesnej*, *Studia Gneznensia*, Vol. 15 (1937); and: Jan. M. Bocheński, "O metodzie teologii w świetle logiki współczesnej," *Collectanea Theologica* Vol. 21 (1949), pp. 181–189.

although they did not present all the assumed theories that they regarded as axioms, still left some explanations on the basis of which we can see what character these basic principles, which we now call axioms, have.[134]. The classic metaphysical concepts do not easily succumb to the modern rigors of the exactness of the deductive system. In my opinion, however, we should not give up trying to refine and systematize the earlier results of human thought. The fact that these concepts using mathematical logic disintegrate, as Jan Łukasiewicz sees it, like "houses of cards" does not mean that they are devoid of cognitive values.

Zawirski struggles with the same difficulty when trying to axiomatize mathematical natural science. However, he was unable to formulate a set of axioms of this natural science, but he focused upon a discussion of their character and the role they should fulfil in a given theory treated as a deductive system. To this day, from what it is known, only a few researchers have managed to formulate a complete set of axioms of specific scientific theories. I am referring here to the results obtained by R. Montague in the traditional (i.e. in formal language) axiomatization of classical mechanics and the many axiomatizations made in a structuralist approach (so-called axiomatization by the definition of a theoretical predicate, made in an informal language), e.g. classical particle mechanics (Suppes, Sugar, McKinsey, 1953[135]) of classic rigid body mechanics (Adams, 1959[136]), classical equilibrium thermodynamics (Garrido, 1986[137]). However, the proposal to build the axiomatization of mathematical natural science should be treated as an open problem for scientific research.

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134 Jan Salamucha, "Pojęcie dedukcji u Arystotelesa i św. Tomasza," in: Jan Salamucha, *Wiedza i wiara. Wybrane pisma filozoficzne*, ed. Jacek Juliusz Jadacki and Kordula Świętorzecka (Lublin: Towarzystwo Naukowe KUL, 1997), p. 277.

135 John Charles McKinsey, A.C. Sugar, Patrick Suppes, "Axiomatic Foundations of Classical Particle Mechanics." *Journal of Rational Mechanics and Analisis,* Vol. 2, 1953, pp. 253-272.

136 Ernst W. Adams, "The Foundations of Rigid Body Mechanics and the Derivation of its Laws from Those of Particle Mechanics," in: *The Axiomatic Method*, Henkin, Suppes, Tarski (ed.), North-Holland, Amsterdam: 1959, pp. 250–265.

137 Julian Garrido Garrido, "Axiomatic Basis of Equilibrium Classical Thermodynamics," *Erkenntnis*, Vol. 25, 1986, pp. 239-263.

Moreover, Zawirski was the first philosopher who tried to use the axiomatic method in physics, and his work, *Metoda aksjomatyczna a przyrodoznawstwo* was widely discussed. On October 24, 1924, the Institute of Philosophy in Warsaw organized a public discussion on the axiomatization of physics, with active participation of, among others, Cz. Białobrzeski, B. Bornstein, B. Gawecki, S. Kobyłecki, T. Kotarbiński and J. Łukasiewicz. Not everyone agreed with the suggestion to use the deductive system to develop physical theories. The principles of the construction of the deductive system in the phase of axiomatization seemed to be too rigorous and incompatible with physics, i.e. an empirical science. B. Gawecki claimed that such formal proceeding would make the given phenomena subject to general principles, whilst physics, being an empirical science, should not depend on formal principles[138].

To evaluate Zawirski's words about the importance of the research on the use of formal science methods in theories of physics and scientific metaphysics, one should compare his studies with works of some other outstanding researchers. For instance, the topics concerning the axiomatization of physical theories were often analyzed by, among others, M. Heller[139], F.S.C. Northrop[140], K.R. Popper[141], P. Suppes[142], M. Przełęcki[143] and R. Wójcicki[144]. It should be mentioned that M. Przełęcki claimed that, when looking at it from the perspective of logical research, every scientific theory can be perceived as a methodological structure. Moreover,

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138 Bolesław Gawecki, in: *Biuletyn Posiedzeń Naukowych Warszawskiego Instytutu Filozoficznego* (Warszawa: 1924–1925), pp. 24–26.

139 Michał Heller, "Kryterium falsyfikacji a ogólna teoria względności," *Studia Philosophiae Christianae*, Vol. 6, No. 1 (1970), pp. 41–67.

140 Filmer Stuart Cuckow Northrop, *The Logic of the Sciences and the Humanities* (New York: Macmillan Co., 1960), pp. 61–63, 135.

141 Karl Raimund Popper, *The Logic of Scientific Discavery* (London: Hutchinson Publishing Group Ltd., 1959), pp. 42–75.

142 Patrick Suppes, "Axioms for Relativistic Kinematics with or without Parity," in: *Studies in the Methodology and Foundations of Science* (Dordrecht: 1969), pp. 194–196.

143 Marian Przełęcki, "Teorie empiryczne w ujęciu logiki współczesnej," in: Marian Przełęcki, *Fragmenty filozoficzne* (Warszawa: PWN, 1967), pp. 75–101.

144 Ryszard Wójcicki, *Metodologia formalna nauk empirycznych* (Wrocław-Warszawa-Kraków: Zakład Narodowy im. Ossolińskich, 1974), pp. 41–47.

the approach of the empirical theory in the form of a formalized axiomatic system is not its faithful representation, but a logical reconstruction. Such proceedings are acceptable because not only these reconstructions, but also structural analyses of particular issues, do not lead to erroneous consequences. According to Przełęcki, very often in the study of empirical theories in a formalized form a mistake of identifying the relation of logical relation with the relation of justification is made; therefore, it is impossible to ascribe logical assumptions from axioms that are to justify other empirical assertions[145].

Modern philosophy of science increasingly talks about the axiomatization or formalization of empirical scientific theories[146]. Such a reconstruction consists in a modification of the theory where each element of it is unambiguously defined conceptually. In this way, the conceptual apparatus of a given theory is developed. In addition, the reconstruction clearly defines a set of sentences that are to be recognized as rules in a given theory and determines the evidence used on the basis of a given theory.

The reconstruction of issues of physics can be found in the M. Heller's work *Fizyka ruchu i czasoprzestrzeni*[147]. Considering the formalization of movement, time and space from Aristotle to the end of the 19th century, presented in the work of Heller, it should be admitted that the problems and theories of physics are subject to development and their axiomatization is progressing with them. Thus, the construction of deductive systems of empirical science proposed by Zawirski remains valid today. However, at the same time, it is difficult to agree with the statement that the axiomatization (formalization) of all physics will be possible, and thus, it will be possible to formalize all mathematical natural science.

2 Justification in natural sciences and metaphysics

The starting point in the methodological discussions conducted by Polish philosophers of the first half of the 20th century is the strict, definition-like description of the terms used for analyses and the definition of the forms

145 Przełęcki, "Teorie empiryczne w ujęciu logiki współczesnej," pp. 76–84.
146 Wójcicki, *Metodologia formalna nauk empirycznych*, pp. 19–67.
147 Michał Heller, *Fizyka ruchu i czasoprzestrzeni* (Warszawa: PWN, 1993).

of refinement of the applied research procedures. It was assumed that it was only then that one could responsibly undertake attempts to critically refer to other methodological positions, (thus showing their value), but also to pay attention to inaccuracies present in the forms of reasoning that were carried out. Each precisely formulated definition of the terminology of a given field contributes to the development of specific research, at the same time making it impossible to conduct unclear, often sterile, philosophical disputes. This situation expresses a tendency present among Polish philosophers to practice scientific philosophy based on strong, solid culture of logical thinking, as exemplified by methodological analyses of Dina Sztejnbarg, Maria Kokoszyńska, Henryk Mehlberg and Jan Łukasiewicz, that concerned the problems of explaining various phenomena and natural laws, as well as inevitability of the occurrence of metaphysical theses in science

It is worth noting that many empirical critics and positivists, when expressing opposition to the possibility of using metaphysical theses in the natural sciences formulate arguments that are meant to prove that metaphysical theses are unprovable, unprofitable, accidental, arbitrary and are not an economic way of presenting facts; therefore, they do not contribute to the development of science. Such an opinion was presented by Józefa Kodisowa who, from the position of an empirical critic, proposed a program of scientific philosophy based on the theory of cognition. Władysław Heinrich was also of a similar opinion. Kodisowa sought to establish a form of experience that was to be "pure", deprived of individual and accidental admixtures, free from contamination with metaphysical "views on the world"[148]. Zawirski, as well as the other Polish methodologists, did not agree with this statement. While analyzing each of the abovementioned arguments, they were able to demonstrate that the claims suggesting omitting metaphysical hypotheses in natural sciences were unjustified[149]. For instance, Dina Sztejnbarg in her analyses discussed the

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148 Józefa Kodisowa, "Metafizyka w nauce," *Przegląd Filozoficzny*, Vol. 16 (1913), pp. 433–442.

149 Dina Sztejnbarg, "Zagadnienie wyjaśniania zjawisk i praw przyrodniczych w nowej literaturze metodologicznej," *Kwartalnik Filozoficzny*, Vol. 7, No. 1 (1929), pp. 73–92.

statements of positivists and critics of empiricism, with reference to works by E. Meyerson[150], S. Jevons[151], E. Navill[152] and H. Poincaré[153].

The results of analyses regarding the noxiousness of metaphysical hypotheses for the development of science, presented by Sztejnbarg, are undoubtedly a reinforcement for empiricism developed by Zawirski, but also for meta-empiricism. In her opinion, a metaphysical thesis is not a factor delaying the development of science. The role of metaphysical hypotheses lies in translating and predicting facts. Only the uncritical use of metaphysical hypotheses is dangerous, but if experience confirms or refutes the consequences of the adopted hypotheses, then each time our knowledge about reality increases and this is a predicative value. Science tends not only to explain the greatest number of laws and facts, but also strives to discover new laws and anticipate new facts[154].

Zawirski explains in an insufficient way the legitimacy of accepting this kind of general, as he calls, synthetic philosophy[155]. In 1948, he returns

150 Dina Sztejnbarg refers also to arguments that can be found in: Emil Meyerson, *Identité et réalité* (Paris: F. Alcan, 1908), p. 439. More generally on the assumptions of Meyerson's epistemology see: Izydora Dąmbska, "Emil Meyerson. Główne założenia jego epistemologji," *Przegląd Filozoficzny*, Vol. 37(1934).

151 Stanley Jevons, *The Principle of Science* (London – New York: Macmillan, 1877).

152 Ernest Neville, *La logique de l'hipothese* (Paris: Librairie Germer Bailliere, 1880).

153 Henri Poincaré, *Nauka i hipoteza*, tłum. Maksymilian Henryk Horowitz (Warszawa: Jakob Mortkowicz Press, 1908).

154 Dina Sztejnbarg writes also on the criteria and characteristics of nature laws, with reference to a wide range of methodological literature in: Dina Sztejnbarg, "Zagadnienie indeterminizmu na terenie fizyki współczesnej," *Przegląd Filozoficzny*, Vol. 35 (1932), pp. 34–69. The critical analysis of the notion of the nature law in Mill can be found in: Dina Sztejnbarg, "Pojęcie prawa przyrodniczego u J. St. Milla," *Przegląd Filozoficzny*, Vol. 34 (1931), p. 17–38. Apart from abovementioned works, these topics are interestingly described in works by Izydora Dąmbska and Joachim Metallmann: Izydora Dąmbska, *O prawach w nauce* (Lwów: Wyd. Gubrynowicz i Syn, 1933); Joachim Metallmann, *Determinizm nauk przyrodniczych* (Kraków: Nakładem Polskiej Akademii Umiejętności, 1934).

155 Zygmunt Zawirski, *O stosunku metafizyki do nauki*, ed. Michał Sepioło (Warszawa: Wydział Filozofii i Socjologii Uniwersytetu Warszawskiego, 2003), p. 31.

to these issues in his work *Uwagi o metodzie nauk przyrodniczych*. It is only in this work where one can find the arguments that justify the forms of empirical knowledge that Zawirski presented in his previous works. It can be stated that in the first decades of the 20th century, Zawirski did not yet have methodological arguments referring to mathematical logic in the full elaboration of scientific metaphysics. For its justification, he referred only to the views of earlier philosophers, including Leibniz, Hume, Kant, Schopenhauer and Mill.

We have to note that in the 1930s a breakthrough in the methodological studies of Zawirski was made, which can be concluded while studying his work *W sprawie syntezy naukowej*. The interest in this study area was due to the comments made in the native environment by Popper's *Logik der Forschung* from 1934. This work came across a well-prepared ground for methodological research, a good example of which are the methodological analyses of science development elaborated in 1929 by Sztejnbarg. I think that in the work of Sztejnbarg we are getting acquainted with the strong enough arguments that Zawirski could have invoked in the study of empirical sciences, but he did not. It turned out that he preferred to verify and/or refute the issues related to the oncoming hypotheses and scientific theories, which he gave a more developed character than Popper originally had proposed, which was a topic of discussion in the first part of our manuscript.

I think that it is would be useful to have a look at a few examples of the works of Polish methodologists, so as to show their value on the one hand, and to indicate their importance for the solid construction of scientific metaphysics consistent with Zawirski's proposal. These works provide solid arguments for the presence of metaphysical theses in detailed sciences.

Dina Sztejberg, in her works, *Zagadnienie wyjaśniania zjawisk i praw przyrodniczych w nowej literaturze metodologicznej* (1929), *Pojęcie prawa przyrodniczego u J. ST. Milla*[156] (1931) and *Zagadnienie indeterminizmu na terenie fizyki współczesnej*[157] (1932), not only critically comments on some selected theses presented by both positivists' and critics' of empiricism, but also formulates arguments that justify the presence as well as

156 Sztejnbarg, "Pojęcie prawa przyrodniczego u J. ST. Milla," pp. 17–38.
157 Sztejnbarg, "Zagadnienie indeterminizmu na terenie fizyki współczesnej," pp. 34–69.

the importance of metaphysical theses in natural science. She also draws attention to the usefulness of his arguments in predicting new phenomena, if we anticipate this by: *X* predicted the phenomenon of *Z* on the basis of the natural thesis *T*, if and only if *X* stated that from the thesis *T* results (inferentially within the system of natural sciences) a natural thesis, of which *Z* is a special case[158].

According to Sztejnbarg, the metaphysical hypotheses are constructed in such a way that they have the highest degree of probability and in this respect do not differ from non-metaphysical hypotheses used in science. Sztejnbarg disagrees with the positivists proclaiming the unpredictability of metaphysical theses by justifying or disproving them in the experimental way. According to Sztejnbarg, it is necessary to notice the dependence of the degree of justification of explanatory theses on their value of explaining facts or natural laws. The dependence of the degree of justification on the value of explaining a given hypothesis does not depend on whether it is a metaphysical or natural thesis. Sztejnbarg justifies this statement referring to Bayes's theorem on the probability of hypotheses due to their consequences[159].

The positivist postulate of disregarding metaphysical thesis to explain facts or natural laws, only due to the lack of full justification of these theses is, in Sztejnbarg's opinion, insufficiently justified and is inconsistent with the development of natural sciences, in which metaphysical thesis often play a key role and contribute to their unquestionable progress in getting to know nature. In the development of knowledge on nature, the hypotheses cannot be justified at the very beginning; it is only after some time when they can be justified through experience as well as with the use of inductive method[160].

Another methodological problem is the inevitable penetration of metaphysical issues into scientific research. According to Maria Kokoszyńska,

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158 D. Sztejnbarg, "Zagadnienie wyjaśniania zjawisk i praw przyrodniczych w nowej literaturze metodologicznej," pp. 85–86.

159 Charlie Dunbar Broad, "On the Relation between Induction and Probability," *Mind*, Vol. 27 (1918), p. 401; and Adam Grobler, *Metodologia nauki* (Kraków: Wyd. Aureus – Znak, 2006), pp. 46–51.

160 Sztejnbarg, "Zagadnienie wyjaśniania zjawisk i praw przyrodniczych w nowej literaturze metodologicznej," p. 92.

this can be done in two different ways. One of them is the adoption of certain methods of recognition of theorems in science, which leads to a specific way of acquiring scientific beliefs. The second possibility of penetrating metaphysics to science is the presence of certain types of terms and theorems, which in turn affects the use of a specific language of science[161].

When reaching the scientific conclusions, Kokoszyńska distinguishes two methods: a method of an *a priori* evidence and an empirical method. Using the first method, one derives theorems from adopted axioms. When it comes to the empirical method, Kokoszyńska formulates the definition of a sentence which is empirically verifiable:

> „the sentence *S* is acknowledged on the basis of the empirical method, if there exists a finite sequence of classes C_1, C_2, ..., C_n, which consists of sentences that meet the following conditions:
>
> 1) *S* is adopted due to non-contradictory sentences of the class C_1, from which it results or due to the sentences of the class which stem from it;
> 2) every sentence of the class C_i (i = 1, 2, ..., n-1) remains in such a relation to the next class C_{i+1}; and
> 3) every sentence of the class C_n remains in this relation to the class C, that is to the already adopted perceptive sentences[162].

One can assign a specific degree of credibility to every verifiable sentence due to a given assumption, which is based on the probability theory or inductive logic[163].

In addition to these two methods of reaching scientific beliefs, Kokoszyńska mentions a dogmatic method that introduces metaphysical elements to scientific knowledge. The dogmatist acts, on the one hand, as if the sentence he considers was in the opinion of a given language, which should be recognized by the rules of being, and this is not the case. On the other hand, the same sentence gives the character of a sentence that concerns reality. Otherwise, such a sentence would only be a linguistic

161 Maria Kokoszyńska, "W sprawie walki z metafizyką", *Przegląd Filozoficzny*, Vol. 41 (1938), pp. 9–13. The translation of the paper titled *On the Fight against Metaphysics*, was read at the International Philosophy Congress, which took place in Paris in 1937.

162 Kokoszyńska, "W sprawie walki z metafizyką," p. 14.

163 Kokoszyńska, "W sprawie walki z metafizyką," s. 14.

convention. Where only the language rules are decisive about the truth or falseness of sentences, the same logical value of these sentences is accepted based on the meanings of language expressions taken into consideration[164]. The close relationship that exists between the meaning of expressions and language rules, which in turn determine the way of using these expressions, was noted by Kazimierz Ajdukiewicz[165]. In the case of assigning a greater or lesser degree of credibility to a sentence than – because of the premises – the logic of induction is entitled to, we also have to use the dogmatic method to reach our beliefs. This means that in cases where metaphysical elements appear, in addition to the methods of acknowledging theorems, i.e. the method of *a priori* proof and the empirical method, dogmatic methods are introduced, which are often understood as unscientific ways of reaching convictions, or as irrational and unlawful methods of recognizing certain theorems[166].

If, through metaphysics, we understand a set of sentences consisting exclusively of synthetic sentences with a non-empirical content, introduced by dogmatic means, metaphysics understood in this way is rightly rejected by the supporters of the Vienna Circle. In the face of such metaphysics, they take a negative attitude, claiming that the sentences of metaphysics are meaningless, or that they are not interested in science from a theoretical point of view. With this in mind, Zygmunt Zawirski and Jan Łukasiewicz argue that metaphysics has to refer to sentences having an empirical character, and thus a confirmable character. Although metaphysical problems have a general dimension and are not easily solved, their resolution ultimately comes down to resolving sentences that are perceptive. Metaphysics understood in this way gains full citizenship rights in science.

In his works, Zawirski elaborates on the issue of verifiability of hypotheses in natural sciences. For the supporters of neo-positivism it was clear

164 Maria Kokoszyńska, "O pewnym warunku semantycznej teorii wiedzy". *Przegląd Filozoficzny*, Vol. 44, No. 4 (1948), pp. 372–381.

165 Kazimierz Ajdukiewicz, *Język i znaczenie*, trans. F. Zeidler, in: *Język i poznanie (wybór pism z lat 1920–1939)*, t. I (Warszawa: PWN, 1985), pp. 145–174.

166 Izydora Dąmbska, "Irracjonalizm a poznanie naukowe," *Kwartalnik Filozoficzny*, Vol. 14 (1937), pp. 185–212.

that the verifiability is the right criterion and all of the scientific statements are subject to it, whilst the metaphysical theorems that do not comply with this postulate are being excluded from the range of scientific theorems[167]. Henryk Mehlberg solved this issue in an interesting way, drawing the readers' attention not only to the introduction of metaphysical elements to science, but also proving that not all theorems of the empirical science are verifiable.

As Mehlberg rightly notices, another very important issue is the question whether unverifiable sentences are present in science and if they are vital for science. When it comes to a new significance of unverifiable sentences, Mehlberg underlines all of the possible consequences that stem from the fact of not including the unverifiable sentences in science[168]. Mehlberg showed that not only in metaphysics, but also in scientific theories, unverifiable sentences play vital role, even when we assume that in verifiable sentences one can include, apart from the statements that can be proved or disproved through a finite or infinite set of observations, even such statements, which can be made possible or impossible by observations[169]. Acknowledging the presence of unverifiable statements in science one does not resign from the possibility of isolating it from metaphysics[170]. Similar remarks on the presence of metaphysical issues in science were presented by Maria Kokoszyńska. She claimed that one should demonstrate to what extent the metaphysical elements that are present in science are acceptable and/or unacceptable[171].

According to Mehlberg, it is first necessary to clearly define what we mean by verbal sentences, since the existing terms of the verbal sentence are not satisfactory and there are many discrepancies in this respect. In his opinion, both analytical and synthetic sentences are verifiable[172]. At

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167 Izydora Dąmbska, "'Koło Wiedeńskie'. Założenia epistemologiczne 'Koła' i niektóre ich konsekwencje," *Przegląd Współczesny*, Vol. 125 (1932), pp. 379–388.

168 Mehlberg, "O niesprawdzalnych założeniach nauki," p. 320.

169 Henryk Mehlberg, "Science et Positivisme," *Studia Philosophica*, Vol. 3 (1948), pp. 211–293.

170 Mehlberg, "O niesprawdzalnych założeniach nauki," p. 320.

171 Kokoszyńska, "W sprawie walki z metafizyką," pp. 9–24.

172 Mehlberg, "O niesprawdzalnych założeniach nauki," p. 321.

the same time, only synthetic sentences can be called empirically verifiable sentences. Among these sentences, due to the type of procedure that verifies their truthfulness or falsity, directly verifiable and indirectly verifiable sentences are distinguished. The indirect verifiability of a given sentence boils down to its being derived from certain directly verifiable sentences. Each positively verifiable sentence results from certain directly verifiable sentences, whereas each negatively verifiable sentence results from the denial of certain directly verifiable sentences. Therefore, one should affix the name of empirically verifiable sentences only to those sentences which are simultaneously positively and negatively verifiable.

Mehlberg's testability criterion is stronger than that presented by Zawirski, who does not take into account the simultaneous positive and negative checking of a given sentence or hypothesis, but only evaluates between these methods of checking. Zawirski accepts the asymmetry between the positive and negative results of testing the hypothesis with the reservation of no change in the concepts included in a given hypothesis or sentence being checked. Valuable, however, is Zawirski's remark regarding Duomen's observation of *experimentum crucis* i.e. that physical experience can never refute one isolated hypothesis, but only the entire set that creates the whole theory of a given phenomenon, Zawirski states that although Duhem is theoretically right, in practice the situation is not that hopeless. Recalling the history of physics, Zawirski notes that although initially there were two inconsistent theories, a corpuscular and a wave one, in quantum mechanics, one is not a negation of the other[173].

Coming back to Mehlberg's criterion of verifiability one should agree that the core of the empirical nature of an indirectly verifiable sentence is the possibility to justify and disprove through the appropriately chosen and directly verifiable sentences. Thus, one can be sure that they do not introduce the metaphysical sentences to the set of empirical sentences. It cannot be done only with the help of positive verifiability, where one can understand the empirical verifiability as an alternative constructed of the directly verifiable sentence and any metaphysical sentence. The metaphysical sentences

173 Zygmint Zawirski, "Uwagi o metodzie nauk przyrodniczych," *Przegląd Filozoficzny*, Vol. 44, No. 4 (1948), pp. 317–318.

introduced in such a way to empirical sciences could not be deleted out of them, as they cannot be disproved through experience. The same applies to the situation in which one uses only the negative verifiability of empirical sentences. In these cases, one should treat as verifiable only the empirical sentences built of the conjunction of any directly verifiable sentence and a metaphysical sentence.

According to Mehlberg, in more complex cases, appropriate sets of immediately verifiable sentences are needed to ensure positive or negative verifiability. For example, for a positive check of the product of directly verifiable sentences, a few directly verifiable sentences are needed, and one directly verifiable sentence suffices for its overthrow. On the other hand, one directly verifiable sentence suffices to justify an alternative formed from immediately verifiable sentences, and the refutation of it requires a set of such sentences. Sentences that can be justified and refuted by means of two consistent and finite sets of directly verifiable sentences were called by Mehlberg as being finistically verifiable[174].

However, it remains an issue unexplained by Mehlberg: what exactly means that a given sentence can be proved or substantiated by referring to a given set of sentences that are directly verifiable. It is not so rare that some concepts of speculative metaphysics work out their theoretical constructions based on empirical data. There is no shortage of such representatives of philosophy, for whom the facts of regeneration or autoregulation of organisms remain a sufficient argument for vitalism, and the achievements of quantum theory support spiritualist positions. In each of these cases, the representatives of metaphysical positions accept the possibility of proving or at least substantiating the theses derived from directly verifiable sentences.

The results of methodological research by Zawirski, presented in the perspective of only selected elements of the methodological discussion of the 1930s and 1940s, allow for an overall assessment of the use of this research to build a scientific metaphysics referring to experience. Certainly, I must say that the advancement of methodological research of native philosophers gave the basis for using them to more fully present the concept of empirology. Unfortunately, Zawirski did not attempt such a test.

174 Mehlberg, “O niesprawdzalnych założeniach nauki,” p. 323.

Among metaphysical reflections outlined in *Nauka i metafizyka*, as well as in *O stosunku metafizyki do nauk*, he become interested only in the possibility of the development of the synthesis of natural science, which we are going to critically comment on in what follows. We will do this by paying attention to the area of discussion from the 1930s regarding the elaboration of a general theory of reality referring to the results of detailed scientific research.

3 Disputes over the synthesis of particular sciences

In the thirties in the works and speeches of, among others, Zygmunt Zawirski, Jan Łukasiewicz, Maria Kokoszyńska, Roman Ingarden, Bolesław Gawecki, Tadeusz Garbowski and Joachim Metallmann, one can notice a very clear polemical tone with the views of the representatives of the Vienna Circle regarding the synthesis of scientific knowledge. This issue was taken at the Third Congress of Polish Philosophy in 1936 in Krakow. However, the philosophical position in this regard was not agreed, but the discussions at this congress were to set the direction for further research into the relationship between science and philosophy and to build scientific metaphysics based on the axiomatic method[175], as Jan Łukasiewicz notes. Such attempts have already been undertaken by Zygmunt Zawirski (in the work *The Axiomatic Method and Natural Science*[176], and in particular in the fourth chapter titled: *Axiomatic Method and Reality*) and by Benedykt Bornstein, in the first volume of *The Architectonics of the World* (we will critically look into this work in the second volume).

The opponents of the generally understood metaphysics often drew attention to the need to synthesize human knowledge. The synthesizing views of their knowledge constituted, after all, some kind of substitute for metaphysical decisions. Representatives of the neo-positivism of the 1930s, in the unification of knowledge, referred to the representatives of classical positivism, such as Comte and Spencer, but on the other hand, they tried

175 Jan Łukasiewicz, "Co dała filozofii współczesna logika matematyczna?," *Przegląd Filozoficzny*, Vol. 39, No. 4 (1936), pp. 325–326.

176 Zygmunt Zawirski, "Metoda aksjomatyczna a rzeczywistość," *Kwartalnik Filozoficzny*, Vol. 2 (1924), pp. 129–157.

to refer to the concept of Leibniz's *mathesis universalis*, which Zawirski also points out[177]. This second reference is unfortunate up to the point, as it introduces some metaphysical elements to the constructed system of knowledge. It should be noted, however, that in the vast majority, the representatives of neo-positivism, while considering the synthesis of scientific knowledge, generally proposed an encyclopedic approach rather than constructing a synthesis for which non-scientific and metaphysical elements should be introduced.

Zawirski, resolving the problem of the synthesis of human knowledge, is in favor of the impossibility of carrying out a demarcation line between scientific synthesis and metaphysics. According to Zawirski, the fundamental undecidability of metaphysical hypotheses cannot be recognized. No metaphysical or scientific hypothesis can be directly verified. We can only talk about the verifiability of the consequences of the accepted hypotheses. In this respect, metaphysical and scientific hypotheses do not differ from each other. This situation is not altered by the acceptance of the Popperian criterion of falsifiability of hypotheses[178]. Zawirski agrees that falsification is an effective method of testing hypotheses.[179]

It is impossible to build a synthesis of human knowledge without the participation of science and metaphysics. According to Zawirski, in constructing a synthesizing approach to knowledge, all scientific terms, as well as terms of scientific metaphysics under the control of experience are used. Zawirski defends such a metaphysics in which deadlines must be subject to the control of experience, and all its theses should fall under the criterion of verifiability. The scope of metaphysics understood in this way should include the issue of temporal-spatial structure and dynamic reality, as well as the problem of determinism, indeterminism or purpose[180]. In building the system

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177 Zygmunt Zawirski, "W sprawie syntezy naukowej," *Przegląd Filozoficzny*, Vol. 39, No. 4 (1936), p. 347.

178 It should be noted that the methodological decisions of Popper were well known to Polish philosophers in the 1930s, cf. Krzysztof Śleziński, "Dyskusje nad popperyzmem w filozofii polskiej pierwszej połowy XX wieku [Discussions on Popperism in Polish Philosophy of the First Half of the Twentieth Century]," *Studia z Filozofii Polskiej*, Vol. I, 2006, pp. 243–259.

179 Zawirski, "W sprawie syntezy naukowej," pp. 347–348.

180 Zawirski, "W sprawie syntezy naukowej," p. 348.

of scientific metaphysics, Zawirski does not rule out the inclusion of intuitive cognition. However, due to the possibility of uncertainty and even contradiction of intuitive data, one should always consider intuitive convictions in an axiomatic system. Only then can you be sure of what you want to say and that what is said is well understood by others. Recognition of beliefs in a system including an appropriate arrangement of sentences together with their consequences never exonerates us from the obligation to look for the equivalent beliefs in the experience. The system created must be susceptible to verification, but also to falsification[181]. This approach to building a system is nothing new. Zawirski notes that even in building the simplest deductive system we deal with the intuitive adoption of its assumptions.

It is worth noting that Zawirski does not remove *a priori* or intuitive elements from learning about reality. What he demands above all is that the intuitive data can be included in the system, which then should be confronted with experience. According to Zawirski, such systems can be constructed more and each of them can be accompanied by an equally strong degree of obviousness. Zawirski accurately expresses the fact that the same set of intuitive data can equally speak for many theories built and related to these data. The final decision, after which one should back the theoretical preparation of intuitive data, is decided by experience[182].

What's more, Zawirski notes that scientific knowledge as well as scientific metaphysics are devoid of Leibniz's illusions regarding the possibility of resolving any scientific problem. Only in the case of complete systems, it can be assumed that the decidability and reasonableness overlap. We are dealing with incomplete systems much more often. Therefore, when investigating such systems, one should take into account the achievements of Kurt Gödel. In elaborated systems containing arithmetic you can construct such sentences, which – on the basis of this system, when referring to its valid methods – cannot be either proved or refuted. Decisiveness of sentences will, however, be possible in the case of enriching the language system with higher-order variables of logic types. Gödel's discovery reveals

181 Zawirski, "W sprawie syntezy naukowej," p. 348.

182 In contemporary methodological solutions, however, this matter is not easy to resolve; for example, it is boiled down to the problem whether experience can determine the falsity of the theory.

the importance of modern logic and the results of research in the field of semantics in determining a language for a system unifying our knowledge. According to Zawirski, the so-called limitation assumptions have changed the cognitive situation. Traditional epistemology must be reborn by considering research in the field of semantics and metalogics[183]. A similar renewal should meet traditional metaphysics, which is to establish closer links with the achievements of particular sciences[184].

Bearing in mind the critical assessment of proposals for developing a synthesis of particular sciences, I have to refer to many analyses of this issue undertaken at that time. It is only in this perspective that it will turn out in what scope Zawirski presented valuable analyses, and at what level there was a discussion concerning the synthesis of particular sciences in the Polish philosophical community. We will therefore go on to discuss selected concepts, critical analyses of this issue, the possibility of synthesis of particular sciences and – in the next subsection – the relationship between science and metaphysics, to show the richness of thought and, on this basis, assess the position presented by Zawirski.

A concept proposed by Roman Ingarden, completely different from the ideas that referred to the synthesis of detailed sciences discussed so far, paid attention to such aspects, which are different from the issues of particular sciences. The said issues include ontological problems and these metaphysical aspects that concern the actual essence of the objects being studied[185]. In the detailed sciences, particular facts are taken into account concerning the occurrence of appropriate physical and psychological processes as well as the detection and justification of relevant claims. As part of these teachings, one cannot capture the actual essence of actually occurring processes or merely capture the essential content and nature of individual claims. Since sensory experience does not teach us which features of objects are relevant and which are not, it follows that these kinds of issues do not belong to

183 See: Zygmunt Zawirski, "Doniosłość badań logicznych i semantycznych dla teoryj fizyki współczesnej," pp. 25–30. The paper mentioned here was delivered at the International Philosophical Congress in Paris in 1937.

184 Zawirski, "W sprawie syntezy naukowej," p. 349.

185 Roman Ingarden, "Czy zadaniem filozofii jest synteza nauk szczegółowych," *Kwartalnik Filozoficzny*, Vol 13, No. 3 (1936), p. 204.

particular sciences. According to Ingarden, it is a mistake to argue that attempts to understand the essence of the subject of particular sciences are meaningless and insoluble[186].

Following Ingarden, there should be noticed the difference between the development of the synthesis of particular sciences and the epistemological, ontological and metaphysical studies. The task of the theory of cognition is to detect the general view of cognition. This theory examines the existence of fixed and variable content in the general idea of cognition. This theory also detects the relationships between the components of this idea content and determines the range of their variability[187]. Research conducted in the field of the theory of cognition should ultimately lead to the formulation of a certain system of axioms and the recognition of elementary terms of cognition in it. Another task of the theory of cognition is to study the less general ideas falling under the general idea of cognition, and to determine the relationships between these ideas. The solution of these tasks allows to determine the conditions that certain individual objects must meet, including ideal or mathematical objects, or possible relationships between these objects. This way one will be able to obtain a system of statements able to serve as criteria for the cognitive value of the results obtained in the fields of other sciences, particular sciences included[188].

According to Ingarden, ontological issues do not assume any whatsoever, objective or real, fact, or a fact related to the existence of a field defined by a given system of axioms. These issues only "[…] relate to pure possibilities or necessary relations between the possibilities detected in direct a priori knowledge"[189]. All solutions to these problems are, in comparison

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186 Ingarden, "Czy zadaniem filozofii jest synteza nauk szczegółowych," p. 204.

187 Roman Ingarden, "Stanowisko teorii poznania w systemie nauk filozoficznych," in: *Sprawozdanie Państwowego Gimnazjum w Toruniu za rok szk. 1924/25* (Toruń: 1925); reprinted in: Roman Ingarden, *U podstaw teorii poznania* (Warszawa: PWN, 1971), pp. 381–406. Ingarden distinguishes the theory of pure and applied cognition. The first provides the system of the *principia* of cognition in general, the second applies these *principia* to particular realms of real accidents.

188 Ingarden, "Stanowisko teorii poznania w systemie nauk filozoficznych," pp. 382–383.

189 Ingarden, "Czy zadaniem filozofii jest synteza nauk szczegółowych," p. 205.

to the results of the detailed sciences, theoretically earlier, more general and do not entail any claims about real facts; they only set limits to their possibilities. On the other hand, formal teachings provide the basics of explanatory concepts that are basic and demonstrate the truthfulness of accepted axioms[190].

Metaphysical research, according to Ingarden, leads to the ultimate, absolute demonstration of the *modus existentiae*, the actual existence of all possible domains of existence, with particular reference to the real world. After solving these issues, metaphysical research seeks to detect the actual essence of entire living domains and their individual elements. The solutions of metaphysical issues are based on the assumption of solvability of certain ontological issues, such as the occurrence of the necessary relationships between elements or features of possible objects. The final solution to the metaphysical problems would be possible only if such a form of experience was available, different from the one adopted in particular sciences, which would guarantee the actual existence of the subjects studied and capture the actual essence of the existing objects[191].

Ontological, metaphysical and epistemological research are fundamentally different from the research of the particular sciences in that they are not dogmatic but critical, which means that they do not adhere to existential assumptions. The common moment connecting ontology, metaphysics and the theory of cognition with particular sciences is that the ultimate goal of the research undertaken is to obtain cognitively justified answers to the issues under examination. Therefore, not only detailed science, but also the entire philosophy can be treated as broadly understood science, provided that there are no significant differences between these fields of knowledge[192]. Ingarden recognizes three areas for such differences. The first one relates to seeing the dogmatic nature of the particular sciences in relation to the critical studies of ontology, metaphysics and the theory of cognition. The second area is concerned with the non-attachment of particular importance to the difference between significant and irrelevant features of the subjects

190 Ingarden, "Czy zadaniem filozofii jest synteza nauk szczegółowych," pp. 205–208.
191 Ingarden, "Czy zadaniem filozofii jest synteza nauk szczegółowych," p. 208.
192 Ingarden, "Czy zadaniem filozofii jest synteza nauk szczegółowych," p. 209.

under study, which in turn, plays a very important role in ontological and metaphysical research. The third area concerns the limitation of research observed within specific sciences only to elements of one's own field of research. At the same time, in ontology and metaphysics, we strive to provide general, final solutions to the issues addressed, concerning either the entire living domains or the whole of all possible domains of existence[193].

In the theory of cognition, we strive to discover the content of the general idea of cognition regardless of what kind of object it concerns. Moreover, the theory of cognition is not dependent on other philosophical sciences or particular sciences. If the theory of cognition were indeed dependent on particular sciences, then it would also have to be as dogmatic as they are. The theory of cognition does not accept any claims from other philosophical sciences, let alone particular sciences, yet, according to Ingarden, it loses nothing of its field of research[194]. The independence of the theory of cognition from the particular sciences comes down to the fact that the general idea of cognition does not belong to learning about the real external world only. Accepting such a supposition would be an unjustified limitation of the general idea of cognition, making it impossible to discover the *principles* of cognition.

Another argument posed by Ingarden, that regards the independence of epistemology from positive sciences is that all knowledge about the real external world is obtained through external perception, which – in no way – is able to provide us with the existence of objects. Moreover, the external perception is in itself inadequate and may be supplemented or corrected in subsequent experiments. According to Ingarden, the field of the real external world must remain outside the scope of epistemological research. If, then, we accept a theory of cognition that will assume the existence of the real world, then such a theory must be as doubtful as the natural sciences[195]. In this moment it is worth observing that the opinion on the said issues backed by Czesław Znamierowski is of exactly the opposite nature, as he

193 Ingarden, "Czy zadaniem filozofii jest synteza nauk szczegółowych," p. 210.
194 Ingarden, "Stanowisko teorii poznania w systemie nauk filozoficznych," pp. 389–392.
195 Ingarden, "Stanowisko teorii poznania w systemie nauk filozoficznych," pp. 397–398.

recognizes the possibility of conducting epistemological research based on the study of particular sciences. For Znamierowski, the theory of cognition remains dependent on these teachings[196].

Roman Ingarden, speaking of the synthesis of particular sciences, distinguishes five types[197]. Each of the selected types of synthesis refers to the results of these sciences. Such synthesizing intakes do not violate either accepted assumptions or obtained results of a given field of research, unless errors occur in the course of the conducted analyses in a given science. Each synthesis presented by Ingarden is a scientific task that preserves the research methods appropriate for a given field. Individual syntheses cannot be moved beyond the scope of particular sciences, but should be treated as a continuation of research on these sciences.

One of the syntheses highlighted by Ingarden is concerned with the simple arrangement, remaining in close agreement to a given principle, of the cognitive results of a given science in a system of related theorems. This arrangement may concern one, many and even all detailed sciences about facts.

Another possible synthesis appears when the problems, boundary for the relevant fields of particular sciences, are detected and solved. Such a situation makes it possible to overcome the accepted limitations for individual particular sciences, resulting most often from the methodologies developed for them and from their fragmented knowledge about the world. The development of particular sciences, however, leads to the emergence of new areas of research, most often of an interdisciplinary nature. If it were possible to solve boundary issues for all detailed sciences about facts, then the whole of related facts would give a synthetic, scientific image of the world.

Another type of synthesis is the attempts to discover a common principle or principles for many different claims. In mathematics, the system of axioms is reached this way. The same can be expected in physics, biology or other scientific disciplines. In this synthesizing approach, some new, more general theorems for states of affairs or more general rules are created,

196 Czesław Znamierowski, "Stanowisko teorii poznania wśród nauk filozoficznych," *Przegląd Warszawski*, Vol. 21 (1923).

197 Ingarden, "Czy zadaniem filozofii jest synteza nauk szczegółowych," pp. 210–212.

taking into account the perceived logical relations occurring between the ordered claims of a given science. Regarding this kind of synthesis, doubts may arise as to the adoption of a specific set of axioms for a number of *a priori* found statements that, for example, would entail introducing ontological issues explaining the basis of a given science to the synthesis. In Ingarden's opinion, the very attempt to explain the foundations of a given deductive theory, able to detect certain simplest states of things among the elements of the content of the idea of a certain field must undoubtedly refer to ontological solutions. We would like to note that, following the stance offered by Ingarden, this kind of synthesis boils down to finding such a system of the highest assumptions, from which some existing sets of theorems would be deducted. At this point, Ingarden does not reflect on the truthfulness of accepted axioms and the assumed sense of the original concepts. In the *a priori* sciences, the highest principles that Ingarden refers to are usually chosen from known mathematical theorems, and therefore they only fulfill the appropriate logical function in a given deductive system[198].

Another possible synthesis of the results of particular sciences is to build a more general theory, the detailed case of which would be scientific theories of a lesser generality. An example of this is non-Euclidean geometry, of which Euclidean geometry is a borderline case. It is also possible to distinguish a synthesis that reduces the expressions of a certain group of sciences to the language of one of them. One of such forms of synthesis is physicalism. Ingarden's discussion about this kind of possible synthesis of the results of particular sciences is very clearly cut off from the ontological problem of whether and under what conditions such a reduction, maintaining the equivalence of expressions, is possible.

In accordance with the solutions proposed by Ingarden, it should be stated that the tasks of ontology and metaphysics should not include the synthesis of the results of particular sciences. However, there are such tasks of ontology and metaphysics that relate to these teachings. These are primarily the tasks of epistemological evaluation of the cognitive value of results obtained in particular sciences and the ontological tasks of interpreting the

198 Ingarden, "Czy zadaniem filozofii jest synteza nauk szczegółowych," p. 213.

original terms found in axioms and the highest scientific principles[199]. The ontological interpretation of scientific results may lead to giving to theorems of particular sciences the sense clearly different from that adopted within the framework of these sciences. Thus, in ontology, one cannot just accept the messages found in the assumptions and/or recognized scientific theories, and conduct further research in a dogmatic way. According to Ingarden, both the tasks of ontological interpretation of the original terms as well as the epistemological evaluation of the cognitive value of the obtained results let us assume that some results of ontological and metaphysical studies will be acquired independently of the particular sciences. Thus, the philosophical synthesis of the results of detailed science research cannot be carried out[200].

Considering the above possible types of syntheses of particular sciences, one may attempt to recognize the position of Zawirski. Undoubtedly, for Zawirski, the closest kind of synthesis of particular sciences is the combination of several types distinguished by Ingarden. It is important for him, to observe such a synthesis being able to order appropriately, according to a given principle, the cognitive results of many detailed sciences about facts thus putting them into a system of related theorems. Zawirski is convinced that the existing divisions of disciplines observed within natural sciences are artificial, because we are dealing with one world of natural phenomena. The possibility of using the axiomatic method is also important, hence he would support the attempt to discover a common set of principles, an arrangement of axioms unifying physics, biology and other natural disciplines. In this synthesizing approach, some new, more general theorems for states of affairs could be created, or more general rules that take into account the perceived logical relationships between the statements of the syntactized realities of facts.

4 On the relationship between science and metaphysics

Many native philosophers sought to capture the unity of reality in accordance with the accepted models of accuracy of analyses and constructions

199 Ingarden, "Stanowisko teorii poznania w systemie nauk filozoficznych," pp. 382–393.

200 Ingarden, "Czy zadaniem filozofii jest synteza nauk szczegółowych," p. 214.

carried out by them. At this point, it is worth pointing out the philosophical achievements of Leon Chwistek, whose works in the field of logic and mathematics occupy an important position among the achievements of Polish philosophers. In the field of the philosophical theory of reality, he takes the opposite position from such philosophers as: Joachim Metallmann, Jan Łukasiewicz, Tadeusz Czeżowski or Bolesław Gawecki. Chwistek, while walking alone in his own ways, that often took him far from the form of precision he adopted in mathematical analysis, proposed the idea of a multifaceted reality[201]. This concept has not been welcomed due to the lack of scientific reliability of its formulation, but also because the proposition of many realities has introduced relativism, and this stood in conflict with the rather common desire to combine the multiplicity of phenomena and realities of the real world into something that would speak for the existence of only one reality.

Despite the above reservations, Chwistek was of the opinion that the starting point in building our view of the world should be simple and clear truths, based on experience and strict reasoning. In the initial period of research, Chwistek assumed that one could build deductive systems within the area of philosophy. In science and philosophy there should be used a construction method, based on the analysis of intuitive concepts that, in turn, lead to the definition of fundamental concepts. These concepts, by means of definitions or axioms, can be introduced into the empirical system, built in accordance with the laws of formal logic[202]. Later, however, noticing the complex nature of philosophical research and disagreeing with the possibility of formalizing philosophical systems, he stated that such forms of conduct are useless (in the work *Granice nauki*). In this connection, the final form of the theory of the multifaceted reality is drawn as possessing

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201 The theory of the multifaceted reality was presented by L. Chwistek in 1917 in the article "Trzy odczyty odnoszące się do pojęcia istnienia," *Przegląd Filozoficzny*, Vol. 20, No. 2–4 (1917), pp. 122–151, and then in an expanded form presented in the work *Wielość rzeczywistości,* which appeared in 1921 in Krakow. The final shape of the theory was presented in 1935 in the work *Granice nauki. Zarys logiki i metodologii nauk ścisłych* (Lvov: Książnica – Atlas, 1935).

202 Leon Chwistek, "Zastosowanie metody konstrukcyjnej do teorii poznania," *Przegląd Filozoficzny*, Vol. 26, No. 3–4 (1923), pp. 175–187.

negligible values of a strict and scientific description of reality, but such an approach should be adopted together with far caution, because many philosophical issues appearing in this concept have gained a new perspective for analysis, which should be thoroughly examined. Without undertaking further analyses of the theory of the multifaceted reality, I would like to proceed with the presentation of other voices and/or points of view to be found in the ongoing discussion regarding the relationship between science and philosophy.

The approach presented by Czesław Białobrzeski concerned the appropriately shaped relationship of science and philosophy. In a completely different perspective, i.e. starting from the study of natural sciences, he aimed to develop a unified image of the world that could not be limited to the synthesis of these sciences only. While conducting research in new areas of physics, Białobrzeski noticed the need to understand the reality that only philosophy can give. In his opinion, where science stops, the search is to be taken over by philosophy, and the answers regarding the "mystery of being", given by it, cannot be contradicted by the postulates and results of science. In the work *Synteza filozoficzna i metodologia nauk przyrodniczych*, Białobrzeski proposes that philosophy should be given the traditional term *philosophiae naturalis*[203]. In this spirit, by conducting further research and paying attention to the views of C.F v. Weizsäcker, A.S. Eddington, H. Reichenbach, D. Błochincew, N. Hartmann and other philosophers that analyzed the relationship between science and philosophy, he developed an ontological interpretation of wave-particle duality and an ontological interpretation of the foundations of physics atomic world[204]. In a lecture delivered at the Philosophical Commission of the PAU on March 15, 1951, he presented the problem of stratification of

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203 Czesław Białobrzeski, "Synteza filozoficzna i metodologia nauk przyrodniczych," *Nauka Polska*, Vol. 25 (1947), pp. 44–45.

204 Czesław Białobrzeski, "Ontologiczna interpretacja dualizmu fali – korpuskuły [the work written in 1952]," in: Czesław Białobrzeski, *Wybór pism* (Warszawa: PAX, 1964), pp. 49–104, and the reading delivered at the PAU Committee on Philosophy on June 15, 1950; see: "O interpretacji ontologicznej podstaw fizyki świata atomowego," in: *Podstawy poznawcze fizyki świata atomowego*, ed. Czesław Białobrzeski (Warszawa: PWN, 1984), pp. 289–308 [first edition in 1956].

reality[205], where he distinguished the physico-chemical layer of non-living bodies, the organic layer of living beings and the psychic layer.

Many philosophers dealt with the possible relationship between science and philosophy. Of these, one should mention Kazimierz Twardowski, Jan Łukasiewicz, Zygmunt Zawirski, Joachim Metallmann, Tadeusz Czeżowski, Kazimierz Ajdukiewicz, Tadeusz Kotarbiński and Bolesław Gawecki[206]. All the philosophers mentioned above place great emphasis on the precision, reliability and clarity of philosophical argumentation. They claim that philosophy, when being a science itself, should refer to certain patterns of specific sciences while maintaining "connectivity" with reality at the same time. In their opinion, a scientific philosophy should not only fulfill meta-scientific tasks, but also involve learning about the real world. They also emphasized the dissimilarity of the approach to the study of the subject and the differentness of research methods for philosophy and particular sciences. The non-identification of philosophy, either with logic or with specific sciences, testified to the autonomy of these scientific disciplines.

As was shown by Jan Łukasiewicz, the method of analysis and construction could lead to scientific metaphysics, understood by him as a general theory of objects. Priority in philosophical considerations was given by him to ontology, and not epistemology, that, in his opinion, not only inevitably led to psychologism but also was the source of numerous errors identified by him. The application of the analytical method leads to solving individual problems, which was presented in a model manner in the work titled *Analiza i konstrukcja pojęcia przyczyny*[207]. At the

205 Czesław Białobrzeski, "Problem uwarstwienia rzeczywistości," in: *Wybór pism*, pp. 127–145.

206 Bolesław Gawecki, "Nauka ścisła a metafizyka," *Przegląd Współczesny*, Vol. 10 (1936), pp. 103–112; and Bolesław Gawecki, "Współczesne zadania filozofii," *Droga*, 1936.

207 Jan Łukasiewicz, "Analiza i konstrukcja pojęcia przyczyny," *Przegląd Filozoficzny*, Vol. 9, 1906, pp. 105–179; also see: J. Łukasiewicz, "Analiza i konstrukcja pojęcia przyczyny," in: *Z zagadnień logiki i filozofii. Pisma wybrane*, ed. Jerzy Słupecki (Warszawa: PWN, 1961), pp. 9–62. Also see:: Krzysztof Śleziński, "Logiczne zasady badania naukowego a krytyka przyczynowości u Jana Łukasiewicza," in: Restaurare omnia in Christo (Bielsko-Biała: 2004), pp. 243–255.

same time in his other work, titled O *determinizmie*[208], he notes that the mathematical logic practiced in Poland has yielded abundant and more valuable fruits than in many other countries. It was better understood what the deductive system is and how such systems should be built, and, above all, a measure of scientific accuracy that exceeded many previous requirements was achieved.

Łukasiewicz, just like Kotarbiński, Czeżowski or Ajdukiewicz, was a supporter of the reform of philosophy. Without denying the possibility of the existence of scientific philosophy, he was convinced that the creation of a complete philosophical system requires enormous effort and commitment of many philosophers who should gradually approach the synthesis of views that regard not only the world, but also our lives. On the other hand, while analyzing Czeżowski's philosophical approaches, the acceptance of scientific philosophy is not strictly connected with respecting the axiomatic principles of scientific conduct within its framework. He recognized as scientific these metaphysical theories, which reach beyond the field of possible experience. In his work titled *O metafizyce, jej kierunkach i zagadnieniach*, he gave arguments for the possibility of treating metaphysics as a science[209].

Remaining in the same perspective of understanding philosophy as the representatives of the Lvov-Warsaw School[210], Joachim Metallmann notes that in the 1930s, both science and metaphysics, put in opposition to each other, are increasingly tightening their relationship. On the one hand, philosophy is more and more evidently recognized as a function of science. Philosophy cannot underestimate the results of science without detriment to its deliberations. Disregarding science would be tantamount

208 Jan Łukasiewicz, "O determinizmie," in: *Z zagadnień logiki i filozofii. Pisma wybrane*, pp. 114–126. This is an article written in Dublin in 1946, and the basis of this article is the Rector's speech, which Łukasiewicz delivered at the University of Warsaw at the inauguration of the academic year 1922/1923.

209 Tadeusz Czeżowski, O *metafizyce, jej kierunkach i zagadnieniach* (Kęty: Antyk, 2004). The first edition was published by the National Bookstore T. Szczęsny i S-ka, Toruń 1948.

210 Jan Woleński, *Filozoficzna szkoła lwowsko-warszawska* (Warszawa: PWN, 1985), pp. 52–76.

to ignoring reality. According to Metallmann, philosophy faces unusual transformations that take place in science, related to Einstein's theory of relativity, the work on radioactivity or the emergence of quantum theory. These transformations are associated with the relevant philosophical consequences of understanding reality. On the other hand, there are numerous reservations and doubts in accepting the physical ideal of the unity of science that strictly refer to the supposedly unshakeable foundation of mathematics[211].

In connection with the above, according to Metallmann, more and more often attempts are made to develop a scientific philosophy or scientific metaphysics[212]. Such metaphysics would be influenced by the development of science. According to Metallmann, as there is no technique without science, although science is far from serving technology, there is also no way today to address the philosophical issues inflicted on us by our innermost spiritual life that would not lead necessarily through science. Thus philosophy should keep its "roots" in science.

In his work *Nauka, pogląd na świat, filozofia*[213] Joachim Metallmann attempts to determine what we expect today from philosophy in the perspective of changes taking place in it. This does not mean that philosophy is reduced to a general science that combines the results of individual real sciences. Philosophy is to go far beyond the field of science, aiming at the

211 Joachim Metallmann, *O budowie i właściwościach nauki* [the Jagiellonian Library No 555698 II], p. 1.

212 Although Metallmann does not use the term "scientific metaphysics" but only "scientific philosophy", it seems possible to define his philosophical position in this way. In his works, Metallmann clearly cuts himself off from speculative metaphysics, advocating for such a general picture of the world that remains in close relation to science and – through it – reality. Moreover, research on reality led Metallmann to discover the existence of structural reality and to present an attempt to determine the role of the cognizing subject in this reality.

213 Joachim Metallmann, "Nauka, pogląd na świat, filozofia," *Przegląd Współczesny*, part. I: Vol. 49 (1939), pp. 72–95; part II: Vol. 49 (1939), pp. 120–145. According to Janusz Mączka, this is the last article published by Metallmann before his arrest in 1939 and his death in a concentration camp in 1942. See: Janusz Mączka, "Filozofia jako funkcja nauki: Joachim Metallmann," *Principia*, Vol. 22–23 (2002), p. 245.

construction of the synthesis of knowledge, which becomes the basis for formatting a holistic image of reality precisely defined for a given era. It means, similar to Zawirski's concepts, that such syntheses can never be completed. New questions are posed and new research is carried out as part of scientific research, and these result in a direct enlargement of the areas of the reality under investigation. According to Metallmann, there is a constant need to transform philosophy and adapt it to the new challenges that keep appearing before it.

Philosophy of a given era, works out a holistic view of reality, also taking into account the cultural context of science as well as different aspects of non-scientific human activity. For Metallmann, an important component of the image of reality, apart from our scientific creativity, is also artistic and religious creativity, as well as the axiological attitude.

Although philosophy and detailed sciences are subject to mutual influence, they still retain relative autonomy and research independence. However, this is not a complete autonomy, because – in such cases – the philosophy would be detached from science, and thus also from reality, which can be observed in respect to H. Bergson's philosophy. According to Metallmann, philosophy should retain a realistic approach to scientific problems and to reality. Philosophy practiced in the context of science is confronted with the concepts and methods found there, as well as the results adopted by science, at the same time making them the subject of its further research. Philosophy, critically assessing the method and results of science, shows its hidden assumptions, which affects the valuation of specific scientific theories. The science presented by Metallmann is a continuous process that has neither a purpose nor an internal necessity. The development of science, however, is entirely dependent on the creative activity of a man, able to respond adequately to emerging scientific problems. By solving these problems, we reveal the structures existing in reality that philosophy uses to deepen understanding of the world. As Metallmann points out, paying attention to the occurrence of genetic and causal relationships becomes insufficient to capture the unity of reality. Attempts to synthesize structures recognized in particular detailed sciences more and more often allow (in this new perspective) to strive to understand the whole of being, not by reducing the whole to its constituent elements, but through the structural recognition of this whole, which exhibits such properties that its elements lack[214].

Establishing the proper relationship between science and philosophy, as Metallmann states in his work titled *Nauka, pogląd na świat, filozofia* is not easy. There are difficulties in establishing the appropriate scientific method, the proper criterion for accepting sentences as sensible and decidable and in seeking to obtain simple and unambiguous answers to both scientific and philosophical questions. What is common for science and philosophy, is the establishment of the so-called research setting. Both science and philosophy strive to solve and explain their own problems by maintaining close contact with reality, and philosophy in addition to contact with reality, proper reference to science.

One can agree with Metallmann that a scientific philosophy is necessary to build a holistic image of reality at a given stage of scientific development. This philosophy allows us to choose the most valuable learning results that can be used to create a specific synthesis. At the same time, the overall picture of reality should also take into account, strongly emphasized by Metallmann, the cultural context of a given epoch. Paying attention to cultural and psychological factors in the development of science seems to be an interesting issue undertaken not only by Metallmann but also by Kazimierz Ajdukiewicz or Ludwik Fleck[215] and requires a separate analysis.

The possibilities of building scientific metaphysics are critically evaluated by Roman Ingarden. In a different perspective, i.e. speculative philosophy, Ingarden, while analyzing the issue of the possibility of the philosophical synthesis of particular sciences, referred to logical problems, presenting an argument for the impossibility of such a synthesis. In his opinion, a categorical judgment has its own formal object, and each true assessment, in addition to the subject, still has a material object, i.e. a certain objective state of

214 Joachim Metallmann, "Problem struktury i jej dominujące stanowisko w nauce współczesnej," *Kwartalnik Filozoficzny*, Vol. 9, No. 4 (1933), pp. 346–350.

215 Ludwik Fleck, "Powstanie i rozwój faktu naukowego. Wprowadzenie do nauki o stylu myślowym i kolektywie myślowym," in: *Psychologia poznania naukowego*, ed. Zdzisław Cackowski, Stefan Symotiuk (Lublin: Wydawnictwo Uniwersytetu Marii Curie-Skłodowskiej, 2006), [first edition: Ludwik Fleck, *Entstehung und Entwicklung einer wissenschaftkichen Tatsache. Einfűhg in die Lehre vom Denkstil und Denkkollektiv* (Basel: 1935)].

being that can be identified with a formal subject. Ingarden, accepted the decisions given by A. Pfänder, namely that there is a relationship of justification between the premises and the consequence, if not only the truth of the premises is given with the necessity of the consequence, but also if the truth of the premises in no way presupposes the consequences of succession. On this basis, Ingarden states that the relation of justification occurs when the totality of material objects as premises leads not only to the necessity of the existence of a material object as a consequence, but at the same time does not require the existence of this object of consequence[216]. This means that the existing object conditioning the existence of the material object of the consequence, alone in its elements, is not conditioned by the existence of this object. In this way, the obtained cognitive result can be used to understand the relation of philosophy to specific sciences. Philosophy can therefore condition the development of positive sciences itself without being conditioned by these teachings. The obtained result of the analysis is interesting because it was achieved taking into account the decisions made in the field of logic, and then was transferred by Ingarden to the field of decisions of particular sciences and individual branches of philosophy.

Zawirski spoke out for the possibility of scientific metaphysics by examining the relationship between metaphysics and science. In his dissertation *O stosunku metafizyki do nauki*, he presented scientific metaphysics as a discipline lying between positive knowledge and metaphysical speculation. On the one hand, in his opinion, there is no such detailed science that would give a complete synthesis of scientific knowledge. There is, however, an obvious need for a general and critical science which, by deepening and supplementing the results of specific sciences, would be a unified theory of reality[217].

On the other hand, the theory of the whole of reality, being a synthetic philosophy, remains different from classical metaphysics[218]. It is obvious in this situation that the theory of reality, i.e. scientific metaphysics, is not a metaphysics in the full sense of the word, because it does not provide firm

216 Ingarden, "Stanowisko teorii poznania w systemie nauk filozoficznych," pp. 388–389.
217 Zawirski, "O stosunku metafizyki do nauki," pp. 25–28.
218 Zawirski, "O stosunku metafizyki do nauki," pp. 29–33.

and reliable answers to humanity's tormenting questions about the value of human life or the ultimate mystery of being. We will not get answers to these questions from either science or the theory of reality.

In the study *Nauka i metafizyka*[219] Zawirski developed the idea of the theory of reality, first of all giving a more succinct definition of it and secondly retaining more consistency in carrying out arguments in favor of properly understood scientific metaphysics, modeled on the method of specific sciences. Zawirski proves in detail the truth of the two judgments, namely that the claims of general science about reality allow for the appearance of many possible interpretations, and that the general science of reality can never replace classical metaphysics.

Zawirski defended the scientific metaphysics, as we know, in his habilitation thesis *Metoda aksjomatyczna a przyrodoznawstwo*. In the last chapter of his work *Metoda aksjomatyczna a rzeczyswistość* he concluded that metaphysics, due to the possible multiplicity of interpretations of the phenomena to which it relates, cannot be replaced by the only scientific view of the world, but should complement it in the pursuit of a unified view of the world[220]. It should be noted that these remarks are very general, often not supported by proper argumentation. In large part they are formulated on the convictions of common-sense-like understanding of the natural reality. Thus, in Zawirski's research, the only clear justification for the uniform image of the world is – accepted in scientific research – the axiomatic method, which is the implementation of the former search of metaphysics to bring the entire reality out of one or several of the highest principles.

It is worth noting here that the program of scientific metaphysics, formulated by philosophers of the first half of the 20th century, was fully implemented by Benedykt Bornstein. The work on logical-geometric metaphysics was a systematic work that occupied the entire creative work of Bornstein. His works were unknown to his contemporary philosophers, due to the fact that the successes of Polish philosophers in the development of

219 Zawirski wrote the work *Nauka i metafizyka* in 1920. The manuscript of this work was published only in the nineties of the 20th century in two parts in the quarterly *Filozofia nauki*. See: Zygmunt Zawirski, "Nauka i metafizyka," *Filozofia Nauki*, Vol. 3 (1995), pp. 104–135; and Vol. 4 (1996), pp. 131–143.

220 Zawirski, "Metoda aksjomatyczna a przyrodoznawstwo," p. 151.

the scope's logic were so great that they were not interested in the problems of content logic and quality mathematics. This situation is also taking place today. I will present the analysis of research results and critics of Bornstein's scientific metaphysics in the second volume of this dissertation.

On the one hand the above-presented positions on the issue of the possibilities of synthesis of particular sciences show the richness of native philosophical thought and critical analyses of this subject; on the other hand, however, they allow for the proper assessment of Zawirski's scientific achievements. Despite the advantages of his work, we would like to note that Zawirski did not discuss many key issues within the framework of the – developed by himself – scientific project of metaphysics, which has to be perceived in the perspective of the above-mentioned positions of other philosophers.

There is no doubt that Zawirski did not use all these possibilities that were available in the ongoing discussions to complement and modernize the previously developed concept of scientific metaphysics. Therefore, it is understandable that the manuscripts that were developed and published in 1995 and 1996 (*Nauka i metafizyka*) and in 2003 (*O stosunku metafizyki do nauki*) were left out in this manuscript. It turns out that the published works have, apart from the historical value, also the actual substantive value, and not only because they clearly are an attempt to build some form of scientific metaphysics that refers to the broadly understood experience while using the axiomatic method. What is more, the advantages of his analyses of the application of the axiomatic method to physics and the development of a scientific project of metaphysics are evidenced by the excellent knowledge of the natural theories to which he refers. In many places one has the impression that the content of new theories are being presented from the contemporary perspective of their understanding, as if forgetting about the fact that he commented on them at a time when they were only getting full citizenship in scientific research.

Part Three: Selected works of Zygmunt Zawirski

1 The significance of many-valued logic for epistemology and its connection with the probability calculus[221]

Many-valued logic is the outcome of the research work done by the Polish philosopher Jan Łukasiewicz and the American Emil Post, who independently and almost simultaneously (the first in 1920–1922, the second in 1921) made this bold generalization of bivalent logic. Neither of them, however, defined the relation of this new logic to the probability calculus, and therefore its meaning for cognition was somewhat unclear. It was only the German logician Hans Reichenbach who attempted to solve the problem of probability in connection with the logic in which the "true-false" disjunction is replaced by a continuous scale of new logical values. However, the way in which Łukasiewicz, Post and Reichenbach understand this new logic is not the same, and therefore we need to learn more about these differences before considering the meaning of the new logic for human cognition.

In 1920, Łukasiewicz first developed a three-valued logic[222] in which the third logical value, called the possibility, is so understood that its

221 Zygmunt Zawirski, "Znaczenie logiki wielowartościowej dla poznania i związek jej z rachunkiem prawdopodobieństwa," *Przegląd Filozoficzny*, Vol. 37, No 4 (1934), pp. 393–398.

222 Cf. *Ruch filozoficzny*, Vol. V, pp. 169–171; also *Przegląd filozoficzny*, Vol. XXIII, pp. 189–205. Attempts to create logic with more than two logical values have already been taken much earlier. And so, MacColl has developed a five-value modality account in his *Symbolic Logic* in 1906. Similarly, C.I. Lewis, developing the concept of "strict implication" in the *Survey of Symbolic Logic* from 1918, introduced the third logical value of "impossibility" as the one appearing next to truth and falsehood. However, after the creation of Prof. Łukasiewicz's many-valued logic, Oscar Becker presented (Oscar Becker, "Zur Logik der Modalitaten," *Jahrbuch für Philosophie und Phänomenologische Forschung*, Vol. XI, 1930, pp. 497-548) the logic of six or ten modalities, thus developing Lewis' ideas. None of the above authors, however, extended their ideas to any number of logical values, nor did they present a system of many-valued logics in a way as correctly as Prof. Łukasiewicz.

denial gives again the possibility. Logical values, false, possibility and truth, are most often marked with the symbols 0, ½ and 1. The implication (i.e. the combination of two sentences with the conjunction: if, then) is defined for the new logical value in such a way that it assumes a value of 1 when the values of both the predecessor and the successor are equal to each other, or when the value of the predecessor is smaller than the value of the successor. In all other cases, the implication is only possible, so it has a value of ½. It was only in 1922 that Łukasiewicz created an infinite-many-valued logic in which new fractions of 0 to 1 were assigned to new logical values. If one of these fractions is marked with the letter p, then the sentence negation value is calculated according to the formula $\sim p = 1\text{-}p$, whereas the implication $p \rightarrow q$ equals 1 for $p \leq q$, and is equal to the value "$1 - p + q$" for $p > q$. It is immediately apparent that these definitions include, however, special cases, definitions of negation and implications of two- and three-valued logic. On the basis of negation and implication, then the logical sum is defined (combining two sentences with the help of a conjunction "or") and the logical product (connection using the conjunction "and"); the definitions are constructed in such a way that the logical sum always receives the value of the greater component, and the product of the value of the smaller component. As a result of the values of logical constants adopted in this way (i.e. negation, implications, sum and product), the law of contradiction and excluded measure loses its sense in both trivalent logic and the infinite-many-valued logic postulated by Prof. Łukasiewicz. This is the most important property of Prof. Łukasiewicz's many-valued logic.

Post[223] gives the same values to logical constants as Łukasiewicz does, and derives a new concept of so-called cyclic negation, based on which the negation of a certain value is a logical value directly lower than it. As the original terms of his system, he chooses this cyclic negation and the symbol of a logical sum, whereas in Lukasiewicz all constants have been defined on the basis of implications and ordinary negation. Post also provides logical formulas for creating any new sentence functions with one argument

223 Emil Post, "Introduction to a General Theory of Propositions," *American Journal of Mathematics*, Vol. 43 (1931), pp. 180–185.

and then any arbitrary arguments. He continues to add a very important remark that one can accept the sentences of *n*-value logic as the class $(n-1)$ of the sentences of bivalent logic. If all these bivalent sentences are false, then the sentence of the *n*-value logic is false, if all are false except one, then the sentence of the many-valued logic gets the value $1/(n-1)$ etc., if all are true, then the many-valued logic sentence is true as well. Thus, the relationship between the new logical values and the way of calculating these values in the probability calculus is indicated where exactly the probability degree is measured (according to the classical way of defining the measure of probability) the number of true sentences ("favorable events") per certain number of true or false sentences ("accidents possible"). Post does not say, however, that such an interpretation is necessary when sentences of *n*-value logic can be considered sensible.

The above remark does not, however, explain the ratio of many-valued logic to the probability calculus; the difficulty of linking both algorithms exists in Post, as well as in Łukasiewicz, but for a different reason. To explain the issue, let us take as an example a five-valued logic, in which the values are marked with the symbols 0, ¼, 2/4, ¾, 1. If two sentences in this logic have a value of 2/4, then the logical sum of these two sentences $2/4 \vee 2/4$ will get a value of 2/4 as defined by Łukasiewicz, or Post. But this corresponds in the probability calculus only to the condition when the probabilities of both sentences overlap; whereas if they are mutually exclusive, the sum has the value 1, and in case of crossing – the value of ¾. Here Post provides formulas for creating new logic functions, but it is not known whether the creation of new logical sums, derived from the probability calculus corresponds to his way of understanding the notion of many-valued logic. And yet this is an extremely important matter; because if we accept only the formulas $2/4 \vee 2/4 = 2/4$, the right of the excluded measure in many-valued logic must be eliminated. (Because $\sim 2/4 = 2/4$, therefore $p \vee \sim p$ will get 2/4 for $p = 2/4$, so it will not be true). However, the right of the excluded measure remains valid even in many-valued logic, if for the case of exclusion we assume the value of the formula $2/4 \vee 2/4 = 1$, and the formula $2/4 \vee 2/4 = 2/4$, will be limited to cases of overlapping probabilities only. It should be remembered that in many-valued logic only the principle of bivalence falls away, according to which every sentence permits only two values, whereas the right of the excluded measure, according to which two contradictions must be true, can be preserved in many-valued logic; and even must be preserved, if this logic is to agree with the probability calculus, because according to this calculation, one of the two contradictory possibilities must occur. One should therefore avoid mixing the principle of bivalence with the principle of excluded measure[224].

In his "probability logic", Reichenbach gave such a link between the new logic and the calculus, which helps him to remove all these difficulties[225]. It distinguishes between qualitative, intentional (which he also calls "topological") many-valued logic and quantitative, experimental or "metric" logic. Only the metric conception of many-valued logic, which commands the sentences of many-valued logic to be interpreted as a class of sentences of bivalent logic, makes this logic a system of verifiable sentences. Therefore, Reichenbach rejects the intentional interpretation that already assigns a certain number of values to a single sentence. Reichenbach, however, corrects Post's demand that bivalent sentences whose ordered classes (or strings) are to be included as elements of many-valued logic can be presented as values of one and the same sentence function. This amendment is not necessarily a new one , as it is already at Łukasiewicz's in the dissertation of 1913 titled *Die logischen Grundlagen der Wahrscheinlichkeitsrechnung* gave a similar interpretation of the probability value. Reichenbach, who is a supporter of the frequency definition of the measure of probability, extended this concept of probability values to propositional functions that allow an infinite number of values.

To calculate the value of the logic functions of sum and product, Reichenbach uses the most general formulas of probability; in his logic so many different values for the sum and the product of how many of them the calculus contains. In this way, this discrepancy of logic and calculus that occurred in Łukasiewicz's and in Post's calculations disappeared in Reichenbach's. However, since Reichenbach has determined the implication

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224 Jan Łukasiewicz, "Philosophiche Bemerkungen zu mehrwertigen Systemen des Aussagenkalkül," in: *Comptes Rendus de la Société des Sciences de Vasovie*, Classe III (Warszawa: 1930).

225 Hans Reichenbach, "Wahrscheinlichkeitslogik," in: *Sitzungsberichte, Preussische Akademie der Wissenschaften, Phys.-Math.* Klasse 29 (Berlin: 1932), pp. 476–490.

by means of negation and logical sum, the ambiguity of sum and product is in his calculations also transferred onto the implication and – at the same time – on equivalence, since the latter depends on the manner of determining the implications.

We allow ourselves to include here some comments about the Reichenbach system. Its distinction between metric and topological treatment of logic is quite accurate; it seems, however, that although topological considerations alongside metrics are not completely superfluous, a far more important thing is that Reichenbach introduced an unnecessary complication to calculate implications and equivalence, so that these logical functions unnecessarily take as much value as the sum and the product. That is why we have created a many-valued logic system that has all the benefits of the Reichenbach system and at the same time avoids – in our opinion – its negative sides. As basic concepts, we took the Łukasiewicz implication and the cyclic negation of Post and – based on the formulas given by Post – we introduced as many logical functions of the sum and product as the calculus needs them. However, the implication and equivalence retain a constant value in us. The laws of contradiction and the excluded measure retain their value in our system as in Reichenbach's, and unlike the systems of Łukasiewicz and Post.

In the article *Les logiques nouvelle et le champ de leur application*, published in 1932 in the French magazine "Revue de Métaphysique et de Morale"[226], we pointed to two possible applications of multivalent logic. The parallelism of wave and corpuscular physics seemed, to us, understandable only in the light of Łukasiewicz's three-valued logic; while an objective interpretation of the probability calculus seemed to indicate the relationship between this calculus and many-valued logic. As for the first application, it is possible that our first attempt was premature; it is possible that both theories do not concern the same details in the real underlying phenomena, i.e. that theories are not contradictory. It is possible that the further development of physics will shed more light on this matter. All the better, if it turns out that our explications are unnecessary, as we must admit

226 Zygmunt Zawirski, "Les logiques nouvelle et le champ de leur application," *Revue de Métaphysique et de Morale*, Vol. 39, No. 4 (1931), pp. 503–579.

that, as it seems, it does not bring any solutions to these difficulties, but only further emphasizes the difficulty of the problem solution.

Regarding the second point, i.e. linking the calculus with many-valued logic, one must admit that Reichenbach's work from 1932 overtook our efforts in this direction. We must express our full appreciation for his work here, however in many details we have moved away from him. We agree with Reichenbach on the point that in many cases probability declaration must pass as the final and reasonable form of decidability. Justifying this claim, Reichenbach, who clearly backs the frequency definition of the measure of probability, referred to the fact that the *limes*-time statement for $u = \infty$ for sequences occurring in nature is undecidable and senseless from the position of bivalent logic, and only within probability logic it becomes a meaningful and decidable theorem.

The above detail indicating some difficulties related to the concept of infinity, however, may be one of the motifs for which the postulate of decidability must satisfy itself with the decidability of probability. There are other motifs that lead to such a position. These are all arguments that justify an objective understanding of probability. The state of contemporary natural science, as we have pointed out in the above-quoted French article, also speaks in favor of this probability understanding. In any case, this problem deserves closer examination, and the contemporary logicians, such as Łukasiewicz, Post and Reichenbach, deserve gratitude for the fact that they have prepared formal tools for the scientific treatment of similar issues.

2 Importance of logical and semantic research for the theory of modern physics[227]

Speaking of the significance of logical and semantic research for physics, we do not want to make it clear that this influence is only one-sided and imposed in some way. On the contrary, contemporary physics, with the help of its theories (like relativity theory or quantum theory) gives impetus to new logical-semantic considerations in the field of theory and one can

227 Zygmunt Zawirski, "Doniosłość badań logicznych i semantycznych dla teorii fizyki współczesnej," *Przegląd Filozoficzny*, Vol. 41 (1938), pp. 25–30. The paper presented at a philosophical convention in Paris in 1937.

also speak well about the influence of mathematics and natural sciences on the theory of scientific cognition.

We distinguish two scientific methods, the deductive method used by mathematical sciences and the inductive method used by empirical sciences. But while the deductive method can only be characterized by deductive reasoning, the method of empirical sciences, i.e. inductive, cannot be defined by inductive reasoning explicitly, because deductive reasoning also finds its application in it. Based on protocol sentences, we rise in the empirical sciences to general laws – as it is usually said – by means of induction, but these laws enter the empirical sciences only when they are checked, and then also the deductive method finds its application in them. In the advanced state of empirical sciences, one almost never goes to check for a single empirical law, treated in isolation from others, but works or disproves the whole system or theory. The number of independent laws and hypotheses decreases to such an extent that every general empirical opinion takes some responsibility for the entire system to which it belongs. One often has the impression that deductive systems are built only to be able to apply them in the empirical sciences. The idea is that there is only one scientific method, the method of real sciences, the science of facts, because the deductive method is only an auxiliary tool for the method of the science of facts. But one can also characterize the development of real science as a series of systems that fight, modify and improve endlessly, and whose number decreases incessantly.

It seems to us that the development of the deductive method contributes the most to the processes aimed at specifying the methods in general, because the gathering of protocol statements has only the effect of reducing the number of systems as the number of protocol sentences increases. Let us see, then, how the scientific nature of the theorem belonging to the system within the physical sciences is being specified. It is said that such a sentence has sense, i.e. it is scientific in nature if it is subject to verification or refutation. It was rightly noted, however, that this definition cannot be applied to deductive systems treated in isolation from their possible applications. In such a system, the language and its components depend on our choice. By building the system, we construct the language simultaneously. The sentence has meaning for us as far as it can be expressed in the terms of our language. But even here the scientific opinion is not identical to a sentence that can be proven or disproved. We distinguish between complete systems and incomplete systems. The system is complete if every sentence expressed in terms of the system in a sensible way functions in the number of theses of the system or, when attached to the system, creates a contradiction[228]. But we also know incomplete systems that do not possess the above property. In the language of such systems, there can be formulated sentences, which are neither theses of the system nor will they create contradictions when attached to the system. An example of such a system is arithmetic. Fermat's great theorem, when attached to the arithmetic system, does not create any contradiction; and all attempts of proposing evidence in the general form have so far failed. The above state of affairs seems not to be exceptional, for the young scholar of Vienna, Kurt Gödel, has created a general method for constructing undecidable sentences in all such systems that are the superstructure of arithmetic. Therefore, as one can see, there are deductive systems in which some sentences are undecidable; thus one cannot equate sensibility with decidability[229].

However, one can give a definition of a real sentence in such a way that even undecidable statements will have to be true. As, in the case specified above, it was about arithmetic, and arithmetic sentences are commonly regarded as tautological tasks, if we equate tautological statements with real ones, we will be forced to consider arithmetical sentences that are undecidable. But one can act differently. It is known that Brouwer and Heyting have constructed a new logic in which they do not recognize the absolute validity of the excluded measure and in which, apart from real

228 Equivalent to the above definition is the following definition: The system is complete if out of two contradictions at least one is the thesis of the system (axiom or proven theorem).

229 We had a problem in the French reading with the translation of the term *undecidable* (*unentscheidbar* in German), which some give away using the term *invérifiable* (see Alexander Hilferding, *Le fondement empirique de la science*, Louvain: 1936, p. 7), whereas others use the term *indéterminable* (vide Chaim Perelman, *L'antinomie de K. Gödel*, Bruxells: 1936). We used both terms, although the first one suggests the importance of the too-tight verification, as an empirical decidability by checking, and the second suggests the importance of broad meaning, which connects with Carnap in its terminology in connection with the distinction of its *Folge-Verfahren* as opposed to *Ableitungs-Verfahren*. We also used the word *insoluble*, but this can refer only to the problems, not to sentences.

and false sentences, undecidable sentences are accepted that are not false in truth, but whose truth cannot be proved. Prof. Łukasiewicz's student named Jaśkowski, showed that the Heyting's logic, seemingly trivalent, in fact, leads to infinite, many-valued logic[230].

The question arises whether these results obtained through consideration of deductive systems have any value for physical theories? We think so, because all physical theories are the superstructure of not only logic but also arithmetic. Thus, each physical theory carries in itself, as applied arithmetic, issues that are undecidable in a certain sense. One can assume that the source of these undecidable problems are certain arithmetic concepts of an exceptional nature, such as the concepts of infinity and continuity, and that if it were possible in natural science to do without these concepts, then all difficulties would disappear. But we are not sure. We omit here the further difficulties that arise in physics from the necessity of choosing one of the various geometries, and we will now approach the difficulties that arise from the special nature of empirical assertions.

We distinguish, as we have already mentioned, detailed sentences, protocol statements (fundamental sentences) and general sentences obtained from the latter through the inductive processes. General sentences enter into the construction of the systems that are always provisional. It would seem that the problem of verification concerns only general sentences, empirical laws, because these are always uncertain and hypothetical. But in recent times it has been argued that even protocol sentences are not inviolable, because they require control and can be shaken. What sometimes occurs is the psychological impossibility of rejecting them, but there is no need to logically preserve them. Sentences can only be justified on the basis of other sentences; but what logical relationship can exist between certain sentences and facts of experience?

It seems that here some difficulties have been exaggerated too much. If we provide empirical data with certain names (not necessarily names but names that exist by means of a coordinate language), their ratio to protocol sentences will be presented as the ratio of the values of certain variables

230 The assertion that the Heyting system is infinitely multivalent comes from Gödel; Jaśkowski gave only proof of this claim.

to the propositional functions in which these variables appear. We say then that these values check our function by providing us with protocol statements (fundamental sentences). In this way, the relation of empirical data, i.e. facts of experience, and fundamental sentences can be expressed in logical terms. But do these empirical facts provided with names unambiguously determine the appropriate protocol sentences? It depends on the language used. As long as our language is not established, the same facts can be expressed using different protocol sentences. However, once our language is established, the fundamental (protocol) sentence is unambiguously determined by the experience data.

But the same difficulty that existed for the ratio of the facts of experience to protocol sentences appears again when we consider the relation of protocol sentences to theory, understood as a set of empirical laws that are a generalization of protocol sentences. In other words, the question arises whether the same detailed sentences always check the same theory, or whether different theories can be checked by the same protocol sentences. As it seems, there is no doubt that different theories may be used to refer to the same protocol sentences, and that they may even lead to predictions of new phenomena. Thus, self-examination is not enough, and what's more, it does not even allow us to distinguish between empirical theory and metaphysical theory. The most diverse and most capricious theories can often lead to the same consequences[231]. Therefore, it was rightly argued that a scientific theory should not only be able to confirm, but also to refute. Popper, who paid attention to this particular detail, committed an exaggeration here, considering this detail as the only criterion for the scientific nature of empirical propositions. This is also why he rejected induction. However, it was rightly noted that the overthrow of an experiment or observation has the same relative character as the check; therefore, if we look closer to the process of checking or disproving, we will see that the alleged asymmetry does not exist.

In accordance to Reichenbach, we maintain that the relation of fundamental sentences to general empirical theorems can be expressed in the terms of logical probability theory, based on the concept of relative

231 Sometimes, however, a change in theory may result in a change of the entire language, and then there may be a change in the formulation of certain protocol sentences and not just rights.

frequency. But is this position really connected with the type of many-valued logic? Undoubtedly, the probability metric is based solely on the two-valued logic and no string of true or false sentences is yet a pattern of a new sentence of many-valued logic. But this empirical sequence can fund a new sentence, a supposition (a *putting*, using Reichenbach's expression here) that is already in the opinion of a many-valued logic, a kind of weakened assertion. This new many-valued logic is completely different from the many-valued logic offered by Brouwer, Heyting or Jaśkowski; it has, as we have seen, its source in the consideration of undecidable sentences (due to a certain way of proving).

One more detail of Popper's position deserves our attention. As the empirical process of confirmation or refutation cannot be prolonged without end, it is possible that our ideal of finite knowledge can never be achieved. If we want to measure the scientific character of empirical propositions according to their ability so as to check and disprove, we must confess that in this respect this scientific character is not sharp at all.

Does this mean that we are moving toward some skeptical consequences? Not at all. We would only advise a little to expand the scale of science for theorems and systems that would have to be considered unscientific if the scientific approach were too close. In addition, we were guided by a different thought. It has been shown recently (Alfred Tarski) that the classic concept of truth can be maintained and that its definition does not put us at risk of a vicious circle or antinomy. Based on this definition, it is possible to prove the validity of the principle of the excluded measure and the principle of contradiction for the languages of such systems in which this definition can be carried out. But the very definition of the real sentence does not give us the criterion of truth. The latter can take place only in very exceptional cases for formalized deductive systems, where this definition may take the form of a structural one. The long-term discussion between absolutism and relativism is not yet closed by the possibility of a correct definition of the true sentence. Actually, we think that in the discussion of this matter the issue of the so-called probability decidability, as the final method of decidability in certain issues, should also be taken into account. Apart from that, one should be more careful while paying attention to all these cases, where bivalent logic and the ideal of uniform knowledge based on it, encounter some embarrassing situations for any whatsoever reasons.

3 Comments on the natural sciences method[232]

The way hypotheses are tested in the natural sciences seems to be of the utmost importance for a philosopher interested in the method of these sciences. The hypothesis is either a general theorem, or a unitary sentence about some elements of reality that are inaccessible to direct observation. Accepting a hypothesis (even provisionally), we derive specific conclusions from it and try to check whether they agree with the other hypotheses it concerns. If there is agreement between predictions drawn from the hypothesis and facts observed directly, then the hypothesis is confirmed and obtains the right of its functional "citizenship" in science. If we find a discrepancy, then the hypothesis is refuted and we reject it.

Recently, it was often emphasized that the negative result of checking the hypothesis is more important than the positive one. Confirmation of the hypothesis does not prove that it is right, it can be changed at any time, if it is demanded by the progress of science. At the same time it is worth observing that the negative result is decisive – the hypothesis is completely refuted. The rejection of the hypothesis corresponds to the logical law (from the theory of deduction) called *modus tollendo tollens*: If the hypothesis H implies the conclusion p and this conclusion p is false, then the hypothesis H is false.

$$\left[(H \supset p) \wedge \sim p\right] \supset \sim H$$

There is, therefore, an asymmetry between the positive and negative results of testing the hypothesis. The positive result only increases the probability of the hypothesis, while the negative result completely refutes the hypothesis.

However, some reservations are needed here. A complete removal of the hypothesis occurs only when none of the concepts included in and playing the role in the description of the experiment have been changed. For if the significance of the terms used is changed at least minimally, the hypothesis that has been refuted can be taken again. For example, the corpuscular theory of light rejected after Foucault's experiments was again introduced into physics by the quantum theory, when along with various changes in the theory of light the meaning of the word "corpuscle" changed. The same

232 Zygmunt Zawirski, "Uwagi o metodzie nauk przyrodniczych," *Przegląd Filozoficzny*, Vol. 44 (1948), pp. 315–318.

applies to the situation *experimentum crucis*, and/or *instantia crucis*, i.e. to the case when one of two competing hypotheses or theories is chosen to provide a new discovered fact. From the two equally acceptable hypotheses, simultaneously, by means of one and the same newly discovered phenomenon, one of the hypotheses is confirmed and the other depreciated. There is an analogy between the verification of a particular hypothesis and the resolution of a conflict between two competing hypotheses. In one or the other case, we are forced to choose one of several possibilities, all of them forming an alternative. In the second case, the alternative is only more complicated. In the first case, what is expected is an affirmative or a negative answer only; in the second case, a positive answer to one hypothesis is at the same time a negative response to the second hypothesis. However, it is easy to see the analogy between two situations and, at the same time, notice the difference between them if one understands the content and complexity of the hypothesis. Let us assume that the hypothesis is a logical conjunction of three sentences: "*p*","*q*" and "*r*", and that it is rejected because of the falseness of its consequences. We receive a negation of this conjunction. But this negation $\sim(p \wedge q \wedge r)$, can be transformed according to the laws of logic in such a way that we get an alternative consisting of seven parts:

$$\sim(p \wedge q \wedge r) \equiv \begin{bmatrix} (\sim p \wedge q \wedge r) \vee (p \wedge \sim q \wedge r) \vee (p \wedge q \wedge \sim r) \vee (\sim p \wedge \sim q \wedge r) \vee \\ (\sim p \wedge q \wedge \sim r) \vee (p \wedge \sim q \wedge \sim r) \vee (\sim p \wedge \sim q \wedge \sim r) \end{bmatrix}$$

We rejected the "$(p \wedge q \wedge r)$" conjunction and we faced the necessity of choosing one of the seven other possibilities. At the same time, the more complicated the hypothesis, the more possibilities we could choose. Only in the case of very simple hypotheses, the rejection of one hypothesis is tantamount to accepting only one other hypothesis. However, these accidents are rare. Even the problem of whether the world is finite or infinite is not such a case, because the meaning of the term *finite* is mixed with the meaning of the term *limited* and for that reason instead of a simple two-part alternative we get a four-part alternative:

$$(p \wedge q) \vee (\sim p \wedge q) \vee (p \wedge \sim q) \vee (\sim p \wedge \sim q)$$

(*p* does not mean that the world is finite, and *q* that it is limited). The physical meaning of the terms used reduces somewhat the alternative, because the situation that the world was infinite and limited is actually impossible, although logically permissible. Thus the "$(\sim p \wedge q)$" element is eliminated; however, despite denying that the world was finite and unlimited, we get an alternative that it can either be finite and unlimited (a case omitted in classical cosmology), or infinite and unlimited. In the case of the so-called *experimentum crucis*, it is rare for the competing hypotheses to be two contradictory statements. Therefore, it is better to pay attention to the complexity of hypotheses than to their number, which often depends on random historical conditions.

Duhem had reservations about the possibility of *experimentum crucis* in respect of case physics. He claimed that "physical experience can never disprove any one isolated hypothesis, only the entire set that creates the whole theory of the phenomenon" and therefore "experimentum crucis is impossible in physics". This reservation is absolutely correct. A formula:

$$\left[(H \supset p) \wedge \sim p\right] \supset \sim H$$

can be used only in very rare cases, when a theory does not exist yet. The conclusion p is often derived not only from one hypothesis "H", but also from the entire set of sentences "T_1", "T_2", "T_3" ... "Tn", creating the theory, to which we add the hypothesis "H". Hence the reasoning scheme should be the sentence:

$$\left[\left(\left(T_1 \wedge T_2 \wedge T_3 \ldots T_n \wedge H\right) \supset p\right) \wedge \sim p\right] \supset \sim \left(T_1 \wedge T_2 \wedge T_3 \ldots T_n \wedge H\right)$$

from which we get a sentence

$$\left[\left(\left(T_1 \wedge T_2 \wedge T_3 \ldots T_n \wedge H\right) \supset p\right) \wedge \sim p\right] \supset \sim T_1 \vee \sim T_2 \vee \sim T_3 \vee \ldots \vee \sim T_n \vee \sim H$$

The negative result of the experiment only proves that the conjunction "$T_1 \wedge T_2 \wedge T_3 \ldots T_n \wedge H$" is false. Hence, something needs to be changed in this conjunction; either the H hypothesis has to be rejected, or one of the laws recognized so far. If the complexity of the H hypothesis were still taken into account, the number of possibilities would have to increase.

However, although in theory Duhem is right, in practice the situation is not so hopeless. We always choose the easiest way. Theory is not just a set of experimental laws; it is a collection that also contains many assumptions and/or definitions. Sometimes it is enough to change the definitions themselves. Sometimes, however, there are more complicated events that can trigger a revolution in science. Such accidents occur when it is difficult to decide which route is really the simplest. Such a situation was in the moment of the emergence of the theory of relativity as well as the one when the formation of quantum theory took place. Classical laws have proved to be incompatible with experience. So, in this moment, one could either doubt all classical physics, or attach some auxiliary hypotheses to it. The second way seemed simple at first. However, when the number of negative experiences kept increasing slowly but steadily and as more and more auxiliary hypotheses grew, the idea of construing a classical physics construction turned out to be the simplest way out of this quite embarrassing situation.

The history of quantum physics again shows us something that has never been seen before, namely, two initially incompatible theories are complementary and can co-exist. A few years ago, we proposed the use of three-valued logic in quantum physics. However, by doing so, one should carefully examine whether the concepts of wave and corpuscles are really contradictory. As it turns out, they are not like that. Wave and corpuscular theory are somewhat incompatible, but the first one is not a negation of the other. One should rather take an expectant attitude, or adopt a more concrete answer, that the constant *h* and therefore the Heisenberg law creates an impassable boundary for checking the microstructure of the world.

4 Toward the analysis of the scientific synthesis[233]

The opponents of metaphysics most often turned and still draw attention to the need to synthesize human knowledge, so that one has the impression that this synthesis is to be a kind of metaphysics. Indeed, today's neo-positivists, by stating the slogan of knowledge unification, refer to Comte and Spencer as their predecessors; but, on the other hand, they would be willing to refer to the tradition of Leibniz's *mathesisi universalis*, which had to solve all reasonably posed issues definitively and was most closely related to metaphysics. If neo-positivists are talking about an encyclopedia rather than a system, it is because they realize that the inclusion of all human

233 Zygmunt Zawirski, "W sprawie syntezy naukowej," *Przegląd Filozoficzny*, Vol. 39, No. 4 (1936), pp. 347–350.

knowledge into one system may fail; at the same time, they are ruthlessly opposed to the gaps in the current state of knowledge to be supplemented with subjective guesses.

The exact separation between scientific synthesis and metaphysics cannot actually be carried out. Metaphysics is often accused of operations of the hypotheses which, unlike scientific hypotheses, are essentially unverifiable. Meanwhile, no hypothesis can be directly tested and only the consequences of hypotheses are verifiable; in this respect, metaphysical hypotheses are no different from scientific ones. In recent times, the ability to falsify *falsification* (Popper, *Logik der Forschung*, Springer: 1935) is undoubtedly better suited for this purpose, but in our opinion, only some wrongly constructed metaphysical hypotheses are not capable of falsifications.

The positivists' claim that scientific notions, seemingly going beyond experience, can be defined with the help of empirical data – as they admit themselves today – was wrong (Carnap, *Actes du Congrés international de philosophie scientifique*, II, Paris: Hermann, 1936, pp. 61–70) and therefore I propose a different, more correct wording that all scientific concepts can be empirical, as well as able to be checked and/or reduced. The notions introduced by the reduction are different from the concepts introduced into the system by definition, so that they cannot be excluded from the system, while the definitively introduced terms can be eliminated i.e. they are translatable. Reductions would therefore only be recognized as some pseudo-definitions. We doubt whether this wording can be considered as final and sufficient: in any case it must be assumed that the meaning of all scientific terms and thus the terms of scientific metaphysics must remain under the constant control of experience.

Scientific metaphysics, if it is based on experience (and only such a form of metaphysics can be defended today), should therefore operate with terms whose meaning must be subject to the control of experience, and which all theses should be not only verifiable, but also *subversive*, if, in this way, following Kotarbiński, we will translate Popper's term *Falsifizierbarkeit*. To the scope of metaphysical issues understood in this way, we include the issue of the temporal-spatial structure of reality, the problem of its dynamic structure, which cannot be separated from that, which includes both deterministic and indeterministic issues discussed on the basis of science, and the purposefulness with which our faith in the moral order of the world has been associated all that time.

We do not exclude our intuition from participating in the construction of such a system. However, since intuitive data is often unstable and even contradictory, there is always a need to capture intuitive beliefs in an axiomatic system, because only then can you be sure that you know yourself what you want to say and that you are well understood by others. Recognition of intuitive beliefs in a system (i.e. a set of sentences that covers all of its consequences), of course, does not absolve us from the obligation to look for counterparts in the experiment and therefore from the obligation to release it on the flop of not only checks but also falsifications. We do not make an exception in this respect for any system, the simplest deductive system that creates the laws of logic included.

It has to be observed that contemporary science, and thus, naturally, scientific metaphysics, is today free from Leibniz's illusions, that every scientific problem is sensible and, therefore, decidable. Determinacy and reasonableness only overlap in complete systems. However, we know incomplete systems. The young scholar of Vienna, Karl Gödel, gave – for all deduction theories including arithmetic – the general method of constructing such sentences, which on the basis of a given theory cannot be proved or disproven; he also stated that the sentences built by his method become undecidable if the language used there has been enriched by entering variables of the higher logical types. The above discoveries reveal the importance of language for a system that unifies our knowledge. Whoever undertakes to work in this direction must not only be familiar with modern logic, but also with the results of research in the field of semantics. Just as traditional metaphysics can be revived only by maintaining a living contact with science, traditional cognitive theory must undergo a rejuvenating treatment by including research in the field of semantics and logic (especially the part that is called metalogic). Without prejudging the question whether all the problems of the traditional theory of perpetration are to be reduced to semantic issues, we will pay attention to the importance of two works published in recent years in Polish, i.e. Dr. Tarski's *Pojęcie prawdy w językach nauk dedukcyjnych* [*The Concept of Truth in the Languages of Deductive Sciences*] and Prof. Ajdukiewicz's *Naukowe perspektywy świata* [*Scientific Perspectives of the World*].

The first author shows that on the basis of deductive languages, one can construct an accurate and formally correct definition of a real sentence, and that this can be done in accordance to the classic understanding of truth, according to which something is true as far as it is able to resemble the reality. At the same time, it is obvious that the scope of the term "true sentence" depends on the language being the subject of research, because it is impossible to speak about the meaning of expressions in isolation from the language to which the expression belongs. The article by Prof. Ajdukiewicz draws attention to the possibility of non-translatable languages, not because some of them aretoo poor, but because they are closed and coherent in the author's sense. The author expresses the supposition that the language of classical and relativistic physics is such an untranslatable language. Following Reichenbach, we tried to describe the relationship of these two languages in the past, saying that the claims of one of them are borderline cases often found within the claims of the other. It is possible, however, that this boundary case is not the old language itself, but its equivalent and our statement would be as erroneous as the natural numbers 1, 2, 3 … are included in the set of rational numbers, while it is not them that are not contained in there, but some of their equivalents 1/1, 2/1, 3/1 … (see Henryk Mehlberg, *La théorie causale du temps*, Lvov: 1935, p. 109).

The inexplicability of languages can also come from the difference in the forms of logic that such languages use. It is known today that there are different logic systems that have the feature that one cannot translate one into another one. And here we have the right to suppose that only one of these systems best suits reality. The future, however, will only show whether it should be a system of binary logic, as we have suspected so far, or one of the many-valued logics.

Conclusion

In this first volume of the monograph titled *Towards scientific metaphysics*, I turned my attention to the results of research done by Zygmunt Zawirski; while analyzing his scientific achievements, I have made an attempt to present it in the context of his aspirations to develop scientific metaphysics. I also carried out a critical analysis of the above issues, referring to other Polish philosophers, so as to determine the place and completeness of his concept of scientific metaphysics and to underline its relevance in philosophical research of the first half of the 20th century. I have provided detailed remarks and criticisms in particular subsections of the second part of the current volume. At this point, I will present the most general observations and conclusions regarding the philosophical achievements of Zygmunt Zawirski.

Many of Zawirski's philosophical proposals still remain valid. It is possible to mention here the analyses of the cyclical nature of time, the problems of causality and the initiation of methodological studies, containing ideas that were developed by Karl Popper, but also Thomas Khun. The application of many-valued logic to contemporary scientific theories remains a valuable contribution to the general picture of scientific research.

The main task, however, was the critical analysis of the scientific concept of metaphysics. It turned out that this concept did not get proper development by Zawirski, although there were strong methodological premises, important achievements in the methodological and metalogical research of the 1930s. In those years, Zawirski limited his own project of empirology and meta-empiria to the study of the possibilities of building the synthesis of natural sciences. It should be stated, therefore, that Zawirski's concept of scientific metaphysics is an interesting and still valid research program that he did not implement. Apart from the timeliness and the need to implement the idea of building a scientific metaphysics referring to experience and using *a priori* science, it should be stated that the proposal presented by Zawirski can be considered as an interesting and still current research proposal.

An important research result of Zawirski's works remains the argument for the existence of a fundamental world of mathematical-logical structures that indicates the existence of the absolute world. Hitherto attempts to determine the philosophical position adopted by Zawirski pointed to the manifestation of positivist tendencies, but the analyses of his issues regarding the determination of a place for metaphysical issues indicate that actually he adopted a position quite similar to the one found in Plato's considerations.

It turns out that the question whether modern knowledge of nature reveal to us the nature of absolute reality still remains positive. According to Zawirski, physical knowledge does not present us with absolute reality, at times being able to indicate its existence. Both the objects revealing their relative features, as well as invariant laws belonging to the world of phenomena have their deeper base in the sphere of absolute reality. The physicists cannot forget about this reality when they make an attempt to relate their subjects of currently performed researches to the whole of the cognized being.

The axiomatic method used by Zawirski in metaphysical studies deserves special treatment. It is undoubtedly a breakthrough in understanding the development of metaphysical systems. The order of metaphysical systems was often considered in the order of time, in accordance with the Hegelian dialectical development pattern. Zawirski's proposal to build scientific metaphysics as a deductive system in which scientific methods are applied is a proposal to enter a path leading to constant progress. In Zawirski's views, this progress is guaranteed by the adoption of the method of particular sciences as the only method of discussing philosophical problems. This progress cannot, therefore, guarantee either reference to the Hegelian dialectical method or the methods of research of intuitionists found in Bergson or Husserl. It is known that scientific metaphysics does not exhaust all issues of interest that may be important to people, therefore although there will always be a need for constructing a more general metaphysical theory, we would like to leave this issue aside.

What is important in Zawirski's works is his view that progress in logic cannot be indifferent or ignored in philosophical research. Even if one treats logic as one of the purely propaedeutic teachings, it is an indispensable field in philosophical education, therefore one cannot be a philosopher without knowing logic. One cannot agree with the objections to the scientific metaphysics conceived in this way, i.e. reduced to the deductive system that it does not allow to examine reality in qualitative terms. These statements, in my opinion, do not reflect the truth; even a simple deductive system of sentences, considered according to the principles of the deductive method, determines the field of logic, i.e. the science which, in this case, does not investigate either size or quantity. Therefore, justifying this type of research, in the second volume of this dissertation, I will focus on Bornstein's scientific metaphysics, and in particular the general theory of reality described in the aspect of quality, not quantity.

Support and strengthening of the building of scientific metaphysics along the lines of the deductive system can be found in the works by Łukasiewicz and Tarski from 1930s, which resulted in the appearance of a fully new discipline of science – metalogic. The results of research on deductive systems should, in my opinion, be used to study systems of scientific philosophy. In my opinion, this type of research does not exclude various interpretations of these systems. An important issue, therefore, is the implementation and philosophical use of the possibilities of different interpretations of deductive systems. Assuming that the system of axioms of the system will also be fulfilled for the new meanings of the original terms appearing in the axioms, we obtain a new interpretation of the axioms, and thus the whole system. This issue will also be the subject of the research contained in the second volume of this monography – "Towards Scientific Methaphysics".

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The book presents results from research conducted by Zygmunt Zawirski on the theory of knowledge, quantum mechanics, logic, ontology and metaphysics. The works undertaken in the field of logic, methodology and philosophy of science, and in particular the philosophy of nature and natural science testify to a solid preparation for the fundamental task of developing contemporary scientific philosophy. The emerging mathematical natural science did not have those possibilities which emerged in the 20th Century and which Zygmunt Zawirski (1882-1948) used. In the development of scientific metaphysics, he took into account both the achievements of modern logic, mathematics and physics. Zawirski builds scientific metaphysics by referring to empiricism, broadly understood experience. Modern metaphysics should meet high standards of precision and uniqueness, which is why Zawirski attempts to apply the axiomatic method to both the analysis of the theory of physics and the scientific metaphysics.

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