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REVEREND PROFESSOR MICHAEL HELLER. HIS LIFE AND PHILOSOPHY¹

Cogitare necesse est. There are people so engrossed in the maxim quoted (“thinking is a necessity”) that they are surprised at any attempt to justify it. One such person is Reverend Professor Michał Heller, a cosmologist and a philosopher, for many years connected with the Faculty of Philosophy of the Pontifical Academy of Theology, who is now celebrating his sixty-fifth birthday. The following paper consists of two parts. The first is a short biography of Professor Michał Heller, written on the basis of an autobiographical note and the information imparted by Prof. Heller himself. The second part attempts to present an introductory sketch of his philosophical thought.

A SHORT BIOGRAPHY OF PROFESSOR MICHAŁ HELLER

Michał Heller was born on March 12, 1936 in Tarnów. His mother, Zofia (nee Strugalewicz) came from a Polish family residing in Ukraine, in the Kiev province; her father owned a small estate near Murafa. She was a young girl at the time of 1917 Revolution and the war of 1921. After the “war against bolsheviks” she clandestinely made her way to Poland.

His father, Kazimierz, was a graduate of the Vienna and Lvov Polytechnics. He began his professional career in Switzerland, but after Poland regained its freedom he returned to his native country and worked as an engineer at Nitrogen Compounds Plant in Mościce, near Tarnów. As a member of minister Kwiatkowski’s group of advisers he actively participated in the implementation of the so called “Poland B” project: he was working on the construction of factories in Nisk and Stalowa Wola. When the Germans marched in, a group of engineers decided to disable the newly built chemical plants in southern Poland. As a result Kazimierz Heller, an active partici-

¹Analecta Cracoviensia XXXIII (2001), s. XI–XXXII, Wyd. Naukowe Pap. Akad. Teolog. w Krakowie. [Some corrections by the PDF ed.]

pant of organized sabotage, had to escape with his family to the east. The Hellers settled in Lvov for a short time, but already in 1940 the Russians removed the family to Siberia.

The life in exile began in a labour camp in the Yakutsk oblast. When Russians concluded a treaty with the Allied Forces, the Poles were released from the camp. The Hellers put up in a town of Aldan, in an area known for gold mining. The times that followed were marked by severe hunger, which set in the Hellers' home even though Kazimierz found employment in a mining school. In 1944 Stalin, afraid of an approaching German offensive, ordered relocation of the Germans from the Volga region to Siberia. The Poles were put in their place. That was how the Hellers found themselves in the steppe kolkhoz in Urbach, near Saratov. It was in Urbach that Michał Heller finished the second and the third form of a primary school which was organized by the Association of Polish Patriots at Russian schools.

The end of the war made it possible for the Hellers, along with many others, to come back to Poland in 1946. Michał's father resumed his job as an engineer in Mościce. It was there that Michał finished his primary school (beginning with the fifth form) and proceeded to a Gymnasium. In 1953 he passed his final exam of secondary education and entered the Higher Seminary in Tarnów.

Religious traditions were always deeply cherished in the Heller's family. Zofia was a devout believer and followed religious principles in her life. Kazimierz gave traditional religiousness an intellectual tinge. He was a versatile intellectual talented in mathematics and the arts (he could draw very well, was interested in philosophy), who also preserved his faith in the times of positivism, during his academic studies, while in Soviet Russia, in exile, and in post-war Poland. Conversations on religious subjects, often held in a circle of very interesting people who visited the Hellers, undoubtedly had a considerable influence on the future priest.

In difficult war conditions, due to hard work under his parents' supervision, student Heller made a more rapid progress than his peers: in Urbach he was admitted to the second form, after the war the situation repeated, and, under recommendation of the school director in Mościce, he skipped the fourth form. Moreover, at the Seminary his class was the last to take a five-year course of studies. On finishing his philosophical and theological studies Michał Heller turned out to be—in the light of Canon Law regulations—too young for ordination. As a result, before taking holy orders he had to wait one whole year in... his family home. He used this time to write a dissertation concerning biblical exegesis entitled: *Współczesny stan egzegezy*

Rdz 1, 1–2, 4 (The Present State of Exegesis, Gen 1, 1–2, 4). Therefore, his ordination year (April 26, 1959) was also the year when on the basis of the above mentioned dissertation the Lublin Catholic University conferred on him the degree of Master of Arts in theology. It may be worth mentioning that, following his son's decision to enter the Seminary, Michael's father suffered various persecutions on the part of communist authorities.

After ordination, Michał Heller was substituting for a priest in Ropczyce and stayed there for one year of curate work. There were certain family recollections for the young priest in Ropczyce. His grandfather Bolesław, who had taken active part in public life (after Poland regained independence he was even a candidate for a minister), held the office of District Starost at the times of Austro–Hungarian rule. The period when Michał Heller came to Ropczyce was a difficult one. It was the last year of teaching religion at schools. Communist authorities were strenuously trying to make the removing of religion classes look as if done “on parents' request.” Priests and parents alike complied with sophisticated and absurd demands of the authorities to save religion lessons. The fight was exhausting and not lacking in tragicomic episodes, e. g. when the young curate was interrogated in a building that had once been his grandfather's property. “This was one of most difficult periods in my life,” Michał Heller said after many years. He added: “not because of skirmishes with the authorities, however, but due to a painful encounter with real life, for which the Seminary had prepared us not at all.”

In 1960, according to bishop Pękala's decision, Michał Heller began his studies in the natural sciences at the Faculty of Christian Philosophy of the Catholic University of Lublin (KUL). During his studies, also on bishop Pękala's suggestion, he applied for a passport to continue his studies in Rome. Yet, his application was rejected by communist authorities. This decision remained unchanged until the “times of Gierek,” as it is only at the beginning of the 70s that Michał Heller was able to go abroad. He finished his studies of natural sciences at KUL and was awarded the degree of Master of Arts in philosophy on the basis of his dissertation devoted to interpretational problems of the special theory of relativity. Soon after that he was appointed prefect (supervisor) and lecturer in philosophy of nature at the Seminary in Tarnów. He was simultaneously working on a doctoral thesis on relativistic cosmology. In 1966 the Lublin Catholic University conferred the degree of doctor on him on the basis of the thesis: *Koncepcja seryjnych modeli wszechświata i jej filozoficzne implikacje* (A Conception of Serial Models of the Universe and its Philosophical Implications). This

work included many elements of the so called inflation model, designed about 20 years later and generally accepted. Soon after that Michał Heller started working on his postdoctoral thesis and completes his Lublin studies as an auditing student at the Faculty of Physics of Jagiellonian University in Krakow. He received his postdoctoral lecturing qualifications certificate at the Catholic University of Lublin in 1969. His thesis was entitled: *Zasada Macha w kosmologii relatywistycznej* (Mach's Principle in Relativistic Cosmology).

In 1972 Michał Heller begins his work as a reader at the Pontifical Faculty of Theology in Krakow (the name used after the Faculty of Theology was removed from the Jagiellonian University), which was later transformed into the Pontifical Academy of Theology (PAT). In 1985 PAT conferred the title of Associate Professor on him and in 1990, the title of Professor. It is worth adding that since 1991 Michał Heller has been the Rector of the Institute of Theology in Tarnów, and since 2000—when the Institute became a branch Faculty of Theology of Kraków Pontifical Academy—the Dean of the Faculty of Theology in Tarnów.

Friendly contacts with astronomers gave Prof. Heller the idea of founding a Kraków Group of Cosmology which came into being before martial law was imposed in Poland. Many young physicists and astronomers have been involved in its activities. The founder admits that in recent years the group's contacts have loosened and he himself has been more and more associated with Warsaw mathematicians, especially Wiesław Sasin. In a number of papers written in collaboration they explain mathematical nature of various types of singularities in cosmology and suggest a model of the so called noncommutative universe.

Philosophical work of Michał Heller, always lingering on the margin of his scientific work, is by no means marginal in his life. To the contrary; asked about his most “cherished” accomplishments he explains that first of all he would wish for preserving the style of practicing philosophy in the context of science. The Centre for Interdisciplinary Studies (Ośrodek Badań Interdyscyplinarnych—OBI), operating at PAT in Krakow, and in Tucson, USA, was initiated and founded by him together with Józef Życiński, is to serve this purpose. A periodical: *Zagadnienia Filozoficzne w Nauce* (Philosophical Problems in Science), in which border-line subjects from empirical sciences and philosophy have been presented for twenty-five years, serves the same purpose.

As was mentioned above, communist authorities refused Professor Heller a passport for quite a long time. His first scientific trip to Belgium—

a scholarship received thanks to the help of cardinal Wojtyła—took place only in the middle of the 70s. Then comparatively frequent trips followed, among others to universities in Lovain-la-Neuve (Belgium), Oxford, Leicester (UK), Bochum (Germany), and Washington (USA). Professor Heller twice held the chair of Lemaître Department in Lovain-la-Neuve. Since 1981 he has been an associate member of the Vatican Astronomical Observatory in Castel Gandolfo, and in 1991 he was elected member of the Pontifical Academy of Sciences in Rome. A list of other societies and associations Professor Heller belongs to is quite long, to name just a few: Polish Physical Society, Polish Astronomical Society, St. Petersburg Academy of History of Science and Technology, International Astronomical Union, European Physical Society, International Society for General Relativity and Gravitation, International Society for the Study of Science and Theology, etc.

Michał Heller is a laureate of many prestigious awards and honors, among others the *honoris causa* degree conferred on him by the Academy of Mining and Metallurgy in Krakow (1996), Rev. Idzi Radziszewski's Award of KUL in Lublin (2000), Hugo Steinhaus' Award (2001), and others. Most of all, however, as is clear from the recent entries in the list of almost 800 publications, Professor Heller is at the peak of his creative abilities. Watching his accomplishments, one can but say: *Fervet opus. Sic itur ad astra!*

MICHAŁ HELLER—A PHILOSOPHER

In a short outline it is impossible to render anybody his due let alone a thinker whose interests and achievements are so extensive. I will therefore try to focus only on the philosophical dimensions of Michał Heller's thought. Obviously, such an endeavor is perilous: Heller the philosopher is organically tied to Heller the cosmologist and Heller the theologian. Moreover, Heller's philosophy is so intertwined with cosmology and science and *cogitare* so frequently transforms in it into *calcolare* that, paraphrasing Descartes, one might say about Michał Heller: "He calculates, therefore he is." All this imposes severe restrictions upon the following remarks, which by no means aim at justifying Heller's philosophy, although he himself—as the title of one of his books emphasizes—tries hard to justify the Universe, or, in any case, for the Universe to justify "that it exists and that it is the way it is."

No one starts thinking in isolation. That is why first teachers are never forgotten. Let us recall the two of Michał Heller's early masters: his father, Kazimierz, an engineer from Mościce, and the first school—the Institute of Theology in Tarnów. Michał Heller's father was an exceptional man. An

originator of a chemical plant, who, risking his life, did not hesitate to destroy his own work at the time of German invasion, a man of deep faith in an atmosphere of prevailing positivism, and a technician with extensive theoretical interests. It might be assumed that Michał Heller's love of natural sciences was inspired by him. One of the mementoes of his father still kept in Hellers' family home is a Russian geometry course-book with fading hand-written notes on the margin, which Kazimierz made in exile in Yakutia.

In post-war Institute of Theology in Tarnów Michał Heller first encountered a coherent philosophical synthesis—Thomism. "I admit"—he said many years later—"that I was so fascinated at [...] all embracing holistic vision of reality offered by it, that I finished the Seminary as a basically convinced Thomist."² Yet, the life of remarkable philosophers is usually marked by divergence. Heller's fascination with Thomistic synthesis lasted but shortly. In intellectual struggles Thomism did not stand the rivalry with... natural sciences. Enriching his knowledge of sciences a young student of natural sciences at KUL saw more and more clearly that Thomism "does not really match" them, and that the problems with it are so serious that "it is not worth worrying about them" and it is necessary to think about "a philosophy in which such problems will not exist."

It is not a suitable place here to recall the problems of Thomistic philosophy of nature. Suffice it to say that the studies, both scheduled by the existing *ratio* and his own private studies, dictated by the books which he was reading, made it clear for Michał Heller that the notion of "natural" philosophy functioning in Christian Europe prior to the appearance of natural sciences was completely outdated. Moreover, there is no and can be no philosophy of nature in separation from natural sciences and philosophical consideration over their method. In the Catholic intellectual circle of the time the conclusion was bold and original. J. Maritain had published his much talked of books 20 years earlier (among others: *La philosophie de la nature, Science et sagesse*) in which, "repairing the centuries of Thomists' negligence," the authoritatively claimed that the problems of philosophy of nature arose from a tragic misunderstanding—the identification of 'natural mathematics' with proper philosophy of nature which, unlike the former, supplies on "ontological explanation of nature."

²M. Heller, *Filozofia jest przygodą człowieka będącego w drodze* (Philosophy is an adventure of a man who is on his way), [in:] *Rozmowy o filozofii* (Disputes about Philosophy), ed. by A. Zieliński, M. Bagiński, J. Wojtysiak, Lublin: Redakcja Wydawnictw KUL, 1996, p. 215.

Michał Heller found this formulation both strange and unnecessary. Since the seventeenth century natural sciences have taken over almost all important philosophical questions concerning nature. This is clearly visible when we analyze the works of the founders of modern science: Galileo, Newton and others. It is true that these works—often treated in a critical way—are still distinctly attached to the prevailing pre-scientific philosophy; yet, in their physical matter they are carrying seeds of comprehension of the new philosophy of nature. Reading them Michał Heller came to the conclusion that the old (prescientific) as well as the new philosophy of nature are marked by a group of issues connected with the method. The core of Aristotelian and scholastic paradigm was a doctrine of degrees of abstraction and a demand for all empirical data (of observational, perceptive nature) to be interpreted in the light of a system category. The “nerve” of the new philosophy of nature, not fully comprehended at the beginning even by its originators, was the ability to pose problems and select appropriate—always open to knowledge resulting from experience—methods of solving them. In other words, the components of the new method were: experiment (observation), its mathematical description and idealization, i. e. the ability to choose these factors of experiment (facts) which help distinguish relevant regularities.

Even critics of natural sciences could not question the efficiency of the new method. Intensive development of these sciences confirmed it significantly. J. Maritain’s accusation that natural sciences mixing “quantity with nature” were not able to discover intelligible essences was an indication of obstinate sticking to notions the use of which—contrary to the French neo-Thomist’s beliefs—had a clearly limited range. “No serious contemporary mathematician—notices Heller—will agree with a claim that mathematics is a science of quantity. It is [rather] a science of deduction [...], it is more and more frequently formulated as a science of structure, of how particular elements of same structures can be deduced from others, or how these structures are related to one another by means of various relations of inference. If one looks at mathematics in this light and applies it to explore the world, then [...] it will really be excavating [...] hidden structures of reality, penetrating the deep structure of the world which the «naked eye» is unable to see. [...] What physics truly encloses is much broader than what is traditionally understood as quantity.”³ What does mathematical physics deal with then? The answer is not difficult. If we stick to traditional terms such as essence, cause, etc., then it is mathematical physics that reveals an

³Ibid. p. 226–227.

“essential” or—as Michał Heller prefers—“deep dimension” of the reality. “The notion of the ‘essence of thing’ has not been eliminated then from philosophical thought through the development of mathematical natural sciences, as positivists and neo-Thomists claimed. It was just transformed. The essences of things are not hypostases, hidden qualities remaining under the surface of all that can be reached by means of cognition through senses. Nature is modeled with the help of formal structures, and the essence of formal structures [...] is that they are composed of a whole hierarchy of essential and non-essential connections. [...] One arrives at relevant cognition of nature not through thinking into the nature of existence but through mathematical modeling of what can be measured.”⁴

If this is so, then what role does the philosophy of nature play? Is it not an example of a respectable science that came to an end with the appearance of mathematical natural science? Rev. Michał Heller often returns to this question. The answer given in many publications (a slight evolution might be traced in his views?) resolves itself into the following conclusion. Philosophy of nature is today the philosophy of relativistic cosmology. It includes a whole range of topics, which remain more or less related to the method of cosmology, i. e. the science about the Universe on the greatest scale and the assumptions which make this science possible. Amongst other natural sciences cosmology occupies an exceptional position as it deals with an exceptional subject—the one and only Universe—and it uses extrapolation much more than physics or other natural sciences. Extrapolating, cosmologists take on a number of assumptions which need revealing. Moreover, as mathematical cosmological theories are quite remote from ordinary experience, they do require an interpretation. Both areas, the accepted assumptions and an interpretation of the theory comprise a philosopher’s domain, be it a cosmologist or a philosopher of science.

Michał Heller *qua* cosmologist and cosmology philosopher shows in his writings how natural science can (should?) be practiced. The recommendations recalled above may be put into effect in various ways. Reverting to the research tradition which has few representatives (in the past: L. Lange and E. Cartan, and presently Penrose, Ehlers, Trautman, Toretti and several others), Michał Heller is searching for an answer to the question: what features would the world have if it corresponded to the structure of a specific physical theory? His works: *Fizyka ruchu i czasoprzestrzeni* (The Physics of Motion and Space-Time), Warszawa: PWN, 1993, and *The Science of*

⁴M. Heller, *Szczęście w przestrzeniach Banacha* (Happiness in Banach’s spaces), Kraków: Wyd. Znak, 1995, p. 42.

Space–Time, Tucson: Pachard Publishing House, 1981, which are a live example of the method discussed, bring analyses of the time and space models assumed by Aristotle’s mechanics, Newton and his followers. Because W. O. Quine in his famous text *On What There Is* put forward a thesis about ontological involvement of theory and language expressions in general, Heller’s method could be regarded, at the cost of a considerable simplification, as a variation of the analytical method. The simplification is considerable because Heller’s analysis is of a particular kind and, to be precise, does not identify itself with any version of the traditional analytical method. It is neither an analysis of colloquial language (physical theories are written in mathematical language) nor a reconstruction of logical syntax of languages of various theories (in what language can such a reconstruction be done?), but it is a reconstruction of the above mentioned models (and so of their contents) with the help of up–to–date geometrical means contrived for the use of more advanced theories, especially the theory of relativity. This method allows distinguishing of philosophical content ascribed to the theory by, for example, its originator from the content really assumed by the mathematical structure of a given theory. It shows the power of a well–known saying of Herz that “theories are often cleverer than their originators.”

In Heller’s opinion the described method is independent of any particular philosophical views; it just favors broadly understood structuralism, i. e. a conviction that structures of mathematical physics “reveal in a certain close–up the structure of the world.”⁵ And its results (understanding of old theories with the help of later mathematical tools) are important for both the philosophy of science and the philosophy of cosmology. In the philosophy of science they belie popular and rather frequently propagated theses about incommensurability of scientific theories. In the philosophy of cosmology, however, they show a complexity and wealth of ontological assumptions of mathematical theories.

The considerations signaled above lead Michał Heller to the rejection of popular simplifications and divisions which appear abundantly in philosophical course–books and popular science books. Let us just mention here a few entries:

- (1) Differentiating “doxa” from “episteme.” This differentiation is one of the greater illusions of philosophy, “I am not afraid of hypotheses in philosophy, I am not afraid of the word ‘I don’t know’”;

⁵M. Heller, *Nauka i wyobraźnia* (Science and Imagination), Kraków: Wyd. Znak, 1995, p. 167.

- (2) Rejection of the ideal of foundational knowledge. “Human thinking is an extremely complex process, with a tendency to be continuously entangled, as it were. It is not possible to single out its first link”;
- (3) Rejecting methodological isolationism, which emphasizes dissimilarity of areas of scientific, philosophical and theological cognition. In the most simplified version, which is a fusion of positivistic phenomenalism and Aristotelian methodology of sciences he claims that the surface of things belongs to sciences, while their depth to philosophy. Yet “in the methodology of nature sciences the most prominent position is occupied rather by structuralism, according to which there is a deep layer of reality which has a character of a structure. We, on our part, construct certain mathematical models which also have certain mathematical structure and if these models somehow fit the real world, it is not because they agree with it on the ‘surface’ but because the internal structure of such a model is similar to the internal structure of the examined area of reality, whether it concerns on atom or just a simple flow of liquid in a pipe”;
- (4) The rejection of dichotomy between theory and experience.⁶ And yet it is not fighting with popular simplifications that is Heller’s merit (Today advocates of contrary opinions are hard to find!) but their implications which lead to the above mentioned method of practicing philosophy.

“All-powerful holism” with a certain qualification results from the rejections listed. (It is well-known that even physicists can understand something provided that not everything depends on everything. The flow of a liquid in a pipe is independent enough of the Big Bang theory to be described ignoring the latter.) The unity of the method justifies holism but a scientific method is not a monolith either. Michał Heller, a priest and a scientist in one person, is especially sensitive to methodological clarity. The matter is quite delicate. Even A. Einstein, who was not hostile towards religion, accused Lemaître of developing “priests’ science.” No wonder that Michał Heller stresses the autonomy of scientific method. Yet intellectual honesty is like a double-edged sword: it can lead and—in Heller’s opinion—*de facto* also leads to noticing the limits of the scientific method. No one more than Heller has expressed the need for reflection on the limits of the method. These limits are not set once and for all. “One of the important elements of

⁶Quotations from: *Rozmowy...* (Disputes...), *ibid.*, p. 215ff.

the scientific method is its expansionism: what today remains beyond the reach of the method may surrender to it tomorrow. The history of science over the recent centuries has supplied a lot of evidence of such expansionistic tendencies. A possibility of researching the curvature of the space-time, the structure of elementary particles, unification of interactions or creative qualities of deterministic chaos were completely beyond the reach of mathematical and experimental method which Newton or Laplace used. The scientific method wins new territories not through brutal pressure assisted by the development of the applied techniques but due to its inner plasticity: it transforms on its own, adapts its abilities to the demands set by new areas. [...] the changes which took place in physics in the early twentieth century are first of all the changes in its method.”⁷

Problems which the new science brings, in Heller’s opinion, call not only for a new philosophy, but also for a “new theology.” Problems posed by contemporary scientific theories go far beyond science itself, beyond what science is inclined to recognize as its own domain. The sheer subject matter of cosmology, given to us as one and only, leads to difficult questions about the beginning or even the reason of the existence of the Universe. These questions cannot be renounced even though, from the point of view of science, they are the questions asked in the “wrong way.” Are not the limits of our knowledge about the Universe the limits of the Universe itself? The question seems a rhetorical one, which does not hinder cosmologists from speculating about a multitude of universes... Nowhere does the instability of borders of science, philosophy and theology show more distinctly than in cosmology. That is why the periodical of the Centre for Interdisciplinary Studies at the Pontifical Academy of Theology in Krakow, edited by Michał Heller is entitled: *Zagadnienia Filozoficzne w Nauce* (Philosophical Problems in Science). And one of the issues to which Heller the philosopher devoted most attention concerns the relations between science and theology: *Wszecławiat i Słowo* (The World and the Word), Kraków: Wyd. Znak, 1981; *Nowa fizyka i nowa teologia* (The New Physics and a New Theology), Tarnów: Biblos, 1994.

It might be a bit surprising then that Michał Heller has not regularly developed metaphysics so far. However, in Prof. Heller’s philosophical publications there are many reflections suggesting something more than just a direction of this quest. They are all connected with the topic of broadly understood mathematical aspect of nature and lead to a certain version

⁷M. Heller, *Nowa fizyka i nowa teologia* (New Physics and New Theology), Tarnów: Biblos, 1992, p. 12.

of a quasi-Platonic idealism. In a slightly simplified expression, this view amounts to stating the supremacy of ideal mathematical superstructure (including all possible mathematical structures) over matter. The existence of such a structure, which Michał Heller likes to call a formal field, or a rationality field, is the condition of the possibility of mathematics and its efficiency in modeling the real world. Can such a metaphysical hypothesis be verified? According to Prof. Heller the development of physics might be regarded as an argument for this hypothesis. “Physics as such (i. e. not subjected to any philosophical interpretation) does not say anything about the existence of matter, or else: physics is neutral towards the problem of existence or non-existence of matter.”⁸ And because outside physics there are no sufficient reasons to assume matter, therefore its existence should be considered as doubtful.

What follows from the above considerations is a postulate that not only the philosophy of nature but all branches of philosophy including the philosophy of man should be developed on the basis of thorough knowledge of natural sciences. For example, “a consideration of the sense of human life and other existential problems of man without placing these considerations in the context of the unity of man and the Universe deprives them of concreteness and can easily lead to fictitious formulations and pseudo-explanations.”⁹ This thought appears again and again in the writings of Michał Heller though for obvious reasons it has never been sufficiently developed. Indeed, this postulate is a program of a reconstruction of philosophy the realization of which calls for co-operation of many people. It is difficult to predict if this program receives a necessary large-scale support. Subsequent publications of Prof. Heller consequently point the way in this direction.

Translated by Bożena Grzebień

⁸See e. g.: M. Heller, *Uchwycić przemijanie* (To Grasp the Passing of Time), Kraków: Wyd. Znak, 1997, the last chapter.

⁹M. Heller, *Nowa fizyka...* (New Physics...), Tarnów: Biblos, 1994, p. 65.