Copernicus Center Reports, no. 1

Copernicus Center Reports »

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Copernicus Center Reports

Kraków 2010

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Annual Report 2009

Essays

It is my great pleasure to initiate *Copernicus Center Reports*. Not so long ago *Copernicus Center* was in the realm of dreams and rather fuzzy planning, and now we have already something to report. Three fields of our activities: research, education and popularization, have been filled in with some results. We are a little proud and happy. However, it would be bad if reporting achievements would totally erase planning and dreaming. To impartially evaluate the beginnings of the *Copernicus Center* let us then dream about still broader horizons.

In this first issue of *CC Reports* you will indeed find a review of various activities pursued by the *Copernicus Center*. We do think, however, that it would not be adequate only to report what we have done without giving a sample of our work. This is why we have decided to enrich this issue with a section entitled 'Essays'. In this section we intend to publish both philosophical essays related to the *Copernicus Center* goals, and research papers but chosen so as to give the non-initiated reader a glimpse of the real thing. We do not exclude that some day this section could change into a full fledged interdisciplinary scientific journal, but first a solid research tradition must build up around the Copernicus Center. A good beginning has been done, but still more is ahead of us.

In the first part of this issue the reader will find a long list of lectures, conferences, meetings, seminars, etc. Behind this list there is – although it remains invisible for the naked eye – an-

other list of many people's work and effort, support of various institutions, social demand and even a pressure to undertake new initiatives. It is a good place to express our deep gratitude to all these people and institutions that help us in pursuing our goals.

When opening the *Copernicus Center Reports* I am fully aware that such an initiative is spanned by two 'arrows of time'. One of them points backwards to the period covered by the report. But this arrow acquires its meaning only if it is associated with the one pointing to the future, the future that will come and will constitute the area for next reports.

February 2010

Michał Heller
Director of the Copernicus Center
for Interdisciplinary Studies

Annual Report 2009 »

Opening of the Copernicus Center

The Copernicus Center for Interdisciplinary Studies in Kraków was officially opened on October 1, 2008 but the ideas that led to its establishment had long been cultivated in Kraków. They were first undertaken by an informal group of researchers that later became the Center for Interdisciplinary Studies (OBI, or Ośrodek Badań Interdyscyplinarnych, in Polish). The history and the ideology of OBI is presented in vol. 25 of *Zagadnienia Filozoficzne w Nauce*, a periodical published by OBI. Currently, OBI is affiliated with the Philosophical Faculty of the John Paul II Pontifical University in Kraków.

The extensive activities of OBI have engaged new researchers and covered new disciplines and research subjects. As an example one can mention OBI's cooperation with the Polish Academy of Arts and Sciences (PAU), in particular with its three commissions: the Philosophy of Natural Sciences, the History of Science and *Fides et Ratio*.

Another example are the Kraków Methodological Conferences, initiated by OBI, and now organized together with the Jagiellonian University (UJ) and PAU. Eminent Polish scholars as well as distinguished guests from abroad participate in these conferences and their characteristic feature is the dialogue between philosophers and scientists. It can be seen as a continuation of a long Kraków tradition, dating back to the last decades of the 19th century, when Kraków's scientists became interested in philosophical matters (Władysław Heinrich, Tadeusz Garbowski), while their students and successors (Joachim Metallmann, Leon Chwistek, Bolesław Gawecki) continued their research in this spirit by philosophizing in the context of the sciences, both the physical and the humanistic.

A different form of this dialogue materialized within the so-called Kraków Circle, established through the initiative of Jan Łukasiewwicz and comprised of Józef Maria Bocheński, Jan Salamucha, Jan Franciszek Drewnowski and Bolesław Sobociński. The main goal of the Circle was the revamping of Christian (Neo-Scholastic) philosophy with the means offered by modern methodology and logic. In a natural way, the problems surrounding the interconnection of science and theology became one of the Circle's subjects of interest.

When OBI began its activities, its members had little knowledge of this Kraków tradition. They unwittingly continued it – likely thanks to Kraków's *genius loci*. The revival of the tradition owes much to the then-bishop of Kraków, Karol Wojtyła, who organized common seminars for philosophers, theologians and the representatives of the sciences.

Within OBI, interdisciplinary research of a particular kind is conducted: OBI's slogan is "philosophy in science", which boils down to tracing the philosophical issues involved in scientific theories. It is characteristic of their philosophical undertakings that their work leads to both new questions and areas of research and this is clearly visible in the case of OBI. The traditional problems of the interconnection of science and philosophy quickly gave rise to research concerning some more specific subjects, such as particular mathematical and physical theories and their philosophical implications, issues connected with evolutionary theory and its history, particular problems of logic and methodology, and the rapidly expanding questions surrounding neuroscience. In those investigations, the history of science was of particular help as an important means for understanding the phenomenon of science.

Such a broad scope of research interests leads firmly to many questions concerning the mutual relation between science and

theology and the history of science is filled with such issues. However, the members of OBI were interested in such questions irrespective of their historical relevance, as OBI was affiliated with a theological university. Thus, the problems belonging to "science and religion" became OBI's second main area of research.

The idea of establishing a new interdisciplinary center emerged as a response to the expansion of OBI's projects that began to surpass its organizational capabilities. The necessity arose to formalize the research groups, as well as to institutionalize all the activities. It is common that institutionalization destroys the enthusiasm of informal contacts and cooperation but all progress, however, bears other fruits: at some stage it may be necessary to make some risky decisions.

The first ideas which led to the development of the Center were put forward by Charles Harper of the Templeton Foundation, who believed that OBI should expand its activities to other Central and Eastern European countries. The members of OBI initially believed that such a task exceeded their organizational capabilities. However, the idea was simply one which would not go away.

The Templeton Foundation is mainly focused on the issues surrounding the new discipline of "science and religion". OBI, on the other hand, is interested in a broader field of interdisciplinary topics, of which "science and religion" is only an important aspect. It is in terms of this more complex direction that the extension of OBI's activities was thought of.

At the end of the summer of 2007, the discussion concerning the establishment of a new institution (a center, a foundation or a society) entered a decisive stage, as a result of the conclusion of the 9th Methodological Conference in Kraków. The idea of establishing a joint-venture between OBI and the Jagiellonian University (UJ) emerged, which was fully supported by the rec-

tor of the Jagiellonian University, Professor Karol Musioł. A few months later a "Steering Committee" was established, including the rector of the UJ Karol Musioł, the director of OBI Professor Michał Heller, Professor Andrzej Pelczar, Professor Jan Kozłowski, Professor Stanisław Wszołek (the Dean of the Philosophical Faculty of the John Paul II Pontifical University), Professor Janusz Mączka and Dr. Jacek Urbaniec.

At the initial stages, the discussion within the Steering Committee concerned the institutional form of the future Center. There were several possibilities: the Center could have been affiliated with one of the faculties of the Jagiellonian University, established as an inter-faculty institution or as an inter-university organization. It is the latter option that was finally chosen. The name of the new institution, the Copernicus Center, was not a subject of controversy but there are many organizations in Poland that bear the name of Copernicus. Therefore, it was decided that the newly established center would be the "Copernicus Center for Interdisciplinary Studies", a name that distinguishes it from other Polish institutions, as well as indicating close ties with the Center for Interdisciplinary Studies (OBI). Moreover, It was decided that the Center would be a self-financing organization.

In March 2008 Fr. Professor Michał Heller was announced as the laureate of the 2008 Templeton Prize and he decided to dedicate the Prize to the creation of the Copernicus Center. In May 2008, during the Prize-awarding ceremonies in London, the rectors of the Jagiellonian University and of the John Paul II Pontifical University met with the representatives of the Templeton Foundation to discuss the future of the Center and the best way to support its activities.

The procedure of establishing the Copernicus Center began in June 2008, when the Senates of both universities agreed to create the Center. On July 10, 2008 an agreement between the

universities was signed and, in September 2008, the statute of the Center was approved. At the same time the decree establishing the Center and appointing Fr. Professor Michał Heller as its first Director was issued by both rectors.

The Copernicus Center opening ceremony took place on October 2, 2008, in Collegium Maius of the Jagiellonian University. Speeches were delivered by Professor Karol Musioł, rector of the Jagiellonian University, Fr. Professor Jan M. Dyduch, rector of the John Paul II Pontifical University, and Charles Harper, vice-president of the Templeton Foundation. Fr. Professor Michał Heller presented the ideas, the goals and the plans of the newly established Center.

The following days, 3–4 October 2008, there was a two-day conference, organized jointly by the Faculty of Physics, Astronomy and Applied Information Technology of the Jagiellonian University and the Faculty of Philosophy of the John Paul II Pontifical University to honour the laureate of the Templeton Prize, Fr. Professor Michał Heller. The title of the conference was "Will Science Replace Religion?"

In order to support the activities of the Copernicus Center, the Copernicus Center Foundation was established, with Fr. Professor Janusz Mączka as its president, and Marcin Gorazda, attorney at law, as its vice-president.

Among the statutory goals that the Copernicus Center pursues are:

1. research in the areas of the mutual relations between theology, science and philosophy, as well as astronomy and cosmology, biology, philosophy, physics, history of science, mathematics and theology;
2. publication of periodicals and monographs;
3. education;
4. popularization of science.

Research

Within the Copernicus Center there are established 11 research groups.

I. Copernican Group

Head:

» Professor Michał Kokowski (Institute of the History of Science, PAN)

Members:

» Professor Tadeusz Sierotowicz (John Paul II Pontifical University)
» Professor Jarosław Włodarczyk (Institute of the History of Science, PAN)

Research fields:

» Copernicus (1473–1543) against the backdrop of his times (biographical and historical aspects)
» detailed analysis of Copernicus' achievements from scientific and cultural perspectives
» detailed analysis of the genesis and reception of Copernicus' achievements
» detailed analysis of the theories formulated by the advocates of Copernicanism (Galileo, Kepler)

Current Research:

» "Różne oblicza Mikołaja Kopernika. Spotkania z historią interpretacji" ("Many Faces of Nicolaus Copernicus. Encoun-

ters with the History of Interpretation") – a monograph in Polish. The monograph (670 pp) will be published in 2010 by the Institute for the History of Science of the Polish Academy of Sciences and the Polish Academy of Arts and Sciences.

» translation into Polish of Galileo's "Il saggiatore" (Rome, 1623). The book has been published by Biblos Publishing House in 2010.
» translation into Polish and a commentary of Galileo's "Sidereus nuncius" (Venice, 1610).
» publication of the series "Studia Copernicana" in cooperation with the Institute for the History of Science, Polish Academy of Sciences.
» research concerning 17th century astronomy.

Publications:

» Michał Kokowski, "The relationships of Copernicus with Arabic science, in the light of the ideas of an intercultural dialogue and a scientific (r–)evolution", [in:]: *Proceedings of the Conference Asia–Europe Dialogue and the Making of Modern Science* (7–8 May 2009, Singapore) (Singapore: The Institute of Southeast Asian Studies, 2010), in print.
» Michał Kokowski, *Różne oblicza Mikołaja Kopernika. Spotkania z historią interpretacji* (Many Faces of Nicolaus Copernicus. Encounters with the History of Interpretation), [Warszawa: Instytut Historii Nauki PAN, Kraków: Polska Akademia Umiejętności], in print.
» Tadeusz Sierotowicz, *Od metodycznej polemiki do polemiki metodologicznej. Impresje z lektury 'Wagi probierczej' Galileusza wraz z antologią* (From Methodical Polemics to

Methodological Polemics. Remarks on Galileo's *Il Saggiatore* with Antology), Tarnów: BIBLOS 2008.

» Tadeusz Sierotowicz, Simonetta Giovannini, translation into Italian of Michał Heller's book *Nowa fizyka i nowa teologia* (New Physics and New Theology), Edizioni San Paolo, 2009.
» Tadeusz Sierotowicz, translation into Italian of a paper by K. Targosz, "Motivi polacchi nella vita e nell'affaire di Galileo", *Epistemologia*, 32(2009), p. 5–52.
» Tadeusz Sierotowicz, "Recenzja książki: Horst Bredekamp, *Galilei der Künstler. Der Mond. Die Sonne. Die Hand*, Berlin: Akademie Verlag 2007, ss. 518", *Zagadnienia Filozoficzne w Nauce*, 42 (2008), 196–200.
» Jarosław Włodarczyk, Richard L. Kremer (eds.), *Johannes Kepler. From Tübingen to Żagań*, "Studia Copernicana", vol. 42 (2009).
» Jarosław Włodarczyk, Reimund Torge, *Astronomia w dawnym Wrocławiu. Ludzie i instrumenty* (Astronomy in Old Wrocław. People and Instruments), (Lublin: Wydawnictwo Uniwersytetu im. Marii Curie–Skłodowskiej, 2009.
» Jarosław Włodarczyk, "Kepler's Moon", [in]: *Johannes Kepler. From Tübingen to Żagań* (Warszawa: "Studia Copernicana", vol. 42 (2009), pp. 119–129.
» Jarosław Włodarczyk, "Hevelius's theory of the lunar libration", [in]: Chantal Grell (ed.), *La Lune au XVII^{e} siècle* (Paris, 2010), in print.
» Jarosław Włodarczyk, "Kosmos Słowackiego" (Słowacki's Cosmos), [in:]: Urszula Makowska (ed.), *Wokół Słowackiego obchód uroczysty* (Warszawa: Instytut Sztuki PAN, 2009), in print.
» Jarosław Włodarczyk, "Aleksy Sylvius", [in]: *Polski Słownik Biograficzny*, vol. 46, Kraków, 2009 , in print.

Conferences:

- Michał Kokowski, "Poszukiwania grobu Kopernika. Refleksje *advocati diaboli* I–III" (The Search For Copernicus' Grave. Remarks of *advocatus diaboli* I–III), Copernicus Center Colloquium #1, (Kraków, 20 March 2009).
- Tadeusz Sierotowicz, "Jan Paweł II i sprawa Galileusza. 'Rehabilitacja' Galileusza?" (John Paul II and the Galileo's Case. 'Rahabilitation' of Galileo?), *Copernicus Center Seminar in the Philosophy of Nature* (Kraków, 12 March 2009).

II. Science and Religion

Head:

- Fr. Dr. Zbigniew Liana (John Paul II Pontifical University)

Members:

- Sr. Dr. Teresa Obolevitch (John Paul II Pontifical University)
- Dr. Jacek Rodzeń (John Paul II Pontifical University)

Research Fields:

- the relationship between science and religion in the 20th century (in cooperation with the PAU *Fides et Ratio* commission)
- the question of science–faith in the life and work of Karol Wojtyła – John Paul II (in cooperation with the PAU *Fides et Ratio* commission)
- history of the relationship between science and religion
- the relationship between technology and religion
- the problems of the relationship between science and religion in Russian philosophy

- epistemological and ontological questions in the context of the relationship between science and religion
- the problematic of symbolism in the thought of the Patristics and Russians

Current Research:

- collaboration with the PAU *Fides et Ratio* commission within the framework of monthly lectures
- theism and technology
- technology as a locus theologicus in the teachings of the Popes: Pius XII, John XXIII, Paul VI
- the mechanical arts (*artes mechanicae*) and theology in ancient and medieval Christianity
- the question of the possibility of objective knowledge in religion and theology

III. Philosophy of Physics and Cosmology

Head:

- Professor Marek Szydłowski (Catholic University of Lublin)

Members:

- The Kraków/Lublin Team:
  - Professor Marek Szydłowski (team coordinator, Catholic University of Lublin)
  - Professor Marek Biesiada (Silesian University)
  - Fr. Dr. Jacek Golbiak (Catholic University of Lublin)
  - Dr. Adam Krawiec (Jagiellonian University)
  - Dr. Monika Hereć (Catholic University of Lublin)
  - Orest Hrycyna, M.A. (Catholic University of Lublin)

- › Fr. Paweł Tambor, M.A. (Catholic University of Lublin)
- › Aleksandra Kurek, M.A. (Jagiellonian University)
- › Jakub Mielczarek, M.A. (Jagiellonian University)
- › Łukasz Kukier, M.A. (UMCS Lublin)
- › J. Pietrak, M.A. (Catholic University of Lublin)
- › Dr. Beata Malec (University of Silesia)
- › Łukasz Łamza, M.A. (University of Silesia)

» The Szczecin Team:

- › Professor Mariusz P. Dąbrowski (team coordinator, Szczecin University)
- › Professor Janusz Garecki (Szczeciń University)
- › Professor Jerzy Stelmach (Szczeciń University)
- › Dr. Tomasz Denkiewicz (Szczeciń University)
- › Adam Balcerzak, M.A. (Szczeciń University)

Research Fields:

- » axiology of modern cosmology
- » temporality of modern cosmology
- » philosophical assumptions in cosmology
- » a study of the boundaries of physics and cosmology
- » complex systems – conceptual foundations and philosophical aspects
- » cosmobiology
- » beginning of the Universe in modern cosmology
- » the notion of multiverse in modern cosmology
- » Feynman's notion of quantum gravity

Current Research:

- » criteria of selection of cosmological models
- » explanation in modern cosmology and astrophysics

- » reductionism, emergence and effectiveness of physical theories
- » research programme of quantum gravitation and quantum cosmology
- » cosmology and social constructivism
- » models of 'ex nihilo' quantum cosmogenesis

IV. Mathematical Structures of the Universe

Head:

- » Professor Andrzej Woszczyna (Jagiellonian University)

Members:

- » Fr. Professor Michał Heller (John Paul II Pontifical University)
- » Professor Zdzisław Golda (Jagiellonian University)
- » Dr. Jacek Gruszczak (Pedagogical University, Kraków)
- » Professor Wiesław Sasin (Warsaw Technical University)
- » Professor Andrzej Sitarz (Jagiellonian University)
- » Professor Leszek Sokołowski (Jagiellonian University)
- » Dr. Zdzisław Odrzygóźdź (Warsaw Technical University)
- » Dr. Leszek Pysiak (Warsaw Technical University)
- » Wojciech Czaja, M.A. (Jagiellonian University)

Research interests:

- » Geometry is the core of our understanding of the universe both at the large as well as the small scales. General Relativity, based on Riemannian geometry describes gravity: the motion of planets, formation of galaxies, black holes and the expansion of the universe. Gauge Theories, which are based on the geometry of fibre bundles and connections

give a consistent description of fields, which are behind the fundamental interactions of elementary particles. Although this description is a great success of modern physics we are still struggling to get a good mathematically consistent description of Quantum Field Theory and the theory of quantum gravity.

» The main goal of the research group is to study modern mathematical structures which aim to fill in the gap in our understanding of fundamental physics. This includes, but is not restricted to, models based on noncommutative geometry, cosmological models of the early universe as well as the study of their experimental evidence.

Research Fields:

» interpretational issues in the applications of noncommutative geometry to physics
» mathematical formulations of gravitational physics
» the theory of structure formation in the Universe
» computer algebra systems with application to general relativity

Current Research:

» Dirac's operator in the formalism of noncommutative geometry
» induced representations of groupoids
» systems of imprimitivity and the concept of the particle
» noncommutative closed Friedman world model
» causal structure in noncommutative regime
» spectral properties of algebras and methods of reconstructing space–time

- » Sikorski's differetial spaces in application to the gravity theory
- » observables in the perturbed universe, Sachs–Wolfe effect
- » exact solutions of the perturbation equations
- » integrability of the dynamic systems of inhomogeneous cosmological models
- » lie symmetry analysis and its application to astrophysics

10-15 July 2009, Pasierbiec. Wotkshop "Noncommutative geometry and cosmology"

Talks:

- » Leszek Pysiak, Axiomatic approach to the "groupoid unification" of general relativity and quantum mechanics.
- » Wiesław Sasin, Spectral properties of differential spaces.
- » Zdzisław Odrzygóźdź, Gravitational Aharobov-Bohm effect.
- » Jacek Gruszczak, Cosmological modelbased on diofferential spaces.
- » Michał Heller, Groupoid properties of von Neumann algebras.

During the workshop a work was continued on

- » causal relations in noncommutative regime,
- » axiomatic approach to the unification of general relativity and quantum mechanics,
- » Hopf-Sikorski algebras.

25-29 August 2009, Technical University, Warsaw. Working group

The work was continued on

- » axiomatic approach to the unification of general relativity and quantum mechanics,
- » Hopf-Sikorski algebras.

Publications:

- » M. Heller, Z. Odrzygóźdź, L. Pysiak, W. Sasin, "Gravitational Aharonov-Bohm Effect", *International Journal of Theoretical Physics* 47, 2008, 2566-2575

The method is presented of analysing the Aharonov-Bohm effect when the symmetries of the system are described in terms of a groupoid rather than in terms of a group. This method is applied for computing the purely gravitational Aharonov-Bohm effect which occurs when the space-time curvature is concentrated in the quasiregular singularity of a cosmic string and is vanishing outside of it.

- » M. Heller, L. Pysiak, W. Sasin, Z. Golda, "Noncommutative Closed Friedman Universe", *General Relativity and Gravitation* 41, 2009, 1625-1637

In J. Math. Phys. 46, 2005, 122501, we have proposed a model unifying general relativity and quantum mechanics based on a noncommutative algebra A defined on a groupoid having the frame bundle over space-time as its base space. The generalized Einstein equation is assumed in the form of the eigenvalue equation of the Einstein operator on a module of derivations of the algebra A. No matter sources are assumed. The closed

Friedman world model, when computed in this formalism, exhibits two interesting properties. First, generalized eigenvalues of the Einstein operator reproduce components of the perfect fluid energy-momentum tensor for the usual Friedman model together with the corresponding equation of state. One could say that, in this case, matter is produced out of pure (noncommutative) geometry. Second, owing to probabilistic properties of the model, in the noncommutative regime (on the Planck level) singularities are irrelevant. They emerge in the process of transition to the usual space-time geometry. These results are briefly discussed.

» M. Heller, "Where Physics Meets Metaphysics", [in:] A.Connes, M.Heller, Sh. Majid, R. Penrose, J. Polkinghorne, A. Tylor, *On Space and Time*, [ed.:] Sh. Majid, Cambridge University Press, Cambridge 2008, pp. 238-277.
» M. Heller, Kosmologia Lemaître'a, Wydawnictwa Uniwersytetu Warszawskiego, Warszawa 2009.

V. Philosophy and History of Physics

Head:

» Fr. Dr. Wojciech P. Grygiel (John Paul II Pontifical University)

Members:

» Fr. Dr. Robert Janusz (Ignatianum)
» Fr. Dr. Tadeusz Pabian (John Paul II Pontifical University)
» Dr. Jacek Rodzeń (UJK)
» Dr. Andrzej Koleżyński (UPJPII/University of Science and Technology)
» Fr. Łukasz Mścisławski OP (KD)

Research Fields:

- the history of 20th century physics
- the philosophical interpretation of physical theories
- the evolution of concepts in physics

Current Research:

- the history of quantum mechanics
- the philosophical implications of Bell's theorems
- the evolution of the conception of physical field
- the philosophical theories of Roger Penrose

VI. History of Mathematics: People–Ideas–Philosphical Aspects

Head:

- Professor Wiesław Wójcik (Institute of the History of Science, PAN)

Members:

- Professor Andrzej Pelczar (Jagiellonian University)
- Professor Grażyna Rosińska (Institute of the History of Science, PAN)
- Professor Krzysztof Maślanka (Institute of the History of Science, PAN)
- Professor Zbigniew Król (IFiS PAN)
- Professor Jerzy Dadaczyński (John Paul II Pontifical University)
- Dr. Zdzisław Pogoda (Jagiellonian University)
- Dr. Stanisław Domoradzki (University of Rzeszow)
- Dr. Zofia Pawlikowska–Brożek
- Dr. Gabriela Teresa Besler (Silesian University)

» Professor Roman Duda (Warsaw University)
» Dr. Andrzej Brzoza (PŚ)
» Dr. Paweł Turkowski (UR)

Research Fields:

» history of Polish mathematics
» conceptions of the unity of mathematics
» philosophical foundations of mathematics
» the changeability of the notion of 'mathematics'
» the evolution and meaning of the mathematical 'basic concepts'
» ancient, modern and contemporary mathematics: differences and their philosophical sources

Current Research:

» Jan Brożek – a mathematician and his times
» "the mathematical module" in the university teaching in the 14th–16th centuries
» the relationship between number theory and quantum mechanics as an example of the rationality of nature
» the roots of the Polish Mathematial School – through the analysis of the foundations of mathematics to the sources of philosophy
» Bolzano and Cantor – 19th century advocates of reductionism in mathematics
» the analysis of the process of the constitution of platonic methods in mathematics
» the phenomenon of the Lvov Mathematical School

In the academic year 2008/2009 there were 7 meetings of the research group, at which the following talks were delivered:

- » "O pewnych błędnych hipotezach w teorii liczb (Legendre, Mertens, Hardy)" ("About certain errorneus hypotheses in the number theory"), Professor Krzysztof Maślanka. Kraków, ul. Sławkowska 19, 14.11.08.
- » "Dlaczego Bolzano nie wprowadził liczby niewymiernej" ("Why didn't Bolzano introduce an irrational number?"), Fr. Professor Jerzy Dadaczyński. Kraków, ul. Łojasiewicza 6, 19.12.08.
- » "Klasyfikacja rozmaitości – narodziny problemu" ("Classification of varietes – the birth of the problem"), dr Zdzisław Pogoda. Kraków, ul. Łojasiewicza 6, 16.01.09.
- » "Między Wrońskim a Janiszewskim – porównanie klasyfikacji matematyki Józefa Marii Hoene–Wrońskiego z jej późniejszym rozwojem" ("Between Wroński and Janiszewski – comparison of classification of mathematics by Józef Maria Hoene–Wroński with its subsequent development"), Professor Wiesław Wójcik. Kraków, ul. Łojasiewicza 6, 20.02.09.
- » "Matematyka we Lwowie przed Lwowską Szkołą Matematyczną" ("Mathematics in Lvov before Lvov School of Mathematics"), dr Stanisław Domoradzki. Kraków, ul. Łojasiewicza 6, 17.04.09.
- » "Koncepcje liczby w pismach Fregego" ("Conceptions of number in Frege's writings"), Dr. Gabriela Besler. Kraków, ul. Łojasiewicza 6, 22.05.09.
- » "O nowym rozwinięciu funkcji zeta Riemanna i jego zastosowaniach dla hipotezy Riemanna" ("About the new expansion of Riemann's zeta function and its application for Riemann's hypothesis"), Professor Krzysztof Maślanka. Warszawa, ul. Nowy Świat 72, 19.06.09.

VII. Neurobiology

Head:
- » Professor Jerzy Vetulani (Polish Academy of Sciences)

Members:
- » Professor Dominika Dudek (Jagiellonian University)
- » Professor Janusz Rybakowski (Medical University, Poznań)

Research Fields:

- » Research connected with experimental work on the functioning of the human brain as well as the question of its interpretation and methodological connection with neurobiology.

VIII. Methodology and Philosophy of Science

Head:
- » Dr. Wojciech Załuski (Jagiellonian University)

Members:
- » Professor Bartosz Brożek (Jagiellonian University)
- » Fr. Dr. Zbigniew Liana (John Paul II Pontifical University)
- » Fr. Dr. Adam Olszewski (John Paul II Pontifical University)
- » Professor Anna Brożek (Warsaw University)

Research Fields:

- » classical philosophy of science (Vienna Circle, Popper, Kuhn, Lakatos)
- » methodology of biosciences

» methods in social sciences

Current Research:

» probabilism vs. falsificationism – the basic controversy in contemporary philosophy of science
» methodological peculiarities of the social sciences – the limits of the naturalistic approach in the social sciences
» the concept of truth in physical and social sciences
» methodological aspects of evolutionary theory
» Popper's metaphilosophy
» questions and answers in the context of scientific discovery
» the problem of Mathematical Subject – from Kant to Hilbert
» history of the Liar Paradox
» the applications of game theory in philosophy

The members of the group meet every week on Tuesdays. In 2009 Adam Olszewski published a monograph, *Teza Churcha. Kontekst historyczno-filozoficzny* (Church's Thesis. Historico-philosophical context).

IX. Analytical Metaphysics

Head:

» Professor Tomasz Placek (Jagiellonian University)

Members:

» Professor Andrzej Wroński (Jagiellonian University)
» Professor Tomasz Bigaj (Warsaw University)
» Dr. Jerzy Gołosz (Jagiellonian University)

Research Fields:

- causality theories in the classical and probabilistic versions
- determinism in nature – determinism of scientific theories
- possible–worlds structures in connection to space–time structures
- metaphysical implications of some physical results such as Bell's theorems

Current Research:

- the principles of probabilistic causality – Reichenbach's analysis of the common cause principle

X. Polish Philosohy Of Nature In The First Half Of The 20th Century

Head:

- Fr. Professor Janusz Mączka (John Paul II Pontifical University)

Members:

- Dr. Paweł Polak (John Paul II Pontifical University)
- Dr. Andrzej Koleżyński (John Paul II Pontifical University)
- Anna Madej, M.A. (John Paul II Pontifical University)
- Małgorzata Stawarz (John Paul II Pontifical University)

Research Fields:

- basic ideas of the Polish philosophy of science in the first half of the 20th century
- the main representatives of the Polish philosophy of science in the first half of the 20th century

- » the peculiarity of the Polish philosophy of science against the backdrop of international philosophy of science
- » preparation of pre-war manuscripts concerning the philosophy of science

Current Research:

- » determinism according to Joachim Metallmann
- » the problems of chance and probability in the philosophy of M. Smoluchowski
- » the main philosophical problems of the theory of relativity and its reception in Poland after World War I
- » the reception of the evolutioary theory in Poland
- » the conception of the philosophy of nature in the writings of J. Metallmann and Z. Zawirski

XI. Biological Foundations Of Law And Ethics

Head:

- » Professor Bartosz Brożek (Jagiellonian University)

Members:

- » Professor Jerzy Stelmach (Jagiellonian University)
- » Dr. Wojciech Załuski (Jagiellonian University)
- » Marcin Gorazda, M.A. (John Paul II Pontifical University)
- » Łukasz Kurek, M.A. (Jagiellonian University)
- » Radosław Zyzik, M. A. (Jagiellonian University)
- » Jakub Kabza, M.A. (Jagiellonian University)
- » Aeddan Shaw, M.A. (Tischer European University)

Research Fields:

- ethics and neuroscience
- law and neuroscience
- the concept of normativity
- conceptual schemes in law and ethics
- the evolutionary model of ethics and law
- evolutionary theory in social sciences
- the methodology of social sciences

Current Research:

- the concept of normativity in the light of neuroscience
- Wittgenstein's problem of rule–following
- the evolutionary approach to law
- criminal law in the light of neuroscience
- the concept of the person in civil law from the perspective of neurosciences
- basic problems of legal bioethics

The group meets every week on Fridays. A webpage of the group (www.biolawgy.org) and a blog (www.biolawgy.wordpress.com) have been established.

In 2009 Wojciech Załuski published a monograph *Evolutionary Theory and Legal Philosophy* with Edgar Elgar Publishing House. A Polish version of the book, *Ewolucyjna filozofia prawa*, was published by Wolters Kluwer Polska.

Three members of the group: Łukasz Kurek, Aeddan Shaw and Radosław Zyzik are preparing PhD dissertations.

Publications

Monografie Centrum Kopernika

In the academic year 2008/2009 the Copernicus Center, in co-operation with Universitas Publishing House, launched a monograph series in Polish *Monografie Centrum Kopernika*. The first volume published within the series is:

> A. Olszewski, *Teza Churcha. Kontekst historyczno-filozoficzny*, Monografie Centrum Kopernika #1, Universitas, Kraków 2009, pp. 519.

Author's summary:

The book is an attempt to analyse Church's Thesis (CT) against a more general historical and philosophical background.

The first part of the book deals with the historical aspects of the development and the reception of CT. Chapter 1 is devoted to the historical roots of the foundational projects in mathematics within which CT was formulated. Painting with a broad brush, I depict a panorama of the conceptions of mathematics that originated in the 19th and at the beginning of the 20th century. I argue that logicism, formalism and intuitionism were developed against the background provided by Kant's philosophy of mathematics. While quite obvious in the case of intuitionism, this stance may be questioned in relation to the other conceptions mentioned. However, I believe that both logicism and formalism are reactions to Kantianism on least at two levels. Firstly, Frege, Hilbert and Brouwer make use of Kantian philosophical jargon. Secondly, and more profoundly, Kant's views are presupposed in

what I call the 'hidden metaphysics' of the foundational projects. In particular, logicism, formalism and intuitionism presuppose (or speak explicitly of) a concept of the Mathematical Subject.

Next, I present and analyse in some detail the mathematical and philosophical views expressed by several thinkers who have contributed to the development of the foundational projects in mathematics. First, I describe briefly H. Grassmann's views on induction before presenting Frege's philosophy, in which I see a reaction to both Kant and Mill. Having formulated Frege's definition of natural numbers, I describe his ontological views. In the following sections I deal with the definitions of natural numbers offered by R. Dedekind and G. Peano, stressing the differences between their approaches and underlining the fact that Frege and Dedekind take advantage of a rich metaphysics, while Peano tries not to engage in metaphysical debates. Because of this, Frege and Dedekind 'construct' numbers from other entities (srets), and Peano offers only an axiomatization of natural numbers.

These remarks are followed by a more detailed presentation of the conceptions of David Hilbert. My aim in this section is to reconstruct Hilbert's views on mathematics, which may be summarized in the following way. Hilbert's aim was to explain the foundations of mathematics in such a way that would 'save' its non-constructive part. Hilbert believed he had achieved it through finitistic formalism and his proof theory. However, I show that, despite popular views, Hilbert's conception of mathematics cannot be reduced to the slogan: 'mathematics is a free play of symbols'. Hilbert distinguishes between mathematical and meta-mathematical reasoning. While the former is purely formal, the latter consists of substantially evaluating the results obtained at the first level. Moreover, Hilbert assumes that such meta-mathematical arguments can only be made by a Thinking

Subject, who fulfils certain philosophical postulates. This 'hidden metaphysics' of Hilbert's Program is, I believe, of the greatest importance with regards to the understanding of the development and interpretations of both Godel's Theorems and CT. Furthermore, I show that Hilbert's Program can be regarded as a scientific research program in the sense defined by Imre Lakatos. The 'hard core' of the program includes the postulates of consistency, completeness and decidability of the elementary arithmetic.

The chapter concludes with a presentation of Skolem's finitistic methods and Godel's theorems.

Chapter 2 relates the story of the formulation of CT, as well as the first reactions to it. First, I report the discoveries that led Alonso Church to formulate his thesis. I concentrate on the presuppositions of Church's philosophy of mathematics and on the problem of decidability. I then present Church's original formulation of the thesis and try to relate it to Hilbert's Program. In my opinion, CT is a direct result of adopting Hilbert's assumptions and, at the same time, CT identifies the limits of this approach to logic and mathematics.

In the following section I reflect on Turing's contributions to the development of the thesis. I describe the idea of Turing Machines and present the way it served to solve the Entscheidungsproblem. I also recall Turing's formulation of CT and contrast it with Church's version thereof.

The subsequent section is devoted to the ideas of S.C. Kleene. His arguments supporting CT are formulated and analysed and I also present the new formulations of the thesis developed by Kleene. Finally, the section concludes with Kleene's famous argument linking CT with Godel's theorem as well as with some remarks concerning Kleene's idea of realizability.

In the section describing K. Godel's reactions to the thesis, his idea of treating TC as a heuristic device is analysed. Only after

reading Turing's seminal paper did Godel change his mind and treat TC as an absolute definition. Both of these views are presented against the background of Godel's philosophy of mathematics.

The final three sections of the chapter are devoted to the views presented by E. Post, B.J. Rosser and J. Pepis. It is especially noteworthy that both Post and Pepis consider CT as an empirical hypothesis.

Chapter 3 outlines the research over CT during the period 1945-1990, when the leading figure of the time was certainly G. Kreisel. I describe Kreisel's original philosophy of mathematics and his understanding of CT and further report on Kreisel's work on the various assumptions of CT, as well as his inquiries into the meaning of CT in constructivism.

Next, four famous critiques of CT are presented: Firstly, Laszlo Kalmar's thesis that there are calculable functions which are not recursive is scrutinized; Secondly, Rozsa Peter's constructivist argument is described; Thirdly, I present Jean Porte's analysis of human calculability and Finally, G. Lee Bowie's intensional critique is given due attention.

In the following section I describe some of the attempts deployed to defend CT. Most notably, I outline the arguments presented by E. Mendelson that reject the critiques by Kalmar, Peter and Porte. In addition, I present a constructivist defence of CT, and analyse several insights from epistemic mathematics. Finally, I describe Gandy's refinement of Turing's analysis and argue that Gandy's work represents one of the most efficient ways of defending CT.

Chapter 4 is devoted to a sketch of the research map of CT after 1990. I analyse some interpretations of CT, the role of CT in mathematics, and the assumption that CT is an empirical hypothesis. Finally, I report some historical research over CT.

In the conclusion of the first part of the book, I formulate the following theses:

- CT was formulated against the background of Hilbert's Program;
- As such, it identifies the limits of the formalist approach to logic and mathematics; it serves as a kind of closure for a formal system;
- Philosophically, CT may be understood only from the perspective of the 'hidden metaphysics' of Hilbert's Program. The metaphysics in question involves the concept of a Mathematical Subject.
- CT is a description of the Mathematical Subject. As such, it is an a priori thesis of a transcendental character.
- The transcendental nature of CT is best seen in the concept of intuitive effective calculability.

Part II of the book concentrates on some particular philosophical problems.

In Chapter 5 I analyse the status of CT, in particular its syntactic category, its logical structure, and the order of the thesis. I argue that there are four canonical forms of CT: the extensional, the intensional, the meaning-as-use version, and CT for concepts in the sense defined by Pavel Materna.

In the following section I reflect on the notion of 'effective calculability'. It is my claim that this expression cannot be understood as a vague one since the vagueness of 'effective calculability' would result in declaring CT to be false, or neither true nor false.

Next, I analyse the claim that CT may be regarded as a synthetic definition. I criticize this claim against the background of the theory of definitions presented by Borkowski and the core of my criticism boils down to the observation that CT as a synthetic definition would not be subject to falsification.

Finally, I analyse the claim that CT may be regarded as a kind of completeness theorem. I submit that CT is not technically a completeness theorem, however, I believe that it may be treated as a kind of philosophical completeness theorem, as it serves as a closure for the concept of the Mathematical Subject.

Chapter 6 is devoted to the problems surrounding the theories of concepts and the notion of subject.

I start with the observation that contemporary philosophy pays little attention to concepts understood objectively, while concentrating on the subjective dimension of concepts. I argue that those contemporary theories are useless when it comes to analyzing CT in its original formulation. Therefore, I propose to apply a theory of concepts developed by Pavel Materna with the use of Tichy's intentional logic. Within this theory, concepts are structures which cannot be reduced to set-theoretic objects.

In the following section I concentrate on the notion of the subject, observing that both Brouwer and Hilbert presupposed a certain conception of Mathematical Subject. It is my claim that both conceptions of subject are co-extensive but that Brouwer and Hilbert adopt different philosophical approaches. Brouwer asks what can be constructed by the Mathematical Subject, while Hilbert's question concerns the scope of the discoveries that can be achieved by the subject. This difference can be translated into the language of possible-worlds since, according to Kripke, there are two ways of developing possible-world semantics: one can either construct those worlds starting with some objects belonging to the actual world, or assume that the worlds exist independently of the subject's activities.

Next, I justify the thesis that the intensional version of CT describes either an empirical, but idealized subject, or a transcendental subject. In the former case, one needs to use S4 modal logic, while in the latter the background logic is S5. I also show

that Murawski and Woleński's thesis that CT is relatively a priori and relatively analytic coincides with my own analysis, which takes the notion of a subject as the starting point.

In the following section, I propose an itinerary that may lead to the axiomatization of the notion of a subject. I start with Hilbert's proposal that describes the Mathematical Subject in five axioms:

(AH1) I think.

(AH2) I think things (about things).

(AH3) With the use of symbols I can:

- » designate the things I think;
- » re-identify the used symbols;
- » assign the symbols freely;

(AH4) The laws of manipulating the symbols can be described completely.

(AH5) I have the power of self-reflection.

Against the background of some important results in logic, I criticise some of the axioms. Moreover, on the basis of the analysis I distinguish between four different concepts of the mathematical subject: the Empirical, the Intuitionistic, the Weak Platonic and the Strong Platonic. They are described in terms of the domain over which their thought ranges, the access to potential and actual infinity, the logic they use, the number of inference rules they operate on, the number of re-applications of the given rule, the possibility of self-reflection, and the status of the CT. I submit that CT is false for the Empirical and the Strong Platonic subjects. It can be either true or false for the Intuitionistic and the Weak Platonic subject.

Finally, I try to formulate CT within the theory of concepts developed by Pavel Materna.

Chapter 7 deals with arguments supporting CT.

I distinguish between three different strategies of arguing for CT. First, I describe and analyze the classical arguments, among which can be found those formulated by Post, Church, Kleene, and Turing. The classical arguments utilize various argumentation strategies.

Secondly, the strategy of weakening the assumptions consists of accepting weaker-than the classical assumptions concerning calculability and showing that they 'produce' a class of functions that is co-extensive with the class of recursive functions. Such methods were utilized by Gandy, Sieg, Mostowski, Grzegorczyk, Gurevich and Derschovitz.

Finally, I describe the connections strategy, which consists of showing that CT is connected with some important results in logic and mathematics. I analyse the arguments which connect CT to Godel's theorems, to the problem of the consistency of arithmetic, to Tarski's definition of truth and to the axiom of choice.

In conclusion, I claim that the analyses carried out in the book show that CT and, more generally, the foundations of mathematics cannot be dealt with within the set-theoretic paradigm. There are important limits to this paradigm, which display themselves clearly in such problems as CT. Furthermore, I believe that in order to analyse CT one needs a proper theory of concepts and of the mathematical subject. I also claim that the most interesting arguments in favour of CT are those that utilize the strategy of weakening the assumptions; however, the connection strategy is also promising.

The books finishes with several appendices that include a list of the historical and philosophical findings of the book, the list of the various formulations of CT, as well as definitions of some of the mathematical and logical concepts used in the book.

Within the *Monografie Centrum Kopernika* series there will be published next:

» M. Piesko, *Nieobliczalna obliczalność* (*Uncalculable calculability*)
» J. Mączka, A. Woszczyna (eds.), *Czy nauka zastąpi religię?* (*Will science replace religion?*)

Monographs in English

The Copernicus Center will launch a new monograph series in English in 2010. The first two titles of the series are:

» M. Heller, *The Sense of Life and the Sense of the Universe*
» B. Brożek, *The Double Truth Controversy. An Analitycal Essay*

Zagadnienia Filozoficzne w Nauce

In cooperation with Ośrodek Badań Interdyscyplinarnych (Center for Interdisciplinary Studies) and Biblos Publishing House the Copernicus Center continues to publish the periodical Zagadnienia Filozoficzne w Nauce. In 2008/2009 two volumes of Zagadnienia, 43 and 44, were published.

Rozprawy OBI

In cooperation with Ośrodek Badań Interdyscyplinarnych (Center for Interdisciplinary Studies) and Biblos Publishing House, the Copernicus Center continues to publish Rozprawy OBI (Monographs of the Center for Interdisciplinary Studies). In 2009 Galileo Gallilei, *Waga probiercza*, Tadeusz Sierotowicz (ed.) was published.

Studia Copernicana

In 2009 Copernicus Center has become the co-publisher, with the Institute for the History of Science of the Polish Academy of Sciences, of *Studia Copernicana*. In 2009 the XLII volume of *Studia: Jonahhes Kepler. From Tübingen to Żagań*, edited by Rochard L. Kremer and Jarosław Włodarczyk was brought out.

Website

In May 2009 Copernicus Center launched its new website, available at www.copernicuscenter.edu.pl. The webpage contains an abundance of educational and research material, including more than 70 online papers, recorded lectures, and promotional material. The website was launched in cooperation with the University of Information Technology and Management in Rzeszów.

Education (Copernicus College)

Seminars in the Philosophy of Nature

The Copernicus Center for Interdisciplinary Studies organized in the last academic year (2008/09), and continues organizing in the current year (2009/2010), *Seminars in the Philosophy of Nature*.

The lectures in the philosophy of nature concern a wide variety of topics such as theory of evolution and its problems, relations between philosophy and science, theory of mathematical objects etc.

Last years, the series of seminars included (all delivered in Polish):

1. Fr. Professor Michał Heller – "Natural sciences and philosophy" (5 March 2009)

2. Professor Tadeusz Sierotowicz – "John Paul II and Galileo's case – Rehabilitation of Galileo?" (12 March 2009)

3. Professor Paweł Koteja – "To capture Darwin in flagranti. Evolutionary experiments in laboratory" (26 March 2009)

4. Professor Zdzisław Pogoda – "Historical aspects of the classification of selected mathematical objects" (7 May 2009)

5. Professor Zdzisław Golda – "Construction of a relativistic cosmological model" (14 May 2009).

In 2009/2010 Copernicus Center continues organizing the seminars. The schedule for the winter semester is as follows:

1. Fr. Dr. Wojciech Grygiel – "The theory of strings in the perspective of the unification of physics" – (29 October 2009).
2. Fr. Dr. Zbigniew Liana – "Empirical science and theology vs. subjective picture of the world" (26 November 2009).
3. Dr. Wojciech Załuski – "Indisputable and disputable issues in the theory of evolution" (10 December 2009).

„Science and the Big Questions" Lectures

In the academic year 2009/2010 the Copernicus Center, in cooperation with Tischner European University and University of Information Technology and Management in Rzeszów has organized a series of lectures "Science and the Big Questions". The lectures are transmitted online and are available at the Center's webpage.

Conferences

I. "Will Science Replace Religion?" (Kraków, 3–4 October 2008)

Delivered lectures in chronological order (delivered in Polish):

1. Professor Roman Duda "God thinks mathematically".
2. Professor Andrzej Tautman "Why science will not replace religion. Thoughts of unreligious physicist."
3. Professor Jerzy Lukierski "Science, religion, progress."
4. Professor Andrzej Satruszkiewicz "About mathematical nature of Nature"
5. Professor Jerzy Szwed "About some similarities between philosophy, religion and physics."
6. Professor Michał Różyczka "Questions old as mankind."
7. Professor Stanisław Krajewski "Will science replace religion?"
8. Fr. Professor Michał Heller "Homo Sapiens in the Copernican Universe"
9. Professor Magdalena Fikus "Contemporary genetics: or playing God?"
10. Professor Jan Kozłowski "Evolutionary roots of science and their implications"
11. Professor Janusz Weiner "Ecology: quasi-science, mythology, religion?"
12. Professor Zbigniew Mirek "Phenomenon of life in the light of science and faith."
13. Professor Jacek Urbaniec "Does Michał Heller prove the existence of God?
14. Fr. Professor Stanisław Wszołek "Mathematical nature of the world and causality."

15. Professor Bartosz Brożek "Ontology of rules in neurocognitive perspective."
16. Fr. Professor Janusz Mączka "Theology of science on Heller's view"

II. Copernicus Center Colloquium #1 (Kraków, 20 March 2009)

On March 20, 2009 there was held the first *Copernicus Center Colloquium*.

The following papers were presented:

1. M. Kokowski, "Poszukiwanie grobu Kopernika. Refleksje *advocati diaboli*" (In Search of Copernicus Grave. Reflections of an *advocatus diaboli*).
2. W. Wójcik, "Filozofia Riemanna – jej źródła i inspiracje" (Riemann's Philosophy - its Sources and Inspirations).
3. T. Placek, "Światy możliwe bez możliwych światów" (Possible Words without Possible Worlds).

A report of the activities of the Copernicus Center was also presented.

III. 13th Krakow Methodological Conference (Kraków, 18-19 May 2009)

"Evolution of the Universe and the Evolution of Life"

On May 18-19, 2009 the 13th Krakow Methodological Conference took place in Kraków, co-organized by the Copernicus Center

for Interdisciplinary Studies for the first time. The conference's topic was the evolution of the universe and the evolution of life. This choice was not surprising, given three anniversaries celebrated in 2009: the 200th anniversary of Darwin's birth, 150th anniversary of the publication of *On the Origin of Species* and the 400th anniversary of the construction of telescope by Galileo.

The conference lasted for only two days, but it brought inspiring lectures and heated debates. The first day began with a paper by Archbishop Professor Józef Życiński on the "Upward Causality and Biological Convergence in the Cosmic Evolution." Życiński presented an analysis of the phenomenon of upward causality which is connected to emergent phenomena, characteristic of some fundamental biological processes.

The following paper, "Cosmological relicts", delivered by Professor Andrzej Woszczyna, centered around the experimental evidence concerning the dynamics of the Universe. Woszczyna pointed out the fundamental problem of cosmology: the lack of astronomical evidence of the dynamics of the universe which makes necessary the use of relict evidence and theoretical cosmological models. He illustrated this issue with some selected examples of observational relicts related to the beginning of the universe (e.g., the redshift, Cosmic Background Radiation and Wilkinson Microwave Anisotropy Probe).

The second session consisted of three presentations. First, Professor Jacek Szymura delivered a lecture entitled "On the Origin of Species: the Puzzle of Diversity". He put forward the thesis that our world is much more complex than the picture resulting from Darwin's theory suggests. He indicated the problem of bio-diversity and showed that living organisms do not instantiate any "pure forms", and that the notion of "species" is conventional, hard to define in a precise and clear manner.

The following paper, "On the Origin of Man: Six Million Years of Evolution", presented by Dr. Katarzyna Kaszycka, was devoted to the history of fossil discoveries and the search for the "missing link" between apes and humans (according to the current state of knowledge, the history of mankind began approximately 6 million years ago, when – most probably in Africa – there lived a common ancestor of two evolutionary lines: one leading to chimpanzees, the other to humans). Dr. Kaszycka reviewed the forms of fossil homoids, starting form orrorin, to *Australopitecus* and *Homo neandertalis*.

Next, Professor Jerzy Dzik delivered a paper "Evolution in Fossil Evidence". He presented the main goals and research methods connected to the examination of fossils, claiming that this is the only acceptable way to introduce an objective time-scale into evolutionary scenarios. By scrutinizing the kinds of information that may be obtained through the examination of fossils, he showed that – in some circumstances – fossil evidence enables direct reconstruction of the actual evolutionary processes and testing of different evolutionary hypotheses. In this way, palaeontology holds an efficient tool to falsify some evolutionary scenarios.

The evening session of the first day of the conference was devoted to a panel discussion between Fr. Professor Michał Heller and Professor Francisco Ayala. The discussion was moderated by Dr Zbigniew Liana. Heller presented a talk on the "The Necessity of Cosmic Evolution for Life Emergence and Evolution". He concentrated on such issues as the emergence of elements in the process of nucleosynthesis and defended the thesis that the universe needs to be a non-linear dynamic system in order to "produce" life, which itself is a nonlinear system. Ayala's talk was entitled "The Evolution of life", and was devoted to the problem of the evolution of species. Ayala showed that on the basis of

statistical analysis of the differences in cyclochrome C one can reconstruct the genealogical tree of species and classify them. Ayala also indicated the unsolved problems that are still to be explained by the scientists: the passage from inanimate matter to life; the problem of ontogenesis; the problem of consciousness; and the passage from apes to *homo sapiens*. The session culminated in a discussion which showed that Heller and Ayala share the basic theses regarding the relationship between the evolution of the universe and the evolution of life. They agreed also on the fundamental unsolved problems of evolution.

The second day of the conference began with a talk delivered by Professor Roman Duda, "Some Remarks on the Evolution of Mathematics". The paper concerned the style or method of mathematical research. Duda identified three main periods in the history of mathematics: the Babylonian (characterized by the emergence of the first general mathematical concepts); the Greek (axiomatization of geometry, the ideal of certainty of mathematical knowledge) and the modern (both axiomatization and general concepts). He also considered pairs of opposite concepts (finite – infinite, global – local, linear-nonlinear), indicating their role in mathematics.

The following paper by Professor Michał Tempczyk, "Three Meanings of the Word 'evolution'", lead to the establishment of the thesis that one can speak of three non-connected kinds of evolution: the evolution of inanimate matter (the increase of entropy), the biological evolution (the emergence and evolution of living organisms, complex structures), and ontological evolution (leading to the emergence of ontologically lasting, unchanging complex structures).

The last speaker of the session was Professor Jan Kozłowski who tried to answer the question "Can Evolutionary Theory be Mathematized"? He considered, first, the original, ordinary-

language formulations of the conception of natural selection by Darwin and Wallace; then he recalled population genetics, which used simple differential equations. These, in turn, were subsituted, in the 1950s, by stochastic methods use to describe the genetic drift. Finally, in 1970s, game theory was used to explain reciprocal altruism and limited aggression. Kozłowski concluded that although Darwin's theory has been mathematized from the very beginning, those attempts are selective and still there is no universal mathematical language to capture evolutionary theory. However, he continued, since biological systems are very complex, one cannot dismiss the thesis that the evolutionary theory will never be fully mathamatized and will use only selective models, created *ad hoc* to solve specific problems.

The second session started with a paper presented by Professor Jacek Radwan, "Evolutionary Causes and Consequences of Sexual Reproduction". Radwan reviewed contemporary hypotheses which eplain the the common character of sexual reproduction (as it is connected to substantial costs and there is no clear explanation why it evolved and how it is advantageous relative to parthenogenesis). He also commented upon the evolutionary consequences of sexual reproduction.

Profesor Bernard Korzeniewski delivered a paper entitled "The Emergence of Life and the Emergence of (Self)consciousness – Some Common Features." He defended the thesis that life might have begun in a spontaneous way, as it developed through several stages. He presented his own hypothesis according to which the beginning of life, as well as the beginning of the universe, are connected to the emergence of networks which are meaningful through the connotation of elements (regulatory mechanisms, neurons) that form a representation of the world, and which are self-referential.

The next session began with a paper "Human Dignity" presented by Professor Elżbieta Kałuszyńska. She concentrated on the main scientific and ethical problems surrounding the notion of human dignity. Latter, Fr. Professor Michał Heller and Dr. Paweł Polak delivered a talk on "The Reaction of the Catholic Church on the Evolutionary Theory: Vatican and Evolution." Heller pointed out six major historical controversies connected to the evolutionary theory and the gradual change of the Church's stance concerning Darwin's ideas. Polak talked about the reception of the evolutionary theory in Poland, illustrating both the reaction of the Catholic Church to the theory and the specific nature of the Polish context.

The final paper was delivered by Profesor Jarosław Włodarczyk ("Galileo and Kepler vs. the inhabitants of Other Worlds"). The figures of Galileo and Kepler were sketched as individuals who opened "extraterrestial" worlds by identifying them as physical objects similar to Earth. This led, in turn, to the reflection over the possibility of life on different planets. Włodarczyk showed how this possibility was dealt with by Galileo and Kepler: the latter used his imagination freely, while the former was much more cautious.

The conference closed with a panel discussion, "Around Evolution", moderated by Dr. Jacek Urbaniec. The participants (Professor Michał Heller, Professor Jan Kozłowski, Professor Paweł Koteja amd Professor Bernard Korzeniowski) discussed the question, whether the evolutionary theory should count as a scientific, mathematized theory which is capable of explaining known facts and the predicting new ones. It is difficult, the participants claimed, to find such predictions, which – when unfulfilled – would lead to the rejection of evolutionary theory according to Popper's falsification criterion.

It is a tradition of the Kraków Methodological Conferences that the final remarks – summarizing the papers and the discussions – are given by Fr. Professor Michał Heller. He began by pointing out the importance of the two types of causality – upward and downward, where the latter is clearly visible in biology (e.g., in the emergence of the DNA structure). Heller stressed also the problems surrounding the mathamatization of the evolutionary theory and identified the fundamental philosophical problems connected to the evolutionary context: first, there is the problem of the three passages (existence: how to bridge the gap between the mathematical equations and the existence; life: the passage from inanimate to animate matter; and consciousness: the passage from unconscious life to the conscious life); second, one should mention the problem of reductionism (to what extent evolutionary explanation is reducible to the laws of physics); third, the problem of complexity (emergence, creation of structures); fourth, the problem of time; fifth, the evolution of culture; and finally, six, history of the evolutionary theory.

Andrzej Koleżyński (WIMiC AGH, Copernicus Center)

IV. Panel Discussion, "How to be a scholar?"

On June 9, 2009 Copernicus Center organized a panel discussion on "How to be a scholar?" The discussion took place at Piec Art Cafe in Kraków, with the participation of Professor Jerzy Vetulani, Professor Romuald Polczyk and Fr. Dr. Wojciech Grygiel. The discussion was moderated by Professor Bartosz Brożek.

V. Patronage

Under the patronage of the Copernicus Center there took place the following conferences:

- Conference "W poszukiwaniu duszy" (In Search of the Soul) at the Jagiellonian University, 12 March 2009
- 5th Polish Philosophical Rally in Kraków, 29-31 May 2009
- John Paul II Days in Kraków, 4-5 November 2009
- Conference "Dowody ontologiczne" (Ontological Proofs) in Kraków, 4-5 December 2009
- Conference "Wymiary czasu" (Dimensions of Time) in Kraków, 11-12 December 2009

Calendar

2 October 2008 – The Opening of the Copernicus Center for Interdisciplinary Studies.

3–4 October 2008 – As a part of the opening of the CC, the conference "Will science replace religion?" was held.

24 October 2008 – First gathering of the members of the CC.

20 January 2009 – Fr. Prof. M. Heller delivers a lecture "Nieprzemienny model kosmologiczny Firedmana – Lemaitre'a" (Noncommutative cosmological model of Firedman – Lemaitre), at the Institute for Theoretical Physics in Warsaw.

21 January 2009 – M. Heller's lecture "Stworzenie Wszechświata" (The Creation of the Universe) at the Warsaw Archbishop residence.

22–23 January 2009 – Fr. Prof. M. Heller receives *honoris causa* doctorate at Cardinal Stefan Wyszyński University in Warsaw.

26 February 2009 – Fr. Prof. M. Heller delivers the Jabłonowski Lecture in Toruń: "Czas człowieka i czas Wszechświata" (The Time of Man and the Time of the Universe)

5 March 2009 – First Seminar in the Philosophy of Nature. Lecture delivered by Fr. Professor Michał Heller

5 March 2009 – First meeting of the Council of the Copernicus Center.

12 March 2009 – Conference "W poszukiwaniu duszy" (In Search of the Soul) at the Jagiellonian University, under the patronage of the Copernicus Center.

12 March 2009 – Second Seminar in the Philosophy of Nature. Lecture delivered by Prof. Tadeusz Sierotowicz.

20 March 2009 – Copernicus Center Colloquium no 1.

26 March 2009 – Third Seminar in the Philosophy of Nature. Lecture delivered by Prof. Paweł Koteja.

7 May 2009 – Fourth Seminar in the Philosophy of Nature. Lecture was delivered by Prof. Zbigniew Pogoda.

11 May 2009 – "Podglądanie nieba", a meeting with Fr. Professor Michał Heller.

14 May 2009 – Fifth seminar in the Philosophy of Nature. Lecture was delivered by Professor Zbigniew Golda.

18–19 May 2009 – 13th Krakow Methodological Conference.

27 May 2009 – M. Heller's lecture at the Royal Observatory in Greenwich (the lecture available at www.nmm.ac.uk/explore/astronomy-and-time/views-on-creation#lecture).

29 May 2009 – M. Heller's lecture at the Philosophical Faculty of the Bristol University: "Noncommutative Friedman Universe".

29–31 May 2009 - 5th Polish Philosophical Rally in Kraków, organized under the patronage of the Copernicus Center.

9 June 2009 – Panel Discussion on "How to be a scholar?" hosted by Professor Bartosz Brożek, with the participation of: Professor Jerzy Vetulani, Professor Romuald Polczyk and Fr. Dr. Wojciech Grygiel.

13 June 2009 – M. Heller participates in a panel discussion "Time since Einstein" during the World Science Festival, New York (www.worldsciencefestival.com/2009/time-since-einstein).

15 September 2009 – M. Heller's lecture at the XXXIV Gathering of the Polish Astronomical Society in Kraków: "Fundamentalne problemy kosmologii kwantowej" (Fundamental Problems of Quantum Cosmology)

16 September 2009 – M. Heller's plenary lecture at the Grassmannian Conference in Fundamental Cosmology in Szczecin: "A Noncommutative Friedmannian Cosmological Model" (www.cosmo.fiz.univ.szczecin.pl/?q=pl/node/67).

17 September 2009 – M. Heller's public talk at the Grassmannian Conference in Fundamental Cosmology in Szczecin: "Wielki Wybuch i stworzenie Wszechświata" (The Big Bang and the Creation of the Universe) (www.cosmo.fiz.univ.szczecin.pl/?q=pl/node/67)

26 September 2009 – M. Heller's lecture at the Illinois Institute of Technology, Chicago: "Creation of the Universe – God and Contemporary Cosmology".

29 September 2009 – M. Heller's talk at the John Paul II Institute, Washington, D.C.: "Origin of the Universe in Science and Theology".

30 September 2009 – M. Heller's talk at Columbia University, N.Y.: "Origin of the Universe in Science and Theology".

7 October 2009 – Fr. Professor Michał Heller's lecture "Science as a Big Question". First lecture of the lecture series "Science and the Big Questions", co-organized with the Tischner European University in Kraków and the University of Information Technology and Management in Rzeszów.

14 October 2009 – Lecture "Copernicus-Galileo-Darwin" ("Science and the Big Questions") was delivered by Fr. Dr. W. Skoczny.

21 October 2009 – First lecture in "Methodology" was given by Fr. Dr. Zbigniew Liana, ("Science and the Big Questions").

23 October 2009 – M. Heller's Medal Lecture at the Eurospine Conference in Warsaw.

28 October 2009 – First lecture in Cosmology ("Science and the Big Questions") was delivered by Fr. Professor Michał Heller.

4 November 2009 – Second lecture in Cosmology ("Science and the Big Questions") was delivered by Fr. Professor Michał Heller.

4-5 November 2009 – John Paul II Days in Kraków, organized under the patronage of the Copernicus Center.

10 November 2009 – H. Heller deliveres Digby Stuart College Occasional Lecture at the Roehampton University, London: "Did it start with a Bang? Cosmology and Creation" (www.roehampton.ac.uk/digby/academic-events/events.html).

12 November 2009 – M. Heller delivers M.B. Grabowski Memorial Lecture 2009 at the Unversity College London: "Creation of the Universe: Science and Philosophy".

16 November 2009 – M. Heller's lecture at UNESCO, Paris: "Big Bang and the Creation of the Universe".

19 November 2009 – Third lecture in Cosmology ("Science and the Big Questions") was delivered by Fr. Dr. Wojciech P. Grygiel.

4–5 December 2009 – Conference "Dowody ontologiczne" (Ontological Proofs) in Kraków, under the patronage of the Copernicus Center.

11–12 December 2009 – Conference "Wymiary czasu" (Dimensions of Time) in Kraków, under the patronage of the Copernicus Center.

Essays »

The Struggle for Meaning*

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1. Introductory Remarks

The search for the meaning of life is one of the oldest and most frustrating occupations of mankind. The battles lost in this pursuit are not only the symptoms of the present cultural crisis, but also stem from its main causes. Contemporary literature and art do almost nothing but exploit the "existential drama" in many guises and forms. I have always had the impression that the pointlessness of human existence stands in deep contrast, in contradiction almost, to the all-pervading rationality of the universe, which reveals itself in the fact that the structure of the universe can be so successfully modelled by mathematical structures and that it is these very mathematical structures that are usually regarded as representing the highest kind of rationality. I was aware that this argument, attractive though it might seem, is far from logical impeccability and this is why I have decided to undertake it in this essay.

2. Three types of rationality

The key for our analysis is the concept of rationality itself, understood not only as the logical machinery with which to draw

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correct conclusions from clearly formulated premises, but understood in the maximalist way as a set of values owing to which "everything is as it should be". Purely for the purposes of this essay I shall distinguish between three types of rationality or rather three groups of rationality types. It goes without saying that this classification does not exhaust all of the possible meanings of this rich but fuzzy concept.

» Rationality of discourse. Under this heading I understand the above mentioned logical tools of drawing correct conclusions from clearly stated premises. Roughly speaking, a process of reasoning is said to be rational if the deduction of conclusions is conducted in accordance with the rules of logic. In spite of the fact that this understanding of rationality seems to be transparent, considerable volumes are continually produced to sharpen and clarify it.

» The rationality of the universe. This concept is sometimes used in philosophical considerations concerning physics and cosmology. One says that the universe (or the world, or nature) is rational because it possesses a property owing to which it can be rationally investigated. It is up to the sciences to determine what is understood by the term "rational investigation". In other words, the universe is rational because its structure is accessible to the method of the empirical sciences.

» The rationality of human life. We are inclined to call Adam's life rational, if Adam conducts his life in a rational manner, which is to say according to principles or rules at least, to some extent, similar to those of rational discourse. We are often strongly committed to the rationality of our own life and this is why it is so difficult to codify the criteria of this rationality. They doubtlessly depend on the goals one chooses to select, the means to reach these goals, one's

psychological equipment and the plethora of various factors of which there is no need and no possibility to enumerate. In grasping the richness of this concept, intuition plays a more dominant role than any logical rules, but this intuition is itself sometimes very strong and imposing.

All these three ways of understanding rationality have something in common and it is not without reason that they are denoted by the same word. This affinity of concepts is more clearly seen if we try to negate or somehow question them. Reasoning conducted against the rules of logic generates nonsense and produces conclusions that contradict each other. Such contradictions are rarely dangerous but sometimes give birth to catastrophes. On the other hand, if we try to imagine an irrational universe, i.e., a universe which functions against the rules of mathematics, we immediately obtain a global catastrophe, a totality that explodes with inconsistencies and contradictions which simply exclude this monstrosity from existence. Human life is more tolerant with respect to nonsense; however, it also reacts with dramas and tragedies if somebody crosses a limit in making nonsensical decisions.

I propose to term this hard to define common denominator of the above three understandings of rationality, as *meaning*. The meaning (in this sense) is something real that justifies speaking about the meaning of discourse, the meaning of the universe and the meaning of human life. This common denominator is most clearly seen if we compare the rationality of discourse with the rationality of the universe. Both these rationalities are related to some formalisms: the rationality of discourse to formalisms of logic, and the rationality of the universe to formalisms of mathematics. In both cases the formalisms are expressions of something objective that characterizes a correctly conducted discourse or certain aspects of the structure of the universe

(provided that they have been corroborated by empirical results). By analogy, I assume that reality has a certain objective property owing to which human life, as a part of this reality, is rational. Our personal decisions can only bring us closer to, or further away from, this ideal of rationality. This assumption has clearly ontological overtones: it asserts something about reality and about our attitude towards it.

3. The Ontology of Meaning

Let us make another step in our mental construction and assume that all three classes of understanding rationality (rationality of discourse, rationality of the universe and rationality of human life) are but special cases of a general concept of rationality, which I will call *Rationality* (with capital *R*) or *Meaning* (with capital *M*). We have access to this concept only through its special cases. It is a transcendental concept in the sense that, although present in the rationality of discourse, the rationality of the universe and the rationality of human life, it goes beyond these types of rationality. It is again a strong ontological assumption.

The meaning of life, if looked upon in the context of our construction, reveals a new aspect. It is not entirely different from the meaning of the world, because both of them are but special cases of the same "superconcept" of Meaning. We could truly say that the meaning of life is inscribed into the meaning of the world and even to the extent that human life should not only be understood in terms of psychology and spirituality, but also in terms of biology together with all its physical conditionings. Psychology and spirituality emerge from the human biological substrate and the biological evolution of man is but one strand of cosmic evolution. We thus obtain a self-consistent vision of the world without an artificial splitting into the "world of matter" and

the "world of value" (whilst, however, preserving their respective autonomies).

I have emphasized the ontological character of this construction. If rationality is to be something more than a pure convention it has to be rooted in reality.

4. The Logic of Persuasion?

The negation of what we have called the meaning of life leads to the existential nonsense of which Sartre wrote so much, and of which contemporary literature does not cease to speak. If we combine this view with the fact that human life is rooted in biology, and that biology is but a part of the world's structure, then we are entitled to say that, through mankind, nonsense infiltrates the very structure of the world. And if, moreover, we believe in the rationality of the world in the above sense, and taking into account the enormous successes in empirical science it is hard not to do so, then we arrive at an "almost contradiction": on the one hand, the structure of the world is the implementation of the very rational pattern (which can be modelled mathematically) and, on the other hand, human existence, being a part of the world, presents itself as a loophole in this pattern. This is by no means a strict reasoning. It is not difficult to see that the rationality of the world and the rationality of human existence are two different concepts, and that the negation of one of them, together with the assertion of the other, does not lead to a logical contradiction. The above reasoning can only be qualified as a persuasive reasoning. The meaninglessness of the human existence in an otherwise rational world would be a dissonance hard to agree with. But if one is insensitive to dissonance and does not agree with the above reasoning, one cannot be blamed from the logical point of view.

However, in the proposed vision of the world, the above reasoning appears in a new light, and its persuasive character is strengthened. The negation of what was only a dissonance becomes now the self-consistency argument: the meaning of human life and the meaning of the world cannot be dissonant with each other because they are but special cases of the same Meaning.

5. The strategy of Random Events

The meaning of the world is relatively easy to digest and yet an interesting one to be investigated. The analysis of the meaning of discourse is reduced to logical analysis; the analysis of the meaning of human life, because of its fuzziness, is notoriously difficult. But the concept of the meaning of the world is rich enough and, because of its affinity with the natural sciences, succumbs well to scrutiny. This is the reason why the proposed vision of the world can be best "tested" by considering the meaning of the world. In the next few paragraphs I will touch upon this subject.

Quite often the idea of the meaning of the world is confronted with the idea of chance and one may claim that "blind chance" excludes any meaningful functioning. The question arises as to whether the overwhelming presence of chance in nature in fact destroys the meaning of the world.

First of all, what does chance mean? There could be many answers to this question, but just a short reflection convinces us that we should regard any event to the appearance of which we ascribe the probability less than one as a chance. There essentially exist two classes of chance influenced events. We are confronted with chance *in the subjective sense* when we treat something as a chance because of our ignorance. For instance, we ask ourselves whether the first bus that arrives at the bus stop will be bus nr 104 or the bus nr 105. For us, the outcome

is chance but the manager at the bus centre knows the outcome perfectly well provided that the buses today stick to their schedule. Chance *in the objective sense* occurs if our ignorance does not influence the outcome. For instance, according to the standard interpretation of quantum mechanics, the result of a quantum measurement is in no way determined before the measurement has been made. One can only calculate the probabilities of obtaining various results in advance. Since our ignorance is not able to destroy the meaning of the world, in the following I will, in principle, constrain myself to chance in the objective sense.

There are many events in the world whose appearance does not depend on our knowledge or ignorance and to which we ascribe a probability less than one. What does it mean to have a "probability less than one"? To answer this question we must look to the mathematical theory of probability. But the probability calculus is an elegant mathematical theory, by no means worse than all other mathematical theories. This assertion includes chancy or random events into the framework of mathematical structures. As a part, or as an aspect, of mathematical structures, they do not destroy the meaning of the world, but are rather built in to the meaning of the world. Let us look at this problem into a more detailed manner.

Elementary physics teaches us that in nature chance influenced events often cooperate with the laws of physics. Let us consider a simple example: let us try to make a pencil stay upright on a smooth surface on its pointed end. It is obvious that if we leave it to stand alone, it will immediately fall down. The pencil simply obeys the law of physics: the unstable state cannot be implemented. However, on which side the pencil will fall? This depends on many chance influenced events such as: small vibrations of my muscles, motions of air molecules, and

many others. Many of these factors are regarded as chance influenced only from the point of view of the physical law in question, whereas in fact they can be implied by other strictly deterministic physical laws. The essential circumstance is that in the network of physical laws there are some "free places" waiting for the action of chance or random events, and there are as many of these places as is necessary (no more and no less). Without them laws of physics would be powerless: the pencil would not know in which direction to fall.

Laws of physics are usually expressed in terms of differential equations. In general, a given differential equation has many solutions, and the particular solution is selected by the choice of initial or boundary conditions. And there are those initial or boundary conditions that are responsible for the action of chance or random events without which the physical law in question could not be put into action.

As we can see, chance does not contradict the meaning of the world, but rather is its important part. For the logic of rationality, chance is indispensable[1].

6. The Mystery of Rationality

When, in our considerations, we go from the meaning of the world to the meaning of human life, things get complicated. Chance events acquire a new significance; they are intermingled with human ignorance and free, often irrational, decisions. How can they be reconciled with the field of rationality? Could one

1 It is interesting to read the 74th chapter of St. Thomas Aquinas *Summa contra gentiles*. The chapter bears the title *Quod divina providentia non excludit casum et fortunam* and in this chapter St. Thomas goes even further and argues that Divine Providence simply requires (*exigit*) the existence of chance in nature.

not imagine that – just as in the case of the world's rationality – there exist "free places" open for free will and their not always rational decisions? Could one not imagine that these "free places" do not ruin the rationality of the whole structure, but rather are its necessary condition? If we agree with such a vision, human dramas and the existence of evil cease to be arguments on behalf of meaninglessness, but become the Mystery of Rationality. It is the *Mystery*, because we are not able to translate it into a net of logical inferences that would be accessible to our mind. It is the Mystery *of Rationality* because thanks to it we are freed from the trap of meaninglessness. This Mystery transcends us, but also gives us meaning, we are a part of it.

Is the acceptance of this Mystery a betrayal of rationality, an acceptance of something that cannot be embraced? To accept the Mystery is not an easy task, but if we do not accept it, the field of rationality shrinks dangerously to the rationality of discourse, and perhaps to the rationality of the world. Without the concept of Meaning, of which the rationality of discourse and the rationality of the world are but incarnations, the latter two types of meaning would not only be drastically restricted, but also put into question. That which would remain would be reduced to the rules of a game, the rules of which hold but are deprived of any deeper reason.

The acceptance of Rationality is a choice, but if we do not make this choice, there are no foundations for rationality and rationality with no foundations is not rationality.

We have constructed (or perhaps discovered?) the concept of Meaning which incarnates itself in the meaning of a logically conducted discourse, in the meaning of the world, and in the meaning of human life. In a similar manner, the ancient Greeks used to speak of Logos, a cosmic Mind permeating everything. Owing to this Meaning-Logos, "two times two equals four", and

owing to it the human life is not absurd. The simple rules of the multiplication table and the mystery of human life are but two faces, or two incarnations, of the same Logos.

Human Nature after Darwin

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Abstract: New developments in evolutionary biology and related biological disciplines (for instance, neurobiology, behavioural genetics, primatology) seem to provide the underpinnings for a solid view of human nature (i.e. a view of the structure of the human mind, of the nature of human morality, and of the level of human rationality), which can be useful for social scientists in their research practice. In the first part of this essay the following main theses of this emerging – I call it 'Darwinian' – view of human nature are presented: the human mind is not a blank slate, human morality is a biological adaptation, human beings are imperfectly rational. In the second part main controversies around these theses are discussed.

Introductory remarks

Social scientists have always wanted to believe that the social sciences are 'true' sciences, just like the natural sciences. However, such a belief has never been fully justified. The social sciences have been usually descriptive rather than explanatory, and if they tried to be explanatory, explanatory theories they provided either had a low predictive power or, if they had a high predictive power, predictions generated by these theories rarely passed empirical tests fully satisfactorily. As a result, the social sciences possess few (if any) theories which equal the natural sciences theories in terms of empirical corroboration and universal acceptance. Arguably, this mainly descriptive character of the social sciences has been due to the fact that *social scientists have not had at their disposal a solid view of human nature*. What is

worse, many social scientists have believed that in order to work out such a view no recourse to the natural sciences is needed. This belief is pernicious for the social sciences: arguably, the social sciences will never reach the status of 'true' sciences if they do not become open to the developments in the natural (especially, biological) sciences – the only sciences which can provide a solid view of human nature. It should be observed, though, that this belief (which may be dubbed 'scepticism toward usefulness of biology in the social sciences' or, less politely, 'biophobia') was to some extent justified in the past when the biological sciences did not have very much interesting to say about human beings as social actors. However, recent developments in evolutionary biology and other biological sciences (for instance, neurobiology, behavioural genetics, primatology) seem to provide the underpinnings for a solid view of human nature, which should be interesting for social scientists and which should be allowed for by them in their research practice. The purpose of this essay is to present the main theses of this emerging view of human nature and main controversies which have arisen around this view. I shall call this view 'Darwinian' because its main theses rest above all on evolutionary biology and related evolutionary disciplines (for instance, evolutionary psychology and human behavioural ecology).

The Darwinian view of human nature

At the outset, let me briefly deal with two problems which one encounters trying to reconstruct the biological – Darwinian – view of human nature. The first problem is definitional: what is a view of human nature? The second problem is related to the doubt if the biological sciences can be said to imply some view of human nature. As for the first problem: by 'a view of human

nature' I shall understand a set of well-thought and coherent answers to the following three questions: what is the structure of the human mind?; what is the nature of human morality?; what is the level of human rationality? Of course, one can offer alternative definitions of a view of human nature. However, the above definition seems to be at least acceptable, because thus defined view of human nature says *very important* things about human beings (even if it does not say *all* important things about human beings). As for the second problem: it should be noticed that no scientific theory entails directly any view of human nature. Rather, a scientific theory can only provide a number of insights regarding human beings. However, these insights can be *interpreted* as endorsing some view of human nature. What follows, then, is an interpretation of insights provided by the biological sciences regarding human nature. This interpretation is aimed to make precise what view of human nature is supported by the biological sciences, i.e., what theses about the structure of the human mind, the nature of human morality and the level of human rationality these sciences seem to support.

> Question 1: What is the structure of the human mind?
>
> Thesis 1 of the Darwinian view of human nature: The human mind is not a blank slate – tabula rasa – upon which everything has to be written by environmental and cultural factors and can be written with equal ease: it is composed of built-in psychological dispositions – computational modules – shaped by natural selection which play a crucial role in shaping our behaviours.

Thus, the human mind consists of innate computational modules – psychological dispositions – and these modules are evolutionary adaptations, i.e., their presence can be accounted for by the fact that they enabled our ancestors to best cope with

the problems they encountered in the ancestral environments (these problems concerned in general survival and reproduction, and in particular, for example, finding mates, succeeding in intra-sexual competition, ensuring the certainty of paternity, deterring the adultery of one's sexual partner, detecting cheats in social exchange interactions) and thereby increased on average their chances of survival and reproductive success. It is often said that the view of the human mind proposed by evolutionary biologists is a form of 'evolutionary Kantianism' with regard to the problem of the existence of innate mental structures: this view assumes (like Kant) that our mental structures, by means of which we grasp the world and act in it, are innate, but (unlike Kant) it assumes that they are not apriorical (and thereby necessarily identical for all rational beings), but shaped in the process of natural selection (and thereby contingent). In sum, Thesis 1 of the Darwinian view of human nature is polemical to the view (called by evolutionary psychologists 'the Standard Social Science Model' and widespread especially among sociologists) that the human mind is almost entirely 'socially constructed' and thus extremely malleable.

Question 2: What is the nature of human morality?

Thesis 2 of the Darwinian view of human nature: Morality, at least in its simpler manifestations, is a biological adaptation: its building blocks (empathy, altruistic and cooperative dispositions, moral emotions such as, e.g., a sense of guilt, gratitude, elementary forms of a sense of justice) are the products of natural selection. Morality is, then, deeply embedded in our nature: it is a manifestation of our nature rather than a purely cultural phenomenon invented in order to counteract our purportedly egoistic and antisocial nature.

In order to clarify this thesis, it is useful to make recourse to the distinction made by the renowned primatologist Frans B. M. De Waal between two theories or views of human morality – morality as a veneer (the Veneer Theory) and morality as an outgrowth of our social instincts (the Social Instincts Theory). The Veneer Theory assumes that human morality is nothing more than a thin cultural overlay on our antisocial and egoistic nature. On this view, moral tendencies are not part and parcel of human nature and morality is a cultural innovation achieved by our species alone. Adherents of this theory were, e.g., Thomas H. Huxley and Sigmund Freud (especially in his *Das Unbehagen in der Kultur*). By contrast, the Social Instincts Theory assumes that human nature is social and altruistic and human morality is a natural outgrowth of our evolved social instincts that we share with many animals. These pro-social instincts (e.g., altruistic and cooperative dispositions, emotions that support these dispositions, empathy) are the building blocks of our morality. This account of human morality was defended, e.g., by Darwin and is defended by De Waal himself. In sum, Thesis 2 of the Darwinian view of human nature is polemical to the view of morality as a veneer.

Question 3: What is the level of human rationality?

Thesis 3 of the Darwinian view of human nature: Human beings are imperfectly rational.

Broadly speaking, there are two competing views of human rationality. One view assumes that human beings are perfectly rational. Agents are said to be perfectly rational if they maximize their utility functions (which implies that they correctly assess objective probabilities of their possible actions bringing about given states of affairs), discount their future utilities exponen-

tially, employ low discount rates, and do not possess self-destructive desires. The opposite view says that human beings are imperfectly rational: they systematically violate at least one of the aforementioned conditions of perfect rationality. Now, apparently, the biological sciences support the view that human beings are imperfectly rational (at least in their current environments). This support seems to flow from two general and interrelated evolutionary insights regarding human rationality. The first insight is that *the human mind is not designed to seek for the truth as end in itself but to seek the truth only in so far as it helps to solve the adaptive problems*. Given that the human mind is not a disinterested truth-seeker, one can expect that it will be prone to generate various illusions if this is the best way for solving a concrete adaptive problem; for instance, a well-established fact is that humans are prone to self-deception, i.e., to unconscious concealing information from themselves and thereby to distorting their picture of reality (it should be noticed, though, that the evolutionary claim that the human mind is essentially practical is not inconsistent with the commonsense claim that it is equipped with a certain autonomy and thereby can be a tool of the disinterested pursuing of the truth and can motivate us to take actions that oppose the imperatives of evolution – survival and reproduction). The second insight, related to the first one and more directly relevant for the question about the level of human rationality, is *the adaptive-lag hypothesis* (called also 'the hypothesis of time-shifted rationality', or 'the hypothesis of mismatch'). The hypothesis says that our psychological mechanisms, which were adaptive in the ancestral environments (in which our psychological dispositions were being shaped), will frequently lead to maladaptive behaviours in our current environments, which are in many respects different from the ancestral environments. The mismatch between biological adaptations of organisms and later environ-

ments in which these adaptations have to operate is conceivable in all animals but it is particularly sharp in the case of humans because, on the one hand, we have psychological mechanisms that were being shaped for hundreds of thousands of years in the ancestral environments and have not changed since then (or, at least, have not changed essentially since then), and, on the other hand, cultural evolution – a typically human process, made possible by our highly-developed brains – causes very considerable changes in our environments, making them look essentially different from the ancestral environments. This hypothesis explains, for instance, why we often employ unreasonably high discount rates. We tend to do so because in the ancestral environments steep discounting usually brought about much higher payoffs than discounting we now consider to be rational, as in these environments people's time horizon was short (i.e., life expectancy was short) and the future was unreliable, so that there was not any strong selective pressure favouring the emergence of the propensity to defer the consumption of the goods with a view to increasing their quantity in the future. In sum, Thesis 3 of the Darwinian view of human nature is polemical to the view (widespread especially among economists) that human beings are perfectly rational. It may also be noted that Thesis 2 and Thesis 3, taken jointly, stand in opposition to the view of human being as *homo oeconomicus*, i.e., rational egoist.

Controversies around the Darwinian view of human nature

An obvious problem with the three theses of the Darwinian view of human nature is that they are not sufficiently precise and thereby admit of various interpretations. In this section I shall present main controversies connected with each of these theses and two main interpretations of each of them.

Thesis 1

The claim that the human mind is modular and that its modules have been produced by natural selection is very plausible. Indeed, it seems that the best way of coping with the problems encountered by our ancestors in the ancestral environments (and thereby the way to have the highest likelihood of having been preserved by natural selection) was not through some general, all-purpose, abstract problem-solving mechanism, but through a set of discrete and functionally specialized problem-solving mechanisms (they would function faster and more effectively than the general mechanism in confrontation with concrete problems). However, this view of the human mind is unclear in three main points. First, there is no consensus among evolutionary biologists regarding the quantity of psychological modules in the brain – as yet no fully plausible taxonomy of these modules has been provided. Second, it is not clear how flexible these psychological modules are (for example, evolutionary psychologists do not make clear to what extent male sexual jealousy – one of those modules – can be 'reduced' by social learning). Third, it is not clear whether the human mind is composed only of discrete and functionally specialized problem-solving mechanisms or whether it also contains some general, all-purpose, abstract problem-solving mechanism which extracts and combines information from different modules and deals with new adaptive problems. Taking into account these three points, we obtain two versions of Thesis 1:

> Theses 1a: The human mind is composed only of domain-specific modules. These modules are numerous and are rigid in their functioning, i.e., they can be modified by social learning to a small degree.

> Thesis 1b: The human mind contains not only domain-specific modules but also a domain-general mechanism. These domain-specific modules are not numerous and are flexible in their functioning, i.e., they can be modified by social learning to a large degree.

As can be easily observed, Thesis 1 in its variant 1b becomes close to the view of human nature as a blank slate.

Thesis 2

The view of morality as an extension of social instincts says only that we are moral by nature, i.e., that we are not egoistic or malicious or in some other way antisocial; it does not make precise what the *content* of our natural moral dispositions is. Accordingly, it is compatible with various more specific views of human morality. Before I present two main views of this kind, I shall define three forms of altruism which I shall employ in this presentation, namely, kin altruism, reciprocal altruism and pure altruism. In the case of kin altruism an agent sustains high costs for the good of a relative without expecting the return of these costs in the future. In the case of reciprocal altruism an agent sustains high costs for the good of an unrelated person expecting the return of these costs in the future (it should be noticed that reciprocally altruistic acts driven are rather peculiar forms of acts: they are neither truly egoistic, because they involve sustaining some costs for other persons, nor truly altruistic, because they are not motivated by the concern with the well-being of the other persons). In the case of pure altruism an agent sustains high costs for the good of an unrelated person without expecting the return of these costs in the future. Now, relying on these three forms of altruism, one can distinguish two varieties of the view of morality as an extension of social instincts. The first va-

riety says that human beings are *narrowly altruistic*, that is, they tend to manifest in many circumstances kin altruism and reciprocal altruism. The second variety says that human beings are *genuinely moral*, that is, they tend they tend to manifest in many circumstances kin altruism, reciprocal altruism *and pure altruism*. It is clear that evolutionary biology supports at least the view that human beings are narrowly altruistic. However, it is not clear whether it supports the second – more optimistic – picture of human morality. Most evolutionary biologists claim that evolution has not endowed us with the tendency to engage in purely altruistic acts: they maintain that such acts are just the maladaptive side-effects of kin altruism and reciprocal altruism. However, some scholars defend the claim that evolution has endowed us with such a tendency. They argue either that such a tendency is a product of sexual selection or that it is a product of group selection. According to the former explanation, the tendency to undertake purely altruistic acts may have evolved, even though it decreased the probability of survival of those who manifested it, if this tendency was for some reason attractive for the opposite sex and thereby increased the probability of mating and reproductive success. According to the latter explanation, genetic group selection may have favoured the tendency to undertake purely altruistic acts, the reason being that groups with many individuals endowed with this tendency and thereby inclined to sacrifice themselves for the group to which they belong are likely to fare better than and win over groups with individuals endowed only with the tendency to display kin altruism and reciprocal altruism. In sum, evolutionary biology does not say clearly if we are only kin and reciprocal altruists, or also pure altruists. Accordingly, we obtain two variants of Thesis 2:

Thesis 2a: Human beings are narrowly altruistic.

Thesis 2b: Human beings are genuinely moral.

Thesis 3

Evolutionary biology supports the view that human beings will systematically deviate from the requirements of perfect rationality. However, it is difficult to say how large deviations from these requirements human beings should be expected (in the light of evolutionary biology) to manifest. The difficulty stems from the fact that, on the one hand, the aforementioned general insights of evolutionary biology into human rationality support the view that human beings are imperfectly rational, but, on the other, evolutionary biology (especially, evolutionary psychology) has led to the reinterpretation of some psychological experiments purportedly demonstrating human imperfect rationality. A classic example is the Wason selection task, which is aimed at testing our understanding of the logical properties of the sentences having the form of an implication. It has turned out that people have problems providing correct answers to the task if the implication has the form of a descriptive sentence, but they cope well with the task if the implication has the form of a norm regulating social exchange. More generally, the evolutionary analysis has shown that various purported violations of the requirements of rationality are often not the effects of our cognitive defects and thereby should not be construed as attesting human imperfect rationality; they can often be interpreted as manifestations of the tendency of the human mind to use rational 'mental shortcuts' for making decisions (e.g., various heuristics) or as the effects of confronting subjects with artificial situations which they can never encounter in real life or with non-artificial situations

but nonetheless having little significance for their survival and reproduction. Accordingly, many evolutionary theorists defend the view that human beings are 'ecologically rational', that is, the view that human beings act rationally in practical situations, especially those situations which resemble contexts which could have been encountered in the ancestral environments. The above remarks show that the evolutionary view of human rationality is more complex and less clear than Thesis 3 may suggest. Taking into account these remarks, it seems that one can distinguish two variants of this thesis:

> Thesis 3a: Human beings are imperfectly rationally and their deviations from perfect rationality are large.

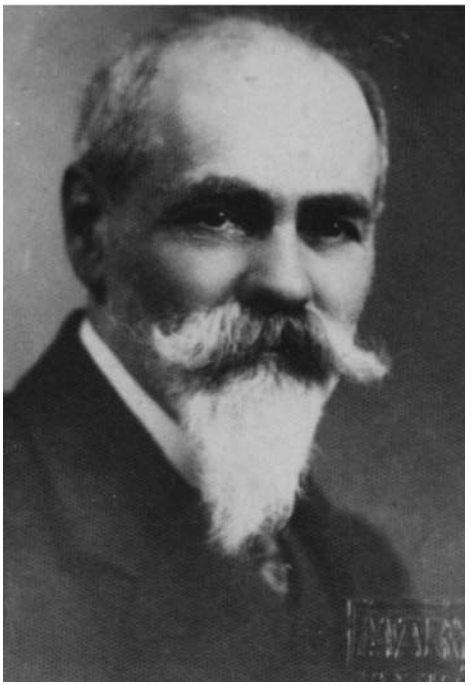
> Thesis 3b: Human beings are imperfectly rationally but their deviations from perfect rationality are small (when viewed from the evolutionary perspective, many violations of perfect rationality prove to be apparent rather than real).

In sum, recent developments in the biological sciences have taught us that the human mind is not a blank slate, that human morality is embedded in our nature and that our rationality is not perfect. These general theses constitute what I have called 'the Darwinian view of human nature'. Unfortunately, the biological sciences, at the present stage of their development, cannot help in deciding unequivocally which of the presented interpretations of these theses are correct: they seem to admit of all these interpretations. Thus, the Darwinian view of human nature is still not fully determinate. Once can hope that this situation will change in the future as a result of the progress in the biological sciences. It seems, though, that even in their general form these theses are illuminating and can be regarded as providing the underpinnings for a solid view of human nature.

Stanisław Zaremba

(120th anniversary of obtaining Ph.D. at the Paris University)

Andrzej Pelczar



Picture 1. Stanisław Zaremba

1. Some remarks on the historical background; Kraków scientific centre.

Since the XVIII-th century, owing to the significant activity of Jan Śniadecki (1756-1830) and reforms made by him, there were two chairs of mathematics at the Jagiellonian University in Kraków. Various people, representing various level of knowledge and competence had chaired them during almost one hundred years, till the end of the XIX-th century, when two outstanding mathematicians, Kazimierz Żorawski in 1895 and Stanisław Zaremba in 1900, came to Kraków and begun a new period of the research and teaching in mathematics, not only at the oldest Polish University but also in the whole country. Let us recall that it was a difficult time in Polish history. Poland had been partitioned in 1772; three empires: Russia, Austria and Prussia controlled three parts of the country. Situation in the

Austrian part was relatively less bad than in the two other parts; in particular, in the last quarter of the XIX-th century Kraków was a real centre of the Polish culture and the Jagiellonian University was really a Polish University. These circumstances made in practice Żorawski and Zaremba almost the only representatives of Polish mathematics on international arena for more than one and half decade.

Before talking in detail on the activity of the hero of this presentation, Stanisław Zaremba, we will give some general information on the scientific centre built up by these two professors. Kazimierz Paulin Żorawski (1866-1953) was a student of Sophus Lie and brought fundamental ideas of his master, of course first of all those related to the theory of continuous groups (called now Lie groups), implementing them creatively in Kraków. He developed also several areas close to the theory of Lie groups and based on it, in particular certain parts of the theory of differential equations and differential geometry, as well as some topics from the theory of integral invariants (new at that time), selected problems from kinematics and some other fields (compare for instance [17]).

Stanisław Zaremba (1863-1942) graduated firstly as an engineer in St. Petersburg studied later on mathematics in Paris, obtaining there his Ph.D. In the Ph.D. thesis "Sur un problème concernant l'état calorifique d'un corps homogène indefini" (see [25]) he presented the solution to a problem posed by the Paris Academy of Sciences. He improved essentially some noncomplete results concerning that problem announced earlier by Riemann[1]. This thesis determined in a sense his future scientific

1 Georg Friedrich Bernhard Riemann (1826-1866) – one of those outstanding mathematicians whose results marked turning points in development of mathematics and whose names were placed in the history of science.

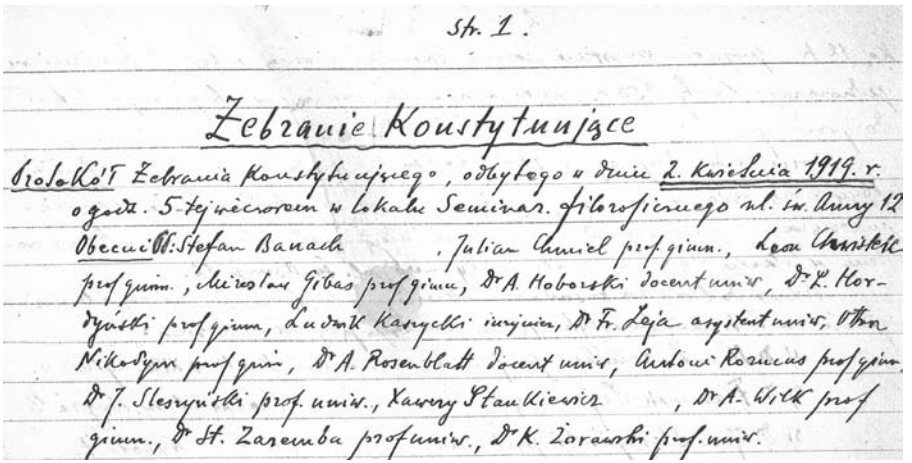
career and described the field of interest. Certain further remarks on the Zaremba's doctorate, at least partially in the occasion of its the 120th anniversary, will be presented below.

None of the two outstanding scientists created a classical "scientific school" in a narrow meaning of this name, but they had built up a true scientific centre being a real basis for future scientific schools of their pupils. Kazimierz Żorawski was the supervisor of the Ph.D. thesis of Franciszek Leja (1885-1979); among his pupils there were Władysław Ślebodziński (1884-1972) and Antoni Hoborski (1879-1940) who was simultaneously scientifically close to Zaremba, obtaining Ph.D. and habilitation under Zaremba's supervision, and then turning to differential geometry, the field from Żorawski's general area of interest. Thus Hoborski should be counted as a pupil of both professors, or rather as a student who was a member of a scientific centre created at that time by them (Hoborski became later the first rector of the Academy of Mining erected in 1919; he died in the concentration camp Sachsenhausen in February 1940 being arrested by nazi occupants together with the majority of professors of the Jagiellonian University and Academy of Mining on November 6, 1939). Zaremba was also the supervisor of Ph.D. theses of – among others – Alfred Rosenblatt (1880–1947), Wacław Sierpiński (1882-1969), Włodzimierz Stożek (1883–1941) and Stanisław Gołąb (1902-1980) who considered himself also as – at least partially – a pupil of Hoborski and was continuing and developing research in differential geometry following Hoborski's works in this domain. One of the outstanding pupils of Stanisław Zaremba (and, later on, his successor) was Tadeusz Ważewski (1896–1972) who received his Ph.D. in 1923 in Paris and habilitation in 1927 in Kraków.

Three strong scientific schools were created by mentioned above pupils of Zaremba and Żorawski. Franciszek Leja built up the well known school of analytic (complex) functions, Tadeusz

Ważewski created the school of differential equations (called often by specialists *the Kraków School of Differential Equations*), Stanisław Gołąb founded the known school of differential geometry and gave a basis for the school of functional equations developed afterwords by his pupils.

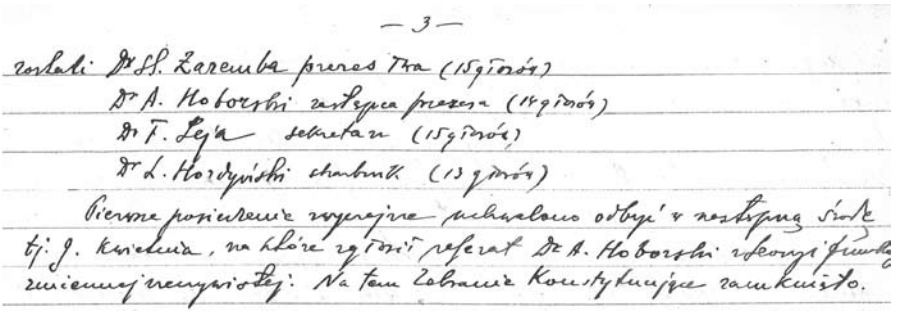
Kazimierz Żorawski moved in autumn of 1919 to Warsaw. However, before that, on the 2nd of April 1919, he had chaired the inaugural meeting of the *Mathematical Society* which was born on that day in Kraków, becoming soon, after changing its name, the *Polish Mathematical Society*; among names of founders of the Society noted in the minutes (protocol) of this first meeting we can find the name of Stefan Banach (at that time the co-author of two papers written together with Hugo


Str. 1.

Zebranie Konstytuujące

Protokół Zebrania Konstytuującego, odbytego w dniu 2. Kwietnia 1919. r.
o godz. 5. tej wieczorem w lokalu Seminar. filozoficznego ul. św. Anny 12
Obecni Pp: Stefan Banach, Julian Chmiel prof gimn., Leon Chwistek
prof gimn., Mieczysław Gibas prof gimn., Dr A. Hoborski docent uniw., Dr L. Hor-
dyński prof gimn., Ludwik Kasyecki inżynier, Dr Fr. Leja asystent uniw., Otton
Nikodym prof gimn., Dr A. Rosenblatt docent uniw., Ambroży Rozicczus prof gimn.
Dr J. Slesyński prof. uniw., Xawery Stankiewicz, Dr A. Wilk prof
gimn., Dr St. Zaremba prof uniw., Dr K. Żorawski prof. uniw.

Picture 2. The beginning of the protocol of the first (inaugurating – "constituting") meeting of the Mathematical Society in Kraków at 5 p.m., April 2nd, 1919 in the hall of the philosophical seminar, St. Anna street, 12. The first in the third line – Stefan Banach, the last but one Dr St. Zaremba, uniwersity professor, the last one Dr.K.Żorawski, university professor.



Picture 3. Results of voting during the first meeting of the newly established Society: S.Zaremba – the president, A.Hoborski – the vice-president, F.Leja – the secretary, L.Hordyński – the treasurer.

Steinhaus[2]), who later lived in Lwów. Stanisław Zaremba had been elected the first President of the Society. In that way the first and the most important period of building up the mathematical centre in Kraków by two outstanding professors acting at the turn of the century has been finished.

Next years were characterised by intensive and fruitful activity of Kraków mathematicians lead by Stanisław Zaremba developing first of all several areas of classical analysis in a large meaning of this term, also some parts of geometry and – in slightly smaller scale - other fields. Zaremba played crucial role in building up new Polish mathematics which was expanding in three significant centres: Kraków, Warsaw and Lwów, and after the end of World War I entered a golden age. Further important progress measured by successes of three Kraków scientific schools mentioned above will take place after the World War II. However, some (few but essential) elements of bases of this progress were

2 Stefan Banach (1892-1945) and Hugo Dionizy Steinhaus (1887-1972) were later co-founders of the Lwów school of mathematics; the theory of *Banach spaces* became one of the fundamentals of the contemporary mathematics.

made during the war, when the Jagiellonian University was acting as an *underground university* (being formally closed by nazi occupants since November 1939); for instance certain important results of Tadeusz Ważewski were obtained during the war, after his return from the Sachsenhausen concentration camp in 1940. One can say, and it will be entirely correct, that the academic society was in that way fighting – without arms - against the occupants. Grey-headed Stanisław Zaremba, however, didn't live to the end of the war.

2. An outline of the curriculum vitae of Stanisław Zaremba.

Stanisław Zaremba was born on the 3rd of September 1863 in a village Romanówka (now Ukraine). After completing his secondary education (in a high school in St.Petersburg) he begun his studies in the Technological Institute in St.Petersburg and graduated from it in 1881 when he got a diploma of an engineer. Next step in his education was done in France where he studied mathematics obtaining – as it was mentioned above - Ph.D. in Paris in 1889. Then he was teaching mathematics in secondary (high) schools in Digne, Nîmes and Cahors. In this period he collaborated with Paul Painlevé (1863-1933) and Eduard Goursat (1858-1936).

In 1900 he came to Kraków being nominated so-called *extraordinary professor*[3]. He became the *ordinary professor (full professor*) in 1905. His first university lecture had been delivered on 22nd of October 1900 on the notions of *limit* and *improper in-*

3 According to the Polish university tradition there are two professorship positions: *extraordinary professor* (practically equivalent to the position of *associate professor* in USA) and *ordinary professor* (*full professor*).

tegral (see a relation of Antoni Hoborski, at that time a student of mathematics, mentioned already in the first section above; [5], p.35). Zaremba served as the Dean of the Faculty of Philosophy of the Jagiellonian University during an extremely difficult academic year 1914/1915 at the beginning of the World War I. In 1903 he was elected a "correspondent member" of the Academy of Arts and Sciences of Kraków[4] and in 1926 the full ("active") member of it (at that time Polish Academy of Sciences and Arts). Zaremba got *doctorate honoris causa* of the Jagiellonian University in Kraków in 1930, University of Caen (France) in 1932, University in Poznań in 1934. The Jagiellonian University offered him in 1935 (at that time Zaremba was *professor emeritus*) the title of the *honorary professor*, very unusual dignity title. Stanisław Zaremba was a member of the Russian Academy of Sciences (in Leningrad), Lwów Scientific Society, Royal Czech Scientific Society (elected in 1910), Poznań Society of Friends of Sciences (Poznańskie Towarzystwo Przyjaciół Nauk) and a honorary

4 in Polish: Akademia Umiejętności established in 1872 (started its real activity in 1873), became in 1919 the Polish Academy of Arts and Sciences (Polska Akademia Umiejętności - PAU). Its activity was interrupted in 1952, reactivated in 1989. It is acting now independently on the Polish Academy of Sciences (Polska Akademia Nauk – PAN) established in 1952. There are two categories of members of PAU: „correspondent" and „active" (=ordinary, full).
In 1900 Zaremba took part in the International Congress of Mathematicians in Paris. In *Actes comptes-rendu des congrès internationaux des mathematiciens: process et communicatiobns, congrès tenu à Paris en 1900* (Gauthier-Villars, Paris 1902) in the chapter *Liste générale des members* one can found: Zaremba, professeur au lycée, rue de Cadourgeus, 18, à Cahors (Lot), but in the *Modifications a la liste de members du congrès* there is the corrected new affiliation: Zaremba, professeur à l'Université de Cracovie (Autriche-Hongrie); the "political-geographical" location of Kraków is a direct consequence of the sad situation of Poland at this time partitioned and occupied by three powers: Russia, Austro-Hungary and Prussia.

member of "La Societé des Sciences, Agriculture et Arts des Bas-Rhin" in Strasbourg (elected in 1920). Zaremba was active in the Polish Mathematical Society (Polskie Towarzystwo Matematyczne); as it was mentioned already, he was the first President, but his activity was longer, larger and deeper than only one cadence of the presidency. One of scientific prizes of the Society, so-called "great prizes" was named "Zaremba prize" (for further details we refer for instance to [4], [6], [11], [12], [13], [16]).

The ceremony of granting Zaremba the doctorate honoris causa of the Jagiellonian University on the 1st of February 1930 was an occasion to express a special tribute to him by several outstanding scientists present in Kraków or sending congratulation. The list of them contains in particular the following names: Stefan Banach, Wilhelm Blaschke, Émile Borel, Georges Bouligand, Élie Cartan, Arnoud Denjoy, Maurice Fréchet, Guido Fubini, Jaques Hadamard, Bronisław Knaster, Henri Lebesgue, Beppo Levi, Tullio Levi-Civitá, Léon Lichtenstein, Franciszek Leja, Jan Łukasiewicz, Stefan Mazurkiewicz, Paul Montel, Paul Painlevé, Giuseppe Peano, Émile Picard, Frédéric Riesz, Wacław Sierpiński, Hugo Steinhaus, Leonida Tonelli, Vito Volterra (compare [5]).

3. Zaremba's scientific output.

Let us turn now our attention to Zaremba's scientific output. Presentation of it will be based on – first of all – the paper [22] written by Tadeusz Ważewski, an outstanding student of Stanisław Zaremba and Jacek Szarski, an outstanding pupil of Tadeusz Ważewski; we refer also to books and papers [4],[6],[7],[9],[10], [11],[12],[13] and [16]. The most essential comments on the scientific contents and importance of Zaremba's papers are presented below following the article [22], which will not be cited in every

case when a particular paper or result is mentioned and commented.

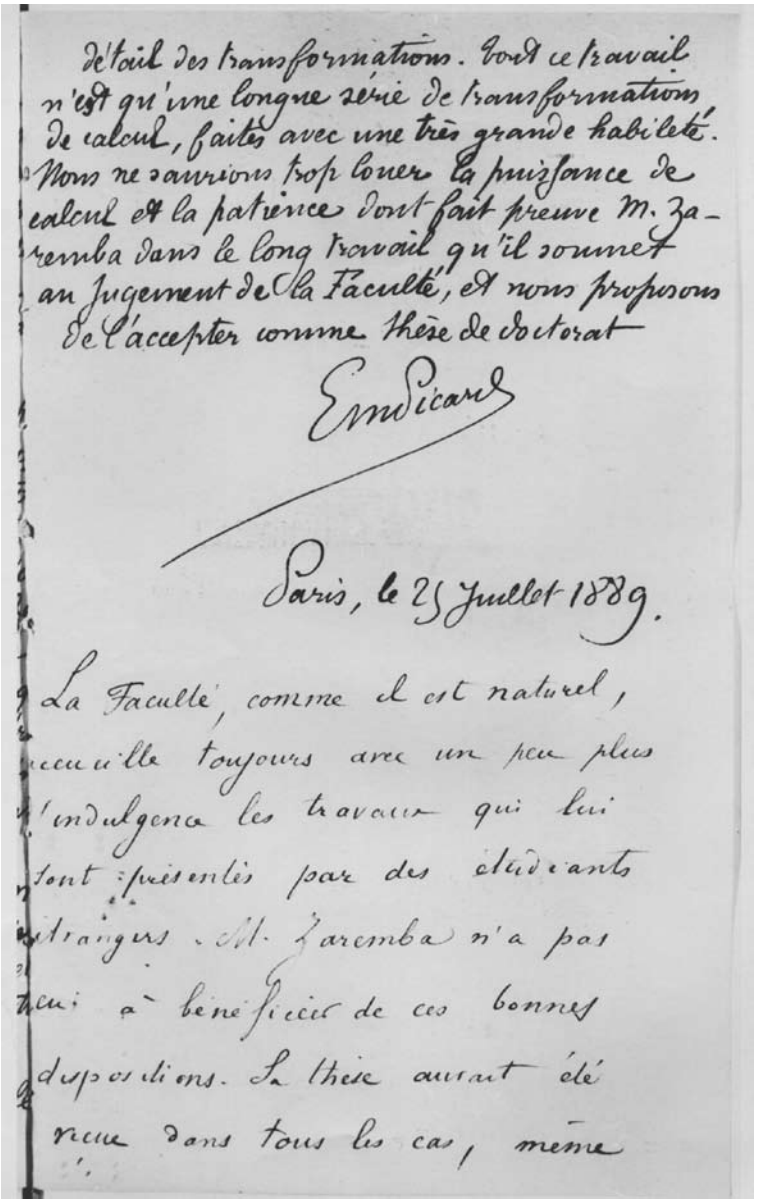
The main and general field of interest of Stanisław Zaremba was the theory of partial differential equations, especially of those coming from so-called mathematical physics and several applications (in particular, but not only, applications in physics).

The topic of the Ph.D. thesis of Zaremba has been already very shortly described above. However, since some details concerning the procedure and opinions of members of the Ph.D. thesis jury seem to be interesting, we will present them.

There are preserved handwritten opinions of three outstanding mathematicians: Gaston Darboux (1842–1917), Charles Hermite (1822–1901) and Émile Picard (1856–1941) on the Zaremba's Ph.D. thesis.

The longest and the most detailed one is written by É. Picard. He presented first of all the origin of the problem discussed by Zaremba, pointing out that it was proposed by the Paris Academy of Sciences in 1858[5] and outlining briefly its purpose. The first – partial – answer was given by Riemann who presented some note on this subject, but his results were – as Picard wrote – only indicated (*oú les résultas étaint seulement indiqués*). Then Picard mentioned that another results concerning a more particular question were given by Weber (*Depuis cette époque M.Weber reprit la question, démntra quelques uns des résultats de Riemann, et traita complétement une question plus particuliere, à savoir le cas où la température s'exprime en fonction du temps et une seule variable*). Zaremba obtained the last results by using a different way (*...retrouve les résultats de M.Weber par une tout*

5 Thus, we should notice that the problem was waiting for a complete solution more than four decades despite an engagement of such outstanding scientist as Georg Friedrich Bernhard Riemann.



détail des transformations. Tout ce travail n'est qu'une longue série de transformations de calcul, faites avec une très grande habileté. Nous ne saurions trop louer la puissance de calcul et la patience dont fait preuve M. Zaremba dans le long travail qu'il soumet au jugement de la Faculté, et nous proposons de l'accepter comme thèse de doctorat

Emdicard

Paris, le 25 Juillet 1889.

La Faculté, comme il est naturel, accueille toujours avec un peu plus d'indulgence les travaux qui lui sont présentés par des étudiants étrangers. M. Zaremba n'a pas eu à bénéficier de ces bonnes dispositions. La thèse aurait été reçue dans tous les cas, même

Picture 4. Last sentences of the Picard opinion and the beginning of the opinion of Darboux.

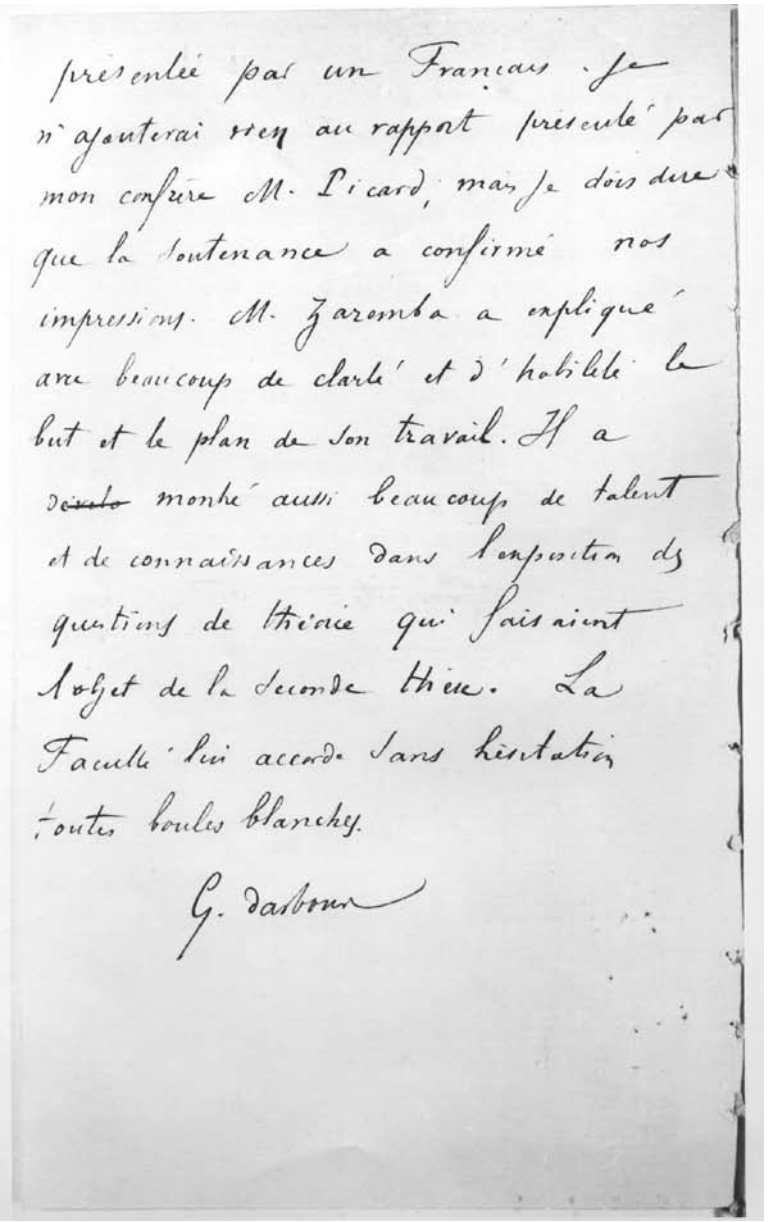
autre voie). Turning to the original problem Picard commented essential progress made by Zaremba who gave a general answer including that related to the most diufficult case of two space variables (Picard underlined that : *Les cas de m=2 est beacoup plus difficile...*). Closing his opinion Picard pointed out that the work of Zaremba needed long and «powerful» calculations done with a great competence and patience, and formulated the final conclusion proposing the acceptance of the Ph.D. thesis (see picture 4).

Shorter opinions are written by G.Darboux and Ch.Hermite. Complete Darboux text is reproduced on pictures 4 and 5[6]. It seems to be interesting that Darboux at the beginning of his opinion displayed some "unofficial customs" being in certain sense admitted by the Faculty of Scietnce of the Paris University, namely some "weaker requirements" expected with respect to foreigners applied for Ph.D. He simultaneously pointed out that Zaremba did not benefit from this "custom". We can read then, that he (Zaremba) showed his talent and knowledge and – at the end of Darboux opinion – that the Faculty accepted the thesis by voting without negative votes[7].

The third opinion presented by Ch.Hermite describes very shortly the essence of the Zaremba's thesis and formulates similar as mentioned above, very positive comments. Closing his opinion Hermite informed, similarly as Darboux, that the voting was unanimous (*...toutes boulles blanches*).

6 Reproductions of documents from the Centre Historique des Archives Nationales (Atelier de Photographie) by courtesy of Dr Zofia Pawlikowska-Brożek and Dr Stanisław Domoradzki. The author is sincerely grateful to them for the information on the opinions on the Zaremba's thesis and for permission to include it into this article.

7 *...touts boules blanches*, which means that, according to the specific way of voting - by selection of white or black ball - everybody voted "yes" (for the acceptance of the thesis)



présentée par un Français. Je n'ajouterai rien au rapport présenté par mon confrère M. Picard, mais je dois dire que la soutenance a confirmé nos impressions. M. Zaremba a expliqué avec beaucoup de clarté et d'habileté le but et le plan de son travail. Il a ~~dévelo~~ montré aussi beaucoup de talent et de connaissances dans l'exposition des questions de théorie qui faisaient l'objet de la seconde thèse. La Faculté lui accorde sans hésitation toutes boules blanches.

G. Darboux

Picture 5. Darboux opinion (the second page)

Let us pass now to further results of Stanisław Zaremba. Among important ones there are those concerning the elliptic equation

$$(1)\quad \Delta u + \xi u + f = 0$$

with boundary Dirichlet conditions as well as Neumann and Fourier type conditions. Some of these results were included into the canon of the fundamental knowledge on the theory of partial differential equations. Before talking about some details let us quote a sentence from the book [9] of Jean Mawhin: *According to Bouligand*[8] *Zaremba's contribution to the development of the theory of the Dirichlet problem is the same as that of Poincaré and Lebesgue.*[9]

In the paper [28] properties of the Green function G for a Dirichlet problem in the three dimensional space is considered and it is shown that the function

$$u = \int_S \frac{\partial G}{\partial n}\ \sigma\ ds$$

is a solution to a given Dirichlet problem with the boundary condition described by a continuous function σ ; a discussion of properties of u in the case of non-continuous σ is included as well.

In the paper [29] Zaremba discussed the equation (1) for $f=0$ with the condition

$$(2)\quad \frac{\partial u}{\partial n} = hu$$

8 Here the paper [2] is referred.

9 A translation of the Polish fraze: *Zdaniem Bouliganda wkład Zaremby w rozwój teorii problemu Dirichleta jest taki sam jak Poincarégo i Lebesgue'a.*

where h is a non-negative constant and $\partial u/\partial n$ is the interior normal derivative. He proved that there exist a sequence of eigenvalues and corresponding sequence $\{u_k\}$ of orthonormal eigenfunctions. He proved also that if ξ is not an eigenvalue then the problem (1)–(2) (with $f=0$) has exactly one solution. Moreover, every function satisfying the boundary condition (2) can be represented as a Fourier series with respect to the sequence $\{u_k\}$ of eigenfunctions. Zaremba developed some idea of Poincaré and used *generalised potentials* defined by replacing in the classical definition of Newtonian potential the function $1/r$ by the function $\exp(-\eta r)/r$ where η is a complex number such that $re\ \eta > 0$ and $\eta^2+\xi=1$. This notion of generalised potentials introduced by Zaremba turned out to be very useful in several other problems.

Analogous results for the homogenous problem: (1) with $f=0$ and the boundary problem $u=0$ are given in the paper [30].

In [31] Zaremba gave some conditions sufficient for derivatives of arbitrary order of solutions of Dirichlet problems for the homogenous equation (1) (with $f=0$) in a domain D to be continuous in the closure of D. Importance of this result is underlined by Jean Mawhin in the preface to the Polish version of his book [8].

The paper [32] deals with the following problem. Let D be a bounded domain in the three dimensional real space, S – the intersection of the boundaries of D and $-D$, n – the normal unit vector directed into the domain D. For a function u of three real variables and a given point $x^0 \in S$ we put

$$\left(\frac{\partial u}{\partial n}\right)_i = \lim \frac{1}{t}\,(u(x^0+tn)-u(x^0))\ \text{as}\ t \to 0+$$

$$\left(\frac{\partial u}{\partial n}\right)_e = \lim \frac{1}{t}\,(u(x^0+tn)-u(x^0))\ \text{as}\ t \to 0-$$

and for a function v and $x^0 \in S$

$$(v)_i = \lim v(x) \text{ as } x \to x^0,\ x \in D, \text{ and}$$

$$(v)_e = \lim v(x) \text{ as } x \to x^0,\ x \notin D.$$

We look for two solutions u and v of the homogenous equation (1) (that is with $f=0$), which are generalised potentials of single layer and of double layer respectively, such that

$$\left(\frac{\partial u}{\partial n}\right)_e - \left(\frac{\partial u}{\partial n}\right)_i = \lambda\left[\left(\frac{\partial n}{\partial n}\right)_e + \left(\frac{\partial u}{\partial n}\right)_i\right] + 2\varphi,$$

$$(v)_e - (v)_i = \lambda[(v)_e + (v)_i] + 2\varphi$$

where λ is a parameter and φ is a given function defined on S. Zaremba proved that this problem has (under general, relatively weak regularity assumptions) a solution which is an analytic function of λ and has at most one essential singularity (at infinity) and single poles at points belonging to sequence of real numbers independent on the function φ. This permits to deal with the Neumann method assuming weak regularity conditions. An analogous problem on the plane is considered in the paper [33] (without the assumption of the continuity of $\partial u/\partial n$).

In an earlier paper [27] Zaremba deals with successive approximations for solutions of a non-linear equation

$$\Delta u = f\left(x, y, z, u, \frac{\partial u}{\partial x}, \frac{\partial u}{\partial y}, \frac{\partial u}{\partial z}\right).$$

This paper, as well as the paper [26], is cited in [14] (p.528) where a canon of the theory of elliptic partial differential equations is presented.

The paper [42] is an extension of an unpublished note presented to the Paris Academy of Sciences and characterised by that Academy as *extrémement honorable*. A biharmonic problem considered there consists of searching a solution u of the equation $\Delta^2 u=0$ considered in a domain D such that $u=\varphi$ and $\partial u/\partial x i=\partial\varphi/\partial x_i$ on the boundary ∂D of the domain D, where φ is a sufficiently regular function defined on ∂D (in particular the second power of the Laplacian of φ is assumed to be integrable) requesting certain natural regularity condition to be fulfilled by u. Zaremba proved that in order to solve that problem it is sufficient to find a function v harmonic in D, such that v^2 is integrable and for every harmonic function h such that h^2 is integrable on D the following equality is satisfied

$$\int_D \Delta\varphi h d\tau = \int_D v h d\tau .$$

Zaremba proved theorems on existence and uniqueness of solutions to that problem. He proved also that this problem can be solved by determining the minimum of an integral on D.

Basing on some result of the paper [38] Witold Wilkosz (1891-1941) proved a theorem on analyticity of harmonic functions (see [23]).

The Dirichlet problem with non-continuous boundary conditions was treated in the paper [39]; the main result of this paper is the first one of that type.

Several other papers were devoted to the theory of the Dirichlet problem (see for instance [41],[43], [45], [51]). In papers [43],[45],[51] Zaremba developed his beautiful and fruitful idea of solving instead of the original Dirichlet problem some other problem which has always solutions. Paper [41] gives some numerical method of solving Dirichlet problems and – in a sense

– extends the idea of the paper [40] which will be referred to later on in another context.

The Dirichlet problem was also the subject of Zaremba presentation [44] during the IV-th International Congress of Mathematicians in Rome in 1908. In papers [43] and [44] Zaremba introduced generalised solutions into the direct method of variational calculus built up by Hilbert (see [9]). In [43] an example of a domain in which there is no solution of a linear Dirichlet problem is given. It was the first such example in the literature, as it is pointed out by Jean Mawhin in [9]. Pierre Dugac, Beno Eckman, Jean Mawhin and Jean-Paul Pier in [3] included this example into the list the most important results obtained in the first half of the XX-th century presented in the section "Guidelines 1900-1950". In the same book ([3], p.6) Zaremba is mentioned as the author of a *method of orthogonal projection in Dirichlet problem.*

In the paper [46] an equation of so-called spherical wave is considered. There is given a method of estimation of

$$\int (grad^2 u)\, d\tau$$

where u is a solution of that equation. The idea of Zaremba used in this method was applied later on by Friedrichs and Levy in order to get (now well-known) integral inequalities satisfied by general solution of hyperbolic equations. These inequalities have been generalised by Juliusz Schauder (and became some fundamental elements in the survey of the theory of hyperbolic equations).

Zaremba considered also several other problems. He discussed for example, as it has been mentioned already, problems of Neumann and Fourier. An important contribution to the theory of Fourier problem was presented in [37].

The Fourier equation

$$\Delta_x u - \frac{\partial u}{\partial t} = 0 \quad (u=u(x,t))$$

was the subject of Zaremba's presentation (see [48]) during the International Congress of Mathematicians in Strasbourg in 1920[10].

Let us now present some special part of Zaremba's contribution to the development of the theory *of reproducing kernels* (see for instance [15]). The best and probably the shortest way to do it is by referring to the Aronszajn paper [1]. He wrote: *Examples of kernels of the type in which we are interested have been known for a long time, since all the Green's functions of self-adjoint ordinary differential equations (as also some Green's functions – the bounded ones – of partial differential equations) belong to this type (...) There have been and continue to be two trends in the consideration of these kernels (...). The second trend was initiated during the first decade of the century in the work of S.Zaremba*

10 Let us recall that the International Mathematical Union (IMU) was founded at that time. As the exact date one should indicate: 20th September 1920 (compare Olli Lechto [8]). Countries-founders were: Belgium, Czechoslovakia, France, Greece, Italy, Japan, Poland, Portugal, Serbia, United Kindom, United States. Zaremba was the Polish representative. Zaremba was involved once again in the activity of IMU being appointed as a member of a Commission to study the question of permanent international collaboration in mathematics formed by the President of the 1932 International Congress of Mathematiciens (Zürich) according to the decision and authorisation of the General Assembly of IMU. *After consultation with E.Cartan, Severi,Veblen and Weyl, he* (President) *appointed* – as we read in [7] (p.58) – *F.Severi (Rome) as Chairman of the Commissio and the following members : P.S.Aleksandrov (Moscow), H.Bohr (Copenhagen), L.Fejér (Budapest), G.Julia (Paris),L.J.Mordell (Manchester), E.Terradas (Madrid), Ch.de la Vallée Poussin (Louvai), O.Veblen (Princeton), H.Weyl (Göttingen) and S.Zaremba (Cracow).*

[1,2][11] *on boundary value problems for harmonic and biharmonic functions. Zaremba was the first to introduce, in a particular case, the kernel corresponding to a class of functions, and to state its reproducing property (...). However, he did not develop any general theory, nor did give any particular name to the kernels he introduced.* In that way one links certain results of Zaremba with some important part of the modern theory of operators which shows how deep were those results now more than ninety years old.

Stanisław Zaremba was interested in many problems of theoretical physics. His contribution to it was important. Let us mention some of his papers concerning theoretical physics, as for instance [34], [35], [36], [48], [50], [52]. Some comments on the paper [48] seems to be appropriate. Zaremba criticised some ways of justification of the relativity theory by experiments mentioned at that time as arguments for it. He didn't find any mistake in this theory considered as an "abstract theory", but he was not ready to agree with its consequences, especially in view of questioned value of discussed experiments. Let us add that Zaremba got later on a certain result concerning the relativity theory (for details see papers [18], [19], [20] by Bronisław Średniawa). In [19] there are some comments on the Zaremba's papers concerning electrodynamics; Średniawa pointed out that statements of Zaremba are correct from the mathematical point of view and methods used there are interesting but conclusions are improper for physics since instead of Lorentz transformation (with respect to which the Maxwell equations are invariant) the Galileo transformation had been used.

Interesting particular questions belonging to theoretical physics (as for instance *visco-elasticity* and *relaxation*) were subjects of vigorous polemics between Zaremba and a well known

11 That is the papers [40] and [41] in the list of the present article

outstanding physicist, professor of the Jagiellonian University, Władysław Natanson (1864-1937). They had different opinions on the degree of accuracy, permissibility of approximations and interpretation of results as well (compare for instance [34], [35], [36]). It is impossible to discuss here all details of that fascinating scientific polemic. One information might be, however, so interesting that it should be mentioned here. When a long sequence of notes and articles of Zaremba and Natanson was continuously published in the *Bulletin Internationale de l'Académie de Sciences de Cracovie (Classe de Sciences Mathématiques et Naturelles)* the editorial board, probably slightly irritated, included to the March 1904 issue of the *Bulletin* a short notice with the following text: *La Classe des Sciences mathématiques et naturelles de l'Académie de Cracovie a decidé de ne publier, dans son Bulletin aucun nouvel article relatif à la polémique qui s'est angagée entre M.Natanson et M.Zaremba.* It should be added that one of the specific problems discussed by these two outstanding scientists was a generalisation (an extension to the three dimensional case) of the one dimensional, Maxwell theory of visco-elasticity. The generalisation done by Natanson was criticised by Zaremba. According to C.Truesdell and W.Noll, authors of the article on the non-linear field theories of mechanics included in the *Encyclopaedia of Physics* (see [21]), Zaremba was right, while it has not been acknowledged in the literature in a proper way; they wrote: *While the decision of time has been wholly for Zaremba, it has come late, and the vast literature on "plasticity" ignores it* ([21], p.47). Trying to summarise briefly Zaremba's contribution to the theory of visco-elasticy (to the study of viscoelastic materials) one should say that results were really important. In particular he applied tensorial technics in this theory and proposed some precise definitions.

The *Encyclopaedia* mentioned above uses the name *the Zaremba-Jaumann form of the principle of material frame-indifference* for the principle of invariantness of a fundamental equation of the theory, patterned upon the Maxwell equation of the kinetic gas theory.

How broad was the variety of fields of Zaremba's interest in theoretical physics one can see referring to – besides papers mentioned above - the paper [49] published in 1924 on motions of solid corps (in the context of Lorentz approach to the problem) and the article [53], written 10 years later, on the notion of *power* in mechanics.

Stanisław Zaremba made an essential and effective effort on the way of axiomatic justification of the notion of *time* in classical mechanics (which was the main subject of his work during the last period of his scientific activity in Kraków, from 1933 to 1940[12]). This joins two domains of his research: theoretical mechanics and logic, since among Zaremba's fields of interest there was also mathematical logic. Besides purely scientific approach (and some publications) he was engaged in a polemic with certain mathematicians and logicians connected with scientific centres of Warsaw and Lwów. The beginning of this polemic was related to the definition of the notion of the *value* (*wielkość* in Polish), but soon the question of the degree of formal strictness in mathematical resoning needed in research papers and in the textbooks became the main subject of vigorous discussion[13]. Interesting comments on this aspect of scientific activity of Za-

12 However, he didn't leave earlier subjects of his interest and wrote a paper on harmonic functions (see [54]).

13 Zaremba's partners (or – rather – counter–partners) were in particular: philosophers and logisticians Jan Łukasiewicz (1878-1956), Tadeusz Czeżowski (1889-1981), Leon Chwistek (1884–1944) and a mathematician Kazimierz Kuratowski (1896-1980).

remba can be found in the book [24] where several other fields of discussions and polemics undertaken by members of Polish scientific centres are presented in a large context.

It was pointed out that Stanisław Zaremba was strongly interested in several applications of mathematics. One more example of his engagement in building up links between mathematics and applications can be indicated by his research, common with a professor of mineralogy Stefan Kreutz, concerning the crystallography. They proposed a precise formal definition of a notion called: *crystallography system* (we refer to [22] for more information and some comments).

It should be added finally that Zaremba wrote several valuable textbooks on analysis and theoretical mechanics (seemed to be the most important) and on selected topics of linear algebra was well.

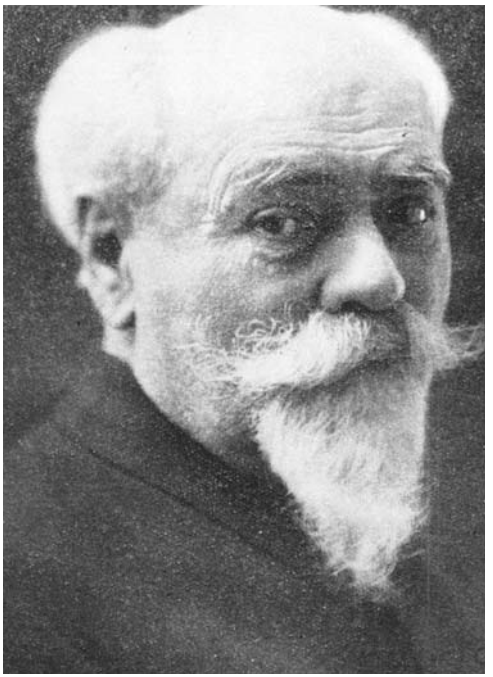
The authors of the paper [22] (to which we have referred here several times) quote a significant phrase of Henri Lebesgue who said that Stanisław Zaremba never wrote a needless paper. It is difficult to imagine more laudatory opinion on scientific activity of anybody.

Concluding this essay let us quote Kazimierz Kuratowski [7] who expressed his view on the Zaremba life and work by saying: *Stanisław Zaremba is the pride of Polish science*.

***

A family tradition of research in mathematics and academic career was kept out by Stanisław Krystyn Zaremba (1904-1990), the son of Stanisław Zaremba. S.K. Zaremba studied at the Jagiellonian University and the Paris University, after that he worked as a member of academic staff of the Jagiellonian University and the Stefan Batory University in Wilno (Vilnius, now Lituania). After wandering about the world (what was forced by the World War II)

he spent the second half of the XX–th century in USA, Canada and Wales ending there his formal academic career as the professor emeritus. Among his significant scientific achievements there are results concerning differential equations and their generalizations. In particular, in 1935, he wrote the paper *Sur les equations au paratingent* (published as an addendum to the Annual of the Polish Mathematical Society, vol. 9 – *Dodatek do Roczników PTM, t.9, 1935*) proposing a generalization of differential equations which now is called differential inclusions[14]. This dissertation was presented in 1936 as the habilitation thesis. S.K. Zaremba was an outstanding climber; his name is known in the mountaineer literature, both as the author of several essays and as the author of first ascents in Tatra and in other mountains.



Picture 6. Stanisław Zaremba in late years of his life.

14 It was one of his two papers on this subject; simultaneously and independently similar idea was proposed by a French mathematician, A.Marchaud, who introduced *contingent equations*.

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Pictures:

1, 2, 3. Stanisław Zaremba and fragments of the protocol of the first meeting of the Mathematical Society in Kraków, by courtesy of the Archive of Science of the Polish Academy of Science and Polish Academy of Arts and Science.

4,5. Centre Historique des Archives Nationales (Atelier de Photographie)
6. Stanislaw Zaremba (photo Bielec), by courtesy of the Institute of Mathematics of the Jagiellonian University.

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Kraków, June 3, 2009

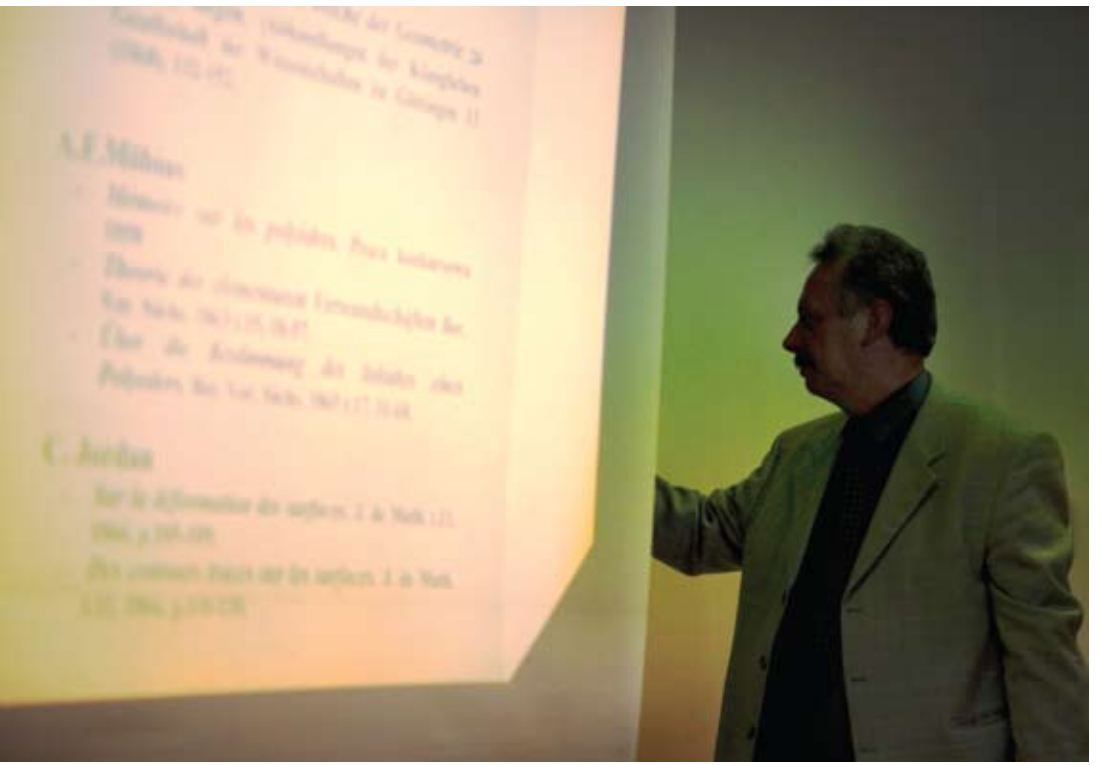
June 9, 2009 - Discussion panel “How to be a scholar?”, Piec’Art Pub, Szewska Str. 12, Kraków (from left: Fr. Dr. Wojciech Grygiel, Professor Jerzy Vetulani, Professor Romuald Polczyk, Professor Bartosz Brożek). Photo: Adam Walanus

May 18-19, 2009, Kraków, Collegium Novum – XIII Kraków Methodological Conference, "Evolution of the Universe - Evolution of Life". Photo: Adam Walanus

March 20, 2009, Larisch Palace, Bracka Str. 12, Kraków, Copernicus Center Colloquium #1. Photo: Bartosz Brożek

May 11, 2009. „Watching the sky" with Fr. Professor Michał Heller, Kijów Theatre, Kraków. Photo: Adam Walanus

May 14, 2009. Seminar in the Philosophy of Nature. Lecture delivered by Professor Zdzisław Golda of the Astronomical Observatory of the Jagiellonian University: "Construction of a Relativistic Cosmological Model", Gronostajowa Str. 3, Kraków. Photo: Adam Walanus



May 7, 2009. Seminar in the Philosophy of Nature. Lecture delivered by Professor Zbigniew Pogoda: "Historical aspects of the classification of chosen mathematical objects", Gronostajowa Str. 3, Kraków. Photo: Adam Walanus

December 11, 2009. Conference “Dimensions of time” under the patronage of the Copernicus Center (from left: Fr. Professor Michał Heller, Professor Władysław Stróżewski). Photo: Adam Walanus