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PROFESSOR JAN MIKUSIŃSKI —THE 20TH ANNIVERSARY OF HIS DEATH

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Jan Mikusiński (3 April 1913 – 27 July 1987) belongs to the generation of outstanding Polish mathematicians which appeared in the scientific circles shortly before the Second World War. He was born in Stanisławów (now in Ukraine) as the second of four sons. His father, Kazimierz Geniusz Mikusiński, came from Lithuania; he was an Austrian officer, a Germanist and a teacher at a secondary school in Stanisławów. Mikusiński's mother, Anna Bełdowska, born in 1889, was also a teacher. She gave birth to four sons: Władysław, Jan, Franciszek, and Stefan. The youngest son, Stefan, died of dysentery at the age of four.

Jan's grandparents on his mother's side were Leopold Bełdowski, a nobleman and a lawyer, a starosty chief inspector under the Austrian rule, and Emilia, née Skomorowska. They came from Galicia and lived in Buczacz (now in Ukraine).

Jan's grandparents on his father's side were Jan Geniusz, born in 1840, who came from Lithuania, earlier a part of Poland, took part in the Polish January Uprising of 1863, and after its collapse had to emigrate to Austria; and Berta von Lesser who was Swedish and related to the Hohenzollern family; she was a pianist, and a student of Liszt.

Jan Geniusz returned to Poland (to a site now in Lithuania) under the pseudonym of **Mikusiński**, taken after a dead brother in arms.

In 1917, the family moved to Austria, escaping from the Russians. After the First World War, when Poland regained its independence, they returned to their homeland. The family first lived in Rogoźno and then in Poznań. In 1918, the Mikusińskis returned

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to their family name, i.e. *Geniusz*, but retained the pseudonym *Mikusiński*. From that time on their name was *Geniusz Mikusiński*. Anna and Kazimierz Geniusz Mikusiński spent the Second World War in Cracow. Kazimierz died in 1942. After the war Anna lived with her son Władysław and his family in Poznań. She died in 1960.

Kazimierz and Anna Geniusz Mikusiński

School years and studies of Jan Geniusz Mikusiński. Jan attended schools and studied in Poznań. At first, he attended the Paderewski Humanistic Secondary School (1923–1928). As his talent for mathematics emerged, he was sent to the Berger Mathematical–Natural Secondary School (1929–1932). In his youth, he dreamt of becoming an engineer. However, his frail health did not allow him to follow the engineering studies. That is why he decided to study mathematics. He graduated from the University of Poznań (suspended due to a three-year illness), obtaining an MSc degree in mathematics on 3rd December 1937. Until his death, engineering was one of his numerous passions.

War time. After his graduation, Mikusiński started to work at the University of Poznań where he was an assistant professor until the war. He spent the German occupation in Zakopane and Cracow. He took an active part in the clandestine teaching of secondary school and university students in Cracow. Because of his teaching activities, he was twice arrested by the Germans. With a group of Cracow mathematicians, he also took part in Tadeusz Ważewski's clandestine seminar. In 1943, the participants of Ważewski's seminar were the first to come in contact with a new theory which is now well known as Mikusiński's operational calculus. The objects of the theory, i.e. operators, provide

a common generalization of numbers and locally integrable functions on the positive half-line. The author first called them "hypernumbers" and gave this title to a paper containing the main ideas of the theory.

The thesis "Hypernumbers" appeared in 1944, in seven copies handmade by the author with the use of X-ray plates. The copies were distributed among the participants of the seminar. Forty years later, the thesis was republished: first as [21] in the USA (Santa Barbara), in Polish with an English translation, and then as [22] in Poland, only in English. Both publications were on the occasion of Mikusiński's 70th birthday.

Academic career. Immediately after the end of the war, Jan Mikusiński started his teaching and research work at the Jagiellonian University in Cracow where, on 25th July 1945, he obtained his PhD degree defending the thesis *Sur un problème d'interpolation pour les intégrales des équations différentielles linéaires*, supervised by Tadeusz Ważewski.

In the academic year 1945–1946, Mikusiński worked as an assistant professor at the University of Poznań and, at the same time, as a professor at the Engineering School in Poznań.

On 28th February 1946 he received his postdoctoral degree at the Maria Curie–Skłodowska University of Lublin where he worked as an associate professor of mathematics from October 1947 until October 1948.

During the period 1948–1955, Jan Mikusiński was a professor of the University of Wrocław and then (1955–1958) of the University of Warsaw. At the same time, he worked at the National Institute of Mathematics (later renamed the Institute of Mathematics of the Polish Academy of Sciences) from the very moment it was founded in 1948. On 10th December 1955, he was granted the degree of Doctor in Mathematics for a collection of papers under a common title *A New Approach to the Operational Calculus*. At that time, there were two scientific degrees: a lower one, candidate of sciences, and a higher one, doctor of sciences. He was made a full professor on 4th February 1958. Because of an eye disease, he was forced to give up teaching and research work. His application for a sick leave was rejected, therefore, on 10th September 1959, he quit his job at the University of Warsaw. Nevertheless, he remained an employee of the Institute of Mathematics of the Polish Academy of Sciences. Around 1953, Jan Geniusz Mikusiński stopped using his family name **Geniusz**. From that time on, he wrote his papers under the name **Mikusiński** exclusively.

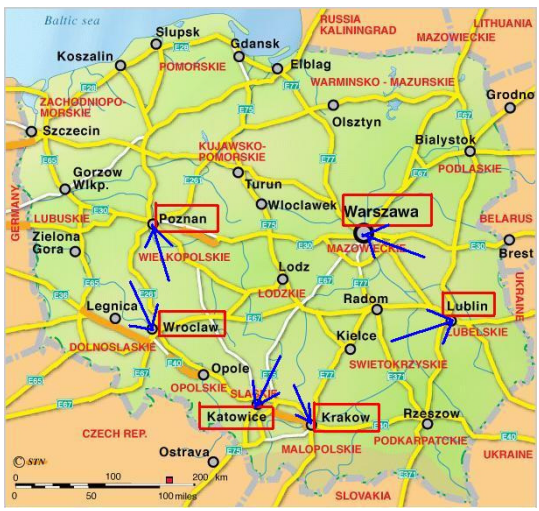
Important seminars until 1960. Professor Jan Mikusiński held the following seminars:

- Wrocław 1948–1954,
- Wrocław–Warsaw 1954–1958.

The results obtained during Mikusiński's seminars were later presented at the Polish Mathematical Society sessions (see [39]). There are three important chapters in his seminar activity.

1. The first period (Wrocław 1948–1954) is connected with the **Operational Calculus** (O.C.). It was the subject of research in Wrocław from 1948, i.e. from the time Jan Mikusiński arrived in Wrocław.

2. The second period (Wrocław and Warsaw 1954–1958) is connected with the **Theory of Distributions** (T.D.). The seminar was called **Mik–Sik**, as it was also frequented by another Warsaw mathematician, Roman Sikorski. The seminars were initially held alternately in Warsaw and Wrocław, and later only at the Institute of Mathematics of the Polish Academy of Sciences in Warsaw.
3. The third period is connected with **Differential Algebra**, Warsaw 1955–1958.



1923–1939 Poznań:
1923–1932 secondary school,
1932–1937 studies,
1937–1939 University of Poznań;
1939–1945 Zakopane, Cracow;
1944–1945 Jagiellonian University;
1945/46–1946/47 Poznań:
University of Poznań;
1947/48 Lublin:
UMCS University;
1948/49-1954/55 Wrocław:
University of Wrocław & IM PAS;
1955/56-1958/59 Warsaw:
University of Warsaw & IM PAS;
1960-1987 Katowice:
IM PAS Warsaw & Katowice Branch

Sites in Poland connected with Jan Mikusiński

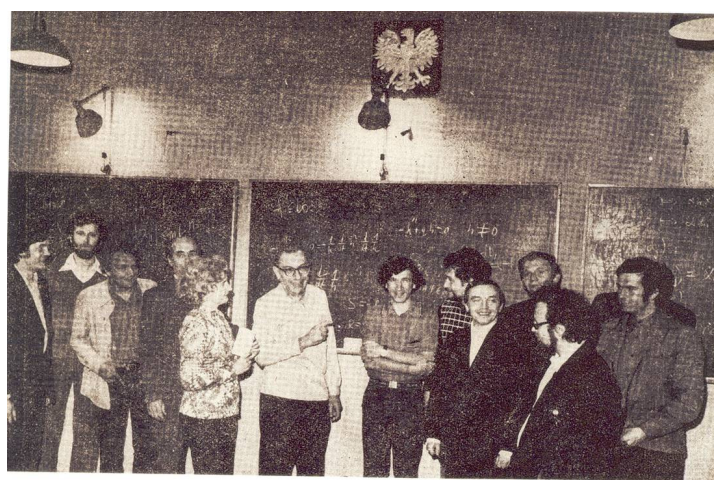
Professor Mikusiński in Silesia. In 1960, when Mikusiński moved from Warsaw to Katowice (Silesia, Poland), he was already a world-famous mathematician. His arrival in Katowice was an event of great importance for the mathematicians working there. Shortly afterwards, a group of young mathematicians from the Higher Pedagogical School in Katowice got in touch with him. Mikusiński delivered a series of lectures on the operational calculus for them. After a year, the lectures turned into a regular seminar, first held at the Higher Pedagogical School, then at his place, **at the Mikusińskis'.** The participants of this seminar (P. Antosik, W. Kierat, K. Skórnik, S. Krasińska, and J. Ligęza) remember the unique atmosphere of those meetings, discussions at the blackboard placed in the garage or on the terrace, or the rooms replacing a seminar hall. These informal scientific contacts of Professor Mikusiński with Silesian mathematicians became formal only in 1966 when the *Mathematical Laboratory* (now *Katowice Branch*) of the Institute of Mathematics of the Polish Academy of Sciences was established. The fact that the Mathematical Laboratory of the Institute of Mathematics of the Polish Academy of Sciences (IM PAS) was opened was a token of recognition for Mikusiński's accomplishments and activity in Silesia. Professor Mikusiński was the head of the Mathematical Laboratory (later IM PAS) until 1983. The Institute owes him the worldwide recognition and regular contacts with scientific centres abroad. The settlement of Jan Mikusiński in Silesia was of great importance, especially at the beginning when the region was deprived of an academic centre and young mathematicians searched for scientific support in other centres,

like Cracow, Lublin or Wrocław. His arrival gave them the possibility of staying in contact with great mathematics. After the Silesian University was founded in 1968 and after the arrival of many new mathematicians from other centres in Silesia, Jan Mikusiński was a person who connected the dispersed mathematical community. It was due to his efforts that monthly Thursday mathematical discussions (at tea, chess, darts) with the participation of mathematicians representing various Silesian scientific institutions were held at the Mathematical Laboratory.

Mikusiński's seminar in Katowice. The seminar directed by Mikusiński, entitled *Generalized Functions and the Theory of Convergence*, was held at the IM PAS Katowice Branch. The research subjects were connected with Mikusiński's interests and included:

- the operational calculus
- the theory of distributions, the sequential approach
- the theory of convergence
- the method of diagonal theorem
- the theory of Lebesgue and Bochner integral
- applications of mathematics.

The participants of the seminars included Piotr Antosik, Jan Błaż, Józef Burzyk, Cezary Ferens, Piotr Hallala, Andrzej Kamiński, Władysław Kierat, Czesław Kliś, Stefania Krasińska, Marek Kuczma, Sabina Lewandowska, Jan Ligęza, Zbigniew Lipecki, Stanisław Łojasiewicz, Piotr Mikusiński, Jan Pochciał, Zbigniew Sadlok, Krystyna Skórnik, Wilhelmina Smajdor, Zygmunt Tyc, Zbigniew Zieleźny, Kazimierz Zima.



Mikusiński's seminar in 1976 (Mathematical Laboratory of the PAS)
From the left: J. Burzyk, P. Mikusiński, Z. Frolik, P. Antosik, K. Skórnik, J. Mikusiński, V. Zharinov, Z. Sadlok, C. Ferens, Z. Tyc, Cz. Kliś and A. Kamiński

The seminars were peculiar in that they were connected with the so called "mountain seminars", i.e. trips to the mountains, usually of one week. As a rule, such seminars were organized once or twice a year and involved the participation of foreign scientists.

Mountain seminar in 1978

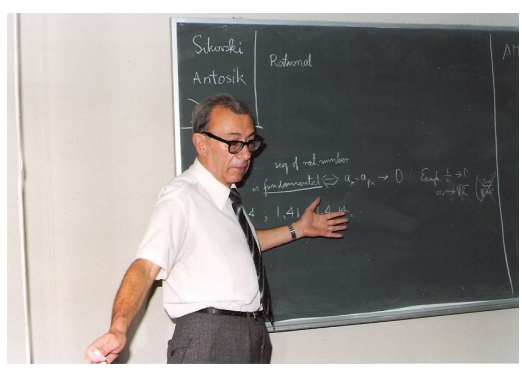
Kneeling (from the left): Anzelm Iwanik, Czesław Kliś, Cezary Ferens; standing (from the left): Zbigniew Lipecki, Victor Zharinov (Moscow), Zygmunt Tyc, Władysław Kierat, Stevan Pilipović (Novi Sad), Krystyna Skórnik, Jan Mikusiński, Piotr Antosik and Czesław Ryll-Nardzewski

The participants of Mikusiński's seminar published 11 books and over 300 papers after 1966; see [2] and [4].

PhD students of Professor Mikusiński. Mikusiński was the supervisor of seven doctor theses, five of which were written during the Silesian period. The authors of the theses were: Zbigniew Zieleźny,Michał Kowalski, Piotr Antosik, Władysław Kierat, Krystyna Skórnik, Andrzej Kamiński and Jan Pochciał.

Scientific life in Silesia. Professor Mikusiński played an inspiring role in creating a mathematical centre in Upper Silesia. He actively supported the organization of the *Silesian University* and of the *Katowice Branch of the Polish Academy of Sciences*. He delivered a series of lectures at the meetings of the Silesian Branch of the Polish Mathematical Society. He gave lectures and took an active part in the scientific life of the Silesian University. His presence in Silesia was a reason for many mathematicians to move to Katowice.

Mikusiński educated many mathematicians working in Silesia. He initiated new directions of research and created the school of generalized functions in Katowice.



Mikusiński's seminar in Warsaw. Independently of the seminar in Katowice, there was the second *Mikusiński's seminar* in Warsaw. This seminar was held every second week (a four-hour session each time) at the Institute of Mathematics of the Polish Academy of Sciences. The seminar attracted participants from the entire country. The following mathematicians took part in the meetings: Adam Bielecki, Roman Sikorski, Stanisław Łojasiewicz, Czesław Ryll–Nardzewski, Krzysztof Maurin, Jan Mycielski, Adam Piskorek, Danuta Przeworska–Rolewicz, Zbigniew Zieleźny, Hanna Marcinkowska, Jan Kisyński, Piotr Antosik, Krystyna Skórnik, Władysław Kierat, Zbigniew Łuszczki and Stefania Krasińska.

Research interests of Jan Mikusiński. At first, Jan Mikusiński took up differential equations, following his teacher, Mieczysław Biernacki. His main results concerned the interpretation of their solutions and distance of their zeros. That direction was also followed in his PhD thesis. In his research on differential equations, he strove for simplified methods of solution and their mathematical justification. In his search for easy methods, Jan Mikusiński arrived at the notion of a field of operators that offered a possibility to solve a wider range of differential equations (including partial differential equations) than in the case of the Laplace transform. Because of the operational calculus, Mikusiński was also interested in other problems of classical analysis, e.g. the theory of moments and analytic functions. He also offered a few proofs of the Titchmarsh theorem (see e.g. [15]) that was the basis for his algebraic approach to the operational calculus (see *Operational Calculus*, 1953) and considered the convolution of continuous functions on the positive half-line. A new view on the operational calculus initiated also certain problems of abstract algebra. In particular, the set of Mikusiński's operators can be regarded as the Ritt field with respect to the algebraic derivative (see [9], [16]). This fact enables the use of the operational calculus to investigate some linear differential equations with polynomial coefficients [37].

The problem of determining the solutions of partial differential equations with constant coefficients in two variables can be rephrased as the problem of determining the solutions of linear ordinary differential equations with operational coefficients, [7], [6], and [13]. This leads to the investigation of arbitrary linear spaces with a derivative [5], [14], [10], [36], [32].

At the same time when the operational calculus was born, mathematicians took great interest in the theory of distributions initiated by S. Sobolev (see [38]) and L. Schwartz (see [33], [34], [35]). This theory was based on difficult tools of functional analysis. In order to make the theory of distributions closer to physicists and engineers, Mikusiński offered an elementary definition of a distribution (see [12]) based on the commonly known notions of mathematical analysis. The theory of distributions, as based on that definition, was developed at Mikusiński's seminar in Wrocław and Warsaw, and was worked out in the form of a two-volume treatise. The treatise, written jointly with Roman Sikorski, was published in English and then translated into other languages (see [29], [30]). There were several editions of the book *Elementary Theory of Distributions* in Polish, English, Russian, Chinese, and French. In comparison to the functional approach, a new element in the theory of distributions developed by Mikusiński was, apart from the original approach, the study of regular and irregular operations (see [17]).

Distributions embrace, as a special case, integrable functions in the sense of Lebesgue. This made Mikusiński interested in the theory of integrable functions (see [27]). He devised a definition of the Lebesgue integral which is not based on the notion of measure. This definition refers to the Bochner integral, elaborated in Mikusiński's book *The Bochner Integral*, 1978 (see [20]). Apart from his main interests such as the operational calculus, the theory of distributions and the theory of measure and integration, Jan Mikusiński was also interested in real and complex analysis, differential and functional equations, generalized functions, functional analysis, algebra, problems of elementary geometry, number theory, general topology, mechanics, electrical engineering, and chromatography. He was also interested in practical problems. He was the author of a project to reconstruct the church vault in the destroyed chapel of the Lublin cathedral, which enabled the preservation of the original, interesting acoustics. He took interest in the theory of music scales, photography, theoretical problems of optics, and environment protection.

Mikusiński's research in the operational calculus and the theory of distributions was continued by many mathematicians, including C. Ryll–Nardzewski, S. Łojasiewicz, K. Urbanik, J. Kisyński, J. Wloka, C. Foiaş, R. Sikorski, T. K. Boehme, R. A. Strubble, B. Beaumer, I. Dimovski, K. Yosida, L. Berg, A. Prudnikov, B. Stanković and Z. Zieleźny.

Books of Jan Mikusiński. Professor Mikusiński had considerable scholar achievements. He published 15 books translated into many languages and over 150 papers in prestigious mathematical journals in Poland and abroad. The books include:

- *Operational Calculus*, first Polish edition 1953 [8], second Polish edition 1957, first English edition 1958; in total: 20 editions in 6 languages
- *Operational Calculus*, Vol. I, 1987 [23]
- *Operational Calculus*, Vol. II, 1987 [25] (with T. K. Boehme)
- *Introduction to Mathematical Analysis* (in Polish), PWN, Warsaw 1957
- *The Theory of Lebesgue Measure and Integration*, 1957 (in Polish), 1961 (in English) [27] (with S. Hartman);
- *Elementary Theory of Distributions*, 1957 [29], 1961 [30], in total: editions in 5 languages (with R. Sikorski)
- *Theory of Distributions. The Sequential Approach*, 1973 [1] (with P. Antosik and R. Sikorski) (see also [19])
- *The Bochner Integral*, Birkhäuser, 1978 [20] (see also [18])
- *On Axially Symmetric Optical Instruments*, 1979 [31] (with K. Skórnik)
- *Hypernumbers*, 1983 [21]
- *From Number to Integral*, 1993 [28] (with P. Mikusiński).

The books and papers of Jan Mikusiński on various topics have several common features: originality, simplicity of approach, usefulness of applications, and elegance. *Operational Calculus* enjoyed a special worldwide renown and was published in Polish, English, Russian, German, Hungarian, and Japanese in numerous editions. The book contained a new mathematical theory which quickly gained its fully deserved fame in the world and was further developed in many foreign mathematical centres under the name of *Mikusiński's operational calculus*. The name of Mikusiński is now widely used in math-

ematics in connection with the notion he created, i.e. *Mikusiński's operators* (see AMS Subject Classification 44A40). For a list of Jan Mikusiński's publications see [3] and [4].

International cooperation and activity in organizations. The scientific achievements of Jan Mikusiński are remarkable and highly valued in the mathematical world. Numerous invitations to deliver lectures and talks in well known scientific centres abroad addressed to him confirm this recognition. He was a visiting professor in France (Paris, 1956), Germany (Ilmenau, 1957) and Czechoslovakia (Prague, 1958). He was a UNESCO expert in Argentina (1962) and a visiting professor in Germany (Aachen, 1961), Turkey (Ankara, 1967), and the USA (Pasadena, 1964; Gainesville 1968–1970; Santa Barbara, 1983; Orlando, 1987). He received many invitations to the Soviet Union, East and West Germany, Hungary, Holland, Bulgaria, Romania, and Yugoslavia. He was also a visiting professor in Netherlands, Switzerland, Israel, Italy, Canada, and Japan. Finally, he was an organizer and a participant of numerous international conventions, conferences and symposia.

Jan Mikusiński in the USA (12 November 1968 – 27 March 1970). The longest trip of Jan Mikusiński as a visiting professor was to Florida in 1968. He gave lectures on the *Operational Calculus* and the *Theory of Distributions*, and held a seminar on *Measure Theory* at the University of Florida, Gainesville. During his stay at the University of Florida, he wrote a paper *A theorem on matrices and its applications in measure theory and functional analysis* and a textbook *Lectures on the Constructive Theory of Distributions* [19], as well as collected and prepared materials for his book *The Bochner Integral*, the work initiated already in [18]. He collaborated with A. R. Bednarek and I. K. Brooks, which resulted in joint papers: *Convergence and topology* [24] (with A. R. Bednarek) and *On some theorems in functional analysis* [26] (with J. K. Brooks). Mikusiński made a scientific trip across the USA. He visited Arizona, Kansas, Ohio, Indiana, and New York. He took part in a meeting of the *American Mathematical Society* in San Antonio (Texas). On his way back to Poland, he visited Amsterdam where he established scientific contacts with the mathematicians working there. Mikusiński visited the USA two more times: in 1983 (in Santa Barbara) and in 1987 (in Orlando).

Jan Mikusiński in Japan. Mikusiński highly valued contacts with Japanese mathematicians, initiated in 1959. He reviewed papers on the operational calculus and on the theory of distributions from Japan. His book *Operational Calculus* had 12 editions in Japan. Moreover, his article on musical scales [11] was published there. He visited Japan on the invitation of the JSPS (Japan Society for Promotion of Science) in September 1980. He spent most of his visit in Kyoto where he met Professors Matsuura, Sato and Hitotumatu from the RIMS (Research Institute for Mathematical Science).

He also took part in a JNS (Japan Mathematical Society) symposium where he delivered a talk *From number to integral*. He was in Nagoya with a lecture *Sequential approach to integration*, in Tsukuba where he gave a talk *Operational calculus in chromatography* and in Tokyo where he met several mathematicians, e.g. K. Yosida and H. Komatsu. He gave a lecture *Integration* at the Tokyo University and *Sequential approach to distributions* at the Waseda University.

K. Yosida & J. Mikusiński

K. Yosida, H. Komatsu, J. Mikusiński, U. Mikusińska

Duties performed. Professor Mikusiński performed many duties: head of the Department of Mathematical Analysis at the University of Wrocław (27 June 1953 – 4 August 1955); expert of the Central Qualifying Commission of the Polish Academy of Sciences (27 November 1953 until its end); member of the Scientific Council of the Institute of Mathematics of the Polish Academy of Sciences (from 1954 until his death); member of the Scientific Council of the Institute of Physics of the Polish Academy of Sciences (from 9 January 1956); member of the Mathematical Sciences Committee (from 13 June 1960); head of the Department of Mathematical Analysis at the Institute of Mathematics of PAS (from 1 December 1962); head of the Mathematical Laboratory (later a branch of the Institute of Mathematics) of PAS (from 1966 until 1985); member of the Scientific Council of the Institute of Mathematics at the Silesian University; member of the Scientific Council of the Institute of Mathematics at the Silesian Technical University; member of the editorial boards of *Studia Mathematica* and *International Journal of Mathematics and Mathematical Sciences*; reviewer of *Mathematical Reviews* and *Zentralblatt für Mathematik*.

Prizes and awards. Mikusiński received numerous prizes and awards for his scientific activity: Polish Mathematical Society Banach Prize for work on the operational calculus,

1950; Second Class State Award, 1953; Honorary Doctorate of the University in Rostock, 1970; membership of the Serbian Academy of Sciences and Art, 1975; honorary membership of the Polish Mathematical Society, 1983; Sierpiński Medal, 1985. Apart from these, he received several national awards, including the Knight's Cross with Star of the Order of Polonia Restituta.

Conferences on Generalized Functions. Due to Mikusiński's efforts, an international conference on *Generalized Functions* was organized in Katowice after the international congress in Moscow in 1966. Many famous specialists in that field participated in the conference: L. Schwartz, S. Sobolev, G. Temple, T. K. Boehme, J. Dieudonné, J. Wloka, A. P. Prudnikov, W. A. J. Luxemburg, D. Laugwitz, G. Marinescu, J. Nons, G. K. Kalisch, J. Korevaar, H. Komatsu, D. Myers, K. Goebel, J.-L. Lions, L. Włodarski, W. Słowikowski, A. Hulanicki, J. A. Synowiec, M. Zerner, and others. The organizing committee included: J. Mikusiński, P. Antosik, K. Skórnik, and W. Kierat. The conference initiated a series of conferences that were held in turn in Poland, Bulgaria, Germany, and, in 1980, in Moscow. These included:

- 1971 Srebreno, Yugoslavia
- 1972 Rostock, East Germany
- 1973 Wisła, Poland
- 1974 Szczyrk, Poland
- 1975 Varna, Bulgaria
- 1978 Oberwolfach, Germany
- 1979 Szczyrk, Poland
- 1980 Moscow, USSR
- 1983 Katowice, Poland
- 1984 Debrecen, Hungary
- 1988 Katowice, Poland
- 1989 Krężelka, Poland.

Jan Mikusiński had many friends among famous mathematicians of world renown. He corresponded with them in many languages, in particular in English, German, French, and Russian. On 10th October 2007, Professor Janos Aczél wrote to me: *Professor Jan Mikusiński was my friend. Our friendship lasted since 1947 till almost his death (since 1947 till 1954 and in many years later by correspondence, mostly but not exclusively mathematical) ...*

Jan Mikusiński died on 27th July 1987 and was buried in a cemetery in Katowice. His death was a great loss to mathematics and Polish science.

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