

EDITORIAL

FCAA RELATED EVENTS AND 100th ANNIVERSARY OF THE BIRTH OF JAN MIKUSIŃSKI (FCAA–VOLUME 16–4–2013)

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Dear readers,

in the Editorial Notes we announce some important news for our journal, information on international meetings, events, anniversaries, new books, etc. related to the FCAA (Fractional Calculus and Applied Analysis) areas.

1. Forthcoming Meetings: Next FDA under IEEE

“International Conference on Fractional Differentiation and Its Applications’ 14” (ICFDA’ 14)

June 23-25, 2014, Catania, Italy

Website <http://www.icfda14.dieei.unict.it/>

The ICFDA’ 14 will be **organized and hosted by the University of Catania, DIIEI** (Dipartimento di Ingegneria, Elettrica, Elettronica e Informatica) in Catania, Italy.

This conference is **technically co-sponsored by IEEE** (Institute of Electrical and Electronics Engineers), the world’s largest technical professional association. The event is already announced on the IEEE calendar, search for “ICFDA” or for June 2014, at: http://www.ieee.org/conferences_events/conferences/organizers/conference_organizer_quick_links.html#.

The ICFDA’ 14 is a continuation, the 7th in the series of the previous FDA meetings: 2004 in France, 2006 in Portugal, 2008 Turkey, 2010 in Spain, 2012 in China, 2013 in France, see **Previous Events** at <http://www.icfda14.dieei.unict.it/previous.html>.

As such, its topics will include all traditional **FDA topics** on fractional order systems and models, both in theoretical and application aspects. Now their list is extended to yet wider range, due to the growing research and development on fractional calculus in the areas of mathematics, physics and engineering, both from university and industry, that motivates this international event to gather, unify and enlarge the FDA community.

Deadlines: – Regular and invited papers submission: Nov. 10, 2013; – Invited sessions submission: Nov. 1, 2013; – Notification of acceptance: Feb. 15, 2014; – Final submission: March 31, 2014; Early registration April 10, 2014

Conference details, and further updates: Please visit the website and follow its updates.

Contacts: ICFDA'14 e-mail address: icfda14@dieei.unict.it

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2. 100th Anniversary of the Birth of Professor Jan Mikusiński

Jan Geniusz Mikusiński

Born: 3 April 1913 in Stanisławów, Austrian-Hungarian Empire (now Ivano-Frankivsk, Ukraine), Died: 27 July 1987 in Katowice, Poland

Article by **John J. O'Connor**² and **Edmund F. Robertson**²
reprinted from website

<http://www-history.mcs.st-and.ac.uk/Biographies/Mikusinski.html>

Jan Mikusiński's parents were Kazimierz Geniusz Mikusiński (1882-1942) and Anna Beldowska (1889-1960). Kazimierz was an Austrian officer and a secondary school teacher in Stanisławów, but he was originally from Lithuania. In fact, the family name of Mikusiński had a strange origin. Kazimierz's father, the paternal grandfather of the subject of this biography, was Jan Geniusz who lived in Lithuania in an area which had been Poland before the partition of that country in the 18th century. Jan Geniusz took part in the January Uprising of 1863, which began when Poles objected to being conscripted into the Russian Army. The uprising was put down and those who took part were executed or deported. Jan Geniusz fled to Austria but later returned to Lithuania having changed his name to Mikusiński to avoid reprisals. Jan Geniusz was married to Berta von Lesser, a Swedish pianist and pupil of Franz Liszt. Jan Mikusiński's maternal grandparents were Leopold Beldowski, an Austrian nobleman, and Emilia Skomorowska. Kazimierz and Anna Mikusiński had four children, Władysław, Jan, Franciszek, and Stefan. The youngest, Stefan, died aged four.

Poland was in a difficult position during World War I since it was partitioned between countries that were at war with each other. However,

most Poles saw the war as an opportunity for the country to regain its independence. As the Red Army advanced from the east, the Mikusiński family fled in 1917 to Austria and lived for a year in Vienna. In March 1918 the Soviet government relinquished control of their part of Poland. This, of course, did not by itself unite Poland since World War I was still in progress. After the war ended with the surrender of the Central Powers, Poland proclaimed itself independent on 11 November 1918. The Mikusiński family returned to Poland and lived for a while in Rogozno, about 40 km north of Poznan, before settling in Poznan. In 1918 the family began again to use the name Geniusz but retained Mikusiński. Jan's school education was in Poznan. He entered the Ignacy Jan Paderewski Humanistic Gymnasium in 1923 and studied there for five years. However, he showed a special aptitude for mathematics so his parents decided that he would receive an education more suited for his interests at the Gotthilf Berger Gymnasium so he studied there between 1929 and 1932.

Although Mikusiński excelled in mathematics, it was engineering that had always been his main interest. However, his health was very fragile and he felt that he would not be physically able to become an engineer so, after beginning his studies in 1932 at the University of Poznan, he concentrated on mathematics. His health did not allow him to continue even with mathematics and he took a break of about three years before his health recovered sufficiently to enable him to continue his studies. He graduated with a Master's Degree on 3 December 1937. He remained at the University of Poznan where he was appointed as an assistant. At the start of World War II in 1939, Russia and Germany had a pact, the so-called Ribbentrop-Molotov pact, to divide Poland between them. The two-pronged attack - the Germans from the west and the Russians from the east - quickly defeated the Polish army. The University of Poznan was closed down by the occupying German forces in October 1939 and many of the faculty were arrested - Mikusiński fled to Kraków. He spent the war years, partly in Kraków and partly in Zakopane, see [16]:

He took an active part in secret education of secondary school pupils and students in Kraków. Because of the teaching activity he was arrested twice by the occupying Nazi force. He also took part in Professor Tadeusz Wazewski's underground seminar together with a group of Kraków mathematicians. The participants of Wazewski's seminar, in 1943, were the first persons to come in contact with a new theory which is now very well known in the world of mathematics as the Mikusiński operational calculus. The objects of the theory, 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.

In 1983 *Studia Mathematica* published an English translation of “Hypernumbers” The paper contains a Preface explaining its wartime origins:

This paper is quite unusual. It is not a new paper. It has been published already (in Polish), but the size of the first edition and the circumstances of its publication were out of the ordinary. The edition was limited to seven copies, and printing was made by the author himself by using X-ray films. The matter will become clear when we add that the paper appeared in Kraków, in the year 1944, during the Nazi occupation of Poland. It also explains why the author conceals his identity under the initials J.G.-M., and why only initials appear in the acknowledgement at the end of the author’s introduction. The time has come to solve this riddle. The letters J.G.-M. stand for Jan G.-Mikusiński (G, being the first letter of Geniusz, the author’s patronymic, which he later abandoned). This name is well known nowadays in the world of mathematics. It belongs to an eminent Polish mathematician ... The paper “Hypernumbers” represents the first version of the Mikusiński operational calculus (improved afterwards by the use of the Titchmarsh theorem) and contains already the main ideas of this theory. The date of the edition of the paper is 1944, but the results were already presented by the author in 1943, during one of the secret wartime seminars conducted by Professor Tadeusz Wazewski in Kraków.

In January 1945 the Soviet forces liberated Kraków from the German occupation. Even before that Mikusiński had been undertaking research advised by Tadeusz Wazewski, but once the city was liberated, he was able to obtain an official position at the Jagiellonian University of Kraków. He submitted his Ph.D. thesis “*Sur un problème d’interpolation pour les intégrales des équations différentielles linéaires*” and, after defending it, was awarded the degree on 25 July 1945. The Germans had opened a new German University of Poznan in 1941, but it was not well received; it operated until 1944. By the time Mikusiński was awarded his Ph.D., the Polish University of Poznan had reopened and he was able to return there and take up a position as assistant professor in the department headed by Wladyslaw Orlicz. He held this position for the academic year 1945-46 during which time he also taught at the Engineering School in Poznan. On 28 February 1946 he habilitated at the Maria Skłodowska-Curie University of Lublin and was appointed as a docent. On 15 October 1947 he was promoted to associate professor of mathematics at Lublin, a position he held for a year. He was appointed to the University of Wrocław as an associate

professor of mathematics on 30 October 1948 and he remained there until August 1955 when he was appointed to the University of Warsaw.

On 20 November 1948 the Polish government set up the State Mathematical Institute. Just before the outbreak of World War II, Poland had been planning two research institutes, one for pure mathematics and one for applied mathematics. However, this plan was put on hold when war broke out and, during the six years of war, the educational system severely damaged. The Institute, opened in 1948, was based on the earlier planned two Institutes, but they were merged into a single mathematics institute, divided into sections which correspond to the particular areas of mathematics. Mikusiński worked at the State Mathematical Institute from its foundation. He submitted a collection of his papers under the title "*A new approach to the operational calculus*", for a degree similar to the present D.Sc. and he was awarded the degree on 10 December 1955. He was promoted to full professor on 4 February 1958. Jan Mikusiński married Urszula and their son Piotr Jan Mikusiński was born in 1956. Piotr Mikusiński became a mathematician with interests similar to those of his father. He was awarded a doctorate from the Institute of Mathematics of the Polish Academy of Sciences in 1983 for his thesis "*Convergence of Boehmians*". He is currently professor of mathematics at the University of Central Florida, Orlando, United States.

Let us look now at some of the contributions which Mikusiński submitted for his D.Sc. In [7], Rudolf Hilfer, Yury Luchko and Zivorad Tomovski write:

In the 1950's, Jan Mikusiński proposed a new approach to develop an operational calculus for the operator of differentiation (see J Mikusiński, "Operational Calculus" (Pergamon Press, New York, 1959)). This algebraic approach was based on the interpretation of the Laplace convolution as a multiplication in the ring of the continuous functions on the real half-axis. The Mikusiński operational calculus was successfully used in ordinary differential equations, integral equations, partial differential equations and in the theory of special functions. It is worth mentioning that the Mikusiński scheme was extended by several mathematicians to develop operational calculi for differential operators with variable coefficients ...

Arthur Erdélyi, reviewing the Polish version of Mikusiński's book "*The Calculus of Operators*" (1953), writes:

Mikusiński's book is a remarkable, and pioneering, venture. It presents a modern and abstract mathematical theory, in a completely elementary manner, to students of physics and engineering. Although the essence of the author's theory is the extension of a ring to a field, and the

introduction of a suitable topology in this field, the terms ring, field, topology do not occur in the book. The exposition is precise but never abstract. The analogy with the extension of the number concept from integers to rationals to reals is pointed out. No knowledge of algebra or topology, and no training in abstract thinking, is required. The author assumes that the reader is familiar with the notions of limit, continuity, convergence, but not necessarily with uniform convergence (which is explained in the book together with the principal theorems relating to it) or Euler's integral of the second kind and the gamma function (which are also explained). By and large, freshman and sophomore calculus are not quite sufficient for reading this book, a good course in advanced calculus is more than sufficient.

Henry Schaerf, reviewing the second Polish edition of Mikusiński's "*The Calculus of Operators*" (published in 1957), writes (see [14]):

In several papers the author has published a theory containing a direct justification of the Heaviside Calculus as opposed to the various well known indirect methods using functional transforms. The purpose of the book under review is to present this theory and its applications both to engineers primarily interested in the use of efficient computational procedures and to readers desiring to understand why these procedures work. To reach such a heterogeneous readership, the author uses the text-book approach and leads the reader gently and with great skill from a completely elementary level to rather abstract concepts.

Mikusiński's career took an unfortunate turn shortly after he became a full professor. He developed serious eye problems which made teaching and research almost impossible and he requested a period of sick leave in which he might recover his health. His request, however, was refused so he resigned his professorship on 10 September 1959. The State Mathematical Institute had become the Mathematical Institute of the Polish Academy of Sciences after the Academy was founded in 1952 and Mikusiński retained his position at the Institute. In 1960 Mikusiński moved to Katowice. Krystyna Skornik writes (see [16]):

His arrival to 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. The Professor delivered for them a series of lectures on operational calculus. After a year, the lectures turned to a regular seminar, first held at the Higher Pedagogical School, then at Mikusiński's home. The participants of this seminar ... remember the unique atmosphere of these meetings, discussions at a blackboard hanging in the garage or

on the terrace, the rooms replacing a seminar room. The informal scientific contacts of Professor Mikusiński with Silesian mathematicians became formal only in 1966 when the Mathematical Laboratory (now the Branch of the Mathematical Institute of the Polish Academy of Sciences) was established.

Piotr Antosik and Andrzej Kaminski are discussing Mikusiński's seminar in Katowice, as in [2]:

The topics of the seminar were closely connected with the mathematical interests of Professor Jan Mikusiński and included the operational calculus, generalized functions, convergence structures and integration theory. In 1966 the members of the seminar organized in Katowice an international conference on generalized functions, in which about seventy mathematicians took part, among them those as eminent as Sergei Sobolev, Laurent Schwartz, Jean Dieudonné, George Temple, Hikosaburo Komatsu, Thomas K Boehme and others. Members of the seminar were invited to many mathematical centres all over the world. In the period of the duration of the seminar (1960-1987) its members published several books (more than 20 editions altogether) and about 250 scientific papers. Eight members of the seminar received their Ph.D.'s, two of them were habilitated and then two were promoted to the position of full professor.

The existence of the seminar led to the establishment of the Katowice Branch of the Institute of Mathematics of the Polish Academy of Sciences which Mikusiński headed from its founding in 1966 until 1985. Before the founding of the Katowice Branch of the Institute of Mathematics, Mikusiński had been made head of the Department of Mathematical Analysis in the Mathematical Institute of the Polish Academy of Sciences.

We should mention a number of Mikusiński's books in addition to "*The Calculus of Operators*" (1953) which we discussed above. The list of his publications given in [8] lists 26 books including: (with Stanislaw Hartman) "*Theory of Measure and Lebesgue Integral*" (Polish) (1957), English edition published under the title "*The Theory of Lebesgue Measure and Integration*" (1961); (with Roman Sikorski) "*Théorie élémentaire des distributions*" (1964); (with Piotr Antosik and Roman Sikorski) "*Theory of Distributions. The Sequential Approach*" (1973); "*The Bochner Integral*" (1978); "*Operational Calculus, Vol. I*" (1983) and (with Thomas K Boehme) "*Operational calculus, Vol. II*" (1987) and (with Piotr Mikusiński) "*An Introduction to Analysis: From Number to Integral*" (1993). This last mentioned work, a collaboration between Mikusiński - father and his son Piotr, is described by the Publisher (Wiley) as follows:

Based on the lifetime work of leading teacher and researcher Jan Mikusiński, this classroom-tested book provides a thorough grounding in mathematical analysis, calculus and mathematical proofing. It introduces natural numbers through a new mathematical approach; replaces the Riemann integral with the more general Lebesgue integral; and rigorously develops the real number system from four simple axioms of natural numbers. Additional features include a wider range of problems than other texts - including simple and routine as well as problems requiring more in depth creativity, answers to common questions, a new approach to the concept of equivalence relation which simplifies the construction of real numbers, and a large number of computational applications.

Jan Mikusiński received numerous honours, prizes and awards. He was awarded the Banach Prize by the Polish Mathematical Society in 1950, he received the National Prize (Class II) in 1953, the University in Rostock awarded him an honorary degree in 1970, he was elected to the Serbian Academy of Sciences and Art in 1975, the Polish Mathematical Society made him an Honorary Member in 1984 and he received the Sierpinski Medal from the Polish Mathematical Society and Warsaw University in 1985.

During the 27 years that he spent in Katowice, Mikusiński struggled to overcome health problems [8]:

In spite of bad conditions of his health, he was a very active researcher and worked to the last days of his life.

Jan Mikusiński died on 27 July 1987 and was buried on the cemetery in Katowice. When *Studia Mathematica* published Mikusiński's 1944 paper "Hypernumbers" in 1983 it was to celebrate both the 40th anniversary of the original publication and Mikusiński's 70th birthday. We end this biography with the final words from the 1983 Preface:

We would like to thank [Professor Jan Mikusiński] for all the theories and theorems with which he has enriched Polish and world mathematics and for his constant pursuit of beauty, simplicity and elegance in mathematics.

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The Operators and My Memories of Jan Mikusiński

Memorial note by **Dennis Nemzer** ³

The elements of the quotient field of the space of continuous functions supported on $[0, \infty)$ with addition and convolution are known as Mikusiński operators. Initially, these operators were called hypernumbers by Jan Mikusiński. The first work was written and published in Poland by him in 1944 under harsh wartime conditions. The work was handwritten on

x-ray film and printed with homemade ink. Only seven copies were made. One of the less desirable characteristics of the space of operators is the lack of local properties. In a 1973 paper, *The support of Mikusiński operators*, T.K. Boehme considered a subring of operators called regular operators. Each regular operator has a well-defined support. Moreover, the Lions theorem of supports is valid for regular operators with compact support. However, the support of a regular operator is bounded on the left. It was thought that this is not necessarily desirable. This was rectified in 1981, in the paper *Quotients de suites et leurs applications dans l'analyse fonctionnelle* written by Jan Mikusiński and Piotr Mikusiński. Then, in 1982, Piotr Mikusiński, in his doctoral thesis, further investigated this space. In honor of T.K. Boehme, he called the elements of this space Boehmians.

In the Spring of 1983, I was finishing up my doctoral thesis at the University of California at Santa Barbara, when my advisor, T.K. Boehme, said that the next fall Jan Mikusiński was going to visit the university. Professor Mikusiński was known for his originality and simplicity of approach. I knew from his papers that he was a talented, insightful, and creative mathematician. I thought this would be an excellent opportunity for me, and so, I asked my advisor if it would be possible to receive funding for the next year so that I could take part in the activities. It was arranged so that I could stay another year.

It was a wonderful year – Professor Mikusiński and his wife Urszula, their son Piotr and his wife Grazyna and their son Greg, plus Professor Antosik all came to Santa Barbara. There were colloquia, including ones given by Professor Mikusiński. I can still recall attending a colloquium given by Professor Mikusiński – watching and listening and thinking with what ease the lecture was being delivered. In addition to colloquia, informal gatherings were hosted by Professor Boehme and his wife Gail at their home. In December 1983, a conference on generalized functions and convergence structures in honor of Professor Mikusiński's visit was held in Santa Barbara. Professor Mikusiński and his wife returned to Poland shortly thereafter.

That year was the most enjoyable and educational period of my mathematical life. I am extremely grateful for having had that opportunity. I left Santa Barbara in the summer of 1984. I didn't get the opportunity to see Professor Mikusiński again as he passed away a few years later.

Extensions of Mikusiński's Operational Calculus

Editorial note by Virginia Kiryakova ¹

Professor Mikusiński had considerable scholar achievements. He published more than 20 books translated into many languages and about 150 papers in prestigious mathematical journals in Poland and abroad, 40 of them in *Studia Mathematica*, a journal where he served as a member of Editorial Board. **A full list of his publications** containing 26 books and his papers arranged by years since 1946 till 1987, can be found in a memorial article by C. Finet, "J. Mikusiński: 3 April 1913 – 27 July 1987", in *Studia Math.* **89**, No 1 (1988), ii-xi. Mikusiński's interests in mathematics and its applications ranged widely and contained real and complex analysis, differential and functional equations, generalized functions, functional analysis, the theory of measure and integration, algebra, geometry, number theory, mechanics, electrotechnics, acoustics, optics, photography, chromatography, and music. However Jan Mikusiński is generally recognized as the **creator of the algebraic approach in operational calculus**, along with other theories as: the elementary theory of distributions, the uniform approach to the Lebesgue and Bochner integrals. The theory of his Operational Calculus presents a direct justification of the Heaviside Calculus as opposed to the various well known indirect methods using integral transforms. Based on the interpretation of the Laplace convolution as a multiplication in the ring of the continuous functions on the real half-axis, **Mikusiński's calculus** provides an algorithmic approach for solving of initial-value problems for (ordinary and partial) differential, integral and integro-differential equations, related to the classical operator of differentiation $D = d/dx$ and has provoked wide interest among many authors from Poland and all over the world. Let us mention some of them: L. Berg, A. Bleyer, T.K. Boehme, R. Bittner, J. Burzyk, I.H. Dimovski, V.A. Ditkin, A. Erdélyi, E. Gesztelyi, H.-J. Glaeske, L. Korevaar, G.L. Krabbe, W. Kierat, A.P. Prudnikov, D. Przeworska-Rolewicz, C. Ryll-Nardzewski, K. Skórnik, W. Słowikowski, R. Struble, A. Szász, J. Włoka, K. Yosida, among others. It is worth mentioning that Mikusiński's scheme has been successfully extended by several mathematicians to develop operational calculi for *differential operators with variable coefficients of higher (integer) orders m* , all of them appearing particular cases of the so-called hyper-Bessel differential operator of the alternative forms

$$\begin{aligned}
 B &= x^{\alpha_0} D x^{\alpha_1} D x^{\alpha_2} \dots D x^{\alpha_m} = x^{-\beta} \prod_{i=1}^m (xD + \beta\gamma_i) \\
 &= x^{-\beta} (x^m D^m + a_1 x^{m-1} D^{m-1} + \dots + a_{m-1} x D + a_m), \quad \beta > 0, \quad m \geq 2.
 \end{aligned}$$

An operational calculus for this operator, and later a family of such isomorphic calculi, have been constructed by Dimovski in his several works since 1966, leading to the more general notion of Convolutional Calculus *for a linear operator mapping a linear space into itself*, and to the book: I. Dimovski, *Convolutional Calculus*, Kluwer Acad. Publ., Dordrecht - London (1990). The author of this note herself (V.K.) has benefitted of her initial studies on Dimovski's operational calculus for the hyper-Bessel operator, to be able to introduce and develop a theory of the generalized fractional integrals and derivatives *of arbitrary multi-orders* $(\delta_1, \delta_2, \dots, \delta_m)$ (instead of integer order $m = (1, 1, \dots, 1)$) having a structure similar to this of the hyper-Bessel operator B , see: V. Kiryakova, *Generalized Fractional Calculus and Applications*, Longman & J. Wiley, Harlow - N. York (1994).

The Mikusiński Operational Calculus has found efficient extensions to the operators of the *classical Fractional Calculus* as the Riemann-Liouville fractional derivative and its modifications, and to the operators of the Generalized Fractional Calculus, named multiple Erdélyi-Kober fractional derivatives, in the works of Yu. Luchko and co-authors, a basic such study published in the book: S. Yakubovich, Yu. Luchko, *The Hypergeometric Approach to Integral Transforms and Convolutions*, Kluwer Acad. Publ., Dordrecht - London (1994). Several papers on the Mikusiński approach and its extensions are published in this journal, "*Fract. Calc. Appl. Anal.*", for example: a survey by K. Skornik, "Mikusinski's operational calculus and its applications" (Vol. 2, No 4 (1999), 509–528); papers by Dimovski et al. (Vol. 2, No 5 (1999), 591–603; Vol. 4, No 2 (2001), 237–244; Vol. 9, No 2 (2006), 89–100); by D. and A. Takaci (Vol. 13, No 4 (2010), 423–434); and basic ones on *operational method in fractional calculus* – by Luchko and co-authors (Vol. 2, No 4 (1999), 463–488; Vol. 7, No 3 (2004), 339–365; Vol. 12, No 3 (2009), 299–318); see at <http://www.math.bas.bg/~fcaa>.

I met personally Prof. Jan Mikusiński and some of his Polish collaborators, for the first time, at the International Conference "Generalized Functions and Operational Calculus", Oct. 1975, in Varna (Bulgarian resort on Black Sea). For me, it was a start of useful scientific relations with his colleagues as Krystyna Skórnik, Piotr Antosik, Andrzej Kaminski, Piotr Mikusiński, etc. I would like to thank his son Piotr for the support to our journal "*Fract. Calc. Appl. Anal.*" as a member of its Editorial Board.

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