Notices from the ISMS

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For the Welfare of the Humankind
Promoting Mathematical Sciences

INTERNATIONAL SOCIETY FOR MATHEMATICAL SCIENCES
Scientiae Mathematicae Japonicae, Notices from the ISMS

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Professor Jan Mikusiński - life and work

by

Krystyna Skórnik

On July, the 27th 2007 twenty years will have been passed since the death of Jan Mikusiński, a world famous mathematician, the creator of the operational calculus and the sequential theory of distributions.

Professor Jan Mikusiński (03.04.1913 - 27.07.1987) belongs to the generation of outstanding Polish mathematicians who appeared in science shortly before the World War II. He was born in Stanisławów (now Ukraine), as the second of four sons. His parents - father Kazimierz, and mother Anna Bełdowska - were both teachers. In 1917 the family moved to Wienna, and after a year moved to Poznań (Poland). Therefore Jan attended a school and studied in Poznań. At first he attended a J. Paderewski Humane Secondary School (1923 - 1928). After his talent for mathematics appeared he was sent to a G. Berger Mathematical-Natural Secondary School (1929-1932). In his youth he dreamt of becoming an engineer. His frail health however did not allow him to follow engineering studies. Therefore he decided to study mathematics. He finished studies at the University of Poznań (given up due to a three years lasting illness), on the 3rd of December 1937 and he obtained the M.Sc. degree in mathematics. Till his death technology, engineering and its achievements were one of his numerous passions.

After graduation from the university he started to work at the University of Poznań were he was an assistant professor till the war. He spent the German occupation in Zakopane (Poland) and Cracow. He took an active part in secret education of secondary school pupils and students in Cracow. Because of the teaching activity he was arrested twice by the occupying Nazi force. He also took part in Professor Tadeusz Ważewski's underground seminar together with a group of Cracow mathematicians. The participants of Ważewski'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 halfline. The author first called them "hypernumbers" and gave this title to a paper containing the main ideas of the theory.

Academic career. Scientific life of Jan Mikusiński fell on the years after the war. Just after the liberation in 1945 he started his teaching and research work on the Jagiellonian University in Cracow, where on 25th of July 1945 he obtained the Ph.D. degree for the thesis

"Sur un problème d'interpolation pour les intégrales des équations diffèrentielles linéaires" supervised by Professor Tadeusz Ważewski. In the academic year 1945/46 he worked as an assistant professor at the University in Poznań and at the same time as a professor at the Engineering School in Poznań.

He received a postdoctoral degree on 28th February 1946 on the Maria Skłodowska-Curie University of Lublin (Poland), where he was made an associate professor of mathematics and worked from 15th of October 1947 to 29th of October 1948.

During the period 1948-1955 Jan Mikusiński was a professor of the University of Wrocław (Poland) and then (1955-1958) of the University of Warsaw. At the same time he worked at the National Institute of Mathematics (later Mathematical Institute of the Polish Academy of Sciences) from the very moment it was founded in 1948. On December the 10th 1955 he obtained the Doctor in Mathematics degree for a collection of papers under a common title *"A new approach to the operational calculus"*. At that time there were two scientific degrees (similarly as in Soviet Union, which was contrary to Polish tradition): a lower - candidate of sciences and a higher - doctor of sciences. He was made full professor on the 4th of February 1958. Because of an eye disease he was forced to resign from teaching and research work. His application for a sick leave was rejected therefore on the 10th of September 1959 he quitted his job at the Warsaw University. Nevertheless he remained an employee of the Mathematical Institute of the Polish Academy of Sciences.

Professor Mikusiński in Silesia. When in 1960 Professor Mikusiński moved from Warsaw to Katowice (Silesia, Poland), he has already been a world famous mathematician. His arrival to Katowice was an event of great importance for the mathematicians working there. Shortly afterwards a group of young mathematicians from Higher Pedagogical School in Katowice got in touch with him. 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 his place (at Mikusiński's home). The participants of this seminar (P. Antosik. W. Kierat, K. Skórnik, S. Krasińska, J. Ligęza) remember a unique atmosphere of these meetings, discussions at the blackboard hanged 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 Science*) was established. The fact that the Mathematical Laboratory of the Institute of Mathematics of the Polish Academy of Sciences (MI PAS) was opened was an expression of recognition of Mikisiński's accomplishments and activity in Silesia by the most important representatives of Polish mathematics. Professor Mikusiński was the head of the Mathematical Laboratory (later IM PAS) till 1985. The Institute owns him world wide recognition and regular contacts with scientific centers abroad. The settlement of Professor Jan Mikusiński in Silesia was of great importance, especially at the beginning, when the region was deprived of an academic center and young mathematicians searched for scientific support in other centers: Cracow, Lublin or Wrocław. His arrival gave them the possibility of contact with great mathematics. After the Silesian University was founded in 1968 and after the arrival of many new mathematicians from other centers, Professor Jan Mikusiński was a person who connected dispersed society. Thanks to his effort in the Mathematical Laboratory the monthly Thursday mathematical discussions (at tee, chess, drafts) with the participation of mathematicians representing various silesian scientific institutions took place.

The seminar led by Professor Jan Mikusiński entitled *Generalized Functions and the Theory of Convergence* was hold in the seat of the Katowice Branch of the MI PAS. The research subject was connected with the interests of J. Mikusiński and embraced:

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

To the participants of the seminars belonged among others: 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.

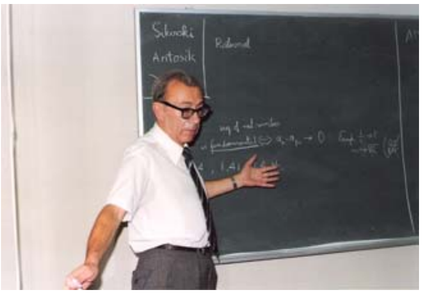
To the peculiarity of these seminars belonged the so called mountain seminars, usually a week lasting trips to the mountains. On average two seminars of this kind took place in a year, also with participation of foreign scientists.

Mountain seminar in 1978

kneeling (from left): Anzelm Ivanik, Czesaw Kliś, Cezary Ferens; standing (from left): Zbigniew Lipecki, Viktor V. Zharinov (Moscow), Zygmunt Tyc, Władysaw Kierat, Steven Piligović (Novi Sad), Krystyna Skórnik, Jan Mikusiński, Piotr Antosik, Czesław Ryll-Nardzewski

The participants of Mikusiński's seminar published 11 new books and over 300 papers after 1966. During that time 9 foreign reprints of their books came out. Prof. J. Mikusiński was the superviser of 8 Doctor Theses, among them 5 during this Silesian period. There are: • Zbigniew Zieleźny, • Zbigniew Łuszczki, • M. Kowalski, • Piotr Antosik, • Władysław Kierat, • Krystyna Skórnik, • Andrzej Kamiński, • Jan Pochciał.

Professor Mikisiński played an inspiring role in creating a mathematical center in Upper Silesia. He took an active part in organization of this mathematical center. During his stay in Silesia he became • a corresponding member of Polish Academy of Sciences (since 4th of June 1965), • a full member of Polish Academy of Sciences (since December 1971).



Independently of the seminar in Katowice, there was a second *MIKUSIŃSKI's seminar* in Warsaw. This seminar was held each two weeks (four hours each time) in the Institute of Mathematics of the Polish Academy of Sciences at Śniadeckich street. It was all-country seminar. In these meetings the following mathematicians took part: Adam Bielecki, Roman Sikorski, Stanisław Łojasiewicz, Czesław Ryll-Nardzewski, Krzysztof Maurin, Jan Mycielski, Danuta Przeworska-Rolewicz, Zbigniew Zieleźny, Hanna Marcinkowska, Jan Kisyński, Piotr Antosik, Krystyna Skórnik, Władysław Kierat, Zbigniew Łuszczki, Stefania Krasińska and later Andrzej Kamiński.

Research interests of Jan Mikusiński. At first Jan Mikusiński took up differential equations referring to his teacher, professor Mieczysława Biernacki. His main results concerned interpolation of solutions and distance of their zeros. Also in his Ph.D. thesis he followed that direction. In his research on differential equations he had striven for simplified methods of solutions and their mathematical justification. In his search for easy methods J. Mikusiński arrived at a notion of ring of operators, that allowed to solve differential equations (also partial) in a wider range than 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 analytical functions. He gave also a few proofs of the Titchmarsh theorem that was the basis of his algebraic approach to operational calculus (see *Operational Calculus*, 1953) and concerned the convolution of continuous functions on a positive halfline. A new view on the operational calculus initiated also certain problems of abstract algebra. He presented their solution in a series of papers on the *algebraic derivative* (see [MJ4]). In these papers he presented algebraic derivative in an arbitrary linear space in contrast to the Ritta theory that concerned algebras.

At the same time when operational calculus was born, mathematicians took great interest in the theory of distributions initiated by S. Sobolew (see [Sob]) and L. Schwartz (see [Sch.1], [Sch.2], [Sch.3]). This theory was based on difficult tools of functional analysis. In order to make the theory of distributions closer to physicists and engineers, Professor Mikusiński gave its elementary definition based on commonly known notions of mathematical analysis. Theory of distributions based on that definition was developed on Mikusiński's seminar in Wrocław and Warsaw and was worked out in a form of two volume treatise. This treatise was edited together with Roman Sikorski and was published in English and then translated into other languages (see [MS.1], [MS.2]). 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 original approach, the study of regular and irregular operations (see [Mi.4]).

Distributions embrace, as a special case, integrable functions in the sense of Lebesgue. This made Mikusiński become interested in the theory of integrable functions (see [MH]). Professor is an author of the definition of the Lebesgue integral which is not based on the notion measure. This definition carries onto the Bochner integral, elaborated in his book entitled *"The Bochner Integral"*, 1978 (see [MJ10]). Apart from his main interests such as operational calculus, the theory of distributions, the theory of measure and integration, Jan Mikusiński was also interested in real and complex analysis, differential and functional equations, functional analysis, algebra, problems of elementary geometry, number theory, general topology, mechanics, electrical engineering and chromatography. He was interested in practical problems. He was the author of a project of a reconstruction of the church vault in a destroyed chapel of the cathedral in Lublin that allowed preserving original interesting old acoustics. He occupied himself with the theory of music scales, photography, theoretical problems of optics (see [MSk]) and with environmental protection.

He had considerable scholarly achievements. He published over 150 papers in prestigious mathematical journals in Poland and abroad and 11 books that were translated into many languages. Among them there are:

- *"Operational Calculus"*, 1953 (20 editions in 6 languages);
- *"Introduction to Mathematical Analysis"*, 1957;
- *"The Theory of Lebesgue Measure and Integration"*, 1957 (with Stanisław Hartman);
- *"Elementary Theory of Distributionsi"*, 1959 (with Roman Sikorski, editions in 5 languages);
- *"Theory of distributions. The sequential approach"*, 1973 (with Piotr Antosik & Roman Sikorsk);
- *"The Bochner Integral"*, 1978;
- *"On Axially Symmetric Optical Instruments"*, 1979 (with Krystyna Skórnik);
- *Hypernumbers*, 1983;
- *"From Number to Integral"*, 1993 (with Piotr Mikusiński).

Books and papers of Jan Mikusiński on various topics in mathematics have several common features: originality, simplicity of approach, usefulness of applications and elegance. Especially *"Operational Calculus"* enjoyed worldwide renown, which was published in Polish, English, Russian, German, Hungarian and Japanese and it had numerous editions. The book contained a new mathematical theory, which gained quickly deserved fame in the world and was developed in many foreign mathematical centers under the name *Mikusiński's operational calculus*. The Mikusiński's name is now widely used in mathematics in connection with a notion that was created by him - *"Mikusiński's operators"* (see Mathematical Review 1991 Subject Classification - 44A40).

International cooperation, Organization activity. Scientific achievements of Professor Jan Mikusiński are remarkable and highly priced in the mathematical world. Numerous invitation to deliver lectures and talks in well known scientific centers abroad confirm this recognition. He was a UNESCO expert in Argentina (1962), and a visiting professor to Germany (Aachen, 1961), Turkey (Ankara, 1967), 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, Yugoslavia. He was also a visiting professor to France, the Netherlands, the Switzerland, Israel, Canada and Japan. He was the organizer and a participant of numerous international conventions, conferences and symposia.

Professor Mikusiński valued contacts with the Japanese mathematicians which were initiated in 1959. He received from Japan papers on operational calculus and on the theory of distributions to review. There were 12 editions of his book *"Operational Calculus"* in Japan. Besides, his papers on music scales were published there. He visited Japan on an invitation of JSPS (Japan Society for Promotion of Science) in September 1980. He spent most of his stay there on Kioto where he met professors form the RIMS (Research Institute for Mathematical Science), among others professors Matsuura, Sato and Hitotumatu. He also took part in the JMS (Japan Mathematical Society), symposium where he delivered a talk *"From Number to Integral"*. He was on Nagoi with a lecture *"Sequential approach to integration"*; in Tsukubie, where he gave a talk *"Operational Calculus in Chromatography"*; in Tokio, where he met many mathematicians, e.g., Kôsaku Yosida and Hikosaburo Komatsu. He gave a lecture on the Tokio University *"Integration"*, and on the Waseda University on *"Sequential Approach to Distributions"*.

J. Mikusiński & K. Yosida

Mikusiński with his wife Urszula & Suzuki

Professor Mikusiński performed many functions, e.g., he was • the head of the Department of Mathematical Analysis at the University of Wrocław (27.06.1953-04.08.1955), • an expert of the Central Qualifying Commission of the Polish Academy of Sciences (from 27.11.1953 to its end), • a member of the Scientific Council of the Institute of Mathematics of the Polish Academy of Sciences (from 1954 till his death), • a member of the Scientific Council of the Institute of Physics of the Polish Academy of Sciences (from 09.01.1956), • a member of the Mathematical Sciences Committee (from 13.06.1960), • the head of the Department of Mathematical Analysis in Mathematical Institute of PAS (from 01.12.1962), • the head of Mathematical Laboratory (later Branch of Institute of Mathematics) PAS (from 1966 till 1985), • a member of the Scientific Council of the Institute of Mathematics of the Silesian University, • a member of the Scientific Council of the Institute of Mathematics of the Silesian Technical University, • a member of the editorial boards: *"Studia Mathematica"* and *"International Journal of Mathematics and Mathematical Sciences"*, and • reviewer of Mathematical Reviews and Zentralblatt für Mathematik.

For his scientific activity Professor Mikusiński received numerous prices and awards. He was awarded • a Polish Mathematical Society Banach Price in 1950 for his works on operational calculus; • the National Price of II Kind in 1953; • Honorary Doctorate of the University in Rostock in 1970; • he was elected member of the Serbian Academy of Sciences and Art in 1975; • Honorary Member of the Polish Mathematical Society in 1984 ; • he was awarded a Sierpiński Medal in 1985. Apart from these awards he received many national awards among others • Knight Cross with Star of Poland's Renaissance.

Professor Jan Mikusiński was closely connected with Silesian scientific center from the beginning of 60ties of the XX century. He supported organization of the scientific life in Katowice with his authority. Thanks to his effort there was an international conference on *Generalized Functions* organized in Katowice after the international congress in Moscow in 1966. Many famous specialists on that field took part in it: L. Schwartz, S. Soboleff, G. Temple, T.K. Boehme, J. Dieudonnè, J. Wloka, A.P. Prudnikov, I.H. Dimovski and others. Professor Mikusiński actively supported the organization of the Silesian University and of the *Branch of the Polish Academy of Sciences in Katowice.* He delivered series of lectures on the meetings of the Uppersilesian 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 for many mathematicians an argument to move to Katowice.

Professor Jan Mikusiński educated many mathematicians working in Silesia. He initiated new directions of research and created the school of generalized functions in Katowice. In recognition of his services the General Meeting of the Polish Mathematical Society conferred on him the rank of the honorary member in 1984.

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

Main directions of research of Professor Mikusiński

I. Mikusiński's operational calculus and its applications

1. *Introduction.* Operational Calculus has got a rich history. The first ideas of "symbolic" operational calculus come from *Leibniz* and were developed to some extend by *Euler, Laplace, Cauchy* and many others. Nevertheless, it is *O. Heaviside* who is regarded to be the father of the operational calculus. In his *"Electromagnetic Theory"* London (1899) [He.1, He.2], he first successfully applied it to ordinary linear differential equations connected with electromagnetical problems. Heaviside's theory was first justified by *Laplace* transform. In his calculus, however, certain operators appeared whose interpretation is difficult to justify. The original operator view-point of Heaviside was displaced by the works of *Carson* [Car], *Doetsch* [Do], *Van der Pol* [VB] and others who took either Laplace transform or the *Mellin* integral as the basis of their investigations.

A complete return to the original operator view-point was made by *Jan Mikusiński* who in 1944 [MJ1] gave entirely new foundations to the operational calculus. He based his calculus on convolution quotients without referring it to the Laplace transform. His calculus, known as Mikusiński's operational calculus, awoke wide interest not only in Poland. Many articles concerning operational calculus and its applications have been published since then. Let me mention some names: L. Berg, T.K. Boehme, R. Bittner, J. Burzyk, I.H. Dimovski, V.A. Ditkin, E. Gesztelyi, G.L. Krabbe, W. Kierat, A.P. Prudnikov, D. Przeworska-Rolewicz, C. Ryll-Nardzewski, K. Skórnik, W. Słowikowski, R. Struble, A. Száz, J. Wloka, K. Yosida.

Operational calculus has also found wide application in a great variety of disciplines: mathematics, physics, mechanics, electrical engineering, informatics, etc. There is a large amount of literature concerned with both special problems in the theory of operational calculus and its various applications.

The work of *V.A. Ditkin "Operational Calculus"* which appeared in 1947 [DV1] belongs to the pioneering works in USSR. V.A.Ditkin together with A.P. Prudnikov [DV2, DV3], published several handbooks about Laplace transforms and operational calculus. Among the most important results obtained by Prudnikov we find the solutions, by operator methods, of a number of specific problems in mathematical physics (related, for example, to heat transfer and thermal diffusion).

2. *Mikusiński hypernumbers.* The work "Hypernumbers" by Jan Mikusiński [MJ1,MJ7] was written and published in 1944 in Poland under wartime conditions. Only seven copies were made. In fact, it is the "first edition" of Mikusiński's "Operational Calculus".

A pair of elements (α, f), consisting of a complex number α and a vector f, belonging to the abstract space $\mathcal{W}$, is called a *hypernumber*; it is written in the form

$$(\alpha, f) = \alpha + f.$$

The set of all possible pairs of complex numbers and vectors of the space $\mathcal{W}$ is called the *hypernumber space* and is denoted by $[\mathcal{W}]$. A particular realization of the spaces $[\mathcal{W}]$ is the set $\mathcal{C}$ of complex-valued continuous functions $f(t)$ defined for $t \in < 0, \infty >$.

3. *The field $\mathfrak{M}$ of Mikusiński operators.* The basis for the Mikusiński operational calculus is the Titchmarsh theorem concerning the convolution of functions continuous on the positive halfline.

Let $\mathcal{C}$ denote the set of all real- or complex-valued continuous functions of a real variable t, defined in the interval $0 \square t < \infty$. If $f, g \in \mathcal{C}$, then by the convolution of f and g, denoted in the operational calculus by the symbol fg of the usual product, we mean the function

$$(fg)(t) = \int_0^t f(t-\tau)g(\tau)d\tau\,.$$

The Titchmarsh theorem (in its weaker so-called global version) states that if $fg = 0$ in $[0, \infty)$, then $f = 0$ on $< 0, \infty)$ or $g = 0$ on $< 0, \infty)$, i.e., the set $\mathcal{C}$ is the *commutative ring* with the usual addition and the convolution as multiplication without divisors of zero. Therefore this ring can be extended to a *quotient field*: i.e., to a set of fractions $\frac{f}{g}$ $(g \neq 0)$ $(f, g \in \mathcal{C})$, where the division denotes the converse operation to the convolution.

The elements of this quotient field are called *Mikusiński operators.* This field is denoted by $\mathfrak{M}$. Mikusiński's field contains all continuous functions f on $< 0, \infty)$, because they may be represented by the fractions $f = \frac{f \cdot g}{g}$, where g is an arbitrary nontrivial continuous function on $< 0; \infty)$. It contains also all elements α of the initial numerical field which can be identified with the functions $\frac{\{\alpha\}}{\{1\}}$.

Here and in the sequel, to distinguish the value $f(t)$ of the function at the point t from the function f itself, the symbol $\{f(t)\}$ is used, i.e., $\{\alpha\}$ and $\{1\}$ are constant functions equal to α and 1 on $< 0; \infty)$.

According to the definition of convolution we have

$$\{1\}\{f(t)\} = \{\int_o^t f(\tau)d\tau\}, \tag{1}$$

what distinguished the function $\{1\}$ is that the formation of its convolution with arbitrary function $\{f(t)\}$ causes the integration of the latter in the interval from 0 to t. Consequently the function $\{1\}$ will be termed the *integral operator* and denoted by l: $l = \{1\}$. It is easy to prove that

$$l^n = \left\{\frac{t^{n-1}}{(n-1)!}\right\}. \tag{2}$$

A fundamental role in the operational calculus is played by the inverse of the integral operator $l = \{1\}$, which will be denoted by $s = \frac{1}{l}$ and called *differential operator.* By this definition we have $ls = sl = 1$.

An important role is played by the theorem:

If a function $x = \{x(t)\}$ has a derivative $x' = \{x'(t)\}$ continuous for $0 \square t < \infty$, then we have the formula

$$sx = x' + x(0), \tag{3}$$

where $x(0)$ is the value of the function x at the point $t = 0$.

The latter formula can be easily generalized, thus we have the following theorem:

If a function $x = \{x(t)\}$ has an n-th derivative $x^{(n)} = \{x^{(n)}(t)\}$, continuous in the interval $0 \square t < \infty$, then

$$s^n x = x^{(n)} + s^{n-1}x(0) + s^{n-2}x^{(1)}(0) + \cdots + sx^{(n-2)}(0) + x^{(n-1)}(0). \tag{4}$$

4. *Operational linear differential equations.* The greatest number of results J. Mikusiński ([MJ2, MJ3, MJ9]) has obtained for linear differential equations of order n with constant coefficients of the form

$$a_n x^{(n)}(z) + a_{n-1}x^{(n-1)}(z) + \cdots + a_o x(z) = f(z), \tag{5}$$

where $a_i, i = 1, 2..., n, (a_n \neq 0)$, are Mikusiński operators and $f(z)$ is an operator function.

The identity (4) makes it possible to solve ordinary differential equations with constant coefficients in a strictly algebraic manner. Let us consider a differential equation (5) of order n with given continuous function f, the constant coefficients $a_n, a_{n-1}, \cdots, a_o$ $(a_n \neq 0)$ and the initial conditions:

$$x(0) = c_1, \quad x'(0) = c_2, \ldots, x^{(n-1)}(0) = c_{n-1}, \tag{6}$$

In view of (4), the problem given by (5) and (6) reduces to a simple algebraic equation whose solution is of the form

$$a_n s^n x + a_{n-1}s^{n-1}x + \cdots + a_0 x = b_{n-1}s^{n-1} + b_{n-2}s^{n-2} + \cdots + b_0 + f,$$

where $b_i = a_{i+1}c_0 + a_{i+2}c_1 + \cdots + a_n c_{n-i-1}$ for $i = 0, 1, \ldots, n-1$. Hence the solution is of the form

$$x = \frac{b_{n-1}s^{n-1} + \cdots + b_0}{a_n s^n + \cdots + a_0} + \frac{1}{a_n s^n + \cdots + a_0} f.$$

To represent the above solution in the form of a function in variable t one can use the standard technique of decomposing fractions into simple fractions of the types $\frac{1}{(s-a)^k}$, $\frac{1}{[(s-a)^2+b^2]^k}$, $\frac{s-a}{[(s-a)^2+b^2]^k}$ $(b \neq 0)$. If $k = 1$, we have $\frac{1}{s-a} = \{e^{at}\}$, $\frac{1}{(s-a)^2+b^2} = \{\frac{1}{b}e^{at}\sin bt\}$, $\frac{s-a}{(s-a)^2+b^2} = \{e^{at}\cos bt\}$. It is equally simply to reduce a system of ordinary differential equations with constant coefficients to a corresponding system of algebraic equations [MJ8]. The operational calculus provides us with convenient methods of solving linear differential equation (5), when the coefficients a_i are continuous functions or operators. In order to solve the homogenous equation

$$a_n x^{(n)} + a_{n-1}\, x^{(n-1)} + \cdots + a_0\, x = 0 \tag{7}$$

we first seek the solutions in the form of exponential function $x = e^{\lambda\omega}$ ([MJ2], p. 254), where ω is a root of the characteristic equation

$$a_n \omega^n + a_{n-1}\, \omega^{n-1} + \cdots + a_0 = 0. \tag{8}$$

The general solution of equation (7) is of the form

$$x(\lambda) = \sum_{k=1}^{n} c_k\, e^{\lambda\omega_k}, \tag{9}$$

where c_k are arbitrary constant operators, ω_k $(k = 1, \ldots, n)$ are the roots of (8) ([MJ2], p. 259). It may happen that the function $e^{\lambda\omega_k}$ does not exist. Namely, for certain operators ω_k a function identically equal to zero may happen to be the only solution of the differential equation $x' = \omega_k x$; consequently the additional condition $x(0) = 1$, which should be satisfied by every exponential function, cannot be satisfied ([MJ2], p. 255, p. 217). If there exists the exponential function $e^{\lambda\omega_k}$, then the operator ω_k is called *logarithmic*. In the general solution (9) of the equation (7) the number of arbitrary constants is equal to the number of logarithmic-roots of the characteristic equation.

Operational calculus makes it also possible to solve certain types of partial differential equations, e.g., the equations of string, heat, telegraphy [MJ8, MJ9].
It should be stressed that the method of operational calculus allows one to find solution of full generality while the method of the Laplace transform imposes restrictions on the growth of the solution at infinity.
Let us consider the differential equation (7) where $a_i \quad (i = 0, 1, 2..., n-1)$ are complex-valued continuous functions defined on the interval (α, β). It is known that there exists exactly one solution of the differential equation (7) satisfying the initial conditions

$$x(t_o) = x_o, \quad x^{(1)}(t_o) = x_1, \cdots, x^{(n-1)}(t_o) = x_{n-1},$$

$t_o \in (\alpha, \beta), \quad x_i \in \mathbb{R}$. Professor Mikusiński has proved that a similar theorem concerning uniqueness is true, when the real valued functions are replaced by functions with values from a commutative ring without divisors of zero ($\mathfrak{M}$) and a relevant derivative (D) [MJ3, MJ5]. The following theorem is true (see [AKS]):

The set of all solutions of the differential equation (7) *in* $\mathfrak{M}$ *(*$a_i \in \mathfrak{M}$*,* $a_n = 1$*) is at most a n-dimensional space over* $\mathbb{C}$.

5. *Linear differential equations with linear coefficients.* Now, we are concerned with the linear differential equations with linear coefficients

$$a_n t x^{(n)}(t) + (a_{n-1}t + b_{n-1})x^{(n-1)}(t) + ... + (a_o t + b_o)x(t) = 0, \tag{10}$$

where $a_i, b_i \in \mathbb{C}, i = 0, 1, ..., n, \ t \in < 0; \infty)$.

We know that if a function $x :< 0, \infty) \to \mathbb{C}$ is n-times continuously differentiable, then

$$x^{(n)} = s^n x - s^{n-1}x(0) - ... - sx^{(n-2)}(0) - x^{(n-1)}(0).$$

Differential equation (10) can be written in the following operational form

$$-a_n D[s^n x - s^{n-1}x(0) - ... - sx^{(n-2)}(0) - x^{(n-1)}(0)] +$$

$$+(-a_{n-1}D + b_{n-1})[s^{n-1}x - s^{n-2}x(0) - ... - sx^{(n-3)}(0) -$$
$$x^{(n-2)}(0) + ... + (-a_o D + b_o) = 0,$$

where operator D is defined in the following way (see [MJ4]):

$$Df = D\{f(t)\} = \{-tf(t)\}, \quad for \quad f = \{f(t)\} \in \mathcal{C},$$

which, when applied to function f, involves the multiplication of their values by $-t$.

Note that the above equation takes the compact form

$$-P(s)Dx + Q(s)x = R(s), \tag{11}$$

where P, Q, R are polynomials,

$$P(s) = a_n s^n + a_{n-1}s^{n-1} + ... + a_1 s + a_o$$

and $degQ$ and $degR$ are less than n. For some initial data the right hand side of the equation (11) vanishes, i.e., $R(s) = 0$.

If $R(s)$ vanishes, then the operational equation (11) can be written as follows

$$\frac{Dx}{x} = \frac{Q(s)}{P(s)}, \quad \text{for} \quad x \neq 0.$$

Naturally, if • there exists an operator $v \in \mathfrak{M}$ such that $Dv = w$ and • there exists the exponential function $e^{v(\cdot)}$ (see [MJ9]) then ce^v (c being a number) is a solution of the operator equation $\frac{Dx}{x} = w$ (see [MJ6]). It is known, that if $w = \frac{Q(s)}{P(s)}$, where P and Q are polynomials, then there exists an operator $v \in \mathfrak{M}$ such that $Dv = w$ (see [Ge]). If $degQ > degP$, then the operational function $e^{v(\cdot)}$ does not exist (see [MJ9], p. 217). The operator $v = \frac{\{-te^{\alpha t}\ln t\}}{\{te^{\alpha t}\}}$ is a solution of the operational equation $Dv = \frac{1}{s-\alpha}$ and operator $v = \frac{\{-t\ln t\}}{\{t\}}$ is a solution of the operator equation $Dv = s^{-1}$ (see [Ge]).

In general, the existence of the exponential function $e^{v(\cdot)}$ is an open problem. For example, there exists the exponential function $e^{-s(\cdot)}$ for real argument but the exponential function $e^{is(\cdot)}$, $i = \sqrt{-1}$ does not exist. In both cases the series

$$1 + \frac{(-s)^2}{2!} + \frac{-s}{1!} + \cdots; \quad 1 + \frac{is}{1!} + \frac{(is)^2}{2!} + \cdots$$

are divergent (see [MJ8], p. 160, 168).

II. Distributions

1. *Introduction.* Distributions are a generalization of locally integrable functions on the real line, or more generally a generalization of functions which are defined on an arbitrary open set in the Euclidean space.

Distributions were introduced as a result of difficulties with solving some problems of mathematical physics, quantum mechanics, electrotechnics, etc. In these domains there are many theoretical and practical problems where the notion of function is not sufficient in this or that sense.

In 1926 the English physicist Paul Dirac introduced a new element of mathematical formalizem into quantum mechanics, [Dir]. He named it the *Delta function* and denoted it by $\delta(t)$. Dirac assumed that the delta function is on the real line and fulfills the following conditions:

(1)
$$\delta = \begin{cases} 0, & \text{for} \quad t \neq 0, \\ +\infty, & \text{for} \quad t = 0, \end{cases}$$

and

(2)
$$\int_{-\infty}^{+\infty} \delta(t)dt = 1.$$

In the theory of real functions the two conditions (1) and (2) are contradictory. No real function exists to fulfill both conditions at the same time. On the other hand both conditions give a not proper but highly convincing evidence of a physical intuition, $\delta(t)$ represents an infinitely large growth of electric tension in the infinitely short time where a unit electric load. Nevertheless, the existence of mathematical models for that the search of mathematical description would lead naturally to *Dirac delta* does not give an excuse to use the imprecise mathematical notion that hides under $\delta(t)$, treat it as a function and at the same time assume that it fulfills conditions (1) and (2). Despite all formal objections many important results were achieved with help of *Dirac delta function.*

At the thirties of the XX century it became obvious that *Dirac delta function* has its fixed position in theoretical physics. As a result scientists sought new mathematical theory that would give tools to a precise definition of the *Dirac delta function* as it was previously with precise definition of real numbers, etc. The mathematical theory called the theory of distributions that enabled introducing the *Dirac delta function* without any logical restrictions was built in the 40ties of the XX century. This theory allowed to generalize the notion of function as it was once done for the real number.

There are many ways to define distributions (as generalizations of functions), e.g., I. Halperin [Hal], H. König [Kö.1], J. Korevar [Kor], J. Mikusiński [Mi.1], R. Sikorski [Sik.1], W. Słowikowski [Sło], S. Soboleff [Sob], L. Schwartz [Sch.1], G. Temple [Tem.1, Tem.2]. The two most important in theory and practice are: • functional approach given by Soboleff (1936) and L. Schwartz (1945), where distributions are defined as linear functionals continuous in certain linear spaces; • sequential approach given by Mikusinski (1948), where distributions are defined as classes of equivalent sequences.

The functional theory is more general but more complicated. Namely it uses difficult notions of functional analysis and the theory of linear spaces. L. Schwartz developed and presented his theory together with applications in a two volume manual [Sch.2, Sch.3].

The sequential approach is easier because it is based on notions of mathematical analysis. It has a geometrical and physical interpretation that relays on intuitive understanding of the *Dirac delta function* which is common in Physics.

Due to that intuition sequential approach is easier to understand and easy in applications. A formal definition of distribution was given by Mikusinski in [Mi.2]. Basing on that definition Mikusinski together with Sikorski developed sequential theory of distributions and published it in [MS.1, MS.2]. The book has been translated into many languages. The theory was developed and together with P. Antosik a monography *"Theory of distribution, The sequential approach"*, [AMS], was published.

2. *Distributions in the sequential approach.* The starting point for the definition of distributions in the sequential approach are sequences of continuous or smooth functions (i.e. of class $\mathcal{C}^\infty$) in a certain fixed interval $(a; b)$, $(-\infty \leqslant a < b \leqslant +\infty)$. The definition given by Mikusiński is analogue to the definition of real numbers in the Cantor's theory. The aim of introducing real numbers was the performance of certain mathematical operation within this set. Similarly, introduction of distributions enabled differentiation which can not be always performed in the set of functions.

A sequence $(\varphi_n)_{n\in\mathbb{N}}$ of smooth (real-valued) function in $\mathbb{R}^1$ is said to be *fundamental* if for every finite open interval I in $\mathbb{R}^1$ there exist a nonnegative integer k and a sequence $(\Phi_n)_{n\in\mathbb{N}}$ of smooth functions so that $\Phi_n^{(k)} = \varphi_n$ in I and $(\Phi_n)_{n\in\mathbb{N}}$ uniformly converges in I. Two fundamental sequences $(\Phi_n)_{n\in\mathbb{N}}$ and $(\Psi_n)_{n\in\mathbb{N}}$ are *equivalent* $\Big((\Phi_n)_{n\in\mathbb{N}} \sim (\Psi_n)_{n\in\mathbb{N}}\Big)$ if the sequence $\varphi_1, \psi_1, \varphi_2, \psi_2, \cdots$ is fundamental. The relation is an equivalence relation and equivalence classes are called *distributions* in $\mathbb{R}^1$ (an analogous definition can be formulate for distributions in an arbitrary open set in $\mathbb{R}^n$). Smooth, continuous and locally integrable functions are easily identified with respective distributions.

An advantage of the sequential approach in the theory of distributions is easiness of extending to distributions many operations which are defined for smooth functions.

We say that an *operation* A, which to every system $(\varphi_1, \cdots, \varphi_k)$ of smooth functions in $\mathbb{R}$ assigns a smooth function in $\mathbb{R}$ (or a number), is *regular* if for arbitrary fundamental sequences $(\varphi_{1n})_{n\in\mathbb{N}}, \cdots, (\varphi_{kn})_{n\in\mathbb{N}}$ of smooth functions in $\mathbb{R}$ the sequence $\Big(A(\varphi_{1n}, \cdots, \varphi_{kn})\Big)_{n\in\mathbb{N}}$ is fundamental.

Every regular operation A defined on smooth functions can be extended automatically to distributions in the following way.

If $f_1, \cdots, f_k$ are arbitrary distributions in $\mathbb{R}$ and $(\varphi_{1n})_{n\in\mathbb{N}}, \cdots, (\varphi_{kn})_{n\in\mathbb{N}}$ the corresponding fundamental sequences, i.e. $f_1 = [\varphi_{1n}], \cdots, f_k = [\varphi_{kn}]$, then the operation A on

$f_1, \quad, f_k$ is defined by the formula

$$A(f_1, \cdots, f_k) = \Big[A(\varphi_{1n}, \cdots, \varphi_{kn})\Big].$$

Remark. *This extension is always unique, i.e. it does not depend on the choice of the fundamental sequences* $(\varphi_{1n})_{n\in\mathbb{N}}, \cdots (\varphi_{kn})_{n\in\mathbb{N}}$ *representing the distributions* $f_1, \cdots, f_k$. *In other words, if* $(\varphi_{1n})_{n\in\mathbb{N}} \sim (\widetilde{\varphi}_{1n})_{n\in\mathbb{N}}, \cdots, (\varphi_{kn})_{n\in\mathbb{N}} \sim (\widetilde{\varphi}_{kn})_{n\in\mathbb{N}}$ *then*

$$\Big(A(\varphi_{1n}, \cdots, \varphi_{kn})\Big)_{n\in\mathbb{N}} \sim \Big(A(\widetilde{\varphi}_{1n}, \cdots, \widetilde{\varphi}_{kn})\Big)_{n\in\mathbb{N}}.$$

The following operations are regular: • addition of smooth functions; • difference of smooth functions; • mulitplication of a smooth function by a fixed number λ: $\lambda\varphi$; • translation of the argument of a smooth function $\varphi(x+h)$; • derivation of a smooth function of a fixed order m: $\varphi^{(m)}$; • multiplication of a smooth function by a fixed smooth function ω: $\omega\varphi$; • substitution a fixed smooth function $\omega \neq 0$; • product of smooth functions with separated variables: $\varphi_1(x)\varphi_2(y)$; • convolution of a smooth function with a fixed function ω from the space $\mathcal{D}$ (of smooth functions whose supports are bounded): $(f * \omega)(x) = \int_{\mathbb{R}} \varphi(x-t)\omega(t)dt$; • inner product of a smooth function with a fixed function from the space $\mathcal{D}$: $(\varphi, \omega) = \int_{\mathbb{R}} \varphi(x)\omega(x)dx$.

An advantage of the sequential approach to the theory of distributions is easiness of extending to distributions many operations which are defined for smooth functions, i.e., regular operations. An example of a regular operation is differentiation (of a given order $k \in \mathbb{N}_o$): $A(f) = f^{(k)}$, which can be performed for an arbitrary distribution f. It is well known that every distribution is locally (i.e., on an arbitrary bounded open interval in $\mathbb{R}$) a distributional derivative of a finite order of a continuous function. In the sequential approach it is a simple consequence of the definition given above and properties of the uniform convergence. Using this theorem one can define the convergence of sequences of distributions in a natural way. It is also easy to show that the sequence $(f * \delta_n)$ is distributionally convergent to f (i.e., fundamental for f) for an arbitrary distribution $f \in \mathbb{R}^1$. where (δ_n) is so-called delta-sequence, i.e., a sequence of nonnegative smooth functions such that $\int \delta_n = 1$ and $\delta_n(x) = 0$ for $|x| \geq \alpha_n$ with $\alpha_n \to 0$ as $n \to \infty$.

It should be noted that among important in practice operations there are regular and not regular ones. For instance, the two-argument operations of product $A(\varphi, \psi) = \varphi \cdot \psi$ and the convolution $A(\varphi, \psi) = \varphi * \psi$ are not regular operations and they cannot be defined for arbitrary distributions.

J. Mikusiński pointed out a general method of defining *irregular operations* on distributions by using delta-sequences (see [Mi.4], [Mi.3] and [AMS], p. 256 - 257).

Let us assume that an operation A is feasible for arbitrary smooth functions $\varphi_1, \varphi_2, \cdots, \varphi_k$ and let $f_1, f_2, \cdots, f_k$ be arbitrary distributions in $\mathbb{R}^1$.

If $f_1, \cdots, f_k$ are arbitrary distributions in $\mathbb{R}$, we say that $A(f_1, \cdots, f_k)$ exists if for an arbitrary delta-seqyence $(\delta_n)_{n\in\mathbb{N}}$ the sequence

$$\Big(A(f_1 * \delta_n, \cdots, f_k * \delta_n)\Big)_{n\in\mathbb{N}}$$

is fundamental; then the operation A on $f_1, \cdots, f_k$ is defined by the formula

$$A(f_1, \cdots, f_k) = [A(f_1 * \delta_n, \cdots, f_k * \delta_n)].$$

If $A(f_1, \cdots, f_k)$ exists then, the distribution does not depend on the choice of a delta-sequence $(\delta)_{n\in\mathbb{N}}$. If A is a regular operation then, of course, A exists and coincides with the earlier defined result of the regular operation. If A is *irregular*, it needs not exist for all distributions, but the definition embraces not only earlier known cases, but also new ones. For instance, for the operation of the product $A(f_1, f_2) = f_1 \cdot f_2$, the definition can be expressed in the form

$$f_1 \cdot f_2 \stackrel{d}{=} \lim_{n\to\infty} (f_1 * \delta_n)(f_2 * \delta_n) \tag{3}$$

and it exists in this sense for a wide class of distributions exist while it not exist in classical sense of L. Schwartz , [S.2]. For example, the significant in physics product $\frac{1}{x} \cdot \delta(x)$ exists and equals, according to expectations of Physicists, $-\frac{1}{2} \cdot \delta(x)$ (see [Mi.8], [AMS], p. 249). The generalizations of this formula can be found in [Fs] and [Is].

Another definition of the product (given by Mikusiński in 1962 see [Mi.5]) is

$$f \cdot g :\stackrel{d}{=} \lim_{n\to\infty} (f * \delta_{1n})(g * \delta_{2n}) \tag{4}$$

where the limit is assumed to exist in the distributional sense for arbitrary delta sequences $(\delta_{1n})_{n\in\mathbb{N}}$, $(\delta_{2n})_{n\in\mathbb{N}}$, is known in the literature under the name of the Mikusiński product. R. Shiraishi and M. Itano have shown in [ShI] that the definition (4) is equivalent to the definition given by Y. Hirata and H. Ogata in [HiO] also with use of delta sequences. Their definition is not as general as (3) because the product $\frac{1}{x}\,\delta(x)$ does not exist in the sense (4) (see [It], [Ka.3]). The product of distributions was also of interest to many other mathematicians, i.e., A. Kamiński ([Ka.1], [Ka.2], [Ka.3]), P. Antosik and J. Ligęza, [AL].

Among other irregular operations an especially important role is played by the convolution of distributions.

The operations of integration, convolution and a product of distributions can be performed only for certain classes of distributions. The operation of convolution of two distributions can be done if e.g. their supports are compatible (see [AMS], p.124). These difficulties were a trigger for further search of new definitions of that operation. This problem is especially visible in the theory of Fourier transform. In the classical mathematical analysis the Fourier transformation transforms the convolution of integrable or square integrable functions into the product of their transforms. The question arises, what similarities can be found for distributions? Some answer to that question can be found in the book by L. Schwartz [S.2] and the papers by Y. Hiraty and H. Ogaty, [HiO], Shiraishi and M. Itano, [ShI]. Those results however have not embraced all possibilities or were to general. R. Shiraishi in [Sh] stated a hypothesis whether a convolution of tempered distributions is a tempered distribution. A negative answer to that problem was given by A. Kamiński [Ka.1], and then independently P. Dierolf and J. Voigt in [DV]. But the question of R. Shiraishi motivated A. Kamiński to modify the notion of compatibile supports (the so called polynomial compatible) that guarantees that a convolution of tempered distributions is a tempered distribution, [Ka.4]. For a definition of tempered distribution see for example [AMS], p. 165.

III. The Lebesgue and Bochner Integrals

The next area of interest of Jan Mikusiński was the theory of integration. Various approaches to the theory of the Lenesgue are known in the literature. Jan Mikusiński's definition of the Lebesgue integral is particulary simple and has a clear geometrical interpretation. The definition can be formulated at once for functions defined in $\mathbb{R}^k$ with values in a Banach space and this yields a uniform approach to the Lebesgue and Bochner integrals.

The function $f : \mathbb{R}^k \to X(f : \mathbb{R}^k \to \mathbb{R}^1)$, where X is a given Banach space, is called Bochner (Lebesgue) integrable if there exists a sequence of interval $I_n = [a_{1n}, b_{1n}) \times \cdots \times [a_{kn}, b_{kn})$ in $\mathbb{R}^k$ and a sequence $(\lambda_n)_{n\in\mathbb{N}}$ of elements of X such that

$$\sum_{n=1}^{\infty} |\lambda_n| vol(I_n) < \infty \tag{1}$$

and

$$f(x) = \sum_{n=1}^{\infty} \lambda_n \chi_{I_n}(x) \tag{2}$$

at those points x at which the series is absolutely convergent, where χ_I denotes the characteristic function of an interval I.

The Bochner (Lebesgue) integral of a function satisfying conditions (1) *and* (2) *is defined as:*

$$\int f = \sum_{n=1}^{\infty} \lambda_n vol(I_n).$$

This definition is equivalent to the classical definitions of Bochner and Lebesgue integrals.

This theory of the Bochner integral based on the definition cited here is developed in [MJ10]. The most of the theorems in the theory are simpler than in the case of other approaches to the integral.

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Communications:

I. Conferences for Young Algebraists

Klaus Denecke*

The following list gives some information on the future conferences of young algebraists:

1. CYA (75. AAA), Darmstadt (Germany), November 1-4, 2007
2. AAA Linz (Austria), May 22-25, 2008
3. CYA (77. AAA), Potsdam, Februar 2009
   (dedicated to K. Denecke)
4. AAA Bern (Switzerland), June 11-14, 2009
5. CYA (79. AAA), Olomouc (Czech Republic), February 2010

See also pages 10 and 11 of Notices from the ISMS, January 2007.

II. Announcement of Meetings in Topology

Communicated by Gerhard Preuss**

Announcemnt of meetings in Topology

1) December 3-7, 2007:
International Conference on Topology and its Applications 2007
(Jointly with 4th Japan Mexico Topology Conference)
Department of Mathematics, Kyoto University, Kitashirakawa-Oiwakecho,
Sakyoku, Kyoto, Japan

Organizing Committee:
Chair:
Akira Kono (Kyoto University)
Salvador Garcia-Ferreira (UNAM)
Algebraic Topology:
Norio Iwase (Kyushu University)
Miguel A. Xicote'ncatl (CINVESTAV) xico at math.cinvestav.mx
Knot Theory:
Akio Kawauchi (Osaka City University)
Mario Eudave (Instituto de Matematicas-UNAM)
Set Theory, Set-theoretic Topology:
Tsugunori Nogura (Ehime University)
Angel Tamariz-Mascarua (Facultad de Ciencias-UNAM)
Diego Rebolledo-Rojas (Instituto de Matematicas-UNAM)
Geometric Topology, Continuum Theory:
Hisao Kato (Tsukuba University)
Sergey Antonyan (Facultad de Ciencias-UNAM)
Alejandro Illanes (Instituto de Matematicas-UNAM)
Dynamical System:
Hiroshi Kokubu (Kyoto University)
See: http://www.math.sci.ehime-u.ac.jp/jamex/

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*Klaus Denecke is a professor of University of Potsdam, Institute of Mathematics, an Editor of SCMJ, and an Editor of Notices from the ISMS.

**Gerhard Preuss is a professor of Freie Universität Berlin, FB Mathematik, an Editor of SCMJ, and an Editor of Notices from the ISMS.

2) June 9-19, 2008
Advances in Set-Theoretic Topology
in Honour of Tsugunori Nogura on his 60th Birthday
Centre for Scientific Culture "Ettore Majorana"
International School of Mathematics "G. Stampacchia"
Erice, Sicily, Italy

Organizers:
Szymon Dolecki (Burgundy University, France)
Yasunao Hattori (Shimane University, Japan)
Dmitri Shakhmatov (Ehime University, Japan)
Gino Tironi (University of Trieste, Italy)

Topics:
Convergence properties and convergence structures;
Dimension theory and related fields;
General topology and its applications in other areas of mathematics;
Hyperspaces, set-valued mapping and their selections;
Set theoretic methods in mathematics;
Topological algebra (topological groups, functions spaces, etc...).
See: http://www.math.sci.ehime-u.ac.jp/erice/

Ⅲ. BIOCOMP2007

Communicated by L.M. Ricciardi *

Stimulated by some friends, and on the grounds of the successful experience of *BIOCOMP2002 and "BIOCOMP2005*: Conferences, Prof. L.M. Ricciardi has now been induced to plan another Conference to be held in the same location (Vietri sul Mare, Italy), September 24-28, 2007.
The title is ***BIOCOMP2007 - Collective Dynamics: Topics on Competition and Cooperation in the Biosciences.***

The title is motivated by the nature of our sponsors and supporting grants, but the main purpose of this Conference is to bring together a limited number of well-known specialists in the fields of applied mathematics, physics and theoretical biology for an in-depth discussion of model building and computational strategies in some selected areas of the life sciences with special emphasis on theoretical neurobiology, molecular motors and quantitative problems in ecology and population dynamics.
This will be implemented through a program of plenary talks, parallel sessions and a poster session.
The interdisciplinary nature of the conference will allow cross-fertilization of recent advances in applied nonlinear mathematics and computational approaches. Several invited lectures on different topics of biomathematical interest will also be given, especially tailored on the needs of graduate students and young researches.

Ⅳ. The 7th International Conference on Optimization (ICOTA 7)

Communicates by Wuyi Yue**

The 7th International Conference on Optimization(ICOTA 7) : Techniques and applications

<u>December 12-December 15, 2007, International Conference Center, Kobe, Japan</u>

ICOTA webpage is: http://www.iict.konan-u.ac.jp/ICOTA7/

See also pages 8 of Notices from the ISMS, November 2006.

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* L.M.Ricciardi is a professor of Dipartimento di Matematica e Applicazioni, Universita di Napoli Federico II, and an International Advisor of SCMJ.

** Wuyi Yue is a professor of Konan University, an editor of SCMJ, and an editor of Notice from the ISMS.

The ISMS

(1)

International Society for Mathematical Sciences ----- Contributions

Dear Colleagues and Friends,

In September 2007, we establish the following two funds.

(1) International ISMS Prizes Fund

in order to award the prizes for the original papers or survey works published in Scientiae Mathematicae Japonicae or Notices from the ISMS.

(2) International Research Promoting Fund

in order to promote and support international joint meetings by IVMS.

The contributions are classified into the following five categories.

(A) ¥500,000 (or $5,000) and above
(B) ¥100,000 (or $1,000) and above
(C) ¥50,000 (or $500) and above
(D) ¥10,000 (or $100) and above
(E) Less than ¥10,000 (or $100)

We deeply appreciate your generous contributions to support the above activities of our society.

Kiyoshi Iseki
Tadashige Ishihara

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(II) Bylaws 2007 (July)

We hereby announce that the Bylaws 2007 (July) are approved and the changes shown at the page 21 of Notices from the ISMS May 2007, are enacted from July 1 2007 as follows.

(1) Contributing member system starts
(2) We announce election of 2008 officers including President elect election

(III) PRESIDENT ELECT (Jan. 1, 2008 ~June 30, 2009)

We hereby accept candidates for President Elect. The election is scheduled as follows.

(1) The candidates should send the following documents by Aug. 20, 2007.

(a) Letters of recommendation from at least two ISMS members
(b) A brief personal resume
(c) Research history (If the candidate has won prizes, write the names of the prizes, the dates and the organization awarding the prizes.)
(d) Administrative policies

(2) The above (a)~(d) of each candidate shall be announced in the September issue of SCMJ (Vol.66, No2) and the election shall begin on the web or by e-mail. The poll closing shall be Oct. 1, 2007

(3)The result shall be announced in the November issue of SCMJ (Vol.66, No.3). The term of office shall begin on Jan.1, 2008.

(IV) ELECTION of 2007 OFFICERS

As set forth in Article I of Bylaws 2007 (July), we hereby accept candidates for the following officers.

(1) Four officers in charge of publishing
(2) Four officers in charge of meetings
(3) Three officers in charge of membership and accounting
(4) One officers in charge of prizes

The candidacy should be followed by the recommendation of at least two ISMS members and be made by Aug 20, 2007. The election shall be done with the deadline of Oct 1, 2007 and the term of office shall begin on Jan 1, 2008

(V) ELECTION OF COUNCIL MEMBERS

After the 2008 Officers Election, which will be conducted from August 2007 through October 2007, the Board of Officers will nominate the new members and the confidence vote by the membership shall be conducted.

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Special Fields (f-1 - f-14)

f-1. Mathematical logic, Set theory, Relative systems, Algebra systems
f-2. Classical algebra, Number theory, Combinatorics, Cryptology
f-3. Topology, Geometry, Imaging
f-4. Real analysis, Complex analysis
f-5. Functional analysis, Operator theory
f-6. Differential equations, Integral equations, Functional equation, Numerical analysis
f-7. Infinite dimensional dynamical systems, Inverse problems
f-8. Fluid dynamics, Atmospheric research, Rheology, Computer aided design, Control theory, Nanoscience
f-9. Probability theory, Statistics, Experimental Design, Quality control
f-10. Operations Research, Decision theory, Queuing theory, Scheduling, Mathematical finance, Mathematical economics
f-11. Informatics, Pattern recognition, Imaging, Computer science, Computer simulation
f-12. Biomathematics, Proteomics, Imaging, Bioscience, System biology
f-13. Mathematical education, History of mathematics
f-14. Over several fields (Ex. Fixed point theory)

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Call for Papers for SCMJ

Scientiae Mathematicae Japonicae(SCMJ) calls for excellent papers.

(1) Authors can choose one of the editors in the Editors List and send their papers directly to him/her for refereeing which promises **quick refereeing and publication.**

(2) If the SCMJ authors prepare their files in ISMS standard format (Js.), the lead time from acceptance to the online publication **will be extremely short or nil.**

(3) In the proofreading is made by the SCMJ (Paper or TeX) author, we will publish the paper on the Web as soon as we receive the corrected galley proof.

(4) The Journal is reviewed by **Mathematical Review** and **Zentralblatt from cover to cover.**

(A) Submission

Authors are requested to choose one of the editors in the SCMJ editors list and send their papers, satisfying all of the following conditions, **directly to the editor.** The editors list can be obtained from (i) URL:http://www.jams.or.jp/ (ii) " Editorial Board" of SCMJ(Vol.64, No.1, July 2006).

Prepare **e-mail Form for Submission and three** hard copies of your paper, **three** hard copies of Form for Submission, and send them as follows.

- **To the editor's e-mail address**; Form for Submission (with the abstract)
- **To the editor's postal address; Two** hard copies of your paper, **two** hard copies of the Form for Submission (with the abstract)
- **To the e-mail address of ISMS** (http://www.jams.or.jp/hp/submission f.html); Form for Submission (with the abstract)
- **To the postal address of ISMS; One** hard copy and **one** Form for Submission

The received date of the paper is the date when the editorial office receives the paper together with the Form for Submission, and not necessarily the date when the editors receive them.

To e-mail Form for Submission is mandatory to support the editor-receive-system, not to waste the precious reseach time of the editors and promote efficiency in the editorial procedure.

(B) Abstract

Every paper should contain an abstract. Try to limit your abstract to 20 lines when typed in TeX. The abstract should be a kind of mini research announcement which is **self-contained** and gives **the overview** of your paper. Abstracts of accepted papers are **very rapidly displayed** on ISMS home page and are announced **all over the world via Internet.** Abstracts in Paper Form and E-mail Form should be typed **in Text file.** If it is inevitable for you to use symbols in the abstract, you may make it in a TeX source file indicating **the kind of TeX** as notes, for example, (via LaTeX2e).

(C) Data

The full postal address, telephone and facsimile numbers, e-mail address of the author should be specified at the bottom of the last page of the manuscript. 2000 AMS Subject Classification and Keywords should be written both in Paper, E-mail Form and at the **footnote** on the first page of the manuscript.

(D) Receipt

ISMS will send a letter of receipt when we receive a hard copy, a Paper Form and E-mail Form (if the author has e-mail facility). The received date is to be specified in the letter.

(E) Revision

If revision of your paper is necessary, the editor informs you directly. When you revise abstract of your paper in that case, you should send new Paper Form with new abstract and E-mail Form with new abstract also.

(F) Acceptance or Rejection, Page Charges

ISMS will inform authors of **acceptance or rejection** of their papers **by e-mail.**

Authors should choose one of the following 3 types of his final draft he will send after acceptance of his paper, (1) **P:** Paper draft only (2) **T:** Paper prepared using TEX and its source file (3) Js: Paper prepared using TEX with ISMS style file, and its source file.

List of the page charges for SCMJ (2007 year)

	Individual/ Associate Member	Non Member
Paper : P	¥3,850(US$35, €28)	¥4,450(US$43, €35)
TEX : T	¥2,200(US$18, €14)	¥2,800(US$26, €21)
Js : Js	¥1,100(US$8, €7)	¥1,700(US$16, €14)

The above page charges include 20 offprints. The additional page charge may be required for the figures contained in the papers. For more information, see our Web Page.

1) **Js** (ISMS style TeX) files mean the files which are ready for publication without any process by our Publication Dept. Please note whether the file meets the requirement of the ISMS style or not **is judged by ISMS Publication Dept.** Js files can be made using the ISMS style file for AMS-LaTeX, LaTeX, or LaTeX2e, which can be downloaded from ISMS Web Page. AMS-TeX files cannot be **Js files** any more.

The procedure to make Js files :

(a) Prepare your paper in AMS-LaTeX, or LaTeX.

(b) Use the following ISMS style file to make your paper "ISMS style TeX" (Js). (The ISMS style files can be obtained from ISMS Web Pages.)

If your paper contains graphs or figures which cannot be processed even in LaTeX(2e), make them EPS (Encapsulated Post Script) files and then PDF files.

(G) After Acceptance

If the paper is accepted, P authors are requested to send the following (1) & (2), T and Js authors (1) – (4).

(1) A hard copy of the final draft(for publishing)
(2) Paper Form for WWW
(3) The source file of the final draft in TeX, by e-mail or on diskette.
(4) E-mail Form for WWW

(H) Proofreading

ISMS will send a galley proof to P and T authors only but **not to Js authors.** We regard the final files sent by Js authors as ready for publication.

(I) Offprints

Every author can obtain a **password to read his paper and** can make **as many offprints as they want,** using Acrobat Reader.

(J) Online version of SCMJ

The full texts of the accepted papers will be located on the online version of SCMJ in the following two manners from Vol.66, No. 1 (July 2007).

(1) A list of papears in the order of the accepted date.
(2) A list of accepted papers organized by filed of specialization with a link to (1). The field of specialization of the accepted papers will be chosen by the authors in the fields of f-1 - f-14.
(See a list of on page 24.)

utility theory

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(c) Fuzzy Theory and its Application, Functional Analysis
(d) 46

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Algorithmic information theory

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(d) Mathematical logic and foundations, Order, lattices, ordered algebraic structures, General algebraic systems, Group theory and generalizations

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(c) Riemannian Geometry, Differential Geometry, Analysis on manifolds, Calculus of Variations (in decreasing order of competence)

(d) Differential geometry, Global analysis, analysis on manifolds, Calculus of variations and optimal control; optimization, Geometry

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(c) (1)Categorical Methods in Topology, (2)Convenient Topology, (3)General Topology

(d) (1)Topological categories, reflections, (2)Semiuniform convergence spaces (and their invariants) (3)Topological spaces and generalizations, convergence (general theory) and limits, proximity structures and generalizations, uniform spaces and generalizations, uniform
spaces and generalizations, nearness spaces

GREECE

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(c) Topological algebra theory, in principle, NOT normed algebras or Banach algebras and the like. Differential Geometry; in particular, infinite-dimensional, and Global Analysis, especially, Differential spaces (58A40), Applications of the above in Physics (53C80)

(d) 46: H05, H15, H20, J05, K05, K10, L80(K-Theory of topological algebras), M05 (Tensor products of topological algebras), N50 (Applications of topological algebras in quantum physics), 58A40, 53C80

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(d) Theory of automata and formal languages

(e) Electronic files only

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(d) Number theory

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A new category "life member" has been established and can be applied for from 2005. An eligible member may become a life member by making a one-time payment of dues. A member who has been an ISMS member for ten years or more is eligible for a life member. The amounts of dues are : \70,000 for the domestic members, US$ 600 (€480)for the foreign members, and US$ 500 (€400)for the members in developing countries.

We have reduced the ISMS memership dues since 2001 and copies of the printed journal have not been distributed to the members, free of charge. Instead, we give User Name and Password to each member so that he/she can view or print out the full text of the papers published in SCMJ except papers in the international plaza from our Web site (http://www.jams.or.jp).

The Membership Dues for each category is as follows. Applications for the 3-year members can be made only in 2005 and in every three years.

Membership Dues for 2007

Membership	JAPAN	S-JAPAN	Foreign	S-Foreign	Developing
1-year	A1 ¥7,000	SA1 ¥3,500	F1 US$50 €40	SF1 US$30 €24	D1 US$30 €24
3-year	A3 ¥18,000	SA3 ¥9,000	F3 US$120 €96	SF3 US$60 €48	D3 US$70 €56
Life Member	Life ¥70,000	Life ¥70,000	FL US$600 €480	FL US$600 €480	DL US$500 €400

Category D is for those who reside in the countries of Eastern Europe, CIS or developing countries. Category S is for students and for the aged (older than 70). The figure 1 and 3 means a year and 3 years respectively.

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Payment Instructions

Payment can be made through a post office or a bank, or by credit card. Members may choose the most convenient way of remittance. Please note that we do not accept payment by bank drafts (checks). For more information, please refer to an invoice.

Methods of Overseas Payment:

Payment can be made through (1) a post office, (2) a bank, (3) by credit card, or (4) UNESCO Coupons.

Authors or members may choose the most convenient way of remittance as are shown below. Please note that **we do not accept payment by bank drafts (checks)**.

(1) Remittance through a post office to our giro account No. 00930-1-11872 or send International Postal Money Order to our postal address (2) Remittance through a bank to our account No. 94103518 at Shinsaibashi Branch of CITIBANK (3) **Payment by credit cards** (AMEX, VISA, MASTER or NICOS), or (4) Payment by UNESCO Coupons.

Methods of Domestic Payment:

Make remittance

(1) to our Post Office Transfer Account - 00930-3-73982 or

(2) to our account No.1565679 at SUMITOMO BANK, Sakai, Osaka, Japan.

All the correspondences concerning subscriptions, back numbers, individual and institutional memberships, should be addressed to the Publications Department, International Society for Mathematical Sciences.

Membership Application Form (from 2007)

To determine what membership category you are eligible for, read "Join ISMS" on the inside of the back cover.

1. Name: Family Name, First Name, Middle Name (in this order)
2. Home Address
3. Name of Firm or Institution affiliation
4. Postal address to which correspondence should be sent
5. e-mail address
6. Telephone Number, Fax Number
7. Membership Category
8. Panel (Please choose one out of the following 12panels and write the panel number. You could choose one or more.)

(e-1)Mathematical Logic, Set Theory, Lattice Theory, Ordered Systems.
(e-2)Algebra, Algebraic Geometry, Number Theory, Combinatorics, Cryptology.
(e-3) Topology, Geometry, Imaging.
(e-4) Real Analysis, Functional Analysis, Complex Functions.
(e-5) Differenation Equations, Integral Equations, Functional Equations.
(e-6) Fluid Dynamics, Rheology, Imaging and other Applied Analysis, Control Theory, Numerical Analysis、Simulation.
(e-7) Probability, Statistics, Data Mining, Decision theory. Quality Control.
(e-8) Game, Finance, Operations Research, Mathematical Economics. Ecology
(e-9) Informatics, Computer Sciences.
(e-10) Biomathematics, Neuroinformatics, Genome Sciences, Nanoscience.
(e-11) Mathematical Education, History of Mathematics.
(e-12) Over several fields.(Ex. Fixed Point Theory, Semi-group)

9. Would you like to buy the printed copies of SCMJ, whose prices a year are US$60(6,000yen) for 1-year-members(A1, D1, S-A1, S-D1)and US$55(5,500yen) for 4-year-members(A4, D4, S-A4, S-D4) ? Type YES or NO.
10. If you apply for an aged member (70 years old or over), please type the year of your birth.
11. If you wish to be a student member, please verify.
12. Is your university (institution) an Academic or Institutional Member of the ISMS? Yes or No.
13. If the answer of 12 is Yes, please answer the following. Are you designated associate member by your university (institution)?
14. Date
15. Signature

For Japanese Applicants, please send two application forms, one in English and the <u>other in Japanese.</u>

I wish to enroll as a member of ISMS and will pay to International Society for Mathematical Sciences the annual dues upon presentation of an invoice. Copies of Mathematica Japonica, Scientiae Mathematicae and Scientiae Mathematicae Japonicae received as an ISMS member will be for my personal use and shall not be placed in institutional, university or other libraries or organizations, nor can membership subscriptions be used for library purposes.

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Join ISMS !

ISMS Publications: We published **Mathematica Japonica (M.J.)**, which enjoyed an international reputation, for about sixty years in print and its offshoot **Scientiae Mathematicae (SCM)** both online and in print. In January 2001, the two publications were unified and changed to **Scientiae Mathematicae Japonicae (SCMJ)**, which is the "21st Century New Unified Series of Mathematica Japonica and Scientiae Mathematicae" and published both online and in print. Ahead of this, the online version of SCMJ was first published in September 2000. The number of the annual total pages of the print version has been from 900 to 1,200 pages in six issues since January 1978. The whole number of SCMJ exceeds 240, which is the largest amount in the publications of mathematical sciences in Japan. The features of SCMJ are:

1) About 90 eminent professors and researchers of not only Japan but also 20 foreign countries join the Editorial Board. The submitted papers are received directly by the editors and are refereed quickly. The accepted papers are published online with no lead time after compiling or proofreading. SCMJ is reviewed by Mathematical Review and Zentralblatt from cover to cover.
2) SCMJ is distributed to many libraries of the world. The papers in SCMJ are introduced to the relevant research groups for the positive exchanges between researchers.
3) The original papers and surveys of distinguished mathematical scientist appear in every issue of SCMJ. The section called "International Plaza" of SCMJ has very interesting expository papers written by the eminent mathematical scientist of the world. Presentations of recent research frontier including award lectures by the winners of the ISMS Prize or Shimizu Prize are made.
4) **ISMS Annual Meeting:** Many researchers of ISMS members and non-members gather and take time to make presentations and discussions in their research groups every year.
5) The ISMS holds inter-regional videoconferences called **International Videoconference of Mathematical Sciences (IVMS)** via internet. There is no need for the participants to travel abroad.

Privileges to ISMS Members: (1) Free access (**including printing out**) to the online version of SCMJ, (2)Discounted price for the printed version of SCMJ (See **Table 1**), (3) Discounted page charges (See **Table 2**).

Privileges to Institutional Members: (1) Two associate members can be registered, free of charge, from an institution. (2) The discounted page charges (Table 2) are applied to the associate members.

Table 1: Subscription Price (from 2007)

	Individual 1-year mem.	Individual 3-year mem.	Institutional member	List Price
Print / year	¥6,000 US$60, €48	¥5,500 * US$55, €44	¥33,000 US$300, €240	¥45,000 US$400, €320
Online/year	Free	Free	—	—
Online+Print / year	¥6,000 US$60, €48	¥5,500 * US$55, €44	¥33,000 US$300, €240	¥45,000 US$400, €320

Postal charge is US$2 (€1.6) per issue. *In case three-year members make the payment at a time in advance, the price for 3 years is ¥15,000 (US$150, €120). The authors can buy a copy of the print version at a price of ¥1,200 (US$12) per issue including postage.

Table 2: Page Charge per printed page

	Individual/Associate Member	Non Member
Paper : P	¥3,850 (US$35, €28)	¥4,450 (US$43、€35)
TeX: T	¥2,200 (US$18, €14)	¥2,800 (US$26, €21)
ISMS style: Js	¥1,100 (US$8, €7)	¥1,700 (US$16, €14)

The above page charges include 20 offprints.

Table 3: Membership Dues for this year

Categories	Domestic	Overseas	Developing countries
1-year member (1A)	A1: ¥7,000	F1: US$50 , €40	D1: US$30, €24
3-year member (3A)	A3: ¥18,000	F3: US$120, €96	D3: US$70, €56
1-year students or aged (1S)	SA1: ¥3,500	SF1: US$30, €24	SD1: US$20, €16
3-year students or aged (3S)	SA3: ¥9,000	SF3: US$70, €56	SD3: US$50, €40
Life member* (L)	AL: ¥70,000	FL: US$600, €480	DL: US$500, €400

*The members who have been the ISMS members for more than 10 years are eligible for this category.The categories 1S and 3S are for students or persons over 70 years old.