Charles University, Prague
Faculty of Mathematics and Physics

SEMINAR ON MATHEMATICAL ANALYSIS

Potential Theory and Related Topics

1967–2001

FACULTY OF MATHEMATICS AND PHYSICS
Charles University

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PRAHA

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The editors appreciate collaboration of participants of the seminar in the course of preparation of this text.

Dedicated to our teacher and friend Josef Král

Contents

History of potential theory in Prague

As far as we know, only a few mathematicians living (for at least some time) in Prague contributed to potential theory before 1960.

The oldest trace we are aware of is a three volume book *Foundations of Theoretical Physics* written in Czech (Základové theoretické fysiky) by August Seydler (1849–1891), a professor of Mathematical Physics and Theoretical Astronomy in the Czech part of Charles-Ferdinand University (nowadays Charles University). In the second one, published in Prague in 1885 and called *Potential Theory. Theory of gravitational, magnetic and electric phenomena* (Theorie potenciálu. Theorie úkazů gravitačních, magnetických a elektrických) potential theory is treated from the physics point of view. It was the first Czech book devoted to the field. He also wrote an article on logarithmic type potential. In 1905 František Graf published the article *On some properties of Newton and logarithmic potential and its first derivatives at simple singularities of mass surfaces and curves* (*O vlastnostech Newtonova logarithmického potenciálu i jeho prvních derivací v některých jednoduchých singularitách hmotných ploch a křivek*). It appeared in Časopis Pěst. Mat. Fyz. 34 (1905), 5–19 and 130–147.

Also Karel Petr (1868–1950), a professor of Charles University in the period 1908–1938 wrote a paper on potential theory. The article *Poisson integral as a direct consequence of Cauchy integral* written in Czech (*Poissonův integrál jako přímý důsledek integrálu Cauchyova*) appeared in Časopis Pěst. Mat. Fyz. 42 (1913), 556–558.

In 1911, under K. Petr, Viktor Trkal (1888–1956) wrote his thesis *On the Dirichlet and Neumann problems from the integral equations viewpoint* (*O problému Dirichletově a Neumannově s hlediska rovnic integrálních*). V. Trkal later became a professor of theoretical physics at Charles University.

George Pick (1859–1942) got his Habilitation from the Prague German University in 1882. From 1888 he was a professor of this university. His main fields were Analysis and Geometry. Among more than 50 of his papers at least two deal with potential theory: *Ein Abschätzungssatz für positive Newtonsche Potentiale*, Jber. Deutsch. Math.-Verein. 24 (1915), 329–332 and *Über positive harmonische Funktionen*, Math. Z. 1 (1918), 44–51.

Karl Löwner (1893–1968) studied at the Prague German University where he became a professor in 1930. Before his emigration in 1939, he was an adviser of Lipman Bers' (1914) thesis *Über das harmonische Mass in Raume*.

Wolfgang Sternberg (1887–1953) belonged to the faculty at Prague German University during the period 1935–1939. He is known as the author of a two volume booklet on potential theory *Potentialtheorie I, II* published by Walter de Gruyter in the series Sammlung Göschen as well as of the book *The Theory of Potential and Spherical Harmonics* (later published in the U.S.A.). His well-known work on the Perron method for the heat equation *Über die Gleichung der Wärmeleitung*, Math. Ann. 101 (1929), 394–398, is often quoted in treatises on modern potential theory.

In the fifties, several papers on potential theory were published by Czech mathematicians interested in PDE's. Ivo Babuška (1926) wrote several articles on the Dirichlet problem for domains with non-smooth boundaries and also papers on biharmonic problem. Rudolf Výborný (1928) contributed to the study of maximum principle by several articles, especially for the heat equation. They also wrote two papers together (*Die Existenz und Eindeutigkeit der Dirichletschen Aufgabe auf allgemeinen Gebieten*, Czechoslovak Math. J. 9 (84) (1959), 130–153 and *Reguläre und stabile Randpunkte für das Problem der Wärmeleitungsgleichung*, Ann. Polon. Math. 12 (1962), 91–104.)

An elementary approach to the Perron method for the Dirichlet problem was published in Czech by Jan Mařík (1920–1994) in the article *The Dirichlet problem* (Dirichletova úloha), Časopis Pěst. Mat. 82 (1957), 257–282.

Personal recollections

The idea of including a course of potential theory in the curriculum of students specializing in mathematics in the Faculty of Mathematics and Physics of the Charles University is due to Professor Jan Mařík, who was concerned with teaching surface integration in the mid fifties; he believed that potential theory would offer many opportunities of illustrating importance of integral formulae such as the divergence theorem and the Green identities.

One of the tasks which I received from him during my postgraduate studies (1956–1959) was to prepare such a course which I started about 1960 as of 4 hours of lectures and 2 hours of exercises per week during one semester. The extent of the course was consecutively changing. In the academic year 1965/66, when I was abroad, the course was taken over by Professor Mařík for approximately 3 years as 4 hours of lectures during one semester. During the period 1970/71–1975/76 the time devoted to this course was reduced to 3 hours per week for one semester and later the obligatory course of potential theory was abolished altogether.

Starting from 1976/77 up to now a non-obligatory course of potential theory was regularly offered (with isolated exceptions, e.g. in 1987 or 1992) as 2 hours of lectures per week in both semesters. Also the content of the lecture was continuously changing. The time available was not sufficient to allow for the teaching of potential theory itself as well as the original intention of using the course as a rigorous introduction of surface integrals and for training in the techniques of surface integration. I have also soon abandoned the exposition of special properties of planar logarithmic potentials (for which only knowledge of curvilinear integrals was sufficient) with their applications to boundary value problems. Mostly the necessary integral formulae were only formulated with reference to courses of integral calculus and analysis on manifolds which were later offered in mathematical curricula, and proper lecture on potential theory was regularly devoted to basic properties of harmonic functions and the Perron method of the generalized Dirichlet problem in Euclidean spaces. Sometimes also potentials derived from Riesz's kernels and their generalizations were treated and notions of energy and capacity together with their applications were discussed. On the whole the exposition was oriented towards classical potential theory on Euclidean spaces.

I was aware of the gap between the content of the course and the research articles in potential theory (represented e.g. by recent issues of the Paris seminar "Séminaire Brelot-Choquet-Deny" which I could buy during my first stay abroad) appearing in the contemporary literature. In an attempt to bridge this gap I invited several friends and my former students to establish a seminar on mathematical analysis which would pay attention to the development of potential theory. We studied consecutively several texts which were accessible to us such as Brelot's "Lectures on Potential Theory" (Tata Institute of Fundamental Research, 1960) and Bauer's treatise "Harmonische Räume und ihre Potentialtheorie" (Springer 1966).

The atmosphere towards the end of the sixties was to a certain extent relatively convenient for establishing international contacts. When I learned about preparation of a summer school devoted to potential theory in Italy, I encouraged younger participants of our seminar to attempt to participate. The result of their attempt was unexpectedly favourable: a whole group of young Czech mathematicians was able to travel to Stresa in 1969. They returned full of enthusiasm—they were able to meet many of distinguished specialists and their students and to establish their first international scientific contacts. Thanks to these contacts many important studies in the field of potential theory (including e.g. the monograph "Potential Theory on Harmonic Spaces" prepared by C. Constantinescu and A. Cornea and published by Springer in 1972) became accessible to our seminar even before their publication.

In spite of problems caused by political development in the seventies and the eighties the scientific contacts were not interrupted and continued to develop. Many outstanding experts visited Bohemia and many participants of our seminar had opportunity to get acquainted with activities of centers of potential-theoretic research abroad; it was significant that some members of the seminar were able to participate in long-term stays in renowned institutions abroad.

Nowadays the possibilities of studying potential theory in Bohemia are good. During the past 30 years a number of gifted mathematicians have grown up who were able to achieve a number of remarkable results; I hope that they will continue in activities of the seminar. I believe that prospects of the future development of research and teaching in the field of potential theory in this country are very promising.

Prague, 1996 *Josef Král*

Program of the seminar

At the end of 1966 J. Král contacted several friends and former students and suggested studying together some parts of potential theory. First slightly irregular lectures were held at the Mathematical Institute of the Czechoslovak Academy of Sciences, Krakovská 10. Soon afterwards a decision to start a regular seminar in the next school year was made. The name *"Seminar on Mathematical Analysis"* was chosen and the meeting time was fixed for Monday afternoons. From the beginning it was agreed to devote the seminar mainly to potential theory not excluding, however, other parts of Analysis which would be of interest of members of the Seminar. The place of meetings was changed and the seminar started at the Faculty of Mathematics and Physics of Charles University, at the building on Malostranské nám. 25.

In what follows, relevant data concerning the program of the seminar are presented. Unfortunately, the list of talks or series of talks is very incomplete and has still serious gaps.

1967/68

The seminar started with a systematic study of modern parts of potential theory. J. Král lectured on various topics, based mostly on books of Marcel Brelot, Heinz Bauer and Robert R. Phelps. Some examples of topics studied at the beginning of the seminar:

Král J.: *Choquet's capacities*
Potentials of measures

1968/69

The seminar was devoted to the study of harmonic spaces. At the end of the school year, several participants of the seminar attended the Summer School on Potential Theory held in Stresa, Italy. Our teacher, Jan Mařík, an active participant of the seminar, left in September 1969 for a one year stay in the U.S.A. The nonsensical course of actions of the Czechoslovak administration after 1969 caused that Jan Mařík did not come back to the country.

Král J.: *Harmonic spaces*
Choquet's capacities
Bauer's theory of harmonic spaces

Netuka I.: *The Harnack principle and its equivalent forms*
The axiomatic system of Brelot

1969/70

J. C. Taylor attended the Third Prague Topological Symposium and delivered a talk on the Martin compactification in axiomatic potential theory.

Brelot M. (University Paris VI, France):
History and new developments in potential theory
Some recent results in the boundary behaviour of functions in potential theory

M. Brelot

Marcel Brelot (1903–1987) The leading personality of the twentieth century potential theory. Studied mathematics at Ecole Normale Supérieure, professor at the universities of Bordeaux, Grenoble and, since 1953, in Paris. Since 1974, the corresponding member of Academie des Sciences, Paris.
M. Brelot's main contributions to potential theory: convergence theorems for superharmonic functions, the Dirichlet problem (the Perron-Wiener-Brelot method, Brelot's resolutivity theorem), outer capacity, polar sets, thinness, fine limits, extremization, réduite, balayage, boundaries in potential theory, Brelot harmonic spaces etc. Textbooks and monographs: *Eléments de la théorie classique du potentiel*, CDU, Paris, 1959, 1961, 1965, 1969,. . . ; *Lectures on potential theory*, Tata Institute, Bombay, 1960, 1967; *Axiomatique des functions harmoniques*, Université Montréal, 1965, 1969; *On topologies and boundaries in potential theory*, Springer-Verlag, Berlin, 1971.

Lukeš J.: *Regular and Choquet's points*

1970/71

Reprints and other materials received in Stresa were of great help. A manuscript of the book of Corneliu Constantinescu and Aurel Cornea *Potential Theory on Harmonic Spaces* reached Prague. Visits of scientists from the West to Czechoslovakia became very difficult.

Netuka I.: *The Choquet boundary*
Bauer's minimum principle

Král J.: *Potential theory on harmonic spaces*

Lukeš J.: *Compactifications of harmonic spaces*
Ideal boundaries and compactifications

1971/72

Král J.: *Potential theory on harmonic spaces (continuation)*

Veselý J.: *On the basis axiom for the heat equation*

Dont M.: *Preiss' example on harmonic sheaves*

1972/73

Dont M.: *Removable singularities of the wave equation*

Král J.: *Removable singularities and anisotropic measures*
On removable singularities for solutions of PDE's

Netuka I.: *Hadamard's three circle theorem*
On tusk-criterion for the heat equation

1973/74

Netuka I.: *Classical and modern potential theory*

Lukeš J.: *A general minimum principle*

Matyska J.: *Approximation properties of measures generated by continuous set functions*

1974/75

Possibilities for visits of foreign speakers, namely from countries from Central and East Europe started to improve. Remark that meetings of seminar moved to the other building of the Faculty of Mathematics and Physics at Sokolovská 83.

Anger G. (University of Halle, Germany):
Inverse problems of potential theory

Netuka I.: *Harnack's metric*
Mean values of subharmonic functions

Lukeš J.: *Topologies and boundaries in potential theory*

Veselý J.: *Approximate solutions of integral equations*

1975/76

Anger G. (University of Halle, Germany):
New results in inverse problems

Dümmel S. (University of Karl-Marx-Stadt, Germany):
Inverse Probleme der Potentialtheorie

Dont M.: *Capacity as a sublinear functional*
Heat potentials and adjoint potentials

Fuka J.: *Analytic capacity and linear measure*

Jůza M.: *On a Hilbert problem*
On dyadic Hausdorff measures

Netuka I.: *On the Brelot-Keldysh theorem and the Wiener type solution in potential theory*
Approximation of capacities by measures

Král J.: *Domination principle*
On continuity principle in potential theory

Čermáková-Pokorná E.: *Harmonic functions on convex sets*

Lukeš J.: *On the Brelot-Keldysh theorem*

1976/77

Among those who came to Prague on the occasion of an international conference on differential equations Equadiff 4 there were colleagues with similar interests in potential theory. Let us mention those with whom we had closer contacts: G. Anger, J. Chabrowski, S. Dümmel, W. Hansen, O. A. Ladyzhenskaja and B.-W. Schulze.

Kondratjev V. A. (Moscow State University, USSR):
Elliptic equations
Integral representations of positive solutions of PDE's

Kleinman R. E. (University of Delaware, USA):
Low frequency iterative solution of integral equations in electromagnetic scattering

Havin V. P. (University of Leningrad, USSR):
On the Cauchy integral

V. P. Havin

Victor P. Havin (1933) Studied mathematics at University of Leningrad (now St. Petersburg). He finished his study in 1955 and continued graduate study under L. V. Kantorovich who led also at the time with G. M. Fichtenholz a seminar on analysis. V. P. Havin worked in complex analysis, harmonic analysis, potential theory and approximation theory. He was appointed a professor of mathematics at the same University in 1971; now he is there a Head of Department of Analysis. He was a supervisor of twenty five Ph.D. students, eight of them got the highest Russian scientific degree D.Sc. Received honorary degree from Linköping University and awarded Onsager Professorship in Trondheim. He is the author of many important results; he published a series of articles on nonlinear potential theory (with V. G. Maz'ya) and initiated this direction of research. He wrote several books: *Foundations of Mathematical Analysis*, LGU, Leningrad, 1989, or (with B. Jöricke) *The uncertainty principle in harmonic analysis*, Springer-Verlag, 1994. As a visiting professor he lectured extensively at many universities. He is an excellent teacher and for a long time a leading personality of Russian mathematics.

Dont M.: *Gleason parts and Harnack's metric*

Fuka J.: *On rational approximation and analytic capacity*
On sets of zero analytic capacity
On analytic capacity

Král J.: *Vitushkin's example*

Lukeš J.: *On the fine topology*

Veselý J.: *On the Dirichlet problem*

Čermáková-Pokorná E.: *Insertion of regular sets*

Mrzena S.: *Continuity of the heat potentials*

1977/78

In this year there was a celebration of the 25th anniversary of the foundation of the Faculty of Mathematics and Physics of Charles University. Among other guests, Gh. Bucur and A. Cornea visited Prague.

Wendland W. (Technical University Darmstadt, Germany):
An integral equation method for mixed boundary value problems in potential theory

Martensen E. (University of Karlsruhe, Germany):
The vector integral operator in potential theory

Jůza M.: *On k-dimensional measures in m-dimensional spaces*

Král J.: *Neumann's method of the arithmetic mean*

1978/79

Malý J.: *Cluster sets of harmonic measures*

1979/80

During the academic year B. Kawohl came to Prague to work with J. Nečas and the close contact with our group started.

Fuglede B. (University of Copenhagen, Denmark):
The fine topology in classical potential theory

B. Fuglede

Bent Fuglede (1925). Studied mathematics and physics in Copenhagen. Among his teachers were Harald Bohr and Børge Jessen. Visited United States 1949–51 (Stanford University and Institute for Advanced Study). Member of Academies of Science in Denmark, Finland, and Bavaria. B. Fuglede began his research with operators in Hilbert space and von Neumann algebras. Then he studied the role of Beurling's concept of extremal length in functional completion (Habilitation 1960). This led him to potential theory (Riesz potentials and capacity with respect to function kernels).
Since 1970 his main field is fine topology and "fine potential theory" in Brelot harmonic spaces satisfying the axiom of domination. His results were published in *Finely Harmonic Functions*, Springer-Verlag, 1972 and in numerous articles. A particular aspect was the finely holomorphic functions. Other topics were spectral sets, harmonic morphisms, stability in the isoperimetric problem, δ-subharmonic functions, the Dirichlet Laplacian, and others. Since 1997 joint work with J. Eells, leading to the book *Harmonic Maps between Riemannian Polyhedra*, Cambridge, 2001.

Král J.: *Problems on analytic capacity*
Hausdorff measures, Minkowski's content and removable singularities

Malý J.: *On semiregular points*
On thin sets
The fine Dirichlet problem in potential theory

Netuka I.: *Polygonal connectedness of finely open domains*

Veselý J.: *Balayage spaces*
On harmonic polynomials and zero sets of harmonic functions

Dont M.: *Heat potentials in the plane*

1980/81

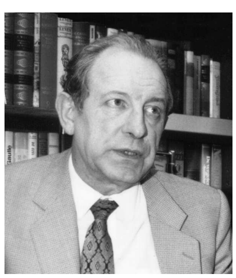
The conference Equadiff 5 organized in Bratislava contained a section devoted to potential theory. Hence we had the pleasure of meeting A. Ancona, J. Bliedtner, W. Wendland, G. Wildenhain. Shortly after the beginning of the school year N. Jacob and I. Laine lectured in Prague.

Bauer H. (University of Erlangen-Nürnberg, Germany):
Korovkin closures

H. Bauer

Heinz Bauer (1928–2002) Studied mathematics in Erlangen and Nancy. Among his teachers were Otto Haupt and Georg Nöbeling. Shortly after finishing his study in Erlangen he spent a year in Paris. He taught in Erlangen, München and Hamburg. Among his more than 35 pupils there were many of those who contributed significantly to the development of mathematics, in particular in potential theory. H. Bauer is a member of several Academies of Sciences and Dr.h.c of several universities, among them also of Charles University, Prague. His field includes functional analysis, Markov processes, measure and integration theory, and he substantially influenced the development of potential theory, especially the theory of harmonic spaces. Several important notions are connected with his name, e.g. Bauer's maximum principle, Bauer's simplex, Bauer's harmonic space. He wrote several textbooks and monographs: *Harmonische Räume und ihre Potentialtheorie*, Springer-Verlag, 1966, *Probability Theory and Elements of Measure Theory*, Holt, Reinehard & Winston Inc., 1972 (1964, 1968 and 1978 in German) or *Maß und Integrationstheorie*, de Gruyter, 1990, 1992 and many works and textbooks of a great importance. For a long time he served as the chief editor of Mathematische Annalen and a member of several editorial boards.

Bertin E. (University of Utrecht, The Netherlands):
Some developments in the theory of Dirichlet spaces



E. Bertin

Emile Bertin (1931–1994) Studied chemistry in Delft and mathematics at the University of Utrecht where he later became professor at the Faculty of Mathematics. His thesis advisors were A. Monna and V. van der Sluis. He published a series of papers in linear and non-linear potential theory: relations to convex functions, potential theory for the Monge-Ampère equation, products of Dirichlet spaces etc. He also worked on unimodal distribution of random variables and on category theory. E. Bertin organized the International Conference on potential Theory, Amersfoort, 1991.

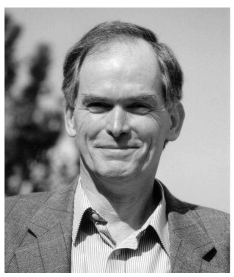
Král J.: *The Wiener measure*

Veselý J.: *Martin boundary and Lipschitz domains*

1981/82

Shortly before Christmas a local meeting *"Harmonic afternoon"* was organized to celebrate the fiftieth birthday of the founder of the Seminar. Talks devoted to his results as well as to other topics of potential theory were held by members of the seminar.

Hansen W. (University of Bielefeld, Germany):
Fine decomposition of Borel sets
Hunt processes and balayage spaces
A probabilistic interpretation of the Dirichlet problem



W. Hansen

Wolfhard Hansen (1940) Studied mathematics in Hamburg and Erlangen. He received the Ph.D. under the direction of Heinz Bauer in 1967. W. Hansen is a specialist in analytic and probabilistic potential theory: semi-groups and Markov processes, harmonic kernels, cohomology and perturbation of harmonic spaces, simplicial cones in potential theory, balayage spaces, approximation by harmonic and superharmonic functions, fine potential theory, the Dirichlet problem, potential theory for the Schrödinger equation, harmonic functions and the restricted mean value property etc. He published with Jürgen Bliedtner the book *Potential Theory, An Analytic and Probabilistic Approach to Balayage*, Springer-Verlag, 1986, and solved several difficult problems posed by outstanding mathematicians.

Laine I. (University of Joensuu, Finland):
Harmonic morphisms and exceptional sets

I. Laine

Ilpo Laine (1942) Studied mathematics and related fields in Helsinki. His thesis advisor was Lauri Myrberg. He is a member of the Finnish Academy of Sciences and Letters. He has published papers in Riemann surfaces, axiomatic potential theory and in complex differential and functional equations, including a monograph *Nevanlinna theory and complex differential equations*, de Gruyter, 1993. He has organized several international conferences in the field of complex analysis, including the 16. Rolf Nevanlinna Colloquium in Joensuu, 1995, to celebrate the centenary of Rolf Nevanlinna's birth. He is the Dean of the Faculty of Sciences of the University of Joensuu.

Kleinman R. E. (University of Delaware, USA):
Modified Green's functions for the Helmholtz equation

Dont M.: *Parabolic potential theory*

Král J.: *Holomorphy in infinite dimension*
The Wiener measure

Medková-Křivánková D.: *On Ugaheri's maximum principle*

Netuka I.: *Smoothness properties of convex functions*
Harmonic spaces

Veselý J.: *Gauss measures and premeasures*
Parabolic mean value property

Zlonická H.: *Gauss premeasures*

Kučera P.: *Polar sets*

1982/83

Just before the beginning of the school year, M. Ohtsuka visited Prague. No lecture was organized but discussions with him were very interesting. For a rather short visit came also W. Fleming.

The winter term was influenced by the preparation of the Winter School *"Probabilistic Aspects of Potential Theory"* which took place in Mariánská, West Bohemia. The main speaker was J. Bliedtner. The school mostly attended by students was well received and thus a new tradition was founded.

Mattila P. (University of Helsinki, Finland):
Measures and projections

Bauer H. (University of Erlangen-Nürnberg, Germany):
Elliptic differential operators and diffusion processes
Approximation and convexity

Krutina M.: *Elements of the theory of stochastic processes*

Štěpán J.: *Probability and potential theory*

Malý J.: *Abstract fine topology*

Netuka I.: *The Shilov boundary*
Semicontinuity of spectrum in Banach algebras

1983/84

Winter Schools on various aspects of analysis were organized for a long time. They were mostly devoted to topology and functional analysis. The main organizer was Z. Frolík. A section on potential theory was included and thus E. Bertin, Gh. Bucur, H. Leutwiler, E. Riemann, U. Steiner and L. Stoica came in January to Srní, South Bohemia. For a very short visit came also H. Bauer.

Later this year the Winter School *"Harmonic Analysis and Potential Theory"* took place again in Mariánská. The main speaker was Ch. Berg who held the course. Also a lecture of S. Gindikin on harmonic analysis was included.

Wildenhain G. (University of Rostock, Germany):
Uniform approximation by solutions of elliptic BVP's

Wittmann R. (University of Eichstätt, Germany):
The Kac potential theory

Lukeš J.: *Fine topology methods*

Netuka I.: *The best harmonic approximation*

Tichý H.: *Generalized transfinite diameter*

Král J.: *Harmonic variation and Fourier series*

Veselý J.: *Riesz potentials*

1984/85

The conference Equadiff 6 was organized in Brno. Among other guests there were L.-I. Hedberg, B. Kawohl, O. Kounchev, E. Martensen, V. G. Maz'ya, B.-W. Schulze.

After the conference, V. G. Maz'ya delivered a lecture in Prague.

The main speaker of the Spring School for students *"Non-standard Analysis and Potential Theory"* organized at Lipno, South Bohemia, was P. Loeb.

Wittmann R. (University of Eichstätt, Germany):
Continuity principle for potentials of signed measures

Kondratjev V. A. (Moscow State University, USSR):
Qualitative properties of elliptic equations of divergent type

Burckel R. B. (Kansas State University, USA):
Some applications of function theory to Banach algebras
Proof of the Littlewood conjecture
Recent elegant proofs of Bishop's Stone-Weierstrass theorem

Kaczmarski J. (University of Łódź, Poland):
On univalent analytic functions

Král J.: *Basic principles and kernels in potential theory*
Wittman's theorem on continuity of potentials of signed measures

Mrázek J.: *Capacity and contraction*

Malý J.: *The Dirichlet problem in H-cones*

Netuka I.: *On gravitational field of a homogeneous body*
Potato Kugel

1985/86

During the school year M. Essén lectured at the Winter School in Srní. Another guest of Prague during the time was R. Kleinman. The Spring School *"Regularity of weak solutions of PDE's"* was held in Teplýšovice near Prague. The main speakers were M. Giaquinta, E. Giusti and G. Modica.

Smyrnélis E. (University of Ioannina, Greece):
Représentation intégrale pour les espaces biharmoniques
Capacity and capacitability

Brzezina M.: *Regular and Choquet's points for the heat equation*

Strnad M.: *The Riemann-Stieltjes integral*

1986/87

Sessions of the seminar were very much affected by the preparation of the International Conference on Potential Theory (ICPT 87) which took place in July in Prague. It was attended by 116 participants from 26 countries. Two volumes of the Proceedings were published by Springer-Verlag and Plenum.

Medková-Křivánková D.: *Invariance of the Fredholm radius*

Sourada M.: *A new criterion of Dirichlet regularity*

Grubhoffer J.: *Sequences of potentials*

Chlebík M.: *Removable singularities for the wave equation*

1987/88

Gruber P. (Technical University Wien, Austria):
Recent results in convexity


P. M. Gruber

Peter M. Gruber (1941) Studied mathematics at the University of Wien and Kansas. The first period of his research activity was devoted to geometric number theory. For almost three decades his main interest lies in geometric convexity where he became to be one of the leading personalities in the field. In particular, he proved a series of results on typical convex bodies (in the sense of Baire's categories), important contributions concern approximation and stability questions. Since his Ph.D. in 1966, he worked at the Technical University, Wien, with the exception of the period 1971–1976 (University of Linz). In 1976 he was appointed the head of the Department of Mathematical Analysis. P. Gruber is the co-author (or a co-Editor) of the following books: *Geometry of Numbers*, North-Holland, 1987; *Lattice points*, Longman Scientific, 1989; *Convexity and Its Applications*, Birkhäuser, 1987; *E. Hlawka, Selecta*, Springer-Verlag, 1991; *Handbook of Convex Geometry A,B*, North-Holland, 1993.

Bliedtner J. (University of Frankfurt, Germany):
Limit theorems in analysis and probability theory


J. Bliedtner

Jürgen Bliedtner (1941) Studied mathematics at Hamburg and Erlangen where finished his studies at 1968. Professor from 1973 at Bielefeld and from 1977 at Frankfurt a/M. Spent a long time at various foreign universities. His interests include boundary behaviour of harmonic functions, compactifications and applications of general potential theory to the study of hypoelliptic operators. He obtained many deep results about simpliciality, balayage spaces (with W. Hansen) and together with him published the book *Potential Theory, An Analytic and Probabilistic Approach to Balayage*, Springer-Verlag, 1986.

Roach G. F. (University of Strathclyde, Great Britain):
Some aspects of scattering theory in nonhomogeneous media

Bertin E. (University of Utrecht, The Netherlands):
Convex potential theory

Král J.: *Removable singularities for the wave equation*

1988/89

Another potential theoretical event happened in Prague. H. Bauer, the guest of the seminar, delivered the lecture *"Heat balls and Fulks measures"* at Mathematical Colloquium organized by J. Nešetřil.

Kawohl B. (University of Erlangen-Nürnberg, Germany):
Solutions to $\operatorname{div}(|\nabla u|^{p-2}\nabla u) = -1$

Browder W. (Princeton University, USA):
Minimal mass, energy and cobordism

Král J.: *Potentials of general kernels*
The Neumann operator in potential theory

Fuka J.: *Lavrentjev domains*

Veselý J.: *Boundary Harnack principle*

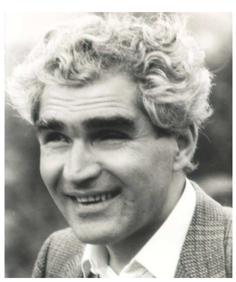
1989/90

After a break of two years, the Spring School *"Nonlinear Potential Theory"* with T. Kilpeläinen, O. Martio and Yu. Reshetnyak was organized. It took place at Paseky, North Bohemia. Also G. F. Roach visited Prague this year. Among participants of the Spring School there were E. Bertin and I. Laine.

The conference Equadiff 7 was organized in August 1989 in Prague. Among many guests some potential theorists and other friends came to Prague: M. Essén, W. Hansen, E. Haouala, N. Jacob, T. Kilpeläinen, E. Martensen, P. Mattila, H. Wallin, W. Wendland. In the time of political changes in November 1989, H. Bauer came to Prague to deliver a series of lectures. His lecture scheduled for 20th November as well as other lectures were cancelled. H. Bauer stayed in Prague and followed the events.

Jacob N. (University of Erlangen-Nürnberg, Germany):
Potential theory for the Kolmogorov equation

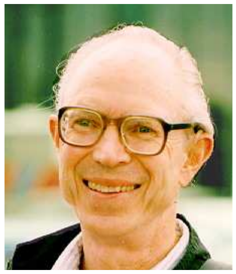
Cornea A. (University of Eichstätt, Germany):
An evaluation of harmonic measure



A. Cornea

Aurel Cornea (1933–2005) Studied mathematics in Bucharest. He finished his study in 1956 and then he worked at several Romanian research institutes. He spent some time as a visiting professor in Paris, Erlangen and Montréal. After leaving Romania in 1978 he worked for two years in Frankfurt a/M. and then he was appointed a professor of mathematics at Katolische Universität in Eichstätt. His research fields include Riemann surfaces, ideal boundaries, axiomatic potential theory, convexity and Choquet's theory. Together with C. Constantinescu he wrote monographs *Ideale Ränder Riemannscher Flächen*, Springer-Verlag, 1963 and *Potential theory on harmonic spaces*, Springer-Verlag, 1972. He is a coauthor of another two books. He obtained many deep results despite of the fact that at the age of 15 he lost by an accident his eyesight.

Phelps R. R. (University of Washington, USA):
Extremal integral representation in noncompact convex sets


R. R. Phelps

Robert R. Phelps (1926) Studied mathematics at University of California, LA. He finished his studies there in 1954 and received Ph.D. from University of Washington in 1958. For a year he worked at the Institute of Advanced Study in Princeton, N.J. as Assistant to Hassler Whitney. Most of his professional career is connected with University of Washington where he was a professor for 26 years, since 1996 he is Professor Emeritus there. He worked in convexity, theory of approximation and functional analysis.
He is the author of well-known *Lectures on Choquet's Theorem*, Van Nostrand, Princeton, 1966 and *Convex functions, monotone operators and differentiability*, Springer-Verlag, Berlin, 1989, 1993.

Pfeffer W. F. (University of California at Davies, USA):
The Gauss-Green theorem

Bauer H. (University of Erlangen-Nürnberg, Germany):
From Weierstrass approximation to the classical means of analysis

Král J.: *On the Poisson-Riemann integral*

Pyrih P.: *Finely holomorphic functions*

Lukeš J.: *Linear extendors*

Veselý J.: *Gradient estimates of the Newtonian potential*

Brzezina M.: *Parabolic thinness*

Fuka J.: *Quasiconformal mappings*

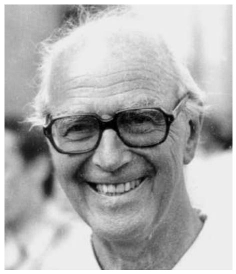
1990/91

The Spring School *"Dirichlet Forms"* with M. Röckner was organized again in Paseky. Mainly thanks to the effort of J. Lukeš and several younger colleagues, Paseky became the stable place for further schools for students.

G. Choquet visited Prague as a guest of the seminar and delivered the lecture *"Determinism and chaos"* at the Mathematical Colloquium organized by J. Nešetřil. He also discussed various topics with students within a meeting organized in collaboration with the Department of Mathematical Analysis.

Björn A. (University of Linköping, Sweden):
Removable singularities of H^p-spaces in plane domains

Choquet G. (University of Paris VI and XI, France):
Mathematics and teaching of mathematics: personal opinion



G. Choquet

Gustave Choquet (1915–2006) One of the most prominent analysts of the second half of the 20th century. Studied mathematics at Ecole Normale Supérieure until 1937 and then in Princeton. Since 1950 he was a professor at Université Paris VI, Université Paris XI, and École Polytechnique. Since 1976 he is a member of the French Academie des Sciences. He worked in real analysis, topology, potential theory, on integral representation theory (Choquet's theory) and also on the theory of capacities. His work was stimulating for many other mathematicians. He is the author of *Topology*, Academic Press, New York, 1966, and *Lectures on Analysis*, N. A. Benjamin, INC., 1969. Among many other honours: Chevalier de la Légion d'Honneur.

Latvala V. R. J. (University of Joensuu, Finland):
Fine topology and non-linear potential theory

Výborný R. (University of Queensland, Australia):
Hadamard three circle theorem and elliptic equations

Scheffold E. (Technical University Darmstadt, Germany):
On Reynolds' operators

Hmissi M. (University of Tunis, Tunisia):
La représentation par les lois de sorties

Gilkey P. B. (University of Oregon, USA):
Spherical harmonics and Ikeda's example

Malý J.: *Non-linear potentials*

Dont M.: *Parabolic potentials*

Netuka I.: *On balayage of measures*
Regularizing sets of irregular points
Balayage in harmonic spaces

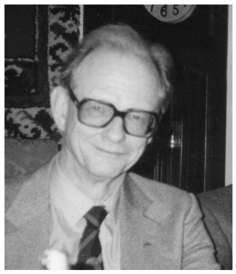
1991/92

After many years spent in East Lansing, J. Mařík lectured again in Prague. This was the first and the only lecture he presented at Charles University after 1969.

The Spring School *"Small and Exceptional Sets in Analysis and Potential Theory"* took place in Paseky. The main speakers were L.-I. Hedberg, J. Král and L. Zajíček. The second *"Harmonic afternoon"* was organized on the occasion of J. Král's 60th birthday.

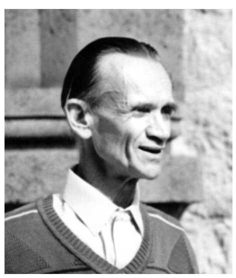
Väisäla J. (University of Helsinki, Finland):
Quasiconformality and its development

Essén M. (University of Uppsala, Sweden):
Aikawa's work on quasiadditivity of Riesz potentials


M. Essén

Matts Essén (1932–2003) studied mathematics at Uppsala University and defended his thesis in 1963 under Y. Domar. From 1965 to 1981, he worked at the Royal Institute of Technology in Stockholm where he was in contact with Bo Kjellberg and through him with M. Heins. After 1981, he has been back at Uppsala University. He spent the academic years 1967–68, 1972–73 and 1977–78 at different universities in the US. His fields include complex analysis (growth problems for entire and meromorphic functions), harmonic analysis (best constants in inequalities for conjugate functions, Q_p-spaces), potential theory and semilinear elliptic partial differential equations. He has published two sets of Lecture Notes: *The* $\cos \pi\lambda$ *theorem*, Springer-Verlag, 1975 and jointly with H. Aikawa *Potential Theory—Selected Topics*, Springer-Verlag, 1996.
He was chairman of the organizing committee for the activities at Institut Mittag-Leffler during the academic year 1999–2000 on *Potential Theory and Non-linear Partial Differential Equations.*

Mařík J. (Michigan State University, USA):
Products of derivatives


J. Mařík

Jan Mařík (1920–1994) Studied mathematics at Charles University where he later became a professor. He was a teacher of Miroslav Dont, Josef Král, Jaroslav Lukeš, Ivan Netuka and Jiří Veselý. In fact, J. Mařík initiated an inclusion of a lecture from potential theory for the mathematical analysis students curriculum. His main interest of research was mathematical analysis, in particular real functions, measure and integration. The most quoted of his results concerns the extendibility of Baire measure to a Borel measure. His original approach to the Gauss-Green theorem from 1956 unfortunately attracted less attention than it would deserve. In 1969, J. Mařík left Czechoslovakia and lived in the U.S.A. He became a professor at the Michigan State University, East Lansing. From this period, mainly results on the algebra generated by derivatives should be mentioned.

Jacob N. (University of Erlangen-Nürnberg, Germany):
On potential theory for Hörmander type operators

Murazawa T. (Kyoto Prefectural University, Japan):
On the representation of a potential on balayage spaces

Netuka I.: *Capacity and contractions*
The existence of a fundamental solution of PDE's with constant coefficients
Boundary point method

Brzezina M.: *On capacities associated to kernels*
On continuous capacities

Veselý J.: *On the restricted mean value property*

1992/93

The Spring School *"Fine Regularity of Solutions of Elliptic PDE's"* with J. Malý and W. Ziemer was organized in Paseky. In August 1993, Summer School *„Banach spaces, Related Areas and Applications"* was held in Prague and Paseky. Among the main speakers were G. Choquet and R. R. Phelps.

Zalcman L. (Bar-Ilan University, Israel):
Morera's theorem: 100 years after
Normal families revisited

O'Farrell A. G. (Maynooth College, Ireland):
Tangent stars: a new tool for extension problems and geometry

Martensen E. (University of Karlsruhe, Germany):
On the characterization of circle and sphere by constant equilibrium distributions: the Gruber conjecture

Kottas J.: *Removable singularities of solutions of elliptic systems*

Fuka J.: *Extreme points in spaces of schlicht holomorphic mappings*
Classes of holomorphic functions with positive real part

Žitný K. & Zolotarev I.: *The Dixon-Loeb proof of the Cauchy theorem*

Medková D.: *Convergence of the Neumann series*

Netuka I.: *Inverse mean value property of harmonic functions*

Brzezina M.: *On Riesz capacities*

1993/94

During holidays after this school year the International Conference on Potential Theory (ICPT 94) was organized in the Czech Republic. It took place in Kouty in August 1994. The conference was attended by 73 participants from 18 countries. The Proceedings were published by Walter de Gruyter.

The Spring School *"Harmonic Analysis Techniques for PDE's in Lipschitz Domains"* with C. Kenig took place, traditionally, in Paseky.

Bendikov A. (University of Erlangen-Nürnberg, Germany):
Heat kernel estimates and eigenvalues of elliptic operators on the infinite dimensional torus

Mantič V. (Technical University Košice, Slovak Republic):
Boundary integral equations and direct method of boundary elements

1994/95

This year as well as in the following years Spring Schools for students were regularly held in Paseky; see p. 40.

Pfeffer W. F. (University of California at Davies, USA):
A non-absolutely convergent integral

Hansen W. (University of Bielefeld, Germany):
Restricted mean value property and harmonic functions

Jakubowski Z. (University of Łódź, Poland):
Selected topics in geometric function theory

Cator E. (University of Utrecht, The Netherlands):
Convex potential theory

Tøpsoe F. (University of Copenhagen, Denmark):
Basic aspects of the Suslin operation

Hoh W. (University of Erlangen-Nürnberg, Germany):
The martingale problem for pseudodifferential operators

Ramaswamy S. (University of Bangalore, India):
Comparison of viscosity subsolutions and L-subharmonic functions

Bauer H. (University of Erlangen-Nürnberg, Germany):
The vague Borel σ-algebra on the space of Radon measures on a locally compact space with countable base

Leutwiler H. (University of Erlangen-Nürnberg, Germany):
On modified quaternionic analysis in $\mathbb{R}^3$

Weil C. E. (Michigan State University, USA):
Extensions of higher order derivatives
Multipliers for spaces of derivatives

Bulirsch R. (Technical University München, Germany):
Scientific computing as a technical tool

Brzezina M.: *Harmonic morphisms for the Kolmogorov equation*

Medková D.: *Double layer potential for polyhedral domains*
The Neumann problem for the Laplace equation on domains with piecewise smooth boundary

Syrovátková J.: *Prevalence in infinite dimensional spaces*

Ranošová J.: *Sets of determination for parabolic functions on a slab*

1995/96

On 13th November participants of the Seminar organized a meeting to commemorate the 75th birthday of the late J. Mařík.

Kargajev E. (University of St. Petersburg, Russia):
Conformal mappings on the "comb" and analytic capacity
The examples of nonclassical weighted norm estimates for some Calderon-Zygmund operators in the plane

Heiming H. (University of Konstanz, Germany):
Composition operators on Hardy spaces and Carleson measures

Hansen W. (University of Bielefeld, Germany):
Some remarks on coupling of balayage spaces

Altomare F. (University of Bari, Italy):
On some degenerate differential operators on weighted function spaces

F. Altomare

Francesco Altomare (1951) Studied mathematics in Bari. Among his teachers were Giovanni Aquaro and Giuseppe Muni. He was appointed professor of Mathematical Analysis at the University of Basilicata (Potenza) in 1987 and since 1990 he has held a professorship at the University of Bari where he is currently employed. From 1999 he is Coordinator of the Ph.D. School in Mathematics of the University of Bari. The main areas of scientific interests of Francesco Altomare are functional analysis, operator theory and approximation theory. He is a co-author (with M. Campiti) of a monograph *Korovkin-type Approximation Theory and its Applications*, de Gruyter, 1994. Among others he wrote papers on Choquet representation theory, function spaces and algebras, semigroups of positive operators, degenerate diffusion equations and Markov processes. Some time he spent in Paris (1980, 1981), Tübingen (1983) and Münster (1985). He co-organized four editions of *Proceedings of the International Conference on Functional Analysis and Approximation Theory.*

Cornea A. (University of Eichstätt, Germany):
Application of controlled convergence in analysis

Gruber P. (Technical University Wien, Austria):
Recent results on polytope approximation of convex bodies

Korevaar J. (University of Amsterdam, The Netherlands):
Approximation of equilibrium distributions by distributions of equal point charges

Pinchuk B. (Bar-Ilan University, Israel):
Configurations of minimal harmonic measure

Douady A. (University of Paris XI – Orsay, France):
Mandelbrot's sets and Julia's sets

Seghier A. (University of Paris XI – Orsay, France):
From fractals to wavelets: a bridge between two recent theories

Pyrih P.: *A counterexample to A. Cornea's conjecture*

Ranošová J.: *Sets of determination for the heat equation*

Kolář J.: *Selection theorems: applications*

Medková D.: *Essential spectral radius and equivalent norms*

Štěpničková L.: *Pointwise and uniform convergence of holomorphic functions*

1996/97

On 29th and 30th November, a Workshop on Potential Theory was organized to commemorate 65th birthday of Josef Král.

Armitage D. (University of Belfast, Great Britain):
Characterization of best harmonic L^1-approximants

Bliedtner J. (University of Frankfurt, Germany):
Compactifications of Martin-type

Boboc N. (University of Bucharest, Romania):
Perturbations of Dirichlet spaces

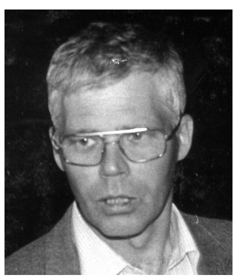
N. Boboc

Nicu Boboc (1933) is one of the leading personalities of Romanian school of potential theory. He graduated from the Faculty of Mathematics, University of Bucharest in 1955 and completed his Ph.D. in 1961. N. Boboc contributed to complex functions theory, theory of Riemann surfaces, partial differential equations, functional analysis (mainly the Choquet theory of convex cones) and, in particular, to potential theory (harmonic spaces, H-cones, Markov processes, Dirichlet spaces). He is the autor of two textbooks and the coauthor of five monographs, e.g. *Convex cones of continuous functions on compact spaces* (Romanian), *Measure and capacity* (Romanian), *Espaces harmoniques asociées aux operateurs differentiels lineaires du second ordre de type elliptique.* During the period 1955–2001, he published 120 papers, a large part of them devoted to abstract potential theory. N. Boboc is co-founder of the theory of H-cones which has been developed by Romanian school since seventies; see *Order and convexity in potential theory: H-cones*, written jointly with Gh. Bucur and A. Cornea.

Essén M. (University of Uppsala, Sweden):
Best constant inequalities for conjugate functions
Identity theorems for superharmonic functions and for functions of bounded characteristic

Hansen W. (University of Bielefeld, Germany):
Perturbation of Schrödinger operators

Martio O. (University of Helsinki, Finland):
Potential theory on a metric space



O. Martio

Olli Martio (1941) studied mathematics at the University of Helsinki and obtained the Ph.D. degree in 1967. He was appointed an associate professor at the same university in 1972 and a professor at the University of Jyväskylä in 1980. Since 1993 he has worked at the University of Helsinki and he is now the head of the Department of Mathematics. His main research areas are quasiconformal and quasiregular mappings and nonlinear PDE's together with the associated potential theory. He has supervised 13 Ph.D. students and received honorary degrees from the Linköping, Volgograd and Jyväskylä Universities. He is a coauthor of the monograph *Nonlinear Potential Theory of Degenerated Elliptic Equations*, Clarendon Press and Oxford University Press, New York, 1993. He has been an editor of the Mathematica Scandinavica and the Acta Mathematica and he is currently the managing editor of the Ann. Acad. Sci. Fenn. Math.

Wendland W. (University of Stuttgart, Germany):
Commutator properties for periodic splines and applications to boundary integral equations

Jacob N. (University of Erlangen-Nürnberg, Germany):
Dirichlet forms

Cator E. (University of Utrecht, The Netherlands):
Laplace operator in Banach spaces

Šimůnková M.: *Harmonic morphisms*

Engliš M.: *Reproducing kernels and harmonic approximation*

Veselý J.: *Mean value property and harmonicity*

Král J.: *Potential-theoretic proof of Picard's theorem*

Medková D.: *Boundary value problems and integral equations method*

Netuka I.: *An elementary proof of Brouwer's theorem*

Kolář J.: *Hyperharmonicity without semicontinuity*

Ranošová J.: *Fatou's theorem*

Lávička R.: *Limit points of arithmetic means of sequences in* $\mathbb{R}^n$

Dont M.: *Reflection and boundary value problems*

1997/98

Hansen W. (University of Bielefeld, Germany):
Harnack inequalities for Schrödinger operators
The Schrödinger equation: an introduction
Liouville's theorem and the restricted mean value property

Boukricha A. (University of Tunis, Tunisia):
Potential theory for nonlinear harmonic spaces

Zorich V. (Moscow State University, Russia):
Asymptotic geometry and conformal type of Riemannian manifolds

Gruber P. (Technical University Wien, Austria):
Relations of convexity to other areas of mathematics and their implications for convex geometry

Houzel Ch. (University of Paris VII, France):
The beginnings of the differential and integral calculus (from Newton and Leibniz to Euler)

Tøpsoe F. (University of Copenhagen, Denmark):
Measure theory: trends which assisted research yesterday and will change teaching tomorow

Malý J.: *Sobolev spaces on metric spaces*

Lávička R.: *Limit points of arithmetic means of sequences in Banach spaces*
The Lévy-Steinitz theorem

Veselý J.: *Polygonal mean value properties*

Brzezina M.: *Fundamental function of distance*

Štěpničková L.: *Pointwise and locally uniform convergence of harmonic functions*

1998/99

A Harmonic Afternoon was organized on May, 30.

Metz V. (University of Bielefeld, Germany):
Laplacian on fractal sets

Bliedtner J. (University of Frankfurt, Germany):
The condensor problem

Janssen K. (University of Düsseldorf, Germany):
On the integral representation of excessive measures and functions

Hansen W. (University of Bielefeld, Germany):
Restricted mean value property and harmonic functions

Namioka I. I. (University of Washington, Seatle, USA):
Survey on fixed point theorems

Heiming H. (University of Konstanz, Germany):
Representation of continuous fields of closed subspaces in the gap topology

Netuka I.: *An extension theorem for content defined on compact sets*
The Lebesgue measure: various approaches

Medková D.: *Essential norm of integral operators in potential theory*

Kolář J.: *Extension operators and the density topology*

Veselý J.: *Aspects of classical and modern potential theory*
On a characterization of derivatives

Šimůnková M.: *Kelvin type transformations for the Weinstein equation*

Pyrih P.: *Sun and circle topologies in the plane*

Brzezina M.: *Remarks on gamma function*

Ranošová J.: *Fatou type theorems*

1999/2000

O'Farrell A. (National University of Ireland, Maynooth, Ireland):
Algebras of smooth functions

Beznea L. (University of Bucharest, Romania):
H-cones techniques in potential theory

Netuka I.: *Cornea's approach to the Dirichlet problem*
Separation properties involving harmonic functions
Examples of integral representation for holomorphic functions

Malý J.: *Comparison of various approaches to solving the Dirichlet problem; the notion of quasi-solution*

Spurný J.: *The Dirichlet problem on the Choquet boundary for Baire class one functions*

Lávička R.: *Maximal operator and superharmonicity*

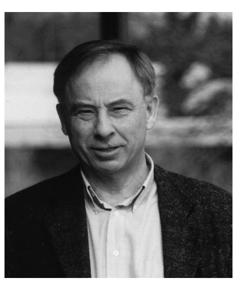
Krbec M.: *Maximal operators and function spaces*

Lukeš J.: *Borel theorem on infinitely differentiable functions*

Zajíček L.: *Null-sets of Lindenstrauss and Preiss: differentiation of Lipschitz mappings*

2000/01

Hedberg L.-I. (University of Linköping, Sweden):
Non-linear eigenvalues and stability of Sobolev spaces



L.-I. Hedberg

Lars Inge Hedberg (1935–2006) Studied mathematics and physics at Uppsala University, Sweden. He became a Ph.D. there in 1965 with Lennart Carleson as his thesis adviser. After appointments at the universities of Uppsala and Stockholm he became a professor at Linköping University in 1984. He has held visiting appointments at the Massachusetts Institute of Technology, the University of Michigan, Indiana University, Université de Nancy, and other universities. His field of research is harmonic analysis, real and complex analysis, and potential theory. He is the author (with David R. Adams) of the book *Function Spaces and Potential Theory*, Springer-Verlag, 1996, 1999.

Loeb P. (University of Illinois, Urbana, USA):
Integration using Riemann-type integrals
The base operator in analysis and the topologies it generate

Netuka I.: *The Krein-Milman theorem in inner product spaces*
On the Choquet integral representation theorem

Žitný K., Zolotarev I.: *The Lebesgue integral à la M. H. Stone*

Lávička R.: *Jensen measures and harmonic measures*

Malý J.: *On a proof of Stokes' theorem*

Brzezina M.: *Volume means for the heat equation*

Spurný J.: *On subclasses of B_1-functions*

Smrčka M.: *Uniform limits of B_1-affine functions*

Veselý J.: *On abstract boundaries and sturdy harmonic functions*

2001/02

Sturm K.-T. (University of Bonn, Germany):
A semigroup approach to harmonic maps into metric spaces

Aizenberg L. (Bar-Ilan University, Israel):
Multidimensional analogues of Bohr's theorem on power series

Netuka I.: *A proof of the Liapounoff convexity theorem*

Malý J.: *Characterization of gradient by means of the Poincaré inequality*

Spurný J.: *Preservation of Borel classes by perfect mappings*

Pick L.: *Good and bad measures*

Lukeš J.: *Zabrejko's lemma and pillars of functional analysis*

Dont M.: *A conjugate holomorphic functions problem*

Veselý J.: *On Riemann's summability method*

Lávička R.: *Concentration of measure and the isoperimetric inequality on spheres in Euclidean spaces: Brunn-Minkowski's inequality*

2002/03

Cornea A. (University of Eichstätt, Germany):
Solution of the Dirichlet problem on Riemannian manifolds on the unit sphere in the tangent space

Spurný J.: *Convex and measure convex sets*
Representation of affine functions by means of the state space

Malý J.: *A unified approach to fine topologies*

Netuka I.: *A proof of the Riesz-Herglotz theorem*

Kaspříková E.: *Harmonic functions on a strip*

Brzezina M.: *A characterization of heat balls*

2003/04

Miyamoto I. and Yoshida H. (Chiba University, Japan):
Quantitative properties of minimally thin sets and rarified sets at infinity in a cone

Björn A. (University of Linköping, Sweden):
Dominating sets for harmonic functions

Björn J. (University of Linköping, Sweden):
The Poincaré inequality

Björn A. and Björn J. (University of Linköping, Sweden):
The Dirichlet problem for p-harmonic functions

Hansen W. (University of Bielefeld, Germany):
Global comparison of perturbed Green functions

Chill R. (University of Ulm, Germany):
Weak maximum principle and applications

Byrnes J. S. (Prometheus — Inc., Newport, USA):
The uncertainty principle, a different perspective

Netuka I.: *Extreme points of doubly stochastic matrices*

Spurný J.: *The Dirichlet problem for Baire-one functions*
Lattice structure of the space of pointwise limits of harmonic functions

Veselý J.: *Hölder continuity of solutions of the Dirichlet problem*

Žitný K., Zolotarev I.: *Eisenberg-Weyl's inequality and Ballian-Löw's theorem*

Šimůnková M.: *Kelvin transformation*

Honzík P.: *Maximal multiplicators*

Lukeš J., Pokorný D.: *Daugavet operators*

2004/05

Iwaniec T. (Syracuse University, USA):
Null lagrangians, the art of integration by parts

Hansen W. (University of Bielefeld, Germany):
Harmonic functions and the restricted mean value property: some fairly recent results

Malý J.: *Green's theorem*

Medková D.: *On C. Neumann's problem*

Lávička R.: *Quaternionic analysis*
Generalized fine holomorphic functions in dimension 4

Netuka I.: *Extreme points of the convex set of holomorphic functions with positive real part: a functional analytic approach*
Forty years with potential theory: recollections and congratulations (dedicated to W. Hansen, J. Lukeš and J. Veselý)

Smrčka M.: *Oscillating functions in topological spaces*
On Banach indicatrix

Pokorný D.: *Daugavet spaces*

Krejčí D.: *A variant of Phillips' lemma and complement of the space* c_0

Veselý J.: *Banach indicatrix and Fourier series*

Kabrhel M.: *Dual approach to the Poisson kernel*

2005/06

Gardiner S. (University College, Dublin, Ireland):
Potential theory for the farthest point distance function
Surprising facts about holomorphic functions
Minimal harmonic functions associated with an irregular boundary point

Hansen W. (University of Bielefeld, Germany):
Littlewood's one circle problem revisited
Large compact planar sets visible from one direction only
Simple counterexamples to 3G-inequality

Byrnes J. S. (Prometheus — Inc., Newport, USA):
Energy spreading polynomials: application

Lávička R.: *Finely differentiable functions*

Medková D.: *Regularity of solution of the Neumann problem for the Laplace equation*

Pokorný D.: *Daugavet's property of the space* L^p

Spurný J.: *Lazar's selection theorem*
Simplexes and their properties
Weak Dirichlet problem for Baire functions

Bačák M.: *Extremal points and diameter norm*

Žitný K., Zolotarev I.: *On a definition of the Fourier-Plancherel operator*

Netuka I.: *Representation of invariant measures by means of ergodic measures*

2006/07

Byrnes J. S. (Prometheus — Inc., Newport, USA):
More on energy spreading polynomials

Gruber P. (Technische Universität Wien, Austria):
Application of an idea of Voronoi to John type and minimum position problems

Hansen W. (University of Bielefeld, Germany):
The Riesz decomposition of finely harmonic functions
Choquet's theory and applications
Convexity of limits of harmonic functions

Zoriy N. (Ukranian Academy of Science, Kiev, Ukraine):
Necessary and sufficient conditions of the solvability of the Gauss variational problem

Krejčí D.: *On Borsuk-Ulam theorem*
On Ulam-Mazur theorem

Pošta P.: *Rao's proof of the Stone-Weierstrass theorem*

Malý L.: *The Dirichlet problem on ellipsoids*

Bačák M.: *One more proof of the fundamental theorem of algebra*
Local simpliciality in Choquet's theory

Netuka I.: *New proofs of the fundamental theorem of algebra*

Spurný J.: *Isomorphic and isometric properties of the space of harmonic functions*

Veselý J.: *Korovkin's theorem and applications*

Doležal M.: *Peano curves and densifiable sets*

In memory of Josef Král:

Netuka I.: *Recollections of Josef Král*

Veselý J.: *From Banach's indicatrix to cyclic variation*

Netuka I.: *C. Neumann's operator of the arithmetic mean on convex domains*

Medková D.: *Integral equations method for sets with non-smooth boundary*

Lukeš J.: *Spaces with harmonic continuation*

Conferences and schools organized by members of the seminar

The list includes those conferences and schools related to potential theory which were organized in our country by members of the seminar. Names of the main speakers are mentioned in brackets.

Conferences

1987 International Conference on Potential Theory (ICPT 87), Praha

[Ancona A., Boboc N., Chung K. L., Fabes E., Fuglede B., Hansen W., Laine I., Landis E. M., Lyons T., Ohtsuka M., Roach G. F., Wendland W., Wildenhain G.]

There were 116 participants from 26 countries. Two volumes of Proceedings were published, see the part Bibliography.

1994 International Conference on Potential Theory (ICPT 94), Kouty

[Bauer H., Bouleau N., Choquet G., Gardiner S. J., Hansen W., Havin V. P., Malý J., Mattila P., Siciak J., Verchota G. C., Woes W.]

There were 73 participants from 18 countries. Proceedings were published, see the part Bibliography.

1996 Workshop on Potential Theory (65$^{\text{th}}$ birthday of Josef Král)

[Armitage D., Bliedtner J., Boboc N., Essén M., Hansen W., Martio O., Medková D., Wendland W.]

2001 Workshop on Potential Theory (70$^{\text{th}}$ birthday of Josef Král), Praha

[Bliedtner J., Gardiner S., Hansen W., Janssen K., Martio O., Mattila P., Metz V.]

2004 Potential Theory and Related Topics, Hejnice

[Bendikov A., Beznea L., Björn A., Bliedtner J., Boboc N., Brzezina M., Cornea A., Di Biase F., Gardiner S., GowriSankaran K., Hansen W., Janssen K., Lávička R., Leutwiler H., Lukeš J., Málek J., Malý J., Metz V., Mizuta Y., Netuka I., O'Farrell A., Popa E., Popa L., Röckner M., Sturm K.-T., Veselý J.]

Traditional Spring Schools for students

1983 Probabilistic Aspects of Potential Theory, Mariánská [Bliedtner J.]

1984 Harmonic Analysis and Potential Theory, Mariánská [Berg Ch.]

1985 Nonstandard Analysis and Potential Theory, Lipno [Loeb P.]

1986 Regularity of Weak Solutions of PDE's, Teplýšovice [Giaquinta M., Giusti E., Modica G.]

1987 A Development of Riemann-Roach and Atiyah-Singer Theorems, Teplýšovice [Hirzebruch F.]

1989 Korovkin Theorems and Related Topics, Alšovice [Bauer H.] (Cancelled because of the Velvet Revolution)

1990 Nonlinear Potential Theory, Paseky [Kilpeläinen T., Martio O., Reshetnyak Yu.]

1991 Dirichlet Forms, Paseky [Röckner M.]

1992 Small and Exceptional Sets in Analysis and Potential Theory, Paseky [Hedberg L.-I., Král J., Zajíček L.]

Recent Trends in Banach Spaces, [Deville R., Godefroy G., Zizler V.]

Variational Inequalities, [Degiovanni M., Kučera M., Marino A., Quittner P., Schuricht F.]

1993 Fine Regularity of Solutions of Elliptic PDE's, Paseky [Malý J., Ziemer W.]

Banach Spaces, Related Areas and Applications, Praha, Paseky [Choquet G., Hušek M., Negrepontis S., Phelps R. R., Pták V., Troyanski S., Tzafriri L., Zizler V.]

Recent Trends in Banach Spaces, [Haydon R.]

1994 Harmonic Analysis Techniques for PDE's in Lipschitz Domains, Paseky [Kenig C.]

Recent Trends in Banach Spaces, [Tomczak-Jaegermann N., Maurey B., Odel E. W., Schlumprecht T.]

1995 Mathematical Models of Microstructure, Paseky [Müller S.]

Recent Trends in Banach Spaces, [Benyamini Y., Enflo P., Mankiewicz P., Schechtman G.]

1996 Recent Trends in Banach Spaces, [Diestel J., Jarchow H., Aron R.]

1997 Boundaries and Convexity in Banach Spaces, Paseky [Altomare F., Choquet G., Simons S., Zizler V.]

Approximations and Uniqueness Properties of Harmonic Differential Forms, Paseky [Havin V. P.]

1998 Harmonic Approximation and Complex Dynamics, Paseky [Rippon P. J., Gardiner S. J.]

Recent Trends in Banach Spaces, Paseky [Godefroy G., Lindenstrauss J., Orihuela J., Payá R.]

1999 Recent Trends in Banach Spaces, Paseky [Namioka I. I., Kalton N., Fonf V., Castillo J. M. F.]

Function Spaces and Their Applications, Paseky [Appel J., Perez C., Pustylnik E.]

2000 (Non)smooth Analysis in Banach Spaces, Paseky [Ioffe A., Rockafellar T., Loewen P., Deville R.]

Some Recent Techniques in Harmonic Analysis, Paseky [Lomonosov V., Treil S., Lyubarskii Yu., Volberg A.]

2001 Analysis in Banach Spaces, Paseky [Hájek P., Lancien G., Lindenstrauss J., Schechtman G.]

Function Spaces and Interpolation, Paseky [Cianchi A., Cwikel M.]

2003 Variational Analysis, Paseky [Ioffe A., Lewis B., Mordukhovich B. S., Penot J.-P.]

Function Spaces and Applications, Paseky [Hedberg L.-I., Verbitsky I.]

2004 Nonseparable Banach Spaces, Paseky [Argyros S., Godefroy G., Marciszewski W., Orihuela J., Todorcevic S., Troyanski S.]

2005 Function Spaces and Applications, Paseky [Evans W. D., Shvartsman P.]

2006 Variational Analysis and its Applications, Paseky [Rockafellar R. T., Borwein J., Outrata J. V., Roemisch W., Mordukhovich B. S.]

2007 Function Spaces: Inequalities and Interpolation, Paseky [Bennett G., Milman M.]

Conferences and schools attended by members of the seminar

The first part consists of conferences and schools organized abroad, the second part of those organized in Czechoslovakia/Czech Republic. The list, again, is hardly complete.

1969 *Summer School on Potential Theory*, Stresa, Italy
(Lukeš, Netuka, Veselý)

1973 *5. Tagung über Probleme und Methoden der Mathematischen Physik*, Karl Marx Stadt, Germany
(Král, Netuka, Veselý)

1974 *Tagung über die Potentialtheorie*, Oberwolfach, Germany
(Netuka)

1976 *3rd Romanian-Finnish Seminar on Complex Analysis*, Bucharest, Romania
(Lukeš, Netuka)

Wissenschaftliche Haupttagung der Mathematischen Gesellschaft der DDR, Karl-Marx-Stadt, Germany
(Král)

Workshop on Methods of Function Theory and Functional Analysis, Alma-Ata, USSR
(Král)

1977 *Elliptische Differentialgleichungen*, Rostock, Germany
(Král, Netuka)

1978 *Funktionenräume und Funktionenalgebren*, Oberwolfach, Germany
(Netuka)

Die moderne Potentialtheorie als Grundlage der Inversen Problemen in der Geophysik, Freiberg, Germany
(Dont)

1979 *Colloquium on Potential Theory*, Copenhagen, Denmark
(Lukeš, Netuka, Veselý)

1981 *Konvexitätstagung*, Wien, Austria
(Netuka)

1982 *International Workshop on Potential Theory*, Erlangen, Germany
(Král, Lukeš, Netuka, Veselý)

Tagung über die Potentialtheorie, Eichstätt, Germany
(Král, Lukeš, Netuka, Veselý)

Recent Trends in Mathematics, Reinhardsbrunn, Germany
(Veselý)

1983 *International Congress of Mathematicians*, Warszawa, Poland
(Fuka, Král, Lukeš, Netuka, Veselý)

1984 *Tagung über die Potentialtheorie*, Oberwolfach, Germany
(Král, Lukeš, Malý, Netuka, Veselý)

1985 *37th British Mathematical Colloquium*, Cambridge, Great Britain
(Netuka)

1988 *Festkolloquium*, Erlangen, Germany
(Král, Lukeš, Malý, Netuka, Veselý)

Praktische Behandlungen von Integralgleichungen, Randelementmethoden und singulären Gleichungen, Oberwolfach, Germany
(Král)

1989 *6th Romanian-Finish Seminar on Complex Analysis*, Bucharest, Roumania
(Fuka, Král, Malý)

1990 *International Congress of Mathematicians*, Kyoto, Japan
(Lukeš)

International Conference on Potential Theory (ICPT 90), Nagoya, Japan
(Lukeš, Netuka, Veselý)

Summer School on Potential Theory, Joensuu, Finland
(Lukeš, Netuka)

Gemeinsame Arbeitssitzung "Potentialtheorie" Prag-Erlangen, Erlangen, Germany
(Brzezina, Král, Lukeš, Malý, Netuka, Veselý)

14th Rolf Nevanlinna Colloquium, Helsinki, Finland
(Malý)

1991 *International Conference on Potential Theory (ICPT 91)*, Amersfoort, The Netherlands
(Brzezina, Král, Lukeš, Malý, Netuka, Veselý)

Approximation by Solutions of Partial Differential Equations (NATO Workshop), Hantsholm, Denmark
(Netuka)

Continuum Mechanics and Related Problems in Analysis, Tbilisi, USSR
(Král)

1992 *Mathematisches Minikolloquium (ÖMG)*, Wien, Austria
(Netuka)

Colloquium in Honour of B. Fuglede, Copenhagen, Denmark
(Netuka)

Summer School on Banach Spaces, Related Areas and Applications (dedicated to the 100 years of the birth of S. Banach), Spetses, Greece
(Lukeš, Pyrih)

1993 *Classical and Modern Potential Theory and Applications (NATO Workshop)*, Chateau de Bonas, France
(Netuka, Lukeš, Veselý)

1994 *Workshop on Potential Theory: Mean Value Property and Related Topics*, Eichstätt, Germany
(Lukeš, Netuka, Veselý)

Summer School on Functional Analysis in Honour of C. Carathéodory, Spetses, Greece
(Lukeš)

1995 *Analysis Year 1995 in Finland*, Helsinki, Finland
(Král)

30 Jahre Potentialtheorie in Erlangen, Erlangen, Germany
(Brzezina, Král, Lukeš, Malý, Netuka, Veselý)

Workshop on Calculus of Variations, Cortona, Italy
(Malý)

Workshop Praha-Heidelberg, Heidelberg, Germany
(Malý)

1996 *Conference in Mathematical Analysis and Applications*, Linköping, Sweden
(Medková, Netuka, Veselý)

Conference on Analysis, Numerics and Applications of Differential and Integral Equations, Stuttgart, Germany
(Medková, Dont)

16th Rolf Nevanlinna Colloquium, Joensuu, Finland
(Malý)

1. Internationale Leibniz Forum, Altdorf, Germany
(Netuka, Veselý)

Kolloqium "Gesellschaftliche Voraussetzungen für Technikentwicklung", Berlin, Germany
(Brzezina)

1997 *Workshop on Potential Theory: Mean Value Property and related Topics II*, Eichstätt, Germany
(Netuka, Veselý)

Complex Analysis and Differential Equations, Uppsala, Sweden
(Netuka)

ISAAC '97, Newark, Delaware, USA
(Medková)

Workshop Praha-Heidelberg, Heidelberg, Germany
(Malý)

Fest-Kolloqium, München, Germany
(Brzezina)

1998 *International Conference on Potential Analysis*, Hammamet, Tunisia
(Brzezina, Kolář, Lukeš, Netuka, Šimůnková)

Kolloqium "Verantwortung und Führung in Mensch-Maschine-Systemen", Berlin, Germany
(Brzezina)

IABEM '98 (International Symposium on Boundary Element Methods), Paris, France
(Medková)

1999 *ICIAM '99 (International Conference on Industrial and Applied Mathematics)*, Edinburgh, Great Britain
(Medková)

The 7th Romanian-Finnish Seminar, Iassy, Romania
(Brzezina, Lávička, Lukeš)

Function Spaces, Differential Operators and Nonlinear Analysis, Pudasjärvi, Finland
(Malý)

International Conference on Analysis and Geometry, Novosibirsk, Russia
(Malý)

New Trends in the Calculus of Variations, Lisbon, Portugal
(Malý)

2000 *Potentialtheorie Tagung, Rückblick und Perspective*, Eichstätt, Germany
(Lukeš, Netuka, Veselý)

20th Century Harmonic Analysis, a Celebration, Il Ciocco-Castelvechio Pascoli, Italy
(Lukeš, Netuka)

Approximation, complex analysis and potential theory, Montreal, Canada
(Brzezina, Lávička)

Potential Theory and Dirichlet Forms, Varenna, Italy
(Netuka)

Eleventh International Colloquium on Differential Equations, Plovdiv, Bulgaria
(Medková)

2001 *New Trends in Potential Theory and Applications*, Bielefeld, Germany
(Brzezina, Lávička, Lukeš, Netuka, Veselý)

Mathematisches Minikolloquium, Wien, Austria
(Netuka)

International Conference on Complex Analysis and Related Topics, Braşov, Romania
(Spurný J.)

3. International ISAAC Congress, Berlin, Germany
(Medková D.)

Function Spaces, Diffrential Operators and Nonlinear Analysis, Teistungen, Germany
(Malý)

2002 *Potential Theory Conference*, Bucharest, Romania
(Lukeš, Netuka, Veselý)

2003 *Gedenk-Kolloquium*, Erlangen, Germany
(Brzezina, Lukeš, Netuka, Veselý)

Advances in Nonlinear Analysis, CMU Pittsburg, USA
(Malý)

Calculus of Variations, University of Warwick, UK
(Malý)

2004 *Austria-Czech Seminar on Analysis*, Austria
(Spurný)

BMC 2004, the Joint Meeting of the 56th British Mathematical Colloquium and the 17th Annual Meeting of the Irish Mathematical Society, Belfast, United Kingdom
(Lávička)

The final meeting of the EEC Research Training Network "Analysis and Operators", Dalfsen, Netherlands
(Lávička)

Analysis on Metric Measure Spaces, Bedlewo, Poland
(Malý)

Trends in the Calculus of Variations, Parma, Italy
(Malý)

2005 *Advances in Sensing with Security Applications*, Il Ciocco-Castelvechio Pascoli, Italy
(Lukeš, Netuka, Veselý)

Northwest Seminar on Functional Analysis, Banff, Canada
(Spurný)

Seminar on Functional Analysis, Edmonton, Canada
(Spurný)

The 7th international conference on Clifford algebras and their applications ICCA7, Toulouse, France
(Lávička)

New Developments in the Calculus of Variations, Benevento, Italy
(Malý)

XXth Nevanlina Colloquium, Université de Lausanne, Switzerland
(Malý)

Research Semester Geometric Methods in Analysis and Probability, Erwin Schrödinger Institute Wien, Austria
(Malý)

2005 Fall Central Section Meeting, University of Nebrasca in Lincoln, USA
(Malý)

2006 *Mathematisches Kolloquium*, Wien, Austria
(Netuka)

Colloquium on Potential Theory, Montreal, Canada
(Lukeš, Netuka)

Function Theories in Higher Dimensions, Tampere, Finland
(Lávička)

The Banach Center Conference Analysis and Partial Differential Equations, In honor of Professor Bogdan Bojarski, Bedlewo, Poland
(Malý)

Barcelona Analysis Conference, Barcelona, Spain
(Malý)

8. konferencia slovenských matematikov v Liptovskom Jáne, Liptovský Ján, Slovakia
(Malý)

2007 *Stochastic and Potential Analysis*, Hammamet, Tunisia
(Netuka)

Potential Theory and Stochastics, Albac, Romania
(Lukeš, Netuka, Veselý)

Lars Ahlfors Centennial Celebration, Helsinki, Finland
(Malý)

Geometric Function Theory and Nonlinear Analysis, on the occasion of the 60th birthday of Tadeusz Iwaniec, Ischia, Napoli, Italy
(Malý)

Moreover, members of the seminar participated in the following meetings organized in Czechoslovakia/Czech Republic:

1972 *Equadiff 3 (Conference on Differential Equations and their Applications)*, Brno

1973 *Non-linear Evolution Equation and Potential Theory*, Podhradí n/S.

1977 *Equadiff 4 (Conference on Differential Equations and their Applications)*, Praha

1981 *Harmonic Afternoon*, Praha

Equadiff 5 (Conference on Differential Equations and their Applications), Bratislava

1983 *Workshop on Applications of Function Theory and Functional Analysis Methods to Problems of Mathematical Physics*, Bechyně

1984 *12th Winter School on Abstract Analysis*, Srní

1985 *13th Winter School on Abstract Analysis*, Srní

Equadiff 6 (Conference on Differential Equations and their Applications), Brno

1986 *14th Winter School on Abstract Analysis*, Srní

1989 *Equadiff 7 (Conference on Differential Equations and their Applications)*, Praha

1991 *Harmonic Afternoon*, Praha

1992 *17th Seminar on Partial Differential Equations*, Cheb

1996 *Recent Trends in Banach Spaces*, Paseky

1997 *Equadiff 9 (Conference on Differential Equations and their Applications)*, Brno

Boundaries and Convexity in Banach Spaces, Paseky

1998 *Approximation and Uniqueness Properties of Harmonic Differential Forms*, Paseky

Recent Trends in Banach Spaces, Paseky

1999 *Winter School on Abstract Analysis*, Lhota nad Rohanovem

2000 *(Non)smooth Analysis in Banach Spaces*, Paseky

Some Recent Techniques in Harmonic Analysis, Paseky

Equadiff 10, Praha

2001 *Spring School on Analysis*, Paseky

2002 *Winter School in Abstract Analysis*, Lhota nad Rohanovem

Nonlinear Analysis, Function Spaces and Applications, Praha

2003 *Spring School on Analysis*, Paseky

Mathematical and Computer Modelling in Science and Engineering, Praha

2004 *Winter School in Abstract Analysis*, Lhota nad Rohanovem

Function Spaces, Differential Operators and Nonlinear Analysis, Svratka

Nonseparable Banach Spaces, Paseky

2005 *The 25th Winter School Geometry and Physics*, Srní

2007 *Spring School on Analysis, Function Spaces, Inequalities and Interpolation*, Paseky

Tenth School Mathematical Theory in Fluid Mechanics, Paseky

Visits abroad

This list (again incomplete) includes visits since 1967. Participation in conferences and schools is included elsewhere.

1972* **Lukeš J.,** Université Paris VI (France)

1973* **Netuka I.,** Université Paris VI (France)

1974 **Král J.,** Université Paris VI (France)

* **Lukeš J.,** University of Cairo, 1974/75 (Egypt)

* **Veselý J.,** University of Leningrad (USSR)

1975 **Král J.,** Martin-Luther-Universität Halle-Wittenberg; Universität Berlin; Universität Rostock (Germany)

1976 **Netuka I.,** TH Darmstadt; Institut für Angewandte Mathematik, Bonn (Germany)

1977 **Král J.,** Universität Karlsruhe; TH Darmstadt (Germany)

Veselý J., Martin-Luther-Universität Halle-Wittenberg (Germany)

1978* **Král J.,** Universidade Estadual de Campinas; Instituto di Matematica Pura ed Aplicada, Rio de Janeiro; Universidade de Brasília; Universidade de Sao Paulo; Universidade de Sao Carlos (Brasil)

Netuka I., Universität Bielefeld (Germany)

* **Veselý J.,** København Universitet; Universitet Århus; Universitet Roskilde (Denmark)

1979 **Lukeš J.,** Moscow State University (USSR)

Netuka I., Veselý J., Martin-Luther-Universität Halle-Wittenberg (Germany)

1980 **Netuka I.,** Université Paris VI (France); Rijksuniversiteit Utrecht (The Netherlands)

1981 **Lukeš J.,** Universität Bielefeld; Universität Frankfurt; Katholische Universität Eichstätt (Germany)

1982 **Král J.,** København Universitet (Denmark)

Veselý J., Rijksuniversiteit Utrecht (The Netherlands)

1983 **Lukeš J.,** University of Ljubljana (Yugoslavia)

Netuka I., University of Ioannina; University of Iraklio (Greece); Moscow State University (USSR)

* stays exceeding one month

1984 **Král J.,** Banach Center Warszawa (Poland)

Malý J., University of Naples (Italy)

Netuka I., Universitet Uppsala; Universitet Umeå; Universitet Götteborg; Universitet Linköping (Sweden)

Veselý J., Rijksuniversiteit Utrecht (The Netherlands)

1985* **Král J.,** University of Delaware, Newark; University of Princeton; University of Maryland, Baltimore (USA)

***** **Netuka I.,** Oxford University; Imperial College London (Great Britain)

1986 **Král J.,** Université Paris VI (France)

1987 **Netuka I.,** Faculté des Sciences de Tunis (Tunisia); Katholische Universität Eichstätt (Germany)

1988 **Lukeš J.,** Rijksuniversiteit Utrecht (The Netherlands); Université de Tunis (Tunisia); Universität Bielefeld; Universität Frankfurt; Katholische Universität Eichstätt; Universität Düsseldorf; Universität Erlangen-Nürnberg (Germany)

Malý J., University of Jyväskylä (Finland)

Netuka I., Rijksuniversiteit Utrecht (The Netherlands); Universität Erlangen-Nürnberg; Universität Frankfurt; Universität Bielefeld; Universität Düsseldorf; Universität Eichstätt (Germany)

Veselý J., Universitet Uppsala; Universitet Linköping (Sweden)

1989 **Lukeš J., Malý J.,** Banach Center Warszawa (Poland)

***** **Netuka I.,** University of Delaware, Newark (USA)

1990* **Brzezina M.,** Universität Erlangen-Nürnberg, 1990–1992 (Germany)

Král J., Universität Erlangen-Nürnberg; Katholische Universität Eichstätt (Germany)

Lukeš J., University of Jyväskylä; University of Joensuu (Finland)

Malý J., University of Jyväskylä (Finland)

Netuka I., Universität Bielefeld (Germany); University of Helsinki (Finland)

Veselý J., Universität Erlangen-Nürnberg (Germany)

1991 **Lukeš J.,** Universität Erlangen-Nürnberg; Universitet Uppsala; Universitet Linköping; Universitet Lund; Universitet Umeå (Sweden)

Netuka I., Maynooth College Kildare (Ireland)

Veselý J., Universität Bielefeld; Katholische Universität Eichstätt (Germany)

* **Malý J.,** University of Florence (Italy); University of Joensuu (Finland)

Veselý J., Stevens Institute, Hoboken (USA)

1992* Netuka I., Universität Erlangen-Nürnberg; Universität Bielefeld; Universität Duisburg; Universität Frankfurt (Germany)
University of Athenas (Greece)

1993 Brzezina M., Universität Erlangen-Nürnberg (Germany)

Lukeš J., Universität Bayreuth (Germany); University of Iraklion (Greece)

* **Lukeš J.,** University of Athenas (Greece)

* **Pyrih P.,** University of Athenas (Greece)

Malý J., University of Jyväskylä (Finland); University of Bonn (Germany)

Netuka I., Bar-Ilan University (Israel); University of Joensuu (Finland)

1994 Brzezina M., Universität Erlangen-Nürnberg (Germany)

Král J., Universität Chemnitz (Germany)

Lukeš J., Universität Konstanz (Germany)

* **Lukeš J.,** University of Athenas (Greece)

* **Malý J.,** University of Minnesota (USA); University of Heidelberg (Germany); University of Madrid (Spain); SISSA Trieste (Italy); University of Bloomington; Carnegie Mellon University, Pittsburgh (USA)

Netuka I., Universitet Uppsala (Sweden); Universität Erlangen-Nürnberg (Germany)

Veselý J., Universität Erlangen-Nürnberg (Germany)

* **Pyrih P.,** University of Paris VI (France)

1995 Brzezina M., Universität Erlangen-Nürnberg (Germany)

Lukeš J., Universität Konstanz; Universität Bayreuth (Germany)

Malý J., University of Jyväskylä (Finland); University of Bayreuth (Germany), Universität Linz (Austria)

Netuka I., Università degli Studi di Bari (Italy); Universität Bielefeld; Universität Erlangen-Nürnberg (Germany)

Pyrih P., Universität Bayreuth (Germany)

1996 Brzezina M., Technische Universität München (Germany)

Lukeš J., Universität Konstanz (Germany); University of Bloomington (USA); University of Edmonton; University of Quebec; University of Montreal (Canada)

Malý J., University of Besançon (France); University of Warszawa (Poland)

Netuka I., Universität Erlangen-Nürnberg (Germany); Universitet Uppsala (Sweden)

Veselý J., Katholische Universität Eichstätt; Universität Bielefeld (Germany)

1997 **Netuka I., Veselý J.,** Rijksuniversiteit Utrecht (The Netherlands)

Netuka I., Universität Bielefeld (Germany)

Brzezina M., Universität Tübingen, Universität Erlangen–Nürnberg (Germany)

1998 **Netuka I.,** Universität Bielefeld (Germany)

Veselý J., Stevens Institute of Technology (New Jersey, USA)

Malý J., University of Jyväskylä (Finland); Universität Bonn (Germany); Max-Planck Institut Leipzig (Germany); University of Helsinki (Finland); Université Toulon Var (France)

1999 **Netuka I.,** Universität Frankfurt (Germany); University of Belfast (Great Britain); University College Dublin (Ireland)

Lukeš J., Universität Bielefeld (Germany)

Brzezina M., Technische Universität München (Germany); University of Cantenbury (New Zealand)

Malý J, Università "La Sapienza" di Roma (Italy); Mittag-Leffler Institute Djursholm (Sweden)

2000 **Brzezina M.,** Technological University of Linköping (Sweden); Technische Universität München (Germany)

***** **Veselý J.,** Stevens Institute of Technology (New Jersey, USA)

Netuka I., Universität Bielefeld (Germany); Universität Köln (Germany)

Malý J., Università di Pisa (Italy); University of Warszawa (Poland)

2001 **Malý J.,** Universität Bonn (Germany); Universität Berlin (Germany); Helsingin yliopisto (university) (Finland)

Netuka I., Technische Universität Wien (Germany)

2002 **Netuka I.,** Universität Bielefeld (Germany)

Malý J., Carnegie Mellon University Pittsburgh (USA); University of Michigan Ann Arbor (USA); University of Minnesota Minneapolis (USA); Indiana University Bloomington (USA)

2003 **Netuka I.,** Universität Frankfurt (Germany)

Malý J., Universität di Parma (Italy); Carnegie Mellon University Pittsburgh (USA); Oxford University (UK); University College London (UK)

2004 **Netuka I.,** University of Iraklio (Grece)

Malý J., Jyväskylän yliopisto (university) (Finland)

*** Lávička R.,** National University of Ireland, Maynooth (Ireland)

2005 **Malý J.,** Max-Planck Institut Leipzig (Germany)

2006 **Netuka I.,** Universität Bielefeld (Germany)

Lávička R., National University of Ireland, Maynooth (Ireland)

Malý J., Universität Zürich (Switzerland)

2007 **Netuka I.,** Universität Bielefeld (Germany); Universität Frankfurt (Germany)

Medková D., Universität Kassel (Germany)

Lávička R., National University of Ireland, Maynooth (Ireland)

Theses

A word of explanation on the system of titles and degrees in Czechoslovakia/Czech Republic is in order. Diploma thesis is required for M.Sc. degree (usually after 5 years of study). For a certain period, a more advanced thesis (called here RNDr. thesis) was required for the academic title *Rerum naturalium doctor* (RNDr.). Unlike the diploma thesis, RNDr. thesis was supposed to contain (at least minor) original results. The degree *Candidatus scientiarum* (CSc) is a research degree corresponding to Ph.D. Therefore we speak of Ph.D. thesis. Another thesis (here called *Habilitation* thesis) is presented for promotion to associate professor (corresponding approximately to German *Dozent*). *Doctor of Science* (DrSc.) is the highest scientific degree awarded in our country.

The name of the thesis supervisor (adviser) is indicated in brackets. Only theses having to do with potential theory or the work of the seminar are included.

DrSc. theses

1968 Král J.: *The Fredholm method in potential theory*

1983 Lukeš J.: *The Dirichlet problem and methods of fine topology in potential theory*

1984 Netuka I.: *The first boundary value problem in potential theory*

1996 Malý J.: *Pointwise estimates and Wiener criteria for quasilinear elliptic equations*

Habilitation theses

1968 Král J.: *Flows of heat and Fourier problem*

1975 Lukeš J.: *Dedekind's closures and Riemann integrable functions*

1977 Netuka I.: *Heat potentials and a mixed boundary value problem for the heat equation*

1979 Veselý J.: *The Dirichlet problem in the theory of harmonic kernels*

1990 Dont M.: *The first boundary value problem for the heat equation*

1994 Brzezina M.: *Capacities, harmonic morphisms and Wiener type theorems in potential theory*

1997 Malý J.: *Weakly differentiable mappings*

1998 Dontová E.: *Reflection and boundary value problems*

1999 Pyrih P.: *Contributions to the study of topologies in the plane*

2005 Medková D.: *Boundary value problem for the Laplace equation on non-smooth domains*

Ph.D. theses

1959 Král J.: *On the Lebesgue area* [Mařík J.]

1968 Lukeš J.: *Estimates of Cauchy integrals on the Carathéodory's boundary* [Král J.]

1970 Veselý J.: *On some properties of double layer potentials* [Král J.]

1972 Netuka I.: *The third boundary value problem in potential theory* [Král J.]

Dont M.: *The Fredholm method and the heat equation* [Král J.]

1984 Čermáková-Pokorná E.: *The Dirichlet problem in resolutive compactifications* [Lukeš J.]

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In Memory of Josef Král

Jaroslav Lukeš, Ivan Netuka, Jiří Veselý, Praha

On May 24, 2006 a farewell ceremony for our teacher, colleague and friend Josef Král was held in the Church of St. Wenceslas in Pečky. He died on May 13, 2006, before his seventy-fifth birthday. Josef Král was an outstanding mathematician, exceptional teacher, model husband and father, and above all, a man of extraordinary human qualities. The results of his research place him among the most important Czech mathematicians of the second half of the twentieth century. His name is associated with original results in mathematical analysis and, in particular, in potential theory.

In 1967 Josef Král founded a seminar in Prague on mathematical analysis, with a particular emphasis on potential theory. He supervised a number of students and created a research group, which has been called *The Prague Harmonic Group* by friends and colleagues. At first lectures were organised, somewhat irreg-

ularly, at the Mathematical Institute of the Czechoslovak Academy of Sciences, Krakovská 10. The name *Seminar on Mathematical Analysis* was chosen and the meeting time was fixed for Monday afternoons. From the beginning it was agreed to devote the seminar mainly to potential theory, but this did not exclude other parts of Analysis which would be of interest to members. Before long the venue changed to the Faculty of Mathematics and Physics of Charles University, at the building on Malostranské nám. 25. The activities of the Seminar continue

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until the present and, for about thirty years now, have been based at the Faculty building at Karlín, Sokolovská 83.

The results of the group soon attracted international interest, and contacts were established with many world-famous specialists in potential theory. Among those who came to Prague were leading figures such as M. Brelot, H. Bauer, A. Cornea, G. Choquet and B. Fuglede. Many others came to Prague in 1987 and to Kouty in 1994 when international conferences devoted specially to potential theory were held in our country. On the occasion of the thirtieth anniversary of the Seminar on Mathematical Analysis an international *Workshop on Potential Theory* was organized in Prague in 1996. Another international conference was organized in Hejnice in 2004.

The oldest writings about potential theory in Bohemia of which we are aware can be found in a three volume book *Foundations of Theoretical Physics* written in Czech (*Základové theoretické fysiky*) by August Seydler (1849–1891), a professor of Mathematical Physics and Theoretical Astronomy in the Czech part of Charles-Ferdinand University (nowadays Charles University). In the second volume, published in Prague in 1885 and called *Potential Theory. Theory of gravitational, magnetic and electric phenomena* (*Theorie potenciálu. Theorie úkazů gravitačních, magnetických a elektrických*) potential theory is treated from the point of view of physics. It was the first Czech book devoted to the field. He also wrote an article on logarithmic potentials.

Some years later František Graf published the article *On some properties of Newton and logarithmic potential and its first derivatives at simple singularities of mass surfaces and curves* (*O vlastnostech Newtonova logarithmického potenciálu i jeho prvních derivací v některých jednoduchých singularitách hmotných ploch a křivek*), in Časopis Pěst. Mat. Fyz. 34 (1905), 5–19 and 130–147. Also, Karel Petr (1868–1950), a professor of Charles University during the period 1903–1938, wrote a note on potential theory: the article *Poisson integral as a direct consequence of Cauchy integral* written in Czech (*Poissonův integrál jako přímý důsledek integrálu Cauchyova*) appeared in Časopis Pěst. Mat. Fyz. 42 (1913), 556–558.

In 1911, under K. Petr, Viktor Trkal (1888–1956) wrote his thesis *On the Dirichlet and Neumann problems from the integral equations viewpoint* (*O problému Dirichletově a Neumannově s hlediska rovnic integrálních*). V. Trkal later became a professor of theoretical physics at Charles University. George Pick (1859–1942) got his Habilitation from the Prague German University in 1882 and, from 1888, was a professor of this university. His main fields were Analysis and Geometry. Among his papers, which numbered more than 50, were at least two dealing with potential theory: *Ein Abschätzungssatz für positive Newtonsche Potentiale*, Jahresber. Dtsch. Math.-Ver. 24 (1915), 329–332, and *Über positive harmonische Funktionen*, Math. Z. 1 (1918), 44–51.

Karl Löwner (1893–1968) studied at the Prague German University where he also became a professor in 1930. Before his emigration in 1939, he was an adviser of Lipman Bers' (1914–1993) thesis *Über das harmonische Mass in Raume.*

Wolfgang Sternberg (1887–1953) belonged to the faculty at Prague German University during the period 1935–1939. He is known as the author of a two volume book on potential theory *Potentialtheorie I, II* published by Walter de Gruyter in the series Sammlung Göschen as well as of the book *The Theory of Potential and Spherical Harmonics*, later published in the U.S. His well-known work on the Perron method for the heat equation, *Über die Gleichung der Wärmeleitung*, Math. Ann. 101 (1929), 394–398, is often quoted in treatises on modern potential theory.

In the fifties, several papers on potential theory were published by Czech mathematicians who were interested in PDE's. Ivo Babuška (*1926) wrote several articles on the Dirichlet problem for domains with non-smooth boundaries and also papers on biharmonic problems. Rudolf Výborný (*1928) contributed to the study of maximum principles in several articles, especially for the heat equation. These mathematicians also wrote two papers jointly (*Die Existenz und Eindeutigkeit der Dirichletschen Aufgabe auf allgemeinen Gebieten*, Czech. Math. J. 9 (1959), 130–153, and *Reguläre und stabile Randpunkte für das Problem der Wärmeleitungsgleichung*, Ann. Polon. Math. 12 (1962), 91–104.)

An elementary approach to the Perron method for the Dirichlet problem was published in Czech by Jan Mařík (1920–1994) in the article *The Dirichlet problem* (Dirichletova úloha), Časopis Pěst. Mat. 82 (1957), 257–282.

Following this a substantial period of development of potential theory in Czechoslovakia and later in Czech Republic is associated with Josef Král. He was born on December 23, 1931 in a village Dolní Bučice near Čáslav and graduated from the Faculty of Mathematics and Physics of Charles University in 1954. He became an Assistant in its Department of Mathematics and soon also a research student (*aspirant*). Under the supervision of J. Mařík he completed his thesis *On Lebesgue area of closed surfaces* and was granted (the equivalent of) a Ph.D. in 1960. In 1965 he joined the Mathematical Institute of the Czechoslovak Academy of Sciences as a researcher in the Department of Partial Differential Equations, and in the period 1980–1990 he served as the Head of the Department of Mathematical Physics. Meanwhile, in 1967, he defended his thesis *Fredholm method in potential theory* to obtain a DrSc., the highest scientific degree available in Czechoslovakia. Around the same time he also submitted his habilitation thesis *Heat flows and the Fourier problem.* In view of the extraordinarily high quality of the thesis, as well as the prominence both of his other research work and his teaching activities at the Faculty, the Scientific Board of the Faculty proposed to appoint J. Král professor in 1969. However, it took twenty years (sic!) before the changes in the country made it possible for J. Král to be actually appointed professor of mathematical analysis in 1990.

Although J. Král was affiliated to the Mathematical Institute for more than 30 years, he never broke his links with the Faculty. His teaching activities were remarkable in their extent. He continued to lecture courses—both elementary and advanced—in the theory of integral and differential equations, measure theory and potential theory. He supervised a number of diploma theses as well as Ph.D.

theses, and was author and co-author of a four-volume lecture notes on potential theory ([73], [82], [90], [92]). He was frequently invited to give talks at conferences and universities abroad, and spent longer periods as visiting professor at Brown University in Providence, U.S.A. (1965–66), University Paris VI, France (1974), and University in Campinas, Brazil (1978). After retirement Josef Král lived in Pečky, a town about fifty kilometers east of Prague. Even though he was no longer able to participate in the seminar he founded, he maintained contact with its members and former students. He passed away in the hospital at Kolín.

Let us now review in more detail the research activities and scientific results of Josef Král. They principally relate to mathematical analysis, in particular to measure theory and integration, and to potential theory. The early papers of Josef Král appear in the scientific context of the late fifties, being strongly influenced by prominent mathematicians of the time, especially J. Mařík, V. Jarník and E. Čech. These papers primarily concern geometric measure theory, see [122].

Measure and integral

In papers [1], [2] [5], [7], [67], [13], and [89], J. Král studied curvilinear and surface integrals. As an illustration let us present a result following from [2], which was included in the lecture notes [73]: Let $f\colon [a,b] \to \mathbb{R}^2$ be a continuous closed parametric curve of finite length, let $f([a,b]) = K$, and let $\operatorname{ind}_f z$ denote the index of a point $z \in \mathbb{R}^2 \setminus K$ with respect to the curve. For any positive integer p set $G_p := \{z \in \mathbb{R}^2 \setminus K; \operatorname{ind}_f z := p\}$, $G := \bigcup_{p\neq 0} G_p$. Let $\omega\colon G \to \overline{\mathbb{R}}$ be a locally integrable function and $v = (v_1, v_2)\colon K \cup G \to \mathbb{R}^2$ a continuous vector function. If

$$\int_{\partial R} (v_1\,dx + v_2\,dy) = \int_R \omega\,dx\,dy$$

for every closed square $R \subset G$ with positively oriented boundary ∂R, then for every $p \neq 0$ there is an appropriately defined improper integral $\iint_{G_p} \omega\;dx\,dy$, and the series

$$\sum_{p=1}^{\infty} p\left(\iint_{G_p} \omega\,dx\,dy - \iint_{G_{-p}} \omega\,dx\,dy\right)$$

(which need not converge) is summable by Cesàro's method of arithmetic means to the sum $\int_f (v_1\,dx + v_2\,dy)$.

Transformation of integrals was studied in [65], [3] and [71]. The last paper deals with the transformation of the integral with respect of the k-dimensional Hausdorff measure on a smooth k-dimensional surface in $\mathbb{R}^m$ to the Lebesgue integral in $\mathbb{R}^k$ (in particular, it implies the Change of Variables Theorem for Lebesgue integration in $\mathbb{R}^m$). A Change of Variables Theorem for one-dimensional Lebesgue-Stieltjes integrals is proved in [3]. As a special case one obtains a Banach-type theorem on the variation of a composed function which, as S. Marcus pointed out [Zentralblatt Math. 80 (1959), p. 271, Zbl. 080.27101], implies a negative answer to a problem of H. Steinhaus from *The New Scottish Book*. To this category also belongs [6], where Král constructed an example of a mapping $T\colon D \to \mathbb{R}^2$, absolutely continuous in the Banach sense on a plane domain $D \subset \mathbb{R}^2$, for which the Banach indicatrix $N(\cdot, T)$ on $\mathbb{R}^2$ has an integral strictly greater than the integral over D of the absolute value of Schauder's generalized Jacobian $J_s(\cdot, T)$. In this way Král solved the problem posed by T. Radó in his monograph *Length and Area* [Amer. Math. Soc. 1948, (i) on p. 419]. The papers [66], [9], [10], [11], [12], [15] deal with surface measures; [9] and [10] are in fact parts of the above mentioned Ph.D. dissertation, in which Král (independently of W. Fleming) solved the problem on the relation between the Lebesgue area and perimeter in three-dimensional space, proposed by H. Federer [Proc. Amer. Math. Soc. 9 (1958), 447–451]. In [11] a question of E. Čech from *The New Scottish Book*, concerning the area of a convex surface in the sense of A. D. Alexandrov, was answered.

Papers [14] and [43] are from the theory of integration. The former yields a certain generalization of Fatou's lemma: *If $\{f_n\}$ is a sequence of integrable functions on a space X with a σ-finite measure μ such that, for each measurable set $M \subset X$, the sequence $\{\int_M f_n \, d\mu\}$ is bounded from above, then the function $\liminf f_n^+$ is μ-integrable* (although the sequence $\{\int_X f_n^+ \, d\mu\}$ need not be bounded). In the latter paper Král proved a theorem on dominated convergence for nonabsolutely convergent GP-integrals, answering a question of J. Mawhin [Czech. Math. J. 106 (1981), 614–632].

In [16] J. Král studied the relation between the length of a generally discontinuous mapping $f\colon [a, b] \to P$, with values in a metric space P, and the integral of the Banach indicatrix with respect to the linear measure on $f([a, b])$. For continuous mappings f the result gives an affirmative answer to a question formulated by G. Nöbeling in 1949.

In [27] it is proved that functions satisfying the integral Lipschitz condition coincide with functions of bounded variation in the sense of Tonelli-Cesari. The paper [89] presents a counterexample to the converse of the Green theorem. Finally, [52] provides an elementary characterization of harmonic functions in a disc representable by the Poisson integral of a Riemann-integrable function.

Still another paper from measure and integration theory is [33], in which Král gives an interesting solution of the mathematical problem on hair (formulated by L. Zajíček): *For every open set $G \subset \mathbb{R}^2$ there is a set $H \subset G$ of full measure and a mapping assigning to each point $x \in H$ an arc $A(x) \subset G$ with the end point x such that $A(x) \cap A(y) = \emptyset$ provided $x \neq y$.*

The method of integral equations in potential theory

In [68] Král began to study the method of integral equations and their application to the solution of the boundary-value problems of potential theory. The roots of the method reach back into the 19$^{\text{th}}$ century and are connected with, among others, the names of C. Neumann, H. Poincaré, A. M. Lyapunov, I. Fredholm and J. Plemelj. The generally accepted view, expressed, for example, in the monographs of F. Riesz and B. Sz.-Nagy, R. Courant and D. Hilbert, and B. Epstein, restrictive assumptions on the smoothness of the boundary were essential for this approach. This led to the belief that, for the planar case, this method had reached the natural limits of its applicability in the results of J. Radon, and was unsuitable for domains with nonsmooth boundaries. Let us note that, nonetheless, the method itself offers some advantages: when used, it beautifully exhibits the duality of the Dirichlet and the Neumann problem, provides an integral representation of the solution and—as was shown recently—is suitable also for numerical calculations.

In order to describe Král's results it is suitable to define an extremely useful quantity introduced by him, the so called cyclic variation. If $G \subset \mathbb{R}^m$ is an arbitrary open set with a compact boundary and $z \in \mathbb{R}^m$, let us denote by $p(z;\theta)$ the halfline with initial point z having direction $\theta \in \Gamma := \{\theta \in \mathbb{R}^m; |\theta| = 1\}$. For every $p(z;\theta)$ we calculate the number of points that are hits of $p(z;\theta)$ at ∂G; these are the points from $p(z;\theta) \cap \partial G$ in each neighborhood U of which, on this halfline, there are sufficiently many (in the sense of one-dimensional Hausdorff measure $\mathscr{H}_1$) points from both G and $\mathbb{R}^m \setminus G$, that is

$$\mathscr{H}_1\big(U \cap p(z;\theta) \cap G\big) > 0, \qquad \mathscr{H}_1\big(U \cap p(z;\theta) \cap (\mathbb{R}^m \setminus G)\big) > 0.$$

Let us denote by $n_r(z,\theta)$ the number of the hits of $p(z;\theta)$ at ∂G whose distance from z is at most $r > 0$, and define $v_r^G(z)$ to be the average number of hits $n_r(z,\theta)$ with respect to all possible halflines originating from z, that is

$$v_r^G(z) := \int_\Gamma n_r(z,\theta)\, d\sigma(\theta),$$

the integral being taken with respect to the (normalized) surface measure σ on Γ. For $r = +\infty$ we write briefly $v^G(z) := v_\infty^G(z)$. From the viewpoint of application of the method of integral equations it is appropriate to consider the following questions:

(1) how general are the sets for which it is possible to introduce in a reasonable way the double-layer potential (the kernel is derived from the fundamental solution of the Laplace equation) or, as the case may be, the normal derivative of the single-layer potential defined by a mass distribution on the boundary ∂G;

(2) under what conditions is it possible to extend this potential (continuously) from the domain onto its boundary;

(3) when is it possible to solve operator equations defined by this extension?

The answers to the first two questions are in the form of necessary and sufficient conditions formulated in terms of the function v^G. In [68] Král definitively solved problem (2) using also the so-called radial variation; both quantities have their inspiration in the Banach indicatrix. We note here that the Dirichlet problem is easily formulated even for domains with nonsmooth boundaries, while attempts to formulate the Neumann problem for such sets encounter major obstacles from the very beginning, regardless of the method used. Therefore it was necessary to pass, in the formulation, from the description in terms of a point function in the boundary condition to a description using the potential flow induced by the signed measure on the boundary.

By the method of integral equations, the Dirichlet and Neumann problems are solved indirectly: the solution is sought in the form of a double-layer and a single-layer potential, respectively. These problems are reduced to the solution of the dual operator equations

$$T^G f = g \qquad \text{and} \qquad N^G U\mu = \nu$$

where f, g are respectively the sought and the given functions, and μ and ν are respectively the sought and given signed measures on the boundary ∂G. Here the operator T^G is connected with the jump formula for the double layer potential whereas N^G is the operator of the generalized normal derivative. Let us consider three quantities of the same nature which are connected with the solvability of problems (1) – (3) and which are all derived from the cyclic variation introduced above:

(a) $v^G(x)$,

(b) $V^G := \sup\{v^G(y)\,;\, y \in \partial G\}$,

(c) $v_0^G := \lim\limits_{r\to 0+} \sup\{v_r^G(y)\,;\, y \in \partial G\}$.

While, in [68], the starting point is the set $G \subset \mathbb{R}^2$ bounded by a curve K of finite length, the subsequent papers [22], [74] consider, from the outset, an arbitrary open set G with compact boundary ∂G. In [68] Král solved problem (2), which opened the way to a generalization of Radon's results established for curves of bounded rotation. The radial variation of a curve is also introduced here, and both variations are used in [70], [19] for studying angular limits of the double-layer potential. The results explicitly determine the value of the limit and give geometrically visualizable criteria which are necessary and sufficient conditions for the existence of these limits. The mutual relation of the two quantities and their relation to the length and boundary rotation of curves is studied in [69] and [17]. For the plane case the results are collected in [18], [20], and [21], where the interrelations of the results are explained and conditions of solvability of the resulting operator equations are given. For the case of $\mathbb{R}^m$, $m \geq 2$, angular limits of the double layer potentials are studied in [57].

Let us present these conditions explicitly for the dimension $m \geq 3$. If $G \subset \mathbb{R}^m$ is a set with a smooth boundary ∂G, then the double-layer potential Wf with a continuous moment f on ∂G is defined by the formula

$$Wf(x) := \int_{\partial G} f(y) \frac{(y-x)\cdot n(y)}{|x-y|^m}\, d\sigma(y), \qquad x \in \mathbb{R}^m \setminus \partial G,$$

where $n(y)$ is the vector of the (outer) normal to G at the point $y \in \partial G$ and σ is the surface measure on ∂G. For $x \notin \partial G$ the value $W\varphi(x)$ can be defined distributively for an arbitrary open G with compact boundary and for every smooth function φ; this value is the integral with respect to a certain measure (dependent on x) if and only if the quantity (a) is finite. Then $Wf(x)$ can naturally be defined for a sufficiently general f by the integral of f with respect to this measure.

Consequently, if we wish to define a generalized double-layer potential on G, the value of (a) must be finite for all $x \in G$. In fact, it suffices that $v^G(x)$ be finite on a finite set of points x from G which, however, must not lie in a single hyperplane; then the set G already has a finite perimeter. On its essential boundary, a certain essential part of boundary, the (Federer) normal can be defined in an approximative sense. This fact proves useful: the formula for calculation of Wf remains valid if the classical normal occurring in it is replaced by the Federer normal. If the quantity V^G from (b) is finite, then v^G is finite everywhere in G, and Wf can be continuously extended from G to $\overline{G}$ for every f continuous on ∂G. This is again a necessary and sufficient condition; hence the solution of the Dirichlet problem can be obtained by solving the first of the above mentioned operator equations. A similar situation which we will not describe in detail occurs for the dual equation with the operator N^G.

These results (generalizing the previous ones to the multidimensional case) can be found in [22], [74], where, in addition, the solvability of the equations in question is studied; see also [49]. Here Král deduced a sufficient condition of solvability depending on the magnitude of the quantity in (c), by means of which he explicitly expressed the so called essential norm of certain operators related to those appearing in the equations considered. It is worth mentioning that the mere smoothness of the boundary does not guarantee the finiteness of the quantities in (b) or (a); see [23].

Considering numerous similar properties of the Laplace equation and the heat equation it is natural to ask whether Král's approach (fulfilling the plan traced out by Plemelj) can be used also for the latter. Replacing in the definition of v^G the pencil of halflines filling the whole space $\mathbb{R}^m$ by a pencil of parabolic arcs filling the halfspace of $\mathbb{R}^{m+1}$ that is in time "under" the considered point (x, t) of the timespace, we can arrive at analogous results also for the heat equation. Only a deeper insight into the relation and distinction of the equations enables us to realise that the procedure had to be essentially modified in order to obtain comparable results; see [76], [24]. It should be mentioned that the cyclic variation introduced by Král has proved to be a useful tool for the study of further problems, for instance those connected with the Cauchy integral; see [25], [28] and [60]. Angular limits of the integral with densities satisfying a Hölder-type condition were studied in [57]. We note that the cyclic variation was also used to solve mixed boundary value problems concerning analytic function by means of a reflection mapping; see [59].

In addition to the lecture notes mentioned above, Král later, in the monograph [38], presented a selfcontained survey of the results described above. This book provides the most accessible way for a reader to get acquainted with the results for the Laplace equation. It also includes some new results; for example, if the quantity in (c) is sufficiently small, then G has only a finite number of components—this is one of the consequences of the Fredholm method, cf. [84], [38]. Part of the publication is devoted to results of [35] concerning the contractivity of the Neumann operator, which is connected with the numerical solution of boundary value problems, a subject more than 100 years old. The solution is again definitive and depends on convexity properties of G. Related results in a more general context were obtained in [54], [61], [62], and [63].

The subject of the papers [87], [91], [97], [47] belongs to the field of application of the method of integral equations; they originated in connection with some invitations to deliver lectures at conferences and symposia. Král further developed the above methods and, for instance, in [97] indicated the applicability of the methods also to the "infinite-dimensional" Laplace equation.

The last period is characterized by Král's return to the original problems from a rather different viewpoint. The quantity in (c) may be relatively small for really complicated sets G, but can be unpleasantly large for some even very simple sets arising for example in $\mathbb{R}^m$ as finite unions of parallelepipeds. Even for this particular case the solution is already known. It turned out that an appropriate re-norming leads to a desirable reduction of the essential norm (the tool used here is a "weighted" cyclic variation); see [44], [48], and also [62], [124].

A characteristic feature of Král's results concerning the boundary value problems is that the analytical properties of the operators considered are expressed in visualizable geometrical terms. For the planar case see, in particular, [46].

The topics described above have also been investigated by V. G. Maz'ya whose results together with relevant references may be found in his treatise *Boundary Integral Equations*, Encyclopaedia of Mathematical Sciences 27, Analysis IV, Springer-Verlag, 1991.

Removable singularities

Let us now pass to Král's contribution to the study of removable singularities of solutions of partial differential equations.

Let $P(D)$ be a partial differential operator with smooth coefficients defined in an open set $U \subset \mathbb{R}^m$ and let $L(U)$ be a set of locally integrable functions on U. A relatively closed set $F \subset U$ is said to be removable for $L(U)$ with respect to $P(D)$ if the following condition holds: for any $h \in L(U)$ such that $P(D)h = 0$ on $U \setminus F$ (in the sense of distributions), $P(D)h = 0$ on the whole set U.

As an example let us consider the case where $P(D)$ is the Laplace operator in $\mathbb{R}^m$, $m > 2$, and $L(U)$ is one of the following two sets of functions: (1) continuous functions on U; (2) functions satisfying the Hölder condition with an exponent $\gamma \in (0, 1)$. It is known from classical potential theory that in the case (1) a set is removable for $L(U)$ if and only if it has zero Newtonian capacity. For the case (2) L. Carleson (1963) proved that a set is removable for $L(U)$ if and only if its Hausdorff measure of dimension $\gamma + m - 2$ is zero.

In [78] Král obtained a result of Carleson-type for solutions of the heat equation. Unlike the Laplace operator, the heat operator fails to be isotropic. Anisotropy enters Král's result in two ways: firstly, the Hölder condition is considered with the exponents γ and $\frac{1}{2}\gamma$ with respect to the spatial and the time variables, respectively, and secondly, anisotropic Hausdorff measure is used. Roughly speaking, the intervals used for covering have a length of edge s in the direction of the space coordinates, and s^2 along the time axis. The paper was the start of an extensive project, the aim of which was to master removable singularities for more general differential operators and wider scales of function spaces.

Let M be a finite set of multi-indices and suppose that the operator

$$P(D) := \sum_{\alpha \in M} a_\alpha D^\alpha$$

has infinitely differentiable complex-valued coefficients on an open set $U \subset \mathbb{R}^m$. Let us choose a fixed m-tuple $n = (n_1, n_2, \ldots, n_m)$ of positive integers such that

$$|\alpha : n| := \sum_{k=1}^{m} \frac{\alpha_k}{n_k} \leq 1$$

for every multiindex $\alpha = (\alpha_1, \alpha_2, \ldots, \alpha_m) \in M$.

We recall that an operator $P(D)$ with constant coefficients a_α is called semielliptic if the only real-valued solution of the equation

$$\sum_{|\alpha:n|=1} a_\alpha \xi^\alpha = 0$$

is $\xi = (\xi_1, \xi_2, \ldots, \xi_m) = 0$. (Of course, for $\alpha = (\alpha_1, \alpha_2, \ldots, \alpha_m)$ we define here $\xi^\alpha = \xi_1^{\alpha_1} \xi_2^{\alpha_2} \ldots \xi_m^{\alpha_m}$.) The class of semielliptic operators includes, among others, the elliptic operators, the parabolic operators in the sense of Petrovskij (in particular, the heat operator), as well as the Cauchy-Riemann operator.

For n fixed and $\overline{n} := \max\{n_k; 1 \leq k \leq m\}$ the operator $P(D)$ is assigned the metric

$$\varrho(x, y) := \max\bigl\{|x_k - y_k|^{n_k/\overline{n}}; 1 \leq k \leq m\bigr\}, \qquad x, y \in \mathbb{R}^m.$$

To each measure function f, a Hausdorff measure on the metric space $(\mathbb{R}^m, \varrho)$ is associated in the usual way. Roughly speaking, this measure reflects the possibly different behaviour of $P(D)$ with respect to the individual coordinates, and it was by measures of this type that J. Král succeeded in characterizing the removable singularities for a number of important and very general situations.

Removable singularities are studied in [30] (see also [83]) for anisotropic Hölder classes, and in [86] for classes with a certain anisotropic modulus of continuity; in the latter case the measure function for the corresponding Hausdorff measure is derived from the modulus of continuity. In [88] Hölder conditions of integral type (covering Morrey's and Campanato's spaces as well as the BMO) are studied.

The papers [39] and [42] go still further: spaces of functions are investigated whose prescribed derivatives satisfy conditions of the above mentioned types.

For general operators Král proved that the vanishing (or, as the case may be, the σ-finiteness) of an appropriate Hausdorff measure is a sufficient condition of removability for a given set of functions. (Let us point out that, when constructing the appropriate Hausdorff measure, the metric ϱ reflects the properties of the operator $P(D)$, while the measure function reflects the properties of the class of the functions considered.)

It is remarkable that, for semielliptic operators with constant coefficients, Král proved that the above sufficient conditions are also necessary. An additional restriction for the operators is used to determine precise growth conditions for the fundamental solution and its derivatives. The potential theoretic method (combined with a Frostman-type result on the distribution of measure), which is applied in the proof of necessary conditions, is very well explained in [111] and also in [56]. In the same work also the results on removable singularities for the wave operator are presented; see [55] and [50] dealing with related topics.

In the conclusion of this section let us demonstrate the completeness of Král's research by the following result for elliptic operators with constant coefficients, which is a consequence of the assertions proved in [42]: the removable singularities for functions that, together with certain of their derivatives, belong to a suitable Campanato space, are characterized by the vanishing of the classical Hausdorff measures, whose dimension (in dependence on the function space) fills in the whole interval between 0 and m. We note that J. Král lectured on removable singularities during the Spring school on abstract analysis (*Small and exceptional sets in analysis and potential theory*) organized at Paseky in 1992.

Potential theory

The theory of harmonic spaces started to develop in the sixties. Its aim was to build up an abstract potential theory that would include not only the classical potential theory but would also make it possible to study wide classes of partial differential equations of elliptic and parabolic types. Further development showed that the theory of harmonic spaces represents an appropriate link between partial differential equations and stochastic processes.

In the abstract theory the role of the Euclidean space is played by a locally compact topological space (this makes it possible to cover manifolds and Riemann surfaces and simultaneously to exploit the theory of Radon measures), while the solutions of a differential equation are replaced by a sheaf of vector spaces of continuous functions satisfying certain natural axioms. One of them, for example, is the axiom of basis, which guarantees the existence of basis of the topology consisting of sets regular for the Dirichlet problem, or the convergence axiom, which is a suitable analogue of the classical Harnack theorem.

While Král probably did not plan to work systematically on the theory of harmonic spaces, he realized that this modern and developing branch of potential theory must not be neglected. In his seminar he gave a thorough report on Bauer's monograph *Harmonische Räume und ihre Potentialtheorie*, and later on the monograph of C. Constantinescu and A. Cornea *Potential Theory on Harmonic Spaces*.

In Král's list of publications there are four papers dealing with harmonic spaces. In [32] an affirmative answer is given to the problem of J. Lukeš concerning the existence of a nondegenerate harmonic sheaf with Brelot's convergence property on a connected space which is not locally connected. The paper [26] provides a complete characterization of sets of ellipticity and absorbing sets on one-dimensional harmonic spaces. All noncompact connected one-dimensional Brelot harmonic spaces are described in [31]. In [29], harmonic spaces with the following continuation property are investigated: Each point is contained in a domain D such that every harmonic function defined on an arbitrary subdomain of D can be harmonically continued to the whole D. It is shown that a Brelot space X enjoys this property if and only if it has the following simple topological structure: for every $x \in X$ there exist arcs $C_1, C_2, \dots, C_n$ such that $\bigcup\{C_j\,;\, 1 \le j \le n\}$ is a neighborhood of x and $C_j \cap C_k = \{x\}$ for $1 \le j < k \le n$.

The papers [41] and [37] are devoted to potentials of measures. In [41] it is shown that, for kernels K satisfying the domination principle, the following continuity principle is valid: If ν is a signed measure whose potential $K\nu$ is finite, and if the restriction of $K\nu$ to the support of ν is continuous, then the potential $K\nu$ is necessarily continuous on the whole space. In the case of a measure this is the classical Evans-Vasilesco theorem. However, this theorem does not yield (by passing to the positive and negative parts) the above assertion, since "cancellation of discontinuities" may occur.

In [37] a proof is given of a necessary and sufficient condition for measures ν on $\mathbb{R}^m$ to have the property that there exists a nontrivial measure ϱ on $\mathbb{R}$ such that the heat potential of the measure $\nu \otimes \varrho$ locally satisfies an anisotropic Hölder condition.

In [45] the size of the set of fine strict maxima of functions defined on $\mathbb{R}^m$ is studied. We recall that the fine topology in the space $\mathbb{R}^m$, $m > 2$, is defined as the coarsest topology for which all potentials are continuous. For $f\colon \mathbb{R}^m \to \mathbb{R}$ let us denote by $M(f)$ the set of all points $x \in \mathbb{R}^m$ which have a fine neighborhood V such that $f < f(x)$ on $V \setminus \{x\}$. It is shown in [45] that the set $M(f)$ has zero Newtonian capacity provided f is a Borel function.

In [40] Král proved the following theorem of Radó's type for harmonic functions (and in this way verified Greenfield's conjecture): If h is a continuously differentiable function on an open set $G \subset \mathbb{R}^m$ and h is harmonic on the set $G_h := \{x \in G;\ h(x) \neq 0\}$, then h is harmonic on the whole set G. In this case the set G_h on which h is harmonic, satisfies $h(G \setminus G_h) \subset \{0\}$. For various function spaces, Král characterized in [40], in terms of suitable Hausdorff measures, the sets $E \subset \mathbb{R}$ for which the condition $h(G \setminus G_h) \subset E$ guarantees that h is harmonic on the whole set G.

An analogue of Radó's theorem for differential forms and for solutions of elliptic differential equations is proved in [51].

The papers [93], [36] do not directly belong to potential theory, being only loosely connected with it. They are devoted to the estimation of the analytic capacity by means of the linear measure. For a compact set $Q \subset \mathbb{C}$ and for $z \in \mathbb{C}$ let us denote by $v^Q(z)$ the average number of points of intersection of the halflines originating at z with Q and set $V(Q) := \sup\{v^Q(z)\,;\, z \in Q\}$. The main result of [36] is as follows: If $Q \subset \mathbb{C}$ is a continuum and $K \subset Q$ is compact, then the following inequality holds for the analytic capacity $\gamma(K)$ and the linear measure $m(K)$:

$$\gamma(K) \geq \frac{1}{2\pi} \, \frac{1}{2V(Q)+1} \, m(K).$$

Josef Král liked to solve problems; he published solutions of some problems which he found interesting; see, for example, [8], [79]. A search of *MathSciNet* reveals that he wrote more than 180 reviews for Mathematical Reviews.

We do hope that we have succeeded in, at least, indicating the depth and elegance of Král's mathematical results. Many of them are of definitive character and thus provide final and elegant solution of important problems. The way in which Král presented his results shows his conception of mathematical exactness, perfection and beauty.

His results, and their international impact, together with his extraordinarily successful activities in mathematical education, have placed Josef Král among the most prominent Czechoslovak mathematicians of the post-war period. His modesty, devotion and humble respect in the face of the immensity of Mathematics made him an exceptional person.

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Diploma theses supervised by Josef Král

1962 J. Lukeš: *On the Lebesgue integral*

1969 J. Štulc: *On the length of curves and continua*

1970 M. Dont: *Limits of potentials in higher dimensional spaces*

M. Řezníček: *Convergence in length and variation*

1973 J. Beránek: *Solutions of the Dirichlet problem by means of logarithmic double layer potentials*

P. Veselý: *Some properties of functions analogous to double layer potentials*

S. Mrzena: *Heat potentials*

1975 Chu Viet Dai: *Heat potentials*

1977 V. Pelikán: *Boundary value problems with a transition condition*

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L. Šolc: *Semielliptic differential operators*

1982 D. Křivánková: *Function kernels in potential theory*

1984 H. Zlonická: *Singularities of solutions of PDE's*

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M. Dont: *The Fredholm method and the heat equation*

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1988 M. Chlebík: *Tricomi's potentials*

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