

# Lecture Notes in Mathematics

For information about Vols. 1-609, please contact your bookseller or Springer-Verlag.

- Vol. 610: G. Jensen, Higher Order Contact of Submanifolds of Homogeneous Spaces. XII, 154 pages. 1977.
- Vol. 611: M. Makkai and G. E. Reyes, First Order Categorical Logic. VIII, 301 pages. 1977.
- Vol. 612: E. M. Kleinberg, Infinitary Combinatorics and the Axiom of Determinateness. VIII, 150 pages. 1977.
- Vol. 613: E. Behrends et al.,  $L^p$ -Structure in Real Banach Spaces. X, 108 pages. 1977.
- Vol. 614: H. Yanagihara, Theory of Hopf Algebras Attached to Group Schemes. VIII, 308 pages. 1977.
- Vol. 615: Turbulence Seminar, Proceedings 1976/77. Edited by P. Bernard and T. Ratiu. VI, 155 pages. 1977.
- Vol. 616: Abelian Group Theory, 2nd New Mexico State University Conference, 1976. Proceedings. Edited by D. Arnold, R. Hunter and E. Walker. X, 423 pages. 1977.
- Vol. 617: K. J. Devlin, The Axiom of Constructibility: A Guide for the Mathematician. VIII, 96 pages. 1977.
- Vol. 618: I. I. Hirschman, Jr. and D. E. Hughes, Extreme Eigen Values of Toeplitz Operators. VI, 145 pages. 1977.
- Vol. 619: Set Theory and Hierarchy Theory V, Bierutowice 1976. Edited by A. Lachian, M. Srebrny, and A. Zarach. VIII, 358 pages. 1977.
- Vol. 620: H. Popp, Moduli Theory and Classification Theory of Algebraic Varieties. VIII, 189 pages. 1977.
- Vol. 621: Kauffman et al., The Deficiency Index Problem. VI, 112 pages. 1977.
- Vol. 622: Combinatorial Mathematics V, Melbourne 1976. Proceedings. Edited by C. Little. VIII, 213 pages. 1977.
- Vol. 623: I. Erdelyi and R. Lange, Spectral Decompositions on Banach Spaces. VIII, 122 pages. 1977.
- Vol. 624: Y. Guivarc'h et al., Marches Aléatoires sur les Groupes de Lie. VIII, 292 pages. 1977.
- Vol. 625: J. P. Alexander et al., Odd Order Group Actions and Witt Classification of Innerproducts. IV, 202 pages. 1977.
- Vol. 626: Number Theory Day, New York 1976. Proceedings. Edited by M. B. Nathanson. VI, 241 pages. 1977.
- Vol. 627: Modular Functions of One Variable VI, Bonn 1976. Proceedings. Edited by J.-P. Serre and D. B. Zagier. VI, 339 pages. 1977.
- Vol. 628: H. J. Baues, Obstruction Theory on the Homotopy Classification of Maps. XII, 387 pages. 1977.
- Vol. 629: W. A. Coppel, Dichotomies in Stability Theory. VI, 98 pages. 1978.
- Vol. 630: Numerical Analysis, Proceedings, Biennial Conference, Dundee 1977. Edited by G. A. Watson. XII, 199 pages. 1978.
- Vol. 631: Numerical Treatment of Differential Equations. Proceedings 1976. Edited by R. Bulirsch, R. D. Grigorieff, and J. Schröder. X, 219 pages. 1978.
- Vol. 632: J.-F. Boutot, Schéma de Picard Local. X, 165 pages. 1978.
- Vol. 633: N. R. Coleff and M. E. Herrera, Les Courants Résiduels Associés à une Forme Méromorphe. X, 211 pages. 1978.
- Vol. 634: H. Kurke et al., Die Approximationseigenschaft lokaler Ringe. IV, 204 Seiten. 1978.
- Vol. 635: T. Y. Lam, Serre's Conjecture. XVI, 227 pages. 1978.
- Vol. 636: Journées de Statistique des Processus Stochastiques, Grenoble 1977. Proceedings. Edité par Didier Dacunha-Castelle et Bernard Van Cutsem. VII, 202 pages. 1978.
- Vol. 637: W. B. Jurkat, Meromorphe Differentialgleichungen. VII, 194 Seiten. 1978.
- Vol. 638: P. Shanahan, The Atiyah-Singer Index Theorem. An Introduction. V, 224 pages. 1978.
- Vol. 639: N. Adasch et al., Topological Vector Spaces. V, 125 pages. 1978.
- Vol. 640: J. L. Dupont, Curvature and Characteristic Classes. X, 175 pages. 1978.
- Vol. 641: Séminaire d'Algèbre Paul Dubreil, Proceedings Paris 1976-1977. Edité par M. P. Malliavin. IV, 367 pages. 1978.
- Vol. 642: Theory and Applications of Graphs, Proceedings, Michigan 1976. Edited by Y. Alavi and D. R. Lick. XIV, 635 pages. 1978.
- Vol. 643: M. Davis, Multiaxial Actions on Manifolds. VI, 141 pages. 1978.
- Vol. 644: Vector Space Measures and Applications I, Proceedings 1977. Edited by R. M. Aron and S. Dineen. VIII, 451 pages. 1978.
- Vol. 645: Vector Space Measures and Applications II, Proceedings 1977. Edited by R. M. Aron and S. Dineen. VIII, 218 pages. 1978.
- Vol. 646: O. Tammi, Extremum Problems for Bounded Univalent Functions. VIII, 313 pages. 1978.
- Vol. 647: L. J. Ratliff, Jr., Chain Conjectures in Ring Theory. VIII, 133 pages. 1978.
- Vol. 648: Nonlinear Partial Differential Equations and Applications, Proceedings, Indiana 1976-1977. Edited by J. M. Chadam. VI, 206 pages. 1978.
- Vol. 649: Séminaire de Probabilités XII, Proceedings, Strasbourg, 1976-1977. Edité par C. Dellacherie, P. A. Meyer et M. Weil. VIII, 805 pages. 1978.
- Vol. 650:  $C^*$ -Algebras and Applications to Physics. Proceedings 1977. Edited by H. Araki and R. V. Kadison. V, 192 pages. 1978.
- Vol. 651: P. W. Michor, Functors and Categories of Banach Spaces. VI, 99 pages. 1978.
- Vol. 652: Differential Topology, Foliations and Gelfand-Fuks-Cohomology, Proceedings 1976. Edited by P. A. Schweitzer. XIV, 252 pages. 1978.
- Vol. 653: Locally Interacting Systems and Their Application in Biology. Proceedings, 1976. Edited by R. L. Dobrushin, V. I. Kryukov and A. L. Toom. XI, 202 pages. 1978.
- Vol. 654: J. P. Buhler, Icosahedral Galois Representations. III, 143 pages. 1978.
- Vol. 655: R. Baeza, Quadratic Forms Over Semilocal Rings. VI, 199 pages. 1978.
- Vol. 656: Probability Theory on Vector Spaces. Proceedings, 1977. Edited by A. Weron. VIII, 274 pages. 1978.
- Vol. 657: Geometric Applications of Homotopy Theory I, Proceedings 1977. Edited by M. G. Barratt and M. E. Mahowald. VIII, 459 pages. 1978.
- Vol. 658: Geometric Applications of Homotopy Theory II, Proceedings 1977. Edited by M. G. Barratt and M. E. Mahowald. VIII, 487 pages. 1978.
- Vol. 659: Bruckner, Differentiation of Real Functions. X, 247 pages. 1978.
- Vol. 660: Equations aux Dérivée Partielles. Proceedings, 1977. Edité par Pham The Lai. VI, 216 pages. 1978.
- Vol. 661: P. T. Johnstone, R. Paré, R. D. Rosebrugh, D. Schumacher, R. J. Wood, and G. C. Wraith, Indexed Categories and Their Applications. VII, 260 pages. 1978.
- Vol. 662: Akin, The Metric Theory of Banach Manifolds. XIX, 306 pages. 1978.
- Vol. 663: J. F. Berglund, H. D. Junghenn, P. Milnes, Compact Right Topological Semigroups and Generalizations of Almost Periodicity. X, 243 pages. 1978.
- Vol. 664: Algebraic and Geometric Topology, Proceedings, 1977. Edited by K. C. Millett. XI, 240 pages. 1978.
- Vol. 665: Journées d'Analyse Non Linéaire. Proceedings, 1977. Edité par P. Bénilan et J. Robert. VIII, 256 pages. 1978.
- Vol. 666: B. Beauzamy, Espaces d'Interpolation Réels: Topologie et Géométrie. X, 104 pages. 1978.
- Vol. 667: J. Gilewicz, Approximants de Padé. XIV, 511 pages. 1978.
- Vol. 668: The Structure of Attractors in Dynamical Systems. Proceedings, 1977. Edited by J. C. Martin, N. G. Markley and W. Perazzo. VI, 264 pages. 1978.
- Vol. 669: Higher Set Theory. Proceedings, 1977. Edited by G. H. Müller and D. S. Scott. XII, 476 pages. 1978.

# Lecture Notes in Mathematics

Edited by A. Dold and B. Eckmann

828

---

## Probability Theory on Vector Spaces II

Proceedings, Błazejewko, Poland,  
September 17 - 23, 1979

Edited by A. Weron

---



Springer-Verlag  
Berlin Heidelberg New York 1980

**Editor**

A. Weron  
Institute of Mathematics  
Wrocław Technical University  
Wybrzeże Wyspiańskiego 27  
50-370 Wrocław  
Poland

AMS Subject Classifications (1980): 28 CXX, 46 B20, 46 B30, 46 C10,  
47 B10, 60 BXX, 60 EXX, 60 FXX, 60 GXX

ISBN 3-540-10253-1 Springer-Verlag Berlin Heidelberg New York  
ISBN 0-387-10253-1 Springer-Verlag New York Heidelberg Berlin

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically those of translation, reprinting, re-use of illustrations, broadcasting, reproduction by photocopying machine or similar means, and storage in data banks. Under § 54 of the German Copyright Law where copies are made for other than private use, a fee is payable to the publisher, the amount of the fee to be determined by agreement with the publisher.

© by Springer-Verlag Berlin Heidelberg 1980  
Printed in Germany

Printing and binding: Beltz Offsetdruck, Hemsbach/Bergstr.  
2141/3140-543210

## F O R E W O R D

The Institute of Mathematics of Wrocław Technical University organized the Second International Conference on Probability Theory on Vector Spaces in Błażejewko from September 17 to September 23, 1979. The first Conference had been organized by the Institute in 1977. At the present Conference there were 74 registered participants from 10 countries, 44 among them from Poland. This Conference was sponsored by the Wrocław Technical University and was organized by the following committee: S. Gładysz, J. Górniak (Secretary), C. Ryll-Nardzewski and A. Weron (Chairman), Mrs. T. Cieślak and Mrs. O. Olak acted as Organizing Secretaries for the Conference.

It was the purpose of this meeting to bring together mathematicians working in Probability Theory on Vector Spaces to discuss the functional analysis aspects of this field. The following (non-disjoint) topics were covered:

Gaussian Processes and Stable Measures	-	Geometry of Banach Spaces, Special Class of Operators.
Limit Theorems (CLT, LIL, IP)	-	Topological Spaces, Geometry of Vector Spaces; $C(S)$ , $D(0,1)$
Random Fields, Stationary and Vector Valued Processes	-	Hilbert Space Methods, Dilation Theory and Reproducing Kernels.
Brownian Motion, Integrability of Random Vectors and Cylindrical Processes	-	Infinite-Dimensional Calculus and Differential Equations, Semigroups of Measures.

*This volume contains 30 contributions - the written and often extended versions of most lectures given at the Conference. A great majority of papers present new results in the field and the rest are expository in nature. The material in this volume complements the material in the earlier volume Probability Theory on Vector Spaces, Proceedings Lecture Notes in Math. vol. 656, 1978, Springer Verlag.*

*While I take the responsibility for any mistakes in the organization of the Conference and the editing of the Proceedings, I wish to express my gratitude to several persons for their valuable help. On behalf of the Organizing Committee I wish to thank the authorities of the Wrocław Technical University for providing facilities which made it possible to hold the Conference in Białejewko. I am indebted to Professors S.Gładysz and C.Ryll-Nardzewski for their help in the organization of the program. I wish to thank to Professors: A.Badrikian, S.D.Chatterji, Z.Ciesielski, X.Fernique, S.Gładysz, P.Masani, V.Mandrekar, V.Paulauskas, C.Ryll-Nardzewski and F.H.Szafraniec for presiding over the sessions. I am grateful to my colleagues from the Institute of Mathematics, in particular to Drs. J.Górniak and P.Kajetanowicz, for their help in various administrative matters. Special thanks are due to the contributors to this volume, to those who reviewed the papers and to Springer-Verlag for their excellent cooperation.*

*Aleksander Weron*

## C O N T E N T S

Hilbert spaces of Hilbert space valued functions J. BURBEA and P. MASANI .....	1
On the integrability of Gaussian random vectors T. BYCZKOWSKI and T. ŻAK .....	21
Infinite dimensional Newtonian potentials R. CARMONA .....	30
Multiparameter processes and vector-valued processes S.D. CHATTERJI .....	44
On geometry of Orlicz spaces Z.G. GORGADZE and V.I. TARIELADZE .....	47
The generalized domain of attraction of spherically symmetric stable laws on $\mathbb{R}^d$ M.G. HAHN and M.J. KLASS .....	52
A class of convolution semi-groups of measures on a Lie group A. HULANICKI .....	82
Convergence of two-sample empirical processes T. INGLOT .....	102
V-decomposable measures on Hilbert spaces R. JAJTE .....	108
On stability of probability measures in Euclidean spaces Z.J. JUREK .....	128
Fourier-Wiener transform on Brownian functionals H.-H. KUO .....	146
On unconditional convergence of random series in Banach spaces V.V. KVARATSKHELIA .....	162

p-stable measures and p-absolutely summing operators W. LINDE, V. MANDREKAR and A. WERON .....	167
Support and seminorm integrability theorems for r-semistable probability measures on LCTVS D. LOUIE and B.S. RAJPUT .....	179
Remark on the extrapolation of Banach space valued stationary processes A. MAKAGON .....	196
Dilations with operator multipliers W. MŁAK and F.H. SZAFRANIEC .....	208
On the construction of Wold-Cramér decomposition for bivariate stationary processes H. NIEMI .....	215
Representation of a bounded operator as a finite linear combination of projectors and some inequalities for a functional on $B(H)$ A. PASZKIEWICZ .....	223
The rates of convergence in the central limit theorem in Banach spaces V. PAULAUSKAS .....	234
The generalized Anscombe condition and its applications in random limit theorems E. RYCHLIK and Z. RYCHLIK .....	244
On moving average representations of Banach-space valued stationary processes over LCA-groups F. SCHMIDT .....	251
Dilations of reproducing kernels R. SHONKWILER .....	259
Remarks on Pettis integrability of cylindrical processes Z. SUCHANECKI .....	269

A probabilistic characterization of unconditionally summing operators	
R. SZTENCEL .....	274
On operator characterization of AM- and AL-spaces	
J. SZULGA .....	277
On nuclear covariance operators	
V.I. TARIELADZE .....	283
On symmetric stable measures with discrete spectral measure on Banach spaces	
DANG HUNG THANG and NGUYEN ZUI TIEN .....	286
A characterization of some probability distributions	
NGUYEN VAN THU .....	302
Banach spaces related to $\alpha$ -stable measures	
NGUYEN ZUI TIEN and A. WERON .....	309
On series representation of second order random elements and stochastic processes	
M.R. ZEBERSKI .....	318



List of Contributors

- J. BURBEA, University of Pittsburgh, Pittsburgh,  
PA 15260, USA.
- T. BYCZKOWSKI, Wrocław Technical University, 50-370 Wrocław,  
Poland.
- R. CARMONA, Université de Saint Etienne, 42025 Saint Etien-  
ne, France.
- S.D. CHATTERJI, Ecole Polytechnique Fédérale, 1007 Lausanne,  
Switzerland.
- Z. GORGADZE, Tbilisi State University, 380093 Tbilisi, USSR.
- M.D. HAHN, Tufts University, Medford MA 02155, USA.
- A. HULANICKI, Polish Academy of Sciences, 51-617 Wrocław,  
Poland.
- T. INGLLOT, Wrocław Technical University, 50-370 Wrocław,  
Poland.
- R. JAJTE, Łódź University, 90-238, Poland.
- Z. JUREK, Wrocław University, 50-384 Wrocław, Poland.
- M.J. KLASS, University of California, Berkeley, CA 94720,  
USA.
- H.H. KUO, Louisiana State University, Baton Rouge,  
LA 70803, USA.

- V. KVARATSKHELIA, Academy of Sciences GSSR, 380093 Tbilisi, USSR.
- V. LINDE, Friedrich-Schiller Universität, 69 Jena, DDR.
- D. LOUIE, University of Tennessee, Knoxville, TE 37916,  
USA.
- A. MAKAGON, Wrocław Technical University, 50-370 Wrocław,  
Poland.
- V. MANDREKAR, Michigan State University, E. Lansing MI 48824,  
USA.
- P. MASANI, University of Pittsburgh, Pittsburgh PA 15260,  
USA.
- W. MLAK, Polish Academy of Sciences, 31-027 Cracow,  
Poland.
- H. NIEMI, University of Helsinki, 00100 Helsinki 10,  
Finland.
- A. PASZKIEWICZ, Łódź University, 90-238 Łódź, Poland.
- V. PAULAUSKAS, Vilnius V. Kapsukas University, Vilnius 232042,  
USSR.
- B. S. RAJPUT, University of Tennessee, Knoxville TE 37916,  
USA.
- E. RYCHLIK, Warsaw University, 00-901 Warsaw, Poland.
- Z. RYCHLIK, MCS University, 20-031 Lublin, Poland.
- F. SCHMIDT, Technische Universität Dresden, 8027 Dresden,  
DDR.
- R. SHONKWILER, Georgia Institute of Technology, Atlanta,  
GA 30332, USA.

- Z. SUCHANECKI, Wrocław Technical University, 50-370 Wrocław,  
Poland.
- F.H. SZAPRANIEC, Jagiellonian University, 30-059 Cracow, Poland.
- R. SZTENCEL, Warsaw University, 00-901 Warsaw, Poland.
- J. SZULGA, Wrocław University, 50-384 Wrocław, Poland.
- V. TARIELADZE, Academy of Science of the GSSR, 380093 Tbilisi,  
USSR.
- D. H. THANG, University of Hanoi, Hanoi, Vietnam.
- N.V. THU, Institut of Mathematics, 208 D Hanoi, Vietnam.
- N. Z. TIEN, University of Hanoi, Hanoi, Vietnam.
- A. WERON, Wrocław Technical University, 50-370 Wrocław,  
Poland.
- T. ŻAK, Wrocław Technical University, 50-370 Wrocław,  
Poland.
- R. ŻEBERSKI, Wrocław Technical University, 50-370 Wrocław,  
Poland.

Titles of non included talks:

The convergence of random variables in topological spaces.

V. BULDYGIN /AN USSR, Kiev/.

Two applications of a lemma on Gaussian covariances.

S. A. CHOBANJAN /AN GSSR, Tbilisi/.

Gaussian covariances in Banach lattices.

S. A. CHOBANJAN and V. I. TARIELADZE /AN GSSR, Tbilisi/.

Weak convergence of sequences of random elements with random indices.

M. CSÖRGO /Carleton University, Ottawa/ and Z. RYCHLIK  
/UMCS, Lublin/.

Certaines fonctionnelles associées a des fonctions aleatoires  
Gausiennes.

X. FERNIQUE /Univ. Louis Pasteur, Strasbourg/.

Remarks on CLT in  $C(S)$ .

E. GINÉ /I.V.I.C., Caracas/.

La loi du logarithme itere dans les espaces de Banach.

B. HEINKEL /Univ. Louis Pasteur, Strasbourg/.

Dilations of Gleason measures.

E. HENSZ /Łódź University/

Aproximation theorems for stochastic operators on  $L^1$ .

A. IWANIK /Wrocław Technical University/.

On certain properties of  $p$ -uniformly smooth Banach spaces.

A. KORZENIOWSKI /Wrocław University/.

Finite generators for ergodic endomorphisms.

Z. KOWALSKI /Wrocław Technical University/.

Continuity of infinitely divisible distributions.

A. ŁUCZAK /Łódź University/.

Quasi-invariant measures and Markov fields.

V. MANDREKAR /Michigan State University, E. Lansing/.

Remarks on operator stability of probability measures on Banach Spaces

B. MINCER /Wrocław University/.

A characterization of Gaussian process based on differentiable equations.

A. PLUCIŃSKA /Warsaw Technical University/.

On the decomposability semigroups for certain probability measures.

T. RAJBA /Wrocław University/.

On stochastic equations with the reflection boundary condition

M. RUTKOWSKI /Warsaw Technical University/.

Multidimensional dissipative random fields.

M. SŁOCIŃSKI /Jagiellonian University, Cracow/

A short proof of 0-1 Law for stable measures.

W. SMOLEŃSKI /Warsaw Technical University/.

Kolmogorov-Bochner extension theorem for semi-spectral measures.

J. STOCHEL /IM PAN, Cracow/.

On the a.e. convergence of ergodic averages for Bernoulli shifts.

J. WOŚ /Wrocław Technical University/.

Properties of spherically symmetric distributions in  $R^n$ .

V. ZOLOTARIEV /AN USSR, Moscow/.

Some new results of V.V. Senatov in multidimensional CLT.

V. ZOLOTARIEV /AN USSR, Moscow/.