

ICM 1998
CONTENTS OF VOLUMES I, II, AND III

Preface	I	11
Past Congresses	I	12
Past Fields Medalists and Rolf Nevanlinna Prize Winners	I	13
MARTIN GRÖTSCHEL: Organization of the Congress	I	15
The Committees of the Congress	I	19
List of Donors	I	21
Opening Ceremony	I	23
YURI I. MANIN: Presentation of the Fields Medals and a Special Tribute	I	45
DAVID MUMFORD: Presentation of the Rolf Nevanlinna Prize	I	49
Fax to the Federal President and to the Governing Mayor	I	50
Closing Ceremony	I	53
List of Participants	I	61
Participants by Country	I	96

THE WORK OF THE FIELDS MEDALISTS
AND OF THE ROLF NEVANLINNA PRIZE WINNER

PETER GODDARD: The Work of Richard Ewen Borcherds	I	99
BÉLA BOLLOBÁS: The Work of William Timothy Gowers	I	109
CLIFFORD HENRY TAUBES: The Work of Maxim Kontsevich	I	119
STEVE SMALE: The Work of Curtis T. McMullen	I	127
RONALD GRAHAM: The Work of Peter W. Shor	I	133

INVITED ONE-HOUR PLENARY LECTURES

JEAN-MICHEL BISMUT: Local Index Theory and Higher Analytic Torsion	I	143
CHRISTOPHER DENINGER: Some Analogies Between Number Theory and Dynamical Systems on Foliated Spaces	I	163
PERSI DIACONIS: From Shuffling Cards to Walking Around the Building: An Introduction to Modern Markov Chain Theory	I	187
GIOVANNI GALLAVOTTI: Chaotic Hypothesis and Universal Large Deviations Properties	I	205
WOLFGANG HACKBUSCH: From Classical Numerical Mathematics to Scientific Computing	I	235
HELMUT H. W. HOFER: Dynamics, Topology, and Holomorphic Curves	I	255
EHUD HRUSHOVSKI: Geometric Model Theory	I	281
I. G. MACDONALD: Constant Term Identities, Orthogonal Polynomials, and Affine Hecke Algebras	I	303
STÉPHANE MALLAT: Applied Mathematics Meets Signal Processing ..	I	319
DUSA MCDUFF: Fibrations in Symplectic Topology	I	339

TETSUJI MIWA: Solvable Lattice Models and Representation Theory of Quantum Affine Algebras	I	359
JÜRGEN MOSER: Dynamical Systems – Past and Present	I	381
GEORGE PAPANICOLAOU: Mathematical Problems in Geophysical Wave Propagation	I	403
GILLES PISIER: Operator Spaces and Similarity Problems	I	429
PETER SARNAK: L-Functions	I	453
PETER W. SHOR: Quantum Computing	I	467
KARL SIGMUND: The Population Dynamics of Conflict and Cooperation	I	487
MICHEL TALAGRAND: Huge Random Structures and Mean Field Models for Spin Glasses	I	507
CUMRUN VAFA: Geometric Physics	I	537
MARCELO VIANA: Dynamics: A Probabilistic and Geometric Perspective	I	557
VLADIMIR VOEVODSKY: A^1 -Homotopy Theory	I	579

**LECTURES BY THE FIELDS MEDALISTS
AND BY THE ROLF NEVANLINNA PRIZE WINNER**

RICHARD E. BORCHERDS: What is Moonshine?	I	607
W. T. GOWERS: Fourier Analysis and Szemerédi's Theorem	I	617
CURTIS T. McMULLEN: Rigidity and Inflexibility in Conformal Dynamics	II	841
see also:	I	630
PETER W. SHOR: Quantum Computing	I	467

**APPENDIX: INVITED FORTY-FIVE MINUTE LECTURES
AT THE SECTION MEETINGS**

This appendix contains three manuscripts of Invited Speakers
which are not included in Volume II or III

SECTION 1. LOGIC: A. J. WILKIE: O-Minimality	I	633
SECTION 10. PARTIAL DIFFERENTIAL EQUATIONS: MIKHAIL SAFONOV: Estimates Near the Boundary for Solutions of Second Order Parabolic Equations	I	637
SECTION 12. PROBABILITY AND STATISTICS: F. GÖTZE: Errata: Lattice Point Problems	I	648
SECTION 16. APPLICATIONS: SERAFIM BATZOGLOU, BONNIE BERGER, DANIEL J. KLEITMAN, ERIC S. LANDER, AND LIOR PACTHER: Recent Developments in Computational Gene Recognition	I	649
AUTHOR INDEX FOR VOLUMES I, II, AND III	I	659

INVITED FORTY-FIVE MINUTE LECTURES
AT THE SECTION MEETINGS
CONTENTS OF VOLUMES II AND III

In case of several authors, Invited Speakers are marked with a *.
The author index is at the end of each of these two volumes.

SECTION 1. LOGIC

MATTHEW FOREMAN: Generic Large Cardinals: New Axioms for Mathematics?	II	11
GREG HJORTH: When is an Equivalence Relation Classifiable?	II	23
LUDOMIR NEWELSKI: Meager Forking and m-Independence	II	33
STEVO TODORCEVIC: Basis Problems in Combinatorial Set Theory ..	II	43

SECTION 2. ALGEBRA

ERIC M. FRIEDLANDER: Geometry of Infinitesimal Group Schemes ..	II	55
SERGEI V. IVANOV: On the Burnside Problem for Groups of Even Exponent	II	67
WILLIAM M. KANTOR: Simple Groups in Computational Group Theory	II	77
GUNTER MALLE: Spetses	II	87
ALEKSANDR V. PUKHLIKOV: Birational Automorphisms of Higher-Dimensional Algebraic Varieties	II	97
IDUN REITEN: Tilting Theory and Quasitilted Algebras	II	109
JEREMY RICKARD: The Abelian Defect Group Conjecture	II	121
ANER SHALEV: Simple Groups, Permutation Groups, and Probability ..	II	129

SECTION 3. NUMBER THEORY AND ARITHMETIC ALGEBRAIC GEOMETRY

VLADIMIR G. BERKOVICH: p-Adic Analytic Spaces	II	141
PIERRE COLMEZ: Représentations p-Adiques d'un Corps Local	II	153
W. DUKE: Bounds for Arithmetic Multiplicities	II	163
FRANÇOIS GRAMAIN: Quelques Résultats d'Indépendance Algébrique ..	II	173
LOÏC MEREL: Points Rationnels et Séries de Dirichlet	II	183
SHINICHI MOCHIZUKI: The Intrinsic Hodge Theory of p-Adic Hyperbolic Curves	II	187
HANS PETER SCHLICKWEI: The Subspace Theorem and Applications ..	II	197
TAKESHI TSUJI: p-Adic Hodge Theory in the Semi-Stable Reduction Case	II	207
SHOU-WU ZHANG: Small Points and Arakelov Theory	II	217

SECTION 4. ALGEBRAIC GEOMETRY

PAUL S. ASPINWALL: String Theory and Duality	II	229
VICTOR V. BATYREV: Mirror Symmetry and Toric Geometry	II	239
MAURIZIO CORNALBA: Cohomology of Moduli Spaces of Stable Curves ..	II	249

A. J. DE JONG: Barsotti-Tate Groups and Crystals	II	259
MARK L. GREEN: Higher Abel-Jacobi Maps	II	267
M. KAPRANOV: Operads and Algebraic Geometry	II	277
SECTION 5. DIFFERENTIAL GEOMETRY AND GLOBAL ANALYSIS		
DMITRI BURAGO: Hard Balls Gas and Alexandrov Spaces of Curvature Bounded Above	II	289
TOBIAS H. COLDING: Spaces with Ricci Curvature Bounds	II	299
S. K. DONALDSON: Lefschetz Fibrations in Symplectic Geometry	II	309
BORIS DUBROVIN: Geometry and Analytic Theory of Frobenius Manifolds	II	315
YAKOV ELIASHBERG: Invariants in Contact Topology	II	327
S. GALLOT: Curvature-Decreasing Maps are Volume-Decreasing	II	339
GERHARD HUISKEN: Evolution of Hypersurfaces by Their Curvature in Riemannian Manifolds	II	349
DOMINIC JOYCE: Compact Manifolds with Exceptional Holonomy	II	361
FRANÇOIS LABOURIE: Large Groups Actions on Manifolds	II	371
JOACHIM LOHKAMP: Curvature Contents of Geometric Spaces	II	381
FRANZ PEDIT AND ULRICH PINKALL*: Quaternionic Analysis on Riemann Surfaces and Differential Geometry	II	389
LEONID POLTEROVICH: Geometry on the Group of Hamiltonian Diffeomorphisms	II	401
YONGBIN RUAN: Quantum Cohomology and its Application	II	411
SECTION 6. TOPOLOGY		
A. N. DRANISHNIKOV: Dimension Theory and Large Riemannian Manifolds	II	423
W. G. DWYER: Lie Groups and p-Compact Groups	II	433
RONALD FINTUSHEL* AND RONALD J. STERN*: Constructions of Smooth 4-Manifolds	II	443
MICHAEL H. FREEDMAN: Topological Views on Computational Complexity	II	453
MARK MAHOWALD: Toward a Global Understanding of $\pi_*(S^n)$	II	465
TOMOTADA OHTSUKI: A Filtration of the Set of Integral Homology 3-Spheres	II	473
BOB OLIVER: Vector Bundles over Classifying Spaces	II	483
CLIFFORD HENRY TAUBES: The Geometry of the Seiberg-Witten Invariants	II	493
SECTION 7. LIE GROUPS AND LIE ALGEBRAS		
JAMES ARTHUR: Towards a Stable Trace Formula	II	507
JOSEPH BERNSTEIN: Analytic Structures on Representation Spaces of Reductive Groups	II	519
IVAN CHEREDNIK: From Double Hecke Algebra to Analysis	II	527
ALEX ESKIN: Counting Problems and Semisimple Groups	II	539

ROBERT E. KOTTWITZ: Harmonic Analysis on Semisimple p-Adic Lie Algebras	II	553
L. LAFFORGUE: Chtoucas de Drinfeld et Applications	II	563
SHAHAR MOZES: Products of Trees, Lattices and Simple Groups	II	571
VERA SERGANOVA: Characters of Irreducible Representations of Simple Lie Superalgebras	II	583
KARI VILONEN: Topological Methods in Representation Theory	II	595
MINORU WAKIMOTO: Representation Theory of Affine Superalgebras at the Critical Level	II	605
SECTION 8. ANALYSIS		
KARI ASTALA: Analytic Aspects of Quasiconformality	II	617
MICHAEL CHRIST: Singularity and Regularity — Local and Global ...	II	627
NIGEL HIGSON: The Baum-Connes Conjecture	II	637
MICHAEL T. LACEY: On the Bilinear Hilbert Transform	II	647
PERTTI MATTILA: Rectifiability, Analytic Capacity, and Singular Integrals	II	657
VITALI MILMAN: Randomness and Pattern in Convex Geometric Analysis	II	665
DETLEF MÜLLER: Functional Calculus on Lie Groups and Wave Propagation	II	679
STEFAN MÜLLER* AND VLADIMIR ŠVERÁK: Unexpected Solutions of First and Second Order Partial Differential Equations	II	691
KLAS DIEDERICH AND SERGEY PINCHUK*: Reflection Principle in Higher Dimensions	II	703
KRISTIAN SEIP: Developments from Nonharmonic Fourier Series	II	713
HART F. SMITH: Wave Equations with Low Regularity Coefficients ..	II	723
NICOLE TOMCZAK-JAEGERMANN: From Finite- to Infinite-Dimensional Phenomena in Geometric Functional Analysis on Local and Asymptotic Levels	II	731
STEPHEN WAINGER: Discrete Analogues of Singular and Maximal Radon Transforms	II	743
THOMAS WOLFF: Maximal Averages and Packing of One Dimensional Sets	II	755
SECTION 9. ORDINARY DIFFERENTIAL EQUATIONS AND DYNAMICAL SYSTEMS		
W. DE MELO: Rigidity and Renormalization in One Dimensional Dynamical Systems	II	765
L. H. ELIASSON: Reducibility and Point Spectrum for Linear Quasi-Periodic Skew-Products	II	779
SHUHEI HAYASHI: Hyperbolicity, Stability, and the Creation of Homoclinic Points	II	789
MICHAEL HERMAN: Some Open Problems in Dynamical Systems	II	797
YURI KIFER: Random Dynamics and its Applications	II	809

SERGEI B. KUKSIN: Elements of a Qualitative Theory of Hamiltonian PDEs	II	819
KRYSZYNA KUPERBERG: Counterexamples to the Seifert Conjecture .	II	831
CURTIS T. MCMULLEN: Rigidity and Inflexibility in Conformal Dynamics	II	841
GRZEGORZ ŚWIĄTEK: Induced Hyperbolicity for One-Dimensional Maps	II	857
ZHIHONG XIA: Arnold Diffusion: A Variational Construction	II	867
SECTION 10. PARTIAL DIFFERENTIAL EQUATIONS		
FABRICE BETHUEL: Vortices in Ginzburg-Landau Equations	III	11
FRÉDÉRIC HÉLEIN: Phenomena of Compensation and Estimates for Partial Differential Equations	III	21
ROBERT R. JENSEN: Viscosity Solutions of Elliptic Partial Differential Equations	III	31
HANS LINDBLAD: Minimal Regularity Solutions of Nonlinear Wave Equations	III	39
M. MACHEDON: Fourier Analysis of Null Forms and Non-linear Wave Equations	III	49
FRANK MERLE: Blow-up Phenomena for Critical Nonlinear Schrödinger and Zakharov Equations	III	57
GUSTAVO PONCE: On Nonlinear Dispersive Equations	III	67
GUNTHER UHLMANN: Inverse Boundary Value Problems for Partial Differential Equations	III	77
D. YAFAEV: Scattering Theory: Some Old and New Problems	III	87
SECTION 11. MATHEMATICAL PHYSICS		
EUGENE BOGOMOLNY: Spectral Statistics	III	99
DETLEV BUCHHOLZ: Scaling Algebras in Local Relativistic Quantum Physics	III	109
J. T. CHAYES: Finite-Size Scaling in Percolation	III	113
P. COLLET: Extended Dynamical Systems	III	123
ROBERT DIJKGRAAF: The Mathematics of Fivebranes	III	133
ANTONIO GIORGILLI: On the Problem of Stability for Near to Integrable Hamiltonian Systems	III	143
GIAN MICHELE GRAF: Stability of Matter in Classical and Quantized Fields	III	153
ALEXANDER BERKOVICH AND BARRY M. MCCOY*: Rogers-Ramanujan Identities: A Century of Progress from Mathematics to Physics	III	163
ROBERTO H. SCHONMANN: Metastability and the Ising Model	III	173
FEODOR A. SMIRNOV: Space of Local Fields in Integrable Field Theory and Deformed Abelian Differentials	III	183
HORNG-TZER YAU: Scaling Limit of Particle Systems, Incompressible Navier-Stokes Equation and Boltzmann Equation	III	193

SECTION 12. PROBABILITY AND STATISTICS

DAVID J. ALDOUS: Stochastic Coalescence	III	205
MAURY BRAMSON: State Space Collapse for Queueing Networks	III	213
MARK I. FREIDLIN: Random and Deterministic Perturbations of Nonlinear Oscillators	III	223
JAYANTA K. GHOSH: Bayesian Density Estimation	III	237
F. GÖTZE: Lattice Point Problems and the Central Limit Theorem in Euclidean Spaces	III	245
PETER HALL* AND BRETT PRESNELL: Applications of Intentionally Biased Bootstrap Methods	III	257
IAIN M. JOHNSTONE: Oracle Inequalities and Nonparametric Function Estimation	III	267
JEAN-FRANÇOIS LE GALL: Branching Processes, Random Trees and Superprocesses	III	279
DAVID SIEGMUND: Genetic Linkage Analysis: an Irregular Statistical Problem	III	291
ALAIN-SOL SZNITMAN: Brownian Motion and Random Obstacles	III	301
BORIS TSIRELSON: Within and Beyond the Reach of Brownian Innovation	III	311
R. J. WILLIAMS: Reflecting Diffusions and Queueing Networks	III	321

SECTION 13. COMBINATORICS

BÉLA BOLLOBÁS: Hereditary Properties of Graphs: Asymptotic Enumeration, Global Structure, and Colouring	III	333
ANDRÁS FRANK: Applications of Relaxed Submodularity	III	343
ALAIN LASCoux: Ordonner le Groupe Symétrique: Pourquoi Utiliser l'Algèbre de Iwahori-Hecke ?	III	355
JIŘÍ MATOUŠEK: Mathematical Snapshots from the Computational Geometry Landscape	III	365
HARALD NIEDERREITER: Nets, (t, s) -Sequences, and Algebraic Curves over Finite Fields with Many Rational Points	III	377
N. J. A. SLOANE: The Sphere Packing Problem	III	387
JOSEPH A. THAS: Finite Geometries, Varieties and Codes	III	397
ANDREI ZELEVINSKY: Multisegment Duality, Canonical Bases and Total Positivity	III	409

SECTION 14. MATHEMATICAL ASPECTS OF COMPUTER SCIENCE

MIKLÓS AJTAI: Worst-Case Complexity, Average-Case Complexity and Lattice Problems	III	421
JOAN FEIGENBAUM: Games, Complexity Classes, and Approximation Algorithms	III	429
JOHAN HÅSTAD: On Approximating NP-Hard Optimization Problems	III	441
TONIANN PITASSI: Unsolvability of Systems of Equations and Proof Complexity	III	451
MADHU SUDAN: Probabilistic Verification of Proofs	III	461

ARTUR ANDRZEJAK AND EMO WELZL*: Halving Point Sets	III	471
SECTION 15. NUMERICAL ANALYSIS AND SCIENTIFIC COMPUTING		
GREGORY BEYLKIN: On Multiresolution Methods in Numerical Analysis	III	481
P. DEIFT*, T. KRIECHERBAUER, K. T-R McLAUGHLIN, S. VENAKIDES AND X. ZHOU: Uniform Asymptotics for Orthogonal Polynomials	III	491
BJORN ENGQUIST: Wavelet Based Numerical Homogenization	III	503
HISASHI OKAMOTO: A Study of Bifurcation of Kolmogorov Flows with an Emphasis on the Singular Limit	III	513
JAN-OLOV STRÖMBERG: Computation with Wavelets in Higher Dimensions	III	523
LLOYD N. TREFETHEN* AND TOBIN A. DRISCOLL: Schwarz–Christoffel Mapping in the Computer Era	III	533
SECTION 16. APPLICATIONS		
MARCO AVELLANEDA: The Minimum-Entropy Algorithm and Related Methods for Calibrating Asset-Pricing Models	III	545
ANDREAS DRESS*, WERNER TERHALLE: The Tree of Life and Other Affine Buildings	III	565
LESLIE GREENGARD* AND XIAOBAI SUN: A New Version of the Fast Gauss Transform	III	575
ULF GRENANDER: Strategies for Seeing	III	585
FRANK HOPPENSTEADT* AND EUGENE IZHIKEVICH: Canonical Models in Mathematical Neuroscience	III	593
THOMAS YIZHAO HOU: Numerical Study of Free Interface Problems Using Boundary Integral Methods	III	601
GÉRARD IOOSS: Travelling Water-Waves, as a Paradigm for Bifurcations in Reversible Infinite Dimensional “Dynamical” Systems	III	611
YURY GRABOVSKY AND GRAEME W. MILTON*: Exact Relations for Composites: Towards a Complete Solution	III	623
CHARLES S. PESKIN: Optimal Dynamic Instability of Microtubules ..	III	633
SECTION 17. CONTROL THEORY AND OPTIMIZATION		
DAVID APPLGATE, ROBERT BIXBY, VAŠEK CHV’ATAL AND WILLIAM COOK*: On the Solution of Traveling Salesman Problems	III	645
MICHEL X. GOEMANS: Semidefinite Programming and Combinatorial Optimization	III	657
RICHARD H. BYRD AND JORGE NOCEDAL*: Active Set and Interior Methods for Nonlinear Optimization	III	667
RANGA ANBIL, JOHN J. FORREST AND WILLIAM R. PULLEYBLANK*: Column Generation and the Airline Crew Pairing Problem	III	677

ALEXANDER SCHRIJVER: Routing and Timetabling by Topological Search	III	687
JAN C. WILLEMS: Open Dynamical Systems and their Control	III	697
MICHAL KOČVARA AND JOCHEM ZOWE*: Free Material Optimization	III	707
SECTION 18. TEACHING AND POPULARIZATION OF MATHEMATICS		
GEORGE E. ANDREWS: Mathematics Education: Reform or Renewal?	III	719
MICHÈLE ARTIGUE: De la Compréhension des Processus d'Apprentissage a la Conception de Processus d'Enseignement	III	723
MARIA G. BARTOLINI BUSSI: Drawing Instruments: Theories and Practices from History to Didactics	III	735
MIGUEL DE GUZMÁN*, BERNARD R. HODGSON*, ALINE ROBERT* AND VINICIO VILLANI*: Difficulties in the Passage from Secondary to Tertiary Education	III	747
D. J. LEWIS: Mathematics Instruction in the Twenty-first Century ..	III	763
MOGENS NISS: Aspects of the Nature and State of Research in Mathematics Education	III	767
DAVID A. SMITH: Renewal in Collegiate Mathematics Education	III	777
SECTION 19. HISTORY OF MATHEMATICS		
KARINE CHEMLA: History of Mathematics in China: A Factor in World History and a Source for New Questions	III	789
JOSEPH W. DAUBEN: Marx, Mao and Mathematics: The Politics of Infinitesimals	III	799
JEREMY J GRAY: The Riemann-Roch Theorem and Geometry, 1854-1914	III	811

