
VOLUME 59 NUMBER 200



OCTOBER 1992

MATHEMATICS OF COMPUTATION

AMERICAN MATHEMATICAL SOCIETY

EDITED BY

James H. Bramble
E. W. Cheney
James W. Demmel
Walter Gautschi, *Managing Editor*
Eugene Isaacson
Heinz-Otto Kreiss
James N. Lyness
Harald Niederreiter
Jorge J. Nocedal
Syvert P. Nørsett
Andrew M. Odlyzko
Frank W. J. Olver
John E. Osborn
Stanley Osher
Carl Pomerance
René Schoof
L. Ridgway Scott
Daniel Shanks
Frank Stenger
Hans J. Stetter
G. W. Stewart
Nico M. Temme
Vidar Thomée
Lars B. Wahlbin
Hugh C. Williams
John W. Wrench, Jr.

PROVIDENCE, RHODE ISLAND USA

ISSN 0025-5718

Mathematics of Computation

This journal publishes research articles in computational mathematics. Areas covered include numerical analysis, the application of computational methods, algorithms for advanced computer architectures, computational number theory and algebra, and related fields. Table errata and reviews of books in areas related to computational mathematics are also included.

Subscription information. *Mathematics of Computation* is published quarterly. Subscription prices for Volumes 58 and 59 (1992) are \$221 list; \$177 institutional member; \$144 member of CBMS organizations; \$133 individual AMS member. A late charge of 10% of the subscription price will be imposed upon orders received from nonmember institutions and organizations after January 1 of the subscription year. Subscribers outside the United States and India must pay a postage surcharge of \$9; subscribers in India must pay a postage surcharge of \$18. Expedited delivery to destinations in North America \$13; elsewhere \$40.

Back number information. For back issues see the *AMS Catalog of Publications*.

Subscriptions and orders should be addressed to the American Mathematical Society, P. O. Box 1571, Annex Station, Providence, RI 02901-1571. *All orders must be accompanied by payment.* Other correspondence should be addressed to P. O. Box 6248, Providence, RI 02940-6248.

Unpublished Mathematical Tables. The editorial office of the journal maintains a repository of Unpublished Mathematical Tables (UMT). When a table is deposited in the UMT repository a brief summary of its contents is published in the section *Reviews and Descriptions of Tables and Books*. Upon request, the chairman of the editorial committee will supply copies of any table for a nominal cost per page. All tables and correspondence concerning the UMT should be sent to Walter Gautschi, Chairman, Editorial Committee, Mathematics of Computation, Department of Computer Sciences, Purdue University, West Lafayette, IN 47907.

Copying and reprinting. Individual readers of this publication, and nonprofit libraries acting for them, are permitted to make fair use of the material, such as to copy an article for use in teaching or research. Permission is granted to quote brief passages from this publication in reviews provided the customary acknowledgment of the source is given.

Republication, systematic copying, or multiple reproduction of any material in this publication (including abstracts) is permitted only under license from the American Mathematical Society. Requests for such permission should be addressed to the Manager of Editorial Services, American Mathematical Society, P. O. Box 6248, Providence, RI 02940-6248.

The appearance of the code on the first page of an article in this journal indicates the copyright owner's consent for copying beyond that permitted by Sections 107 or 108 of the U.S. Copyright Law, provided that the fee of \$1.00 plus \$.25 per page for each copy be paid directly to the Copyright Clearance Center, Inc., 27 Congress Street, Salem, MA 01970. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale.

Mathematics of Computation is published quarterly by the American Mathematical Society at 201 Charles Street, Providence, RI 02904-2213. Second-class postage is paid at Providence, Rhode Island. Postmaster: Send address changes to Mathematics of Computation, American Mathematical Society, P. O. Box 6248, Providence, RI 02940-6248.

Copyright ©1992 by the American Mathematical Society. All rights reserved.

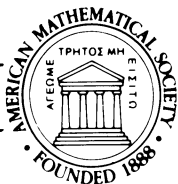
Printed in the United States of America.

The paper used in this book is acid-free and falls within the guidelines established to ensure permanence and durability. ∞

This publication was typeset using $\mathcal{A}\mathcal{M}\mathcal{S}$ - $\mathcal{T}\mathcal{E}\mathcal{X}$,
the American Mathematical Society's $\mathcal{T}\mathcal{E}\mathcal{X}$ macro system.

10 9 8 7 6 5 4 3 2 1 97 96 95 94 93 92

VOLUME 59



1992

MATHEMATICS OF COMPUTATION

A M E R I C A N M A T H E M A T I C A L S O C I E T Y

EDITED BY

James H. Bramble
E. W. Cheney
James W. Demmel
Walter Gautschi, *Managing Editor*
Eugene Isaacson
Heinz-Otto Kreiss
James N. Lyness
Harald Niederreiter
Jorge J. Nocedal
Syvert P. Nørsett
Andrew M. Odlyzko
Frank W. J. Olver
John E. Osborn
Stanley Osher
Carl Pomerance
René Schoof
L. Ridgway Scott
Daniel Shanks
Frank Stenger
Hans J. Stetter
G. W. Stewart
Nico M. Temme
Vidar Thomée
Lars B. Wahlbin
Hugh C. Williams
John W. Wrench, Jr.

PROVIDENCE, RHODE ISLAND USA

ISSN 0025-5718

Mathematics of Computation

This journal publishes research articles in computational mathematics. Areas covered include numerical analysis, the application of computational methods, algorithms for advanced computer architectures, computational number theory and algebra, and related fields. Table errata and reviews of books in areas related to computational mathematics are also included.

Subscription information. *Mathematics of Computation* is published quarterly. Subscription prices for Volumes 58 and 59 (1992) are \$221 list; \$177 institutional member; \$144 member of CBMS organizations; \$133 individual AMS member. A late charge of 10% of the subscription price will be imposed upon orders received from nonmember institutions and organizations after January 1 of the subscription year. Subscribers outside the United States and India must pay a postage surcharge of \$9; subscribers in India must pay a postage surcharge of \$18. Expedited delivery to destinations in North America \$13; elsewhere \$40.

Back number information. For back issues see the *AMS Catalog of Publications*.

Subscriptions and orders should be addressed to the American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571. *All orders must be accompanied by payment.* Other correspondence should be addressed to P.O. Box 6248, Providence, RI 02940-6248.

Unpublished Mathematical Tables. The editorial office of the journal maintains a repository of Unpublished Mathematical Tables (UMT). When a table is deposited in the UMT repository a brief summary of its contents is published in the section *Reviews and Descriptions of Tables and Books*. Upon request, the chairman of the editorial committee will supply copies of any table for a nominal cost per page. All tables and correspondence concerning the UMT should be sent to Walter Gautschi, Chairman, Editorial Committee, Mathematics of Computation, Department of Computer Sciences, Purdue University, West Lafayette, IN 47907.

Copying and reprinting. Individual readers of this publication, and nonprofit libraries acting for them, are permitted to make fair use of the material, such as to copy an article for use in teaching or research. Permission is granted to quote brief passages from this publication in reviews provided the customary acknowledgment of the source is given.

Republication, systematic copying, or multiple reproduction of any material in this publication (including abstracts) is permitted only under license from the American Mathematical Society. Requests for such permission should be addressed to the Manager of Editorial Services, American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248.

The appearance of the code on the first page of an article in this journal indicates the copyright owner's consent for copying beyond that permitted by Sections 107 or 108 of the U.S. Copyright Law, provided that the fee of \$1.00 plus \$.25 per page for each copy be paid directly to the Copyright Clearance Center, Inc., 27 Congress Street, Salem, MA 01970. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale.

Mathematics of Computation is published quarterly by the American Mathematical Society at 201 Charles Street, Providence, RI 02904-2213. Second-class postage is paid at Providence, Rhode Island. Postmaster: Send address changes to Mathematics of Computation, American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248.

Copyright ©1992 by the American Mathematical Society. All rights reserved.

Printed in the United States of America.

The paper used in this book is acid-free and falls within the guidelines established to ensure permanence and durability. ☺

This publication was typeset using $\mathcal{A}\mathcal{M}\mathcal{S}$ - $\mathcal{T}\mathcal{E}\mathcal{X}$,
the American Mathematical Society's $\mathcal{T}\mathcal{E}\mathcal{X}$ macro system.

10 9 8 7 6 5 4 3 2 1 97 96 95 94 93 92

MATHEMATICS OF COMPUTATION

TABLE OF CONTENTS

JULY 1992

Uday Banerjee and Manil Suri , The effect of numerical quadrature in the p -version of the finite element method	1
Houde Han and Xiaonan Wu , The approximation of the exact boundary conditions at an artificial boundary for linear elastic equations and its application.....	21
Jiang Zhu , Finite element approximation to initial-boundary value problems of the semiconductor device equations with magnetic influence	39
Christine Bernardi, Giuseppe Coppoletta, and Yvon Maday , Some spectral approximations of two-dimensional fourth-order problems	63
Christopher Beattie and W. M. Greenlee , Improved convergence rates for intermediate problems	77
Wolfgang Dahmen, Charles A. Micchelli, and Hans-Peter Seidel , Blossoming begets B -spline bases built better by B -patches	97
D. S. Meek and D. J. Walton , Clothoid spline transition spirals.....	117
G. W. Stewart , Error analysis of QR updating with exponential windowing	135
Steve Batterson and David Day , Linear convergence in the shifted QR algorithm	141
P. Feinsilver and R. Schott , On Bessel functions and rate of convergence of zeros of Lommel polynomials.....	153
J. Boersma and J. P. Dempsey , On the numerical evaluation of Legendre's chi-function	157
B. C. Carlson , A table of elliptic integrals: two quadratic factors	165
Karlheinz Gröchenig , Reconstruction algorithms in irregular sampling ...	181
Andrew Bremner and Richard K. Guy , Nu-configurations in tiling the square	195
R. J. Stroeker , Improvement of Nakamura's upper bound for the absolute discriminant of a sextic number field with two real conjugates	203
Stéphane Louboutin , L -functions and class numbers of imaginary quadratic fields and of quadratic extensions of an imaginary quadratic field ..	213
Harvey Cohn and Jesse Deutsch , Some singular moduli for $\mathbb{Q}(\sqrt{3})$	231
R. Ernvall and T. Metsänkylä , Cyclotomic invariants for primes to one million	249
Renate Scheidler and Hugh C. Williams , A method of tabulating the number-theoretic function $g(k)$	251
Karl Dilcher , Generalized Euler constants for arithmetical progressions..	259
Charles J. Colbourn, Spyros S. Magliveras, and D. R. Stinson , Steiner triple systems of order 19 with nontrivial automorphism group	283

Reviews and Descriptions of Tables and Books	297
Kincaid and Cheney 14, Cox and Hammarling, Editors 15, Watkins 16, Allgower and Georg 17, Gustafson and Sethian, Editors 18, Kaper and Garbey, Editors 19, Sprott 20, Crutzen, Molinari, and Rubinacci, Editors 21, Koonin and Meridith 22, Chui, Editor 23, Laurent, Le Méhauté, and Schumaker, Editors 24, Gómez, Hennart, and Tapia, Editors 25	
Corrigenda	309
Supplement to “Nu-configurations in tiling the square” by Andrew Bremner and Richard K. Guy	S1
Supplement to “Generalized Euler constants for arithmetical progressions” by Karl Dilcher	S21
Supplement to “Steiner triple systems of order 19 with nontrivial automorphism group” by Charles J. Colbourn, Spyros S. Magliveras, and D. R. Stinson	S25
Microfiche Supplement	
D. S. Dummit, “Solving solvable quintics”, Math. Comp., 57 (1991), 387–401	

TABLE OF CONTENTS

OCTOBER 1992

Jinchao Xu and Xiao-Chuan Cai , A preconditioned GMRES method for nonsymmetric or indefinite problems	311
Susanne C. Brenner and Li-Yeng Sung , Linear finite element methods for planar linear elasticity	321
P. Lesaint and J. Pousin , Error estimates for a nonlinear degenerate parabolic problem	339
Endre Süli , The accuracy of cell vertex finite volume methods on quadrilateral meshes	359
Bernardo Cockburn and Ioana Triandaf , Convergence of a finite element method for the drift-diffusion semiconductor device equations: the zero diffusion case	383
A. Ostermann and M. Roche , Runge-Kutta methods for partial differential equations and fractional orders of convergence	403
Z. Jackiewicz and M. Zennaro , Variable-stepsize explicit two-step Runge-Kutta methods	421
Daniel Okunbor and Robert D. Skeel , Explicit canonical methods for Hamiltonian systems	439
José Mario Martínez , On the relation between two local convergence theories of least-change secant update methods	457

T. Y. Li and Zhonggang Zeng , Homotopy-determinant algorithm for solving nonsymmetric eigenvalue problems	483
B. Z. Kacewicz and L. Plaskota , Termination conditions for approximating linear problems with noisy information	503
Giuliana Criscuolo, Giuseppe Mastroianni, and Péter Vértesi , Pointwise simultaneous convergence of extended Lagrange interpolation with additional knots	515
R. Grothmann and H. N. Mhaskar , Detection of singularities using segment approximation	533
David Galant , Algebraic methods for modified orthogonal polynomials ..	541
Yuan Xu , Gaussian cubature and bivariate polynomial interpolation	547
Stephen Joe and Ian H. Sloan , On computing the lattice rule criterion R	557
Daniela Calvetti , A stochastic roundoff error analysis for the convolution	569
F. C. Bussemaker and A. Neumaier , Exceptional graphs with smallest eigenvalue -2 and related problems	583
Yeow Meng Chee and Gordon F. Royle , Enumeration of small nonisomorphic 1-rotational twofold triple systems	609
D. R. Heath-Brown , The density of zeros of forms for which weak approximation fails	613
R. A. Mollin and H. C. Williams , On real quadratic fields of class number two	625
James J. Solderitsch , Quadratic fields with special class groups	633
Tom Hansen and Gary L. Mullen , Primitive polynomials over finite fields	639
Gerhard Hiss and Josephine Shamash , 2-blocks and 2-modular characters of the Chevalley groups $G_2(q)$	645
Avner Ash and Mark McConnell , Doubly cuspidal cohomology for principal congruence subgroups of $GL(3, \mathbb{Z})$	673
Robert Sandling , Presentations for unit groups of modular group algebras of groups of order 16	689
Jean-Joël Delorme , On the Diophantine equation $x_1^6 + x_2^6 + x_3^6 = y_1^6 + y_2^6 + y_3^6$	703
J. P. Buhler, R. E. Crandall, and R. W. Sompolski , Irregular primes to one million	717
Reviews and Descriptions of Tables and Books	723
Mesirov, Editor 26, Van Huffel and Vandewalle 27, Harper, Wooff, and Hodgkinson 28, Papalambros and Wilde 29	
Table Errata	727
Abramowitz and Stegun, Editors 614	
Indexes to Volumes 58 and 59	729
Supplement to “Convergence of a finite element method for the drift-diffusion semiconductor device equations: the zero diffusion case” by Bernardo Cockburn and Ioana Triandaf	S29
Supplement to “Primitive polynomials over finite fields” by Tom Hansen and Gary L. Mullen	S47

Microfiche Supplements

F. C. Bussemaker and A. Neumaier, Exceptional graphs with smallest eigenvalue -2 and related problems

Yeow Meng Chee and Gordon F. Royle, Enumeration of small non-isomorphic 1-rotational twofold triple systems

Editorial Information

As of August 1, 1992, the backlog for this journal was approximately 2 issues. This estimate is the result of dividing the number of manuscripts for this journal in the Providence office that have not yet gone to the printer on the above date by the average number of articles per issue over the previous twelve months.

A Copyright Transfer Agreement is required before a paper will be published in this journal. By submitting a paper to this journal, authors certify that the manuscript has not been submitted to nor is it under consideration for publication by another journal, conference proceedings, or similar publication.

Information for Authors

The first page must consist of a *descriptive title*, followed by an *abstract* that summarizes the article in language suitable for workers in the general field (algebra, analysis, etc.). The *descriptive title* should be short, but informative; useless or vague phrases such as “some remarks about” or “concerning” should be avoided. The *abstract* must be brief and reasonably self-contained. Included with the footnotes to the paper, there should be the 1991 *Mathematics Subject Classification* representing the primary and secondary subjects of the article. This may be followed by a list of *key words and phrases* describing the subject matter of the article and taken from it. A list of the numbers may be found in the annual index of *Mathematical Reviews*, published with the December issue starting in 1990, as well as from the electronic service e-MATH [telnet e-MATH.ams.com (or telnet 130.44.1.100). Login and password are e-math]. For journal abbreviations used in bibliographies, see the list of serials in the latest *Mathematical Reviews* annual index. When the manuscript is submitted, authors should supply the editor with electronic addresses if available. These will be printed after the postal address at the end of each article.

Electronically-prepared manuscripts. The AMS encourages submission of electronically-prepared manuscripts in $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\mathcal{T}\mathcal{E}\mathcal{X}$ or $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\mathcal{L}\mathcal{A}\mathcal{T}\mathcal{E}\mathcal{X}$ because properly prepared electronic manuscripts save the author proofreading time and move more quickly through the production process. To this end, the Society has prepared “preprint” style files, specifically the amsppt style of $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\mathcal{T}\mathcal{E}\mathcal{X}$ and the amsart style of $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\mathcal{L}\mathcal{A}\mathcal{T}\mathcal{E}\mathcal{X}$, which will simplify the work of authors and of the production staff. Those authors who make use of these style files from the beginning of the writing process will further reduce their own effort.

Guidelines for Preparing Electronic Manuscripts provide additional assistance and are available for use with either $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\mathcal{T}\mathcal{E}\mathcal{X}$ or $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\mathcal{L}\mathcal{A}\mathcal{T}\mathcal{E}\mathcal{X}$. Authors with FTP access may obtain these *Guidelines* from the Society’s Internet node e-MATH.ams.com (130.44.1.100). For those without FTP access they can be obtained free of charge from the e-mail address guide-elec@math.ams.com (Internet) or from the Publications Department, P. O. Box 6248, Providence, RI 02940-6248. When requesting *Guidelines* please specify which version you want.

Electronic manuscripts should be sent to the Providence office only after the paper has been accepted for publication. Please send electronically prepared manuscript files via e-mail to pub-submit@math.ams.com (Internet) or on diskettes to the Publications Department address listed above. When

submitting electronic manuscripts please be sure to include a message indicating in which publication the paper has been accepted.

An author should submit the original and two copies of the manuscript and retain one copy. The author may suggest an appropriate editor for his paper. All contributions intended for publication and all books for review should be addressed to Walter Gautschi, Chairman, Editorial Committee, Mathematics of Computation, Department of Computer Sciences, Purdue University, West Lafayette, Indiana 47907. The date received, which is published with the final version of an accepted paper, is the date received in the office of the Chairman of the Editorial Committee, and it is the responsibility of the author to submit manuscripts directly to this office. At the time of submission, authors should indicate if the paper has been prepared using \AA MS-TEX or \AA MS-L\AA TEX . The *Manual for Authors of Mathematical Papers* should be consulted for symbols and style conventions. The *Manual* may be obtained free of charge from the e-mail address cust-serv@math.ams.com or from AMS, Customer Services Department, P. O. Box 6248, Providence, RI 02940-6248.

Any inquiries concerning a paper that has been accepted for publication should be sent directly to the Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940-6248.

Editorial Committee

WALTER GAUTSCHI, Chairman. Department of Computer Sciences, Purdue University, West Lafayette, IN 47907; *E-mail*: wxc@cs.purdue.edu

ANDREW M. ODLYZKO, AT&T Bell Laboratories, 600 Mountain Avenue, Murray Hill, NJ 07974; *E-mail*: amo@research.att.com

FRANK W. J. OLVER, Institute for Physical Science and Technology, University of Maryland, College Park, MD 20742; *E-mail*: olver@bessel.umd.edu

LARS B. WAHLBIN, Department of Mathematics, Cornell University, Ithaca, NY 14853; *E-mail*: wahlbin@mathvax.msi.cornell.edu

Technical Editor

ERIKA GAUTSCHI, Department of Computer Sciences, Purdue University, West Lafayette, IN 47907; *E-mail*: exg@cs.purdue.edu

Board of Associate Editors

JAMES H. BRAMBLE, Department of Mathematics, Cornell University, Ithaca, NY 14853; *E-mail*: bramble@mathvax.msi.cornell.edu

E. W. CHENEY, Department of Mathematics, University of Texas at Austin, Austin, TX 78712-1082; *E-mail*: cheney@cs.utexas.edu

JAMES W. DEMMEL, Department of Mathematics, University of California, Berkeley, CA 94720; *E-mail*: demmel@robalo.berkeley.edu

EUGENE ISAACSON, Courant Institute of Mathematical Sciences, New York University, 251 Mercer Street, New York, NY 10012; *E-mail*: isaacson@acf7.nyu.edu

HEINZ-OTTO KREISS, Department of Applied Mathematics, California Institute of Technology, Pasadena, CA 91125

JAMES N. LYNESS, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439; *E-mail*: lyness@mcs.anl.gov

HARALD NIEDERREITER, Institute for Information Processing, Austrian Academy of Sciences, Sonnenfelsgasse 19, A-1010 Vienna, Austria; *E-mail*: nied@qiinfo.oeaw.ac.at

JORGE J. NOCEDAL, Department of Electrical Engineering and Computer Science,
Northwestern University, Evanston, IL 60208-3118; *E-mail*: nocedal@eecs.nwu.edu

SYVERT P. NØRSETT, Division of Numerical Mathematics, The University of
Trondheim and The Norwegian Institute of Technology, Alfred Getz vei 1, N-7034
Trondheim-NTH, Norway; *E-mail*: norsett@imf.unit.no

JOHN E. OSBORN, Department of Mathematics, University of Maryland, College Park,
MD 20742; *E-mail*: jeo@julia.umd.edu

STANLEY OSHER, Department of Mathematics, University of California, Los Angeles,
CA 90024; *E-mail*: sjo@math.ucla.edu

CARL POMERANCE, Department of Mathematics, The University of Georgia, Athens,
GA 30602; *E-mail*: carl@joe.math.uga.edu

RENÉ SCHOOF, Dipartimento di Matematica, Università degli Studi di Trento, I-38050
Povo (Trento), Italy; *E-mail*: schoof@itnvax.cineca.it (schoof@math.ruu.nl)

L. RIDGWAY SCOTT, Department of Mathematics, University of Houston, Houston,
TX 77204-3476; *E-mail*: scott@casc.math.uh.edu

DANIEL SHANKS, Department of Mathematics, University of Maryland, College Park,
MD 20742; *E-mail*: dns@gaby.umd.edu

FRANK STENGER, Department of Mathematics, University of Utah, Salt Lake City,
UT 84112; *E-mail*: stenger@sinc.utah.edu

HANS J. STETTER, Institut für Numerische Mathematik, Technische Universität Wien,
Wiedner Hauptstrasse 6-10, A-1040, Wien, Austria; *E-mail*: stetter@uranus.tuwien.ac.at

G. W. STEWART, Department of Computer Science, University of Maryland, College
Park, MD 20742; *E-mail*: stewart@thales.cs.umd.edu

NICO M. TEMME, Stichting Mathematisch Centrum, Centrum voor Wiskunde en Infor-
matica, Kruislaan 413, 1098 SJ Amsterdam, The Netherlands; *E-mail*: nicot@cw.nl

VIDAR THOMÉE, Mathematics Department, Chalmers University of Technology,
S-412 96 Göteborg, Sweden; *E-mail*: thomee@math.chalmers.se

HUGH C. WILLIAMS, Department of Computer Science, University of Manitoba, Win-
nipeg, Manitoba, Canada R3T 2N2; *E-mail*: Hugh_Williams@csmail.cs.umanitoba.ca

JOHN W. WRENCH, JR., 102 Mt. Olivet Boulevard, Frederick, MD 21701

CONTEMPORARY MATHEMATICS

Volumes 135 & 136

Symbolic Dynamics and its Applications

Peter Walters, *Editor*

This volume contains the proceedings of the conference, Symbolic Dynamics and its Applications, held at Yale University in the summer of 1991 in honor of Roy L. Adler on his sixtieth birthday. The conference focused on symbolic dynamics and its applications to other fields, including:

- ergodic theory
- smooth dynamical systems
- information theory
- automata theory
- statistical mechanics.

Featuring a range of contributions from some of the leaders in the field, this volume presents an excellent overview of the subject.

1991 *Mathematics Subject Classification*: 28, 54; 58, 60
ISBN 0-8218-5146-2, 452 pages (softcover), September 1992
Individual member \$33, List price \$55, Institutional member \$44
Your ordering code is CONM/135MC

Curves, Jacobians, and Abelian Varieties: Proceedings of a Summer Research Conference on the Schottky Problem

Ron Donagi, *Editor*

This volume contains the proceedings of an AMS-IMS-SIAM Joint Summer Research Conference on the Schottky Problem, held in June 1990 at the University of Massachusetts at Amherst. The conference explored various aspects of the Schottky problem of characterizing Jacobians of curves among all abelian varieties. Some of the articles study related themes, including the moduli of stable vector bundles on a curve, Prym varieties and intermediate Jacobians, and special Jacobians with exotic polarizations or product structures.

1991 *Mathematics Subject Classification*: 14; 32
ISBN 0-8218-5143-8, 342 pages (softcover), September 1992
Individual member \$37, List price \$62, Institutional member \$50
Your ordering code is CONM/136MC

All prices subject to change. *Prepayment required.* **Order from:** American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS in the U.S. and Canada to charge with VISA or MasterCard. Residents of Canada, please include 7% GST.



Translations of

MATHEMATICAL MONOGRAPHS

Wulff Construction: A Global Shape from Local Interaction

Roland Dobrushin, R. Kotecky, and Senya Shlosman

This research monograph considers the Wulff construction in the case of a two-dimensional Ising ferromagnet with periodic boundary conditions and at sufficiently low temperatures. Heuristically, the main result can be stated this way: a droplet of one phase immersed in the opposite one will be formed with the separation line following with high accuracy the shape yielded by the Wulff construction. This book brings the reader through the entire development of the proof of this result.

1991 *Mathematics Subject Classification*: 82, 85; 60
ISBN 0-8218-4563-2, 204 pages (hardcover), August 1992
Individual member \$78, List price \$130, Institutional member \$104
Your ordering code is MMONO/104MC

Mathematical Scattering Theory: General Theory

D. R. Yafaev

Yafaev presents a comprehensive and systematic exposition of the theory, covering different methods (of trace class and smooth perturbations) and approaches (time dependent and stationary) and discussing the relationships among them. Yafaev also fills some gaps in the monographic literature, such as the properties of the scattering matrix and the theory of the spectral shift function. Addressed to graduate students as well as researchers, this book will prove an invaluable reference and research tool.

1991 *Mathematics Subject Classification*: 47; 81
ISBN 0-8218-4558-6, 341 pages (hardcover), August 1992
Individual member \$130, List price \$216, Institutional member \$173
Your ordering code is MMONO/105MC

All prices subject to change. *Prepayment required.* **Order from:**
American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS in the U.S. and Canada to charge with VISA or MasterCard. Residents of Canada, please include 7% GST.

MEMOIRS

of the
American Mathematical Society



New Titles!

Vol. 99, Number 475

On the Existence of Feller Semigroups with Boundary Conditions

Kazuaki Taira

This monograph provides a careful and accessible exposition of functional analytic methods in stochastic analysis.

1991 *Mathematics Subject Classifications*: 35, 47; 60
ISBN 0-8218-2535-6, 65 pages (softcover), August 1992
Individual member \$14, List \$23, Institutional member \$18
Your ordering code is MEMO/99/475MC

Vol. 99, Number 476

The Subregular Germ of Orbital Integrals

Thomas C. Hales

Hales shows how the properties of a variety Y may be used to confirm some predictions of Langlands theory on orbital integrals, Shalika germs, and endoscopy.

1991 *Mathematics Subject Classification*: 20; 12, 22
ISBN 0-8218-2539-9, 142 pages (softcover), September 1992
Individual member \$17, List \$28, Institutional member \$22
Your ordering code is MEMO/99/476/MC

Vol. 99, Number 477

The Continued Fractions Found in the Unorganized Portions of Ramanujan's Notebooks

*George Andrews, Bruce C. Berndt, Lisa Jacobsen,
and Robert L. Lamphere*

This monograph will be of special interest to those who work in continued fractions, q -series, special functions, theta-functions, and combinatorics.

1991 *Mathematics Subject Classification*: 30, 40
ISBN 0-8218-2538-0, 71 pages (softcover), September 1992
Individual member \$14, List \$23, Institutional member \$18
Your ordering code is MEMO/99/477/MC

All prices subject to change. Free shipment by surface: for air delivery, please add \$6.50 per title. *Prepayment required.* **Order from:** American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS in the U.S. and Canada to charge with VISA or MasterCard. Residents of Canada, please include 7% GST.

Advances in SOVIET MATHEMATICS

Volumes 10 & 11

Properties of Global Attractors of Partial Differential Equations

A. V. Babin and M. I. Vishik, *Editors*

The four papers in this volume examine attractors of partial differential equations, with a focus on investigation of elements of attractors. Considered here is the dependence of attractors on singular perturbations of the equations. The theory of unbounded attractors of equations without bounded attracting sets is also covered. All of the articles are systematic and detailed, furnishing an excellent review of new approaches and techniques developed by the Moscow school.

1991 *Mathematics Subject Classification*: 35, 58, 76
ISBN 0-8218-4109-2, 172 pages (hardcover), July 1992
Individual member \$64, List price \$106, Institutional member \$85
Your ordering code is ADVSOV/10MC

Entire and Subharmonic Functions

B. Ya. Levin, *Editor*

The papers in this collection, written by participants of the Research Seminar on the Theory of Functions at Khar'kov University, primarily address the theory of entire and subharmonic functions. Founded in 1953 by B. Ya. Levin and still functioning today, this seminar ranges over different problems in the theory of functions, functional analysis, and related problems in calculus and mathematical physics. *Entire and Subharmonic Functions* contains works presented recently in the seminar.

1991 *Mathematics Subject Classification*: 14, 30, 31, 34, 42, 60
ISBN 0-8218-4110-6, 275 pages (hardcover), October 1992
Individual member \$88, List price \$147, Institutional member \$118
Your ordering code is ADVSOV/11MC

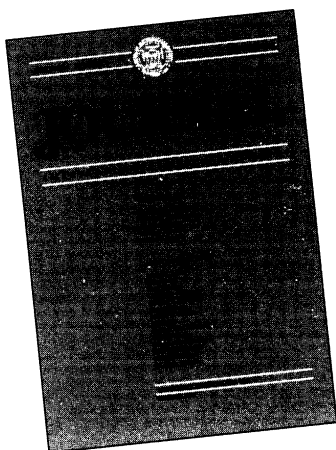
All prices subject to change. *Prepayment required.* **Order from:** American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS in the U.S. and Canada to charge with VISA or MasterCard. Residents of Canada, please include 7% GST.



JOURNAL

OF THE

AMERICAN MATHEMATICAL SOCIETY



When the *Journal of the American Mathematical Society* first appeared in 1988, it gained instant respect for its careful selection of relevant, important, and timely research. The editors are devoted to publishing research articles of the highest quality in all areas of pure and applied mathematics. Editors of this journal include: H. Blaine Lawson, Jr., Robert D. MacPherson, Richard Melrose, Andrew Odlyzko, and Wilfried Schmid.

1993 Subscription Prices: List \$144*, Institutional member \$115*, Individual member \$86* (ISSN 0894-0347)
Back volumes are also available. Call AMS Customer Services for prices.

*Add for postage: Surface delivery to destinations outside the U.S. and India - \$8; to India - \$18. Expedited delivery to destinations in North America - \$13; elsewhere - \$36. A 10% late charge applies. All prices subject to change. *Prepayment required.*

Order from: American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS in the United States and Canada to charge with VISA or MasterCard. Residents of Canada, please include 7% GST.

(Continued from back cover)

Gerhard Hiss and Josephine Shamash , 2-blocks and 2-modular characters of the Chevalley groups $G_2(q)$	645
Avner Ash and Mark McConnell , Doubly cuspidal cohomology for principal congruence subgroups of $GL(3, \mathbb{Z})$	673
Robert Sandling , Presentations for unit groups of modular group algebras of groups of order 16	689
Jean-Joël Delorme , On the Diophantine equation $x_1^6 + x_2^6 + x_3^6 = y_1^6 + y_2^6 + y_3^6$	703
J. P. Buhler, R. E. Crandall, and R. W. Sompolski , Irregular primes to one million	717
Reviews and Descriptions of Tables and Books	723
Mesirov, Editor 26 , Van Huffel and Vandewalle 27 , Harper, Wooff, and Hodgkinson 28 , Papalambros and Wilde 29	
Table Errata	727
Abramowitz and Stegun, Editors 614	
Indexes to Volumes 58 and 59	729
Supplement to "Convergence of a finite element method for the drift-diffusion semiconductor device equations: the zero diffusion case" by Bernardo Cockburn and Ioana Triandaf	S29
Supplement to "Primitive polynomials over finite fields" by Tom Hansen and Gary L. Mullen	S47
Microfiche Supplements	
F. C. Bussemaker and A. Neumaier , Exceptional graphs with smallest eigenvalue -2 and related problems	
Yeow Meng Chee and Gordon F. Royle , Enumeration of small non-isomorphic 1-rotational twofold triple systems	

MATHEMATICS OF COMPUTATION

TABLE OF CONTENTS

OCTOBER 1992

Jinchao Xu and Xiao-Chuan Cai , A preconditioned GMRES method for nonsymmetric or indefinite problems	311
Susanne C. Brenner and Li-Yeng Sung , Linear finite element methods for planar linear elasticity	321
P. Lesaint and J. Pousin , Error estimates for a nonlinear degenerate parabolic problem	339
Endre Süli , The accuracy of cell vertex finite volume methods on quadrilateral meshes	359
Bernardo Cockburn and Ioana Triandaf , Convergence of a finite element method for the drift-diffusion semiconductor device equations: the zero diffusion case	383
A. Ostermann and M. Roche , Runge-Kutta methods for partial differential equations and fractional orders of convergence	403
Z. Jackiewicz and M. Zennaro , Variable-stepsize explicit two-step Runge-Kutta methods	421
Daniel Okunbor and Robert D. Skeel , Explicit canonical methods for Hamiltonian systems	439
José Mario Martínez , On the relation between two local convergence theories of least-change secant update methods	457
T. Y. Li and Zhonggang Zeng , Homotopy-determinant algorithm for solving nonsymmetric eigenvalue problems	483
B. Z. Kacewicz and L. Plaskota , Termination conditions for approximating linear problems with noisy information	503
Giuliana Criscuolo, Giuseppe Mastroianni, and Péter Vértési , Pointwise simultaneous convergence of extended Lagrange interpolation with additional knots	515
R. Grothmann and H. N. Mhaskar , Detection of singularities using segment approximation	533
David Galant , Algebraic methods for modified orthogonal polynomials ..	541
Yuan Xu , Gaussian cubature and bivariate polynomial interpolation	547
Stephen Joe and Ian H. Sloan , On computing the lattice rule criterion R ..	557
Daniela Calvetti , A stochastic roundoff error analysis for the convolution ..	569
F. C. Bussemaker and A. Neumaier , Exceptional graphs with smallest eigenvalue -2 and related problems	583
Yeow Meng Chee and Gordon F. Royle , Enumeration of small nonisomorphic 1-rotational twofold triple systems	609
D. R. Heath-Brown , The density of zeros of forms for which weak approximation fails	613
R. A. Mollin and H. C. Williams , On real quadratic fields of class number two	625
James J. Solderitsch , Quadratic fields with special class groups	633
Tom Hansen and Gary L. Mullen , Primitive polynomials over finite fields ..	639

(Continued on inside back cover)