

---

VOLUME 26 NUMBER 1



JANUARY 1992

---

# BULLETIN

(NEW SERIES)  
OF THE

---

AMERICAN MATHEMATICAL SOCIETY

---

## EDITORS

Richard S. Palais, *Research-Expository Papers*  
Murray Protter, *Book Reviews*  
Frank Quinn, *Research Announcements*

---

PROVIDENCE, RHODE ISLAND USA

ISSN 0273-0979

---

## BULLETIN (New Series) of the American Mathematical Society

BULLETIN (New Series) contains articles of the types listed below. Information on Manuscript, Proof, and Copying can be found at the back of this journal.

### RESEARCH-EXPOSITORY PAPERS

These are, by definition, papers which present a clear and insightful exposition of significant aspects of contemporary mathematical research. Gibbs lectures, Progress in Mathematics lectures, and retiring presidential addresses will be included in this section. Manuscripts should be submitted to Professor Richard S. Palais, Department of Mathematics, Brandeis University, Waltham, MA 02154-9110.

### RESEARCH ANNOUNCEMENTS

The purpose of this department is to publish quickly and disseminate widely significant new mathematics. A Research Announcement should be designed to communicate its contents to a broad mathematical audience and should meet high standards for clarity as well as mathematical content. It should begin with an abstract containing a brief technical description of the new material. Then there should be an introductory section addressed to nonexperts describing the motivation, background, and significance of the results announced. Following the statement of results, there should follow a sketch of proofs which may be addressed to experts. Having colleagues, including nonexperts, proofread a manuscript can be an effective way to improve readability. An announcement should normally not exceed 8 journal pages, and preferably not exceed 6 pages. Authors should send five (5) copies of each manuscript to Professor Frank Quinn, Department of Mathematics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0123. Under ideal conditions, papers appear about 7 months after submission.

---

**Subscription Information:** BULLETIN (New Series) of the American Mathematical Society is published quarterly. Subscription prices for Volumes 26 and 27 (1992) are \$202 list, \$162 institutional member, \$121 individual member. The subscription price for members is included in the annual dues. A late charge of 10% of the subscription price will be imposed upon orders received from nonmembers after January 1 of the subscription year. Subscribers outside the United States and India must pay a postage surcharge of \$8.00; subscribers in India must pay a postage surcharge of \$13.00. Expedited delivery to destinations in North America \$12; elsewhere \$21. Combination paper and microfiche subscription prices are \$269 list, \$215 institutional member. Microfiche of each issue will be mailed the fastest way before the camera copy is sent to the printer. Microfilm subscriptions may be purchased from University Microfilms International, 300 North Zeeb Road, Ann Arbor, MI 48106.

**Back Number Information:** Back number prices (per volume) for BULLETIN (New Series) Volume 1 are \$71 list, \$57 institutional member; for Volumes 2-9 \$36 list, \$29 institutional member; for Volumes 10-11 \$44 list, \$35 institutional member; for Volumes 12-13 \$107 list, \$86 institutional member; for Volumes 14-15 \$131 list, \$105 institutional member; for Volumes 16-19 \$141 list, \$113 institutional member; for Volumes 20-21 \$144 list, \$115 institutional member; for Volumes 22-23 \$138 list, \$110 institutional member; for Volumes 24-25 \$148 list, \$118 institutional member. Back number prices (per volume) of Volumes 1-84 for the BULLETIN of the American Mathematical Society which ceased publication in 1978 are \$71 list, \$57 institutional member. Back volumes may be purchased on microfilm or microfiche from University Microfilms International, 300 North Zeeb Road, Ann Arbor, MI 48106.

Subscriptions and orders for publications should be addressed to the American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-9930. All orders must be accompanied by payment. Other correspondence should be addressed to the Society at P.O. Box 6248, Providence, RI 02940-6248

BULLETIN (New Series) of the American Mathematical Society (USPS 075640) 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 and additional mailing offices. Postmaster: Send address changes to BULLETIN, American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248.

Copyright © 1992 American Mathematical Society. All rights reserved.  
Information on copying and reprinting can be found at the back of this journal.  
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  $\mathcal{A}_M\mathcal{S}\text{-}\mathcal{T}_E\mathcal{X}$ ,  
the American Mathematical Society's  $\mathcal{T}_E\mathcal{X}$  macro system.

# JOURNALS PUBLISHED BY THE AMERICAN MATHEMATICAL SOCIETY

## TRANSLATION JOURNALS

**Soviet Mathematics–Doklady** is a bimonthly translation journal containing the entire pure mathematics section of the DOKLADY AKADEMII NAUK SSSR.

**Mathematics of the USSR–Izvestiya**, a bimonthly journal, is a cover-to-cover translation of IZVESTIYA AKADEMII NAUK SSSR SERIYA MATEMATICHESKAYA.

**Mathematics of the USSR–Sbornik** is a bimonthly journal and is a cover-to-cover translation of MATEMATICHESKIĬ SBORNIK (NOVAYA SERIYA).

**Theory of Probability and Mathematical Statistics** is the cover-to-cover translation into English of the TEORIYA VEROYATNOSTEĬ I MATEMATICHESKAYA STATISTIKA.

**Transactions of the Moscow Mathematical Society** is a translation into English of TRUDY MOSKOVSKOGO MATEMATICHESKOGO OBSHCHESTVA.

**Proceedings of the Steklov Institute of Mathematics** is a translation of AKADEMIYA NAUK SSSR TRUDY ORDENA LENINA MATEMATICHESKOGO INSTITUTA IMENI V. A. STEKLOVA.

**Leningrad Mathematical Journal** is a translation of ALGEBRA I ANALIZ.

## RESEARCH JOURNALS

Submission information for these journals is included in the April and October issues of this BULLETIN.

**Bulletin (New Series) of the American Mathematical Society** is a quarterly journal which contains research-expository papers, research announcements, and reviews of books on advanced mathematics.

**Journal of the American Mathematical Society** is devoted to research articles of the highest quality in all areas of pure and applied mathematics.

**Mathematics of Computation** is a quarterly journal devoted to original papers in numerical analysis, the application of numerical methods and high-speed calculator devices, the computation of mathematical tables, the theory of high-speed calculating devices, and other aids to computation.

**Memoirs of the American Mathematical Society** is a bimonthly journal constituting a series of paperbound research tracts which are of the same general character as the papers published in the TRANSACTIONS.

**Proceedings of the American Mathematical Society** is a monthly journal devoted entirely to research in pure and applied mathematics, principally to the publication of original papers of moderate length. A department called Shorter Notes was established for the purpose of publishing very short papers of an unusually elegant and polished character for which there is normally no other outlet.

**Transactions of the American Mathematical Society** is a monthly journal devoted entirely to research in pure and applied mathematics and, in general, includes longer papers than those in the PROCEEDINGS.

## OTHER JOURNALS

**Abstracts of Papers Presented to the American Mathematical Society** contains abstracts of invited hour addresses, of papers presented in special sessions or in sessions for contributed papers, and of papers presented to the Society “by title”.

**Current Mathematical Publications**, issued three times a month, contains a subject-classified index of papers and books being published currently in mathematics.

**Mathematical Reviews** is a monthly journal devoted to abstracts and reviews of the current mathematical literature of the world. Abstracts and reviews are grouped according to the 1991 Mathematics Subject Classification scheme. The subscription includes an annual author and subject index.

**Notices of the American Mathematical Society**, published ten times a year, contains programs and reports of the meetings of the Society, reports on Society business, communications to the membership, and news items and information of interest to the mathematical community.

# BULLETIN (New Series) of the American Mathematical Society

## EDITORS

### EDITORIAL BOARD FOR RESEARCH-EXPOSITORY PAPERS

Persi Diaconis  
Jerry Kazdan  
Barry Mazur  
Richard S. Palais  
Chair

David Vogan  
Alan Weinstein  
Guido L. Weiss

### EDITORIAL BOARD FOR RESEARCH ANNOUNCEMENTS

Gregory L. Cherlin  
William G. Dwyer  
Charles L. Epstein  
Daniel S. Freed  
Michael D. Fried

Harry Kesten  
Zoltan Furedi  
Robert Lazarsfeld  
Paul S. Muhly  
Frank Quinn  
Chair

BOOK REVIEWS EDITOR: Murray Protter

MANAGING EDITOR: Richard S. Palais

## MANUSCRIPT, PROOF, AND COPYING INFORMATION

### MANUSCRIPT

Articles submitted for publication should be typewritten and double-spaced. The *Manual for Authors*, available from the Society, should be consulted for symbols and style conventions. Authors should take the greatest possible care in preparing the original manuscript. Hand-drawn symbols are satisfactory if clearly done; special instructions for the typesetter, when necessary, should be included on a separate sheet.

For Research-Expository Articles and Research Announcements, the first footnote should include *subject classification numbers* representing the primary and secondary subjects of the article. The 1991 Mathematics Subject Classification scheme can be found in the annual subject index volumes of *Mathematical Reviews*.

To encourage the submission of manuscripts in electronic form using  $\text{\TeX}$  and the  $\text{\LaTeX}$  macro package, the Executive Committee of the Council has adopted a policy that allows for accelerating the publication date of such manuscripts by as much as 20 weeks, which is approximately equal to the time normally needed by the Society for copyediting, typesetting, and proofreading an average manuscript.

### GALLEY PROOF

When a paper with more than one author has been accepted for publication, only one set of galley proof will be sent. Joint authors should, therefore, indicate which of them should receive galley proof in the event that the manuscript is accepted for publication.

### 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, Rhode Island 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 Copyright Clearance Center, Inc., 27 Congress Street, Salem, Massachusetts 01970. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotion purposes, for creating new collective works, or for resale.

## OFFPRINTS AND ADDRESS CHANGES

Any inquiries concerning a paper which has been accepted for publication, including information regarding reprints or changes of address for mailing proof, should be sent directly to the Editorial Department, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940-6248.

## COPYRIGHT TRANSFER AGREEMENT

The signing of a Copyright Transfer Agreement is a requirement of publication in the BULLETIN. A copy of the agreement is sent to the author upon receipt of a manuscript in the Providence Office of the Society; in case of joint authors, a copy is sent to each author. Authors are urged to return the form immediately to prevent delays in processing and publishing the manuscript. The 1990 edition of the *Manual for Authors* has a description of Society policy concerning copyright.

## PUBLICATION CHARGES

There are no page charges assessed on papers published in the BULLETIN.

## REMARKS ON RESEARCH ANNOUNCEMENTS

The BULLETIN of the American Mathematical Society is the only research mathematical journal received as a privilege of membership in the Society. Its circulation is larger, by an order of magnitude, than that of most journals, in particular specialized journals. Thus, a BULLETIN Research Announcement should contain results of sufficient depth and import to be of interest to a wide mathematical audience. And, consequently, beyond basic mathematical standards, Research Announcements should meet high standards for style.

Beyond general exhortations to write clearly and precisely, the following more specific suggestions are offered.

1. Keep in mind that you are writing for as wide an audience as possible. Avoid the shorthand and jargon of your area as much as you can. Carefully introduce the terminology needed to understand the main results. If space considerations prevent a full development of the concepts, delineate clearly what you are not explaining and provide references to it in the literature. Consider an Announcement an opportunity to explain your area of research to the world at large.
2. Do not confuse a graceful style with a sloppy style. Although a light touch or a colorful phrase can relieve the tedium of definitions, excessive breeziness and imprecision confuse readers who have only a casual knowledge of the subject. We say this not to encourage pedantic writing but to discourage obscure writing. Your results should be stated precisely with all important concepts and notations made clear.
3. Ask a colleague to review your manuscript before you submit it. Even better, ask two colleagues, one whose work is very close to yours, one whose work is farther away. (If you can't get two people you know to read your work before it is published, how many will want to read it after?) Ask for suggestions on how to improve the readability.





**Research-Expository Papers**

**Editors' remarks** by *Morris W. Hirsch and Richard S. Palais* ..... 1

**Some basic information on information-based complexity theory** by *Beresford N. Parlett*..... 3

**Perspectives on information-based complexity** by *J. F. Traub and H. Woźniakowski* 29

**Semilinear wave equations** by *Michael Struwe* ..... 53

**$\Lambda$ -Trees and their applications** by *John W. Morgan* ..... 87

**Research Announcements**

**Lifting of cohomology and unobstructedness of certain holomorphic maps** by *Ziv Ran* ..... 113

**A steepest descent method for oscillatory Riemann-Hilbert problems** by *P. Deift and X. Zhou* ..... 119

**Nonunique tangent maps at isolated singularities of harmonic maps** by *Brian White* 125

**Semistability of amalgamated products, HNN-extensions, and all one-relator groups** by *Michael L. Mihalik and Steven T. Tschantz* ..... 131

**Some non-analytic-hypoelliptic sums of squares of vector fields** by *Michael Christ* 137

**Pleating coordinates for the Teichmüller space of a punctured torus** by *Linda Keen and Caroline Series* ..... 141

**Book Reviews**

**Weak convergence methods for nonlinear partial differential equations** by *Lawrence C. Evans*—Reviewed by *Michel Chipot and David Kinderlehrer* ..... 147

**Finsler geometry and applications** by *Aurel Bejancu*—Reviewed by *Hanno Rund* . 148

**Unbounded operator algebras and representation theory** by *Konrad Schmüdgen*—Reviewed by *Palle Jorgensen* ..... 152

**Topics in Nevanlinna theory** by *Serge Lang and William Cherry*—Reviewed by *Paul Vojta* ..... 153

**Set-valued analysis** by *Jean-Pierre Aubin and Helene Frankowska*—Reviewed by *Jonathan Borwein* ..... 157

**Large deviation techniques in decision, simulation, and estimation** by *James A. Bucklew*—Reviewed by *Richard S. Ellis* ..... 160

**Handbook of differential equations** by *Daniel Zwillingner*—Reviewed by *Ray Redheffer*..... 171

**Retarded dynamical systems: stability and characteristic functions** by *G. Stépán*—Reviewed by *Kenneth L. Cooke* ..... 175

**Classification theories of polarized varieties** by *Takao Fujita*—Reviewed by *Andrew J. Sommese* ..... 179

**The geometry and physics of knots** by *Michael Atiyah*—Reviewed by *Raoul Bott* . 182

**Variational principles of topology. Multidimensional minimal surface theory** by *Anatolii T. Fomenko*—Reviewed by *Fred Almgren* ..... 188

**Induced modules over group algebras** by *Gregory Karpilovsky*—Reviewed by *Gerald Cliff*..... 193