

JOURNAL JOST THE

AMERICAN MATHEMATICAL SOCIETY

EDITORS

William Fulton Benedict H. Gross Andrew Odlyzko Elias M. Stein Clifford Taubes

ASSOCIATE EDITORS

James G. Arthur
Alexander Beilinson
Persi Diaconis
Michael H. Freedman
Joe Harris
Sergio Klainerman
Dusa McDuff
Hugh L. Montgomery
Marina Ratner
Richard Schoen
Richard Stanley
Gang Tian
W. Hugh Woodin

PROVIDENCE, RHODE ISLAND USA

ISSN 0894-0347

Journal of the American Mathematical Society

This journal is devoted to research articles of the highest quality in all areas of pure and applied mathematics.

Submission information. See Information for Authors at the end of this issue.

Subscription information. The Journal of the American Mathematical Society is published quarterly. Beginning January 1996 the Journal of the American Mathematical Society is accessible from e-MATH via the World Wide Web at the URL http://www.ams.org/publications/. Subscription prices for Volume 9 (1996) are as follows: for paper delivery, \$174 list, \$139 institutional member, \$157 corporate member, \$104 individual member; for electronic delivery, \$157 list, \$125 institutional member, \$141 corporate member, \$94 individual member; for combination paper and electronic delivery, \$200 list, \$160 institutional member, \$180 corporate member, \$120 individual member. If ordering the paper version, add \$18 for surface delivery outside the United States and India; \$18 to India. Expedited delivery to destinations in North America is \$13; elsewhere \$36. For paper delivery a late charge of 10% of the subscription price will be imposed upon orders received from nonmembers after January 1 of the subscription year.

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 5904, Boston, MA 02206-5904. *All orders must be accompanied by payment.* Other correspondence should be addressed to P.O. Box 6248, Providence, RI 02940-6248.

Copying and reprinting. Material in this journal may be reproduced by any means for educational and scientific purposes without fee or permission with the exception of reproduction by services that collect fees for delivery of documents and provided that the customary acknowledgment of the source is given. This consent does not extend to other kinds of copying for general distribution, for advertising or promotional purposes, or for resale. Requests for permission for commercial use of material should be addressed to the Assistant to the Publisher, American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248. Requests can also be made by e-mail to reprint-permission@ams.org.

Excluded from these provisions is material in articles for which the author holds copyright. In such cases, requests for permission to use or reprint should be addressed directly to the author(s). (Copyright ownership is indicated in the notice in the lower right-hand corner of the first page of each article.)

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

^{© 1996} by the American Mathematical Society. All rights reserved. This journal is indexed in *Science Citation Index*[®], *SciSearch*[®], Research Alert[®], CompuMath Citation Index[®], and Current Contents[®]/Physical, Chemical & Earth Sciences.

Printed in the United States of America.

 $[\]otimes$ The paper used in this journal is acid-free and falls within the guidelines established to ensure permanence and durability.

A Printed on recycled paper.

Editors

Chairman
William Fulton
Department of Mathematics
University of Chicago
5734 University Avenue
Chicago, IL 60637-1514
fulton@math.uchicago.edu

Benedict H. Gross Department of Mathematics Harvard University Cambridge, MA 02138-2901 gross@math.harvard.edu

Andrew Odlyzko Room 2C-355 AT & T Bell Laboratories 600 Mountain Avenue Murray Hill, NJ 07974-2070 amo@research.att.com Elias M. Stein Department of Mathematics Princeton University Princeton, NJ 08544-1000 stein@math.princeton.edu

Clifford Taubes
Department of Mathematics
Harvard University
Cambridge, MA 02138-2901
chtaubes@math.harvard.edu

Associate Editors

James G. Arthur, University of Toronto
Alexander Beilinson, Massachusetts Institute of Technology
Louis Caffarelli, Institute for Advanced Study, Princeton
Persi Diaconis, Harvard University
Michael H. Freedman, University of California, San Diego
Joe Harris, Stanford University
Dusa McDuff, SUNY at Stony Brook
Hugh L. Montgomery, University of Michigan
Marina Ratner, University of California, Berkeley
Richard Schoen, Stanford University
Richard Stanley, Massachusetts Institute of Technology
Gang Tian, Courant Institute, New York University
W. Hugh Woodin, University of California, Berkeley

Assistant to the Editorial Board

Laurie Talbo
Department of Mathematics
University of Chicago
Chicago, IL 60637-1514
laurie@math.uchicago.edu

Editorial Information

As of March 31, 1996, 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, reduced

by the number of issues published in four months (the time necessary for editing and composing a typical issue).

A Consent to Publish and Copyright 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 and Editors

Initial submission. Two copies of the paper should be sent directly to one of the Editors and the author should keep one copy.

The first page must contain a descriptive title that is short, but informative; useless or vague phrases such as "some remarks about" or "concerning" should be avoided. 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 classifications may be found in the annual index of Mathematical Reviews, published with the December issue starting in 1990. Journal abbreviations used in bibliographies are also listed in the latest Mathematical Reviews annual index. The classifications and the journal abbreviations are accessible from e-MATH via the World Wide Web through the URL http://www.ams.org/committee/publications/mr-info.html or via FTP to e-math.ams.org (login as anonymous and enter username as password). The classifications are available as a browsable list, and the journal abbreviations are available through a search tool. 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 $\mathcal{A}_{\mathcal{M}}\mathcal{S}$ -TeX or $\mathcal{A}_{\mathcal{M}}\mathcal{S}$ -IATeX; properly prepared electronic manuscripts save the author proofreading time and move more quickly through the production process. To this end, the Society has prepared author packages for each AMS publication. Author packages include instructions for preparing electronic manuscripts, the AMS Author Handbook, samples, and a style file that generates the particular design specifications of that publication series for both $\mathcal{A}_{\mathcal{M}}\mathcal{S}$ -TeX and $\mathcal{A}_{\mathcal{M}}\mathcal{S}$ -LATeX.

Those authors who make use of these style files from the beginning of the writing process will further reduce their own efforts. Electronically submitted manuscripts prepared in plain T_EX or L^AT_EX are normally not acceptable due to the high amount of technical time required to insure that the file will run properly through the AMS in-house production system. Users of plain T_EX should have little difficulty learning A_MS - T_EX , and L^AT_EX users will find that A_MS - L^AT_EX is the same as L^AT_EX with additional commands to simplify the typesetting of mathematics.

Authors may retrieve an author package from e-MATH via the World Wide Web through the URL http://www.ams.org/tex/or via FTP to e-math.ams.org (login as anonymous and enter username as password). The author package can also be obtained free of charge by sending e-mail to pub@ams.org (Internet) or from the Publication Division, American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248. When requesting an author package, please specify AMS-TEX or AMS-LATEX, Macintosh or IBM (3.5) format, and the publication in which your paper will appear. Please be sure to include your complete mailing address.

At the time of submission, authors should indicate if the paper has been prepared using AMS-TEX or AMS-INTEX and provide the Editor with a paper manuscript that matches the electronic manuscript. The final version of the electronic manuscript should be sent to the Providence office immediately after the paper has been accepted for publication. The author should also send the final version of the paper manuscript to the Editor, who will forward a copy to the Providence office. Editors will require authors to send their electronically prepared manuscripts to the Providence office in a timely fashion. Electronically prepared manuscripts can be sent via e-mail to pub-submit@ams.org (Internet) or on diskette to the Electronic Prepress Department, American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248. When submitting an electronic manuscript, please be sure to include a message indicating in which publication the paper has been accepted. No corrections will be accepted electronically. Authors must mark their changes on their proof copies and return them to the Providence office. Complete instructions on how to submit files are included in the author package.

Electronic graphics. Figures may be submitted to the AMS in an electronic format. The AMS recommends that graphics created electronically be saved in Encapsulated PostScript (EPS) format. This includes graphics originated via a graphics application as well as scanned photographs or other computer-generated images.

If the graphics package used does not support EPS output, the graphics file should be saved in one of the standard graphics formats—such as TIFF, PICT, GIF, etc.—rather than in an application-dependent format. Graphics files submitted in an application-dependent format are not likely to be used. No matter what method was used to produce the graphic, it is necessary to provide a paper copy to the AMS.

Authors using graphics packages for the creation of electronic art should also avoid the use of any lines thinner than 0.5 points in width. Many graphics packages allow the user to specify a "hairline" for a very thin line. Hairlines often look acceptable when proofed on a typical laser printer. However, when produced on a high-resolution laser imagesetter, hairlines become nearly invisible and will be lost entirely in the final printing process.

Screens should be set to values between 15% and 85%. Screens which fall outside of this range are too light or too dark to print correctly.

TEX files available. Beginning with the January 1992 issue of the Bulletin and the January 1996 issues of Transactions, Proceedings, Mathematics of Computation, and the Journal of the AMS, TEX files can be downloaded from e-MATH, starting from URL http://www.ams.org/journals/. For Bulletin papers published in 1987 through 1991 and for Transactions, Proceedings, Mathematics of Computation, and the Journal of the AMS papers published in 1987 through 1995, TEX files are available upon request by sending e-mail to file-request@ams.org or by contacting the Electronic Prepress Department, American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248. The request should include the title of the paper, the name(s) of the author(s), the name of the publication in which the paper has or will appear, and the volume and issue numbers if known. The TEX file will be sent to the author making the request after the article goes to the printer. If the requestor can receive Internet e-mail, please include the e-mail address to which the file should be sent. Otherwise please indicate a diskette format and postal address to which a disk should be mailed. Note: Because TEX production

at the AMS sometimes requires extra fonts and macros that are not yet publicly available, TeX files cannot be guaranteed to run through the author's version of TeX without errors. The AMS regrets that it cannot provide support to eliminate such errors in the author's TeX environment.

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

JOURNAL OF THE AMERICAN MATHEMATICAL SOCIETY CONTENTS

Vol. 9, No. 3	1996
Leo Harrington and Robert I. Soare, The Δ_3^0 -automorphism method	
and noninvariant classes of degrees	617
Ehud Hrushovski, The Mordell-Lang conjecture for function fields	667
Michael Thaddeus, Geometric invariant theory and flips	691
V. Bergelson and A. Leibman, Polynomial extensions of van der	
Waerden's and Szemerédi's theorems	725
Y. Taguchi and D. Wan, L-functions of φ -sheaves and Drinfeld modules	755
Bjorn Poonen, Fractional power series and pairings on Drinfeld modules .	783
James E. Pommersheim, Products of cycles and the Todd class of a toric	
variety	813
Lothar Göttsche, Modular forms and Donaldson invariants for 4-manifolds	
with $b_+ = 1$	827
Clifford H. Taubes, SW => Gr: From the Seiberg-Witten equations to	
pseudo-holomorphic curves	845