

JOURNAL JOETHE

AMERICAN MATHEMATICAL SOCIETY

EDITORS

H. Blaine Lawson, Jr. Robert D. MacPherson Richard Melrose Andrew Odlyzko Wilfried Schmid

ASSOCIATE EDITORS

James G. Arthur
Persi Diaconis
Gerd Faltings
Charles L. Fefferman
Michael H. Freedman
Ronald L. Graham
Joe Harris
Andrew Majda
Dusa McDuff
Hugh L. Montgomery
Marina Ratner
Richard Schoen
Richard Stanley
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.

Subscription information. The Journal of the American Mathematical Society is published quarterly. Subscription prices for Volume 5 (1992) are \$136 list, \$109 institutional member, \$82 individual member. Subscribers outside the United States and India must pay a postage surcharge of \$8; subscribers in India must pay a postage surcharge of \$18. Expedited delivery to destinations in North America \$13; elsewhere \$36.

Back number information. For back issues see the AMS Catalogue 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.

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 acknowledgement 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.

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 is pending at Providence, Rhode Island. Postmaster: Send address changes to Journal of the AMS, 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 AMS-TeX, the American Mathematical Society's TeX macro system.

97 96 95 94 93 92

10 9 8 7 6 5 4 3 2 1

Editors

Chairman
Wilfried Schmid
Department of Mathematics
Harvard University
Cambridge, MA 02138

H. Blaine Lawson, Jr. Department of Mathematics SUNY at Stony Brook Stony Brook, NY 11794

Robert D. MacPherson Department of Mathematics 2-246 Massachusetts Institute of Technology Cambridge, MA 02139 Richard Melrose

Department of Mathematics 2-243 Massachusetts Institute of Technology

Cambridge, MA 02139

Andrew Odlyzko Room 2C-355 AT & T Bell Laboratories 600 Mountain Avenue Murray Hill, NJ 07974

Associate Editors

James G. Arthur, University of Toronto
Persi Diaconis, Harvard University
Gerd Faltings, Princeton University
Charles L. Fefferman, Princeton University
Michael H. Freedman, University of California, San Diego
Ronald L. Graham, AT & T Bell Laboratories
Joe Harris, Harvard University
Andrew Majda, Princeton 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
W. Hugh Woodin, University of California, Berkeley

Assistant to the Editorial Board

Joanne Jonsson
Department of Mathematics 2-108
Massachusetts Institute of Technology
Cambridge, MA 02139

Editorial Information

As of March 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 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 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 AMS-TEX or AMS-LATEX 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 AMS-TEX and the amsart style of AMS-LATEX, 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 AMS-TEX or AMS-LATEX. 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.

Two copies of the paper should be sent directly to one of the Editors or to the Assistant to the Editorial Board and the author should keep one copy. At that time authors should indicate if the paper has been prepared using AMS-TEX or AMS-LATEX. 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.

JOURNAL OF THE AMERICAN MATHEMATICAL SOCIETY

Volume 5, Number 2 April	1992
The even cycle problem for directed graphs CARSTEN THOMASSEN	217
Paradoxical decompositions, 2-generator Kleinian groups, and volumes of hyperbolic 3-manifolds MARC CULLER and PETER B. SHALEN	
Twistors, Kähler manifolds, and bimeromorphic geometry. I CLAUDE LEBRUN	
Twistors, Kähler manifolds, and bimeromorphic geometry. II CLAUDE LEBRUN and YAT-SUN POON	317
Nilpotent structures and invariant metrics on collapsed manifolds JEFF CHEEGER, KENJI FUKAYA, and MIKHAEL GROMOV	327
Points on some Shimura varieties over finite fields ROBERT E. KOTTWITZ	373
Lie-Poisson structure on some Poisson Lie groups VIKTOR L. GINZBURG and ALAN WEINSTEIN	445