VOLUME 2 NUMBER 3



**JULY 1989** 

# JOURNAL

# AMERICAN MATHEMATICAL SOCIETY

## **EDITORS**

Michael Artin H. Blaine Lawson, Jr. Richard Melrose Wilfried Schmid Robert E. Tarjan

# **ASSOCIATE EDITORS**

James G. Arthur Peter Bickel Gerd Faltings Charles L. Fefferman Michael H. Freedman Daniel Friedan Ronald L. Graham Joe Harris Hendrik W. Lenstra, Jr. Andrew Majda Hugh L. Montgomery Paul H. Rabinowitz Karen Uhlenbeck W. Hugh Woodin

PROVIDENCE, RHODE ISLAND USA

ISSN 0894-0347

### Journal of the American Mathematical Society

The Journal of the American Mathematical Society has been established for the publication of research articles in all areas of pure and applied mathematics.

### **EDITORS**

Chairman Michael Artin Department of Mathematics 2-239 Massachusetts Institute of Technology Cambridge, MA 02139

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

Richard Melrose Department of Mathematics 2-180 Massachusetts Institute of Technology Cambridge, MA 02139 Wilfried Schmid Department of Mathematics Harvard University Science Center 430 Cambridge, MA 02138

Robert E. Tarjan Department of Computer Science Princeton University Princeton, NJ 08544

### ASSOCIATE EDITORS

James G. Arthur, University of Toronto Peter Bickel, University of California, Berkeley Gerd Faltings, Princeton University Charles L. Fefferman, Princeton University Michael H. Freedman, University of California, San Diego Daniel Friedan, University of Chicago Ronald L. Graham, AT & T Bell Laboratories Joe Harris, Harvard University Hendrik W. Lenstra, Jr., University of California, Berkeley Andrew Majda, Princeton University Hugh L. Montgomery, University of Michigan Paul H. Rabinowitz, University of Wisconsin Karen Uhlenbeck, University of Texas at Austin W. Hugh Woodin, University of California, Berkeley

**Subscription information.** The Journal of the American Mathematical Society is published quarterly. Subscription prices for Volume 2 (1989) are \$111 list, \$89 institutional member, \$67 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.

**Back number information.** Back number prices per volume are: for Volume 1, \$150 list, \$120 institutional member.

Manuscript submission. See inside back cover.

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

The Journal of the American Mathematical Society is published quarterly by the American Mathematical Society at 201 Charles Street, Providence, R.I. 02904 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, R.I. 02940.

Copyright © 1989 American Mathematical Society. All rights reserved. Printed in the United States of America Information on Copying and Reprinting can be found at the back of this journal. The paper used in this journal is acid-free and falls within the guidelines established to ensure permanence and durability. This publication was typeset using A<sub>M</sub>S-T<sub>E</sub>X, the American Mathematical Society's T<sub>E</sub>X macro system. **Manuscript submission.** Manuscripts submitted for publication should either be typewritten double spaced or prepared using  $T_EX$  and the  $A_MS$ - $T_EX$  package. Two copies of the manuscript should be sent directly to one of the Editors. The signing of a Copyright Transfer Agreement is a requirement for publication.

**Subject classification.** Included with the footnotes to the paper, but placed before the first footnote, the subject classification should represent the primary and secondary subjects of the article. A list may be found in the annual subject index of *Mathematical Reviews*, published with the December issue starting in 1984.

Galley proof. When a paper with more than one author has been accepted for publication, only one set of proof will be sent. Joint authors should, therefore, indicate on the original manuscript 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 Executive Director, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

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., 21 Congress Street, Salem, Massachusetts 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.

# JOURNAL OF THE AMERICAN MATHEMATICAL SOCIETY

1000

Volume 2, rumber 5	1707
Hopf algebras up to homotopy DAVID J. ANICK	417
Ricci curvature bounds and Einstein metrics on compact manifolds MICHAEL T. ANDERSON	455
Oscillatory integrals and unique continuation for second order elliptic dif- ferential equations CHRISTOPHER D. SOGGE	491
Limits of weight spaces, Lusztig's q-analogs, and fiberings of adjoint orbits RANEE KATHRYN BRYLINSKI	517
Transcending classical invariant theory ROGER HOWE	535
Two elementary proofs of the L <sup>2</sup> boundedness of Cauchy integrals on Lipschitz curves R. R. COIFMAN, PETER W. JONES, and STEPHEN SEMMES	553
The unitary dual for the multiplicative group of arbitrary division algebras over local fields LAWRENCE CORWIN	565
Affine Hecke algebras and their graded version GEORGE LUSZTIG	599