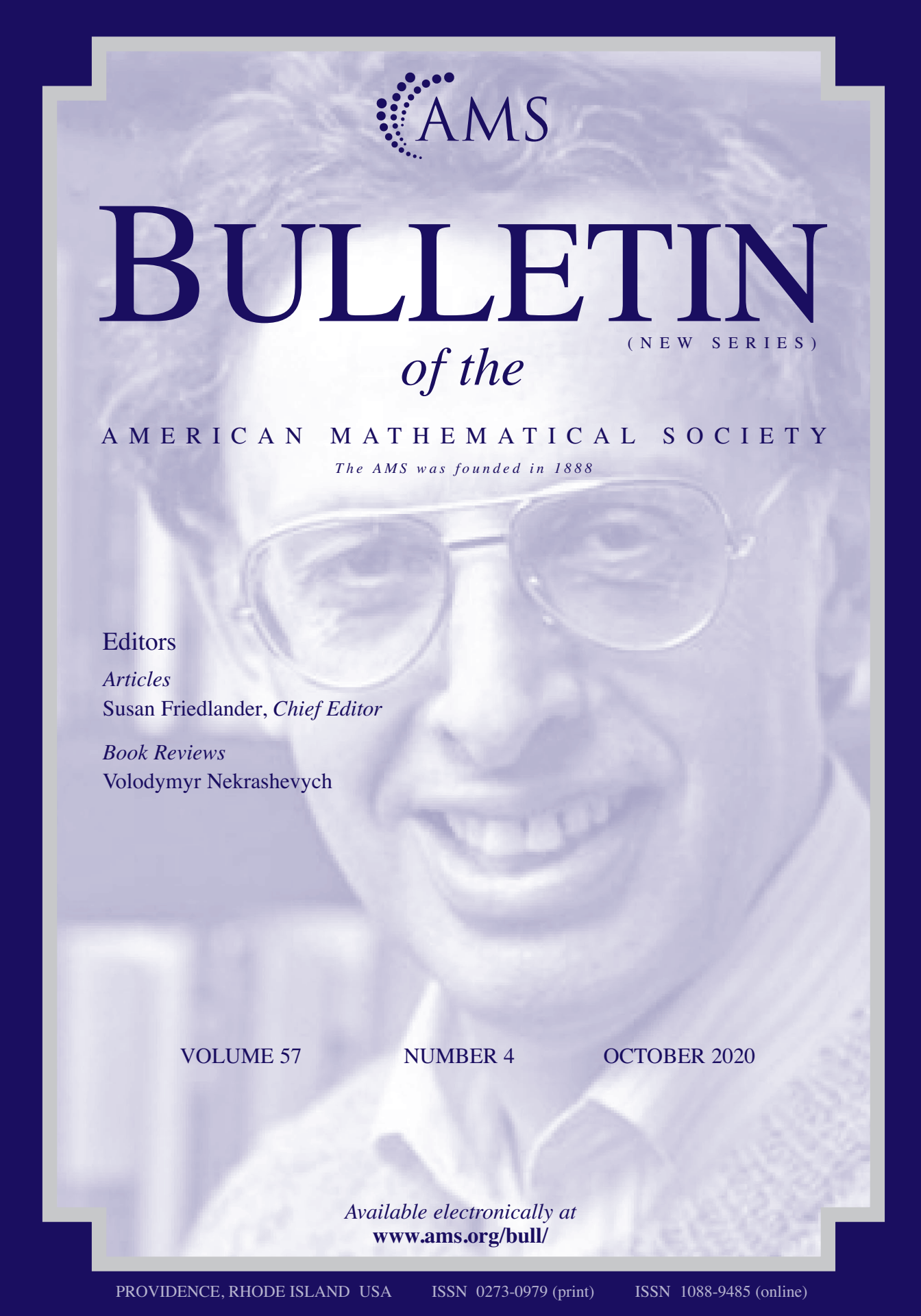

AMS

BULLETIN

(NEW SERIES)

of the

AMERICAN MATHEMATICAL SOCIETY

The AMS was founded in 1888

VOLUME 57 NUMBER 4 OCTOBER 2020

Available electronically at
www.ams.org/bull/

PROVIDENCE, RHODE ISLAND USA ISSN 0273-0979 (print) ISSN 1088-9485 (online)

Bulletin (New Series) of the American Mathematical Society

The *Bulletin* publishes expository articles on contemporary mathematical research written in a way that gives insight to mathematicians who may not be experts in the particular topic. The *Bulletin* publishes, by invitation only, reviews of selected books in mathematics and short articles in the "Mathematical Perspectives" section.

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

Publication on the AMS website. Articles are published on the AMS website individually after proof is returned from authors and before appearing in an issue.

Subscription information. *Bulletin (New Series) of the American Mathematical Society* is published quarterly. It is available electronically from `www.ams.org/journals/`. For paper delivery, subscription prices for Volume 57 (2020) are US$675 list, US$540 institutional member, US$405 individual member, US$607.50 corporate member. The subscription price for members is included in the annual dues. Subscription renewals are subject to late fees. See `www.ams.org/journal-faq` for more journal subscription information. If ordering the paper version, add US$5.00 for delivery within the United States; US$8.00 for delivery outside the United States.

Back number information. For back issues see `www.ams.org/backvols`.

Subscriptions and orders should be addressed to the American Mathematical Society, P.O. Box 845904, Boston, MA 02284-5904 USA. *All orders must be accompanied by payment.* Other correspondence should be addressed to the American Mathematical Society, 201 Charles Street, Providence, RI 02904-2213 USA.

Bulletin (New Series) of the American Mathematical Society (ISSN 0273-0979 (print); ISSN 1088-9485 (online)) is published quarterly by the American Mathematical Society at 201 Charles Street, Providence, RI 02904-2213 USA. Periodicals postage is paid at Providence, Rhode Island, and additional mailing offices. POSTMASTER: Send address changes to Bulletin (New Series) of the American Mathematical Society, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2213 USA.

This journal is indexed in *Mathematical Reviews*, *Science Citation Index*®, *Science Citation Index*™*–Expanded*, *ISI Alerting Services*℠, *CompuMath Citation Index*®, and *Current Contents*®*/Physical, Chemical & Earth Sciences*. This journal is archived in *Portico* and in *CLOCKSS*.

Printed in the United States of America.

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

10 9 8 7 6 5 4 3 2 1 25 24 23 22 21 20

BULLETIN OF THE AMERICAN MATHEMATICAL SOCIETY

CONTENTS

Vol. 57, No. 4 October 2020

ARTICLES

MATHEMATICAL PERSPECTIVES

BOOK REVIEWS

INDEX TO VOLUME 57 (2020)

BULLETIN ARTICLES

MATHEMATICAL PERSPECTIVES

BOOK REVIEWS

VOLUME 57 AMS 2020

BULLETIN

(NEW SERIES)

of the

AMERICAN MATHEMATICAL SOCIETY

The AMS was founded in 1888

PROVIDENCE, RHODE ISLAND USA

ISSN 0273-0979

Available electronically at
www.ams.org/bull/

BULLETIN OF THE AMERICAN MATHEMATICAL SOCIETY

CONTENTS

Vol. 57, No. 1 **January 2020**

Articles

Mathematical Perspectives

Book Reviews

Vol. 57, No. 2 **April 2020**

Articles

Mathematical Perspectives

Book Reviews

Vol. 57, No. 3 **July 2020**

Articles

Mathematical Perspectives

Book Reviews

Vol. 57, No. 4 **October 2020**

Articles

Mathematical Perspectives

Book Reviews

Editorial Information

Information on the backlog for this journal can be found on the AMS website starting from `http://www.ams.org/bull`.

In an effort to make articles available as quickly as possible, articles are electronically published on the AMS website individually after proof is returned from authors and before appearing in an issue.

A Consent to Publish is required before we can begin processing your paper. After a paper is accepted for publication, the Providence office will send a Consent to Publish form to all authors of the paper. By submitting a paper to this journal, authors certify that the results have not been submitted to nor are they under consideration for publication by another journal, conference proceedings, or similar publication.

Information for Authors

The *Bulletin* publishes expository articles on contemporary mathematical research written in a way that gives insight to mathematicians who may not be experts in the particular topic. All articles submitted to this journal are peer reviewed. The AMS has a single-blind peer-review process in which the reviewers know who the authors of the manuscripts are, but the authors do not have access to information on who the peer reviewers are.

The first page must consist of a short *descriptive title*, followed by an *abstract* that summarizes the article in language suitable for mathematicians in the general area. The *descriptive title* should be short but informative; useless or vague phrases such as "some remarks about" or "concerning" should be avoided. The *abstract* should be a brief technical description of the new material.

A well-written expository article will include motivating problems and examples, some indication of the historical development of the subject, and of course the results and open problems that make it an interesting and exciting area of mathematics. In most cases proofs should be at most briefly sketched, and there should be a good bibliography whose main aim is to help those wishing to pursue the subject further. Articles reporting on recent mathematical research should include an introductory section addressed to nonexperts describing the motivation, background, and significance of the results announced.

Following the statement of results, there should be a sketch of proofs that may be addressed to experts, including elements of the proof which are novel. References should be given so that an interested reader can find the details.

Each paper should include a footnote with the 2010 *Mathematics Subject Classification* representing the primary and secondary subjects of the article. The classifications are accessible from `www.ams.org/msc/`. The Mathematics Subject Classification footnote may be followed by a list of *key words and phrases* describing the subject matter of the article and taken from it. Journal abbreviations used in bibliographies are listed in the latest *Mathematical Reviews* annual index. The series abbreviations are also accessible from `www.ams.org/msnhtml/serials.pdf`. To help in preparing and verifying references, the AMS offers MR Lookup, a Reference Tool for Linking, at `www.ams.org/mrlookup/`. When the manuscript is submitted, authors should supply the Editor with electronic addresses if available.

Mathematicians giving AMS lectures (Gibbs Lectures, Colloquium Lectures, and Progress in Mathematics Lectures) or invited hour addresses at meetings of the Society are encouraged to write up their lectures using the guidelines for expository articles described above. Submissions will be reviewed by the Editorial Board for Articles, and authors will be notified of its decision.

Book Reviews are by invitation only. The first page must include the title of the book being reviewed; the name(s) of the author(s); publisher; city of publication; year of publication; number of pages, including front matter; price if known; and ISBN. There should also be a footnote with the 2010 *Mathematics Subject Classification* representing the primary and secondary subjects of the book under review. The classifications are accessible from `www.ams.org/msc/`. To help in preparing and verifying references, the AMS offers MR Lookup, a Reference Tool for Linking, at `www.ams.org/mrlookup/`.

Initial submission. Authors of articles may submit manuscripts for consideration as PDF files at `http://www.ams.org/peer-review/submission.pl`. Manuscripts must be a single file with images embedded. Authors will have a chance to view the manuscript and data entered before releasing the manuscript into the system. Two-digit 2010 *Mathematics Subject Classification* numbers are included in a pull-down menu; classifications are accessible from `http://www.ams.org/msc/`. Complete author instructions are available at the site.

Authors who cannot supply a PDF file may submit a paper copy of their manuscript to *Bulletin*/Peer-Review Manuscript Submissions, 201 Charles Street, Providence, RI 02904-2213 USA. These submissions will be scanned into a PDF file and entered by AMS staff into the peer-review system. All the data required in the submission form must be provided to avoid delays in publishing the manuscript.

The *Bulletin* Chief Editor will be notified as new submissions arrive. The Editor will collect these submissions and assign them to subject area specialists.

Electronically prepared manuscripts. Manuscripts should be electronically prepared in $\mathcal{A}\mathcal{M}\mathcal{S}$-LaTeX. To this end, the Society has prepared $\mathcal{A}\mathcal{M}\mathcal{S}$-LaTeX 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. Articles properly prepared using the $\mathcal{A}\mathcal{M}\mathcal{S}$-LaTeX style file and the \label and \ref commands automatically enable extensive intra-document linking to the bibliography and other elements of the article for searching electronically on the Web.

Authors may retrieve an author package for the *Bulletin of the AMS* from `www.ams.org/bull/bullauthorpac.html`. The *AMS Author Handbook* is available in PDF format from the author package link. The author package can also be obtained free of charge by sending email to `tech-support@ams.org` or from the Publication Division, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2213 USA. When requesting an author package, please specify the publication in which your paper will appear. Please be sure to include your complete email address.

After acceptance. The source files for the final version of the electronic manuscript should be sent to the Providence office immediately after the paper has been accepted for publication. Authors should indicate if the paper has been prepared using $\mathcal{A}\mathcal{M}\mathcal{S}$-LaTeX or $\mathcal{A}\mathcal{M}\mathcal{S}$-TeX. Electronically prepared manuscripts can be submitted via the Web at `www.ams.org/submit-book-journal/`, sent via email to `pub-submit@ams.org`, or sent on CD to the Electronic Prepress Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2213 USA. When sending a manuscript electronically via email or CD, please be sure to include a message indicating in which publication the paper has been accepted. Complete instructions on how to send files are included in the author package.

The final file of an accepted article should also be sent by email to both `bulletin@math.uic.edu` and `susan@math.northwestern.edu`.

Electronic graphics. Comprehensive instructions on preparing graphics are available from `www.ams.org/authors/journals.html`. A few of the major requirements are given here.

Submit files for graphics as EPS (Encapsulated PostScript) files. This includes graphics originated via a graphics application as well as scanned photographs or other computer-generated images. If this is not possible, TIFF files are acceptable as long as they can be opened in Adobe Photoshop or Illustrator.

Authors using graphics packages for the creation of electronic art should 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. Variations of screens within a graphic should be no less than 10%.

AMS policy on making changes to articles after publication. Articles are published on the AMS website individually after proof is returned from authors and before appearing in an issue. To preserve the integrity of electronically published articles, once an article is individually published to the AMS website, changes cannot be made in place in the paper. The AMS does not keep author-related information such as affiliation, current address, and email address up to date after a paper is electronically published.

Corrections of critical errors may be made to the paper by submitting an errata article to the Editor. The errata article will be published electronically, will appear in a future print issue, and will link back and forth on the Web with the original article.

Secure manuscript tracking on the Web. Authors can track their manuscripts through the AMS journal production process using the personal AMS ID and Article ID printed in the upper right-hand corner of the Consent to Publish form sent to each author who publishes in AMS journals. Access to the tracking system is available from `www.ams.org/mstrack/`. An explanation of each production step is provided on the Web through links from the manuscript tracking screen. Questions may be sent to `bull-query@ams.org`.

Inquiries. Any inquiries concerning a paper that has been accepted for publication that cannot be answered via the manuscript tracking system mentioned above should be sent to `bull-query@ams.org` or directly to the Electronic Prepress Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2213 USA.

BULLETIN OF THE AMERICAN MATHEMATICAL SOCIETY

CONTENTS

Vol. 57, No. 4 **October 2020**

ARTICLES

MATHEMATICAL PERSPECTIVES

BOOK REVIEWS

0273-0979(202010)57;4*:1-M

American Mathematical Society Distribution Center
35 Monticello Place, Pawtucket, RI 02861 USA

AMS
www.ams.org