<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amenability of groupoids arising from partial semigroup actions and</td>
<td>Jean N. Renault and Dana P. Williams</td>
<td>2255</td>
</tr>
<tr>
<td>topological higher rank graphs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear sofic groups and algebras</td>
<td>Goulnara Arzhantseva and Liviu Păunescu</td>
<td>2285</td>
</tr>
<tr>
<td>On quantitative unique continuation properties of fractional</td>
<td>Angkana Rüland</td>
<td>2311</td>
</tr>
<tr>
<td>Schrödinger equations: Doubling, vanishing order and nodal domain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>applications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard parabolic subsets of highest weight modules</td>
<td>Apoorva Khare</td>
<td>2363</td>
</tr>
<tr>
<td>Arithmetic of abelian varieties with constrained torsion</td>
<td>Christopher Rasmussen and Akio Tamagawa</td>
<td>2395</td>
</tr>
<tr>
<td>Nakayama automorphism and applications</td>
<td>J.-F. Lü, X.-F. Mao, and J. J. Zhang</td>
<td>2425</td>
</tr>
<tr>
<td>Every abelian group is the class group of a simple Dedekind domain</td>
<td>Daniel Smertnig</td>
<td>2477</td>
</tr>
<tr>
<td>Hilbert transform along measurable vector fields constant on</td>
<td>Shaoming Guo</td>
<td>2493</td>
</tr>
<tr>
<td>Lipschitz curves: $L^p$ boundedness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Derangements in subspace actions of finite classical groups</td>
<td>Jason Fulman and Robert Guralnick</td>
<td>2521</td>
</tr>
<tr>
<td>Stability, uniqueness and recurrence of generalized traveling waves</td>
<td>Wenxian Shen and Zhongwei Shen</td>
<td>2573</td>
</tr>
<tr>
<td>time heterogeneous media of ignition type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The generalized Mukai conjecture for symmetric varieties</td>
<td>Giuliano Gagliardi and Johannes Hofscheier</td>
<td>2615</td>
</tr>
<tr>
<td>Rationality of homogeneous varieties</td>
<td>CheeWhye Chin and De-Qi Zhang</td>
<td>2651</td>
</tr>
<tr>
<td>On noncommutative finite factorization domains</td>
<td>Jason P. Bell, Albert Heinle, and Viktor Levandovskyy</td>
<td>2675</td>
</tr>
<tr>
<td>Galois groups and cohomological functors</td>
<td>Ido Efrat and Ján Mináč</td>
<td>2697</td>
</tr>
<tr>
<td>Abelian-by-central Galois groups of fields I: A formal description</td>
<td>Adam Topaz</td>
<td>2721</td>
</tr>
<tr>
<td>A class of large global solutions for the wave-map equation</td>
<td>Elisabetta Chiodaroli and Joachim Krieger</td>
<td>2747</td>
</tr>
<tr>
<td>Representations of quantum affine algebras of type $B_N$</td>
<td>Mathheus Brito and Evgeny Mukhin</td>
<td>2775</td>
</tr>
<tr>
<td>The pair correlation density</td>
<td>Morten S. Risager and Anders Södergren</td>
<td>2807</td>
</tr>
<tr>
<td>A bilateral extension of the $q$-Selberg integral</td>
<td>Masahiko Ito and Peter J. Forrester</td>
<td>2843</td>
</tr>
<tr>
<td>Central theorems for cohomologies of certain solvable groups</td>
<td>Hisashi Kasuya</td>
<td>2879</td>
</tr>
<tr>
<td>Analysis of a Double Kruskal Theorem</td>
<td>Timothy Carlson</td>
<td>2897</td>
</tr>
<tr>
<td>$C^1$ estimates for the Weil-Petersson metric</td>
<td>Georgios Daskalopoulos and Chikako Mese</td>
<td>2917</td>
</tr>
</tbody>
</table>
Liviu I. Nicolaescu and Nikhil Savale, The Gauss-Bonnet-Chern theorem: A probabilistic perspective ........................................... 2951
Suyoung Choi, Mikiya Masuda, and Sang-il Oum, Classification of real Bott manifolds and acyclic digraphs ........................................... 2987
Piotr Bizoń and Patryk Mach, Erratum to “Global dynamics of a Yang-Mills field on an asymptotically hyperbolic space” .................. 3013
Apoorva Khare, Erratum to “Standard parabolic subsets of highest weight modules” ................................................................. 3015
Editorial Information

To be published in the Transactions, a paper must be correct, new, nontrivial, and significant. Further, it must be well written and of interest to a substantial number of mathematicians. Piecemeal results, such as an inconclusive step toward an unproved major theorem or a minor variation on a known result, are in general not acceptable for publication.

Papers submitted to the Transactions should be 15 or more published journal pages in length. Shorter papers may be submitted to the Proceedings of the American Mathematical Society. Published pages are the same size as those generated in the style files provided for \texttt{AMSLaTeX}.

Information on the backlog for this journal can be found on the AMS website starting from \url{http://www.ams.org/tran}.

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 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

Initial submission. 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 manuscript are, but the authors do not have access to the information on who the reviewers are. The AMS uses Centralized Manuscript Processing for initial submissions. Authors should submit a PDF file using the Initial Manuscript Submission form found at \url{www.ams.org/submission/tran}, or send one copy of the manuscript to the following address: Centralized Manuscript Processing, TRANSACTIONS OF THE AMS, 201 Charles Street, Providence, RI 02904-2294 USA. If a paper copy is being forwarded to the AMS, indicate that it is for Transactions and include the name of the corresponding author, contact information such as email address or mailing address, and the name of an appropriate Editor to review the paper (see the list of Editors below).

The first page of an article must consist of a descriptive title, followed by an abstract that summarizes the article in language suitable for workers in the general field (algebra, analysis, etc.). 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 at least one complete sentence, and at most 300 words. Included with the footnotes to the paper should be the 2010 Mathematics Subject Classification representing the primary and secondary subjects of the article. The classifications are accessible from \url{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 \url{www.ams.org/msnhtml/serials.pdf}. To help in preparing and verifying references, the AMS offers MR Lookup, a Reference Tool for Linking, at \url{www.ams.org/mrlookup/}. 
**Electronically prepared manuscripts.** Manuscripts should be electronically prepared in \texttt{AMSLaTeX}. To this end, the Society has prepared \texttt{AMSLaTeX} author packages for each AMS publication. Author packages include instructions for preparing electronic manuscripts, samples, and a style file that generates the particular design specifications of that publication series. Articles properly prepared using the \texttt{AMSLaTeX} style file and the \texttt{\label} and \texttt{\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 *Transactions of the AMS* from \url{www.ams.org/tran/tranauthorpac.html} or via FTP to \url{ftp.ams.org} (login as \texttt{anonymous}, enter your complete email address as password, and type \texttt{cd pub/author-info}). The *AMS Author Handbook* and the *Instruction Manual* are available in PDF format from the author package link. The author package can also be obtained free of charge by sending email to \texttt{tech-support@ams.org}, or from the Publication Division, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294 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. The author should also submit a PDF of the final version of the paper to the Editor, who will forward a copy to the Providence office. Accepted electronically prepared manuscripts can be submitted via the web at \url{www.ams.org/submit-book-journal/}, sent via email to \texttt{pub-submit@ams.org}, or sent on CD to the Electronic Prepress Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294 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.

**Electronic graphics.** Comprehensive instructions on preparing graphics are available starting from \url{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 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. Variations of screens within a graphic should be no less than 10\%.

Any graphics created in color will be rendered in grayscale for the printed version unless color printing is authorized by the Managing Editor and the Publisher. In general, color graphics will appear in color in the online version.

**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/](http://www.ams.org/mstrack/). An explanation of each production step is provided on the web through links from the manuscript tracking screen. Questions can be sent to tran-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 tran-query@ams.org or directly to the Electronic Prepress Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294 USA.
Editors

The AMS uses Centralized Manuscript Processing for initial submissions to AMS journals. Authors should follow instructions listed on the Initial Submission page found at www.ams.org/tran/transubmit.html.

Algebra, MICHAEL LARSEN, Department of Mathematics, Rawles Hall, Indiana University, 831 E 3rd St., Bloomington, IN 47405 USA; e-mail: mjlarsen@indiana.edu

Algebraic and enumerative combinatorics, JIM HAGLUND, Department of Mathematics, University of Pennsylvania, Philadelphia, PA 19104 USA; e-mail: jhaglund@math.upenn.edu

Algebraic geometry, LUCIA CAPORASO, Department of Mathematics and Physics, Roma Tre University, Largo San Leonardo Murialdo, I-00146 Rome, Italy; e-mail: LCedit@mat.uniroma3.it

Algebraic topology, MICHAEL HILL, Department of Mathematics, University of California Los Angeles, Los Angeles, CA 90095 USA; e-mail: mkehill@math.ucla.edu

Arithmetic geometry, TED C. CHINBURG, Department of Mathematics, University of Pennsylvania, Philadelphia, PA 19104-6395 USA; e-mail: ted@math.upenn.edu

Automorphic forms, representation theory and combinatorics, DANIEL BUMP, Department of Mathematics, Building 380, Sloan Hall, Stanford University, Stanford, CA 94305 USA; e-mail: bump@math.stanford.edu

Combinatorics and discrete geometry, IGOR PAK, Department of Mathematics, University of California Los Angeles, Los Angeles, CA 90095 USA; e-mail: trans.ucla@gmail.com

Commutative algebra, IRENA PEEVA, Department of Mathematics, Cornell University, Ithaca, NY 14853 USA; e-mail: irena@math.cornell.edu

Differential geometry, CHIU-CHU MELISSA LIU, Department of Mathematics, Columbia University, New York, NY 10027 USA; e-mail: ccxiu@math.columbia.edu

Dynamical systems and ergodic theory, VIVIANE BALADI, Institut de Mathématiques de Jussieu-Paris Rive Gauche, U.P.M.C., B.C. 247, 4 Place Jussieu, F 75252 Paris cedex 05, France; e-mail: viviane.baladi@imj-prg.fr

Ergodic theory and combinatorics, VITALY BERGELSON, Department of Mathematics, Ohio State University, 231 W. 18th Avenue, Columbus, OH 43210 USA; e-mail: vitaly@math.ohio-state.edu

Functional analysis and operator algebras, STEFAAN VAES, Department of Mathematics, Katholieke Universiteit Leuven, Celestijnenlaan 200B, B-3001 Leuven, Belgium; e-mail: stefaan.vaes@wis.kuleuven.be

Geometric analysis, TATIANA TORO, Department of Mathematics, University of Washington, Box 354350, Seattle, WA 98195-4530 USA; e-mail: toro@uw.edu

Harmonic analysis and complex analysis, MALABKA PRAMANIK, Department of Mathematics, University of British Columbia, 1984 Mathematics Road, Vancouver, British Columbia V6T 1Z2, Canada; e-mail: malabika@math.ubc.ca

Harmonic analysis, representation theory, and Lie theory, ERIK VAN DEN BAN, Department of Mathematics, Utrecht University, P.O. Box 80 010, 3508 TA Utrecht, The Netherlands; e-mail: E.P.vandenB@uu.nl

Logic, NOAM GREENBERG, School of Mathematics and Statistics, Victoria University of Wellington, Wellington 6140, New Zealand; e-mail: greenberg@msor.vuw.ac.nz

Low-dimensional topology and geometric structures, RICHARD CANARY, Department of Mathematics, University of Michigan, Ann Arbor, MI 48109-1043 USA; e-mail: canary@umich.edu

Number theory, HENRI DARMON, Department of Mathematics, McGill University, Montreal, Quebec H3A 034, Canada; e-mail: daron@math.mcgill.ca

Partial differential equations, MARKUS R. KEEL, School of Mathematics, University of Minnesota, Minneapolis, MN 55455 USA; e-mail: keel@math.umn.edu

Partial differential equations and functional analysis, ALEXANDER A. KISELEV, Department of Mathematics, MS-136, Rice University, 6100 Main Street, Houston, TX 77005 USA; e-mail: kiselev@rice.edu

Probability and statistics, PATRICK J. FITZSIMMONS, Department of Mathematics, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0112 USA; e-mail: pfitzsim@ucsd.edu

Real analysis and partial differential equations, WILHELM SCHLAG, Department of Mathematics, The University of Chicago, 5734 South University Avenue, Chicago, IL 60637 USA; e-mail: schlag@math.uchicago.edu

All other communications to the editors should be addressed to the Managing Editor, ALEJANDRO ADEM, Department of Mathematics, University of British Columbia, Room 121, 1984 Mathematics Road, Vancouver, British Columbia V6T 1Z2, Canada; e-mail: transactions@math.ubc.ca

MEMOIRS OF THE AMERICAN MATHEMATICAL SOCIETY

Memoirs is devoted to research in pure and applied mathematics of the same nature as Transactions. An issue consists of one or more separately bound research tracts for which the authors provide reproduction copy. Papers intended for Memoirs should normally be at least 80 pages in length. Memoirs has the same editorial committee as Transactions; authors may choose an Editor from the list above upon submission.
Masahiko Ito and Peter J. Forrester, A bilateral extension of the $q$-Selberg integral ................................................................. 2843
Hisashi Kasuya, Central theorems for cohomologies of certain solvable groups ................................................................. 2879
Timothy Carlson, Analysis of a Double Kruskal Theorem ................. 2897
Georgios Daskalopoulos and Chikako Mese, $C^1$ estimates for the Weil-Petersson metric ......................................................... 2917
Liviu I. Nicolaescu and Nikhil Savale, The Gauss-Bonnet-Chern theorem: A probabilistic perspective ......................... 2951
Suyoung Choi, Mikiya Masuda, and Sang-il Oum, Classification of real Bott manifolds and acyclic digraphs ........................ 2987
Piotr Bizoń and Patryk Mach, Erratum to “Global dynamics of a Yang-Mills field on an asymptotically hyperbolic space” ............ 3013
Apoorva Khare, Erratum to “Standard parabolic subsets of highest weight modules” ................................................................. 3015
Jean N. Renault and Dana P. Williams, Amenability of groupoids arising from partial semigroup actions and topological higher rank graphs ... 2255
Goulnara Arzhantseva and Liviu Păunescu, Linear sofic groups and algebras ................................................................. 2285
Angkana Rüland, On quantitative unique continuation properties of fractional Schrödinger equations: Doubling, vanishing order and nodal domain estimates .................................................. 2311
Apoorva Khare, Standard parabolic subsets of highest weight modules ... 2363
Christopher Rasmussen and Akio Tamagawa, Arithmetic of abelian varieties with constrained torsion .................................. 2395
J.-F. Lü, X.-F. Mao, and J. J. Zhang, Nakayama automorphism and applications .............................................................. 2425
Dietmar Bisch, Vaughan F. R. Jones, and Zhengwei Liu, Singly generated planar algebras of small dimension, Part III ............ 2461
Daniel Smertnig, Every abelian group is the class group of a simple Dedekind domain .......................................................... 2477
Shaoming Guo, Hilbert transform along measurable vector fields constant on Lipschitz curves: $L^p$ boundedness ..................... 2493
Jason Fulman and Robert Guralnick, Derangements in subspace actions of finite classical groups ........................................... 2521
Wenxian Shen and Zhongwei Shen, Stability, uniqueness and recurrence of generalized traveling waves in time heterogeneous media of ignition type ........................................................................ 2573
Giuliano Gagliardi and Johannes Hofscheier, The generalized Mukai conjecture for symmetric varieties .................................. 2615
Chee-Whye Chin and De-Qi Zhang, Rationality of homogeneous varieties .................................................................................... 2651
Jason P. Bell, Albert Heinle, and Viktor Levandovskyy, On noncommutative finite factorization domains ............................... 2675
Ido Efrat and Ján Mináč, Galois groups and cohomological functors ... 2697
Adam Topaz, Abelian-by-central Galois groups of fields I: A formal description ........................................................................ 2721
Elisabetta Chiodaroli and Joachim Krieger, A class of large global solutions for the wave-map equation ...................................... 2747
Matheus Brito and Evgeny Mukhin, Representations of quantum affine algebras of type $B_N$ ..................................................... 2775
Morten S. Risager and Anders Södergren, Angles in hyperbolic lattices: The pair correlation density ........................................... 2807

(Continued on inside back cover)