

# CONTEMPORARY MATHEMATICS

682

## Manifolds and $K$ -Theory

Conference on  
Manifolds,  $K$ -Theory, and Related Topics  
June 23–27, 2014  
Dubrovnik, Croatia

Gregory Arone  
Brenda Johnson  
Pascal Lambrechts  
Brian A. Munson  
Ismar Volić  
Editors



American Mathematical Society

# Manifolds and $K$ -Theory



# CONTEMPORARY MATHEMATICS

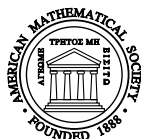
---

682

## Manifolds and $K$ -Theory

Conference on  
Manifolds,  $K$ -Theory, and Related Topics  
June 23–27, 2014  
Dubrovnik, Croatia

Gregory Arone  
Brenda Johnson  
Pascal Lambrechts  
Brian A. Munson  
Ismar Volić  
Editors



---

American Mathematical Society  
Providence, Rhode Island



## EDITORIAL COMMITTEE

Dennis DeTurck, Managing Editor

Michael Loss      Kailash Misra      Catherine Yan

2010 *Mathematics Subject Classification*. Primary 18F25, 19D10,  
52B45, 55P43, 55P65, 57R19.

---

### Library of Congress Cataloging-in-Publication Data

Names: Arone, Gregory, editor.

Title: Manifolds and  $K$ -theory : conference on manifolds,  $K$ -theory, and related topics, June 23-27, 2014, Dubrovnik, Croatia / Gregory Arone [and four others], editors.

Description: Providence, Rhode Island : American Mathematical Society, [2017] | Series: Contemporary mathematics ; volume 682 | Includes bibliographical references.

Identifiers: LCCN 2016041075 | ISBN 9781470417000 (alk. paper)

Subjects: LCSH: $K$ -theory–Congresses. | Manifolds (Mathematics)–Congresses. | Homology theory–Congresses. | AMS: Category theory; homological algebra – Categories and geometry – Algebraic  $K$ -theory and  $L$ -theory. msc |  $K$ -theory – Higher algebraic  $K$ -theory – Algebraic  $K$ -theory of spaces. msc | Convex and discrete geometry – Polytopes and polyhedra – Dissections and valuations (Hilbert’s third problem, etc.). msc | Algebraic topology – Homotopy theory – Spectra with additional structure ( $E_\infty$ ,  $A_\infty$ , ring spectra, etc.). msc | Algebraic topology – Homotopy theory – Homotopy functors. msc | Manifolds and cell complexes – Differential topology – Algebraic topology on manifolds. msc

Classification: LCC QA612.33 .M36 2017 | DDC 512/.6–dc23 LC record available at <https://lccn.loc.gov/2016041075>

Contemporary Mathematics ISSN: 0271-4132 (print); ISSN: 1098-3627 (online)

DOI: <http://dx.doi.org/10.1090/conm/682>

---

**Color graphic policy.** Any graphics created in color will be rendered in grayscale for the printed version unless color printing is authorized by the Publisher. In general, color graphics will appear in color in the online version.

**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 select pages 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 is permitted only under license from the American Mathematical Society. Permissions to reuse portions of AMS publication content are handled by Copyright Clearance Center’s RightsLink® service. For more information, please visit: <http://www.ams.org/rightslink>.

Send requests for translation rights and licensed reprints to [reprint-permission@ams.org](mailto:reprint-permission@ams.org).

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

© 2017 by the American Mathematical Society. All rights reserved.

The American Mathematical Society retains all rights  
except those granted to the United States Government.  
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.

Visit the AMS home page at <http://www.ams.org/>

10 9 8 7 6 5 4 3 2 1      22 21 20 19 18 17



Courtesy of Ismar Volić

This volume is dedicated to Tom Goodwillie on the occasion of his 60th birthday, in appreciation of the mathematics he has created and inspired.



## Contents

Preface	ix
Manifolds, K-theory, and the calculus of functors GREGORY ARONE and MICHAEL CHING	1
Diagrams encoding group actions on $\Gamma$ -spaces JULIA E. BERGNER and PHILIP HACKNEY	39
Contractible manifolds with exotic positive scalar curvature behavior STANLEY CHANG, SHMUEL WEINBERGER, and GUOLIANG YU	51
Relative Schur multipliers and universal extensions of group homomorphisms EMMANUEL D. FARJOUN and YOAV SEGEV	65
Scissors congruence with mixed dimensions THOMAS G. GOODWILLIE	81
On the moduli space of $A_\infty$ -structures JOHN R. KLEIN and SEAN TILSON	141
Nilpotence in the symplectic bordism ring JUSTIN NOEL	161
A geometric homology representative in the space of knots KRISTINE E. PELATT and DEV P. SINHA	167
Brauer spaces for commutative rings and structured ring spectra MARKUS SZYMIK	189
Bridgeland stability, 2-Segal spaces, and the Ran space of the line HIRO LEE TANAKA	209
Occupants in manifolds STEFFEN TILLMANN and MICHAEL S. WEISS	237



## Preface

The conference Manifolds,  $K$ -Theory, and Related Topics took place in Dubrovnik, Croatia on June 23–27, 2014. It focused on the themes of the title: manifolds,  $K$ -theory, and other closely related topics in algebraic and geometric topology, with an emphasis on the interactions between these fields. It was held in honor of Tom Goodwillie to celebrate his 60th birthday, as well as his deep influence on the subject. The schedule consisted of 16 plenary lecturers, 27 contributed talks in parallel sessions, and 9 shorter “bell session” talks given by graduate students. The conference attracted 128 participants. The plenary speakers and their talk titles are listed below.

- Gunnar Carlsson, Stanford University, *On the topology of finite metric spaces*
- Michael Ching, Amherst College, *Manifolds,  $K$ -theory, and the calculus of functors*
- Ralph Cohen, Stanford University, *The mathematical work of Tom Goodwillie*
- Ralph Cohen, Stanford University, *Calabi-Yau categories, string topology, and Floer field theory*
- Bjørn Dundas, University of Bergen, *Higher topological Hochschild homology*
- Tom Goodwillie, Brown University, *Scissors congruences in mixed dimensions*
- Kathryn Hess, Ecole Polytechnique Fédérale de Lausanne, *Waldhausen  $K$ -theory via comodules*
- John Klein, Wayne State University, *Topological stochasticity*
- Nick Kuhn, University of Virginia, *The Whitehead conjecture and the Goodwillie tower of the circle*
- Ib Madsen, University of Copenhagen, *Automorphisms of manifolds and rational homotopy theory*
- Randy McCarthy, University of Illinois at Urbana-Champaign, *Unbased calculus*
- Charles Rezk, University of Illinois at Urbana-Champaign, *Koszul resolutions of power operation algebras*
- Hiro Lee Tanaka, Harvard University, *Hall algebras and Bridgeland stability conditions for stable infinity-categories*
- Ulrike Tillmann, Oxford University, *Commutative  $K$ -theory and other new cohomology theories*

- Nathalie Wahl, University of Copenhagen, *Homological stability for families of groups*
- Michael Weiss, University of Münster, *Spaces of smooth embeddings via operads and configuration categories*

Speakers at the conference were invited to submit a paper to this volume. We would like to thank all the conference speakers and participants for their enthusiasm, which made the event a success. Special thanks to the anonymous referees for their vital, though uncredited, work. We offer our eternal gratitude to the National Science Foundation, the Clay Mathematics Institute, and the Alexander von Humboldt foundation, whose generous support made the conference possible. Finally, we thank the Inter-University Centre in Dubrovnik for hosting the conference.

Gregory Arone  
Brenda Johnson  
Pascal Lambrechts  
Brian A. Munson  
Ismar Volić

## Selected Published Titles in This Series

- 682 **Gregory Arone, Brenda Johnson, Pascal Lambrechts, Brian A. Munson, and Ismar Volić, Editors**, *Manifolds and  $K$ -Theory*, 2017
- 676 **Pierre Martinetti and Jean-Christophe Wallet, Editors**, *Noncommutative Geometry and Optimal Transport*, 2016
- 675 **Ana Claudia Nabarro, Juan J. Nuño-Ballesteros, Raúl Oset Sinha, and Maria Aparecida Soares Ruas, Editors**, *Real and Complex Singularities*, 2016
- 674 **Bogdan D. Suceavă, Alfonso Carriazo, Yun Myung Oh, and Joeri Van der Veken, Editors**, *Recent Advances in the Geometry of Submanifolds*, 2016
- 673 **Alex Martsinkovsky, Gordana Todorov, and Kiyoshi Igusa, Editors**, *Recent Developments in Representation Theory*, 2016
- 672 **Bernard Russo, Asuman Güven Aksoy, Ravshan Ashurov, and Shavkat Ayupov, Editors**, *Topics in Functional Analysis and Algebra*, 2016
- 671 **Robert S. Doran and Efton Park, Editors**, *Operator Algebras and Their Applications*, 2016
- 670 **Krishnendu Gongopadhyay and Rama Mishra, Editors**, *Knot Theory and Its Applications*, 2016
- 669 **Sergii Kolyada, Martin Möller, Pieter Moree, and Thomas Ward, Editors**, *Dynamics and Numbers*, 2016
- 668 **Gregory Budzban, Harry Randolph Hughes, and Henri Schurz, Editors**, *Probability on Algebraic and Geometric Structures*, 2016
- 667 **Mark L. Agranovsky, Matania Ben-Artzi, Greg Galloway, Lavi Karp, Dmitry Khavinson, Simeon Reich, Gilbert Weinstein, and Lawrence Zalcman, Editors**, *Complex Analysis and Dynamical Systems VI: Part 2: Complex Analysis, Quasiconformal Mappings, Complex Dynamics*, 2016
- 666 **Vicențiu D. Rădulescu, Adélia Sequeira, and Vsevolod A. Solonnikov, Editors**, *Recent Advances in Partial Differential Equations and Applications*, 2016
- 665 **Helge Glöckner, Alain Escassut, and Khodr Shamseddine, Editors**, *Advances in Non-Archimedean Analysis*, 2016
- 664 **Dihua Jiang, Freydoon Shahidi, and David Soudry, Editors**, *Advances in the Theory of Automorphic Forms and Their  $L$ -functions*, 2016
- 663 **David Kohel and Igor Shparlinski, Editors**, *Frobenius Distributions: Lang-Trotter and Sato-Tate Conjectures*, 2016
- 662 **Zair Ibragimov, Norman Levenberg, Sergey Pinchuk, and Azimbay Sadullaev, Editors**, *Topics in Several Complex Variables*, 2016
- 661 **Douglas P. Hardin, Doron S. Lubinsky, and Brian Z. Simanek, Editors**, *Modern Trends in Constructive Function Theory*, 2016
- 660 **Habib Ammari, Yves Capdeboscq, Hyeonbae Kang, and Imbo Sim, Editors**, *Imaging, Multi-scale and High Contrast Partial Differential Equations*, 2016
- 659 **Boris S. Mordukhovich, Simeon Reich, and Alexander J. Zaslavski, Editors**, *Nonlinear Analysis and Optimization*, 2016
- 658 **Carlos M. da Fonseca, Dinh Van Huynh, Steve Kirkland, and Vu Kim Tuan, Editors**, *A Panorama of Mathematics: Pure and Applied*, 2016
- 657 **Noé Bárcenas, Fernando Galaz-García, and Mónica Moreno Rocha, Editors**, *Mexican Mathematicians Abroad*, 2016
- 656 **José A. de la Peña, J. Alfredo López-Mimbela, Miguel Nakamura, and Jimmy Petean, Editors**, *Mathematical Congress of the Americas*, 2016
- 655 **A. C. Cojocaru, C. David, and F. Pappalardi, Editors**, *SCHOLAR—a Scientific Celebration Highlighting Open Lines of Arithmetic Research*, 2015

For a complete list of titles in this series, visit the  
AMS Bookstore at [www.ams.org/bookstore/conmseries/](http://www.ams.org/bookstore/conmseries/).



This volume contains the proceedings of the conference on Manifolds,  $K$ -Theory, and Related Topics, held from June 23–27, 2014, in Dubrovnik, Croatia.

The articles contained in this volume are a collection of research papers featuring recent advances in homotopy theory,  $K$ -theory, and their applications to manifolds. Topics covered include homotopy and manifold calculus, structured spectra, and their applications to group theory and the geometry of manifolds.

This volume is a tribute to the influence of Tom Goodwillie in these fields.

ISBN 978-1-4704-1700-0



9 781470 417000

CONM/682

AMS on the Web  
[www.ams.org](http://www.ams.org)