

CONTEMPORARY MATHEMATICS

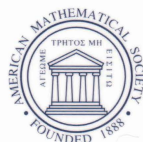
372

Geometric Methods in Group Theory

AMS Special Session
Geometric Group Theory
October 5–6, 2002
Northeastern University
Boston, Massachusetts

Special Session at the First Joint Meeting
of the American Mathematical Society
and the Real Sociedad Matemática Española
June 18–21, 2003
Seville, Spain

José Burillo
Sean Cleary
Murray Elder
Jennifer Taback
Enric Ventura
Editors



Geometric Methods in Group Theory

CONTEMPORARY MATHEMATICS

372

Geometric Methods in Group Theory

AMS Special Session
Geometric Group Theory
October 5–6, 2002
Northeastern University
Boston, Massachusetts

Special Session at the First Joint Meeting
of the American Mathematical Society
and the Real Sociedad Matemática Española
June 18–21, 2003
Seville, Spain

José Burillo
Sean Cleary
Murray Elder
Jennifer Taback
Eric Ventura
Editors



American Mathematical Society
Providence, Rhode Island

Editorial Board

Dennis DeTurck, managing editor

Andreas Blass Andy R. Magid Michael Vogelius

This volume contains articles by speakers and participants in the AMS Special Session “Geometric Group Theory”, held October 5–6, 2002, at Northeastern University, and in the Special Session “Geometric Methods in Group Theory” at the First Joint Meeting of the AMS and the Real Sociedad Matemática Española, held June 18–21, 2003, in Seville, Spain.

2000 *Mathematics Subject Classification*. Primary 20–06, 20F65, 20F36, 20F10, 20E05, 20E06, 20E08, 20E26, 20E22, 57M60.

Library of Congress Cataloging-in-Publication Data

AMS Special Session Geometric Group Theory (2002 : Northeastern University)

Geometric methods in group theory : AMS Special Session Geometric Group Theory, October 5–6, 2002, Northeastern University, Boston, Massachusetts : special session at the First Joint Meeting of the American Mathematical Society and the Real Sociedad Matemática Española, June 18–21, 2003, Seville, Spain / José Burillo . . . [et al.], editors.

p. cm. — (Contemporary mathematics, ISSN 0271-4132 ; 372)

Includes bibliographical references.

ISBN 0-8218-3362-6 (soft : alk. paper)

1. Group theory—Congresses. 2. Finite groups—Congresses. I. Burillo, José, 1965– II. Joint Meeting of the American Mathematical Society and the Real Sociedad Matemática Española (1st : 2003 : Seville, Spain) III. Title. IV. Contemporary mathematics (American Mathematical Society) ; v. 372.

QA174.A67 2002

512'.2—dc22

2004065011

Copying and reprinting. Material in this book may be reproduced by any means for educational and scientific purposes without fee or permission with the exception of reproduction by services that collect fees for delivery of documents and provided that the customary acknowledgment of the source is given. This consent does not extend to other kinds of copying for general distribution, for advertising or promotional purposes, or for resale. Requests for permission for commercial use of material should be addressed to the Acquisitions Department, American Mathematical Society, 201 Charles Street, Providence, Rhode Island 02904-2294, USA. Requests can also be made by e-mail to reprint-permission@ams.org.

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

© 2005 by the American Mathematical Society. All rights reserved.

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

Copyright of individual articles may revert to the public domain 28 years
after publication. Contact the AMS for copyright status of individual articles.

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 10 09 08 07 06 05

Contents

Preface	vii
Properly 3-realizable groups: a survey M. CÁRDENAS AND F. F. LASHERAS	1
Free actions on \mathbb{Z}^n -trees: a survey A. MARTINO AND S. O ROURKE	11
Characterizing rigid simplicial actions on trees GILBERT LEVITT	27
Improving an algorithm to solve multiple simultaneous conjugacy problems in braid groups JUAN GONZÁLEZ-MENESES	35
On singular Artin monoids EDDY GODELLE AND LUIS PARIS	43
A surface groups analogue of a theorem of Magnus OLEG BOGOPOLSKI	59
Shift automorphisms of finite order VENU ADDEPALLI AND EDWARD C. TURNER	71
Counting primitive elements of a free group VLADIMIR SHPILRAIN	91
A rank formula for amalgamated products with finite amalgam RICHARD WEIDMANN	99
A simple proof of a theorem of Karrass and Solitar DELARAM KAHROBAEI	107
Distortion functions and the membership problem for submonoids of groups and monoids STUART W. MARGOLIS, JOHN MEAKIN, AND ZORAN ŠUNIĆ	109
Thompson's group F is maximally nonconvex JAMES BELK AND KAI-UWE BUX	131
Seesaw words in Thompson's group F SEAN CLEARY AND JENNIFER TABACK	147
Piecewise-projective representation of Thompson's group T XAVIER MARTIN	161

Bijjective quasi-isometries of amenable groups TULLIA DYMARZ	181
On definitions of relatively hyperbolic groups INNA BUMAGIN	189
Embedding wreath-like products in finitely presented groups. I GILBERT BAUMSLAG	197
Metric properties of the lamplighter group as an automata group SEAN CLEARY AND JENNIFER TABACK	207
An example of non-contracting weakly branch automaton group FRANÇOIS DAHMANI	219
Travelling salesman problem in groups AZER AKHMEDOV	225

Preface

This volume consists of articles by speakers and participants in two special sessions held at AMS meetings. The first special session, “Geometric Group Theory”, was held at Northeastern University in Boston, Massachusetts, on October 5–6, 2002, and was organized by Sean Cleary, Murray Elder and Jennifer Taback. The second special session, “Geometric Methods in Group Theory”, was held at the First Joint Meeting of the American Mathematical Society and the Real Sociedad Matemática Española at the Universidad de Sevilla in Seville, Spain, on June 18–21, 2003, and was organized by José Burillo, Jennifer Taback and Enric Ventura.

This volume contains research articles covering a wide range of active areas of research in geometric group theory, as well as two survey articles.

We are very grateful to the American Mathematical Society for their help in organizing the special sessions and for their help with the preparation of this volume. In particular, we thank Christine Thivierge for her assistance in the publication of this volume.

José Burillo
Sean Cleary
Murray Elder
Jennifer Taback
Enric Ventura

Titles in This Series

- 372 **José Burillo, Sean Cleary, Murray Elder, Jennifer Taback, and Enric Ventura, Editors**, Geometric methods in group theory, 2005
- 371 **Gui-Qiang Chen, George Gasper, and Joseph Jerome, Editors**, Nonlinear partial differential equations and related analysis, 2005
- 370 **Pietro Poggi-Corradini, Editor**, The p -harmonic equation and recent advances in analysis, 2005
- 369 **Jaime Gutierrez, Vladimir Shpilrain, and Jie-Tai Yu, Editors**, Affine algebraic geometry, 2005
- 368 **Sagun Chanillo, Paulo D. Cordaro, Nicholas Hanges, Jorge Hounie, and Abdelhamid Meziani, Editors**, Geometric analysis of PDE and several complex variables, 2005
- 367 **Shu-Cheng Chang, Bennett Chow, Sun-Chin Chu, and Chang-Shou Lin, Editors**, Geometric evolution equations, 2005
- 366 **Bernhelm Booß-Bavnbek, Gerd Grubb, and Krzysztof P. Wojciechowski, Editors**, Spectral geometry of manifolds with boundary and decomposition of manifolds, 2005
- 365 **Robert S. Doran and Richard V. Kadison, Editors**, Operator algebras, quantization, and non-commutative geometry, 2004
- 364 **Mark Agranovsky, Lavi Karp, David Shoikhet, and Lawrence Zalcman, Editors**, Complex analysis and dynamical systems, 2004
- 363 **Anthony To-Ming Lau and Volker Runde, Editors**, Banach algebras and their applications, 2004
- 362 **Carlos Concha, Raul Manasevich, Gunther Uhlmann, and Michael S. Vogelius, Editors**, Partial differential equations and inverse problems, 2004
- 361 **Ali Enayat and Roman Kossak, Editors**, Nonstandard models of arithmetic and set theory, 2004
- 360 **Alexei G. Myasnikov and Vladimir Shpilrain, Editors**, Group theory, statistics, and cryptography, 2004
- 359 **S. Dostoglou and P. Ehrlich, Editors**, Advances in differential geometry and general relativity, 2004
- 358 **David Burns, Christian Popescu, Jonathan Sands, and David Solomon, Editors**, Stark's Conjectures: Recent work and new directions, 2004
- 357 **John Neuberger, Editor**, Variational methods: open problems, recent progress, and numerical algorithms, 2004
- 356 **Idris Assani, Editor**, Chapel Hill ergodic theory workshops, 2004
- 355 **William Abikoff and Andrew Haas, Editors**, In the tradition of Ahlfors and Bers, III, 2004
- 354 **Terence Gaffney and Maria Aparecida Soares Ruas, Editors**, Real and complex singularities, 2004
- 353 **M. C. Carvalho and J. F. Rodrigues, Editors**, Recent advances in the theory and applications of mass transport, 2004
- 352 **Marek Kubale, Editor**, Graph colorings, 2004
- 351 **George Yin and Qing Zhang, Editors**, Mathematics of finance, 2004
- 350 **Abbas Bahri, Sergiu Klainerman, and Michael Vogelius, Editors**, Noncompact problems at the intersection of geometry, analysis, and topology, 2004
- 349 **Alexandre V. Borovik and Alexei G. Myasnikov, Editors**, Computational and experimental group theory, 2004
- 348 **Hiroshi Isozaki, Editor**, Inverse problems and spectral theory, 2004
- 347 **Motoko Kotani, Tomoyuki Shirai, and Toshikazu Sunada, Editors**, Discrete geometric analysis, 2004

TITLES IN THIS SERIES

- 346 **Paul Goerss and Stewart Priddy, Editors**, Homotopy theory: Relations with algebraic geometry, group cohomology, and algebraic K -theory, 2004
- 345 **Christopher Heil, Palle E. T. Jorgensen, and David R. Larson, Editors**, Wavelets, frames and operator theory, 2004
- 344 **Ricardo Baeza, John S. Hsia, Bill Jacob, and Alexander Prestel, Editors**, Algebraic and arithmetic theory of quadratic forms, 2004
- 343 **N. Sthanumoorthy and Kailash C. Misra, Editors**, Kac-Moody Lie algebras and related topics, 2004
- 342 **János Pach, Editor**, Towards a theory of geometric graphs, 2004
- 341 **Hugo Arizmendi, Carlos Bosch, and Lourdes Palacios, Editors**, Topological algebras and their applications, 2004
- 340 **Rafael del Río and Carlos Villegas-Blas, Editors**, Spectral theory of Schrödinger operators, 2004
- 339 **Peter Kuchment, Editor**, Waves in periodic and random media, 2003
- 338 **Pascal Auscher, Thierry Coulhon, and Alexander Grigor'yan, Editors**, Heat kernels and analysis on manifolds, graphs, and metric spaces, 2003
- 337 **Krishan L. Duggal and Ramesh Sharma, Editors**, Recent advances in Riemannian and Lorentzian geometries, 2003
- 336 **José González-Barríos, Jorge A. León, and Ana Meda, Editors**, Stochastic models, 2003
- 335 **Geoffrey L. Price, B. Mitchell Baker, Palle E.T. Jorgensen, and Paul S. Muhly, Editors**, Advances in quantum dynamics, 2003
- 334 **Ron Goldman and Rimvydas Krasauskas, Editors**, Topics in algebraic geometry and geometric modeling, 2003
- 333 **Giovanni Alessandrini and Gunther Uhlmann, Editors**, Inverse problems: Theory and applications, 2003
- 332 **John Bland, Kang-Tae Kim, and Steven G. Krantz, Editors**, Explorations in complex and Riemannian geometry, 2003
- 331 **Luchezar L. Avramov, Marc Chardin, Marcel Morales, and Claudia Polini, Editors**, Commutative algebra: Interactions with algebraic geometry, 2003
- 330 **S. Y. Cheng, C.-W. Shu, and T. Tang, Editors**, Recent advances in scientific computing and partial differential equations, 2003
- 329 **Zhangxin Chen, Roland Glowinski, and Kaitai Li, Editors**, Current trends in scientific computing, 2003
- 328 **Krzysztof Jarosz, Editor**, Function spaces, 2003
- 327 **Yulia Karpeshina, Günter Stolz, Rudi Weikard, and Yanni Zeng, Editors**, Advances in differential equations and mathematical physics, 2003
- 326 **Kenneth D. T-R McLaughlin and Xin Zhou, Editors**, Recent developments in integrable systems and Riemann-Hilbert problems, 2003
- 325 **Seok-Jin Kang and Kyu-Hwan Lee, Editors**, Combinatorial and geometric representation theory, 2003
- 324 **Caroline Grant Melles, Jean-Paul Brasselet, Gary Kennedy, Kristin Lauter, and Lee McEwan, Editors**, Topics in algebraic and noncommutative geometry, 2003
- 323 **Vadim Olshevsky, Editor**, Fast algorithms for structured matrices: theory and applications, 2003

For a complete list of titles in this series, visit the
AMS Bookstore at www.ams.org/bookstore/.

This volume presents articles by speakers and participants in two AMS special sessions, Geometric Group Theory and Geometric Methods in Group Theory, held respectively at Northeastern University (Boston, MA) and at Universidad de Sevilla (Spain). The expository and survey articles in the book cover a wide range of topics, making it suitable for researchers and graduate students interested in group theory.

ISBN 0-8218-3362-6



9 780821 833629

CONM/372

AMS *on the Web*
www.ams.org