Indian Statistical Institute Series

The *Indian Statistical Institute Series* publishes high-quality content in the domain of mathematical sciences, bio-mathematics, financial mathematics, pure and applied mathematics, operations research, applied statistics and computer science and applications with primary focus on mathematics and statistics. Editorial board comprises of active researchers from major centres of Indian Statistical Institute. Launched at the 125th birth Anniversary of P. C. Mahalanobis, the series will publish textbooks, monographs, lecture notes and contributed volumes. Literature in this series will appeal to a wide audience of students, researchers, educators, and professionals across mathematics, statistics and computer science disciplines.

More information about this series at http://www.springer.com/series/15910

N. S. Narasimha Sastry · Manoj Kumar Yadav
Editors

Group Theory and Computation

Springer

Editors
N. S. Narasimha Sastry
Department of Mathematics
Indian Institute of Technology Dharwad
Dharwad, Karnataka, India

Manoj Kumar Yadav
Harish-Chandra Research Institute
Allahabad, Uttar Pradesh, India

ISSN 2523-3114 ISSN 2523-3122 (electronic)
Indian Statistical Institute Series
ISBN 978-981-13-2046-0 ISBN 978-981-13-2047-7 (eBook)
https://doi.org/10.1007/978-981-13-2047-7

Library of Congress Control Number: 2018951549

Cover photo: Reprography & Photography Unit, Indian Statistical Institute, Kolkata, India

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Preface

This volume is a collection of invited articles by some of the leading and very active researchers in the theory of finite groups and their representations, and the Monster group, with an emphasis on computational aspects. Among the authors are participants who led workshops and delivered invited talks in the international program "Group Theory and Computational Methods" held at the International Center for Theoretical Sciences (ICTS), Bangalore, from November 05–14, 2016. The program comprised of two parts: workshops (November 05–09, 2016) and discussion meetings (November 11–14, 2016).

The workshops comprised of the following five minicourses of 6-h duration each:

(1) Computational homological algebra
(2) Computational representation theory
(3) Computational aspects of finite p-groups
(4) Computer algebra system GAP
(5) Introduction to Monster simple group and Moonshine

The discussion meetings comprised of 20 invited talks by eminent mathematicians. They presented recent developments and problems of current mathematical interest on a variety of topics in group theory and related areas. Poster presentation session consisted of 11 posters by young researchers.

The topics of the articles include finite loops, non-abelian tensor product, periodic groups, character table of finite groups, computing subgroups using computer algebra system GAP, Majorana theory related to the Monster group, groups with abelian automorphism groups, unit groups of integral group rings, and Camina groups and generalizations.

We thank the authors for writing the articles and our colleagues for carefully refereeing them. We also thank the speakers and the participants of the workshops and discussion meetings mentioned above whose participation helped closer mathematical scrutiny of the themes discussed.

We thank ICTS, Bangalore, for the excellent facilities and support for the smooth and successful conduct of the program. We also thank Springer for publishing this volume, and Shamim Ahmad, for his friendly and efficient handling of the publication process.

Dharwad, India — N. S. Narasimha Sastry
Allahabad, India — Manoj Kumar Yadav

Contents

Editors and Contributors

About the Editors

N. S. Narasimha Sastry is currently a visiting professor at the Indian Institute of Technology Dharwad, Karnataka, India. Prior to this, he was a professor of mathematics and head of the Indian Statistical Institute, Bangalore Centre, India. He received his Ph.D. from the University of Pittsburgh, Pennsylvania, USA, and has held visiting positions at the Tata Institute of Fundamental Research, Mumbai, India; Michigan State University, East Lansing, USA; The University of Western Australia, Perth, Australia; Rutgers University–New Brunswick, USA; The University of Florida, Gainesville, USA; and Ghent University, Belgium. In addition to publishing more than 30 research articles in various journals, he has also edited books: *Buildings, Finite Geometries and Groups* and *Groups of Exceptional Type, Coxeter Groups and Related Geometries*, both published by Springer, as well as *Essays in Geometric Group Theory*, published by the Ramanujan Mathematical Society. He also co-edited *Perspectives in Mathematical Sciences* (Volumes 1 and 2), published by World Scientific. His research interests are finite groups including finite simple groups, geometries related to finite simple groups, algebraic codes, Coxeter groups, and the Monster group.

Manoj Kumar Yadav is Professor of Mathematics at the Harish-Chandra Research Institute, Allahabad, India. He is also associated with the Homi Bhabha National Institute, Mumbai, India. He received his PhD in Mathematics from Kurukshetra University, Kurukshetra (2002). Professor Yadav has been awarded the Indian National Science Academy Medal for Young Scientists (2009) and the Department of Science & Technology, Science and Engineering Research Council (SERC), fellowship Fast Track Scheme for Young Scientists (2005). He is a member of The National Academy of Sciences, India (NASI). His research interests lie in group theory, particularly automorphisms, conjugacy classes and Schur multipliers of groups. He has published over 25 research papers in various respected journals, conference proceedings and contributed volumes.

Contributors

Katharina Artic Lehrstuhl B für Mathematik, RWTH Aachen University, Aachen, Germany

Valeriy G. Bardakov Sobolev Institute of Mathematics, Novosibirsk, Russia; Novosibirsk State University, Novosibirsk, Russia; Novosibirsk State Agrarian University, Novosibirsk, Russia

Silvio Dolfi Dipartimento di Matematica U. Dini, Università degli Studi di Firenze, Firenze, Italy

Marcel Herzog School of Mathematical Sciences, Tel-Aviv University, Ramat-Aviv, Tel-Aviv, Israel

Gerhard Hiss Lehrstuhl D für Mathematik, RWTH Aachen University, Aachen, Germany

Alexander Hulpke Department of Mathematics, Colorado State University, Fort Collins, CO, USA

Alexander A. Ivanov Department of Mathematics, Imperial College, London, UK

Rahul Dattatraya Kitture School of Mathematics, Harish-Chandra Research Institute, Jhunsi, Allahabad, India; Homi Bhabha National Institute, Mumbai, India

Mark L. Lewis Department of Mathematical Sciences, Kent State University, Kent, OH, USA

Patrizia Longobardi Dipartimento di Matematica, Università di Salerno, Fisciano (Salerno), Italy

Sugandha Maheshwary Indian Institute of Science Education and Research, Mohali, Mohali, Punjab, India

Mercede Maj Dipartimento di Matematica, Università di Salerno, Fisciano (Salerno), Italy

Gabriel Navarro Departament of Mathematics, Universitat de València, Burjassot, Valencia, Spain

Mikhail V. Neshchadim Sobolev Institute of Mathematics and Novosibirsk State University, Novosibirsk, Russia

Emanuele Pacifici Dipartimento di Matematica F. Enriques, Università degli Studi di Milano, Milano, Italy

Inder Bir S. Passi Indian Institute of Science Education and Research, Mohali, Mohali, Punjab, India; Centre for Advanced Study in Mathematics, Panjab University, Chandigarh, India

Lucia Sanus Departament de Matemàtiques, Facultat de Matemàtiques, Universitat de València, Valencia, Spain

Manoj K. Yadav School of Mathematics, Harish-Chandra Research Institute, Jhunsi, Allahabad, India; Homi Bhabha National Institute, Mumbai, India