

CONTEMPORARY MATHEMATICS

480

Rings, Modules and Representations

International Conference on Rings and Things
in Honor of Carl Faith and Barbara Osofsky

June 15–17, 2007

Ohio University-Zanesville
Zanesville, OH

Nguyen Viet Dung
Franco Guerriero
Lakhdar Hammoudi
Pramod Kanwar
Editors



Rings, Modules and Representations

CONTEMPORARY MATHEMATICS

480

Rings, Modules and Representations

International Conference on Rings and Things
in Honor of Carl Faith and Barbara Osofsky

June 15–17, 2007
Ohio University-Zanesville
Zanesville, OH

Nguyen Viet Dung
Franco Guerriero
Lakhdar Hammoudi
Pramod Kanwar
Editors



American Mathematical Society
Providence, Rhode Island

Editorial Board

Dennis DeTurck, managing editor

George Andrews Abel Klein Martin J. Strauss

2000 *Mathematics Subject Classification*. Primary 13–XX, 16–XX, 18–XX.

Library of Congress Cataloging-in-Publication Data

International Conference on Rings and Things in Honor of Carl Faith and Barbara Osofsky (2007 : Ohio University-Zanesville)

Rings, modules, and representations : International Conference on Rings and Things in Honor of Carl Faith and Barbara Osofsky, June 15–17, 2007, Ohio University-Zanesville / Nguyen Viet Dung . . . [et al.], editors.

p. cm. — (Contemporary mathematics, ISSN 0271-4132 ; 480)

Includes bibliographical references.

ISBN 978-0-8218-4370-3 (alk. paper)

1. Associative rings. 2. Modules (Algebra) 3. Representations of algebras. I. Faith, Carl Clifton, 1927– II. Osofsky, Barbara. III. Nguyen, Viet Dung.

QA251.5.I63 2009

512'.46—dc22

2008039856

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.)

© 2009 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 14 13 12 11 10 09

Dedicated to
Carl Faith and Barbara Osofsky

Contents

Preface	ix
Subgroups of Direct Products of Groups, Ideals and Subrings of Direct Products of Rings, and Goursat's Lemma D.D. ANDERSON and V. CAMILLO	1
An Example of Osofsky and Essential Overrings GARY F. BIRKENMEIER, JAE KEOL PARK, and S. TARIQ RIZVI	13
On Commutative Clean Rings and pm Rings W.D. BURGESS and R. RAPHAEL	35
Modules Satisfying the Ascending Chain Condition on Submodules with Bounded Uniform Dimension ESPERANZA SÁNCHEZ CAMPOS and PATRICK F. SMITH	57
Relative Purity, Flatness, and Injectivity JOHN DAUNS	73
Repeated-Root Constacyclic Codes of Prime Power Length HAI Q. DINH	87
The Socle Series of Indecomposable Injective Modules Over a Principal Left and Right Ideal Domain ALINA N. DUCA	101
Some Remarks on a Question of Faith NOYAN ER	133
Subdirect Representations of Categories of Modules ALBERTO FACCHINI	139
Fitting's Lemma for Modules with Well-behaved Clones JOSÉ L. GÓMEZ PARDO and PEDRO A. GUIL ASENSIO	153
Leavitt Path Algebras and Direct Limits K.R. GOODEARL	165
Simple Modules over Small Rings DOLORS HERBERA	189
A Hierarchy of Parametrizing Varieties for Representations B. HUISGEN-ZIMMERMANN	207

On the CS Condition and Rings with Chain Conditions DINH VAN HUYNH, DINH DUC TAI, and LE VAN AN	241
Ore Extensions and V -Domains S.K. JAIN, T.Y. LAM, and A. LEROY	249
Oka and Ako Ideal Families in Commutative Rings T.Y. LAM and MANUEL L. REYES	263
Matrix Representations of Skew Polynomial Rings with Semisimple Coefficient Rings SERGIO LÓPEZ-PERMOUTH and STEVE SZABO	289
Topological Representations of Von Neumann Regular Algebras PETER PAPPAS	297
A Unified Approach to Some Results on One-sided Ideals and Matrix Rings of Associative Rings EDMUND R. PUCZYLOWSKI	311
Tilting and Cotilting Classes Over Gorenstein Rings JAN TRLIFAJ and DAVID POSPÍŠIL	319
Semigroups of Modules: A Survey ROGER WIEGAND and SYLVIA WIEGAND	335
Generators in Module and Comodule Categories ROBERT WISBAUER	351

Preface

Continuing the tradition of algebra conferences hosted by Ohio University, the summer of 2007 saw the addition of yet another chapter - an international conference on rings and modules. The conference, attended by over seventy mathematicians of international repute from more than twenty countries, provided an excellent opportunity for the experts in Theory of Rings and Modules and other related topics to exchange ideas and discuss new developments in these rapidly growing areas of research. The conference also stimulated new exciting collaborations among the participants.

The conference, named *International Conference on Rings and Things*, is a reference to Carl Faith's well-known book *Rings and Things*. The conference was hosted by the Zanesville campus of Ohio University and was held in honor of Carl Faith's 80th birthday and Barbara Osofsky's 70th birthday. It was a pleasure to host the conference and then present these Proceedings dedicated to such outstanding algebraists. Their work through the years speaks for itself and is certainly of the highest quality.

This volume represents some of the recent work of the invited speakers and other participants of the conference. It is our hope that the articles presented in this volume will be an important source of inspiration for the researchers interested in Theory of Rings and Modules, Representation Theory and applications.

We would like to thank all of the mathematicians who participated by either attending or presenting their work and generating new ideas for further research. We would especially like to thank those who graciously accepted our invitations and those who submitted their work for publication in these proceedings.

We would like to thank the National Security Agency, the Deans of the Chillicothe, Lancaster and Zanesville Campuses of Ohio University for their financial support. Thanks are also due to the Vice President for Regional Higher Education and the Office of Research at Ohio University for their continued support of scholarly activities at Ohio University and its regional campuses.

Of great assistance and inspiration for this conference and subsequent proceedings is the Center for Ring Theory and its Applications (CRA) at Ohio University. CRA has been a driving force that keeps the State of Ohio on the forefront of research in Algebra. The Director of CRA, S.K. Jain, not only offered financial support but also gave many helpful suggestions in the organization of the conference.

On a personal and professional level we would like to thank our colleagues Dinh V. Huynh and Sergio R. Lopez-Permouth at Ohio University for their assistance. We would also like to thank the staff of the American Mathematical Society for

their hard work and we are especially indebted to Ms. Christine Thivierge for her effort and professionalism in getting this project through.

Finally, we thank all of our colleagues who served as anonymous referees for the papers presented here. Their meticulous review and thoughtful suggestions were extremely helpful in the editing of this volume.

Editors

Titles in This Series

- 480 **Nguyen Viet Dung, Franco Guerriero, Lakhdar Hammoudi, and Pramod Kanwar, Editors**, Rings, modules and representations, 2009
- 479 **Timothy Y. Chow and Daniel C. Isaksen, Editors**, Communicating mathematics, 2009
- 478 **Zongzhu Lin and Jianpan Wang, Editors**, Representation theory, 2009
- 477 **Ignacio Luengo, Editor**, Recent Trends in Cryptography, 2009
- 476 **Carlos Villegas-Blas, Editor**, Fourth summer school in analysis and mathematical physics: Topics in spectral theory and quantum mechanics, 2008
- 475 **Jean-Paul Brasselet, José Luis Cisneros-Molina, David Massey, José Seade, and Bernard Teissier, Editors**, Singularities II: Geometric and topological aspects, 2008
- 474 **Jean-Paul Brasselet, José Luis Cisneros-Molina, David Massey, José Seade, and Bernard Teissier, Editors**, Singularities I: Algebraic and analytic aspects, 2008
- 473 **Alberto Farina and Jean-Claude Saut, Editors**, Stationary and time dependent Gross-Pitaevskii equations, 2008
- 472 **James Arthur, Wilfried Schmid, and Peter E. Trapa, Editors**, Representation Theory of Real Reductive Lie Groups, 2008
- 471 **Diego Dominici and Robert S. Maier, Editors**, Special functions and orthogonal polynomials, 2008
- 470 **Luise-Charlotte Kappe, Arturo Magidin, and Robert Fitzgerald Morse, Editors**, Computational group theory and the theory of groups, 2008
- 469 **Keith Burns, Dmitry Dolgopyat, and Yakov Pesin, Editors**, Geometric and probabilistic structures in dynamics, 2008
- 468 **Bruce Gilligan and Guy J. Roos, Editors**, Symmetries in complex analysis, 2008
- 467 **Alfred G. Noël, Donald R. King, Gaston M. N'Guérékata, and Edray H. Goins, Editors**, Council for African American researchers in the mathematical sciences: Volume V, 2008
- 466 **Boo Cheong Khoo, Zhilin Li, and Ping Lin, Editors**, Moving interface problems and applications in fluid dynamics, 2008
- 465 **Valery Alexeev, Arnaud Beauville, C. Herbert Clemens, and Elham Izadi, Editors**, Curves and Abelian varieties, 2008
- 464 **Gestur Ólafsson, Eric L. Grinberg, David Larson, Palle E. T. Jorgensen, Peter R. Massopust, Eric Todd Quinto, and Boris Rubin, Editors**, Radon transforms, geometry, and wavelets, 2008
- 463 **Kristin E. Lauter and Kenneth A. Ribet, Editors**, Computational arithmetic geometry, 2008
- 462 **Giuseppe Dito, Hugo García-Compeán, Ernesto Lupercio, and Francisco J. Turrubiates, Editors**, Non-commutative geometry in mathematics and physics, 2008
- 461 **Gary L. Mullen, Daniel Panario, and Igor Shparlinski, Editors**, Finite fields and applications, 2008
- 460 **Megumi Harada, Yael Karshon, Mikiya Masuda, and Taras Panov, Editors**, Toric topology, 2008
- 459 **Marcelo J. Saia and José Seade, Editors**, Real and complex singularities, 2008
- 458 **Jinho Baik, Thomas Kriecherbauer, Luen-Chau Li, Kenneth D. T-R McLaughlin, and Carlos Tomei, Editors**, Integrable systems and random matrices, 2008
- 457 **Tewodros Amdeberhan and Victor H. Moll, Editors**, Tapas in experimental mathematics, 2008
- 456 **S. K. Jain and S. Parvathi, Editors**, Noncommutative rings, group rings, diagram algebras and their applications, 2008

TITLES IN THIS SERIES

- 455 **Mark Agranovsky, Daoud Bshouty, Lavi Karp, Simeon Reich, David Shoikhet, and Lawrence Zalcman, Editors**, Complex analysis and dynamical systems III, 2008
- 454 **Rita A. Hibscheweiler and Thomas H. MacGregor, Editors**, Banach spaces of analytic functions, 2008
- 453 **Jacob E. Goodman, János Pach, and Richard Pollack, Editors**, Surveys on Discrete and Computational Geometry—Twenty Years Later, 2008
- 452 **Matthias Beck, Christian Haase, Bruce Reznick, Michèle Vergne, Volkmar Welker, and Ruriko Yoshida, Editors**, Integer points in polyhedra, 2008
- 451 **David R. Larson, Peter Massopust, Zuhair Nashed, Minh Chuong Nguyen, Manos Papadakis, and Ahmed Zayed, Editors**, Frames and operator theory in analysis and signal processing, 2008
- 450 **Giuseppe Dito, Jiang-Hua Lu, Yoshiaki Maeda, and Alan Weinstein, Editors**, Poisson geometry in mathematics and physics, 2008
- 449 **Robert S. Doran, Calvin C. Moore, and Robert J. Zimmer, Editors**, Group representations, ergodic theory, and mathematical physics: A tribute to George W. Mackey, 2007
- 448 **Alberto Corso, Juan Migliore, and Claudia Polini, Editors**, Algebra, geometry and their interactions, 2007
- 447 **François Germinet and Peter Hislop, Editors**, Adventures in mathematical physics, 2007
- 446 **Henri Berestycki, Michiel Bertsch, Felix E. Browder, Louis Nirenberg, Lambertus A. Peletier, and Laurent Véron, Editors**, Perspectives in Nonlinear Partial Differential Equations, 2007
- 445 **Laura De Carli and Mario Milman, Editors**, Interpolation Theory and Applications, 2007
- 444 **Joseph Rosenblatt, Alexander Stokolos, and Ahmed I. Zayed, Editors**, Topics in harmonic analysis and ergodic theory, 2007
- 443 **Joseph Stephen Verducci and Xiaotong Shen, Editors**, Prediction and discovery, 2007
- 442 **Yi-Zhi Huang and Kailash C Misra, Editors**, Lie algebras, vertex operator algebras and their applications, 2007
- 441 **Louis H. Kauffman, David E. Radford, and Fernando J. O. Souza, Editors**, Hopf algebras and generalizations, 2007
- 440 **Fernanda Botelho, Thomas Hagen, and James Jamison, Editors**, Fluids and Waves, 2007
- 439 **Donatella Danielli, Editor**, Recent developments in nonlinear partial differential equations, 2007
- 438 **Marc Burger, Michael Farber, Robert Ghrist, and Daniel Koditschek, Editors**, Topology and robotics, 2007
- 437 **José C. Mourão, João P. Nunes, Roger Picken, and Jean-Claude Zambrini, Editors**, Prospects in mathematical physics, 2007
- 436 **Luchezar L. Avramov, Daniel Christensen, William G Dwyer, Michael A Mandell, and Brooke E Shipley, Editors**, Interactions between homotopy theory and algebra, 2007
- 435 **Krzysztof Jarosz, Editor**, Function spaces, 2007
- 434 **S. Paycha and B. Uribe, Editors**, Geometric and topological methods for quantum field theory, 2007

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

This volume originated from talks given at the International Conference on Rings and Things held in June, 2007 at Ohio University–Zanesville.

The papers in this volume contain the latest results in current active research areas in the theory of rings and modules, including noncommutative and commutative ring theory, module theory, representation theory, and coding theory. In particular, papers in this volume deal with topics such as decomposition theory of modules, injectivity and generalizations, tilting theory, rings and modules with chain conditions, Leavitt path algebras, representations of finite dimensional algebras, and codes over rings. While most of these papers are original research articles, some are expository surveys.

This book is suitable for graduate students and researchers interested in noncommutative ring and module theory, representation theory, and applications.

ISBN 978-0-8218-4370-3



9 780821 843703

CONM/480

AMS on the Web
www.ams.org