

Cambridge University Press

978-1-107-14972-4 - Commutative Algebra and Noncommutative Algebraic Geometry:
Volume II: Research Articles

Edited by David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford and
Michel Van Den Bergh

Frontmatter

[More information](#)

In the 2012–13 academic year, the Mathematical Sciences Research Institute, Berkeley, hosted programs in Commutative Algebra (Fall 2012 and Spring 2013) and Noncommutative Algebraic Geometry and Representation Theory (Spring 2013). There have been many significant developments in these fields in recent years; what is more, the boundary between them has become increasingly blurred. This was apparent during the MSRI program, where there were a number of joint seminars on subjects of common interest: birational geometry, D-modules, invariant theory, matrix factorizations, noncommutative resolutions, singularity categories, support varieties, and tilting theory, to name a few. These volumes reflect the lively interaction between the subjects witnessed at MSRI.

The Introductory Workshops and Connections for Women Workshops for the two programs included lecture series by experts in the field. The volumes include a number of survey articles based on these lectures, along with expository articles and research papers by participants of the programs.

Cambridge University Press

978-1-107-14972-4 - Commutative Algebra and Noncommutative Algebraic Geometry:
Volume II: Research Articles

Edited by David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford and
Michel Van Den Bergh

Frontmatter

[More information](#)

Cambridge University Press

978-1-107-14972-4 - Commutative Algebra and Noncommutative Algebraic Geometry:
Volume II: Research Articles

Edited by David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford and
Michel Van Den Bergh

Frontmatter

[More information](#)

Mathematical Sciences Research Institute
Publications

68

Commutative Algebra and
Noncommutative Algebraic Geometry
Volume II: Research Articles

Cambridge University Press

978-1-107-14972-4 - Commutative Algebra and Noncommutative Algebraic Geometry:
Volume II: Research ArticlesEdited by David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford and
Michel Van Den Bergh

Frontmatter

[More information](#)

Mathematical Sciences Research Institute Publications

- 1 Freed/Uhlenbeck: *Instantons and Four-Manifolds*, second edition
- 2 Chern (ed.): *Seminar on Nonlinear Partial Differential Equations*
- 3 Lepowsky/Mandelstam/Singer (eds.): *Vertex Operators in Mathematics and Physics*
- 4 Kac (ed.): *Infinite Dimensional Groups with Applications*
- 5 Blackadar: *K-Theory for Operator Algebras*, second edition
- 6 Moore (ed.): *Group Representations, Ergodic Theory, Operator Algebras, and Mathematical Physics*
- 7 Chorin/Majda (eds.): *Wave Motion: Theory, Modelling, and Computation*
- 8 Gersten (ed.): *Essays in Group Theory*
- 9 Moore/Schochet: *Global Analysis on Foliated Spaces*, second edition
- 10–11 Drasin/Earle/Gehring/Kra/Marden (eds.): *Holomorphic Functions and Moduli*
- 12–13 Ni/Peletier/Serrin (eds.): *Nonlinear Diffusion Equations and Their Equilibrium States*
- 14 Goodman/de la Harpe/Jones: *Coxeter Graphs and Towers of Algebras*
- 15 Hochster/Huneke/Sally (eds.): *Commutative Algebra*
- 16 Ihara/Ribet/Serre (eds.): *Galois Groups over \mathbb{Q}*
- 17 Concus/Finn/Hoffman (eds.): *Geometric Analysis and Computer Graphics*
- 18 Bryant/Chern/Gardner/Goldschmidt/Griffiths: *Exterior Differential Systems*
- 19 Alperin (ed.): *Arboreal Group Theory*
- 20 Dazord/Weinstein (eds.): *Symplectic Geometry, Groupoids, and Integrable Systems*
- 21 Moschovakis (ed.): *Logic from Computer Science*
- 22 Ratiu (ed.): *The Geometry of Hamiltonian Systems*
- 23 Baumslag/Miller (eds.): *Algorithms and Classification in Combinatorial Group Theory*
- 24 Montgomery/Small (eds.): *Noncommutative Rings*
- 25 Akbulut/King: *Topology of Real Algebraic Sets*
- 26 Judah/Just/Woodin (eds.): *Set Theory of the Continuum*
- 27 Carlsson/Cohen/Hsiang/Jones (eds.): *Algebraic Topology and Its Applications*
- 28 Clemens/Kollár (eds.): *Current Topics in Complex Algebraic Geometry*
- 29 Nowakowski (ed.): *Games of No Chance*
- 30 Grove/Petersen (eds.): *Comparison Geometry*
- 31 Levy (ed.): *Flavors of Geometry*
- 32 Cecil/Chern (eds.): *Tight and Taut Submanifolds*
- 33 Axler/McCarthy/Sarason (eds.): *Holomorphic Spaces*
- 34 Ball/Milman (eds.): *Convex Geometric Analysis*
- 35 Levy (ed.): *The Eightfold Way*
- 36 Gavosto/Krantz/McCallum (eds.): *Contemporary Issues in Mathematics Education*
- 37 Schneider/Siu (eds.): *Several Complex Variables*
- 38 Billera/Björner/Green/Simion/Stanley (eds.): *New Perspectives in Geometric Combinatorics*
- 39 Haskell/Pillay/Steinhorn (eds.): *Model Theory, Algebra, and Geometry*
- 40 Bleher/Its (eds.): *Random Matrix Models and Their Applications*
- 41 Schneps (ed.): *Galois Groups and Fundamental Groups*
- 42 Nowakowski (ed.): *More Games of No Chance*
- 43 Montgomery/Schneider (eds.): *New Directions in Hopf Algebras*
- 44 Buhler/Stevenhagen (eds.): *Algorithmic Number Theory: Lattices, Number Fields, Curves and Cryptography*
- 45 Jensen/Ledet/Yui: *Generic Polynomials: Constructive Aspects of the Inverse Galois Problem*
- 46 Rockmore/Healy (eds.): *Modern Signal Processing*
- 47 Uhlmann (ed.): *Inside Out: Inverse Problems and Applications*
- 48 Gross/Kotiuga: *Electromagnetic Theory and Computation: A Topological Approach*
- 49 Darmon/Zhang (eds.): *Heegner Points and Rankin L-Series*
- 50 Bao/Bryant/Chern/Shen (eds.): *A Sampler of Riemann–Finsler Geometry*
- 51 Avramov/Green/Huneke/Smith/Sturmfels (eds.): *Trends in Commutative Algebra*
- 52 Goodman/Pach/Welzl (eds.): *Combinatorial and Computational Geometry*
- 53 Schoenfeld (ed.): *Assessing Mathematical Proficiency*
- 54 Hasselblatt (ed.): *Dynamics, Ergodic Theory, and Geometry*
- 55 Pinsky/Birnir (eds.): *Probability, Geometry and Integrable Systems*
- 56 Albert/Nowakowski (eds.): *Games of No Chance 3*
- 57 Kirsten/Williams (eds.): *A Window into Zeta and Modular Physics*
- 58 Friedman/Hunsicker/Libgober/Maxim (eds.): *Topology of Stratified Spaces*
- 59 Caporaso/M^cKernan/Mustața/Popa (eds.): *Current Developments in Algebraic Geometry*
- 60 Uhlmann (ed.): *Inverse Problems and Applications: Inside Out II*
- 61 Breuillard/Oh (eds.): *Thin Groups and Superstrong Approximation*
- 62 Eguchi/Eliashberg/Maeda (eds.): *Symplectic, Poisson, and Noncommutative Geometry*
- 63 Nowakowski (ed.): *Games of No Chance 4*
- 65 Deift/Forrester (eds.): *Random Matrix Theory, Interacting Particle Systems, and Integrable Systems*
- 67–68 Eisenbud/Iyengar/Singh/Stafford/Van den Bergh (eds.): *Commutative Algebra and Noncommutative Algebraic Geometry*

Cambridge University Press

978-1-107-14972-4 - Commutative Algebra and Noncommutative Algebraic Geometry:
Volume II: Research Articles

Edited by David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford and
Michel Van Den Bergh

Frontmatter

[More information](#)

Commutative Algebra and Noncommutative Algebraic Geometry

Volume II: Research Articles

Edited by

David Eisenbud

*University of California, Berkeley
and Mathematical Sciences Research Institute*

Srikanth B. Iyengar

University of Utah

Anurag K. Singh

University of Utah

J. Toby Stafford

University of Manchester

Michel Van den Bergh

*Fonds Wetenschappelijk Onderzoek - Vlaanderen
and Universiteit Hasselt*



Cambridge University Press

978-1-107-14972-4 - Commutative Algebra and Noncommutative Algebraic Geometry:

Volume II: Research Articles

Edited by David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford and

Michel Van Den Bergh

Frontmatter

[More information](#)

David Eisenbud
de@msri.org

Srikanth B. Iyengar
iyengar@math.utah.edu

Anurag K. Singh
singh@math.utah.edu

J. Toby Stafford
toby.stafford@manchester.ac.uk

Michel Van den Bergh
michel.vandenbergh@uhasselt.be

Silvio Levy (*Series Editor*)
Mathematical Sciences Research Institute
levy@msri.org

The Mathematical Sciences Research Institute wishes to acknowledge support by the
National Science Foundation for the publication of this series.

CAMBRIDGE
UNIVERSITY PRESS

32 Avenue of the Americas, New York, NY 10013-2473, USA

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education,
learning and research at the highest international levels of excellence.

www.cambridge.org

Information on this title: www.cambridge.org/9781107149724

© Mathematical Sciences Research Institute 2015

This publication is in copyright. Subject to statutory exception
and to the provisions of relevant collective licensing agreements,
no reproduction of any part may take place without the written
permission of Cambridge University Press.

First published 2015

A catalog record for this publication is available from the British Library.

ISBN 978-1-107-14972-4 Hardback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for
external or third-party Internet websites referred to in this publication and does not guarantee
that any content on such websites is, or will remain, accurate or appropriate.

Cambridge University Press

978-1-107-14972-4 - Commutative Algebra and Noncommutative Algebraic Geometry:
Volume II: Research ArticlesEdited by David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford and
Michel Van Den Bergh

Frontmatter

[More information](#)Commutative Algebra and Noncommutative Algebraic Geometry, II
MSRI Publications
Volume 68, 2015

Contents

Preface	ix
When is a squarefree monomial ideal of linear type? ALI ALILOOEE AND SARA FARIDI	1
Modules for elementary abelian groups and hypersurface singularities DAVID J. BENSON	19
Ideals generated by superstandard tableaux ANDREW BERGET, WINFRIED BRUNS AND ALDO CONCA	43
Zariski topologies on stratified spectra of quantum algebras KENNETH A. BROWN AND KENNETH R. GOODEARL	63
The derived category of a graded Gorenstein ring JESSE BURKE AND GREG STEVENSON	93
Singularities with respect to Mather–Jacobian discrepancies LAWRENCE EIN AND SHIHOKO ISHII	125
Reduction numbers and balanced ideals LOUIZA FOULI	169
Unipotent and Nakayama automorphisms of quantum nilpotent algebras KENNETH R. GOODEARL AND MILEN T. YAKIMOV	181
Formal fibers of prime ideals in polynomial rings WILLIAM HEINZER, CHRISTEL ROTTHAUS AND SYLVIA WIEGAND	213
Bounding the socles of powers of squarefree monomial ideals JÜRGEN HERZOG AND TAKAYUKI HIBI	223
An intriguing ring structure on the set of d -forms JÜRGEN HERZOG, LEILA SHARIFAN AND MATTEO VARBARO	231
On the subadditivity problem for maximal shifts in free resolutions JÜRGEN HERZOG AND HEMA SRINIVASAN	245
The cone of Betti tables over a rational normal curve MANOJ KUMMINI AND STEVEN V SAM	251
Adjoint associativity: an invitation to algebra in ∞ -categories JOSEPH LIPMAN	265

Cambridge University Press

978-1-107-14972-4 - Commutative Algebra and Noncommutative Algebraic Geometry:
Volume II: Research Articles

Edited by David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford and
Michel Van Den Bergh

Frontmatter

[More information](#)

Cambridge University Press

978-1-107-14972-4 - Commutative Algebra and Noncommutative Algebraic Geometry:

Volume II: Research Articles

Edited by David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford and

Michel Van Den Bergh

Frontmatter

[More information](#)

Commutative Algebra and Noncommutative Algebraic Geometry, II
MSRI Publications
Volume 68, 2015

Preface

In the 2012–13 academic year, the Mathematical Sciences Research Institute, in Berkeley, hosted programs in Commutative Algebra (Fall 2012 and Spring 2013) and Noncommutative Algebraic Geometry and Representation Theory (Spring 2013). The programs had 174 participants visiting for periods ranging between one and nine months, and many others for shorter periods and for week-long workshops.

There have been many significant developments in these fields in recent years; what is more, the once rather strict boundary between them has become increasingly blurred. This was apparent during the MSRI program, where there were a number of joint seminars on subjects of common interest: birational geometry, \mathcal{D} -modules, invariant theory, matrix factorizations, non-commutative resolution of singularities, singularity categories, support varieties, and tilting theory, to name a few. This volume is intended to reflect, and stimulate, the lively interaction between the two subjects that we witnessed at MSRI.

The Introductory Workshops and Connections for Women Workshops for the two programs included lecture series by experts in the field; the volume includes a number of survey articles based on these lectures. There are also expository articles and research papers by some of the other participants of the programs.

In addition to the editors of this volume, the organizers of the programs and the Introductory and Connections for Women workshops were Mike Artin, Georgia Benkart, Victor Ginzburg, Bernard Keller, Ellen Kirkman, Ezra Miller, Claudia Polini, Idun Reiten, Sue Sierra, Karen E. Smith, Catharina Stroppel, Alexander Vainshtein, Lauren Williams, and Efim Zelmanov. We take this opportunity to express our thanks to the participants, our co-organizers, the MSRI staff, and the National Science Foundation, which supported the programs under grant DMS 0932078000, and the National Security Agency, which supported the workshops through grants H98230-12-1-0236/0256/0296/0298.

David Eisenbud
Srikanth B. Iyengar
Anurag K. Singh
J. Toby Stafford
Michel Van den Bergh