

Dieter Blessenohl • Manfred Schocker

NONCOMMUTATIVE
CHARACTER THEORY
OF THE
SYMMETRIC GROUP

Imperial College Press

Noncommutative Character Theory Of The Symmetric Group

A.A. Kirillov



Noncommutative Character Theory Of The Symmetric Group:

Noncommutative Character Theory Of The Symmetric Group Dieter Blessenohl, Manfred Schocker, 2005-01-27 A new approach to the character theory of the symmetric group has been developed during the past fifteen years which is in many ways more efficient more transparent and more elementary In this approach to each permutation is assigned a class function of the corresponding symmetric group Problems in character theory can thereby be transferred into a completely different setting and reduced to combinatorial problems on permutations in a natural and uniform way This is the first account in book form entirely devoted to the new noncommutative method As a modern and comprehensive survey of the classical theory the book contains such fundamental results as the Murnaghan Nakayama and Littlewood Richardson rules as well as more recent applications in enumerative combinatorics and in the theory of the free Lie algebra But it is also an introduction to the vibrant theory of certain combinatorial Hopf algebras such as the Malvenuto Reutenauer algebra of permutations The three detailed appendices on group characters the Solomon descent algebra and the Robinson Schensted correspondence makes the material self contained and suitable for undergraduate level Students and researchers alike will find that noncommutative character theory is a source of inspiration and an illuminating approach to this versatile field of algebraic combinatorics a

Coxeter Groups and Hopf Algebras Marcelo Aguiar, 2006 An important idea in the work of G C Rota is that certain combinatorial objects give rise to Hopf algebras that reflect the manner in which these objects compose and decompose Recent work has seen the emergence of several interesting Hopf algebras of this kind which connect diverse subjects such as combinatorics algebra geometry and theoretical physics This monograph presents a novel geometric approach using Coxeter complexes and the projection maps of Tits for constructing and studying many of these objects as well as new ones The first three chapters introduce the necessary background ideas making this work accessible to advanced graduate students The later chapters culminate in a unified and conceptual construction of several Hopf algebras based on combinatorial objects which emerge naturally from the geometric viewpoint This work lays a foundation and provides new insights for further development of the subject

Representations of Finite Dimensional Algebras and Related Topics in Lie Theory and Geometry Vlastimil Dlab, Claus Michael Ringel, 2004 These proceedings are from the Tenth International Conference on Representations of Algebras and Related Topics ICRA X held at The Fields Institute In addition to the traditional instructional workshop preceding the conference there were also workshops on Commutative Algebra Algebraic Geometry and Representation Theory Finite Dimensional Algebras Algebraic Groups and Lie Theory and Quantum Groups and Hall Algebras These workshops reflect the latest developments and the increasing interest in areas that are closely related to the representation theory of finite dimensional associative algebras Although these workshops were organized separately their topics are strongly interrelated The workshop on Commutative Algebra Algebraic Geometry and Representation Theory surveyed various recently established connections such as those pertaining to the classification of

vector bundles or Cohen Macaulay modules over Noetherian rings coherent sheaves on curves or ideals in Weyl algebras In addition methods from algebraic geometry or commutative algebra relating to quiver representations and varieties of modules were presented The workshop on Finite Dimensional Algebras Algebraic Groups and Lie Theory surveyed developments in finite dimensional algebras and infinite dimensional Lie theory especially as the two areas interact and may have future interactions The workshop on Quantum Groups and Hall Algebras dealt with the different approaches of using the representation theory of quivers and species in order to construct quantum groups working either over finite fields or over the complex numbers In particular these proceedings contain a quite detailed outline of the use of perverse sheaves in order to obtain canonical bases The book is recommended for graduate students and researchers in algebra and geometry

An Introduction to Quasisymmetric Schur Functions Kurt Luoto, Stefan Mykytiuk, Stephanie van

Willigenburg, 2013-06-19 An Introduction to Quasisymmetric Schur Functions is aimed at researchers and graduate students in algebraic combinatorics The goal of this monograph is twofold The first goal is to provide a reference text for the basic theory of Hopf algebras in particular the Hopf algebras of symmetric quasisymmetric and noncommutative symmetric functions and connections between them The second goal is to give a survey of results with respect to an exciting new basis of the Hopf algebra of quasisymmetric functions whose combinatorics is analogous to that of the renowned Schur functions

Representations of the Infinite Symmetric Group Alexei Borodin, Grigori Olshanski, 2017 An introduction to the modern representation theory of big groups exploring its connections to probability and algebraic combinatorics *Bimonoids for Hyperplane Arrangements* Marcelo Aguiar, Swapneel Mahajan, 2020-03-19 The goal of this monograph is to develop Hopf theory in a new setting which features centrally a real hyperplane arrangement The new theory is parallel to the classical theory of connected Hopf algebras and relates to it when specialized to the braid arrangement Joyal's theory of combinatorial species ideas from Tits theory of buildings and Rota's work on incidence algebras inspire and find a common expression in this theory The authors introduce notions of monoid comonoid bimonoid and Lie monoid relative to a fixed hyperplane arrangement They also construct universal bimonoids by using generalizations of the classical notions of shuffle and quasishuffle and establish the Borel Hopf Poincaré Birkhoff Witt and Cartier-Milnor-Moore theorems in this setting This monograph opens a vast new area of research It will be of interest to students and researchers working in the areas of hyperplane arrangements semigroup theory Hopf algebras algebraic Lie theory operads and category theory

Representation Theory of Symmetric Groups Pierre-Loïc Meliot, 2017-05-12 Representation Theory of Symmetric

Groups is the most up to date abstract algebra book on the subject of symmetric groups and representation theory Utilizing new research and results this book can be studied from a combinatorial algorithmic or algebraic viewpoint This book is an excellent way of introducing today's students to representation theory of the symmetric groups namely classical theory From there the book explains how the theory can be extended to other related combinatorial algebras like the Iwahori-Hecke

algebra In a clear and concise manner the author presents the case that most calculations on symmetric group can be performed by utilizing appropriate algebras of functions Thus the book explains how some Hopf algebras symmetric functions and generalizations can be used to encode most of the combinatorial properties of the representations of symmetric groups Overall the book is an innovative introduction to representation theory of symmetric groups for graduate students and researchers seeking new ways of thought

Handbook of Algebra M. Hazewinkel, 2009-07-08 Algebra as we know it today consists of many different ideas concepts and results A reasonable estimate of the number of these different items would be somewhere between 50 000 and 200 000 Many of these have been named and many more could and perhaps should have a name or a convenient designation Even the nonspecialist is likely to encounter most of these either somewhere in the literature disguised as a definition or a theorem or to hear about them and feel the need for more information If this happens one should be able to find enough information in this Handbook to judge if it is worthwhile to pursue the quest In addition to the primary information given in the Handbook there are references to relevant articles books or lecture notes to help the reader An excellent index has been included which is extensive and not limited to definitions theorems etc The Handbook of Algebra will publish articles as they are received and thus the reader will find in this third volume articles from twelve different sections The advantages of this scheme are two fold accepted articles will be published quickly and the outline of the Handbook can be allowed to evolve as the various volumes are published A particularly important function of the Handbook is to provide professional mathematicians working in an area other than their own with sufficient information on the topic in question if and when it is needed Thorough and practical source of information Provides in depth coverage of new topics in algebra Includes references to relevant articles books and lecture notes

Coxeter Bialgebras Marcelo Aguiar, Swapneel Mahajan, 2022-11-17 The goal of this monograph is to develop Hopf theory in the setting of a real reflection arrangement The central notion is that of a Coxeter bialgebra which generalizes the classical notion of a connected graded Hopf algebra The authors also introduce the more structured notion of a Coxeter bimonoid and connect the two notions via a family of functors called Fock functors These generalize similar functors connecting Hopf monoids in the category of Joyal species and connected graded Hopf algebras This monograph opens a new chapter in Coxeter theory as well as in Hopf theory connecting the two It also relates fruitfully to many other areas of mathematics such as discrete geometry semigroup theory associative algebras algebraic Lie theory operads and category theory It is carefully written with effective use of tables diagrams pictures and summaries It will be of interest to students and researchers alike

Topics in Hyperplane Arrangements Marcelo Aguiar, Swapneel Mahajan, 2017-11-22 This monograph studies the interplay between various algebraic geometric and combinatorial aspects of real hyperplane arrangements It provides a careful organized and unified treatment of several recent developments in the field and brings forth many new ideas and results It has two parts each divided into eight chapters and five appendices with background material Part I gives a detailed discussion on faces flats

chambers cones gallery intervals lunes and other geometric notions associated with arrangements The Tits monoid plays a central role Another important object is the category of lunes which generalizes the classical associative operad Also discussed are the descent and lune identities distance functions on chambers and the combinatorics of the braid arrangement and related examples Part II studies the structure and representation theory of the Tits algebra of an arrangement It gives a detailed analysis of idempotents and Peirce decompositions and connects them to the classical theory of Eulerian idempotents It introduces the space of Lie elements of an arrangement which generalizes the classical Lie operad This space is the last nonzero power of the radical of the Tits algebra It is also the socle of the left ideal of chambers and of the right ideal of Lie elements Lie elements generalize the classical Lie idempotents They include Dynkin elements associated to generic half spaces which generalize the classical Dynkin idempotent Another important object is the lune incidence algebra which marks the beginning of noncommutative Möbius theory These ideas are also brought upon the study of the Solomon descent algebra The monograph is written with clarity and in sufficient detail to make it accessible to graduate students It can also serve as a useful reference to experts

Algebras, Rings and Modules Michiel

Hazewinkel, Nadezhda Mikhailovna Gubareni, Vladimir V. Kirichenko, 2010 The main goal of this book is to present an introduction to and applications of the theory of Hopf algebras The authors also discuss some important aspects of the theory of Lie algebras The first chapter can be viewed as a primer on Lie algebras with the main goal to explain and prove the Gabriel Bernstein Gelfand Ponomarev theorem on the correspondence between the representations of Lie algebras and quivers this material has not previously appeared in book form The next two chapters are also primers on coalgebras and Hopf algebras respectively they aim specifically to give sufficient background on these topics for use in the main part of the book Chapters 4–7 are devoted to four of the most beautiful Hopf algebras currently known the Hopf algebra of symmetric functions the Hopf algebra of representations of the symmetric groups although these two are isomorphic they are very different in the aspects they bring to the forefront the Hopf algebras of the nonsymmetric and quasisymmetric functions these two are dual and both generalize the previous two and the Hopf algebra of permutations The last chapter is a survey of applications of Hopf algebras in many varied parts of mathematics and physics Unique features of the book include a new way to introduce Hopf algebras and coalgebras an extensive discussion of the many universal properties of the functor of the Witt vectors a thorough discussion of duality aspects of all the Hopf algebras mentioned emphasis on the combinatorial aspects of Hopf algebras and a survey of applications already mentioned The book also contains an extensive more than 700 entries bibliography The main goal of this book is to present an introduction to and applications of the theory of Hopf algebras The authors also discuss some important aspects of the theory of Lie algebras The first chapter can be viewed as a primer on Lie algebras with the main goal to explain and prove the Gabriel Bernstein Gelfand Ponomarev theorem on the correspondence between the representations of Lie algebras and quivers this material has not previously appeared in book

form The next two chapters are also primers on coalgebras and Hopf algebras respectively they aim specifically to give sufficient background on these topics for use in the main part of the book Chapters 4-7 are devoted to four of the most beautiful Hopf algebras currently known the Hopf algebra of symmetric functions the Hopf algebra of representations of the symmetric groups although these two are isomorphic they are very different in the aspects they bring to the forefront the Hopf algebras of the nonsymmetric and quasisymmetric functions these two are dual and both generalize the previous two and the Hopf algebra of permutations The last chapter is a survey of applications of Hopf algebras in many varied parts of mathematics and physics Unique features of the book include a new way to introduce Hopf algebras and coalgebras an extensive discussion of the many universal properties of the functor of the Witt vectors a thorough discussion of duality aspects of all the Hopf algebras mentioned emphasis on the combinatorial aspects of Hopf algebras and a survey of applications already mentioned The book also contains an extensive more than 700 entries bibliography

Classical Hopf Algebras and Their Applications Pierre Cartier, Frédéric Patras, 2021-09-20 This book is dedicated to the structure and combinatorics of classical Hopf algebras Its main focus is on commutative and cocommutative Hopf algebras such as

algebras of representative functions on groups and enveloping algebras of Lie algebras as explored in the works of Borel Cartier Hopf and others in the 1940s and 50s The modern and systematic treatment uses the approach of natural operations illuminating the structure of Hopf algebras by means of their endomorphisms and their combinatorics Emphasizing notions such as pseudo coproducts characteristic endomorphisms descent algebras and Lie idempotents the text also covers the important case of enveloping algebras of pre Lie algebras A wide range of applications are surveyed highlighting the main ideas and fundamental results Suitable as a textbook for masters or doctoral level programs this book will be of interest to algebraists and anyone working in one of the fields of application of Hopf algebras

Algebraic Combinatorics and Coinvariant Spaces Francois Bergeron, 2009-07-06 Written for graduate students in mathematics or non specialist

mathematicians who wish to learn the basics about some of the most important current research in the field this book provides an intensive yet accessible introduction to the subject of algebraic combinatorics After recalling basic notions of combinatorics representation theory and

The Mathematics of Frobenius in Context Thomas Hawkins, 2013-07-23 Frobenius made many important contributions to mathematics in the latter part of the 19th century Hawkins here focuses on his work in linear algebra and its relationship with the work of Burnside Cartan and Molien and its extension by Schur and Brauer He also discusses the Berlin school of mathematics and the guiding force of Weierstrass in that school as well as the fundamental work of d'Alembert Lagrange and Laplace and of Gauss Eisenstein and Cayley that laid the groundwork for Frobenius's work in linear algebra The book concludes with a discussion of Frobenius's contribution to the theory of stochastic matrices

Formal Power Series and Algebraic Combinatorics Daniel Krob, Alexander A. Mikhalev, Alexander V. Mikhalev, 2013-03-09 This book contains the extended abstracts presented at the 12th International Conference on Power

Series and Algebraic Combinatorics FPSAC 00 that took place at Moscow State University June 26 30 2000 These proceedings cover the most recent trends in algebraic and bijective combinatorics including classical combinatorics combinatorial computer algebra combinatorial identities combinatorics of classical groups Lie algebra and quantum groups enumeration symmetric functions young tableaux etc Quantum Lie Theory Vladislav Kharchenko, 2015-12-24 This is an introduction to the mathematics behind the phrase quantum Lie algebra The numerous attempts over the last 15 20 years to define a quantum Lie algebra as an elegant algebraic object with a binary quantum Lie bracket have not been widely accepted In this book an alternative approach is developed that includes multivariable operations Among the problems discussed are the following a PBW type theorem quantum deformations of Kac Moody algebras generic and symmetric quantum Lie operations the Nichols algebras the Gurevich Manin Lie algebras and Shestakov Umirbaev operations for the Lie theory of nonassociative products Opening with an introduction for beginners and continuing as a textbook for graduate students in physics and mathematics the book can also be used as a reference by more advanced readers With the exception of the introductory chapter the content of this monograph has not previously appeared in book form Über die Struktur der Solomon-Tits-Algebren der symmetrischen Gruppen: Eine Analyse assoziativer, gruppentheoretischer und Lie-theoretischer Phänomene; mit 218 Übungsaufgaben Sven Bodo Wirsing, 2015-09 Das vorliegende Buch beschäftigt sich mit der Struktur der Solomon Tits Algebren der symmetrischen Gruppen motiviert durch Forschungsergebnisse von Manfred Schocker zur Modulstruktur dieser Algebren Mit Struktur sind hier gleichsam drei Strukturen gemeint *Enumerative Combinatorics: Volume 2* Richard P. Stanley, 2001-06-04 An introduction suitable for beginning graduate students showing connections to other areas of mathematics **Representation Theory and Noncommutative Harmonic Analysis II** A.A. Kirillov, 2013-03-09 At first only elementary functions were studied in mathematical analysis Then new functions were introduced to evaluate integrals They were named special functions integral sine logarithms the exponential function the probability integral and so on Elliptic integrals proved to be the most important They are connected with rectification of arcs of certain curves The remarkable idea of Abel to replace these integrals by the corresponding inverse functions led to the creation of the theory of elliptic functions They are doubly periodic functions of a complex variable This periodicity has led to consideration of the lattice of periods and to linear fractional transformations of the complex plane which leave this lattice invariant The group of these transformations is isomorphic to the quotient group of the group $GL(2, \mathbb{Z})$ of unimodular matrices of the second order with integral elements with respect to its center Investigation of properties of elliptic functions led to the study of automorphic functions and forms This gave the first connection between the theory of groups and this important class of functions The further development of the theory of automorphic functions was related to geometric concepts connected with the fact that the group of linear fractional transformations with real elements can be realized as the group of motions of the Lobachevskij plane We also note that at the beginning of the 19 century Gauss used the group $GL(2, \mathbb{Z})$ in his

papers on the theory of indeterminate quadratic forms

Quantum Potential Theory Philippe Biane, Luc Bouten, Fabio Cipriani, Norio Konno, Quanhua Xu, 2008-09-23 This book offers the revised and completed notes of lectures given at the 2007 conference Quantum Potential Theory Structures and Applications to Physics These lectures provide an introduction to the theory and discuss various applications

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Table of Contents Noncommutative Character Theory Of The Symmetric Group

1. Understanding the eBook Noncommutative Character Theory Of The Symmetric Group
 - The Rise of Digital Reading Noncommutative Character Theory Of The Symmetric Group
 - Advantages of eBooks Over Traditional Books
2. Identifying Noncommutative Character Theory Of The Symmetric Group
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in a Noncommutative Character Theory Of The Symmetric Group
 - User-Friendly Interface
4. Exploring eBook Recommendations from Noncommutative Character Theory Of The Symmetric Group
 - Personalized Recommendations
 - Noncommutative Character Theory Of The Symmetric Group User Reviews and Ratings
 - Noncommutative Character Theory Of The Symmetric Group and Bestseller Lists

5. Accessing Noncommutative Character Theory Of The Symmetric Group Free and Paid eBooks
 - Noncommutative Character Theory Of The Symmetric Group Public Domain eBooks
 - Noncommutative Character Theory Of The Symmetric Group eBook Subscription Services
 - Noncommutative Character Theory Of The Symmetric Group Budget-Friendly Options
6. Navigating Noncommutative Character Theory Of The Symmetric Group eBook Formats
 - ePub, PDF, MOBI, and More
 - Noncommutative Character Theory Of The Symmetric Group Compatibility with Devices
 - Noncommutative Character Theory Of The Symmetric Group Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Noncommutative Character Theory Of The Symmetric Group
 - Highlighting and Note-Taking Noncommutative Character Theory Of The Symmetric Group
 - Interactive Elements Noncommutative Character Theory Of The Symmetric Group
8. Staying Engaged with Noncommutative Character Theory Of The Symmetric Group
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Noncommutative Character Theory Of The Symmetric Group
9. Balancing eBooks and Physical Books Noncommutative Character Theory Of The Symmetric Group
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Noncommutative Character Theory Of The Symmetric Group
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Noncommutative Character Theory Of The Symmetric Group
 - Setting Reading Goals Noncommutative Character Theory Of The Symmetric Group
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Noncommutative Character Theory Of The Symmetric Group
 - Fact-Checking eBook Content of Noncommutative Character Theory Of The Symmetric Group
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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