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The Theory of Lie Superalgebras Dualities and Representations of Lie Superalgebras Introduction to Vertex Operator Superalgebras and Their Modules Advances in Lie Superalgebras Introduction to Finite and Infinite Dimensional Lie (Super)algebras Differential Geometrical Methods in Theoretical Physics Groups, Rings, Lie and Hopf Algebras Lie Superalgebras and Enveloping Algebras Invariant Theory and Superalgebras Encyclopaedia of Mathematics Non-Associative Algebra and Its Applications Advances in Ring Theory The Orbit Method in Geometry and Physics Perspectives in Lie Theory Supersymmetry in Mathematics and Physics Representations of Algebraic Groups, Quantum Groups, and Lie Algebras Highlights in Lie Algebraic Methods Algebra and Applications 1 Engineering Mathematics II Lie Algebras, Lie Superalgebras, Vertex Algebras and Related Topics Combinatorial Aspects of Lie Superalgebras Classical Lie Algebras at Infinity Groups, Algebras and Applications Graded Simple Jordan Superalgebras of Growth One Lie Theory and Its Applications in Physics Associative and Non-Associative Algebras and Applications Affine, Vertex and W-algebras Lattice Statistics and Mathematical Physics Lattice Statistics and Mathematical Physics Non-Associative and Non-Commutative Algebra and Operator Theory Graded Simple Jordan Superalgebras of Growth One Recent Advances in Representation

Theory, Quantum Groups, Algebraic Geometry, and Related Topics Representations of Nilpotent Lie Algebras and Superalgebras Automorphic Forms and Lie Superalgebras Algebra, Geometry and Mathematical Physics Supersymmetries and Infinite-Dimensional Algebras Quantum Stochastic Calculus and Representations of Lie Superalgebras Algebras, Representations and Applications Linear and Quadratic Jordan Superalgebras NonasSociative Algebra and Its Applications

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Introduction Structure of the even part Cartan type Even part is direct sum of two loop algebras A is a loop algebra J is a finite dimensional Jordan superalgebra or a Jordan superalgebra of a superform The main case Impossible cases Bibliography. This ENCYCLOPAEDIA OF MATHEMATICS aims to be a reference work for all parts of mathe matics. It is a translation with updates and editorial comments of the Soviet Mathematical Encyclopaedia published by 'Soviet Encyclopaedia Publishing House' in five volumes in 1977-1985. The annotated translation consists of ten volumes including a special index volume. There are three kinds of articles in this ENCYCLOPAEDIA. First of all there are survey-type articles dealing with the various main directions in mathematics (where a rather fme subdivi sion has been used). The main requirement for these articles has been that they should give a reasonably complete

up-to-date account of the current state of affairs in these areas and that they should be maximally accessible. On the whole, these articles should be understandable to mathematics students in their first specialization years, to graduates from other mathematical areas and, depending on the specific subject, to specialists in other domains of science, en gineers and teachers of mathematics. These articles treat their material at a fairly general level and aim to give an idea of the kind of problems, techniques and concepts involved in the area in question. They also contain background and motivation rather than precise statements of precise theorems with detailed definitions and technical details on how to carry out proofs and constructions. The second kind of article, of medium length, contains more detailed concrete problems, results and techniques. "Papers presented at the Nankai Symposium on 'Lattice Statistics and Mathematical Physics ... took place at the Nankai Institute of Mathematics in Tianjin, China"--P. v. Traditionally, Lie Theory is a tool to build mathematical models for physical systems. Recently, the trend is towards geometrisation of the mathematical description of physical systems and objects. A geometric approach to a system yields in general some notion of symmetry which is very helpful in understanding its structure. Geometrisation and symmetries are meant in their broadest sense, i.e., classical geometry, differential geometry, groups and quantum groups, infinite-dimensional (super-)algebras, and their representations. Furthermore, we include the necessary tools from functional analysis and number

theory. This is a large interdisciplinary and interrelated field. Samples of these new trends are presented in this volume, based on contributions from the Workshop "Lie Theory and Its Applications in Physics" held near Varna, Bulgaria, in June 2011. This book is suitable for an extensive audience of mathematicians, mathematical physicists, theoretical physicists, and researchers in the field of Lie Theory. This book is part of Algebra and Geometry, a subject within the SCIENCES collection published by ISTE and Wiley, and the first of three volumes specifically focusing on algebra and its applications. Algebra and Applications 1 centers on non-associative algebras and includes an introduction to derived categories. The chapters are written by recognized experts in the field, providing insight into new trends, as well as a comprehensive introduction to the theory. The book incorporates self-contained surveys with the main results, applications and perspectives. The chapters in this volume cover a wide variety of algebraic structures and their related topics. Jordan superalgebras, Lie algebras, composition algebras, graded division algebras, non-associative C-algebras, H*-algebras, Krichever-Novikov type algebras, preLie algebras and related structures, geometric structures on 3-Lie algebras and derived categories are all explored. Algebra and Applications 1 is of great interest to graduate students and researchers. Each chapter combines some of the features of both a graduate level textbook and of research level surveys. Lie superalgebras are a natural generalization of Lie algebras, having applications in geometry, number theory, gauge field*

theory, and string theory. This book develops the theory of Lie superalgebras, their enveloping algebras, and their representations. The book begins with five chapters on the basic properties of Lie superalgebras, including explicit constructions for all the classical simple Lie superalgebras. Borel subalgebras, which are more subtle in this setting, are studied and described. Contragredient Lie superalgebras are introduced, allowing a unified approach to several results, in particular to the existence of an invariant bilinear form on $\mathfrak{g}$. The enveloping algebra of a finite dimensional Lie superalgebra is studied as an extension of the enveloping algebra of the even part of the superalgebra. By developing general methods for studying such extensions, important information on the algebraic structure is obtained, particularly with regard to primitive ideals. Fundamental results, such as the Poincare-Birkhoff-Witt Theorem, are established. Representations of Lie superalgebras provide valuable tools for understanding the algebras themselves, as well as being of primary interest in applications to other fields. Two important classes of representations are the Verma modules and the finite dimensional representations. The fundamental results here include the Jantzen filtration, the Harish-Chandra homomorphism, the Sapovalov determinant, supersymmetric polynomials, and Schur-Weyl duality. Using these tools, the center can be explicitly described in the general linear and orthosymplectic cases. In an effort to make the presentation as self-contained as possible, some background material is included on Lie theory, ring theory, Hopf algebras,

and combinatorics. Lie superalgebras are a natural generalization of Lie algebras, having applications in geometry, number theory, gauge field theory, and string theory. Introduction to Finite and Infinite Dimensional Lie Algebras and Superalgebras introduces the theory of Lie superalgebras, their algebras, and their representations. The material covered ranges from basic definitions of Lie groups to the classification of finite-dimensional representations of semi-simple Lie algebras. While discussing all classes of finite and infinite dimensional Lie algebras and Lie superalgebras in terms of their different classes of root systems, the book focuses on Kac-Moody algebras. With numerous exercises and worked examples, it is ideal for graduate courses on Lie groups and Lie algebras. Discusses the fundamental structure and all root relationships of Lie algebras and Lie superalgebras and their finite and infinite dimensional representation theory Closely describes BKM Lie superalgebras, their different classes of imaginary root systems, their complete classifications, root-supermultiplicities, and related combinatorial identities Includes numerous tables of the properties of individual Lie algebras and Lie superalgebras Focuses on Kac-Moody algebras Combinatorial Aspects of Lie Superalgebras emphasizes the algorithmic and computational aspects of the combinatorial techniques of Lie superalgebras. It is written primarily for mathematicians and scientists who do not have a background in the field of infinite dimensional Lie superalgebras, but who realize the potential uses of the results. Consequently, the discussions provided

on the applications of Lie superalgebras theory are clear and comprehensive and, throughout the text, primary attention is given to algorithms and examples. The examples illustrate theoretical results, and the algorithms, which can be used for symbolic calculations with Lie superalgebras, are based on basic and generally applicable rules and theorems. Combinatorial Aspects of Lie Superalgebras contains comprehensive literature citations and provides an excellent reference on the techniques and results of combinatorial theory of Lie superalgebras. Programs that have been developed by the authors for computation are included on a diskette at the back of the book, and complete directions for use are provided. This book describes the representations of Lie superalgebras that are yielded by a graded version of Hudson-Parthasarathy quantum stochastic calculus. Quantum stochastic calculus and grading theory are given concise introductions, extending readership to mathematicians and physicists with a basic knowledge of algebra and infinite-dimensional Hilbert spaces. The develpment of an explicit formula for the chaotic expansion of a polynomial of quantum stochastic integrals is particularly interesting. The book aims to provide a self-contained exposition of what is known about Z_2-graded quantum stochastic calculus and to provide a framework for future research into this new and fertile area. Contains the proceedings of the XVIII Latin American Algebra Colloquium, held from August 3-8, 2009, in Sao Paulo, Brazil. It includes research articles as well as up-to-date surveys covering several directions of current research in algebra, such as Asymptotic

Codimension Growth, Hopf Algebras, Structure Theory of both Associative and Non-Associative Algebras, Partial Actions of Groups on Rings, and contributions to Coding Theory. The volume is almost entirely composed of the research and expository papers by the participants of the International Workshop "Groups, Rings, Lie and Hopf Algebras", which was held at the Memorial University of Newfoundland, St. John's, NF, Canada. All four areas from the title of the workshop are covered. In addition, some chapters touch upon the topics, which belong to two or more areas at the same time. Audience: The readership targeted includes researchers, graduate and senior undergraduate students in mathematics and its applications. Supersymmetry was created by the physicists in the 1970's to give a unified treatment of fermions and bosons, the basic constituents of matter. Since then its mathematical structure has been recognized as that of a new development in geometry, and mathematicians have busied themselves with exploring this aspect. This volume collects recent advances in this field, both from a physical and a mathematical point of view, with an accent on a rigorous treatment of the various questions raised. This book gathers together selected contributions presented at the 3rd Moroccan Andalusian Meeting on Algebras and their Applications, held in Chefchaouen, Morocco, April 12-14, 2018, and which reflects the mathematical collaboration between south European and north African countries, mainly France, Spain, Morocco, Tunisia and Senegal. The book is divided in three parts and features contributions from the following fields: algebraic and analytic methods in

associative and non-associative structures; homological and categorical methods in algebra; and history of mathematics. Covering topics such as rings and algebras, representation theory, number theory, operator algebras, category theory, group theory and information theory, it opens up new avenues of study for graduate students and young researchers. The findings presented also appeal to anyone interested in the fields of algebra and mathematical analysis. This book contains thirty-six short papers on recent progress in a variety of subjects in mathematical and theoretical physics, written for the proceedings of a symposium in honor of the seventieth birthday of Professor F Y Wu, held at the Nankai Institute of Mathematics, October 7–11, 2001. The collection of papers is aimed at researchers, including graduate students, with an interdisciplinary interest and gives a brief introduction to many of the topics of current interest. These include new results on exactly solvable models in statistical mechanics, integrable through the Yang–Baxter equations, quantum groups, fractional statistics, random matrices, index theorems on the lattice, combinatorics, and other related topics. Contents:Happer's Curious Degeneracies and Yangian (C-M Bai et al.)The Rotor Model and Combinatorics (M T Batchelor et al.)Mutually Local Fields from Form Factors (A Fring)Dimers and Spanning Trees: Some Recent Results (F Y Wu)Exotic Galilean Symmetry and the Hall Effect (C Duval & P A Horváthy)The Three-State Chiral Clock Model (B-Q Jin et al.)Quantum Dynamics and Random Matrix Theory (H Kunz)Short-Time Behaviors of Long-Ranged Interactions (H Fang et al.)Comments on the

Deformed WN Algebra (S Odake)New Results for Susceptibilities in Planar Ising Models (H Au-Yang & J H H Perk)Limitations on Quantum Control (A I Solomon & S G Schirmer)R-Matrices and the Tensor Product Graph Method (M D Gould & Y-Z Zhang)and other papers Readership: Graduate students and researchers in mathematical physics and statistical mechanics. Keywords:Exactly Solvable Models in Statistical Mechanics;Integrable Models;Yang-Baxter Equations;Quantum Groups;Fractional Statistics;Dimer Models;Random Matrices;Index Theorems This volume contains the proceedings of two AMS Special Sessions "Geometric and Algebraic Aspects of Representation Theory" and "Quantum Groups and Noncommutative Algebraic Geometry" held October 13–14, 2012, at Tulane University, New Orleans, Louisiana. Included in this volume are original research and some survey articles on various aspects of representations of algebras including Kac–Moody algebras, Lie superalgebras, quantum groups, toroidal algebras, Leibniz algebras and their connections with other areas of mathematics and mathematical physics. A collection of lectures presented at the Fourth International Conference on Nonassociative Algebra and its Applications, held in Sao Paulo, Brazil. Topics in algebra theory include alternative, Bernstein, Jordan, lie, and Malcev algebras and superalgebras. The volume presents applications to population genetics theory, physics, and more. Originating from graduate topics courses given by the first author, this book functions as a unique text-monograph hybrid that bridges a traditional graduate course to research level representation theory. The exposition includes an introduction to

the subject, some highlights of the theory and recent results in the field, and is therefore appropriate for advanced graduate students entering the field as well as research mathematicians wishing to expand their knowledge. The mathematical background required varies from chapter to chapter, but a standard course on Lie algebras and their representations, along with some knowledge of homological algebra, is necessary. Basic algebraic geometry and sheaf cohomology are needed for Chapter 10. Exercises of various levels of difficulty are interlaced throughout the text to add depth to topical comprehension. The unifying theme of this book is the structure and representation theory of infinite-dimensional locally reductive Lie algebras and superalgebras. Chapters 1-6 are foundational; each of the last 4 chapters presents a self-contained study of a specialized topic within the larger field. Lie superalgebras and flag supermanifolds are discussed in Chapters 3, 7, and 10, and may be skipped by the reader. This volume contains contributions from the conference on "Algebras, Representations and Applications" (Maresias, Brazil, August 26-September 1, 2007), in honor of Ivan Shestakov's 60th birthday. The collection of papers presented here is of great interest to graduate students and researchers working in the theory of Lie and Jordan algebras and superalgebras and their representations, Hopf algebras, Poisson algebras, Quantum Groups, Group Rings and other topics. This volume contains the proceedings of the Third International Conference on Non-Associative Algebra and Its Applications, held in Oviedo, Spain, July 12--17, 1993. The conference

brought together specialists from all over the world who work in this interesting and active field, which is currently enjoying much attention. All aspects of non-associative algebra are covered. Topics range from purely mathematical subjects to a wide spectrum of applications, and from state-of-the-art articles to overview papers. This collection will point the way for further research for many years to come. The volume is of interest to researchers in mathematics as well as those whose work involves the application of non-associative algebra in such areas as physics, biology and genetics. Covers various aspects of the representation theory of Lie algebras, finite groups of Lie types, Hecke algebras, and Lie super algebras. This book outlines connections among irreducible representations of certain blocks of reduced enveloping algebras of semi-simple Lie algebras in positive characteristic. This book presents a systematic study on the structures of vertex operator superalgebras and their modules. Related theories of self-dual codes and lattices are included, as well as recent achievements on classifications of certain simple vertex operator superalgebras and their irreducible twisted modules, constructions of simple vertex operator superalgebras from graded associative algebras and their anti-involutions, self-dual codes and lattices. Audience: This book is of interest to researchers and graduate students in mathematics and mathematical physics. Proceedings of the NATO Advanced Research Workshop and the 16th International Conference, Como, Italy, August 24-29, 1987 This book gives a systematic account of the structure and representation theory of finite-

dimensional complex Lie superalgebras of classical type and serves as a good introduction to representation theory of Lie superalgebras. Several folklore results are rigorously proved (and occasionally corrected in detail), sometimes with new proofs. Three important dualities are presented in the book, with the unifying theme of determining irreducible characters of Lie superalgebras. In order of increasing sophistication, they are Schur duality, Howe duality, and super duality. The combinatorics of symmetric functions is developed as needed in connections to Harish-Chandra homomorphism as well as irreducible characters for Lie superalgebras. Schur-Sergeev duality for the queer Lie superalgebra is presented from scratch with complete detail. Howe duality for Lie superalgebras is presented in book form for the first time. Super duality is a new approach developed in the past few years toward understanding the Bernstein-Gelfand-Gelfand category of modules for classical Lie superalgebras. Super duality relates the representation theory of classical Lie superalgebras directly to the representation theory of classical Lie algebras and thus gives a solution to the irreducible character problem of Lie superalgebras via the Kazhdan-Lusztig polynomials of classical Lie algebras. This book focuses on recent developments in the theory of vertex algebras, with particular emphasis on affine vertex algebras, affine W-algebras, and W-algebras appearing in physical theories such as logarithmic conformal field theory. It is widely accepted in the mathematical community that the best way to study the representation theory of affine Kac–Moody algebras is by investigating the

representation theory of the associated affine vertex and W-algebras. In this volume, this general idea can be seen at work from several points of view. Most relevant state of the art topics are covered, including fusion, relationships with finite dimensional Lie theory, permutation orbifolds, higher Zhu algebras, connections with combinatorics, and mathematical physics. The volume is based on the INdAM Workshop Affine, Vertex and W-algebras, held in Rome from 11 to 15 December 2017. It will be of interest to all researchers in the field. Presenting the collaborations of over thirty international experts in the latest developments in pure and applied mathematics, this volume serves as an anthology of research with a common basis in algebra, functional analysis and their applications. Special attention is devoted to non-commutative algebras, non-associative algebras, operator theory and ring and module theory. These themes are relevant in research and development in coding theory, cryptography and quantum mechanics. The topics in this volume were presented at the Workshop on Non-Associative & Non-Commutative Algebra and Operator Theory, held May 23–25, 2014 at Cheikh Anta Diop University in Dakar, Senegal in honor of Professor Amin Kaidi. The workshop was hosted by the university's Laboratory of Algebra, Cryptology, Algebraic Geometry and Applications, in cooperation with the University of Almería and the University of Málaga. Dr. Kaidi's work focuses on non-associative rings and algebras, operator theory and functional analysis, and he has served as a mentor to a generation of mathematicians in Senegal and around the world. This volume consists of expository and

research articles that highlight the various Lie algebraic methods used in mathematical research today. Key topics discussed include spherical varieties, Littelmann Paths and Kac–Moody Lie algebras, modular representations, primitive ideals, representation theory of Artin algebras and quivers, Kac–Moody superalgebras, categories of Harish–Chandra modules, cohomological methods, and cluster algebras. The orbit method influenced the development of several areas of mathematics in the second half of the 20th century and remains a useful and powerful tool in such areas as Lie theory, representation theory, integrable systems, complex geometry, and mathematical physics. Among the distinguished names associated with the orbit method is that of A.A. Kirillov, whose pioneering paper on nilpotent orbits (1962), places him as the founder of orbit theory. The original research papers in this volume are written by prominent mathematicians and reflect recent achievements in orbit theory and other closely related areas such as harmonic analysis, classical representation theory, Lie superalgebras, Poisson geometry, and quantization. Contributors: A. Alekseev, J. Alev, V. Baranovksy, R. Brylinski, J. Dixmier, S. Evens, D.R. Farkas, V. Ginzburg, V. Gorbounov, P. Grozman, E. Gutkin, A. Joseph, D. Kazhdan, A.A. Kirillov, B. Kostant, D. Leites, F. Malikov, A. Melnikov, P.W. Michor, Y.A. Neretin, A. Okounkov, G. Olshanski, F. Petrov, A. Polishchuk, W. Rossmann, A. Sergeev, V. Schechtman, I. Shchepochkina. The work will be an invaluable reference for researchers in the above mentioned fields, as well as a useful text for graduate seminars and courses. This book provides the reader

with the tools to understand the ongoing classification and construction project of Lie superalgebras. It presents the material in as simple terms as possible. Coverage specifically details Borcherds-Kac-Moody superalgebras. The book examines the link between the above class of Lie superalgebras and automorphic form and explains their construction from lattice vertex algebras. It also includes all necessary background information. This book contains the proceedings of the 2012–2014 Southeastern Lie Theory Workshop Series held at North Carolina State University in April 2012, at College of Charleston in December 2012, at Louisiana State University in May 2013, and at University of Georgia in May 2014. Some of the articles by experts in the field survey recent developments while others include new results in representations of Lie algebras, and quantum groups, vertex (operator) algebras and Lie superalgebras. We classify graded simple Jordan superalgebras of growth one which correspond the so called 'superconformal algebras' via the Tits-Kantor-Koecher construction. The superconformal algebras with a 'hidden' Jordan structure are those of type K and the recently discovered Cheng-Kac superalgebras $CK(6)$. We show that Jordan superalgebras related to the type K are Kantor Doubles of some Jordan brackets on associative commutative superalgebras and list these brackets. The volume is the outcome of the conference "Lie superalgebras," which was held at the Istituto Nazionale di Alta Matematica, in 2012. The conference gathered many specialists in the subject, and the talks held provided comprehensive insights into the newest trends in research on Lie

superalgebras (and related topics like vertex algebras, representation theory and supergeometry). The book contains contributions of many leading esperts in the field and provides a complete account of the newest trends in research on Lie Superalgebras. This book highlights the latest advances in engineering mathematics with a main focus on the mathematical models, structures, concepts, problems and computational methods and algorithms most relevant for applications in modern technologies and engineering. It addresses mathematical methods of algebra, applied matrix analysis, operator analysis, probability theory and stochastic processes, geometry and computational methods in network analysis, data classification, ranking and optimisation. The individual chapters cover both theory and applications, and include a wealth of figures, schemes, algorithms, tables and results of data analysis and simulation. Presenting new methods and results, reviews of cutting-edge research, and open problems for future research, they equip readers to develop new mathematical methods and concepts of their own, and to further compare and analyse the methods and results discussed. The book consists of contributed chapters covering research developed as a result of a focused international seminar series on mathematics and applied mathematics and a series of three focused international research workshops on engineering mathematics organised by the Research Environment in Mathematics and Applied Mathematics at Mälardalen University from autumn 2014 to autumn 2015: the International Workshop on Engineering Mathematics for Electromagnetics and Health Technology; the

International Workshop on Engineering Mathematics, Algebra, Analysis and Electromagnetics; and the 1st Swedish-Estonian International Workshop on Engineering Mathematics, Algebra, Analysis and Applications. It serves as a source of inspiration for a broad spectrum of researchers and research students in applied mathematics, as well as in the areas of applications of mathematics considered in the book. Recent devopments, particularly in high-energy physics, have projected group theory and symmetry consideration into a central position in theoretical physics. These developments have taken physicists increasingly deeper into the fascinating world of pure mathematics. This work presents important mathematical developments of the last fifteen years in a form that is easy to comprehend and appreciate. Lie theory is a mathematical framework for encoding the concept of symmetries of a problem, and was the central theme of an INdAM intensive research period at the Centro de Giorgi in Pisa, Italy, in the academic year 2014-2015. This book gathers the key outcomes of this period, addressing topics such as: structure and representation theory of vertex algebras, Lie algebras and superalgebras, as well as hyperplane arrangements with different approaches, ranging from geometry and topology to combinatorics. This book collects the proceedings of the Algebra, Geometry and Mathematical Physics Conference, held at the University of Haute Alsace, France, October 2011. Organized in the four areas of algebra, geometry, dynamical symmetries and conservation laws and mathematical physics and applications, the book covers deformation theory and quantization; Hom-

algebras and n-ary algebraic structures; Hopf algebra, integrable systems and related math structures; jet theory and Weil bundles; Lie theory and applications; non-commutative and Lie algebra and more. The papers explore the interplay between research in contemporary mathematics and physics concerned with generalizations of the main structures of Lie theory aimed at quantization and discrete and non-commutative extensions of differential calculus and geometry, non-associative structures, actions of groups and semi-groups, non-commutative dynamics, non-commutative geometry and applications in physics and beyond. The book benefits a broad audience of researchers and advanced students. This book brings the reader to the frontiers of research in some topics in superalgebras and symbolic method in invariant theory. Superalgebras are algebras containing positively-signed and negatively-signed variables. One of the book's major results is an extension of the standard basis theorem to superalgebras. This extension requires a rethinking of some basic concepts of linear algebra, such as matrices and coordinate systems, and may lead to an extension of the entire apparatus of linear algebra to ``signed'' modules. The authors also present the symbolic method for the invariant theory of symmetric and of skew-symmetric tensors. In both cases, the invariants are obtained from the symbolic representation by applying what the authors call the umbral operator. This operator can be used to systematically develop anticommutative analogs of concepts of algebraic geometry, and such results may ultimately turn out to be the main byproduct of this

investigation. While it will be of special interest to mathematicians and physicists doing research in superalgebras, invariant theory, straightening algorithms, Young bitableaux, and Grassmann's calculus of extension, the book starts from basic principles and should therefore be accessible to those who have completed the standard graduate level courses in algebra and/or combinatorics.

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