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Pavel Mnev

Advances in Topological Quantum Field Theory John M. Bryden.2005-03-02

Topological Quantum Field Theories from Subfactors Vijay Kodiyalam.2019-05-20 Pure mathematicians have only recently begun a rigorous study of topological quantum field theories (TQFTs). Ocneanu, in particular, showed that subfactors yield TQFTs that complement the Turaev-Viro construction. Until now, however, it has been difficult to find an account of this work that is both detailed and accessible. Topological Quant

Frobenius Algebras and 2D Topological Quantum Field Theories Joachim Kock.2003 Proves striking results connecting topology and algebra and shows how the result fits into a more general pattern. The book will prove valuable to students or researchers entering this field who will learn a host of modern techniques. There are numerous exercises and examples making the book suitable for teaching.

Monoidal Categories and Topological Field Theory Vladimir Turaev,Alexis Virelizier.2017-06-28 This monograph is devoted to monoidal categories and their connections with 3-dimensional topological field theories. Starting with basic definitions, it proceeds to the forefront of current research. Part 1 introduces monoidal categories and several of their classes, including rigid, pivotal, spherical, fusion, braided, and modular categories. It then presents deep theorems of Müger on the center of a pivotal fusion category. These theorems are proved in Part 2 using the theory of Hopf monads. In Part 3 the authors define the notion of a topological quantum field theory (TQFT) and construct a Turaev-Viro-type 3-dimensional state sum TQFT from a spherical fusion category. Lastly, in Part 4 this construction is extended to 3-manifolds with colored ribbon graphs, yielding a so-called graph TQFT (and, consequently, a 3-2-1 extended TQFT). The authors then prove the main result of the monograph: the state sum graph TQFT derived from any spherical fusion category is isomorphic to the Reshetikhin-Turaev surgery graph TQFT derived from the center of that category. The book is of interest to researchers and students studying topological field theory, monoidal categories, Hopf algebras and Hopf monads.

Dirichlet Branes and Mirror Symmetry Paul Aspinwall.2009 Research in string theory has generated a rich interaction with algebraic geometry, with exciting work that includes the Strominger-Yau-Zaslow conjecture. This monograph

builds on lectures at the 2002 Clay School on Geometry and String Theory that sought to bridge the gap between the languages of string theory and algebraic geometry.

Geometric and Topological Methods for Quantum Field Theory Hernan Ocampo,Eddy Pariguan,Sylvie Paycha.2010-04-29 Aimed at graduate students in physics and mathematics, this book provides an introduction to recent developments in several active topics at the interface between algebra, geometry, topology and quantum field theory. The first part of the book begins with an account of important results in geometric topology. It investigates the differential equation aspects of quantum cohomology, before moving on to noncommutative geometry. This is followed by a further exploration of quantum field theory and gauge theory, describing AdS/CFT correspondence, and the functional renormalization group approach to quantum gravity. The second part covers a wide spectrum of topics on the borderline of mathematics and physics, ranging from orbifolds to quantum indistinguishability and involving a manifold of mathematical tools borrowed from geometry, algebra and analysis. Each chapter presents introductory material before moving on to more advanced results. The chapters are self-contained and can be read independently of the rest.

Frobenius Algebras and 2-D Topological Quantum Field Theories Joachim Kock.2004 This 2003 book describes a striking connection between topology and algebra, namely that 2D topological quantum field theories are equivalent to commutative Frobenius algebras. The precise formulation of the theorem and its proof is given in terms of monoidal categories, and the main purpose of the book is to develop these concepts from an elementary level, and more generally serve as an introduction to categorical viewpoints in mathematics. Rather than just proving the theorem, it is shown how the result fits into a more general pattern concerning universal monoidal categories for algebraic structures. Throughout, the emphasis is on the interplay between algebra and topology, with graphical interpretation of algebraic operations, and topological structures described algebraically in terms of generators and relations. The book will prove valuable to students or researchers entering this field who will learn a host of modern techniques that will prove useful for future work.

Deep Beauty Hans Halvorson.2011-04-18 No scientific theory has caused more puzzlement and confusion than quantum theory. Physics is supposed to help us to understand the world, but quantum theory makes it seem a very strange place. This book is about how mathematical innovation can help us gain deeper insight into the structure of the physical world. Chapters by top researchers in the mathematical foundations of physics explore new ideas, especially novel mathematical concepts at the cutting edge of future physics. These creative developments in mathematics may catalyze the advances that enable us to understand our current physical theories, especially quantum theory. The authors bring diverse perspectives, unified only by the attempt to introduce fresh concepts that will open up new vistas in our understanding of future physics.

Quantum Invariants of Knots and 3-Manifolds Vladimir G. Turaev.2016-07-11 Due to the strong appeal and wide use of this monograph, it is now available in its third revised edition. The monograph gives a systematic treatment of 3-

dimensional topological quantum field theories (TQFTs) based on the work of the author with N. Reshetikhin and O. Viro. This subject was inspired by the discovery of the Jones polynomial of knots and the Witten-Chern-Simons field theory. On the algebraic side, the study of 3-dimensional TQFTs has been influenced by the theory of braided categories and the theory of quantum groups.The book is divided into three parts. Part I presents a construction of 3-dimensional TQFTs and 2-dimensional modular functors from so-called modular categories. This gives a vast class of knot invariants and 3-manifold invariants as well as a class of linear representations of the mapping class groups of surfaces. In Part II the technique of 6j-symbols is used to define state sum invariants of 3-manifolds. Their relation to the TQFTs constructed in Part I is established via the theory of shadows. Part III provides constructions of modular categories, based on quantum groups and skein modules of tangles in the 3-space.This fundamental contribution to topological quantum field theory is accessible to graduate students in mathematics and physics with knowledge of basic algebra and topology. It is an indispensable source for everyone who wishes to enter the forefront of this fascinating area at the borderline of mathematics and physics. Contents:Invariants of graphs in Euclidean 3-space and of closed 3-manifoldsFoundations of topological quantum field theoryThree-dimensional topological quantum field theoryTwo-dimensional modular functors6j-symbolsSimplicial state sums on 3-manifoldsShadows of manifolds and state sums on shadowsConstructions of modular categories

Quantum Topology Louis H Kauffman,Randy A Baadhio.1993-09-15 This book constitutes a review volume on the relatively new subject of Quantum Topology. Quantum Topology has its inception in the 1984/1985 discoveries of new invariants of knots and links (Jones, Homfly and Kauffman polynomials). These invariants were rapidly connected with quantum groups and methods in statistical mechanics. This was followed by Edward Witten's introduction of methods of quantum field theory into the subject and the formulation by Witten and Michael Atiyah of the concept of topological quantum field theories. This book is a review volume of on-going research activity. The papers derive from talks given at the Special Session on Knot and Topological Quantum Field Theory of the American Mathematical Society held at Dayton, Ohio in the fall of 1992. The book consists of a self-contained article by Kauffman, entitled Introduction to Quantum Topology and eighteen research articles by participants in the special session. This book should provide a useful source of ideas and results for anyone interested in the interface between topology and quantum field theory. Contents:Introduction to Quantum Topology (L H Kauffman)Knot Theory, Exotic Spheres and Global Gravitational Anomalies (R A Baadhio)A Diagrammatic Theory of Knotted Surfaces (J S Carter & M Saito)A Categorical Construction of 4D Topological Quantum Field Theories (L Crane & D Yetter)Evaluating the Crane-Yetter Invariant (L Crane, L H Kauffman & D Yetter)A Method for Computing the Arf Invariants of Links (P Gilmer)Triangulations, Categories and Extended Topological Field Theories (R J Lawrence)The Casson Invariant for Two-Fold Branched Covers of Links (D Mullins)Elementary Conjectures in Classical Knot Theory (J H Przytycki)Knot Polynomials as States of Nonperturbative Four Dimensional Quantum Gravity (J Pullin)On Invariants of 3-

Manifolds Derived from Abelian Groups (J Mattes, M M Polyak & N Reshetikhin)and other papers Readership: Mathematicians and mathematical physicists. keywords:Quantum Topology;Topological Quantum Field Theory;Meeting;AMS Special Session;Dayton, OH (USA)

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Non-Semisimple Topological Quantum Field Theories for 3-Manifolds with Corners Thomas Kerler,Volodymyr V. Lyubashenko.2014-09-01

Topological Quantum Computation Zhenghan Wang.2010 Topological quantum computation is a computational paradigm based on topological phases of matter, which are governed by topological quantum field theories. In this approach, information is stored in the lowest energy states of many-anyon systems and processed by braiding non-abelian anyons. The computational answer is accessed by bringing anyons together and observing the result. Besides its theoretical esthetic appeal, the practical merit of the topological approach lies in its error-minimizing hypothetical hardware: topological phases of matter are fault-avoiding or deaf to most local noises, and unitary gates are implemented with exponential accuracy. Experimental realizations are pursued in systems such as fractional quantum Hall liquids and topological insulators. This book expands on the author's CBMS lectures on knots and topological quantum computing and is intended as a primer for mathematically inclined graduate students. With an emphasis on introducing basic notions and current research, this book gives the first coherent account of the field, covering a wide range of topics: Temperley-Lieb-Jones theory, the quantum circuit model, ribbon fusion category theory, topological quantum field theory, anyon theory, additive approximation of the Jones polynomial, anyonic quantum computing models, and mathematical models of topological phases of matter.

Dualizable Tensor Categories Christopher L. Douglas,Christopher Schommer-Pries,Noah Snyder.2021-06-18 We investigate the relationship between the algebra of tensor categories and the topology of framed 3-manifolds. On the one hand, tensor categories with cer-tain algebraic properties determine topological invariants. We prove that fusion categories of nonzero global dimension are 3-dualizable, and therefore provide 3-dimensional 3-framed local field theories. We also show that all finite tensor cat-egories are 2-dualizable, and yield categorified 2-dimensional 3-framed local field theories. On the other hand, topological properties of 3-framed manifolds deter-mine algebraic equations among functors of tensor categories. We show that the 1-dimensional loop bordism, which exhibits a single full rotation, acts as the double dual autofunctor of a tensor category. We prove that the 2-dimensional belt-trick bordism, which unravels a double rotation, operates on any finite tensor category, and therefore supplies a trivialization of the quadruple dual. This approach pro-duces a quadruple-dual theorem for suitably dualizable objects in any symmetric monoidal 3-category. There is furthermore a correspondence between algebraic structures on tensor categories and homotopy fixed point structures, which in turn provide structured field theories; we describe the expected connection between piv-otal tensor categories and combed fixed

point structures, and between spherical tensor categories and oriented fixed point structures.

Frobenius Manifolds, Quantum Cohomology, and Moduli Spaces ÎU. I. Manin.

Non-Semisimple Topological Quantum Field Theories for 3-Manifolds with Corners Thomas Kerler,Volodymyr V. Lyubashenko.2003-07-01 This book presents the (to date) most general approach to combinatorial constructions of topological quantum field theories (TQFTs) in three dimensions. The authors describe extended TQFTs as double functors between two naturally defined double categories: one of topological nature, made of 3-manifolds with corners, the other of algebraic nature, made of linear categories, functors, vector spaces and maps. Atiyah's conventional notion of TQFTs as well as the notion of modular functor from axiomatic conformal field theory are unified in this concept. A large class of such extended modular catergory is constructed, assigning a double functor to every abelian modular category, which does not have to be semisimple.

Factorization Algebras in Quantum Field Theory Kevin Costello,Owen Gwilliam.2017 This first volume develops factorization algebras with a focus upon examples exhibiting their use in field theory, which will be useful for researchers and graduates.

Quantum Field Theory: Batalin–Vilkovisky Formalism and Its Applications Pavel Mnev.2019-08-20 This book originated from lecture notes for the course given by the author at the University of Notre Dame in the fall of 2016. The aim of the book is to give an introduction to the perturbative path integral for gauge theories (in particular, topological field theories) in Batalin–Vilkovisky formalism and to some of its applications. The book is oriented toward a graduate mathematical audience and does not require any prior physics background. To elucidate the picture, the exposition is mostly focused on finite-dimensional models for gauge systems and path integrals, while giving comments on what has to be amended in the infinite-dimensional case relevant to local field theory. Motivating examples discussed in the book include Alexandrov–Kontsevich–Schwarz–Zaboronsky sigma models, the perturbative expansion for Chern–Simons invariants of 3-manifolds given in terms of integrals over configurations of points on the manifold, the BF theory on cellular decompositions of manifolds, and Kontsevich's deformation quantization formula.

Lectures on Field Theory and Topology Daniel S. Freed.2019-08-23 These lectures recount an application of stable homotopy theory to a concrete problem in low energy physics: the classification of special phases of matter. While the joint work of the author and Michael Hopkins is a focal point, a general geometric frame of reference on quantum field theory is emphasized. Early lectures describe the geometric axiom systems introduced by Graeme Segal and Michael Atiyah in the late 1980s, as well as subsequent extensions. This material provides an entry point for mathematicians to delve into quantum field theory. Classification theorems in low dimensions are proved to illustrate the framework. The later lectures turn to more specialized topics in field theory, including the relationship between invertible field theories and stable homotopy theory,

extended unitarity, anomalies, and relativistic free fermion systems. The accompanying mathematical explanations touch upon (higher) category theory, duals to the sphere spectrum, equivariant spectra, differential cohomology, and Dirac operators. The outcome of computations made using the Adams spectral sequence is presented and compared to results in the condensed matter literature obtained by very different means. The general perspectives and specific applications fuse into a compelling story at the interface of contemporary mathematics and theoretical physics.

Topological Methods In Quantum Field Theories Werner Nahm,Seifallah Randjbar-daemi,Ergin Sezgin,Edward Witten.1991-05-17 Over the last two decades, topological ideas have found increasingly more applications in quantum field theory. Topological field theories are the culmination of these developments, and they formed the dominating theme of the conference. The other focal point was two-dimensional quantum gravity. The participation of such leading mathematicians as M Atiyah, R Bott, G Segal, and I Singer, is a testmony to the deep interplay of mathematics and theoretical physics.

Lectures on Tensor Categories and Modular Functors Bojko Bakalov,Alexander A. Kirillov.2001 This book gives an exposition of the relations among the following three topics: monoidal tensor categories (such as a category of representations of a quantum group), 3-dimensional topological quantum field theory, and 2-dimensional modular functors (which naturally arise in 2-dimensional conformal field theory). The following examples are discussed in detail: the category of representations of a quantum group at a root of unity and the Wess-Zumino-Witten modular functor. The idea that these topics are related first appeared in the physics literature in the study of quantum field theory. Pioneering works of Witten and Moore-Seiberg triggered an avalanche of papers, both physical and mathematical, exploring various aspects of these relations. Upon preparing to lecture on the topic at MIT, however, the authors discovered that the existing literature was difficult and that there were gaps to fill. The text is wholly expository and finely succinct. It gathers results, fills existing gaps, and simplifies some proofs. The book makes an important addition to the existing literature on the topic. It would be suitable as a course text at the advanced-graduate level.

Discrete Gauge Theory Robert Oeckl.2005-08-22 This book provides an introduction to topological quantum field theory as well as discrete gauge theory with quantum groups. In contrast to much of the existing literature, the present approach is at the same time intuitive and mathematically rigorous, making extensive use of suitable diagrammatic methods. It provides a highly unified description of lattice gauge theory, topological quantum field theory and models of quantum (super)gravity. The reader is thus in a unique position to understand the relations between these subjects as well as the underlying groundwork. Contents: Quantization of Discretized Gauge TheoriesTopology: Decomposition of ManifoldsCategories and DiagramsRepresentation Theory: Groups and Hopf AlgebrasCellular Gauge TheoryTopological Quantum Field TheoryRelated ConstructionsApplications to Lattice Models and Quantum Gravity Readership: Researchers in theoretical physics and mathematical physics. Key Features:Extends the discussion with many different models in higher

dimensionsProvides a coherent understanding of different subjects and their relations and foundationsMathematically self-contained; the advanced material required is introduced in separate chapters with no prior knowledge of physics necessaryPresents a wide range of cutting-edge applications to quantum gravity and lattice models, not covered in any other bookKeywords:Lattice Gauge Theory;Quantum Groups;Topological Quantum Field Theory (TQFT);Topology;Category Theory;Representation Theory;Quantum GravityReviews:“Both mathematicians and physicists will benefit from this excellent monograph.”Zentralblatt MATH

Mathematical Aspects of Conformal and Topological Field Theories and Quantum Groups Paul Sally.1994 This book contains papers presented by speakers at the AMS-IMS-SIAM Joint Summer Research Conference on Conformal Field Theory, Topological Field Theory and Quantum Groups, held at Mount Holyoke College in June 1992. One group of papers deals with one aspect of conformal field theory, namely, vertex operator algebras or superalgebras and their representations. Another group deals with various aspects of quantum groups. Other topics covered include the theory of knots in three-manifolds, symplectic geometry, and tensor products. This book provides an excellent view of some of the latest developments in this growing field of research.

Categories in Algebra, Geometry and Mathematical Physics Alexei Davydov,Michael Batanin,Amnon Neeman,Michael Johnson.2007 Category theory has become the universal language of modern mathematics. This book is a collection of articles applying methods of category theory to the areas of algebra, geometry, and mathematical physics. Among others, this book contains articles on higher categories and their applications and on homotopy theoretic methods. The reader can learn about the exciting new interactions of category theory with very traditional mathematical disciplines.

Integrable Structures of Exactly Solvable Two-Dimensional Models of Quantum Field Theory S. Pakuliak,G. von Gehlen.2011-05-06 Integrable quantum field theories and integrable lattice models have been studied for several decades, but during the last few years new ideas have emerged that have considerably changed the topic. The first group of papers published here is concerned with integrable structures of quantum lattice models related to quantum group symmetries. The second group deals with the description of integrable structures in two-dimensional quantum field theories, especially boundary problems, thermodynamic Bethe ansatz and form factor problems. Finally, a major group of papers is concerned with the purely mathematical framework that underlies the physically-motivated research on quantum integrable models, including elliptic deformations of groups, representation theory of non-compact quantum groups, and quantization of moduli spaces.

Integrable Systems, Quantum Groups, and Quantum Field Theories Alberto Ibort,M.A. Rodríguez.2012-12-06 In many ways the last decade has witnessed a surge of interest in the interplay between theoretical physics and some traditional areas of pure mathematics. This book contains the lectures delivered at the NATO-ASI Summer School on `Recent Problems

in Mathematical Physics' held at Salamanca, Spain (1992), offering a pedagogical and updated approach to some of the problems that have been at the heart of these events. Among them, we should mention the new mathematical structures related to integrability and quantum field theories, such as quantum groups, conformal field theories, integrable statistical models, and topological quantum field theories, that are discussed at length by some of the leading experts on the areas in several of the lectures contained in the book. Apart from these, traditional and new problems in quantum gravity are reviewed. Other contributions to the School included in the book range from symmetries in partial differential equations to geometrical phases in quantum physics. The book is addressed to researchers in the fields covered, PhD students and any scientist interested in obtaining an updated view of the subjects.

Homotopy Quantum Field Theory Vladimir G. Turaev.2010 Homotopy Quantum Field Theory (HQFT) is a branch of Topological Quantum Field Theory founded by E. Witten and M. Atiyah. It applies ideas from theoretical physics to study principal bundles over manifolds and, more generally, homotopy classes of maps from manifolds to a fixed target space. This book is the first systematic exposition of Homotopy Quantum Field Theory. It starts with a formal definition of an HQFT and provides examples of HQFTs in all dimensions. The main body of the text is focused on 2-dimensional and 3-dimensional HQFTs. A study of these HQFTs leads to new algebraic objects: crossed Frobenius group-algebras, crossed ribbon group-categories, and Hopf group-coalgebras. These notions and their connections with HQFTs are discussed in detail. The text ends with several appendices including an outline of recent developments and a list of open problems. Three appendices by M. Muger and A. Virelizier summarize their work in this area. The book is addressed to mathematicians, theoretical physicists, and graduate students interested in topological aspects of quantum field theory. The exposition is self-contained and well suited for a one-semester graduate course. Prerequisites include only basics of algebra and topology.

Quantum Field Theory and Topology Albert S. Schwarz.2013-04-09 In recent years topology has firmly established itself as an important part of the physicist's mathematical arsenal. It has many applications, first of all in quantum field theory, but increasingly also in other areas of physics. The main focus of this book is on the results of quantum field theory that are obtained by topological methods. Some aspects of the theory of condensed matter are also discussed. Part I is an introduction to quantum field theory: it discusses the basic Lagrangians used in the theory of elementary particles. Part II is devoted to the applications of topology to quantum field theory. Part III covers the necessary mathematical background in summary form. The book is aimed at physicists interested in applications of topology to physics and at mathematicians wishing to familiarize themselves with quantum field theory and the mathematical methods used in this field. It is accessible to graduate students in physics and mathematics.

Noncommutative Geometry, Quantum Fields and Motives Alain Connes,Matilde Marcolli.2019-03-13 The unifying theme of this book is the interplay among noncommutative geometry, physics, and number theory. The two main objects of

investigation are spaces where both the noncommutative and the motivic aspects come to play a role: space-time, where the guiding principle is the problem of developing a quantum theory of gravity, and the space of primes, where one can regard the Riemann Hypothesis as a long-standing problem motivating the development of new geometric tools. The book stresses the relevance of noncommutative geometry in dealing with these two spaces. The first part of the book deals with quantum field theory and the geometric structure of renormalization as a Riemann-Hilbert correspondence. It also presents a model of elementary particle physics based on noncommutative geometry. The main result is a complete derivation of the full Standard Model Lagrangian from a very simple mathematical input. Other topics covered in the first part of the book are a noncommutative geometry model of dimensional regularization and its role in anomaly computations, and a brief introduction to motives and their conjectural relation to quantum field theory. The second part of the book gives an interpretation of the Weil explicit formula as a trace formula and a spectral realization of the zeros of the Riemann zeta function. This is based on the noncommutative geometry of the adèle class space, which is also described as the space of commensurability classes of Q-lattices, and is dual to a noncommutative motive (endomotive) whose cyclic homology provides a general setting for spectral realizations of zeros of L-functions. The quantum statistical mechanics of the space of Q-lattices, in one and two dimensions, exhibits spontaneous symmetry breaking. In the low-temperature regime, the equilibrium states of the corresponding systems are related to points of classical moduli spaces and the symmetries to the class field theory of the field of rational numbers and of imaginary quadratic fields, as well as to the automorphisms of the field of modular functions. The book ends with a set of analogies between the noncommutative geometries underlying the mathematical formulation of the Standard Model minimally coupled to gravity and the moduli spaces of Q-lattices used in the study of the zeta function.

Applications of Quantum Mechanical Techniques to Areas Outside of Quantum Mechanics. 2nd Edition Emmanuel Haven,Andrei Khrennikov.2019-11-14 This book deals with applications of quantum mechanical techniques to areas outside of quantum mechanics, so-called quantum-like modeling. Research in this area has grown over the last 15 years. But even already more than 50 years ago, the interaction between Physics Nobelist Pauli and the psychologist Carl Jung in the 1950's on seeking to find analogous uses of the complementarity principle from quantum mechanics in psychology needs noting. This book does NOT want to advance that society is quantum mechanical! The macroscopic world is manifestly not quantum mechanical. But this rules not out that one can use concepts and the mathematical apparatus from quantum physics in a macroscopic environment. A mainstay ingredient of quantum mechanics, is 'quantum probability' and this tool has been proven to be useful in the mathematical modelling of decision making. In the most basic experiment of quantum physics, the double slit experiment, it is known (from the works of A. Khrennikov) that the law of total probability is violated. It is now well documented that several decision making paradoxes in psychology and economics (such as the Ellsberg paradox) do exhibit this violation of the law of total probability. When data is collected with experiments which test 'non-rational' decision

making behaviour, one can observe that such data often exhibits a complex non-commutative structure, which may be even more complex than if one considers the structure allied to the basic two slit experiment. The community exploring quantum-like models has tried to address how quantum probability can help in better explaining those paradoxes. Research has now been published in very high standing journals on resolving some of the paradoxes with the mathematics of quantum physics. The aim of this book is to collect the contributions of world’s leading experts in quantum like modeling in decision making, psychology, cognition, economics, and finance.

Associative and Non-Associative Algebras and Applications Mercedes Siles Molina,Laiachi El Kaoutit,Mohamed Louzari,L'Moufadal Ben Yakoub,Mohamed Benslimane.2020-01-02 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.

Complex Cobordism and Stable Homotopy Groups of Spheres Douglas C. Ravenel.2023-02-09 Since the publication of its first edition, this book has served as one of the few available on the classical Adams spectral sequence, and is the best account on the Adams-Novikov spectral sequence. This new edition has been updated in many places, especially the final chapter, which has been completely rewritten with an eye toward future research in the field. It remains the definitive reference on the stable homotopy groups of spheres. The first three chapters introduce the homotopy groups of spheres and take the reader from the classical results in the field though the computational aspects of the classical Adams spectral sequence and its modifications, which are the main tools topologists have to investigate the homotopy groups of spheres. Nowadays, the most efficient tools are the Brown-Peterson theory, the Adams-Novikov spectral sequence, and the chromatic spectral sequence, a device for analyzing the global structure of the stable homotopy groups of spheres and relating them to the cohomology of the Morava stabilizer groups. These topics are described in detail in Chapters 4 to 6. The revamped Chapter 7 is the computational payoff of the book, yielding a lot of information about the stable homotopy group of spheres. Appendices follow, giving self-contained accounts of the theory of formal group laws and the homological algebra associated with Hopf algebras and Hopf algebroids. The book is intended for anyone wishing to study computational stable homotopy theory. It is accessible to graduate students with a knowledge of algebraic topology and recommended to anyone wishing to

venture into the frontiers of the subject.

Quantum Groups, Quantum Categories and Quantum Field Theory Jürg Fröhlich,Thomas Kerler.2006-11-15 This book reviews recent results on low-dimensional quantum field theories and their connection with quantum group theory and the theory of braided, balanced tensor categories. It presents detailed, mathematically precise introductions to these subjects and then continues with new results. Among the main results are a detailed analysis of the representation theory of U (sl), for q a primitive root of unity, and a semi-simple quotient thereof, a classfication of braided tensor categories generated by an object of q-dimension less than two, and an application of these results to the theory of sectors in algebraic quantum field theory. This clarifies the notion of quantized symmetries in quantum fieldtheory. The reader is expected to be familiar with basic notions and resultsin algebra. The book is intended for research mathematicians, mathematical physicists and graduate students.

Quantum Field Theory and Noncommutative Geometry Ursula Carow-Watamura,Yoshiaki Maeda.2005-02-21 This volume reflects the growing collaboration between mathematicians and theoretical physicists to treat the foundations of quantum field theory using the mathematical tools of q-deformed algebras and noncommutative differential geometry. A particular challenge is posed by gravity, which probably necessitates extension of these methods to geometries with minimum length and therefore quantization of space. This volume builds on the lectures and talks that have been given at a recent meeting on Quantum Field Theory and Noncommutative Geometry. A considerable effort has been invested in making the contributions accessible to a wider community of readers - so this volume will not only benefit researchers in the field but also postgraduate students and scientists from related areas wishing to become better acquainted with this field.

Topological Phases of Matter and Quantum Computation Paul Bruillard,Carlos Ortiz Marrero,Julia Plavnik.2020-03-31 This volume contains the proceedings of the AMS Special Session on Topological Phases of Matter and Quantum Computation, held from September 24–25, 2016, at Bowdoin College, Brunswick, Maine. Topological quantum computing has exploded in popularity in recent years. Sitting at the triple point between mathematics, physics, and computer science, it has the potential to revolutionize sub-disciplines in these fields. The academic importance of this field has been recognized in physics through the 2016 Nobel Prize. In mathematics, some of the 1990 Fields Medals were awarded for developments in topics that nowadays are fundamental tools for the study of topological quantum computation. Moreover, the practical importance of this discipline has been underscored by recent industry investments. The relative youth of this field combined with a high degree of interest in it makes now an excellent time to get involved. Furthermore, the cross-disciplinary nature of topological quantum computing provides an unprecedented number of opportunities for cross-pollination of mathematics, physics, and computer science. This can be seen in the variety of works contained in this volume. With articles coming from mathematics, physics, and computer science, this volume aims to provide a taste of different sub-disciplines for novices and a

wealth of new perspectives for veteran researchers. Regardless of your point of entry into topological quantum computing or your experience level, this volume has something for you.

Geometry and Quantum Field Theory Daniel S. Freed,Karen K. Uhlenbeck.1995 Exploring topics from classical and quantum mechnanics and field theory, this book is based on lectures presented in the Graduate Summer School at the Regional Geometry Institute in Park City, Utah, in 1991. The chapter by Bryant treats Lie groups and symplectic geometry, examining not only the connection with mechanics but also the application to differential equations and the recent work of the Gromov school. Rabin's discussion of quantum mechanics and field theory is specifically aimed at mathematicians. Alvarez describes the application of supersymmetry to prove the Atiyah-Singer index theorem, touching on ideas that also underlie more complicated applications of supersymmetry. Quinn's account of the topological quantum field theory captures the formal aspects of the path integral and shows how these ideas can influence branches of mathematics which at first glance may not seem connected. Presenting material at a level between that of textbooks and research papers, much of the book would provide excellent material for graduate courses. The book provides an entree into a field that promises to remain exciting and important for years to come.

Factorization Algebras in Quantum Field Theory: Volume 2 Kevin Costello,Owen Gwilliam.2021-09-23 Factorization algebras are local-to-global objects that play a role in classical and quantum field theory that is similar to the role of sheaves in geometry: they conveniently organize complicated information. Their local structure encompasses examples like associative and vertex algebras; in these examples, their global structure encompasses Hochschild homology and conformal blocks. In this second volume, the authors show how factorization algebras arise from interacting field theories, both classical and quantum, and how they encode essential information such as operator product expansions, Noether currents, and anomalies. Along with a systematic reworking of the Batalin–Vilkovisky formalism via derived geometry and factorization algebras, this book offers concrete examples from physics, ranging from angular momentum and Virasoro symmetries to a five-dimensional gauge theory.

Tensor Categories Pavel Etingof,Shlomo Gelaki,Dmitri Nikshych,Victor Ostrik.2016-08-05 Is there a vector space whose dimension is the golden ratio? Of course not—the golden ratio is not an integer! But this can happen for generalizations of vector spaces—objects of a tensor category. The theory of tensor categories is a relatively new field of mathematics that generalizes the theory of group representations. It has deep connections with many other fields, including representation theory, Hopf algebras, operator algebras, low-dimensional topology (in particular, knot theory), homotopy theory, quantum mechanics and field theory, quantum computation, theory of motives, etc. This book gives a systematic introduction to this theory and a review of its applications. While giving a detailed overview of general tensor categories, it focuses especially on the theory of finite tensor categories and fusion categories (in particular, braided and modular ones), and discusses the main

results about them with proofs. In particular, it shows how the main properties of finite-dimensional Hopf algebras may be derived from the theory of tensor categories. Many important results are presented as a sequence of exercises, which makes the book valuable for students and suitable for graduate courses. Many applications, connections to other areas, additional results, and references are discussed at the end of each chapter.

Mathematical Foundations of Quantum Field Theory and Perturbative String Theory Hisham Sati,Urs Schreiber.2011-12-07 Conceptual progress in fundamental theoretical physics is linked with the search for the suitable mathematical structures that model the physical systems. Quantum field theory (QFT) has proven to be a rich source of ideas for mathematics for a long time. However, fundamental questions such as ``What is a QFT?'' did not have satisfactory mathematical answers, especially on spaces with arbitrary topology, fundamental for the formulation of perturbative string theory. This book contains a collection of papers highlighting the mathematical foundations of QFT and its relevance to perturbative string theory as well as the deep techniques that have been emerging in the last few years. The papers are organized under three main chapters: Foundations for Quantum Field Theory, Quantization of Field Theories, and Two-Dimensional Quantum Field Theories. An introduction, written by the editors, provides an overview of the main underlying themes that bind together the papers in the volume.

Geometry and Quantum Field Theory Daniel S. Freed,Karen K. Uhlenbeck,American Mathematical Society,Institute for Advanced Study (Princeton, N.J.).1995 The first title in a new series, this book explores topics from classical and quantum mechanics and field theory. The material is presented at a level between that of a textbook and research papers making it ideal for graduate students. The book provides an entree into a field that promises to remain exciting and important for years to come.

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