Topological Quantum Field Theory And Four Manifol

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Lectures on Tensor Categories and Modular Functors American Mathematical Soc.
Describes random geometry and applications to strings, quantum gravity, topological field theory and membrane physics.

Advances in Topological Quantum Field Theory Elsevier
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.

Quantum Topology Cambridge University Press
This volume is the conference proceedings of the NATO ARW during August 2001 at Kananaskis Village, Canada on 'New Techniques in Topological Quantum Field Theory'. This conference brought together specialists from a number of different fields all related to Topological Quantum Field Theory. The theme of this conference was to attempt to find new methods in quantum topology from the interaction with specialists in these other fields. The featured articles include papers by V. Vassiliev on combinatorial formulas for cohomology of spaces of Knots, the computation of Ohtsuki series by N. Jacoby and R. Lawrence, and a paper by M. Asaeda and J. Przytycki on the torsion conjecture for Khovanov homology by Shumakovitch. Moreover, there are articles on more classical topics related to manifolds and braid groups by such well known authors as D. Rolfsen, H. Zieschang and F. Cohen.

Homotopy Quantum Field Theory CRC Press
Quantum Field Theory and TopologySpringer Science & Business Media

Frobenius Algebras and 2-D Topological Quantum Field Theories Cambridge University Press
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.

Advances in Topological Quantum Field Theory Cambridge University Press
This book presents a selection of advanced lectures from leading researchers, providing recent theoretical results on strongly coupled quantum field theories. It also analyzes their use for describing new quantum states, which are physically realizable in condensed matter, cold-atomic systems, as well as artificial materials. It particularly focuses on the engineering of these states in quantum devices and novel materials useful for quantum information processing. The book offers graduate students and young researchers in the field of modern condensed matter theory an updated review of the most relevant theoretical methods used in strongly coupled field theory and string theory. It also provides the tools for understanding their relevance in describing the emergence of new quantum states in a variety of physical settings. Specifically, this proceedings book summarizes new and previously unrelated developments in modern condensed matter physics, in particular: the interface of condensed matter theory and quantum information theory; the interface of condensed matter physics and the mathematics emerging from the classification of the topological phases of matter, such as topological insulators and topological superconductors; and the simulation of condensed matter systems with cold atoms in optical lattices.

Discrete Gauge Theory American Mathematical Soc.
These notes deal with an area that lies at the crossroads of mathematics and physics and rest primarily on the pioneering work of Vaughan Jones and Edward Witten, who related polynomial invariants of knots to a topological quantum field theory in 2+1 dimensions.

Quantum Topology Cambridge University Press
The remarkable developments in differential topology and how these recent advances have been applied as a primary research tool in quantum field theory are presented here in a style reflecting the genuinely two-sided interaction between mathematical physics and applied mathematics. The author, following his previous work (Nash/Sen: Differential Topology for Physicists, Academic Press, 1983), covers elliptic differential and pseudo-differential operators, Atiyah-Singer index theory, topological quantum field theory, string theory, and knot theory. The explanatory approach serves to illuminate and clarify these theories for graduate students and research workers entering the field for the first time. Treats differential geometry, differential topology, and quantum field theory Includes elliptic differential and pseudo-differential operators, Atiyah-Singer index theory, topological quantum field theory, string theory, and knot theory Tackles problems of quantum field theory using differential topology as a tool

Quantum Field Theory: Batalin–Vilkovisky Formalism and Its Applications CRC Press
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.

Topology And Physics World Scientific
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.
Topological Quantum Numbers In Nonrelativistic Physics Cambridge University Press
Topological quantum numbers are distinguished from quantum numbers based on symmetry because they are insensitive to the imperfections of the systems in which they are observed. They have become very important in precision measurements in recent years, and provide the best measurements of voltage and electrical resistance. This book describes the theory of such quantum numbers, starting with Dirac's argument for the quantization of electric charge, and continuing with discussions on the helium superfluids, flux quantization and the Josephson effect in superconductors, the quantum Hall effect, solids and liquid crystals, and topological phase transitions. The accompanying reprints include some of the classic experimental and theoretical papers in this area.Physicists — both experimental and theoretical — who are interested in the topic will find this book an invaluable reference.
Topology, Geometry and Quantum Field Theory Cambridge University Press
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.
Quantum Field Theory and Condensed Matter World Scientific
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.
Field Theories of Condensed Matter Physics American Mathematical Soc.
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.
Springer Nature
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.
Lectures on Field Theory and Topology Quantum Field Theory and Topology
For most of the last century, condensed matter physics has been dominated by band theory and Landau's symmetry breaking theory. In the last twenty years, however, there has been the emergence of a new paradigm associated with fractionalisation, topological order, emergent gauge bosons and fermions, and string condensation. These new physical concepts are so fundamental that they may even influence our understanding of the origin of light and fermions in the universe. This book is a pedagogical and systematic introduction to the new concepts and quantum field theoretical methods (which have fuelled the rapid developments) in condensed matter physics. It discusses many basic notions in theoretical physics which underlie physical phenomena in nature. Topics covered are dissipative quantum systems, boson condensation, symmetry breaking and gapless excitations, phase transitions, Fermi liquids, spin density wave states, Fermi and fractional statistics, quantum Hall effects, topological and quantum order, spin liquids, and string condensation. Methods covered are the path integral, Green's functions, mean-field theory, effective theory, renormalization group, bosonization in one- and higher dimensions, non-linear sigma-model, quantum gauge theory, dualities, slave-boson theory, and exactly soluble models beyond one-dimension. This book is aimed at teaching graduate students and bringing them to the frontiers of research in condensed matter physics.
Non-Semisimple Topological Quantum Field Theories for 3-Manifolds with Corners Springer Science & Business Media
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
Non-Semisimple Topological Quantum Field Theories for 3-Manifolds with Corners American Mathematical Soc.
This is a monograph on geometrical and topological features which arise in quantum field theory. It is well known that when a chiral fermion interacts with a gauge field we have chiral anomaly which corresponds to the fact that divergence of the axial vector current does not vanish. It is observed that this is related to certain topological features associated with the fermion and leads to the realization of the topological origin of fermion number as well as the Berry phase. The role of gauge fields in the quantization procedure has its implications in these topological features of a fermion and helps us to consider a massive fermion as a soliton (skyrrnion). In this formalism chiral anomaly is found to be responsible for mass generation. This has its relevance in electroweak theory where it is observed that weak interaction gauge bosons attain mass topologically. The geometrical feature of a skyrmion also helps us to realize the internal symmetry of hadrons from reflection group. Finally it has been shown that noncommutative geometry where the space time manifold is taken to be X = M x Zz has its relevance in the description of a massive 4 fermion as a skyrmion when the discrete space is considered as the internal space and the symmetry breaking leads to chiral anomaly. In chap. l preliminary mathematical formulations related to the spinor structure have been discussed. In chap.
Quantum Geometry OUP Oxford
This should be a useful reference for anybody with an interest in quantum theory.
Quantum Field Theory for Mathematicians Springer
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.