Low-Dimensional Topology and Quantum Field Theory

Edited by
Hugh Osborn

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Zhenghan Wang,Weiping Zhang,Kelvin Lin

Low Dimensional Topology And Quantum Field Theory:

   Low-Dimensional Topology and Quantum Field Theory Hugh Osborn,2013-11-11 The motivations goals and general culture of theoretical physics and mathematics are different Most practitioners of either discipline have no necessity for most of the time to keep abreast of the latest developments in the other However on occasion newly developed mathematical concepts become relevant in theoretical physics and the less rigorous theoretical physics framework may prove valuable in understanding and suggesting new theorems and approaches in pure mathematics Such interdis ciplinary successes invariably cause much rejoicing as over a prodigal son returned In recent years the framework provided by quantum field theory and functional in tegrals developed over half a century in theoretical physics have proved a fertile soil for developments in low dimensional topology and especially knot theory Given this background it was particularly pleasing that NATO was able to generously sup port an Advanced Research Workshop to be held in Cambridge England from 6th to 12th September 1992 with the title Low Dimensional Topology and Quantum Field Theory Although independently organised this overlapped as far as some speak ers were concerned with a longer term programme with the same title organised by Professor M Green Professor E Corrigan and Dr R Lickorish The contents of this proceedings of the workshop demonstrate the breadth of topics now of interest on the interface between theoretical physics and mathematics as well as the sophistication of the mathematical tools required in current theoretical physics   *Topology, Geometry, and Field Theory* ,1994   Topology And Physics - Proceedings Of The Nankai International Conference In Memory Of Xiao-song Lin Zhenghan Wang,Weiping Zhang,Kelvin Lin,2008-08-11 This unique volume resulting from a conference at the Chern Institute of Mathematics dedicated to the memory of Xiao Song Lin presents a broad connection between topology and physics as exemplified by the relationship between low dimensional topology and quantum field theory The volume includes works on picture 2 1 TQFTs and their applications to quantum computing Berry phase and Yang Baxterization of the braid relation finite type invariant of knots categorification and Khovanov homology Gromov Witten type invariants twisted Alexander polynomials Faddeev knots generalized Ricci flow Calabi Yau problems for CR manifolds Milnor s conjecture on volume of simplexes Heegaard genera of 3 manifolds and the A B slice problem It also includes five unpublished papers of Xiao Song Lin and various speeches related to the memorial conference   **Low Dimensional Topology** Hanna Nencka,1999 The book has two main parts The first is devoted to the Poincare conjecture characterizations of PL manifolds covering quadratic forms of links and to categories in low dimensional topology that appear in connection with conformal and quantum field theory   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 **Topology and Physics** Zhenghan Wang,2008 This unique volume resulting from a conference at the Chern Institute of Mathematics dedicated to the memory of Xiao Song Lin presents a broad connection between topology and physics as exemplified by the relationship between low dimensional topology and quantum field theory The volume includes works on picture 2 1 TQFTs and their applications to quantum computing Berry phase and YangOCoBaxterization of the braid relation finite type invariant of knots categorification and Khovanov homology GromovOCoWitten type invariants twisted Alexander polynomials Faddeev knots generalized Ricci flow CalabiOCoYau problems for CR manifolds Milnor s conjecture on volume of simplexes Heegaard genera of 3 manifolds and the A B slice problem It also includes five unpublished papers of Xiao Song Lin and various speeches related to the memorial conference Geometry and Topology of Low Dimensional Systems T. R. Govindarajan,Pichai Ramadevi,2024-09-16 This book introduces the field of topology a branch of mathematics that explores the properties of geometric space with a focus on low dimensional systems The authors discuss applications in various areas of physics The first chapters of the book cover the formal aspects of topology including classes homotopic groups metric spaces and Riemannian and pseudo Riemannian geometry These topics are essential for understanding the theoretical concepts and notations used in the next chapters of the book The applications encompass defects in crystalline structures space topology spin statistics Braid group Chern Simons field theory and 3D gravity among others This self contained book provides all the necessary additional material for both physics and mathematics students The presentation is enriched with examples and exercises making it accessible for readers to grasp the concepts with ease The authors adopt a pedagogical approach posing many unsolved questions in simple situations that can serve as challenging projects for students Suitable for a one semester postgraduate level course this text is ideal for teaching purposes Low-dimensional Quantum Field Theories for Condensed Matter Physicists Stig Lundqvist,Giuseppe Morandi,Lu Yu,International Centre for Theoretical Physics,1995 This volume contains a set of pedagogical reviews covering the most recent applications of low dimensional quantum field theory in condensed matter physics written by experts who have made major contributions to this rapidly developing field of research The main purpose is to introduce active young researchers to new ideas and new techniques which are not covered by the standard textbooks **Operator Algebras, Mathematical Physics, and Low Dimensional Topology** Richard Herman,Betül Tanbay,1993-11-15 This volume records the proceedings of an international conference that explored recent developments

and the interaction between mathematical theory and physical phenomena **Open Issues in Topology** Pasquale De Marco,2025-03-08 Open Issues in Topology embarks on a captivating journey through the unsolved problems that lie at the heart of this fascinating field This book is a treasure trove of mathematical challenges inviting readers to explore the frontiers of human knowledge and push the boundaries of understanding Within these pages readers will encounter a diverse collection of topics each representing a unique and intriguing puzzle Knot theory captivates with its intricate knots links and braids while the Poincar conjecture unveils the profound connections between topology and geometry Low dimensional topology unveils the beauty of surfaces and their classification while topological data analysis harnesses the power of topology to unlock hidden patterns in vast datasets Algebraic topology unveils the intricate interplay between algebra and topology revealing the elegance and power of mathematical structures Geometric topology takes readers on a journey through shapes and spaces exploring the connections between geometry and topology Homotopy theory emerges as a central pillar of topology offering a framework for understanding the behavior of spaces under continuous deformations Open Issues in Topology is more than just a collection of unsolved problems it is an invitation to join the quest for new knowledge and to contribute to the advancement of human understanding Whether you are a seasoned mathematician a budding researcher or simply someone fascinated by the enigmatic world of topology this book offers a wealth of challenges and insights that will ignite your curiosity and inspire your intellect If you like this book write a review *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 manifolds Foundations of topological quantum field theory Three dimensional topological quantum field theory Two dimensional modular functors 6j symbols Simplicial state sums on 3 manifolds Shadows of manifolds and state sums on shadows

Constructions of modular categories   *Advances in Topological Quantum Field Theory* John M. Bryden,2007-09-27 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   Proceedings of the International Symposium on Frontiers of Science Chen Ning Yang,Hwa-Tung Nieh,2003 The International Symposium on Frontiers of Science was held to celebrate the 80th birthday of Chen Ning Yang one of the great physicists of the 20th century and arguably the most admired living scientist in China today Many of the world s great scientists including sixteen Nobel laureates Fields medallists and Wolf Prize winners converged on Beijing from all corners of the globe to pay tribute to Professor Yang The Symposium was organized by Tsinghua University with which Professor Yang has had a lifelong relationship In 1997 he helped to found the Center for Advanced Study at Tsinghua was appointed to the university s faculty and has since devoted his energy to the growth of the Center This unique and invaluable birthday volume is a collection of the presentations made at the Symposium including fifteen plenary talks seven of which are by Nobel laureates It covers a wide range of topics and mirrors Professor Yang s research and intellectual interests The range of fields encompasses high energy condensed matter mathematical applied bio astro atomic and quantum physics Also included are talks given at the birthday banquet About C N YangBorn in 1922 in Anwhei China C N Yang was brought up in the academic atmosphere of Tsinghua University in Beijing where his father was a professor of mathematics He received his college education at the National Southwest Associated University in Kunming China and completed his BSc there in 1942 His MSc was received in 1944 from Tsinghua University He entered the University of Chicago in 1946 where he came under the strong influence of Prof E Fermi After receiving his PhD in 1948 Prof Yang served for a year at the University of Chicago as an instructor Since 1949 he has been associated with the Institute for Advanced Study Princeton where he became a professor in 1955 Prof Yang has worked on various subjects in physics but is mainly interested in statistical mechanics and symmetry principles He is a prolific author his numerous articles appearing in the Bulletin of the American Mathematical Society The Physical Review Reviews of Modern Physics and the Chinese Journal of Physics Prof Yang won the Nobel Prize in Physics in 1957 jointly with T D Lee He has been elected a Fellow of the American Physical Society and of Academia Sinica   *Mathematical Physics in Mathematics and Physics* Roberto Longo,2001 The beauty and the mystery surrounding the interplay between mathematics and physics is captured by E Wigner s famous expression The

unreasonable effectiveness of mathematics We don t know why but physical laws are described by mathematics and good mathematics sooner or later finds applications in physics often in a surprising way In this sense mathematical physics is a very old subject as Egyptian Phoenician or Greek history tells us But mathematical physics is a very modern subject as any working mathematician or physicist can witness It is a challenging discipline that has to provide results of interest for both mathematics and physics Ideas and motivations from both these sciences give it a vitality and freshness that is difficult to find anywhere else One of the big physical revolutions in the twentieth century quantum physics opened a new magnificent era for this interplay With the appearance of noncommutative analysis the role of classical calculus has been taken by commutation relations a subject still growing in an astonishing way A good example where mathematical physics showed its power beauty and interdisciplinary character is the Doplicher Haag Roberts analysis of superselection sectors in the late 1960s Not only did this theory explain the origin of statistics and classify it but year after year new connections have merged for example with Tomita Takesaki modular theory Jones theory of subfactors and Doplicher Roberts abstract duality for compact groups This volume contains the proceedings of the conference Mathematical Physics in Mathematics and Physics dedicated to Sergio Doplicher and John E Roberts held in Siena Italy The articles offer current research in various fields of mathematical physics primarily concerning quantum aspects of operator algebras *Algebraic and Geometric Methods in Mathematical Physics* Anne Boutet de Monvel,Vladimir Marchenko,1996-01-31 Proceedings of the Kaciveli Summer School Crimea Ukraine 1993 **Geometry and Physics** H. Pedersen,2021-01-07 Based on the proceedings of the Special Session on Geometry and Physics held over a six month period at the University of Aarhus Denmark and on articles from the Summer school held at Odense University Denmark Offers new contributions on a host of topics that involve physics geometry and topology Written by more than 50 leading international experts Graphs and Patterns in Mathematics and Theoretical Physics Mikhail Lyubich,Leon Armenovich Takhtadzhi︠a︡n,2005 The Stony Brook Conference Graphs and Patterns in Mathematics and Theoretical Physics was dedicated to Dennis Sullivan in honor of his sixtieth birthday The event s scientific content which was suggested by Sullivan was largely based on mini courses and survey lectures The main idea was to help researchers and graduate students in mathematics and theoretical physics who encounter graphs in their research to overcome conceptual barriers The collection begins with Sullivan s paper Sigma models and string topology which describes a background algebraic structure for the sigma model based on algebraic topology and transversality Other contributions to the volume were organized into five sections Feynman Diagrams Algebraic Structures Manifolds Invariants and Mirror Symmetry Combinatorial Aspects of Dynamics and Physics These sections along with more research oriented articles contain the following surveys Feynman diagrams for pedestrians and mathematicians by M Polyak Notes on universal algebra by A Voronov Unimodal maps and hierarchical models by M Yampolsky and Quantum geometry in action big bang and black holes by A Ashtekar This comprehensive volume is suitable for graduate students and research mathematicians interested in graph

theory and its applications in mathematics and physics *Quantum Invariants* Tomotada Ohtsuki,2002 This book provides an extensive and self contained presentation of quantum and related invariants of knots and 3 manifolds Polynomial invariants of knots such as the Jones and Alexander polynomials are constructed as quantum invariants i e invariants derived from representations of quantum groups and from the monodromy of solutions to the Knizhnik Zamolodchikov equation With the introduction of the Kontsevich invariant and the theory of Vassiliev invariants the quantum invariants become well organized Quantum and perturbative invariants the LMO invariant and finite type invariants of 3 manifolds are discussed The ChernOCoSimons field theory and the WessOCoZuminoOCoWitten model are described as the physical background of the invariants Contents Knots and Polynomial Invariants Braids and Representations of the Braid Groups Operator Invariants of Tangles via Sliced Diagrams Ribbon Hopf Algebras and Invariants of Links Monodromy Representations of the Braid Groups Derived from the KnizhnikOCoZamolodchikov Equation The Kontsevich Invariant Vassiliev Invariants Quantum Invariants of 3 Manifolds Perturbative Invariants of Knots and 3 Manifolds The LMO Invariant Finite Type Invariants of Integral Homology 3 Spheres Readership Researchers lecturers and graduate students in geometry topology and mathematical physics *The Feynman Integral and Feynman's Operational Calculus* ,2000-03-16 The aim of this book is to make accessible to mathematicians physicists and other scientists interested in qunatum theory the beautiful but mathematically difficult subjects of the Feynman integral and Feynman s operational calculus Some advantages of the approaches to the Feynman integral which are treated in detail in this book are the following the existence of the Feynman integral is established for very general potentials in all four cases under more restrictive but still broad conditions three of these Feynman integrals agree with one another and with the unitary group from the usual approach to quantum dynamics these same three Feynman integrals possess pleasant stability properties Much of the material covered here was previously available only in the research literature and the book also contains some new results The background material in mathematics and physics that motivates the study of the Feynman integral and Feynman s operational calculus is discussed and detailed proofs are provided for the central results Selected Papers on Differential Equations and Analysis ,2005 Contains translations of papers that originally appeared in the Japanese journal Sugaku This book covers a variety of topics including differential equations with free boundary singular integral operators and operator algebras It is suitable for graduate students and research mathematicians interested in analysis and differential equations

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Table of Contents Low Dimensional Topology And Quantum Field Theory

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