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Vladimir G. Turaev

QUANTUM INVARIANTS OF KNOTS AND 3-MANIFOLDS

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Quantum Invariants Of Knots And 3manifolds De Gruyter Studies In Mathematics

Slavik V. Jablan, Radmila Sazdanovic



Quantum Invariants Of Knots And 3-manifolds De Gruyter Studies In Mathematics:

Quantum Invariants of Knots and 3-manifolds Vladimir Turaev, 1994 **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 **Quantum Invariants of Knots and 3-Manifolds** Vladimir G. Turaev, 2020-03-23 This monograph provides a systematic treatment of topological quantum field theories TQFT s in three dimensions inspired by the discovery of the Jones polynomial of knots the Witten Chern Simons field theory and the theory of quantum groups The author one of the leading experts in the subject gives a rigorous and self contained exposition of new fundamental algebraic and topological concepts that emerged in this theory The book is divided into three parts Part I presents a construction of 3 dimensional TQFT s and 2 dimensional modular functors from so called modular categories This gives new knot and 3 manifold invariants as well as linear representations of the mapping class groups of surfaces In Part II the machinery of $6j$ symbols is used to define state sum invariants of 3 manifolds Their relation to the TQFT s constructed in Part I is established via the theory of shadows Part III provides constructions of modular categories based on quantum groups and Kauffman s skein modules This book is accessible to graduate students in mathematics and physics with a knowledge of basic algebra and topology It will be an indispensable source for everyone who wishes to enter the forefront of this rapidly growing and fascinating area at the borderline of mathematics and physics Most of the results and techniques presented here appear in book form for the first time **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

Introductory Lectures on Knot Theory Louis H. Kauffman, 2012 More recently Khovanov introduced link homology as a generalization of the Jones polynomial to homology of chain complexes and Ozsvath and Szabo developed Heegaard Floer homology that lifts the Alexander polynomial These two significantly different theories are closely related and the dependencies are the object of intensive study These ideas mark the beginning of a new era in knot theory that includes relationships with four dimensional problems and the creation of new forms of algebraic topology relevant to knot theory The theory of skein modules is an older development also having its roots in Jones discovery Another significant and related development is the theory of virtual knots originated independently by Kauffman and by Goussarov Polyak and Viro in the 90s All these topics and their relationships are the subject of the survey papers in this book

LinKnot Slavik V. Jablan, Radmila Sazdanovic, 2007 LinKnot OCo Knot Theory by Computer provides a unique view of selected topics in knot theory suitable for students research mathematicians and readers with backgrounds in other exact sciences including chemistry molecular biology and physics The book covers basic notions in knot theory as well as new methods for handling open problems such as unknotting number braid family representatives invertibility amphicheirality undetectability non algebraic tangles polyhedral links and 2 2 moves Hands on computations using Mathematica or the webMathematica package LinKnot available online at <http://math.ict.edu/rs> and beautiful illustrations facilitate better learning and understanding LinKnot is also a powerful research tool for experimental mathematics implementation of Caudron's ideas The use of Conway notation enables experimenting with large families of knots and links Conjectures discussed in the book are explained at length The beauty universality and diversity of knot theory is illuminated through various non standard applications mirror curves fullerenes self referential systems and KL automata Sample Chapter s 1 1 Basic graph theory 176 KB Contents Notation of Knots and Links Recognition and Generation of Knots and Links History of Knot Theory and Applications of Knots and Links Readership Researchers interested in knot

theory and users of Mathematica Quantum Field Theory and Manifold Invariants Daniel S. Freed, Sergei Gukov, Ciprian Manolescu, Constantin Teleman, Ulrike Tillmann, 2021-12-02 This volume contains lectures from the Graduate Summer School Quantum Field Theory and Manifold Invariants held at Park City Mathematics Institute 2019 The lectures span topics in topology global analysis and physics and they range from introductory to cutting edge Topics treated include mathematical gauge theory anti self dual equations Seiberg Witten equations Higgs bundles classical and categorified knot invariants Khovanov homology Heegaard Floer homology instanton Floer homology invertible topological field theory BPS states and spectral networks This collection presents a rich blend of geometry and topology with some theoretical physics thrown in as well and so provides a snapshot of a vibrant and fast moving field Graduate students with basic preparation in topology and geometry can use this volume to learn advanced background material before being brought to the frontiers of current developments Seasoned researchers will also benefit from the systematic presentation of exciting new advances by leaders in their fields **Topological Methods in Hydrodynamics** Vladimir I. Arnold, Boris A. Khesin, 2008-01-08 The first monograph to treat topological group theoretic and geometric problems of ideal hydrodynamics and magnetohydrodynamics from a unified point of view It describes the necessary preliminary notions both in hydrodynamics and pure mathematics with numerous examples and figures The book is accessible to graduates as well as pure and applied mathematicians working in hydrodynamics Lie groups dynamical systems and differential geometry *Topological Recursion and its Influence in Analysis, Geometry, and Topology* Chiu-Chu Melissa Liu, Motohico Mulase, 2018-11-19 This volume contains the proceedings of the 2016 AMS von Neumann Symposium on Topological Recursion and its Influence in Analysis Geometry and Topology which was held from July 4 8 2016 at the Hilton Charlotte University Place Charlotte North Carolina The papers contained in the volume present a snapshot of rapid and rich developments in the emerging research field known as topological recursion It has its origin around 2004 in random matrix theory and also in Mirzakhani's work on the volume of moduli spaces of hyperbolic surfaces Topological recursion has played a fundamental role in connecting seemingly unrelated areas of mathematics such as matrix models enumeration of Hurwitz numbers and Grothendieck's dessins d'enfants Gromov Witten invariants the A polynomials and colored polynomial invariants of knots WKB analysis and quantization of Hitchin moduli spaces In addition to establishing these topics the volume includes survey papers on the most recent key accomplishments discovery of the unexpected relation to semi simple cohomological field theories and a solution to the remodeling conjecture It also provides a glimpse into the future research direction for example connections with the Airy structures modular functors Hurwitz Frobenius manifolds and ELSV type formulas **Moduli Spaces of Curves, Mapping Class Groups and Field Theory** Xavier Buff, 2003 It concludes with a study of the canonical Galois action on the fundamental groupoids computed using Grothendieck Teichmüller theory Finally Chapter 3 studies strict ribbon categories which are closely related to braided tensor categories here they are used to construct invariants of 3 manifolds which in turn give rise to quantum field

theories BOOK JACKET Solitons, Geometry, and Topology: On the Crossroad V. M. Buchstaber, Sergei Petrovich Novikov, 1997 Xivth International Congress On Mathematical Physics Jean-claude Zambrini, 2006-03-07 In 2003 the XIV International Congress on Mathematical Physics ICMP was held in Lisbon with more than 500 participants Twelve plenary talks were given in various fields of Mathematical Physics E Carlen On the relation between the Master equation and the Boltzmann Equation in Kinetic Theory A Chenciner Symmetries and simple solutions of the classical n body problem M J Esteban Relativistic models in atomic and molecular physics K Fredenhagen Locally covariant quantum field theory K Gawedzki Simple models of turbulent transport I Krichever Algebraic versus Liouville integrability of the soliton systems R V Moody Long range order and diffraction in mathematical quasicrystals S Smirnov Critical percolation and conformal invariance J P Solovej The energy of charged matter V Schomerus Strings through the microscope C Villani Entropy production and convergence to equilibrium for the Boltzmann equation D Voiculescu Aspects of free probability The book collects as well carefully selected invited Session Talks in Dynamical Systems Integrable Systems and Random Matrix Theory Condensed Matter Physics Equilibrium Statistical Mechanics Quantum Field Theory Operator Algebras and Quantum Information String and M Theory Fluid Dynamics and Nonlinear PDE General Relativity Nonequilibrium Statistical Mechanics Quantum Mechanics and Spectral Theory Path Integrals and Stochastic Analysis *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 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 Lectures on Differential Topology Riccardo Benedetti, 2021-10-27 This book gives a comprehensive introduction to the theory of smooth manifolds maps and fundamental associated structures with an emphasis on bare hands approaches combining differential topological cut and paste procedures and applications of transversality In particular the smooth cobordism cup product is defined from scratch and used as the main tool in a variety of settings After establishing the fundamentals the book proceeds to a broad range of more advanced topics in differential topology including degree theory the Poincaré Hopf index theorem bordism characteristic numbers and the Pontryagin-Thom construction Cobordism intersection forms are used to classify compact surfaces their quadratic enhancements are developed and applied to studying the homotopy groups of spheres the bordism group of immersed surfaces in a 3-manifold and congruences mod 16 for the signature of intersection forms of 4-manifolds Other topics include the high-dimensional h -cobordism theorem stressing the role of the Whitney trick a determination of the singleton bordism modules in low dimensions and proofs of parallelizability of orientable 3-manifolds and the Lickorish-Wallace theorem Nash manifolds and Nash's questions on the existence of real algebraic models are also discussed This book will be useful as a textbook for beginning masters and doctoral students interested in differential topology who have finished a standard undergraduate mathematics curriculum It emphasizes an active learning approach and exercises are included within the text as part of the flow of ideas Experienced readers may use this book as a source of alternative constructive approaches to results commonly presented in more advanced contexts with specialized techniques **Branched Standard Spines of 3-manifolds** Riccardo Benedetti, Carlo Petronio, 2006-11-14 This book provides a unified combinatorial realization of the categories of closed oriented 3-manifolds combed 3-manifolds framed 3-manifolds and spin 3-manifolds In all four cases the objects of the realization are finite enhanced graphs and only finitely many local moves have to be taken into account These realizations are based on the notion of branched standard spine introduced in the book as a combination of the notion of branched surface with that of standard spine The book is intended for readers interested in low-dimensional topology and some familiarity with the basics is assumed A list of questions some of which concerning relations with the theory of quantum invariants is enclosed **Dynamical Zeta Functions, Nielsen Theory and Reidemeister Torsion** Alexander Fel'shtyn, Alexander Fel'shtyn, 2000 In the paper we study new dynamical zeta functions connected with Nielsen fixed point theory The study of dynamical zeta functions is part of the theory of dynamical systems but it is also intimately related to algebraic geometry number theory topology and statistical mechanics The paper consists of four parts Part I presents a brief account of the Nielsen fixed point theory Part II deals with dynamical zeta functions connected with Nielsen fixed point theory Part III is concerned with analogs of Dold congruences for the Reidemeister and Nielsen numbers In Part IV we explain

how dynamical zeta functions give rise to the Reidemeister torsion a very important topological invariant which has useful applications in knots theory quantum field theory and dynamical systems

Noncommutative Geometry and Representation Theory in Mathematical Physics Jürgen Fuchs, 2005 Mathematics provides a language in which to formulate the laws that govern nature It is a language proven to be both powerful and effective In the quest for a deeper understanding of the fundamental laws of physics one is led to theories that are increasingly difficult to put to the test In recent years many novel questions have emerged in mathematical physics particularly in quantum field theory Indeed several areas of mathematics have lately become increasingly influential in physics and in turn have become influenced by developments in physics Over the last two decades interactions between mathematicians and physicists have increased enormously and have resulted in a fruitful cross fertilization of the two communities This volume contains the plenary talks from the international symposium on Noncommutative Geometry and Representation Theory in Mathematical Physics held at Karlstad University Sweden as a satellite conference to the Fourth European Congress of Mathematics The scope of the volume is large and its content is relevant to various scientific communities interested in noncommutative geometry and representation theory It offers a comprehensive view of the state of affairs for these two branches of mathematical physics The book is suitable for graduate students and researchers interested in mathematical physics

Topology And Physics - Proceedings Of The Nankai International Conference In Memory Of Xiao-song Lin Zhengnan 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

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