QUANTUM INVARIANTS

A Study of Knots, 3-Manifolds, and Their Sets

Tomotada Ohtsuki

Quantum Invariants

P.A. Clarkson

Quantum Invariants:

Quantum Invariants: A Study Of Knots, 3-manifolds, And Their Sets Tomotada Ohtsuki,2001-12-21 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 Chern Simons field theory and the Wess Zumino Witten model are described as the physical background of the invariants

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   **An Introduction to Quantum and Vassiliev Knot Invariants** David M. Jackson,Iain Moffatt,2019-05-04 This book provides an accessible introduction to knot theory focussing on Vassiliev invariants quantum knot invariants constructed via representations of quantum groups and how these two apparently distinct theories come together through the Kontsevich invariant Consisting of four parts the book opens with an introduction to the fundamentals of knot theory and to knot invariants such as the Jones polynomial The second part introduces quantum invariants of knots working constructively from first principles towards the construction of Reshetikhin Turaev invariants and a description of how these arise through Drinfeld and Jimbo s quantum groups Its third

part offers an introduction to Vassiliev invariants providing a careful account of how chord diagrams and Jacobi diagrams arise in the theory and the role that Lie algebras play The final part of the book introduces the Konstevich invariant This is a universal quantum invariant and a universal Vassiliev invariant and brings together these two seemingly different families of knot invariants The book provides a detailed account of the construction of the Jones polynomial via the quantum groups attached to sl 2 the Vassiliev weight system arising from sl 2 and how these invariants come together through the Kontsevich invariant *Quantum Invariants of Knots and 3-manifolds* Vladimir Turaev,1994 **Introduction to Vassiliev Knot Invariants** S. Chmutov,Sergeĭ Vasilʹevich Duzhin,J. Mostovoy,2012-05-24 A detailed exposition of the theory with an emphasis on its combinatorial aspects Temperley-Lieb Recoupling Theory and Invariants of 3-Manifolds (AM-134), Volume 134 Louis H. Kauffman,Sostenes Lins,2016-03-02 This book offers a self contained account of the 3 manifold invariants arising from the original Jones polynomial These are the Witten Reshetikhin Turaev and the Turaev Viro invariants Starting from the Kauffman bracket model for the Jones polynomial and the diagrammatic Temperley Lieb algebra higher order polynomial invariants of links are constructed and combined to form the 3 manifold invariants The methods in this book are based on a recoupling theory for the Temperley Lieb algebra This recoupling theory is a q deformation of the SU 2 spin networks of Roger Penrose The recoupling theory is developed in a purely combinatorial and elementary manner Calculations are based on a reformulation of the Kirillov Reshetikhin shadow world leading to expressions for all the invariants in terms of state summations on 2 cell complexes Extensive tables of the invariants are included Manifolds in these tables are recognized by surgery presentations and by means of 3 gems graph encoded 3 manifolds in an approach pioneered by Sostenes Lins The appendices include information about gems examples of distinct manifolds with the same invariants and applications to the Turaev Viro invariant and to the Crane Yetter invariant of 4 manifolds **Encyclopedia of Knot Theory** Colin Adams,Erica Flapan,Allison Henrich,Louis H. Kauffman,Lewis D. Ludwig,Sam Nelson,2021-02-10 Knot theory is a fascinating mathematical subject with multiple links to theoretical physics This enyclopedia is filled with valuable information on a rich and fascinating subject Ed Witten Recipient of the Fields Medal I spent a pleasant afternoon perusing the Encyclopedia of Knot Theory It s a comprehensive compilation of clear introductions to both classical and very modern developments in the field It will be a terrific resource for the accomplished researcher and will also be an excellent way to lure students both graduate and undergraduate into the field Abigail Thompson Distinguished Professor of Mathematics at University of California Davis Knot theory has proven to be a fascinating area of mathematical research dating back about 150 years Encyclopedia of Knot Theory provides short interconnected articles on a variety of active areas in knot theory and includes beautiful pictures deep mathematical connections and critical applications Many of the articles in this book are accessible to undergraduates who are working on research or taking an advanced undergraduate course in knot theory More advanced articles will be useful to graduate students working on a related thesis topic to researchers in another area of

topology who are interested in current results in knot theory and to scientists who study the topology and geometry of biopolymers Features Provides material that is useful and accessible to undergraduates postgraduates and full time researchers Topics discussed provide an excellent catalyst for students to explore meaningful research and gain confidence and commitment to pursuing advanced degrees Edited and contributed by top researchers in the field of knot theory

One-cocycles And Knot Invariants Thomas Fiedler,2023-01-04 One Cocycles and Knot Invariants is about classical knots i e smooth oriented knots in 3 space It introduces discrete combinatorial analysis in knot theory in order to solve a global tetrahedron equation This new technique is then used to construct combinatorial 1 cocycles in a certain moduli space of knot diagrams The construction of the moduli space makes use of the meridian and the longitude of the knot The combinatorial 1 cocycles are therefore lifts of the well known Conway polynomial of knots and they can be calculated in polynomial time The 1 cocycles can distinguish loops consisting of knot diagrams in the moduli space up to homology They give knot invariants when they are evaluated on canonical loops in the connected components of the moduli space They are a first candidate for numerical knot invariants which can perhaps distinguish the orientation of knots **Intelligence of Low Dimensional Topology 2006** J. Scott Carter,2007 This volume gathers the contributions from the international conference Intelligence of Low Dimensional Topology 2006 which took place in Hiroshima in 2006 The aim of this volume is to promote research in low dimensional topology with the focus on knot theory and related topics The papers include comprehensive reviews and some latest results **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 **Knots And Physics (Third Edition)** Louis H Kauffman,2001-07-26 This invaluable book is an introduction to knot and link invariants as generalised amplitudes for a quasi physical process The demands of knot theory coupled with a quantum statistical framework create a context that naturally and powerfully includes an extraordinary range of interrelated topics in topology and mathematical physics The author takes a primarily combinatorial stance toward knot theory and its relations with these subjects This stance has the advantage of providing direct access to the algebra and to the combinatorial topology as well as physical ideas The book is divided into two parts Part I is a systematic course on knots and physics starting from the ground up and Part II is a set of lectures on various topics related to Part I Part II includes topics such as frictional

properties of knots relations with combinatorics and knots in dynamical systems In this third edition a paper by the author entitled Knot Theory and Functional Integration has been added This paper shows how the Kontsevich integral approach to the Vassiliev invariants is directly related to the perturbative expansion of Witten s functional integral While the book supplies the background this paper can be read independently as an introduction to quantum field theory and knot invariants and their relation to quantum gravity As in the second edition there is a selection of papers by the author at the end of the book Numerous clarifying remarks have been added to the text   Knots And Physics (Second Edition) Louis H Kauffman,1994-01-15 In this second edition the following recent papers have been added Gauss Codes Quantum Groups and Ribbon Hopf Algebras Spin Networks Topology and Discrete Physics Link Polynomials and a Graphical Calculus and Knots Tangles and Electrical Networks An appendix with a discussion on invariants of embedded graphs and Vassiliev invariants has also been included This book is an introduction to knot and link invariants as generalized amplitudes vacuum vacuum amplitudes for a quasi physical process The demands of knot theory coupled with a quantum statistical framework create a context that naturally and powerfully includes an extraordinary range of interrelated topics in topology and mathematical physics The author takes a primarily combinatorial stance toward knot theory and its relations with these subjects This has the advantage of providing very direct access to the algebra and to the combinatorial topology as well as the physical ideas This book is divided into 2 parts Part I of the book is a systematic course in knots and physics starting from the ground up Part II is a set of lectures on various topics related to and sometimes based on Part I Part II also explores some side topics such as frictional properties of knots relations with combinatorics and knots in dynamical systems   *Knots And Physics (Fourth Edition)* Louis H Kauffman,2012-11-09 This invaluable book is an introduction to knot and link invariants as generalized amplitudes for a quasi physical process The demands of knot theory coupled with a quantum statistical framework create a context that naturally and powerfully includes an extraordinary range of interrelated topics in topology and mathematical physics The author takes a primarily combinatorial stance toward knot theory and its relations with these subjects This stance has the advantage of providing direct access to the algebra and to the combinatorial topology as well as physical ideas The book is divided into two parts Part I is a systematic course on knots and physics starting from the ground up and Part II is a set of lectures on various topics related to Part I Part II includes topics such as frictional properties of knots relations with combinatorics and knots in dynamical systems In this new edition an article on Virtual Knot Theory and Khovanov Homology has beed added   **New Ideas In Low Dimensional Topology** Vassily Olegovich Manturov,Louis H Kauffman,2015-01-27 This book consists of a selection of articles devoted to new ideas and developments in low dimensional topology Low dimensions refer to dimensions three and four for the topology of manifolds and their submanifolds Thus we have papers related to both manifolds and to knotted submanifolds of dimension one in three classical knot theory and two in four surfaces in four dimensional spaces Some of the work involves virtual knot theory where the knots are abstractions of

classical knots but can be represented by knots embedded in surfaces This leads both to new interactions with classical topology and to new interactions with essential combinatorics **The Mathematics of Knots** Markus Banagl,Denis Vogel,2010-11-25 The present volume grew out of the Heidelberg Knot Theory Semester organized by the editors in winter 2008 09 at Heidelberg University The contributed papers bring the reader up to date on the currently most actively pursued areas of mathematical knot theory and its applications in mathematical physics and cell biology Both original research and survey articles are presented numerous illustrations support the text The book will be of great interest to researchers in topology geometry and mathematical physics graduate students specializing in knot theory and cell biologists interested in the topology of DNA strands *Applications of Analytic and Geometric Methods to Nonlinear Differential Equations* P.A. Clarkson,2012-12-06 In the study of integrable systems two different approaches in particular have attracted considerable attention during the past twenty years 1 The inverse scattering transform IST using complex function theory which has been employed to solve many physically significant equations the soliton equations 2 Twistor theory using differential geometry which has been used to solve the self dual Yang Mills SDYM equations a four dimensional system having important applications in mathematical physics Both soliton and the SDYM equations have rich algebraic structures which have been extensively studied Recently it has been conjectured that in some sense all soliton equations arise as special cases of the SDYM equations subsequently many have been discovered as either exact or asymptotic reductions of the SDYM equations Consequently what seems to be emerging is that a natural physically significant system such as the SDYM equations provides the basis for a unifying framework underlying this class of integrable systems i e soliton systems This book contains several articles on the reduction of the SDYM equations to soliton equations and the relationship between the IST and twistor methods The majority of nonlinear evolution equations are nonintegrable and so asymptotic numerical perturbation and reduction techniques are often used to study such equations This book also contains articles on perturbed soliton equations Painlev analysis of partial differential equations studies of the Painlev equations and symmetry reductions of nonlinear partial differential equations ABSTRACT In the study of integrable systems two different approaches in particular have attracted considerable attention during the past twenty years the inverse scattering transform IST for soliton equations and twistor theory for the self dual Yang Mills SDYM equations This book contains severalarticles on the reduction of the SDYM equations to soliton equations and the relationship between the IST and twistor methods Additionally it contains articles on perturbed soliton equations Painlev analysis of partial differential equations studies of the Painlev equations and symmetry reductions of nonlinear partial differential equations *Topology and Geometry of Manifolds* Gordana Matic,Clint McCrory,2003 Since 1961 the Georgia Topology Conference has been held every eight years to discuss the newest developments in topology The goals of the conference are to disseminate new and important results and to encourage interaction among topologists who are in different stages of their careers Invited speakers are encouraged to aim their talks

to a broad audience and several talks are organized to introduce graduate students to topics of current interest Each conference results in high quality surveys new research and lists of unsolved problems some of which are then formally published Continuing in this 40 year tradition the AMS presents this volume of articles and problem lists from the 2001 conference Topics covered include symplectic and contact topology foliations and laminations and invariants of manifolds and knots Articles of particular interest include John Etnyre s Introductory Lectures on Contact Geometry which is a beautiful expository paper that explains the background and setting for many of the other papers This is an excellent introduction to the subject for graduate students in neighboring fields Etnyre and Lenhard Ng s Problems in Low Dimensional Contact Topology and Danny Calegari s extensive paper Problems in Foliations and Laminations of 3 Manifolds are carefully selected problems in keeping with the tradition of the conference They were compiled by Etnyre and Ng and by Calegari with the input of many who were present This book provides material of current interest to graduate students and research mathematicians interested in the geometry and topology of manifolds   Advances in Two-Dimensional Homotopy and Combinatorial Group Theory Wolfgang Metzler,Stephan Rosebrock,2018 Presents the current state of knowledge in all aspects of two dimensional homotopy theory Useful for both students and experts   **Singularities** Vladimir I. Arnold,Gert-Martin Greuel,Joseph H.M. Steenbrink,2012-12-06 In July 1996 a conference was organized by the editors of this volume at the Mathematische Forschungsinstitut Oberwolfach to honour Egbert Brieskorn on the occasion of his 60th birthday Most of the mathematicians invited to the conference have been influenced in one way or another by Brieskorn s work in singularity theory It was the first time that so many people from the Russian school could be present at a conference in singularity theory outside Russia This volume contains papers on singularity theory and its applications written by participants of the conference In many cases they are extended versions of the talks presented there The diversity of subjects of the contributions reflects singularity theory s relevance to topology analysis and geometry combining ideas and techniques from all of these fields as well as demonstrating the breadth of Brieskorn s own interests This volume contains papers on singularity theory and its applications written by participants of the conference In many cases they are extended versions of the talks presented there The diversity of subjects of the contributions reflects singularity theory s relevance to topology analysis and geometry combining ideas and techniques from all of these fields as well as demonstrates the breadth of Brieskorn s own interests   **Symmetries and Integrability of Difference Equations** Decio Levi,Luc Vinet,Pavel Winternitz,

The Enigmatic Realm of **Quantum Invariants**: Unleashing the Language is Inner Magic

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