



# Low-Dimensional Topology and Quantum Field Theory

Edited by  
Hugh Osborn

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# Low Dimensional Topology And Quantum Field Theory

**Canadian Mathematical Society.  
Summer Meeting**



## **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 interdisciplinary successes invariably cause much rejoicing as over a prodigal son returned In recent years the framework provided by quantum field theory and functional integrals 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 support 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 speakers 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** 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 **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

**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

**Topology and Physics** Zhengnan 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

**Differential and Low-Dimensional Topology** András Juhász,2023-04-20 A concise introduction to the most important parts of differential and low dimensional topology for incoming graduate students

**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

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 *Knots, Low-Dimensional Topology and Applications* Colin C. Adams, Cameron McA. Gordon, Vaughan F.R. Jones, Louis H. Kauffman, Sofia Lambropoulou, Kenneth C. Millett, Jozef H. Przytycki, Renzo Ricca, Radmila Sazdanovic, 2019-06-26 This proceedings volume presents a diverse collection of high quality state of the art research and survey articles written by top experts in low dimensional topology and its applications The focal topics include the wide range of historical and contemporary invariants of knots and links and related topics such as three and four dimensional manifolds braids virtual knot theory quantum invariants braids skein modules and knot algebras link homology quandles and their homology hyperbolic knots and geometric structures of three dimensional manifolds the mechanism of topological surgery in physical processes knots in Nature in the sense of physical knots with applications to polymers DNA enzyme mechanisms and protein structure and function The contents is based on contributions presented at the International Conference on Knots Low Dimensional Topology and Applications Knots in Hellas 2016 which was held at the International Olympic Academy in Greece in July 2016 The goal of the international conference was to promote the exchange of methods and ideas across disciplines and generations from graduate students to senior researchers and to explore fundamental research problems in the broad fields of knot theory and low dimensional topology This book will benefit all researchers who wish to take their research in new directions to learn about new tools and methods and to discover relevant and recent literature for future study

*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 **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 **Let Us Use White Noise** Takeyuki Hida, Ludwig Streit, 2017-03-10 Why should we use white noise analysis Well one reason of course is that it fills that earlier gap in the tool kit As Hida would put it

white noise provides us with a useful set of independent coordinates parametrized by time And there is a feature which makes white noise analysis extremely user friendly Typically the physicist and not only he sits there with some heuristic ansatz like e g the famous Feynman integral wondering whether and how this might make sense mathematically In many cases the characterization theorem of white noise analysis provides the user with a sweet and easy answer Feynman s integral can now be understood the It s all in the vacuum ansatz of Haag and Coester is now making sense via Dirichlet forms and so on in many fields of application There is mathematical finance there have been applications in biology and engineering many more than we could collect in the present volume Finally there is one extra benefit when we internalize the structures of Gaussian white noise analysis we will be ready to meet another close relative We will enjoy the important similarities and differences which we encounter in the Poisson case championed in particular by Y Kondratiev and his group Let us look forward to a companion volume on the uses of Poisson white noise The present volume is more than a collection of autonomous contributions The introductory chapter on white noise analysis was made available to the other authors early on for reference and to facilitate conceptual and notational coherence in their work

**Floer Homology, Gauge Theory, and Low-Dimensional Topology** Clay Mathematics Institute. Summer School, 2006 Mathematical gauge theory studies connections on principal bundles or more precisely the solution spaces of certain partial differential equations for such connections Historically these equations have come from mathematical physics and play an important role in the description of the electro weak and strong nuclear forces The use of gauge theory as a tool for studying topological properties of four manifolds was pioneered by the fundamental work of Simon Donaldson in the early 1980s and was revolutionized by the introduction of the Seiberg Witten equations in the mid 1990s Since the birth of the subject it has retained its close connection with symplectic topology The analogy between these two fields of study was further underscored by Andreas Floer s construction of an infinite dimensional variant of Morse theory that applies in two a priori different contexts either to define symplectic invariants for pairs of Lagrangian submanifolds of a symplectic manifold or to define topological invariants for three manifolds which fit into a framework for calculating invariants for smooth four manifolds Heegaard Floer homology the recently discovered invariant for three and four manifolds comes from an application of Lagrangian Floer homology to spaces associated to Heegaard diagrams Although this theory is conjecturally isomorphic to Seiberg Witten theory it is more topological and combinatorial in flavor and thus easier to work with in certain contexts The interaction between gauge theory low dimensional topology and symplectic geometry has led to a number of striking new developments in these fields The aim of this volume is to introduce graduate students and researchers in other fields to some of these exciting developments with a special emphasis on the very fruitful interplay between disciplines This volume is based on lecture courses and advanced seminars given at the 2004 Clay Mathematics Institute Summer School at the Alfred Renyi Institute of Mathematics in Budapest Hungary Several of the authors have added a considerable amount of additional material to that presented at the

school and the resulting volume provides a state of the art introduction to current research covering material from Heegaard Floer homology contact geometry smooth four manifold topology and symplectic four manifolds

**Advances in Non-Archimedean Analysis and Applications** W. A. Zúñiga-Galindo, Bourama Toni, 2021-12-02 This book provides a broad interdisciplinary overview of non Archimedean analysis and its applications Featuring new techniques developed by leading experts in the field it highlights the relevance and depth of this important area of mathematics in particular its expanding reach into the physical biological social and computational sciences as well as engineering and technology In the last forty years the connections between non Archimedean mathematics and disciplines such as physics biology economics and engineering have received considerable attention Ultrametric spaces appear naturally in models where hierarchy plays a central role a phenomenon known as ultrametricity In the 80s the idea of using ultrametric spaces to describe the states of complex systems with a natural hierarchical structure emerged in the works of Fraunfelder Parisi Stein and others A central paradigm in the physics of certain complex systems for instance proteins asserts that the dynamics of such a system can be modeled as a random walk on the energy landscape of the system To construct mathematical models the energy landscape is approximated by an ultrametric space a finite rooted tree and then the dynamics of the system is modeled as a random walk on the leaves of a finite tree In the same decade Volovich proposed using ultrametric spaces in physical models dealing with very short distances This conjecture has led to a large body of research in quantum field theory and string theory In economics the non Archimedean utility theory uses probability measures with values in ordered non Archimedean fields Ultrametric spaces are also vital in classification and clustering techniques Currently researchers are actively investigating the following areas  $p$  adic dynamical systems  $p$  adic techniques in cryptography  $p$  adic reaction diffusion equations and biological models  $p$  adic models in geophysics stochastic processes in ultrametric spaces applications of ultrametric spaces in data processing and more This contributed volume gathers the latest theoretical developments as well as state of the art applications of non Archimedean analysis It covers non Archimedean and non commutative geometry renormalization  $p$  adic quantum field theory and  $p$  adic quantum mechanics as well as  $p$  adic string theory and  $p$  adic dynamics Further topics include ultrametric bioinformation cryptography and bioinformatics in  $p$  adic settings non Archimedean spacetime gravity and cosmology  $p$  adic methods in spin glasses and non Archimedean analysis of mental spaces By doing so it highlights new avenues of research in the mathematical sciences biosciences and computational sciences

**A Survey of Knot Theory** Akio Kawauchi, 2012-12-06 Knot theory is a rapidly developing field of research with many applications not only for mathematics The present volume written by a well known specialist gives a complete survey of knot theory from its very beginnings to today s most recent research results The topics include Alexander polynomials Jones type polynomials and Vassiliev invariants With its appendix containing many useful tables and an extended list of references with over 3 500 entries it is an indispensable book for everyone concerned with knot theory The book can serve as an introduction to the field for advanced

undergraduate and graduate students Also researchers working in outside areas such as theoretical physics or molecular biology will benefit from this thorough study which is complemented by many exercises and examples

**Differential Geometry, Global Analysis, and Topology** Canadian Mathematical Society. Summer Meeting, 1992 This book contains the proceedings of a special session on differential geometry global analysis and topology held during the Summer Meeting of the Canadian Mathematical Society in June 1990 at Dalhousie University in Halifax The session featured many fascinating talks on topics of current interest The articles collected here reflect the diverse interests of the participants but are united by the common theme of the interplay among geometry global analysis and topology Some of the topics include applications to low dimensional manifolds control theory integrable systems Lie algebras of operators and algebraic geometry Readers will appreciate the insight the book provides into some recent trends in these areas

Modern Nonlinear Optics, Volume 119, Part 2 Myron W. Evans, 2001-09-24 The new edition will provide the sole comprehensive resource available for non linear optics including detailed descriptions of the advances over the last decade from world renowned experts

**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 quantum 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



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