

Grid Homology for Knots and Links

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American Mathematical Society

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**Mikhail Khovanov, Joshua
Sussan, Anton Zeitlin**



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Grid Homology for Knots and Links Peter S. Ozsváth, András I. Stipsicz, Zoltán Szabó, 2015-12-04 Knot theory is a classical area of low dimensional topology directly connected with the theory of three manifolds and smooth four manifold topology In recent years the subject has undergone transformative changes thanks to its connections with a number of other mathematical disciplines including gauge theory representation theory and categorification contact geometry and the theory of pseudo holomorphic curves Starting from the combinatorial point of view on knots using their grid diagrams this book serves as an introduction to knot theory specifically as it relates to some of the above developments After a brief overview of the background material in the subject the book gives a self contained treatment of knot Floer homology from the point of view of grid diagrams Applications include computations of the unknotting number and slice genus of torus knots asked first in the 1960s and settled in the 1990s and tools to study variants of knot theory in the presence of a contact structure Additional topics are presented to prepare readers for further study in holomorphic methods in low dimensional topology especially Heegaard Floer homology The book could serve as a textbook for an advanced undergraduate or part of a graduate course in knot theory Standard background material is sketched in the text and the appendices Singularities and Low Dimensional Topology Javier Fernández de Bobadilla, Marco Marengon, András Némethi, András Stipsicz, 2024-10-09 The special semester Singularities and low dimensional topology in the Spring of 2023 at the Erdős Center Budapest brought together algebraic geometers and topologists to discuss and explore the strong connection between surface singularities and topological properties of three and four dimensional manifolds The semester featured a Winter School with four lecture series and several focused weeks This volume contains the notes of the lecture series of the Winter School and some of the lecture notes from the focused weeks Topics covered in this collection range from algebraic geometry of complex curves lattice homology of curve and surface singularities to novel results in smooth four dimensional topology and grid homology and to Seiberg Witten homotopy theory and spacification of knot invariants Some of these topics are already well documented in the literature and the lectures aim to provide a new perspective and fresh connections Other topics are rather new and have been covered only in research papers We hope that this volume will be useful not only for advanced graduate students and early stage researchers but also for the more experienced geometers and topologists who want to be informed about the latest developments in the field 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 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 encyclopedia 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 **Frontiers in Geometry and Topology** Paul M. N. Feehan, Lenhard L. Ng, Peter S.

Ozsváth, 2024-07-19 This volume contains the proceedings of the summer school and research conference Frontiers in Geometry and Topology celebrating the sixtieth birthday of Tomasz Mrowka which was held from August 1-12 2022 at the Abdus Salam International Centre for Theoretical Physics ICTP The summer school featured ten lecturers and the research conference featured twenty three speakers covering a range of topics A common thread reflecting Mrowka's own work was the rich interplay among the fields of analysis geometry and topology Articles in this volume cover topics including knot theory the topology of three and four dimensional manifolds instanton monopole and Heegaard Floer homologies Khovanov homology and pseudoholomorphic curve theory **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 *Seeing Four-dimensional Space And Beyond: Using Knots!* Eiji Ogasa, 2023-07-21 According to string theory our universe exists in a 10 or 11 dimensional space However the idea the space beyond 3 dimensions seems hard to grasp for beginners This book presents a way to understand four dimensional space and beyond with knots Beginners can see high dimensional space although they have not seen it With visual illustrations we present the manipulation of figures in high dimensional space examples of which are high dimensional knots and n spheres embedded in the $n+2$ sphere and generalize results on relations between local moves and knot invariants into high dimensional space Local moves on knots circles embedded in the 3 space are very important to research in knot theory It is well known that crossing changes are connected with the Alexander polynomial the Jones polynomial HOMFLYPT polynomial Khovanov homology Floer homology Khovanov homotopy type etc We show several results on relations between local moves on high dimensional knots and their invariants The following related topics are also introduced projections of knots knot products slice knots and slice links an open question can the Jones polynomial be defined for links in all 3 manifolds and Khovanov Lipshitz Sarkar stable homotopy type Slice knots exist in the 3 space but are much related to the 4 dimensional space The slice problem is connected with many exciting topics Khovanov homology Khovanov Lipshitz Sarkar stable homotopy type gauge theory Floer homology etc Among them the Khovanov Lipshitz Sarkar stable homotopy type is one of the exciting new areas it is defined for links in the 3 sphere but it is a high dimensional CW complex in general Much of the book will be accessible to freshmen and sophomores with some basic knowledge of topology [From Representation Theory to Mathematical Physics and Back](#) Mikhail Khovanov, Joshua Sussan, Anton Zeitlin, 2025-05-14 This volume is a proceedings of a workshop at the Simons Center for Geometry and Physics from May 31 June 4 2022 The workshop highlighted progress in the areas of vertex operator algebras conformal field theory categorification low dimensional topology and representation theory of affine Lie algebras loop groups and quantum groups In the past 40 years string theory gave rise to the mathematical theory of vertex operator algebras which led to the construction of representations of affine Lie algebras and the Moonshine module of the Monster group These mathematical constructions have in turn led to ideas about 3 dimensional quantum gravity In another direction the discovery of the Jones polynomial led to a physical construction of 3 dimensional topological quantum field theories TQFTs which in turn advanced many mathematical developments in quantum groups and low dimensional topology Louis Crane and Igor Frenkel introduced the categorification program with the goal of upgrading 3 dimensional TQFTs coming from representation theory of quantum groups to 4 dimensional TQFTs This idea gave rise to the development of link homologies constructed from representation theoretic algebraic geometric combinatorial and physical structures Articles in this volume present both classical and new results related to these topics They will be

interesting to researchers and graduate students working in mathematical aspects of modern quantum field theory 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

Quandles and Topological Pairs Takefumi Nosaka, 2017-11-20 This book surveys quandle theory starting from basic motivations and going on to introduce recent developments of quandles with topological applications and related topics The book is written from topological aspects but it illustrates how esteemed quandle theory is in mathematics and it constitutes a crash course for studying quandles More precisely this work emphasizes the fresh perspective that quandle theory can be useful for the study of low dimensional topology e g knot theory and relative objects with symmetry The direction of research is summarized as We shall thoroughly re interpret the previous studies of relative symmetry in terms of the quandle The perspectives contained herein can be summarized by the following topics The first is on relative objects G/H where G and H are groups e g polyhedrons reflection and symmetric spaces Next central extensions of groups are discussed e g spin structures $K2$ groups and some geometric anomalies The third topic is a method to study relative information on a 3 dimensional manifold with a boundary e g knot theory relative cup products and relative group cohomology For applications in topology it is shown that from the perspective that some existing results in topology can be recovered from some quandles a method is provided to diagrammatically compute some relative homology Such classes since have been considered to be uncomputable and speculative Furthermore the book provides a perspective that unifies some previous studies of quandles The former part of the book explains motivations for studying quandles and discusses basic properties of quandles The latter focuses on low dimensional topology or knot theory Finally problems and possibilities for future developments of quandle theory are posed

Differential and Symplectic Topology of Knots and Curves Serge Tabachnikov, 1999 This book presents a collection of papers on two related topics topology of knots and knot like objects such as curves on surfaces and topology of Legendrian knots and links in 3 dimensional contact manifolds Featured is the work of international experts in knot theory quantum knot invariants knot invariants of finite type in symplectic and contact topology and in singularity theory The interplay of diverse methods from these fields makes this volume unique in the study of Legendrian knots and knot like objects such as wave fronts A particularly enticing feature of the volume is its international significance The volume successfully embodies a fine collaborative effort by worldwide experts from Belgium France Germany Israel Japan Poland

Russia Sweden the U K and the U S *Perspectives in Analysis, Geometry, and Topology* Ilia Itenberg, Burglind Jöricke, Mikael Passare, 2011-12-14 The articles in this volume are invited papers from the Marcus Wallenberg symposium and focus on research topics that bridge the gap between analysis geometry and topology The encounters between these three fields are widespread and often provide impetus for major breakthroughs in applications Topics include new developments in low dimensional topology related to invariants of links and three and four manifolds Perelman's spectacular proof of the Poincare conjecture and the recent advances made in algebraic complex symplectic and tropical geometry

Handbook of Knot Theory William Menasco, Morwen Thistlethwaite, 2005-08-02 This book is a survey of current topics in the mathematical theory of knots For a mathematician a knot is a closed loop in 3 dimensional space imagine knotting an extension cord and then closing it up by inserting its plug into its outlet Knot theory is of central importance in pure and applied mathematics as it stands at a crossroads of topology combinatorics algebra mathematical physics and biochemistry Survey of mathematical knot theory Articles by leading world authorities Clear exposition not over technical Accessible to readers with undergraduate background in mathematics 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 *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

Knot Theory Vassily Olegovich Manturov, 2018-04-17 Over the last fifteen years the face of knot theory has changed due to various new theories and invariants coming from physics topology combinatorics and algebra It suffices to mention the great progress in knot homology theory Khovanov homology and Ozsvath Szabo Heegaard Floer homology the A polynomial which give rise to strong invariants of knots and 3 manifolds in particular many new unknot detectors New to this Edition is a discussion of Heegaard Floer homology theory and A polynomial of classical links as well as updates throughout

the text Knot Theory Second Edition is notable not only for its expert presentation of knot theory's state of the art but also for its accessibility. It is valuable as a professional reference and will serve equally well as a text for a course on knot theory.

Knot Theory and Its Applications Krishnendu Gongopadhyay, Rama Mishra, 2016-09-21 This volume contains the proceedings of the ICTS program Knot Theory and Its Applications KTH 2013 held from December 10-20, 2013 at IISER Mohali, India. The meeting focused on the broad area of knot theory and its interaction with other disciplines of theoretical science. The program was divided into two parts. The first part was a week-long advanced school which consisted of minicourses. The second part was a discussion meeting that was meant to connect the school to the modern research areas. This volume consists of lecture notes on the topics of the advanced school as well as surveys and research papers on current topics that connect the lecture notes with cutting edge research in the broad area of knot theory. **Geometry and**

Topology of Manifolds Hans U. Boden, 2005 This book contains expository papers that give an up-to-date account of recent developments and open problems in the geometry and topology of manifolds along with several research articles that present new results appearing in published form for the first time. The unifying theme is the problem of understanding manifolds in low dimensions, notably in dimensions three and four, and the techniques include algebraic topology, surgery theory, Donaldson and Seiberg-Witten gauge theory, Heegaard Floer homology, contact and symplectic geometry, and Gromov-Witten invariants. The articles collected for this volume were contributed by participants of the Conference Geometry and Topology of Manifolds held at McMaster University on May 14-18, 2004 and are representative of the many excellent talks delivered at the conference. **In the Tradition of Thurston** Ken'ichi Ohshika, Athanasios Papadopoulos, 2020-12-07 This book consists of

16 surveys on Thurston's work and its later development. The authors are mathematicians who were strongly influenced by Thurston's publications and ideas. The subjects discussed include, among others, knot theory, the topology of 3-manifolds, circle packings, complex projective structures, hyperbolic geometry, Kleinian groups, foliations, mapping class groups, Teichmüller theory, anti-de Sitter geometry, and co-Minkowski geometry. The book is addressed to researchers and students who want to learn about Thurston's wide-ranging mathematical ideas and their impact. At the same time, it is a tribute to Thurston, one of the greatest geometers of all time, whose work extended over many fields in mathematics and who had a unique way of perceiving forms and patterns and of communicating and writing mathematics. Surveys on Surgery Theory Sylvain E.

Cappell, Charles Terence Clegg Wall, Andrew Ranicki, Jonathan Rosenberg, 2000-01-10 Surgery theory, the basis for the classification theory of manifolds, is now about forty years old. There have been some extraordinary accomplishments in that time which have led to enormously varied interactions with algebra, analysis, and geometry. Workers in many of these areas have often lamented the lack of a single source that surveys surgery theory and its applications. Indeed, no one person could write such a survey. The sixtieth birthday of C. T. C. Wall, one of the leaders of the founding generation of surgery theory, provided an opportunity to rectify the situation and produce a comprehensive book on the subject. Experts have written state-

of the art reports that will be of broad interest to all those interested in topology not only graduate students and mathematicians but mathematical physicists as well Contributors include J Milnor S Novikov W Browder T Lance E Brown M Kreck J Klein M Davis J Davis I Hambleton L Taylor C Stark E Pedersen W Mio J Levine K Orr J Roe J Milgram and C Thomas

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