Vladimir Turaev

Introduction to Combinatorial Torsions

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Alfredo Lorenzi,Bernhard Ruf

Introduction To Combinatorial Torsions:

Introduction to Combinatorial Torsions Vladimir Turaev,2001-01-01 This book is an introduction to combinatorial torsions of cellular spaces and manifolds with special emphasis on torsions of 3 dimensional manifolds The first two chapters cover algebraic foundations of the theory of torsions and various topological constructions of torsions due to K Reidemeister J H C Whitehead J Milnor and the author We also discuss connections between the torsions and the Alexander polynomials of links and 3 manifolds The third and last chapter of the book deals with so called refined torsions and the related additional structures on manifolds specifically homological orientations and Euler structures As an application we give a construction of the multivariable Conway polynomial of links in homology 3 spheres At the end of the book we briefly describe the recent results of G Meng C H Taubes and the author on the connections between the refined torsions and the Seiberg Witten invariant of 3 manifolds The exposition is aimed at students professional mathematicians and physicists interested in combinatorial aspects of topology and or in low dimensional topology The necessary background for the reader includes the elementary basics of topology and homological algebra   **Introduction to Combinatorial Torsions** Vladimir Turaev,2001-01-01   **Introduction to Combinatorial Torsions** Vladimir Turaev,2012-12-06 This book is an introduction to combinatorial torsions of cellular spaces and manifolds with special emphasis on torsions of 3 dimensional manifolds The first two chapters cover algebraic foundations of the theory of torsions and various topological constructions of torsions due to K Reidemeister J H C Whitehead J Milnor and the author We also discuss connections between the torsions and the Alexander polynomials of links and 3 manifolds The third and last chapter of the book deals with so called refined torsions and the related additional structures on manifolds specifically homological orientations and Euler structures As an application we give a construction of the multivariable Conway polynomial of links in homology 3 spheres At the end of the book we briefly describe the recent results of G Meng C H Taubes and the author on the connections between the refined torsions and the Seiberg Witten invariant of 3 manifolds The exposition is aimed at students professional mathematicians and physicists interested in combinatorial aspects of topology and or in low dimensional topology The necessary background for the reader includes the elementary basics of topology and homological algebra   Introduction to Combinatorial Torsions Vladimir Turaev (Mathematkier),Felix Schlenk,2000   *Torsions of 3-dimensional Manifolds* Vladimir Turaev,2012-12-06 Three dimensional topology includes two vast domains the study of geometric structures on 3 manifolds and the study of topological invariants of 3 manifolds knots etc This book belongs to the second domain We shall study an invariant called the maximal abelian torsion and denoted T It is defined for a compact smooth or piecewise linear manifold of any dimension and more generally for an arbitrary finite CW complex X The torsion T X is an element of a certain extension of the group ring Z Hl X The torsion T can be naturally considered in the framework of simple homotopy theory In particular it is invariant under simple homotopy equivalences and can distinguish homotopy equivalent but non homeomorphic CW spaces and manifolds for

instance lens spaces The torsion T can be used also to distinguish orientations and so called Euler structures Our interest in the torsion T is due to a particular role which it plays in three dimensional topology First of all it is intimately related to a number of fundamental topological invariants of 3 manifolds The torsion T M of a closed oriented 3 manifold M dominates determines the first elementary ideal of 7fl M and the Alexander polynomial of 7fl M The torsion T M is closely related to the cohomology rings of M with coefficients in Z and ZjrZ r 2 It is also related to the linking form on Tors Hi M to the Massey products in the cohomology of M and to the Thurston norm on H2 M *The Reidemeister Torsion of 3-Manifolds* Liviu I. Nicolaescu,2008-08-22 This is a state of the art introduction to the work of Franz Reidemeister Meng Taubes Turaev and the author on the concept of torsion and its generalizations Torsion is the oldest topological but not with respect to homotopy invariant that in its almost eight decades of existence has been at the center of many important and surprising discoveries During the past decade in the work of Vladimir Turaev new points of view have emerged which turned out to be the right ones as far as gauge theory is concerned The book features mostly the new aspects of this venerable concept The theoretical foundations of this subject are presented in a style accessible to those who wish to learn and understand the main ideas of the theory Particular emphasis is upon the many and rather diverse concrete examples and techniques which capture the subleties of the theory better than any abstract general result Many of these examples and techniques never appeared in print before and their choice is often justified by ongoing current research on the topology of surface singularities The text is addressed to mathematicians with geometric interests who want to become comfortable users of this versatile invariant

Introduction to the Baum-Connes Conjecture Alain Valette,2002-04-01 The Baum Connes conjecture is part of A Connes non commutative geometry programme It can be viewed as a conjectural generalisation of the Atiyah Singer index theorem to the equivariant setting the ambient manifold is not compact but some compactness is restored by means of a proper co compact action of a group gamma Like the Atiyah Singer theorem the Baum Connes conjecture states that a purely topological object coincides with a purely analytical one For a given group gamma the topological object is the equivariant K homology of the classifying space for proper actions of gamma while the analytical object is the K theory of the C algebra associated with gamma in its regular representation The Baum Connes conjecture implies several other classical conjectures ranging from differential topology to pure algebra It has also strong connections with geometric group theory as the proof of the conjecture for a given group gamma usually depends heavily on geometric properties of gamma This book is intended for graduate students and researchers in geometry commutative or not group theory algebraic topology harmonic analysis and operator algebras It presents for the first time in book form an introduction to the Baum Connes conjecture It starts by defining carefully the objects in both sides of the conjecture then the assembly map which connects them Thereafter it illustrates the main tool to attack the conjecture Kasparov s theory and it concludes with a rough sketch of V Lafforgue s proof of the conjecture for co compact lattices in in Spn1 SL 3R and SL 3C **Organized Collapse: An Introduction to**

Discrete Morse Theory Dmitry N. Kozlov,2021-02-18 Applied topology is a modern subject which emerged in recent years at a crossroads of many methods all of them topological in nature which were used in a wide variety of applications in classical mathematics and beyond Within applied topology discrete Morse theory came into light as one of the main tools to understand cell complexes arising in different contexts as well as to reduce the complexity of homology calculations The present book provides a gentle introduction into this beautiful theory Using a combinatorial approach the author emphasizes acyclic matchings as the central object of study The first two parts of the book can be used as a stand alone introduction to homology the last two parts delve into the core of discrete Morse theory The presentation is broad ranging from abstract topics such as formulation of the entire theory using poset maps with small fibers to heavily computational aspects providing for example a specific algorithm of finding an explicit homology basis starting from an acyclic matching The book will be appreciated by graduate students in applied topology students and specialists in computer science and engineering as well as research mathematicians interested in learning about the subject and applying it in context of their fields *Chern-Simons Gauge Theory: 20 Years After* Jørgen E. Andersen,Jørgen Ellegaard Andersen,2011 In 1989 Edward Witten discovered a deep relationship between quantum field theory and knot theory and this beautiful discovery created a new field of research called Chern Simons theory This field has the remarkable feature of intertwining a large number of diverse branches of research in mathematics and physics among them low dimensional topology differential geometry quantum algebra functional and stochastic analysis quantum gravity and string theory The 20 year anniversary of Witten s discovery provided an opportunity to bring together researchers working in Chern Simons theory for a meeting and the resulting conference which took place during the summer of 2009 at the Max Planck Institute for Mathematics in Bonn included many of the leading experts in the field This volume documents the activities of the conference and presents several original research articles including another monumental paper by Witten that is sure to stimulate further activity in this and related fields This collection will provide an excellent overview of the current research directions and recent progress in Chern Simons gauge theory **In the Tradition of Thurston II** Ken'ichi Ohshika,Athanase Papadopoulos,2022-08-02 The purpose of this volume and of the other volumes in the same series is to provide a collection of surveys that allows the reader to learn the important aspects of William Thurston s heritage Thurston s ideas have altered the course of twentieth century mathematics and they continue to have a significant influence on succeeding generations of mathematicians The topics covered in the present volume include com plex hyperbolic Kleinian groups M bius structures hyperbolic ends cone 3 manifolds Thurston s norm surgeries in representation varieties triangulations spaces of polygo nal decompositions and of singular flat structures on surfaces combination theorems in the theories of Kleinian groups hyperbolic groups and holomorphic dynamics the dynamics and iteration of rational maps automatic groups and the combinatorics of right angled Artin groups **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   C*-algebras and Elliptic Theory Bogdan Bojarski,Alexander S. Mishchenko,Evgenij V. Troitsky,Andrzej Weber,2006-11-09 This book consists of reviewed original research papers and expository articles in index theory especially on singular manifolds topology of manifolds operator and equivariant K theory Hopf cyclic cohomology geometry of foliations residue theory Fredholm pairs and others and applications in mathematical physics The wide spectrum of subjects reflects the diverse directions of research for which the starting point was the Atiyah Singer index theorem   **Algebraic Invariants of Links** Jonathan Arthur Hillman,2012 This book serves as a reference on links and on the invariants derived via algebraic topology from covering spaces of link exteriors It emphasizes the features of the multicomponent case not normally considered by knot theorists such as longitudes the homological complexity of many variable Laurent polynomial rings the fact that links are not usually boundary links free coverings of homology boundary links the lower central series as a source of invariants nilpotent completion and algebraic closure of the link group and disc links Invariants of the types considered here play an essential role in many applications of knot theory to other areas of topology This second edition introduces two new chapters OCo twisted polynomial invariants and singularities of plane curves Each replaces brief sketches in the first edition Chapter 2 has been reorganized and new material has been added to four other chapters   **Intelligence Of Low Dimensional Topology 2006** J Scott Carter,Seiichi Kamada,Louis H Kauffman,Akio Kawauchi,Toshitake Kohno,2007-05-29 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   **Gradient Flows** Luigi Ambrosio,Nicola Gigli,Giuseppe Savare,2005-01-28 This book is devoted to a theory of gradient ows in spaces which are not nec sarily endowed with a natural linear or di erentiable structure It is made of two parts the rst one concerning gradient ows in metric spaces and the second one 2 1 devoted to gradient ows in the L Wasserstein space of probability measures on p a separable Hilbert space X we consider the L Wasserstein distance p 1 as well The two parts have some connections due to the fact that the Wasserstein space of probability measures provides an important model to which the metric theory applies but the book is conceived in such a way that the two parts can be read independently the rst one by the reader more interested to Non Smooth Analysis and Analysis in Metric Spaces and the second one by the reader more oriented to theapplications in Partial Di erential Equations Measure Theory and Probability   Adaptive Finite Element Methods for Differential Equations Wolfgang Bangerth,Rolf

Rannacher,2013-11-11 These Lecture Notes have been compiled from the material presented by the second author in a lecture series Nachdiplomvorlesung at the Department of Mathematics of the ETH Zurich during the summer term 2002 Concepts of self adaptivity in the numerical solution of differential equations are discussed with emphasis on Galerkin finite element methods The key issues are a posteriori er ror estimation and automatic mesh adaptation Besides the traditional approach of energy norm error control a new duality based technique the Dual Weighted Residual method or shortly D WR method for goal oriented error estimation is discussed in detail This method aims at economical computation of arbitrary quantities of physical interest by properly adapting the computational mesh This is typically required in the design cycles of technical applications For example the drag coefficient of a body immersed in a viscous flow is computed then it is minimized by varying certain control parameters and finally the stability of the resulting flow is investigated by solving an eigenvalue problem Goal oriented adaptivity is designed to achieve these tasks with minimal cost The basics of the DWR method and various of its applications are described in the following survey articles R Rannacher 114 Error control in finite element computations In Proc of Summer School Error Control and Adaptivity in Scientific Computing H Bulgak and C Zenger eds pp 247 278 Kluwer Academic Publishers 1998 M Braack and R Rannacher 42 Adaptive finite element methods for low Mach number flows with chemical reactions **Selected Chapters in the Calculus of Variations** Jürgen Moser,2003-05-23 0 1 Introduction These lecture notes describe a new development in the calculus of variations which is called Aubry Mather Theory The starting point for the theoretical physicist Aubry was a model for the descrip tion of the motion of electrons in a two dimensional crystal Aubry investigated a related discrete variational problem and the corresponding minimal solutions On the other hand Mather started with a specific class of area preserving annulus mappings the so called monotone twist maps These maps appear in mechanics as Poincare maps Such maps were studied by Birkhoff during the 1920s in several papers In 1982 Mather succeeded to make essential progress in this field and to prove the existence of a class of closed invariant subsets which are now called Mather sets His existence theorem is based again on a variational principle Although these two investigations have different motivations they are closely re lated and have the same mathematical foundation We will not follow those ap proaches but will make a connection to classical results of Jacobi Legendre Weier strass and others from the 19th century Therefore in Chapter I we will put together the results of the classical theory which are the most important for us The notion of extremal fields will be most relevant In Chapter II we will investigate variational problems on the 2 dimensional torus We will look at the corresponding global minimals as well as at the relation be tween minimals and extremal fields In this way we will be led to Mather sets Normal Surface Singularities András Némethi,2022-10-07 This monograph provides a comprehensive introduction to the theory of complex normal surface singularities with a special emphasis on connections to low dimensional topology In this way it unites the analytic approach with the more recent topological one combining their tools and methods In the first chapters the book sets out the foundations of the theory of

normal surface singularities This includes a comprehensive presentation of the properties of the link as an oriented 3 manifold and of the invariants associated with a resolution combined with the structure and special properties of the line bundles defined on a resolution A recurring theme is the comparison of analytic and topological invariants For example the Poincar series of the divisorial filtration is compared to a topological zeta function associated with the resolution graph and the sheaf cohomologies of the line bundles are compared to the Seiberg Witten invariants of the link Equivariant Ehrhart theory is introduced to establish surgery additivity formulae of these invariants as well as for the regularization procedures of multivariable series In addition to recent research the book also provides expositions of more classical subjects such as the classification of plane and cuspidal curves Milnor fibrations and smoothing invariants the local divisor class group and the Hilbert Samuel function It contains a large number of examples of key families of germs rational elliptic weighted homogeneous superisolated and splice quotient It provides concrete computations of the topological invariants of their links Casson Walker and Seiberg Witten invariants Turaev torsion and of the analytic invariants geometric genus Hilbert function of the divisorial filtration and the analytic semigroup associated with the resolution The book culminates in a discussion of the topological and analytic lattice cohomologies as categorifications of the Seiberg Witten invariant and of the geometric genus respectively and of the graded roots Several open problems and conjectures are also formulated Normal Surface Singularities provides researchers in algebraic and differential geometry singularity theory complex analysis and low dimensional topology with an invaluable reference on this rich topic offering a unified presentation of the major results and approaches   Evolution Equations, Semigroups and Functional Analysis Brunello Terreni,2002 Brunello Terreni 1953 2000 was a researcher and teacher with vision and dedication The present volume is dedicated to the memory of Brunello Terreni His mathematical interests are reflected in 20 expository articles written by distinguished mathematicians The unifying theme of the articles is evolution equations and functional analysis which is presented in various and diverse forms parabolic equations semigroups stochastic evolution optimal control existence uniqueness and regularity of solutions inverse problems as well as applications Contributors P Acquistapace V Barbu A Briani L Boccardo P Colli Franzone G Da Prato D Donatelli A Favini M Fuhrmann M Grasselli R Illner H Koch R Labbas H Lange I Lasiecka A Lorenzi A Lunardi P Marcati R Nagel G Nickel V Pata M M Porzio B Ruf G Savar R Schnaubelt E Sinestrari H Tanabe H Teismann E Terraneo R Triggiani A Yagi
   Evolution Equations, Semigroups and Functional Analysis Alfredo Lorenzi,Bernhard Ruf,2012-12-06 Brunello Terreni 1953 2000 was a researcher and teacher with vision and dedication The present volume is dedicated to the memory of Brunello Terreni His mathematical interests are reflected in 20 expository articles written by distinguished mathematicians The unifying theme of the articles is evolution equations and functional analysis which is presented in various and diverse forms parabolic equations semigroups stochastic evolution optimal control existence uniqueness and regularity of solutions inverse problems as well as applications Contributors P Acquistapace V Barbu A Briani L Boccardo P Colli Franzone G Da

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