Progress in Mathematics

Matthias Schwarz

Morse Homology

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Morse Homology Progress In Mathematics Vol 111

Martin Markl, Steven Shnider, James D. Stasheff

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Morse Homology Schwarz, 2012-12-06 1 1 Background The subject of this book is Morse homology as a combination of relative Morse theory and Conley's continuation principle The latter will be used as an instrument to express the homology encoded in a Morse complex associated to a fixed Morse function independent of this function Originally this type of Morse theoretical tool was developed by Andreas Floer in order to find a proof of the famous Arnold conjecture whereas classical Morse theory turned out to fail in the infinite dimensional setting In this framework the homological variant of Morse theory is also known as Floer homology This kind of homology theory is the central topic of this book But first it seems worthwhile to outline the standard Morse theory 1 1 1 Classical Morse Theory The fact that Morse theory can be formulated in a homological way is by no means a new idea The reader is referred to the excellent survey paper by Raoul Bott Bol Morse Homology with Differential Graded Coefficients Jean-François Barraud, Mihai Damian, Vincent Humilière, Alexandru Oancea, 2025-05-29 The key geometric objects underlying Morse homology are the moduli spaces of connecting gradient trajectories between critical points of a Morse function The basic question in this context is the following How much of the topology of the underlying manifold is visible using moduli spaces of connecting trajectories. The answer provided by classical Morse homology as developed over the last 35 years is that the moduli spaces of isolated connecting gradient trajectories recover the chain homotopy type of the singular chain complex The purpose of this monograph is to extend this further the fundamental classes of the compactified moduli spaces of connecting gradient trajectories allow the construction of a twisting cocycle akin to Brown s universal twisting cocycle As a consequence the authors define and compute Morse homology with coefficients in any differential graded DG local system As particular cases of their construction they retrieve the singular homology of the total space of Hurewicz fibrations and the usual Morse homology with local coefficients A full theory of Morse homology with DG coefficients is developed featuring continuation maps invariance functoriality and duality Beyond applications to topology this is intended to serve as a blueprint for analogous constructions in Floer theory The new material and methods presented in the text will be of interest to a broad range of researchers in topology and symplectic topology At the same time the authors are particularly careful to give gentle introductions to the main topics and have structured the text so that it can be easily read at various degrees of detail As such the book should already be accessible and of interest to graduate students with a general interest in algebra and topology A Morse-Bott Approach to Monopole Floer Homology and the Triangulation Conjecture Francesco Lin, 2018-10-03 In the present work the author generalizes the construction of monopole Floer homology due to Kronheimer and Mrowka to the case of a gradient flow with Morse Bott singularities Focusing then on the special case of a three manifold equipped equipped with a structure which is isomorphic to its conjugate the author defines the counterpart in this context of Manolescu's recent Pin 2 equivariant Seiberg Witten Floer homology In particular the author provides an alternative approach to his disproof of the celebrated Triangulation conjecture

Morse Theory: Smooth And Discrete Kevin P Knudson, 2015-05-29 Morse Theory Smooth and Discrete serves as an introduction to classical smooth Morse theory and to Forman's discrete Morse theory highlighting the parallels between the two subjects This is the first time both smooth and discrete Morse theory have been treated in a single volume This makes the book a valuable resource for students and professionals working in topology and discrete mathematics With a strong focus on examples the text is suitable for advanced undergraduates or beginning graduate students Complexes Augustin Banyaga, David Hurtubise, Peter Spaeth, 2024-11-01 This book gives a detailed presentation of twisted Morse homology and cohomology on closed finite dimensional smooth manifolds It contains a complete proof of the Twisted Morse Homology Theorem which says that on a closed finite dimensional smooth manifold the homology of the Morse Smale Witten chain complex with coefficients in a bundle of abelian groups G is isomorphic to the singular homology of the manifold with coefficients in G It also includes proofs of twisted Morse theoretic versions of well known theorems such as Eilenberg s Theorem the Poincar Lemma and the de Rham Theorem The effectiveness of twisted Morse complexes is demonstrated by computing the Lichnerowicz cohomology of surfaces giving obstructions to spaces being associative H spaces and computing Novikov numbers Suitable for a graduate level course the book may also be used as a reference for graduate students and Lectures on Contact 3-Manifolds, Holomorphic Curves and Intersection Theory working mathematicians or physicists Chris Wendl, 2020-03-26 An accessible introduction to the intersection theory of punctured holomorphic curves and its Perturbed Gradient Flow Trees and A∞-algebra Structures in Morse Cohomology applications in topology Stephan Mescher, 2018-04-25 This book elaborates on an idea put forward by M Abouzaid on equipping the Morse cochain complex of a smooth Morse function on a closed oriented manifold with the structure of an A algebra by means of perturbed gradient flow trajectories This approach is a variation on K Fukaya's definition of Morse A categories for closed oriented manifolds involving families of Morse functions To make A structures in Morse theory accessible to a broader audience this book provides a coherent and detailed treatment of Abouzaid's approach including a discussion of all relevant analytic notions and results requiring only a basic grasp of Morse theory In particular no advanced algebra skills are required and the perturbation theory for Morse trajectories is completely self contained In addition to its relevance for finite dimensional Morse homology this book may be used as a preparation for the study of Fukaya categories in symplectic geometry It will be of interest to researchers in mathematics geometry and topology and to graduate students in mathematics with a basic command of the Morse theory 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 The Wild World of 4-Manifolds Alexandru Scorpan, 2005-05-10 What a wonderful book I strongly recommend this book to anyone especially graduate students interested in getting a sense of 4 manifolds MAA Reviews The book gives an excellent overview of 4 manifolds with many figures and historical notes Graduate students nonexperts and experts alike will enjoy browsing

through it Robion C Kirby University of California Berkeley This book offers a panorama of the topology of simply connected smooth manifolds of dimension four Dimension four is unlike any other dimension it is large enough to have room for wild things to happen but small enough so that there is no room to undo the wildness For example only manifolds of dimension four can exhibit infinitely many distinct smooth structures Indeed their topology remains the least understood today To put things in context the book starts with a survey of higher dimensions and of topological 4 manifolds In the second part the main invariant of a 4 manifold the intersection form and its interaction with the topology of the manifold are investigated In the third part as an important source of examples complex surfaces are reviewed In the final fourth part of the book gauge theory is presented this differential geometric method has brought to light how unwieldy smooth 4 manifolds truly are and while bringing new insights has raised more questions than answers The structure of the book is modular organized into a main track of about two hundred pages augmented by extensive notes at the end of each chapter where many extra details proofs and developments are presented To help the reader the text is peppered with over 250 illustrations and has an Differential Geometry and Mathematical Physics Gerd Rudolph, Matthias Schmidt, 2012-11-09 Starting from an undergraduate level this book systematically develops the basics of Calculus on manifolds vector bundles vector fields and differential forms Lie groups and Lie group actions Linear symplectic algebra and symplectic geometry Hamiltonian systems symmetries and reduction integrable systems and Hamilton Jacobi theory The topics listed under the first item are relevant for virtually all areas of mathematical physics. The second and third items constitute the link between abstract calculus and the theory of Hamiltonian systems The last item provides an introduction to various aspects of this theory including Morse families the Maslov class and caustics The book guides the reader from elementary differential geometry to advanced topics in the theory of Hamiltonian systems with the aim of making current research literature accessible The style is that of a mathematical textbook with full proofs given in the text or as exercises The material is illustrated by numerous detailed examples some of which are taken up several times for demonstrating how the methods evolve and interact Singularity Theory Denis Ch niot, 2007 The Singularity School and Conference took place in Luminy Marseille from January 24th to February 25th 2005 More than 180 mathematicians from over 30 countries converged to discuss recent developments in singularity theory The volume contains the elementary and advanced courses conducted by singularities specialists during the conference general lectures on singularity theory and lectures on applications of the theory to various domains The subjects range from geometry and topology of singularities through real and complex singularities to applications of singularities Geometrical Themes Inspired by the N-body Problem Luis Hernández-Lamoneda, Haydeé Herrera, Rafael Herrera, 2018-02-26 Presenting a selection of recent developments in geometrical problems inspired by the N body problem these lecture notes offer a variety of approaches to study them ranging from variational to dynamical while developing new insights making geometrical and topological detours and providing

historical references A Guillot's notes aim to describe differential equations in the complex domain motivated by the evolution of N particles moving on the plane subject to the influence of a magnetic field Guillot studies such differential equations using different geometric structures on complex curves in the sense of W Thurston in order to find isochronicity conditions R Montgomery's notes deal with a version of the planar Newtonian three body equation Namely he investigates the problem of whether every free homotopy class is realized by a periodic geodesic The solution involves geometry dynamical systems and the McGehee blow up A novelty of the approach is the use of energy balance in order to motivate the McGehee transformation A Pedroza's notes provide a brief introduction to Lagrangian Floer homology and its relation to the solution of the Arnol d conjecture on the minimal number of non degenerate fixed points of a Hamiltonian diffeomorphism

Floer Cohomology and Flips François Charest, Chris T. Woodward, 2022-08-31 View the abstract **Developments in Mathematics** ,2005 The Mathematics of Data Michael W. Mahoney, John C. Duchi, Anna C. Gilbert, 2018-11-15 Nothing provided Operads in Algebra, Topology and Physics Martin Markl, Steven Shnider, James D. Stasheff, 2002 Operads are mathematical devices which describe algebraic structures of many varieties and in various categories From their beginnings in the 1960s they have developed to encompass such areas as combinatorics knot theory moduli spaces string field theory and deformation quantization Naturality and Mapping Class Groups in Heegard Floer Homology András Juhász, Dylan P. Thurston, Ian Zemke, 2021-12-09 View the abstract Contact and Symplectic **Geometry** Charles Benedict Thomas, 1996-09-28 This volume presents some of the lectures and research during the special programme held at the Newton Institute in 1994 The two parts each contain a mix of substantial expository articles and research papers that outline important and topical ideas Many of the results have not been presented before and the lectures on Floer homology is the first avaliable in book form Symplectic methods are one of the most active areas of research in mathematics currently and this volume will attract much attention A Concise Course in Algebraic Topology J. P. May,1999-09 Algebraic topology is a basic part of modern mathematics and some knowledge of this area is indispensable for any advanced work relating to geometry including topology itself differential geometry algebraic geometry and Lie groups This book provides a detailed treatment of algebraic topology both for teachers of the subject and for advanced graduate students in mathematics either specializing in this area or continuing on to other fields I Peter May's approach reflects the enormous internal developments within algebraic topology over the past several decades most of which are largely unknown to mathematicians in other fields But he also retains the classical presentations of various topics where appropriate Most chapters end with problems that further explore and refine the concepts presented The final four chapters provide sketches of substantial areas of algebraic topology that are normally omitted from introductory texts and the book concludes with a list of suggested readings for those interested in delving further into the field **Invitations to Geometry and Topology** Martin R. Bridson, Simon Salamon, 2002 This volume presents an array of topics that introduce the reader to key ideas in

active areas in geometry and topology The material is presented in a way that both graduate students and researchers should find accessible and enticing The topics covered range from Morse theory and complex geometry theory to geometric group theory and are accompanied by exercises that are designed to deepen the reader s understanding and to guide them in exciting directions for future investigation The editors M R Bridson and S M Salamon have each written an article and are accompanied by A J Berrick M C Crabb and A J B Potter M Eastwood and J Sawon M A Guest N J Hitchin and J Seade

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