

**Mathematical
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Topological Modular Forms

**Christopher L. Douglas
John Francis
André G. Henriques
Michael A. Hill
Editors**



American Mathematical Society

Topological Modular Forms Mathematical Surveys And Monographs

Takeo Ohsawa, Norihiko Minami



Topological Modular Forms Mathematical Surveys And Monographs:

Topological Modular Forms Christopher L. Douglas, John Francis, André G. Henriques, Michael A. Hill, 2014-12-04 The theory of topological modular forms is an intricate blend of classical algebraic modular forms and stable homotopy groups of spheres The construction of this theory combines an algebro geometric perspective on elliptic curves over finite fields with techniques from algebraic topology particularly stable homotopy theory It has applications to and connections with manifold topology number theory and string theory This book provides a careful accessible introduction to topological modular forms After a brief history and an extended overview of the subject the book proper commences with an exposition of classical aspects of elliptic cohomology including background material on elliptic curves and modular forms a description of the moduli stack of elliptic curves an explanation of the exact functor theorem for constructing cohomology theories and an exploration of sheaves in stable homotopy theory There follows a treatment of more specialized topics including localization of spectra the deformation theory of formal groups and Goerss Hopkins obstruction theory for multiplicative structures on spectra The book then proceeds to more advanced material including discussions of the string orientation the sheaf of spectra on the moduli stack of elliptic curves the homotopy of topological modular forms and an extensive account of the construction of the spectrum of topological modular forms The book concludes with the three original pioneering and enormously influential manuscripts on the subject by Hopkins Miller and Mahowald

The Adams Spectral Sequence for Topological Modular Forms Robert R. Bruner, John Rognes, 2021-12-23 The connective topological modular forms spectrum tmf is in a sense initial among elliptic spectra and as such is an important link between the homotopy groups of spheres and modular forms A primary goal of this volume is to give a complete account with full proofs of the homotopy of tmf and several tmf module spectra by means of the classical Adams spectral sequence thus verifying correcting and extending existing approaches In the process folklore results are made precise and generalized Anderson and Brown Comenetz duality and the corresponding dualities in homotopy groups are carefully proved The volume also includes an account of the homotopy groups of spheres through degree 44 with complete proofs except that the Adams conjecture is used without proof Also presented are modern stable proofs of classical results which are hard to extract from the literature Tools used in this book include a multiplicative spectral sequence generalizing a construction of Davis and Mahowald and computer software which computes the cohomology of modules over the Steenrod algebra and products therein Techniques from commutative algebra are used to make the calculation precise and finite The H infinity ring structure of the sphere and of tmf are used to determine many differentials and relations

New Directions in Homotopy Theory Nitya Kitchloo, Mona Merling, Jack Morava, Emily Riehl, W. Stephen Wilson, 2018-05-29 This volume contains the proceedings of the Second Mid Atlantic Topology Conference held from March 12 13 2016 at Johns Hopkins University in Baltimore Maryland The focus of the conference and subsequent papers was on applications of innovative methods from homotopy theory in category theory

algebraic geometry and related areas emphasizing the work of younger researchers in these fields

Geometric and Topological Aspects of the Representation Theory of Finite Groups Jon F. Carlson, Srikanth B. Iyengar, Julia Pevtsova, 2018-10-04 These proceedings comprise two workshops celebrating the accomplishments of David J Benson on the occasion of his sixtieth birthday The papers presented at the meetings were representative of the many mathematical subjects he has worked on with an emphasis on group representations and cohomology The first workshop was titled Groups Representations and Cohomology and held from June 22 to June 27 2015 at Sabhal Mòr Ostaig on the Isle of Skye Scotland The second was a combination of a summer school and workshop on the subject of Geometric Methods in the Representation Theory of Finite Groups and took place at the Pacific Institute for the Mathematical Sciences at the University of British Columbia in Vancouver from July 27 to August 5 2016 The contents of the volume include a composite of both summer school material and workshop derived survey articles on geometric and topological aspects of the representation theory of finite groups The mission of the annually sponsored Summer Schools is to train and draw new students and help Ph D students transition to independent research

Bousfield Classes and Ohkawa's Theorem Takeo Ohsawa, Norihiko Minami, 2020-03-18 This volume originated in the workshop held at Nagoya University August 28-30 2015 focusing on the surprising and mysterious Ohkawa's theorem the Bousfield classes in the stable homotopy category SH form a set An inspiring extensive mathematical story can be narrated starting with Ohkawa's theorem evolving naturally with a chain of motivational questions Ohkawa's theorem states that the Bousfield classes of the stable homotopy category SH surprisingly forms a set which is still very mysterious Are there any toy models where analogous Bousfield classes form a set with a clear meaning The fundamental theorem of Hopkins Neeman Thomason and others states that the analogue of the Bousfield classes in the derived category of quasi-coherent sheaves $D_{qc} X$ form a set with a clear algebro-geometric description However Hopkins was actually motivated not by Ohkawa's theorem but by his own theorem with Smith in the triangulated subcategory SH_c consisting of compact objects in SH Now the following questions naturally occur 1 Having theorems of Ohkawa and Hopkins Smith in SH are there analogues for the Morel-Voevodsky A_1 stable homotopy category SH_k which subsumes SH when k is a subfield of $\mathbb{C}$ 2 Was it not natural for Hopkins to have considered $D_{qc} X_c$ instead of $D_{qc} X$ However whereas there is a conceptually simple algebro-geometrical interpretation $D_{qc} X_c \simeq D_{perf} X$ it is its close relative $Db_{coh} X$ that traditionally ever since Oka and Cartan has been intensively studied because of its rich geometric and physical information This book contains developments for the rest of the story and much more including the chromatic homotopy theory which the Hopkins-Smith theorem is based upon and applications of Lurie's higher algebra all by distinguished contributors

Character Map In Non-abelian Cohomology, The: Twisted, Differential, And Generalized Domenico Fiorenza, Hisham Sati, Urs Schreiber, 2023-08-11 This book presents a novel development of fundamental and fascinating aspects of algebraic topology and mathematical physics extra-ordinary and further generalized cohomology theories

enhanced to twisted and differential geometric form with focus on firstly their rational approximation by generalized Chern character maps and then the resulting charge quantization laws in higher n form gauge field theories appearing in string theory and the classification of topological quantum materials Although crucial for understanding famously elusive effects in strongly interacting physics the relevant higher non abelian cohomology theory higher gerbes has had an esoteric reputation and remains underdeveloped Devoted to this end this book's theme is that various generalized cohomology theories are best viewed through their classifying spaces or moduli stacks not necessarily infinite loop spaces from which perspective the character map is really an incarnation of the fundamental theorem of rational homotopy theory thereby not only uniformly subsuming the classical Chern character and a multitude of scattered variants that have been proposed but now seamlessly applicable in the hitherto elusive generality of twisted differential and non abelian cohomology In laying out this result with plenty of examples this book provides a modernized introduction and review of fundamental classical topics 1 abstract homotopy theory via model categories 2 generalized cohomology in its homotopical incarnation 3 rational homotopy theory seen via homotopy Lie theory whose fundamental theorem we recast as a twisted non abelian de Rham theorem which naturally induces the twisted non abelian character map

Introduction to Stable Homotopy Theory David

Barnes, Constanze Roitzheim, 2020-03-26 A comprehensive introduction to stable homotopy theory for beginning graduate students from motivating phenomena to current research

Equivariant Topology and Derived Algebra Scott

Balchin, David Barnes, Magdalena Kędziorek, Markus Szymik, 2022 A collection of research papers both new and expository based on the interests of Professor J P C Greenlees

Interactions between Homotopy Theory and Algebra Luchezar L.

Avramov, 2007 This book is based on talks presented at the Summer School on Interactions between Homotopy theory and Algebra held at the University of Chicago in the summer of 2004 The goal of this book is to create a resource for background and for current directions of research related to deep connections between homotopy theory and algebra including algebraic geometry commutative algebra and representation theory The articles in this book are aimed at the audience of beginning researchers with varied mathematical backgrounds and have been written with both the quality of exposition and the accessibility to novices in mind

Directions in Number Theory Ellen E. Eischen, Ling Long, Rachel Pries, Katherine E.

Stange, 2016-09-26 Exploring the interplay between deep theory and intricate computation this volume is a compilation of research and survey papers in number theory written by members of the Women In Numbers WIN network principally by the collaborative research groups formed at Women In Numbers 3 a conference at the Banff International Research Station in Banff Alberta on April 21-25 2014 The papers span a wide range of research areas arithmetic geometry analytic number theory algebraic number theory and applications to coding and cryptography The WIN conference series began in 2008 with the aim of strengthening the research careers of female number theorists The series introduced a novel research mentorship model women at all career stages from graduate students to senior members of the community joined forces to work in

focused research groups on cutting edge projects designed and led by experienced researchers The goals for Women In Numbers 3 were to establish ambitious new collaborations between women in number theory to train junior participants about topics of current importance and to continue to build a vibrant community of women in number theory Forty two women attended the WIN3 workshop including 15 senior and mid level faculty 15 junior faculty and postdocs and 12 graduate students

Homotopy Theory: Tools and Applications Daniel G. Davis, 2019-05-30 This volume contains the proceedings of the conference Homotopy Theory Tools and Applications in honor of Paul Goerss's 60th birthday held from July 17-21 2017 at the University of Illinois at Urbana Champaign Urbana IL The articles cover a variety of topics spanning the current research frontier of homotopy theory This includes articles concerning both computations and the formal theory of chromatic homotopy different aspects of equivariant homotopy theory and K theory as well as articles concerned with structured ring spectra cyclotomic spectra associated to perfectoid fields and the theory of higher homotopy operations

Superstrings, Geometry, Topology, and C^ -algebras* Robert S. Doran, Greg Friedman, Jonathan Rosenberg, 2010-10-13 This volume contains the proceedings of an NSF CBMS Conference held at Texas Christian University in Fort Worth Texas May 18-22 2009 The papers written especially for this volume by well known mathematicians and mathematical physicists are an outgrowth of the talks presented at the conference Topics examined are highly interdisciplinary and include among many other things recent results on D brane charges in K homology and twisted K homology Yang Mills gauge theory and connections with non commutative geometry Landau Ginzburg models C algebraic non commutative geometry and ties to quantum physics and topology the rational homotopy type of the group of unitary elements in an Azumaya algebra and functoriality properties in the theory of C crossed products and fixed point algebras for proper actions An introduction written by Jonathan Rosenberg provides an instructive overview describing common themes and how the various papers in the volume are interrelated and fit together The rich diversity of papers appearing in the volume demonstrates the current interplay between superstring theory geometry topology and non commutative geometry The book will be of interest to graduate students mathematicians mathematical physicists and researchers working in these areas

Higher Structures in Topology, Geometry, and Physics Ralph M. Kaufmann, Martin Markl, Alexander A. Voronov, 2024-07-03 This volume contains the proceedings of the AMS Special Session on Higher Structures in Topology Geometry and Physics held virtually on March 26-27 2022 The articles give a snapshot survey of the current topics surrounding the mathematical formulation of field theories There is an intricate interplay between geometry topology and algebra which captures these theories The hallmark are higher structures which one can consider as the secondary algebraic or geometric background on which the theories are formulated The higher structures considered in the volume are generalizations of operads models for conformal field theories string topology open closed field theories BF BV formalism actions on Hochschild complexes and related complexes and their geometric and topological aspects

Mathematical Foundations of Quantum Field Theory and

Perturbative String Theory Hisham Sati, Urs Schreiber, 2011-12-07 Conceptual progress in fundamental theoretical physics is linked with the search for the suitable mathematical structures that model the physical systems Quantum field theory QFT has proven to be a rich source of ideas for mathematics for a long time However fundamental questions such as What is a QFT did not have satisfactory mathematical answers especially on spaces with arbitrary topology fundamental for the formulation of perturbative string theory This book contains a collection of papers highlighting the mathematical foundations of QFT and its relevance to perturbative string theory as well as the deep techniques that have been emerging in the last few years The papers are organized under three main chapters Foundations for Quantum Field Theory Quantization of Field Theories and Two Dimensional Quantum Field Theories An introduction written by the editors provides an overview of the main underlying themes that bind together the papers in the volume

Calabi-Yau Varieties: Arithmetic, Geometry and Physics Radu Laza, Matthias Schütt, Noriko Yui, 2015-08-27 This volume presents a lively introduction to the rapidly developing and vast research areas surrounding Calabi Yau varieties and string theory With its coverage of the various perspectives of a wide area of topics such as Hodge theory Gross Siebert program moduli problems toric approach and arithmetic aspects the book gives a comprehensive overview of the current streams of mathematical research in the area The contributions in this book are based on lectures that took place during workshops with the following thematic titles Modular Forms Around String Theory Enumerative Geometry and Calabi Yau Varieties Physics Around Mirror Symmetry Hodge Theory in String Theory The book is ideal for graduate students and researchers learning about Calabi Yau varieties as well as physics students and string theorists who wish to learn the mathematics behind these varieties

Topological Phases of Matter and Quantum Computation Paul Bruillard, Carlos Ortiz Marrero, Julia Plavnik, 2020-03-31 This volume contains the proceedings of the AMS Special Session on Topological Phases of Matter and Quantum Computation held from September 24 25 2016 at Bowdoin College Brunswick Maine Topological quantum computing has exploded in popularity in recent years Sitting at the triple point between mathematics physics and computer science it has the potential to revolutionize sub disciplines in these fields The academic importance of this field has been recognized in physics through the 2016 Nobel Prize In mathematics some of the 1990 Fields Medals were awarded for developments in topics that nowadays are fundamental tools for the study of topological quantum computation Moreover the practical importance of this discipline has been underscored by recent industry investments The relative youth of this field combined with a high degree of interest in it makes now an excellent time to get involved Furthermore the cross disciplinary nature of topological quantum computing provides an unprecedented number of opportunities for cross pollination of mathematics physics and computer science This can be seen in the variety of works contained in this volume With articles coming from mathematics physics and computer science this volume aims to provide a taste of different sub disciplines for novices and a wealth of new perspectives for veteran researchers Regardless of your point of entry into topological quantum computing or your experience level this

volume has something for you *Topology and Quantum Theory in Interaction* David Ayala, Daniel S. Freed, Ryan E. Grady, 2018-10-25 This volume contains the proceedings of the NSF CBMS Regional Conference on Topological and Geometric Methods in QFT held from July 31 August 4 2017 at Montana State University in Bozeman Montana In recent decades there has been a movement to axiomatize quantum field theory into a mathematical structure In a different direction one can ask to test these axiom systems against physics Can they be used to rederive known facts about quantum theories or better yet be the framework in which to solve open problems Recently Freed and Hopkins have provided a solution to a classification problem in condensed matter theory which is ultimately based on the field theory axioms of Graeme Segal Papers contained in this volume amplify various aspects of the Freed Hopkins program develop some category theory which lies behind the cobordism hypothesis the major structure theorem for topological field theories and relate to Costello's approach to perturbative quantum field theory Two papers on the latter use this framework to recover fundamental results about some physical theories two dimensional sigma models and the bosonic string Perhaps it is surprising that such sparse axiom systems encode enough structure to prove important results in physics These successes can be taken as encouragement that the axiom systems are at least on the right track toward articulating what a quantum field theory is

Topological Automorphic Forms Mark Behrens, Tyler Lawson, 2010-02-22 The authors apply a theorem of J Lurie to produce cohomology theories associated to certain Shimura varieties of type $U(1, n-1)$ These cohomology theories of topological automorphic forms mathit TAF are related to Shimura varieties in the same way that mathit TMF is related to the moduli space of elliptic curves **Stable Homotopy Around the Arf-Kervaire Invariant** Victor P. Snaith, 2009-03-28 Were I to take an iron gun And re it o towards the sun I grant twould reach its mark at last But not till many years had passed But should that bullet change its force And to the planets take its course Twould never reach the nearest star Because it is so very far from FACTS by Lewis Carroll 55 Let me begin by describing the two purposes which prompted me to write this monograph This is a book about algebraic topology and more especially about homotopy theory Since the inception of algebraic topology 217 the study of homotopy classes of continuous maps between spheres has enjoyed a very exc n n tional central role As is well known for homotopy classes of maps $f: S^n \rightarrow S^n$ with $n \geq 1$ the sole homotopy invariant is the degree which characterises the homotopy class completely The search for a continuous map between spheres of different dimensions and not homotopic to the constant map had to wait for its resolution until the remarkable paper of Heinz Hopf 111 In retrospect nding 3 an example was rather easy because there is a canonical quotient map from S^3 to S^1 2 the orbit space of the free circle action $S^1 \times CP^\infty \rightarrow CP^\infty$ **Stable Stems** Daniel C. Isaksen, 2020-02-13 The author presents a detailed analysis of 2 complete stable homotopy groups both in the classical context and in the motivic context over $\mathbb{C}$ He uses the motivic May spectral sequence to compute the cohomology of the motivic Steenrod algebra over $\mathbb{C}$ through the 70 stem He then uses the motivic Adams spectral sequence to obtain motivic stable homotopy groups through the 59 stem He also describes the

complete calculation to the 65 stem but defers the proofs in this range to forthcoming publications In addition to finding all Adams differentials the author also resolves all hidden extensions by 2 and through the 59 stem except for a few carefully enumerated exceptions that remain unknown The analogous classical stable homotopy groups are easy consequences The author also computes the motivic stable homotopy groups of the cofiber of the motivic element This computation is essential for resolving hidden extensions in the Adams spectral sequence He shows that the homotopy groups of the cofiber of are the same as the E2 page of the classical Adams Novikov spectral sequence This allows him to compute the classical Adams Novikov spectral sequence including differentials and hidden extensions in a larger range than was previously known

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