

PRIMER OF MAPPING CLASS GROUPS

PRIMER OF MAPPING CLASS GROUPS PROVIDES AN ESSENTIAL INTRODUCTION TO ONE OF THE CENTRAL OBJECTS IN GEOMETRIC TOPOLOGY AND ALGEBRAIC GEOMETRY. THIS FUNDAMENTAL CONCEPT PLAYS A PIVOTAL ROLE IN UNDERSTANDING THE SYMMETRIES OF SURFACES AND THEIR MODULI SPACES. THE PRIMER COVERS THE DEFINITION, BASIC PROPERTIES, AND SIGNIFICANT APPLICATIONS OF MAPPING CLASS GROUPS, OFFERING A COMPREHENSIVE OVERVIEW SUITABLE FOR BOTH BEGINNERS AND ADVANCED SCHOLARS. KEY TOPICS INCLUDE THE ALGEBRAIC STRUCTURE OF THESE GROUPS, THEIR CONNECTIONS TO TEICHMÜLLER THEORY, AND THEIR IMPLICATIONS IN LOW-DIMENSIONAL TOPOLOGY. THIS ARTICLE ALSO EXPLORES NOTABLE RESULTS AND CLASSICAL THEOREMS THAT SHAPE THE STUDY OF MAPPING CLASS GROUPS. THE DISCUSSION NATURALLY PROGRESSES INTO A STRUCTURED EXAMINATION OF THE SUBJECT, BEGINNING WITH FOUNDATIONAL DEFINITIONS, MOVING THROUGH ALGEBRAIC AND GEOMETRIC ASPECTS, AND CULMINATING IN ADVANCED APPLICATIONS. THE FOLLOWING SECTIONS OUTLINE THE KEY THEMES COVERED IN THIS PRIMER OF MAPPING CLASS GROUPS.

- DEFINITION AND BASIC PROPERTIES OF MAPPING CLASS GROUPS
- ALGEBRAIC STRUCTURE AND GENERATORS
- CONNECTIONS TO TEICHMÜLLER THEORY
- APPLICATIONS IN TOPOLOGY AND GEOMETRY
- CLASSICAL THEOREMS AND RECENT DEVELOPMENTS

DEFINITION AND BASIC PROPERTIES OF MAPPING CLASS GROUPS

THE MAPPING CLASS GROUP OF A SURFACE IS A FUNDAMENTAL CONCEPT IN TOPOLOGY THAT ENCODES THE SYMMETRIES OF THE SURFACE UP TO ISOTOPY. FORMALLY, FOR A CLOSED, ORIENTED SURFACE (S) , THE MAPPING CLASS GROUP, OFTEN DENOTED AS $(\text{Mod}(S))$ OR $(\Gamma(S))$, IS DEFINED AS THE GROUP OF ISOTOPY CLASSES OF ORIENTATION-PRESERVING HOMEOMORPHISMS OF (S) . THIS MEANS EACH ELEMENT REPRESENTS AN EQUIVALENCE CLASS OF HOMEOMORPHISMS WHERE TWO HOMEOMORPHISMS ARE CONSIDERED THE SAME IF ONE CAN BE CONTINUOUSLY DEFORMED INTO THE OTHER WITHOUT CUTTING OR GLUING THE SURFACE.

MAPPING CLASS GROUPS CAPTURE THE GLOBAL SYMMETRIES AND PLAY A CRUCIAL ROLE IN UNDERSTANDING THE MODULI SPACE OF RIEMANN SURFACES. THEY ALSO SERVE AS A BRIDGE BETWEEN GEOMETRIC TOPOLOGY, ALGEBRAIC GEOMETRY, AND GROUP THEORY. KEY PROPERTIES INCLUDE BEING FINITELY GENERATED AND OFTEN HAVING RICH ALGEBRAIC STRUCTURES THAT REFLECT THE TOPOLOGY OF THE UNDERLYING SURFACE.

SURFACES AND ISOTOPIES

SURFACES CONSIDERED IN THE STUDY OF MAPPING CLASS GROUPS ARE TYPICALLY COMPACT, CONNECTED, AND ORIENTED. THEY CAN HAVE BOUNDARY COMPONENTS OR PUNCTURES, AND THESE FEATURES AFFECT THE STRUCTURE OF THE MAPPING CLASS GROUP. ISOTOPIES ARE CONTINUOUS DEFORMATIONS THROUGH HOMEOMORPHISMS, WHICH ENSURE THE CLASSIFICATION FOCUSES ON THE ESSENTIAL SYMMETRIES RATHER THAN ARBITRARY DEFORMATIONS.

NOTATION AND EXAMPLES

THE NOTATION $(\text{Mod}(S_{g,n}))$ IS COMMONLY USED TO DENOTE THE MAPPING CLASS GROUP OF A SURFACE OF GENUS (g) WITH (n) BOUNDARY COMPONENTS OR PUNCTURES. FOR EXAMPLE, $(\text{Mod}(S_{0,3}))$ CORRESPONDS TO THE MAPPING CLASS GROUP OF A SPHERE WITH THREE PUNCTURES, WHICH IS ISOMORPHIC TO THE BRAID GROUP ON THREE STRANDS MODULO ITS CENTER.

ALGEBRAIC STRUCTURE AND GENERATORS

UNDERSTANDING THE ALGEBRAIC STRUCTURE OF MAPPING CLASS GROUPS IS ESSENTIAL FOR STUDYING THEIR PROPERTIES AND APPLICATIONS. THESE GROUPS ARE FINITELY GENERATED AND OFTEN ADMIT FINITE PRESENTATIONS. A KEY RESULT IN THIS AREA IS THAT THE MAPPING CLASS GROUP CAN BE GENERATED BY A FINITE SET OF DEHN TWISTS, WHICH ARE SPECIFIC HOMEOMORPHISMS ASSOCIATED WITH SIMPLE CLOSED CURVES ON THE SURFACE.

DEHN TWISTS

DEHN TWISTS ARE ELEMENTARY BUILDING BLOCKS OF THE MAPPING CLASS GROUP. GIVEN A SIMPLE CLOSED CURVE ON THE SURFACE, A DEHN TWIST CUTS THE SURFACE ALONG THE CURVE, TWISTS ONE SIDE BY 360 DEGREES, AND THEN REGLUES. SUCH TWISTS GENERATE THE ENTIRE MAPPING CLASS GROUP FOR SURFACES OF GENUS AT LEAST ONE, MAKING THEM FUNDAMENTAL TO THE ALGEBRAIC UNDERSTANDING OF THESE GROUPS.

FINITE PRESENTATIONS

MAPPING CLASS GROUPS ADMIT FINITE PRESENTATIONS INVOLVING GENERATORS AND RELATIONS. THE CLASSICAL PRESENTATIONS, SUCH AS THOSE DEVELOPED BY DEHN, LICKORISH, AND HUMPHRIES, PROVIDE EXPLICIT GENERATORS AND RELATIONS. FOR INSTANCE, HUMPHRIES SHOWED THAT A MINIMAL GENERATING SET FOR $\pi_1(\text{Mod}(S_g))$ CONSISTS OF $(2g + 1)$ DEHN TWISTS. THESE PRESENTATIONS ALLOW FOR COMPUTATIONAL AND THEORETICAL ANALYSIS OF THE GROUP'S STRUCTURE.

GROUP PROPERTIES

MAPPING CLASS GROUPS EXHIBIT RICH ALGEBRAIC PROPERTIES, INCLUDING:

- BEING RESIDUALLY FINITE, MEANING EVERY NONTRIVIAL ELEMENT CAN BE DETECTED IN SOME FINITE QUOTIENT.
- HAVING TORSION ELEMENTS CORRESPONDING TO PERIODIC HOMEOMORPHISMS OF SURFACES.
- CONTAINING IMPORTANT SUBGROUPS SUCH AS THE TORELLI GROUP, WHICH ACTS TRIVIALY ON HOMOLOGY.

CONNECTIONS TO TEICHMÜLLER THEORY

TEICHMÜLLER THEORY STUDIES THE SPACE OF COMPLEX STRUCTURES ON A SURFACE, KNOWN AS TEICHMÜLLER SPACE. THE MAPPING CLASS GROUP ACTS NATURALLY ON THIS SPACE BY CHANGING THE MARKINGS OF SURFACES, AND THIS ACTION IS FUNDAMENTAL TO UNDERSTANDING BOTH THE GEOMETRY OF TEICHMÜLLER SPACE AND THE STRUCTURE OF MODULI SPACES.

TEICHMÜLLER SPACE AND MODULI SPACE

TEICHMÜLLER SPACE $\mathcal{T}(S)$ IS THE SPACE OF MARKED CONFORMAL STRUCTURES ON A SURFACE (S) , UP TO ISOTOPY. IT IS CONTRACTIBLE AND CARRIES A NATURAL COMPLEX STRUCTURE. THE MODULI SPACE $\mathcal{M}(S)$ IS OBTAINED AS THE QUOTIENT OF $\mathcal{T}(S)$ BY THE MAPPING CLASS GROUP ACTION, REPRESENTING UNMARKED COMPLEX STRUCTURES. THIS QUOTIENT IS AN ORBIFOLD THAT ENCODES THE GEOMETRY OF RIEMANN SURFACES.

ACTION OF THE MAPPING CLASS GROUP

THE MAPPING CLASS GROUP ACTS PROPERLY DISCONTINUOUSLY ON TEICHMÜLLER SPACE BY CHANGING THE MARKING OF SURFACES. THIS ACTION IS CENTRAL TO THE STUDY OF MODULI SPACES AND YIELDS DEEP INSIGHTS INTO GEOMETRIC STRUCTURES ON SURFACES. THE DYNAMICS OF THIS ACTION ARE ALSO A RICH AREA OF RESEARCH, WITH CONNECTIONS TO ERGODIC THEORY AND GEOMETRIC GROUP THEORY.

APPLICATIONS IN COMPLEX ANALYSIS AND GEOMETRY

THE INTERPLAY BETWEEN MAPPING CLASS GROUPS AND TEICHMÜLLER THEORY FACILITATES PROGRESS IN COMPLEX ANALYSIS, ALGEBRAIC GEOMETRY, AND HYPERBOLIC GEOMETRY. FOR INSTANCE, IT HELPS DESCRIBE THE DEFORMATION SPACES OF HYPERBOLIC STRUCTURES AND PROVIDES TOOLS FOR UNDERSTANDING THE GEOMETRY OF MODULI SPACES AND MAPPING CLASS GROUP ORBITS.

APPLICATIONS IN TOPOLOGY AND GEOMETRY

MAPPING CLASS GROUPS HAVE WIDESPREAD APPLICATIONS ACROSS VARIOUS FIELDS IN MATHEMATICS, PARTICULARLY IN LOW-DIMENSIONAL TOPOLOGY AND GEOMETRIC STRUCTURES. THEIR STUDY YIELDS INSIGHTS INTO 3-MANIFOLD THEORY, KNOT THEORY, AND SYMPLECTIC GEOMETRY.

3-MANIFOLD THEORY

MAPPING CLASS GROUPS APPEAR NATURALLY IN THE THEORY OF 3-MANIFOLDS THROUGH HEEGAARD SPLITTINGS. A 3-MANIFOLD CAN BE DECOMPOSED INTO TWO HANDLEBODIES GLUED ALONG A SURFACE, AND THE GLUING MAP, AN ELEMENT OF THE MAPPING CLASS GROUP, DETERMINES THE MANIFOLD'S TOPOLOGY. THUS, UNDERSTANDING MAPPING CLASS GROUPS AIDS IN CLASSIFYING 3-MANIFOLDS.

KNOT THEORY AND BRAIDS

THE BRAID GROUP IS CLOSELY RELATED TO THE MAPPING CLASS GROUP OF A PUNCTURED DISK. THIS CONNECTION ENABLES THE APPLICATION OF MAPPING CLASS GROUP TECHNIQUES TO KNOT THEORY, PARTICULARLY IN STUDYING BRAID REPRESENTATIONS OF KNOTS AND LINKS AND THEIR INVARIANTS.

SYMPLECTIC AND ALGEBRAIC GEOMETRY

MAPPING CLASS GROUPS ALSO ARISE IN SYMPLECTIC GEOMETRY AS GROUPS OF SYMPLECTOMORPHISMS UP TO ISOTOPY, REFLECTING SYMMETRIES OF SYMPLECTIC MANIFOLDS. IN ALGEBRAIC GEOMETRY, THEY RELATE TO MONODROMY REPRESENTATIONS AND MODULI PROBLEMS, LINKING TOPOLOGICAL AND ALGEBRAIC PERSPECTIVES.

CLASSICAL THEOREMS AND RECENT DEVELOPMENTS

THE STUDY OF MAPPING CLASS GROUPS HAS A RICH HISTORY WITH MANY CLASSICAL RESULTS THAT FORM THE FOUNDATION OF MODERN RESEARCH. ADDITIONALLY, RECENT DEVELOPMENTS HAVE EXPANDED UNDERSTANDING AND UNVEILED NEW CONNECTIONS TO OTHER MATHEMATICAL AREAS.

CLASSICAL RESULTS

IMPORTANT CLASSICAL THEOREMS INCLUDE:

1. **DEHN-NIELSEN-BAER THEOREM:** ESTABLISHES AN ISOMORPHISM BETWEEN THE MAPPING CLASS GROUP AND THE OUTER AUTOMORPHISM GROUP OF THE SURFACE'S FUNDAMENTAL GROUP.
2. **LICKORISH GENERATORS THEOREM:** DEMONSTRATES THAT A FINITE SET OF DEHN TWISTS GENERATES THE ENTIRE MAPPING CLASS GROUP.
3. **BIRMAN EXACT SEQUENCE:** DESCRIBES THE RELATIONSHIP BETWEEN MAPPING CLASS GROUPS OF SURFACES WITH DIFFERENT NUMBERS OF PUNCTURES.

RECENT ADVANCES

RECENT RESEARCH HAS FOCUSED ON:

- UNDERSTANDING THE GEOMETRY AND DYNAMICS OF MAPPING CLASS GROUP ACTIONS ON VARIOUS SPACES.
- EXPLORING CONNECTIONS WITH GEOMETRIC GROUP THEORY, INCLUDING PROPERTIES LIKE HYPERBOLICITY AND $CAT(0)$ STRUCTURES.
- INVESTIGATING THE STRUCTURE AND COHOMOLOGY OF SUBGROUPS SUCH AS THE TORELLI GROUP AND JOHNSON KERNEL.
- APPLICATIONS TO STRING THEORY, QUANTUM TOPOLOGY, AND CATEGORIFICATION.

OPEN QUESTIONS

DESPITE SIGNIFICANT PROGRESS, MANY OPEN PROBLEMS REMAIN, SUCH AS CLASSIFYING ALL POSSIBLE FINITE SUBGROUPS, UNDERSTANDING THE FULL STRUCTURE OF CERTAIN SUBGROUPS, AND EXPLORING THE MAPPING CLASS GROUP'S ROLE IN HIGHER-DIMENSIONAL ANALOGUES.

FREQUENTLY ASKED QUESTIONS

WHAT IS A MAPPING CLASS GROUP IN TOPOLOGY?

A MAPPING CLASS GROUP OF A SURFACE IS THE GROUP OF ISOTOPY CLASSES OF ORIENTATION-PRESERVING SELF-HOMEOMORPHISMS OF THAT SURFACE. IT ENCODES SYMMETRIES OF THE SURFACE UP TO CONTINUOUS DEFORMATION.

WHY IS A PRIMER ON MAPPING CLASS GROUPS IMPORTANT FOR MATHEMATICIANS?

A PRIMER ON MAPPING CLASS GROUPS PROVIDES FOUNDATIONAL KNOWLEDGE ABOUT THESE GROUPS, WHICH ARE CENTRAL IN LOW-DIMENSIONAL TOPOLOGY, GEOMETRIC GROUP THEORY, AND ALGEBRAIC GEOMETRY. IT HELPS RESEARCHERS UNDERSTAND SURFACE SYMMETRIES, MODULI SPACES, AND RELATED STRUCTURES.

WHAT ARE SOME KEY TOPICS COVERED IN A PRIMER OF MAPPING CLASS GROUPS?

KEY TOPICS INCLUDE THE DEFINITION OF MAPPING CLASS GROUPS, DEHN TWISTS, THE NIELSEN-THURSTON CLASSIFICATION OF SURFACE HOMEOMORPHISMS, THE ACTION ON $TEICHM[\Sigma]$ LLER SPACE, AND CONNECTIONS TO BRAID GROUPS AND MODULI SPACES.

HOW DOES THE NIELSEN-THURSTON CLASSIFICATION RELATE TO MAPPING CLASS GROUPS?

THE NIELSEN-THURSTON CLASSIFICATION CATEGORIZES ELEMENTS OF THE MAPPING CLASS GROUP INTO THREE TYPES: PERIODIC, REDUCIBLE, AND PSEUDO-ANOSOV. THIS CLASSIFICATION IS FUNDAMENTAL FOR UNDERSTANDING THE DYNAMICS AND ALGEBRAIC PROPERTIES OF MAPPING CLASSES.

WHAT ARE SOME MODERN APPLICATIONS OF THE THEORY OF MAPPING CLASS GROUPS?

MAPPING CLASS GROUPS APPEAR IN VARIOUS AREAS SUCH AS THE STUDY OF 3-MANIFOLDS, STRING THEORY, TEICHMÜLLER THEORY, AND QUANTUM TOPOLOGY. THEY ARE ALSO USED IN UNDERSTANDING MODULI SPACES OF RIEMANN SURFACES AND HAVE CONNECTIONS TO COMBINATORIAL GROUP THEORY.

ADDITIONAL RESOURCES

1. *A PRIMER ON MAPPING CLASS GROUPS* BY BENSON FARB AND DAN MARGALIT

THIS BOOK SERVES AS AN ACCESSIBLE INTRODUCTION TO THE THEORY OF MAPPING CLASS GROUPS, WHICH ARE CENTRAL OBJECTS IN GEOMETRIC TOPOLOGY AND LOW-DIMENSIONAL GEOMETRY. IT COVERS FOUNDATIONAL CONCEPTS SUCH AS DEHN TWISTS, CURVE COMPLEXES, AND NIELSEN-THURSTON CLASSIFICATION. THE TEXT BALANCES RIGOROUS PROOFS WITH INTUITIVE EXPLANATIONS, MAKING IT SUITABLE FOR GRADUATE STUDENTS AND RESEARCHERS NEW TO THE FIELD.

2. *MAPPING CLASS GROUPS AND MODULI SPACES OF RIEMANN SURFACES* EDITED BY BENSON FARB

THIS COLLECTION OF SURVEY ARTICLES EXPLORES THE INTERPLAY BETWEEN MAPPING CLASS GROUPS AND MODULI SPACES OF RIEMANN SURFACES. IT INCLUDES CONTRIBUTIONS FROM LEADING EXPERTS DISCUSSING TOPICS SUCH AS TEICHMÜLLER THEORY, AUTOMORPHISMS OF SURFACES, AND APPLICATIONS TO ALGEBRAIC GEOMETRY. THE VOLUME IS IDEAL FOR THOSE INTERESTED IN THE GEOMETRIC AND ALGEBRAIC ASPECTS OF MAPPING CLASS GROUPS.

3. *INTRODUCTION TO TEICHMÜLLER SPACE* BY Y. IMAYOSHI AND M. TANIGUCHI

THOUGH PRIMARILY FOCUSED ON TEICHMÜLLER THEORY, THIS BOOK PROVIDES ESSENTIAL BACKGROUND ON MAPPING CLASS GROUPS THROUGH THEIR ACTION ON TEICHMÜLLER SPACES. IT OFFERS DETAILED TREATMENTS OF HYPERBOLIC GEOMETRY, QUASICONFORMAL MAPPINGS, AND THE STRUCTURE OF MODULI SPACES. THE TEXT IS WELL-SUITED FOR READERS SEEKING A GEOMETRIC PERSPECTIVE ON MAPPING CLASS GROUPS.

4. *AUTOMORPHISMS OF SURFACES AFTER NIELSEN AND THURSTON* BY ANDREW J. CASSON AND STEVEN A. BLEILER

THIS CLASSIC TEXT DELVES INTO THE NIELSEN-THURSTON CLASSIFICATION OF SURFACE AUTOMORPHISMS, A CORNERSTONE IN THE STUDY OF MAPPING CLASS GROUPS. IT EXPLAINS THE CLASSIFICATION INTO PERIODIC, REDUCIBLE, AND PSEUDO-ANOSOV TYPES, PROVIDING PROOFS AND EXAMPLES. THE BOOK IS A VALUABLE RESOURCE FOR UNDERSTANDING THE DYNAMICAL ASPECTS OF MAPPING CLASS GROUPS.

5. *GEOMETRIC GROUP THEORY* EDITED BY CORNELIA DRUȚU AND MICHAEL KAPOVICH

WHILE COVERING A BROAD RANGE OF TOPICS IN GEOMETRIC GROUP THEORY, THIS VOLUME INCLUDES IMPORTANT CHAPTERS ON MAPPING CLASS GROUPS AND THEIR GEOMETRIC PROPERTIES. IT DISCUSSES CURVE COMPLEXES, HYPERBOLICITY, AND RIGIDITY PHENOMENA ASSOCIATED WITH MAPPING CLASS GROUPS. THE BOOK IS SUITABLE FOR READERS INTERESTED IN THE BROADER CONTEXT OF MAPPING CLASS GROUPS WITHIN GEOMETRIC GROUP THEORY.

6. *SURFACE HOMEOMORPHISMS AND THEIR MAPPING CLASS GROUPS* BY JOAN S. BIRMAN

JOAN BIRMAN'S WORK PROVIDES A COMPREHENSIVE STUDY OF SURFACE HOMEOMORPHISMS AND THE RESULTING MAPPING CLASS GROUPS. IT COVERS BRAID GROUPS, DEHN TWISTS, AND THE ALGEBRAIC STRUCTURE OF MAPPING CLASS GROUPS. THIS FOUNDATIONAL TEXT IS OFTEN RECOMMENDED FOR THOSE BEGINNING RESEARCH IN THE TOPOLOGY OF SURFACES.

7. *COMBINATORIAL GROUP THEORY AND TOPOLOGY* EDITED BY S.M. GERSTEN AND J.R. STALLINGS

THIS COLLECTION INCLUDES INFLUENTIAL PAPERS AND SURVEYS RELATED TO THE ALGEBRAIC AND TOPOLOGICAL ASPECTS OF MAPPING CLASS GROUPS. TOPICS SUCH AS PRESENTATIONS OF GROUPS, COMPLEXES OF CURVES, AND APPLICATIONS TO 3-MANIFOLDS ARE TREATED. IT IS AN EXCELLENT RESOURCE FOR UNDERSTANDING THE COMBINATORIAL SIDE OF MAPPING CLASS GROUPS.

8. *TRAIN TRACKS AND SURFACE HOMEOMORPHISMS* BY R.C. PENNER AND J.L. HARER

FOCUSING ON TRAIN TRACK TECHNIQUES, THIS BOOK PROVIDES POWERFUL TOOLS FOR STUDYING MAPPING CLASS GROUPS AND SURFACE AUTOMORPHISMS. IT EXPLORES THE COMBINATORIAL AND GEOMETRIC METHODS THAT ILLUMINATE THE STRUCTURE OF MAPPING CLASS GROUPS, ESPECIALLY IN THE CONTEXT OF PSEUDO-ANOSOV HOMEOMORPHISMS. THE TEXT IS BOTH COMPREHENSIVE AND TECHNICAL, SUITABLE FOR ADVANCED READERS.

9. *HYPERBOLIC GEOMETRY AND MAPPING CLASS GROUPS* BY LEE MOSHER

THIS MONOGRAPH EXPLORES THE RICH CONNECTIONS BETWEEN HYPERBOLIC GEOMETRY AND MAPPING CLASS GROUPS, EMPHASIZING THE GEOMETRIC STRUCTURES THAT ARISE FROM SURFACE GROUP ACTIONS. IT DISCUSSES HYPERBOLIC 3-MANIFOLDS, CURVE COMPLEXES, AND THE GEOMETRY OF THE TEICHMÜLLER SPACE. THE BOOK IS VALUABLE FOR THOSE INTERESTED IN THE GEOMETRIC AND DYNAMICAL ASPECTS OF MAPPING CLASS GROUPS.

Primer Of Mapping Class Groups

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primer of mapping class groups: Problems on Mapping Class Groups and Related Topics Benson Farb, 2006-09-12 The appearance of mapping class groups in mathematics is ubiquitous. The

book presents 23 papers containing problems about mapping class groups, the moduli space of Riemann surfaces, Teichmüller geometry, and related areas. Each paper focusses completely on open problems and directions. The problems range in scope from specific computations, to broad programs. The goal is to have a rich source of problems which have been formulated explicitly and accessibly. The book is divided into four parts. Part I contains problems on the combinatorial and (co)homological group-theoretic aspects of mapping class groups, and the way in which these relate to problems in geometry and topology. Part II concentrates on connections with classification problems in 3-manifold theory, the theory of symplectic 4-manifolds, and algebraic geometry. A wide variety of problems, from understanding billiard trajectories to the classification of Kleinian groups, can be reduced to differential and synthetic geometry problems about moduli space. Such problems and connections are discussed in Part III. Mapping class groups are related, both concretely and philosophically, to a number of other groups, such as braid groups, lattices in semisimple Lie groups, and automorphism groups of free groups. Part IV concentrates on problems surrounding these relationships. This book should be of interest to anyone studying geometry, topology, algebraic geometry or infinite groups. It is meant to provide inspiration for everyone from graduate students to senior researchers.

primer of mapping class groups: Hochschild Cohomology, Modular Tensor Categories, and Mapping Class Groups I Simon Lentner, Svea Nora Mierach, Christoph Schweigert, Yorck Sommerhäuser, 2023-07-25 The book addresses a key question in topological field theory and logarithmic conformal field theory: In the case where the underlying modular category is not semisimple, topological field theory appears to suggest that mapping class groups do not only act on the spaces of chiral conformal blocks, which arise from the homomorphism functors in the category, but also act on the spaces that arise from the corresponding derived functors. It is natural to ask whether this is indeed the case. The book carefully approaches this question by first providing a detailed introduction to surfaces and their mapping class groups. Thereafter, it explains how representations of these groups are constructed in topological field theory, using an approach via nets and ribbon graphs. These tools are then used to show that the mapping class groups indeed act on the so-called derived block spaces. Toward the end, the book explains the relation to Hochschild cohomology of Hopf algebras and the modular group.

primer of mapping class groups: Proceedings Of The International Congress Of Mathematicians 2010 (Icm 2010) (In 4 Volumes) - Vol. I: Plenary Lectures And Ceremonies, Vols. II-IV: Invited Lectures Rajendra Bhatia, Arup Pal, G Rangarajan, V Srinivas, M Vanninathan, 2011-06-06 ICM 2010 proceedings comprises a four-volume set containing articles based on plenary lectures and invited section lectures, the Abel and Noether lectures, as well as contributions based on lectures delivered by the recipients of the Fields Medal, the Nevanlinna, and Chern Prizes. The first volume will also contain the speeches at the opening and closing ceremonies and other highlights of the Congress.

primer of mapping class groups: Moduli Spaces of Riemann Surfaces Benson Farb, Richard Hain, Eduard Looijenga, 2013-08-16 Mapping class groups and moduli spaces of Riemann surfaces were the topics of the Graduate Summer School at the 2011 IAS/Park City Mathematics Institute. This book presents the nine different lecture series comprising the summer school, covering a selection of topics of current interest. The introductory courses treat mapping class groups and Teichmüller theory. The more advanced courses cover intersection theory on moduli spaces, the dynamics of polygonal billiards and moduli spaces, the stable cohomology of mapping class groups, the structure of Torelli groups, and arithmetic mapping class groups. The courses consist of a set of intensive short lectures offered by leaders in the field, designed to introduce students to exciting, current research in mathematics. These lectures do not duplicate standard courses available elsewhere. The book should be a valuable resource for graduate students and researchers interested in the topology, geometry and dynamics of moduli spaces of Riemann surfaces and related topics. Titles in this series are co-published with the Institute for Advanced Study/Park City Mathematics Institute. Members of the Mathematical Association of America (MAA) and the National Council of

Teachers of Mathematics (NCTM) receive a 20% discount from list price.

primer of mapping class groups: *Office Hours with a Geometric Group Theorist* Matt Clay, Dan Margalit, 2017-07-11 Geometric group theory is the study of the interplay between groups and the spaces they act on, and has its roots in the works of Henri Poincaré, Felix Klein, J.H.C. Whitehead, and Max Dehn. *Office Hours with a Geometric Group Theorist* brings together leading experts who provide one-on-one instruction on key topics in this exciting and relatively new field of mathematics. It's like having office hours with your most trusted math professors. An essential primer for undergraduates making the leap to graduate work, the book begins with free groups—actions of free groups on trees, algorithmic questions about free groups, the ping-pong lemma, and automorphisms of free groups. It goes on to cover several large-scale geometric invariants of groups, including quasi-isometry groups, Dehn functions, Gromov hyperbolicity, and asymptotic dimension. It also delves into important examples of groups, such as Coxeter groups, Thompson's groups, right-angled Artin groups, lamplighter groups, mapping class groups, and braid groups. The tone is conversational throughout, and the instruction is driven by examples. Accessible to students who have taken a first course in abstract algebra, *Office Hours with a Geometric Group Theorist* also features numerous exercises and in-depth projects designed to engage readers and provide jumping-off points for research projects.

primer of mapping class groups: Geometric Group Theory Mladen Bestvina, Michah Sageev, Karen Vogtmann, 2014-12-24 Geometric group theory refers to the study of discrete groups using tools from topology, geometry, dynamics and analysis. The field is evolving very rapidly and the present volume provides an introduction to and overview of various topics which have played critical roles in this evolution. The book contains lecture notes from courses given at the Park City Math Institute on Geometric Group Theory. The institute consists of a set of intensive short courses offered by leaders in the field, designed to introduce students to exciting, current research in mathematics. These lectures do not duplicate standard courses available elsewhere. The courses begin at an introductory level suitable for graduate students and lead up to currently active topics of research. The articles in this volume include introductions to $CAT(0)$ cube complexes and groups, to modern small cancellation theory, to isometry groups of general $CAT(0)$ spaces, and a discussion of nilpotent genus in the context of mapping class groups and $CAT(0)$ groups. One course surveys quasi-isometric rigidity, others contain an exploration of the geometry of Outer space, of actions of arithmetic groups, lectures on lattices and locally symmetric spaces, on marked length spectra and on expander graphs, Property tau and approximate groups. This book is a valuable resource for graduate students and researchers interested in geometric group theory. Titles in this series are co-published with the Institute for Advanced Study/Park City Mathematics Institute. Members of the Mathematical Association of America (MAA) and the National Council of Teachers of Mathematics (NCTM) receive a 20% discount from list price.

primer of mapping class groups: *In the Tradition of Thurston III* Ken'ichi Ohshika, Athanase Papadopoulos, 2024-03-19 William 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 purpose of the present volume and of the other volumes in the same series is to provide a collection of articles that allows the reader to learn the important aspects of Thurston's heritage. The topics covered in this volume include Kleinian groups, holomorphic motions, earthquakes from the Anti-de Sitter point of view, the Thurston and Weil-Petersson metrics on Teichmüller space, 3-manifolds, geometric structures, dynamics on surfaces, homeomorphism groups of 2-manifolds and the theory of orbifolds.

primer of mapping class groups: *Lectures on Geometry* Nicholas Michael John Woodhouse, 2017 This book contains a series of chapters by leading researchers and practitioners on community engagement approaches in the field of counterterrorism and counterinsurgency. It presents existing and emerging community engagement models in various parts of the world which could serve as effective models for governments keen to work with community leaders to manage and reduce the terrorist threat. The book emphasizes the strength of communities as central to government

approaches in countering violent extremism.

primer of mapping class groups: *Computational Algebraic and Analytic Geometry* Mika Seppälä, Emil Volcheck, 2012 This volume contains the proceedings of three AMS Special Sessions on Computational Algebraic and Analytic Geometry for Low-Dimensional Varieties held January 8, 2007, in New Orleans, LA; January 6, 2009, in Washington, DC; and January 6, 2011, in New Orleans, LA. Algebraic, analytic, and geometric methods are used to study algebraic curves and Riemann surfaces from a variety of points of view. The object of the study is the same. The methods are different. The fact that a multitude of methods, stemming from very different mathematical cultures, can be used to study the same objects makes this area both fascinating and challenging.

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the memory of Anastasios Mallios (Athens, Greece). This series of conferences started in 1999 in Tartu, Estonia and were subsequently held in Rabat, Morocco (2000), Oulu, Finland (2001), Oaxaca, Mexico (2002), Bedlewo, Poland (2003), Athens, Greece (2005) and Tartu, Estonia (2008 and 2013). The topics of the conference include all areas of mathematics, connected with (preferably general) topological algebras and their applications, including all kinds of topological-algebraic structures as topological linear spaces, topological rings, topological modules, topological groups and semigroups; bornological-algebraic structures such as bornological linear spaces, bornological algebras, bornological groups, bornological rings and modules; algebraic and topological K-theory; topological module bundles, sheaves and others. Contents Some results on spectral properties of unital algebras and on the algebra of linear operators on a unital algebra Descriptions of all closed maximal one-sided ideals in topological algebras On non self-adjoint operators defined by Riesz bases in Hilbert and rigged Hilbert spaces Functional calculus on algebras of operators generated by a self-adjoint operator in Pontryagin space Π_1 On Gelfand-Naimark type Theorems for unital abelian complex and real locally C^* -, and locally JB-algebras Multipliers and strictly real topological algebras Multipliers in some perfect locally m-pseudo-convex algebras Wedderburn structure theorems for two-sided locally m-convex H^* -algebras Homologically best modules in classical and quantized functional analysis Operator Grüss inequality Main embedding theorems for symmetric spaces of measurable functions Mapping class groups are linear Subnormable A-convex algebras Commutative BP^* -algebras and Gelfand-Naimark's theorem Discrete nonclosed subsets in maximally nondiscrete topological groups Faithfully representable topological $*$ -algebras: some spectral properties On continuity of complementors in topological algebras Dominated ergodic theorem for isometries of non-commutative L_p -spaces, $1 \leq p \neq 2$ Ranks and the approximate n -th root property of C^* -algebras Dense ideals in topological algebras: some results and open problems

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