

Torus Fibrations Gerbes And Duality

[#Torus Fibrations](#) [#Gerbes](#) [#Mathematical Duality](#) [#Algebraic Topology](#) [#Higher Category Theory](#)

Explore the intricate connections between Torus Fibrations, fundamental structures in topology and geometry, and Gerbes, advanced concepts often encountered in higher category theory and differential geometry. This content illuminates the profound principle of Duality as it applies across these complex mathematical frameworks, offering insights into their theoretical underpinnings and potential applications in fields like mathematical physics.

Each note is structured to summarize important concepts clearly and concisely.

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Torus Fibrations, Gerbes, and Duality

Let $X \rightarrow B$ be a smooth elliptic fibration over a smooth base B . Under mild assumptions, the authors establish a Fourier-Mukai equivalence between the derived categories of two objects, each of which is an $\mathcal{O} \otimes \mathbb{Z}$ gerbe over a genus one fibration which is a twisted form

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String-Math 2013

This volume contains the proceedings of the conference 'String-Math 2013' which was held June 17-21, 2013 at the Simons Center for Geometry and Physics at Stony Brook University. This was the third in a series of annual meetings devoted to the interface of mathematics and string theory. Topics include the latest developments in supersymmetric and topological field theory, localization techniques, the mathematics of quantum field theory, superstring compactification and duality, scattering amplitudes and their relation to Hodge theory, mirror symmetry and two-dimensional conformal field theory, and many more. This book will be important reading for researchers and students in the area, and for all mathematicians and string theorists who want to update themselves on developments in the math-string interface.

K-theory and Noncommutative Geometry

Since its inception 50 years ago, K-theory has been a tool for understanding a wide-ranging family of mathematical structures and their invariants: topological spaces, rings, algebraic varieties and operator algebras are the dominant examples. The invariants range from characteristic classes in cohomology, determinants of matrices, Chow groups of varieties, as well as traces and indices of elliptic operators.

Thus K-theory is notable for its connections with other branches of mathematics. Noncommutative geometry develops tools which allow one to think of noncommutative algebras in the same footing as commutative ones: as algebras of functions on (noncommutative) spaces. The algebras in question come from problems in various areas of mathematics and mathematical physics; typical examples include algebras of pseudodifferential operators, group algebras, and other algebras arising from quantum field theory. To study noncommutative geometric problems one considers invariants of the relevant noncommutative algebras. These invariants include algebraic and topological K-theory, and also cyclic homology, discovered independently by Alain Connes and Boris Tsygan, which can be regarded both as a noncommutative version of de Rham cohomology and as an additive version of K-theory. There are primary and secondary Chern characters which pass from K-theory to cyclic homology. These characters are relevant both to noncommutative and commutative problems and have applications ranging from index theorems to the detection of singularities of commutative algebraic varieties. The contributions to this volume represent this range of connections between K-theory, noncommutative geometry, and other branches of mathematics.

The Many Facets of Geometry

Few people have proved more influential in the field of differential and algebraic geometry, and in showing how this links with mathematical physics, than Nigel Hitchin. Oxford University's Savilian Professor of Geometry has made fundamental contributions in areas as diverse as: spin geometry, instanton and monopole equations, twistor theory, symplectic geometry of moduli spaces, integrable systems, Higgs bundles, Einstein metrics, hyperkähler geometry, Frobenius manifolds, Painlevé equations, special Lagrangian geometry and mirror symmetry, theory of gerbes, and many more. He was previously Rouse Ball Professor of Mathematics at Cambridge University, as well as Professor of Mathematics at the University of Warwick, is a Fellow of the Royal Society and has been the President of the London Mathematical Society. The chapters in this fascinating volume, written by some of the greats in their fields (including four Fields Medalists), show how Hitchin's ideas have impacted on a wide variety of subjects. The book grew out of the Geometry Conference in Honour of Nigel Hitchin, held in Madrid, with some additional contributions, and should be required reading for anyone seeking insights into the overlap between geometry and physics.

Enumerative Invariants in Algebraic Geometry and String Theory

Starting in the middle of the 80s, there has been a growing and fruitful interaction between algebraic geometry and certain areas of theoretical high-energy physics, especially the various versions of string theory. Physical heuristics have provided inspiration for new mathematical definitions (such as that of Gromov-Witten invariants) leading in turn to the solution of problems in enumerative geometry. Conversely, the availability of mathematically rigorous definitions and theorems has benefited the physics research by providing the required evidence in fields where experimental testing seems problematic. The aim of this volume, a result of the CIME Summer School held in Cetraro, Italy, in 2005, is to cover part of the most recent and interesting findings in this subject.

Geometric Aspects of Dwork Theory

Dieses zweibändige Werk versammelt Vorlesungen, gehalten in memoriam Professor Bernard Dwork (1923-1998), anlässlich eines dreimonatigen Vorlesungszyklus in Norditalien von Mai bis Juli 2001.

String-Math 2011

The nature of interactions between mathematicians and physicists has been thoroughly transformed in recent years. String theory and quantum field theory have contributed a series of profound ideas that gave rise to entirely new mathematical fields and revitalized older ones. The influence flows in both directions, with mathematical techniques and ideas contributing crucially to major advances in string theory. A large and rapidly growing number of both mathematicians and physicists are working at the string-theoretic interface between the two academic fields. The String-Math conference series aims to bring together leading mathematicians and mathematically minded physicists working in this interface. This volume contains the proceedings of the inaugural conference in this series, String-Math 2011, which was held June 6-11, 2011, at the University of Pennsylvania.

Fourier-Mukai and Nahm Transforms in Geometry and Mathematical Physics

Integral transforms, such as the Laplace and Fourier transforms, have been major tools in mathematics for at least two centuries. In the last three decades the development of a number of novel ideas in algebraic geometry, category theory, gauge theory, and string theory has been closely related to generalizations of integral transforms of a more geometric character. "Fourier–Mukai and Nahm Transforms in Geometry and Mathematical Physics" examines the algebro-geometric approach (Fourier–Mukai functors) as well as the differential-geometric constructions (Nahm). Also included is a considerable amount of material from existing literature which has not been systematically organized into a monograph. Key features: Basic constructions and definitions are presented in preliminary background chapters - Presentation explores applications and suggests several open questions - Extensive bibliography and index. This self-contained monograph provides an introduction to current research in geometry and mathematical physics and is intended for graduate students and researchers just entering this field.

Algebraic Geometry

This volume contains research and expository papers by some of the speakers at the 2005 AMS Summer Institute on Algebraic Geometry. Numerous papers delve into the geometry of various moduli spaces, including those of stable curves, stable maps, coherent sheaves, and abelian varieties.

Mixed-Norm Inequalities and Operator Space L_p Embedding Theory

Contains the proof of a noncommutative analogue of the inequality for sums of free random variables over a given von Neumann subalgebra.

Cohomological Invariants: Exceptional Groups and Spin Groups

This volume concerns invariants of G -torsors with values in mod p Galois cohomology--in the sense of Serre's lectures in the book Cohomological invariants in Galois cohomology--for various simple algebraic groups G and primes p . The author determines the invariants for the exceptional groups F_4 mod 3, simply connected E_6 mod 3, E_7 mod 3, and E_8 mod 5. He also determines the invariants of Spin_n mod 2 for $n \leq 12$ and constructs some invariants of Spin_{14} . Along the way, the author proves that certain maps in nonabelian cohomology are surjective. These surjectivities give as corollaries Pfister's results on 10- and 12-dimensional quadratic forms and Rost's theorem on 14-dimensional quadratic forms. This material on quadratic forms and invariants of Spin_n is based on unpublished work of Markus Rost. An appendix by Detlev Hoffmann proves a generalization of the Common Slot Theorem for 2-Pfister quadratic forms.

Regular Subgroups of Primitive Permutation Groups

Addresses the classical problem of determining finite primitive permutation groups G with a regular subgroup B .

Multi-Pulse Evolution and Space-Time Chaos in Dissipative Systems

The authors study semilinear parabolic systems on the full space $\mathbb{R}^n$ that admit a family of exponentially decaying pulse-like steady states obtained via translations. The multi-pulse solutions under consideration look like the sum of infinitely many such pulses which are well separated. They prove a global center-manifold reduction theorem for the temporal evolution of such multi-pulse solutions and show that the dynamics of these solutions can be described by an infinite system of ODEs for the positions of the pulses. As an application of the developed theory, The authors verify the existence of Sinai-Bunimovich space-time chaos in 1D space-time periodically forced Swift-Hohenberg equation.

Thermodynamical Formalism and Multifractal Analysis for Meromorphic Functions of Finite Order

"Volume 203, number 954 (third of 5 numbers)."

A Proof of Alon's Second Eigenvalue Conjecture and Related Problems

A d -regular graph has largest or first (adjacency matrix) eigenvalue $\lambda_1 = d$. Consider for an even $d \geq 4$, a random d -regular graph model formed from $d/2$ uniform, independent permutations on $\{1, \dots, n\}$. The author shows that for any $\epsilon > 0$ all eigenvalues aside

from $\lambda_1=d$ are bounded by $2\sqrt{d-1}+\epsilon$ with probability $1-O(n^{-\tau})$, where $\tau=\lceil \frac{\sqrt{d-1}+1}{2} \rceil-1$. He also shows that this probability is at most $1-c/n^\tau$, for a constant c and a τ that is either τ or $\tau+1$ ("more often" τ than $\tau+1$). He proves related theorems for other models of random graphs, including models with d odd.

Rank One Higgs Bundles and Representations of Fundamental Groups of Riemann Surfaces

This expository article details the theory of rank one Higgs bundles over a closed Riemann surface X and their relation to representations of the fundamental group of X . The authors construct an equivalence between the deformation theories of flat connections and Higgs pairs. This provides an identification of moduli spaces arising in different contexts. The moduli spaces are real Lie groups. From each context arises a complex structure, and the different complex structures define a hyperkähler structure. The twistor space, real forms, and various group actions are computed explicitly in terms of the Jacobian of X . The authors describe the moduli spaces and their geometry in terms of the Riemann period matrix of X .

The Recognition Theorem for Graded Lie Algebras in Prime Characteristic

The "Recognition Theorem" for graded Lie algebras is an essential ingredient in the classification of finite-dimensional simple Lie algebras over an algebraically closed field of characteristic $p>3$. The main goal of this monograph is to present the first complete proof of this fundamental result.

Brownian Brownian Motion-I

A classical model of Brownian motion consists of a heavy molecule submerged into a gas of light atoms in a closed container. In this work the authors study a 2D version of this model, where the molecule is a heavy disk of mass $M \gg 1$ and the gas is represented by just one point particle of mass $m=1$, which interacts with the disk and the walls of the container via elastic collisions. Chaotic behavior of the particles is ensured by convex (scattering) walls of the container. The authors prove that the position and velocity of the disk, in an appropriate time scale, converge, as $M \rightarrow \infty$, to a Brownian motion (possibly, inhomogeneous); the scaling regime and the structure of the limit process depend on the initial conditions. The proofs are based on strong hyperbolicity of the underlying dynamics, fast decay of correlations in systems with elastic collisions (billiards), and methods of averaging theory.

On the convergence of $\sum c_{k(n_k)}$

Presents a general study of the convergence problem and intends to prove several fresh results and improve a number of old results in the field. This title studies the case when the n_k are random and investigates the discrepancy the sequence $(n_k) \bmod 1$.

The Topological Dynamics of Ellis Actions

An Ellis semigroup is a compact space with a semigroup multiplication which is continuous in only one variable. An Ellis action is an action of an Ellis semigroup on a compact space such that for each point in the space the evaluation map from the semigroup to the space is continuous. At first the weak linkage between the topology and the algebra discourages expectations that such structures will have much utility. However, Ellis has demonstrated that these actions arise naturally from classical topological actions of locally compact groups on compact spaces and provide a useful tool for the study of such actions. In fact, via the apparatus of the enveloping semigroup the classical theory of topological dynamics is subsumed by the theory of Ellis actions. The authors' exposition describes and extends Ellis' theory and demonstrates its usefulness by unifying many recently introduced concepts related to proximality and distality. Moreover, this approach leads to several results which are new even in the classical setup.

Heisenberg Calculus and Spectral Theory of Hypoelliptic Operators on Heisenberg Manifolds

This memoir deals with the hypoelliptic calculus on Heisenberg manifolds, including CR and contact manifolds. In this context the main differential operators at stake include the Hormander's sum of squares, the Kohn Laplacian, the horizontal sublaplacian, the CR conformal operators of Gover-Graham and the contact Laplacian. These operators cannot be elliptic and the relevant pseudodifferential calculus to study them is provided by the Heisenberg calculus of Beals-Greiner and Taylor.

Degree Theory for Operators of Monotone Type and Nonlinear Elliptic Equations with Inequality Constraints

In this paper the authors examine the degree map of multivalued perturbations of nonlinear operators of monotone type and prove that at a local minimizer of the corresponding Euler functional, this degree equals one.

Scattering Resonances for Several Small Convex Bodies and the Lax-Phillips Conjecture

This work deals with scattering by obstacles which are finite disjoint unions of strictly convex bodies with smooth boundaries in an odd dimensional Euclidean space. The class of obstacles of this type which is considered are contained in a given (large) ball and have some additional properties.

Hypocoercivity

This memoir attempts at a systematic study of convergence to stationary state for certain classes of degenerate diffusive equations, taking the general form $\frac{\partial f}{\partial t} + Lf = 0$. The question is whether and how one can overcome the degeneracy by exploiting commutators.

Twisted Pseudodifferential Calculus and Application to the Quantum Evolution of Molecules

The authors construct an abstract pseudodifferential calculus with operator-valued symbol, suitable for the treatment of Coulomb-type interactions, and they apply it to the study of the quantum evolution of molecules in the Born-Oppenheimer approximation, in the case of the electronic Hamiltonian admitting a local gap in its spectrum. In particular, they show that the molecular evolution can be reduced to the one of a system of smooth semiclassical operators, the symbol of which can be computed explicitly. In addition, they study the propagation of certain wave packets up to long time values of Ehrenfest order.

Points and Curves in the Monster Tower

Cartan introduced the method of prolongation which can be applied either to manifolds with distributions (Pfaffian systems) or integral curves to these distributions. Repeated application of prolongation to the plane endowed with its tangent bundle yields the Monster tower, a sequence of manifolds, each a circle bundle over the previous one, each endowed with a rank $2s$ distribution. In an earlier paper (2001), the authors proved that the problem of classifying points in the Monster tower up to symmetry is the same as the problem of classifying Goursat distribution flags up to local diffeomorphism. The first level of the Monster tower is a three-dimensional contact manifold and its integral curves are Legendrian curves. The philosophy driving the current work is that all questions regarding the Monster tower (and hence regarding Goursat distribution germs) can be reduced to problems regarding Legendrian curve singularities.

Center Manifolds for Semilinear Equations with Non-Dense Domain and Applications to Hopf Bifurcation in Age Structured Models

Several types of differential equations, such as delay differential equations, age-structure models in population dynamics, evolution equations with boundary conditions, can be written as semilinear Cauchy problems with an operator which is not densely defined in its domain. The goal of this paper is to develop a center manifold theory for semilinear Cauchy problems with non-dense domain. Using Liapunov-Perron method and following the techniques of Vanderbauwhede et al. in treating infinite dimensional systems, the authors study the existence and smoothness of center manifolds for semilinear Cauchy problems with non-dense domain. As an application, they use the center manifold theorem to establish a Hopf bifurcation theorem for age structured models.

The Minimal Polynomials of Unipotent Elements in Irreducible Representations of the Classical Groups in Odd Characteristic

The minimal polynomials of the images of unipotent elements in irreducible rational representations of the classical algebraic groups over fields of odd characteristic are found. These polynomials have the form $(t-1)^d$ and hence are completely determined by their degrees. In positive characteristic the degree of such polynomial cannot exceed the order of a relevant element. It occurs that for each unipotent element the degree of its minimal polynomial in an irreducible representation is equal to the order of this element provided the highest weight of the representation is large enough with respect to the ground field characteristic. On the other hand, classes of unipotent elements for which in every nontrivial representation the degree of the minimal polynomial is equal to the order of the element are indicated. In the general case the problem of computing the minimal polynomial of the image of a given element of order p^s in a fixed irreducible representation of a classical group over a field of characteristic $p > 2$ can be reduced to a similar problem for certain s unipotent elements and a certain irreducible representation of some semisimple group over the field of complex numbers. For the latter problem an explicit algorithm is given. Results of explicit computations for groups of small ranks are contained in Tables I-XII. The article may be regarded as a contribution to the programme of extending the fundamental results of Hall and Higman (1956) on the minimal polynomials from p -solvable linear groups to semisimple groups.

Index Theory, Eta Forms, and Deligne Cohomology

This paper sets up a language to deal with Dirac operators on manifolds with corners of arbitrary codimension. In particular the author develops a precise theory of boundary reductions. The author introduces the notion of a taming of a Dirac operator as an invertible perturbation by a smoothing operator. Given a Dirac operator on a manifold with boundary faces the author uses the tamings of its boundary reductions in order to turn the operator into a Fredholm operator. Its index is an obstruction against extending the taming from the boundary to the interior. In this way he develops an inductive procedure to associate Fredholm operators to Dirac operators on manifolds with corners and develops the associated obstruction theory.

Sum Formula for SL_2 Over a Totally Real Number Field

The authors prove a general form of the sum formula SL_2 over a totally real number field. This formula relates sums of Kloosterman sums to products of Fourier coefficients of automorphic representations. The authors give two versions: the spectral sum formula (in short: sum formula) and the Kloosterman sum formula. They have the independent test function in the spectral term, in the sum of Kloosterman sums, respectively.

Asymptotic Expansions for Infinite Weighted Convolutions of Heavy Tail Distributions and Applications

The authors establish some asymptotic expansions for infinite weighted convolution of distributions having regularly varying tails. Applications to linear time series models, tail index estimation, compound sums, queueing theory, branching processes, infinitely divisible distributions and implicit transient renewal equations are given. A noteworthy feature of the approach taken in this paper is that through the introduction of objects, which the authors call the Laplace characters, a link is established between tail area expansions and algebra. By virtue of this representation approach, a unified method to establish expansions across a variety of problems is presented and, moreover, the method can be easily programmed so that a computer algebra package makes implementation of the method not only feasible but simple.

Moderate Deviations for the Range of Planar Random Walks

Given a symmetric random walk in $\mathbb{Z}^2$ with finite second moments, let R_n be the range of the random walk up to time n . The authors study moderate deviations for $R_n - \sqrt{n}E[R_n]$ and $E[R_n] - R_n$. They also derive the corresponding laws of the iterated logarithm.

The Mapping Class Group from the Viewpoint of Measure Equivalence Theory

The author obtains some classification result for the mapping class groups of compact orientable surfaces in terms of measure equivalence. In particular, the mapping class groups of different closed surfaces cannot be measure equivalent. Moreover, the author gives various examples of discrete

groups which are not measure equivalent to the mapping class groups. In the course of the proof, the author investigates amenability in a measurable sense for the actions of the mapping class group on the boundary at infinity of the curve complex and on the Thurston boundary and, using this investigation, proves that the mapping class group of a compact orientable surface is exact.

Rock Blocks

Consider representation theory associated to symmetric groups, or to Hecke algebras in type A, or to q -Schur algebras, or to finite general linear groups in non-describing characteristic. Rock blocks are certain combinatorially defined blocks appearing in such a representation theory, first observed by R. Rouquier. Rock blocks are much more symmetric than general blocks, and every block is derived equivalent to a Rock block. Motivated by a theorem of J. Chuang and R. Kessar in the case of symmetric group blocks of abelian defect, the author pursues a structure theorem for these blocks.

Noncommutative Curves of Genus Zero

In these notes the author investigates noncommutative smooth projective curves of genus zero, also called exceptional curves. As a main result he shows that each such curve $\mathbb{A}^1$ admits, up to some weighting, a projective coordinate algebra which is a not necessarily commutative graded factorial domain R in the sense of Chatters and Jordan. Moreover, there is a natural bijection between the points of $\mathbb{A}^1$ and the homogeneous prime ideals of height one in R , and these prime ideals are principal in a strong sense.

The Dynamics of Modulated Wave Trains

The authors investigate the dynamics of weakly-modulated nonlinear wave trains. For reaction-diffusion systems and for the complex Ginzburg-Landau equation, they establish rigorously that slowly varying modulations of wave trains are well approximated by solutions to the Burgers equation over the natural time scale. In addition to the validity of the Burgers equation, they show that the viscous shock profiles in the Burgers equation for the wave number can be found as genuine modulated waves in the underlying reaction-diffusion system. In other words, they establish the existence and stability of waves that are time-periodic in appropriately moving coordinate frames which separate regions in physical space that are occupied by wave trains of different, but almost identical, wave number. The speed of these shocks is determined by the Rankine-Hugoniot condition where the flux is given by the nonlinear dispersion relation of the wave trains. The group velocities of the wave trains in a frame moving with the interface are directed toward the interface. Using pulse-interaction theory, the authors also consider similar shock profiles for wave trains with large wave number, that is, for an infinite sequence of widely separated pulses. The results presented here are applied to the FitzHugh-Nagumo equation and to hydrodynamic stability problems.

Volume Doubling Measures and Heat Kernel Estimates on Self-Similar Sets

This paper studies the following three problems. 1. When does a measure on a self-similar set have the volume doubling property with respect to a given distance? 2. Is there any distance on a self-similar set under which the contraction mappings have the prescribed values of contractions ratios? 3. When does a heat kernel on a self-similar set associated with a self-similar Dirichlet form satisfy the Li-Yau type sub-Gaussian diagonal estimate? These three problems turn out to be closely related. The author introduces a new class of self-similar set, called rationally ramified self-similar sets containing both the Sierpinski gasket and the (higher dimensional) Sierpinski carpet and gives complete solutions of the above three problems for this class. In particular, the volume doubling property is shown to be equivalent to the upper Li-Yau type sub-Gaussian diagonal estimate of a heat kernel.

Birational Geometry, Rational Curves, and Arithmetic

This book features recent developments in a rapidly growing area at the interface of higher-dimensional birational geometry and arithmetic geometry. It focuses on the geometry of spaces of rational curves, with an emphasis on applications to arithmetic questions. Classically, arithmetic is the study of rational or integral solutions of diophantine equations and geometry is the study of lines and conics. From the modern standpoint, arithmetic is the study of rational and integral points on algebraic varieties over nonclosed fields. A major insight of the 20th century was that arithmetic properties of an algebraic variety are tightly linked to the geometry of rational curves on the variety and how they vary in families.

This collection of solicited survey and research papers is intended to serve as an introduction for graduate students and researchers interested in entering the field, and as a source of reference for experts working on related problems. Topics that will be addressed include: birational properties such as rationality, unirationality, and rational connectedness, existence of rational curves in prescribed homology classes, cones of rational curves on rationally connected and Calabi-Yau varieties, as well as related questions within the framework of the Minimal Model Program.

The Creation of Strange Non-Chaotic Attractors in Non-Smooth Saddle-Node Bifurcations

The author proposes a general mechanism by which strange non-chaotic attractors (SNA) are created during the collision of invariant curves in quasiperiodically forced systems. This mechanism, and its implementation in different models, is first discussed on an heuristic level and by means of simulations. In the considered examples, a stable and an unstable invariant circle undergo a saddle-node bifurcation, but instead of a neutral invariant curve there exists a strange non-chaotic attractor-repeller pair at the bifurcation point. This process is accompanied by a very characteristic behaviour of the invariant curves prior to their collision, which the author calls 'exponential evolution of peaks'.