GSCAGT 2017 Title and Abstract List

Talks marked with a dagger (†) indicate expository talks

Inscrutability

Michael Andersen, Brigham Young University

A standard tool in algebraic topology is to pass between a continuous map between spaces and the corresponding homomorphism of fundamental groups using the π_1 functor. It is a non-trivial question to ask when a specific homomorphism is induced by a continuous map; that is, what is the image of the π_1 functor on homomorphisms?

CAT(0) groups with path connected boundaries

Michael Ben-Zvi, Tufts University

In the land of hyperbolic groups, there is an important connection between the algebraic properties of the group and the topological properties of the visual boundary. A breakthrough result in that theory was showing that one-ended hyperbolic groups have locally connected boundary; this is related to understanding the splittings of the group over two-ended subgroups. Since the boundary is a compact metric space, this implies such boundaries are globally path-connected. For CAT(0) groups, the connection is less clear. It is known that there are one-ended CAT(0) groups with connected and non-locally connected boundary as well as those with non path-connected boundaries. These examples are obtained using amalgamated products of CAT(0) groups over convex subgroups. We provide sufficient conditions for when such a group also has path-connected boundary and then apply this to the case of CAT(0) groups with the Isolated Flats Property.

Conullity 2 Manifolds (†)

Thomas Brooks, University of Pennsylvania

A conullity 2 manifold is a Riemannian n-manifold whose curvature tensor has a kernel of dimension $n-2$ at each point. In dimension 3, this is equivalent to the Ricci tensor having eigenvalues $\lambda, \lambda, 0$. Trivial conullity 2 manifolds are products of surfaces and Euclidean space. We examine some non-trivial examples and provide the historic motivation for studying them.

Infinitely many families of infinitely many knots with isomorphic Khovanov homology

Jacob Caudell, Boston College

Kanenobu's knots were first presented by T. Kanenobu in 1986 as "[infinitely many families of] infinitely many knots with the same polynomial invariant", following the discovery of the Jones polynomial in 1984. In 2006, L. Watson showed that, moreover, these knots have identical Khovanov homology. We use this fact to show that the double branched cover of any of Kanenobu's knots is an L-space, and furthermore show that its fundamental group is not left-orderable, providing support for a conjecture of S. Boyer, C. Gordon, and L. Watson.

Hierarchies of non-positively curved cube complexes

Teddy Einstein, Cornell University

Wise's malnormal special quotient theorem (MSQT) is a key ingredient in Agol's proof of the Virtual Haken Conjecture. The most important step in proving the MSQT is the construction of a hierarchy for hyperbolic compact special non-positively curved cube complexes. In this talk, I will explain what a hierarchy of a compact special non-positively curved cube complex is and discuss how to generalize a new proof of the MSQT by Agol, Groves and Manning to the relatively hyperbolic setting.

Finite presentability of Kac-Moody groups over finite fields

Zachary Gates, University of Virginia

Kac-Moody groups are groups associated to a class of infinite-dimensional Lie algebras and exist over any ground field. They come with an associated Weyl group and hence Coxeter diagram. A Kac-Moody group G over F_q is always finitely generated, so it is natural to ask if it is also finitely presented. If all labels in the Coxeter diagram are finite, then Abramenko and Mhlherr showed that G is finitely presented with a few exceptions if $q = 2$ or 3. It has been conjectured that G is never finitely presented if there is one infinite label in the Coxeter diagram. We show that this is the case for at least a few classes of such diagrams by utilizing a theorem of Gandini and choosing an appropriate space on which we let G act.

Translation flow on holomorphic maps out of the poly-plane

Dmitri Gekhtman, California Institute of Technology

We study the family of holomorphic maps from the polydisk to the disk which restrict to the identity on the diagonal. In particular, we analyze the asymptotics of the orbit of such a map under the conjugation action of a unipotent subgroup of $\mathrm{PSL}_2(\mathbb{R})$. We discuss an application of our results to the study of the Carathéodory metric on Teichmüller space.

Exponentiation of motivic zeta functions

Jonathan Huang, University of Maryland College Park

We provide a formula for the generating series of the Hasse-Weil zeta function $Z(X,t)$ of symmetric powers $\mathrm{Sym}^n X$ of varieties X over finite fields. This realizes the zeta function $Z(X,t)$ as an exponentiable measure whose associated Kapranov motivic zeta function takes values in $W(R)$ the big Witt ring of $R = W(\mathbb{Z})$. The formula provided takes the form of a MacDonald formula for the zeta function. Moreover, we show that λ-ring valued motivic measures also have zeta function measures which are exponentiable. We apply our formula to compute $Z(\mathrm{Sym}^n X,t)$ in a number of explicit cases.

Alternating links have representativity 2

Thomas Kindred, University of Iowa

We prove that if L is a non-trivial alternating link embedded (without crossings) in a closed surface $F \subset S^3$, then F has a compressing disk whose boundary intersects L in no more than two points.

Fundamental groups in algebra and geometry (†)

Andrew Kobin, University of Virginia

There are two important notions in algebraic topology which, for various reasons, one might want to transport to an algebraic setting. These are covering spaces and the fundamental group, and they are intimately connected. We will first recall the close relationship between fundamental groups in topology and Galois groups in field theory, and then develop a common generalization of these in the language of algebraic geometry. We will see then that all three approaches – topology, algebra and geometry – coincide beautifully in the case of a nonsingular curve over the complex numbers. The study of fundamental groups in algebra and geometry has rich applications to the Inverse Galois Problem and Diophantine equations.

Height pairing and determinant line bundle

Yordanka Kovacheva, University of Chicago

I want to present my work on height pairing of cycles modulo relations and the corresponding determinant line bundle and point possible directions for future research. More specifically, I consider the map $CH^p(X) \times CH^q(X) \to Pic(S)$ of Chow groups of a variety X over a base S. Here $p + q = d + 1$, where d is the relative dimension of the morphism $X \to S$. I treat the Chow groups $CH^p(X)$ as categories with the obvious objects and morphisms arising from the $Z^p(X, 1)$ term in Bloch's complex modulo the image of Tame symbols of $K2$-chains. This pairing coincides with the Knudsen-Mumford determinant line bundle using the structure sheaves of the cycles on X.
When the base S is a field F and restricting to algebraically trivial cycles, I show that the image in $Pic(F)$ does not depend on the rational equivalence of the cycles. Based on this, I construct a line bundle on $CH^p_{alg}(X) \times CH^q_{alg}(X)$, which I want to prove is canonically isomorphic to the pull-back via the Abel-Jacobi map of the Poincare line bundle on the Intermediate Jacobians $J^p(X) \times J^q(X)$, in the case $p = 1$. Additionally, I hope to extend the pairing to the case of numerically trivial cycles.

Generating mapping class groups with elements of fixed finite order

Justin Lanier, Georgia Institute of Technology

A surface of genus g has many symmetries. These form the surfaces mapping class group, or $\mathrm{Mod}(S_g)$. After introducing $\mathrm{Mod}(S_g)$, we will discuss some generating sets for this group, focusing on several that are comprised of elements of some fixed finite order. Previous results focused on elements of small order. For example, Brendle and Farb showed that $\mathrm{Mod}(S_g)$ is generated by six elements of order 2 for $g \geq 3$. We will discuss our extension of these results to elements of arbitrary order: for $k > 5$ and g sufficiently large, $\mathrm{Mod}(S_g)$ is generated by three elements of order k.

Group actions on fusion categories and equivariantization

Alex Levin, University of New Hampshire

Let $\mathcal{A}$ be a fusion category over $\mathbb{C}$, and let G be a finite group acting on $\mathcal{A}$. We parameterize subcategories of the equivariantization $\mathcal{A}^G$ by *invariant triples* consisting of a G-stable subcategory of $\mathcal{A}$, a normal subgroup of G, and an isomorphism of actions satisfying a G-invariance condition.

Nonnegatively/positively curved manifolds with symmetry (†)

Yuhang Liu, University of Pennsylvania

In the 1980's,Wu Yi Hsiang and Bruce Kleiner proved that positively curved 4-dimensional compact Riemannian manifolds with continuous symmetry must be quotients of S^4 or $\mathbb{CP}^2$, thus giving a partial answer to the famous Hopf conjecture. Motivated by this, Kasten Grove proposed his "symmetry program", aiming to study positively/nonnegatively curved Riemannian manifolds with "large" symmetry group. In this spirit, people developed many results, including Grove and Searle's work on the maximal rank of positively curved manifolds and classification of fixed point homogeneous positively curved spaces, and Wilking's work on torus action on positively curved manifolds, and many others. If time permits, I will expose more results in this field to the audience.

Analytic aspects of the multiple zeta values and multiple Hurwitz zeta values.

Cezar Lupu, University of Pittsburgh

In this talk, we shall discuss about some new results in the evaluation of some multiple zeta values (MZV). After a careful introduction of the multiple zeta values (Euler-Zagier sums) we point out some conjectures back in the early days of MZV and their combinatorial aspects. Moreover, we provide an evaluation of the Hoffman basis in terms of an infinite rational series involving even values of the Riemann zeta function. We also discuss similar results for the multiple t-values and alternating multiple zeta values. The multiple zeta values (Euler-Zagier sums) were introduced independently by Hoffman and Zagier in 1992 and they play a crucial role at the interface between analysis, number theory, combinatorics, algebra and physics.

The effect of Dehn filling on Thurston norm vs Suzuki's unknotting conjecture (†)

Maggie Miller, Princeton University

We will discuss classical results of Gabai (1987) and Sela (1990) on the effect of Dehn filling on Thurston norm (both terms to be defined during the talk). We will see that these results are related to an old conjecture of Suzuki (1976) on 2-dimensional knots in S^4, and then consider a recent extension by Baker and Taylor (2016) on the effect of Dehn filling on the norms of classes meeting the filled boundary.

Hölder maps on Heisenberg groups

Jacob Mirra, University of Pittsburgh

I will discuss a recent development of the analysis of Hölder continuous mappings to the Heisenberg Group. The line of research was initiated by Roger Züst with the motivation of answering the celebrated Hölder equivalence problem of Gromov. I will show that this method can be used to prove Gromov's Theorem about non-existence of Hölder embeddings of manifolds into $\mathbb{H}^n$ if the Hölder continuity exponent is too large. Also I will show numerical evidence for a counter-example to a conjecture of Gromov. The talk will be based on my joint work with P. Hajłasz and A. Schikorra.

Topological field theories and factorization homology (†)

Benedict Morrissey, University of Pennsylvania

This talk will introduce the notion of a topological field theory. Factorization homology will be used to describe topological field theories related to representation theory and to physical observables. Finally some novel results about extending these theories to higher dimensions will be described.

Computing a database of Belyi maps

Michael Musty, Dartmouth College

We will start with an introduction to Grothendieck's theory of dessins d'enfants (also known as Belyi maps) and the various equivalent categories. Afterwards, we will discuss our current efforts to tabulate a database of all Belyi maps in low degree. This is joint work with Sam Schiavone, Jeroen Sijsling, and John Voight.

Decomposing CAT(0) cube complexes

Christopher O'Donnell, Tufts University

It is known that if a CAT(0) cube complex decomposes as a product, then any group of automorphisms must virtually act as a product of automorphisms of the factors. My talk will discuss how much we can say about a CAT(0) cube complex which admits a nice enough action by a product of groups.

Determinantal representations of hyperbolic plane curves with cyclic invariance

Lillian Faye Pasley, North Carolina State University

Given a determinantal representation by means of a cyclic weighted shift matrix with complex entries, one can show the resulting polynomial is hyperbolic and invariant under the action of the cyclic group. By properly modifying a determinantal representation construction of Dixon (1902), we show for every hyperbolic polynomial with cyclic invariance there exists a determinantal representation admitted via some cyclic weighted shift matrix with complex entries. This is joint work with Konstantinos Lentzos.

Translation like actions of nilpotent groups

Mark Pengitore, Purdue University

We show that for nilpotent groups with the same growth, having non-isomorphic asymptotic cones obstructs the existence of translation like actions.

The elementary theory of groups (†)

Christopher Perez, University of Illinois Chicago

The *elementary theory* of a group G is the set $\mathrm{Th}(G)$ of valid first-order sentences in the language of G. In 2006, Sela and Kharlampovich-Myasnikov proved that any two non-abelian free groups have the same elementary theory, solving a problem first posed by Tarski in 1945.
The geometric approach used by Sela to solve Tarski's problem enabled him to apply the same techniques to study the elementary theory of torsion-free hyperbolic groups. He showed in 2009 that, given a fixed torsion-free hyperbolic group Γ, if G is a finitely generated group such that $\mathrm{Th}(G) = \mathrm{Th}(\Gamma)$, then G is a torsion-free hyperbolic group (not necessarily isomorphic to Γ). The implication of such a result is that elementary theories are capable of detecting the geometric properties of groups.
In this talk we will discuss the history of Tarski's problem and its generalizations, some of the tools developed by geometric group theorists to solve it, and some more recent developments in this field.

Covers of elliptic curves and good reduction

James Phillips, University of Virginia

Raynaud gave a criterion for a branched G-cover $Y \to X$ of curves defined over a discretely valued field K with residue characteristic p to have good reduction in the case of either a three-point cover of $\mathbb{P}^1$ or a one-point cover of an elliptic curve; specifically, such a cover has potentially good reduction whenever G has a Sylow p-subgroup of order p and the absolute ramification index of K is less than the number of conjugacy classes of order p in G. In the case of an elliptic curve, we show how we can generalize this to the case in which G has an arbitrarily large cyclic Sylow p-subgroup.

Mathematical aspects of supersymmetric field theories (†)

Surya Raghavendran, Perimeter Institute for Theoretical Physics

This talk will be an introduction to mathematical aspects of SUSY field theories, with two main goals. The first of these is to motivate a precise definition of perturbative SUSY field theories in the language of formal derived symplectic geometry. The second is to illustrate the utility of such a formulation in extracting representation-theoretic and topological invariants. To this end, I'll describe a construction of Khovanov homology from a twist of 5d N=2 Super Yang-Mills in which the spaces of Hecke modifications appearing in Geometric Langlands play a prominent role. No physics background will be assumed.

Fibered 3-component links of genus zero

Carson Rogers, University of California Davis

A link in a 3-manifold is *fibered* if its complement is a fiber bundle over the circle. The closure of a fiber is a Seifert surface for the link called a *fiber surface*. This talk surrounds the problem of classifying the fibered links in S^3 whose fiber surfaces are of simple topological types. When the fiber surface is an annulus or a once-punctured torus, the list of links is finite and very short. In contrast, when the fiber surface is a pair of pants, there are infinitely many examples. However, it is still possible to classify all of the corresponding links explicitly. I will explain how to do this by using operations known as Stallings twists and the theory of genus two Heegaard diagrams.

An overview of hierarchically hyperbolic spaces (†)

Jacob Russell, CUNY Graduate Center

As a classical example of a group with an interesting and illuminating geometry, the mapping class group of a surface sits as a central example for much of geometric group theory. Masur and Minksy demonstrated that the coarse geometry of the mapping class group can be recovered by examining the hierarchy of projections from the mapping class group onto the curve complex of each subsurface and this prospective has produced substantial progress in understanding the mapping class group. Recently, Behrstock, Hagen, and Sisto proposed the new class of hierarchically hyperbolic spaces which are spaces admitting a hierarchical structure reminiscent of mapping class groups. Surprisingly, this class of spaces encompasses not only the mapping class group, but several other key examples in geometric group theory including, right angled Artin and Coxeter groups, Tiechmüller space, and the fundamental groups of most 3–manifolds. In this talk we will: (1) Give an overview of the definition of a hierarchically hyperbolic space and some of the key properties of this class of spaces. (2) Highlight how the hierarchy machinery has be utilized to produce new results in all of the examples above. (3) Discuss possible avenues for further uses of the theory.

Hom-tensor categories

Paul Schrader, Bowling Green State University

It is known that tensor categories provide the appropriate categorical framework for Hopf algebras. *Hom-algebras(coalgebras)* are algebraic structures that satisfy a generalized associativity (coassociativity) condition. In this presentation we introduce a new type of category called a *hom-tensor category* and show how it provides the appropriate setting for the category of modules over a hom-bialgebra. We then study the notion of a *hom-braided category* and argue that this is the right setting for the category of modules over quasitriangular hom-bialgebras. We also discuss how the hom-Yang-Baxter equation fits into this framework.

Introducing growth of groups (†)

Hang Lu Su, McGill University

The growth of a group is an aesthetically pleasing large-scale property that is borderline geometric and algorithmic. Formally, the growth function of a group G with a generating set S is the number of vertices of the Cayley graph $\gamma(G, S)$ contained in the a ball of radius n with the word metric. I will give an overview on some of the research on growth by historical and intuitive examples. Finally, I will talk a little bit about my research on the growth of the Heisenberg group as time allows.

Inhomogeneous supersymmetric bilinear forms

McKay Sullivan, North Carolina State

We introduce inhomogeneous supersymmetric bilinear forms on a complex superspace and show that they lead to oscillator-like superalgebras where the products of bosonic oscillators with fermionic oscillators are not necessarily zero. We give a classification for superspaces up to dimension 7, provide examples, and indicate a possible approach to generalize the classification to any finite dimension. This talk is based on joint work with Bojko Bakalov.

Linear progress without acylindrical hyperbolicity

Matt Sunderland, CUNY Graduate Center

A random walk on a separable Gromov hyperbolic space converges to a unique point on the boundary at infinity with probability one when two of the probable steps are independent loxodromics. In particular, the random walk escapes from the origin at a linear rate.
This rate of escape is known to approach an exactly linear rate exponentially fast when the set of steps (1) are distributed with exponential tails, and (2) satisfy acylindricality.
We extend the result to the non-acylindrical case.

The Euler characteristic of the moduli space of curves (†)

Ivan Telpukhovskiy, University of Toronto

In the mid-80's, John Harer with Don Zagier found a striking formula for the orbifold euler characteristic of the moduli space of curves, which connects it with the values of the Riemann zeta function at negative integers. Here it is:

$$\chi(\mathcal{M}_g) = \frac{\zeta(1-2g)}{2-2g}$$

In my talk, I will try to explain where it comes from. It will involve lots of polygon gluings, generating functions, some combinatorics and a little bit of integration over the space of hermitian matrices.

Anosov representations (and their degenerations) (†)

Feng Zhu, University of Michigan

The study of hyperbolic manifolds and representations of their fundamental groups leads us to convex co-compact subgroups as a natural and interesting class of discrete subgroups of Lie groups. However, convex co-compact subgroups of higher-rank Lie groups are all essentially lattices. A generalization of convex co-compactness which encompasses a richer range of examples is given by the Anosov condition, which has figured prominently in the emerging field of higher Teichmuller theory. I will describe and motivate the Anosov condition, give examples of Anosov representations, and discuss some open questions, in particular about degenerations of these representations.