Spring 2018

- **January 16** (algebra crosspost - meets in WH-100E at 2:50)
  Speaker: **Jonas Deré** (KU Leuven Kulak)
  Title: **Which manifolds admit expanding maps** *Abstract:* In 1981, M. Gromov completed the proof that every manifold admitting an expanding map is, up to finite cover, homeomorphic to a nilmanifold. Since then it was an open question to give an algebraic characterization of the nilmanifolds admitting an expanding map. During my talk, I will start by introducing the basic notions of expanding maps and nilmanifolds. Then I explain how the existence of such an expanding map only depends on the covering Lie group and on the existence of certain gradings on the corresponding Lie algebra. One of the applications is the construction of a nilmanifold admitting an Anosov diffeomorphism but no expanding map, which is the first example of this type.

- **February 1**
  Speaker: **Jonathan Williams** (Binghamton University)
  Title: **Sewing a homotopy into pieces** *Abstract:* In this talk, I will try to explain the title. There will be 4-manifolds, many pictures, and very little background needed.

- **February 8**
  Speaker: **Russell Ricks** (Binghamton University)
  Title: **A Rank Rigidity Result for Certain Nonpositively Curved Spaces via Spherical Geometry**
  Abstract: To understand the geometry of nonpositively curved (NPC) spaces, it is natural to classify the various types of spaces that can occur. The Rank Rigidity Theorem for compact NPC manifolds separates the class of compact NPC manifolds into three very distinct types, and proves that nothing else can exist. A version of Rank Rigidity has been conjectured for more general NPC spaces (CAT(0) spaces). In this talk, we discuss some progress toward this general conjecture, by reducing the problem to looking at patterns on spheres. In particular, we prove the conjecture for certain NPC spaces with one-dimensional boundary. Unlike previous results in this area, there are no additional constraints on the CAT(0) space (such as a manifold or polyhedral structure).

- **February 15**
  Speaker: **Carlos Vega** (Binghamton University)
  Title: **Null Distance on a Spacetime** *Abstract:* In contrast to the Riemannian setting, a Lorentzian manifold (M,g) is not known to possess any naturally induced distance function. I will first try to explain why that is, starting with some of the basics of spacetime (Lorentzian) geometry. We will then discuss a `null distance function' introduced in joint work with Christina Sormani, some of its properties, examples, and some open questions.

- **February 22 (special two-part talk: see next entry)**
  Speaker: **Olakunle Abawonse** (Binghamton University)
  Title: **Topology of the Grunbaum-Hadwiger-Ramos Hyperplane Mass Partition Problem**
  Abstract: In this talk, we will discuss a problem raised by Ramos that asks for the smallest dimension $d=\Delta(j,k)$ such that for any j measures in $\mathbb{R}^d$, there are k affine hyperplanes that simultaneously cut each measure into $2k$ equal parts. We will give a general configuration space/test map scheme for this problem and show how the theory of relative equivariant obstruction theory applies to this problem.

This is part of a candidacy talk, with committee Laura Anderson (chair), Ross Geoghegan and Michael Dobbins. It is open to all.

- **February 22 (Special time: 4:15pm)**
  Speaker: **Olakunle Abawonse** (Binghamton University)
  Title: **Hyperplane Mass Partitions Via Relative Equivariant Obstruction Theory** *Abstract:* We will give solutions to some of the few cases in which the minimum value $d=\Delta(j,k)$ is known. We will achieve this by showing the non-existence of a certain G-equivariant map. By the theory of relative equivariant obstruction theory, this problem reduces to evaluating some obstruction classes.

  This is part of a candidacy talk, with committee Laura Anderson (chair), Ross Geoghegan and Michael Dobbins. It is open to all.

- **March 1**
  Speaker: **Jun Li** (University of Michigan)
  Title: **The symplectomorphism groups of rational surfaces** *Abstract:* This talk is on the topology of $Symp(M,\omega)$, where $Symp(M,\omega)$ is the symplectomorphism group of a symplectic rational surface (M,ω). We will illustrate our approach with the 5 point blowup of the projective plane. For an arbitrary symplectic form on this rational surface, we are able to determine the symplectic mapping class group (SMC) and describe the answer in terms of the Dynkin diagram of Lagrangian sphere classes. In particular, when deforming the symplectic form, the SMC of a rational surface behaves in the way of forgetting strand map of braid groups. We are also able to compute the fundamental group of $Symp(M, \omega)$ for an open region of the symplectic cone. This is a joint work with Tian-Jun Li and Weiwei Wu.

- **March 8**
  Speaker: **Lisa Piccirillo** (UT-Austin)
  Title: **Stein Knot Traces** *Abstract:* Four-manifolds which admit a Stein structure have many nice properties, for example the Stein structure gives bounds on the genus function of the manifold and Stein cobordisms induce nontrivial maps on the Heegaard Floer homology of the boundary. However, handed an arbitrary four-manifold it can be difficult to determine whether it admits a Stein structure. A question in the field asked whether it is ever straightforward to detect Stein structures on particularly simple manifolds; more technically it asked whether the four manifold $X_n(K)$ obtained by attaching an n-framed 2-handle to B^4 along K is Stein if and only if $n<\overline{tb}(K)$. We answer this in the negative, and in fact show that a Stein $X_n(K)$ can have n arbitrarily much larger than $\overline{tb}(K)$. This talk will focus on the constructive part of our proof, a technique due largely to Osoinach for building knots K and K' with $X_n(K)$ diffeomorphic to $X_n(K')$. This is joint work with Tom Mark and Faramarz Vafaee.

- **March 15 (Special time 2:30 pm)**
  Speaker: **Gili Golan** (Vanderbilt University)
  Title: **Invariable generation of Thompson groups** *Abstract:* A subset S of a group G invariably generates G if for every choice of $g(s)\in G$, $s\in S$ the set $\{s^{g(s)}:s\in S\}$ is a generating set of G. We say that a group G is invariably generated if such S exists, or equivalently if $S=G$ invariably generates G. In this talk, we study invariable generation of Thompson groups. We show that Thompson group F is invariable generated by a finite set, whereas Thompson groups T and V are not invariable generated. This is joint work with Tsachik Gelander and Kate Juschenko.

- **March 22**

Speaker: **Yair Hartman** (Northwestern University)
Title: **Stationary C*-Dynamical Systems** *Abstract:* We introduce the notion of stationary actions in the context of C*-algebras, and prove a new characterization of C*-simplicity in terms of unique stationarity. This ergodic-theoretic characterization provides an intrinsic understanding for the relation between C*-simplicity and the unique trace property, and provides a framework in which C*-simplicity and random walks interact. Joint work with Mehrdad Kalantar.

- **March 29**
  Speaker: **Yuhang Liu** (Penn)
  Title: **Closed 6-manifolds with Positive Sectional Curvature and Non-Abelian symmetry**
  Abstract: Understanding the structure of Riemannian manifolds with strictly positive sectional curvature remains a fundamental problem in Riemannian geometry. In this talk, I will briefly go over the history of the classification of positively curved manifolds in low dimensions under certain symmetry assumptions on the isometry group. Then I will focus on dim 6 and discuss positively curved 6-manifolds whose isometry groups are non-Abelian Lie groups. Examples of such manifolds will be given together with the isometric group actions, and if time permits I will present some results I got in this direction. This is ongoing work on my thesis problem.

- **April 12** 2018 Hilton Memorial lecture
  Speaker: **Vaughan Jones** (Vanderbilt)
  Title: **Local scale transformations in one dimension** *Special time and place:* 3pm–4pm in AA G023

  Abstract: In two dimensional conformal field theory, local scaling symmetry means invariance of some kind under conformal transformations. The quantum theory splits into two one dimensional theories called the “chiral halves”. Conformal invariance then gives a projective representation of the the diffeomorphism group (of the line or the circle) on each of the chiral halves. In an attempt to approximate this local scaling invariance we have considered the Thompson groups F and T as approximations to the diffeomorphism groups. Though this does not work perfectly, it has yielded a kind of “topsy turvy” version of chiral CFT including an interesting family of unitary representations of F and T whose coefficients give, among other things, a way to construct all knots and links from elements of F and T, analogous to the standard construction from the braid groups.

- **April 12**
  Speaker: **Vaughan Jones** (Vanderbilt)
  Title: **The Wysiwyg representations of the Thompson groups** *This is a topology seminar talk in WH-100E at a special time, 1:15pm. See the entry immediately below for the Hilton lecture, immediately following this seminar.*

  Abstract: I will describe a general construction of actions of Thompson’s groups *F, T* and *V* and focus on a special kind - unitary representations on a (necessarily infinite dimensional) Hilbert space, coming from very simple combinatorial data. They can be approached via their matrix coefficients which are literally visible. There are many open questions but at least for one family of combinatorial data we can decide equivalence and irreducibility.

- **April 19**
  Speaker: **Akram Alishahi** (Columbia)
  Title: **Khovanov homology and unknotting number** *Abstract:* Khovanov homology is a combinatorially-defined knot invariant which refines the Jones polynomial. In this talk we will recall the definition of Khovanov homology and one of its refined versions called Bar-Natan homology, and we will

show that the order of h-torsion classes in Bar-Natan homology gives a lower bound for unknotting number.

- **Special date and time: April 24, 1:15pm in WH-100E** (joint with combinatorics)
  Speaker: **Robert Connelly** (Cornell)
  Title: **Tensegrities: Geometric Structures Suspended in Midair** *Abstract:* Suppose you have a finite collection of points in Euclidean space or the plane. Some pairs are connected by inextendible cables, others by incompressible struts, and some by fixed length bars. The artist Kenneth Snelson constructed several large structures, made of cables and bars, that hold their shape under tension, where the struts appear to be suspended in midair. Buckminster Fuller, the architect and inventor, called them “tensegrities” because of their “tensional integrity”. But why do they hold their shape? There is a very simple principle using quadratic energy functions that provides the key to their stability. I will show a catalog of highly symmetric tensegrities, created with the help of a little bit of representation theory, as well as tangible models, where you can feel their rigidity first-hand.

- **Special date and time: May 1, 1:15pm in WH-100E** (joint with combinatorics)
  Speaker: **Boris Bukh** (Carnegie Mellon)
  Title: **Topological Version of Pach's Overlap Theorem** *Abstract:* Consider the collection of all the simplices spanned by some n-point set in $\mathbb{R}^d$. There are several results showing that simplices defined in this way must overlap very much. In this talk I focus on the generalization of these results to 'curvy' simplices. Specifically, Pach showed that every $d+1$ sets of points $Q_1, \ldots, Q_{d+1}$ in $\mathbb{R}^d$ contain linearly-sized subsets $P_i\subset Q_i$ such that all the transversal simplices that they span intersect. In joint work with Alfredo Hubard, we show, by means of an example, that a topological extension of Pach's theorem does not hold with subsets of size $C(\log n)^{1/(d-1)}$. We show that this is tight in dimension 2, for all surfaces other than S^2. Surprisingly, the optimal bound for S^2 is $(\log n)^{1/2}$. This improves upon results of Bárány, Meshulam, Nevo, and Tancer.

- **May 3**
  Speaker: **Jamie Conway** (UC Berkeley)
  Title: **Classifying Contact Structures on Hyperbolic 3-Manifolds** *Abstract:* Two of the basic questions in contact topology are which manifolds admit tight contact structures, and on those that do, can we classify such structures. In dimension 3, these questions have been answered for large classes of manifolds, but notably not on any hyperbolic manifolds. In this talk, I will discuss a new classification result on an infinite family of hyperbolic 3-manifolds arising from Dehn surgery on the figure-eight knot. This is joint work with Hyunki Min.