GeMTRAK Weekend Program: April 12th-14th

Day	Time	Activity
Friday		*PATCH at Temple*
		Participants arrive
Saturday	9:30—10:00am	*Welcome and coffee*
McNeil 150	10:00am—11:00am	Plenary Speaker: Linda Chen
	11:00am—11:15am	*Break*
	11:15am—11:30am	Louisa Liles (10 mins)
	11:30am—11:45am	Emmett Lennen (10 mins)
	11:45am—12:00pm	Ellie Gurvich (10 mins)
	12:00pm—1:00pm	*Lunch*
	1:00pm—1:30pm	Zoe Cooperband (20 mins)
	1:45 pm—2:15pm	Max Lahn (20 mins)
	2:30pm—3:00pm	Hazel Brenner (20 mins)
	3:00pm—3:30pm	*Tea*
	3:30pm—4:00pm	Amy Herron (20 mins)
	4:00pm—6:00pm	Free time
	6:30pm	*Dinner at Su Xing House*
Sunday	9:30am—10:00am	*Coffee*
DRL A6	10:00am—11:00am	Plenary Speaker: Chikako Mese
	11:00am—11:15am	*Break*
	11:15am—11:45am	Beth Branman (20 mins)
	11:45am—12:00pm	Quincy Frias (10 mins)
	12:00pm—	*Lunch and goodbye*

Titles and Abstracts

Beyond enumerative geometry

Linda Chen

Abstract: Enumerative geometry is the art of counting geometric objects satisfying various conditions. Indeed, Hilbert's Fifteenth Problem was to understand methods developed by nineteenth century algebraic geometers. I will describe some underlying algebraic structures and extensions. I will also discuss related combinatorics, including applications to Brill-Noether theory.

Constructing Annular Links from Thompson's Group T

Louisa Liles

Abstract: In 2014, Jones showed how to associate links in the 3-sphere to elements of Thompson's group T. I provide an analogue of this program for annular links and Thompson's group T. The main result is that any edge-signed graph embedded in the annulus is the Tait graph of an annular link built from an element of T. In analogy to the work of Aiello and Conti, I also show that the coefficients of certain unitary representations of T recover the Jones polynomial of annular links.

Symplectic Duality

Emmett Lennen

Abstract: The Springer resolution is a symplectic resolution of the nilpotent cone of a semisimple Lie algebra g by the cotangent bundle of the associated flag variety. The geometry associated to this resolution is heavily tied to representation theory associated to g, particularly its category O. The idea of symplectic duality is to generalize this story to pairs of symplectic resolutions that occur as Higgs and Coulomb branches in 3d N=4 gauge theories. In this expository talk, I will overview the story of the Springer resolution and discuss some examples of symplectic dual pairs.

Strong and Weak Solutions for a Fluid-Poroelastic-Structure Interaction via a Semigroup Approach

Ellie Gurvich

Abstract: A filtration system, comprising a Biot poroelastic solid coupled to an incompressible Stokes free-flow, is considered in 3D. Across the 2D interface, the Beavers-Joseph-Saffman coupling conditions are enforced. A semigroup approach circumvents typical issues associated with mismatched trace regularities at the interface. The linear hyperbolic-parabolic coupled problem in the fully inertial and non-degenerate case is posed through a dynamics operator on an appropriate energy space. Strong and generalized solutions are obtained via C_0-semigroup generation for the dynamics operator. A standard argument by density is shown to yield weak solutions, including the degenerate cases where the Biot compressibility of the constituents vanishes. Thus, for the inertial Biot-Stokes filtration, we provide a clear elucidation of strong and weak solutions and their regularity with associated energy estimates.

Cosheaf Homology and Structural Engineering

Zoe Cooperband

Abstract: Before the advent of computers, many structural engineers designed buildings using graphic statics, a form of geometric Poincare duality developed primarily by James Clerk Maxwell and Luigi Cremona over 150 years ago. In this talk, we will discuss connections between homology and the statics and kinematics of physical structures such as pin-jointed trusses, linkages, and frames. We will conclude by deriving the graphic statics relation using the long exact sequence of homology.

Reducible Suspensions of Anosov Representations

Max Lahn

Abstract: We will introduce a class of reducible representations of word hyperbolic groups analogous to the classical construction of Hitchin representations as deformations of irreducibly embedded Fuchsian representations. After characterizing which of these representations are Anosov, we will make conclusions about the failure modes for the Anosov conditions under deformations.

Actions of $\mathrm{Homeo}_0(S^1)$ on Three-manifolds

Hazel Brenner

Abstract: Actions of compact Lie groups on manifolds have long been a rich source of geometric topological intrigue. Studying the actions of the circle group on three-manifolds gives rise to the classification of Seifert fibered spaces, an key innovation in early three-manifold topology. If you consider non-proper actions of non-compact Lie groups (or worse yet - infinite-dimensional Lie groups) it becomes virtually impossible to say anything interesting with full generality. However, if you consider actions of homeomorphism groups on manifolds (which are monstrously large and non-compact), suddenly you regain a surprising amount of structure and rigidity. In this talk, I will discuss Katie Mann and Lei Chen's orbit classification theorem for such actions, and zoom into a particular case of $\mathrm{Homeo}_0(S^1)$ acting on closed three-manifolds.

$\widetilde{A}_2$ Bruhat-Tits Buildings

Amy Herron

Abstract: $\widetilde{A}_2$ Bruhat-Tits buildings are simplicial complexes made up of triangles and the link of any vertex is the incidence graph of a projective plane. A projective plane of finite order q has $q+1$ points on a line and has q^2+q+1 total points.

The 1-skeleton of the building is isomorphic to the Cayley graph of an abstract group with relations coming from "triangle presentations." This abstract group either embeds into $\mathrm{PGL}(3, \mathbb{F}_q((x)))$ or $\mathrm{PGL}(3, \mathbb{Q}_q)$, or else is exotic. Currently, the complete list of triangle presentations for projective planes of orders 2, 3 is known.

Harmonic Maps and Geometric Rigidity

Chikako Mese

Abstract: Harmonic maps have proven to be useful tools in various branches of mathematics. The focus of this talk is the application of harmonic maps in rigidity problems. The idea is to first establish the existence of a harmonic map between the two geometric spaces and then to verify, through further analysis, that the map satisfies additional properties. In some cases, we can prove that the harmonic map is actually holomorphic and/or totally geodesic maps. This is joint work with D. Brotbek, G. Daskalopoulos, and Y. Deng.

Spaces of Pants Decompositions for Surfaces of Infinite Type

Beth Branman

Abstract: When S is an orientable surface of finite type, the graph of pants decompositions $P(S)$ is well understood, and it provides a combinatorial model for the space of hyperbolic structures of S. When S has infinite type (that is, when $\pi_1(S)$ is infinitely generated), the usual definition of $P(S)$ yields a disconnected graph. In this talk, we introduce a variation of the pants graph for infinite-type surfaces, and we extend several classical results about finite-type pants graphs to the infinite-type setting.

D(erived)-Manifolds and Field Theory

Quincy Frias

Abstract: Theorists in gauge theory deal with infinities and singularities on a daily basis; spaces of solutions to PDEs can be both infinite-dimensional and singular. This stems from an issue of transversality– an issue familiar to algebraic geometers dealing with intersection theory. In algebraic geometry, this leads to the change of realm from commutative rings to more structured objects such as differential graded algebras. This is the passage to the derived setting of geometry, where intersections are taken in a homotopical sense and as a result are allowed to behave much better than their classical counterparts. In differential geometry, this has been an active topic of study since the introduction of derived manifolds by David Spivak, and the invention of d-manifolds by Dominic Joyce. In this talk we will go through a very brief history of derived differential geometry and its different guises, from Q-manifolds to homotopical C^∞-rings and (not quite) everything in between.