MOAB TOPOLOGY CONFERENCE 2015

Plenary Speakers (60 minute talks):

David Futer, Temple University

Title: Generic few-relator groups
Abstract: Given a presentation of a group G with many more generators than relations, where the relations are random long words, we construct a 2-dimensional complex with nice geometry whose fundamental group is G. This complex is built out of hyperbolic polygons, glued by isometry along the edges, with a negative curvature condition at the vertices. This "geometric realization" of the group implies that G is hyperbolic and enjoys several other pleasant group-theoretic properties. This is joint work with Dani Wise.

Eli Grigsby, Boston College

Title: (Sutured) Khovanov homology and representation theory
Abstract: I will discuss some of the representation theory underlying sutured annular Khovanov homology, a variant of Khovanov homology particularly well-suited to studying braid closures. This is joint work with Tony Licata and Stephan Wehrli.

Matt Hedden, Michigan State University

Title: Khovanov-Floer theories are functorial
Abstract: Khovanov homology is an easily defined homological invariant of links in the 3-sphere, which generalizes the Jones polynomial. Motivation for this definition is provided by the additional "functoriality" gained by associating groups to links (as opposed to polynomials). This allows for the definition of maps on Khovanov homology associated to cobordisms between links. There are several other, much less easily defined homological invariants of links e.g. singular instanton link homology, Heegaard, Monopole, or Instanton Floer homologies of the branched double cover of the link. These theories are also functorial with respect to link cobordisms. Surprisingly, Khovanov homology is connected to each of these theories (and several others) through a spectral sequence, and a natural question asks whether this connection is functorial. In this talk I'll define an abstract algebraic notion of a "Khovanov-Floer" theory, and prove that such theories are functorial with respect to link cobordisms. I'll then show that all the aforementioned invariants satisfy our definition, thus proving that the spectral sequences connnecting them to Khovanov homology are functorial with respect to link cobordisms. This is joint work with John Baldwin and Andrew Lobb.

Jen Hom, Columbia University

Title: Surgery obstructions and Heegaard Floer homology
Abstract: Lickorish and Wallace proved that every closed oriented three-manifold can be expressed as surgery on a link in the three-sphere. This naturally leads to the question of which three-manifolds are surgery on a knot. We give an obstruction coming from Heegaard Floer homology, and use it to construct infinitely many small Seifert fibered integer homology spheres which are not surgery on a knot. This is joint work with Cagri Karakurt and Tye Lidman.

Peter Horn, Syracuse University

Title: Noncommutative knot Floer homology
Abstract: Noncommutative knot Floer homology (*ncHFK*) is a variant of combinatorial knot Floer homology with an Alexander filtration taking values in a nonabelian group. The noncommutative grading lifts the integer-valued Alexander filtration in a certain sense. In this talk I will define the noncommutative Alexander filtration and the chain complex for *ncHFK* and discuss the difficulties that lie ahead.

Tom Mrowka, MIT

Title: Instanton Knot Homology for knots, links and even knotted (trivalent) graphs

Olga Plamenevskaya, Stony Brook University

Title: Braids, transverse knots, and right-veering
Abstract: There are a few well-known ways to think about braids: as words on standard generators, as elements of the mapping class group of a disk with punctures, and (up to an equivalence relation) as transverse knots in standard contact 3-space. We will discuss some questions related to "positivity" of braids and orderings on the braid group. Namely, we will focus on the right-veering property, where the braid action on the punctured disk twists every arc to the right, and discuss some results, examples, and conjectures about braid orderings, transverse knots, and knot homologies.

Saul Schleimer, Warwick University

Title: End invariants of splitting sequences
Abstract: Thurston introduced train tracks and geodesic laminations as tools to study surface diffeomorphisms and Kleinian groups. We'll start the talk with a

relaxed introduction to these. Then, in analogy with the end invariants of Kleinian groups and Teichmüller geodesics, we will define the end invariants of an infinite splitting sequence of train tracks. These end invariants determine the set of laminations that are carried by all tracks in the infinite splitting sequence. If there is time, we'll use these ideas to sketch a new proof of Klarreich's theorem, determining the boundary of the curve complex.

Henry Segerman, Oklahoma State University

Title: Veering Dehn surgery
Abstract: This is joint work with Saul Schleimer. Veering structures on ideal triangulations of cusped manifolds were introduced by Ian Agol, who showed that every pseudo-Anosov mapping torus over a surface, drilled along all singular points of the measured foliations, has an ideal triangulation with a veering structure. Any such structure coming from Agol's construction is necessarily layered, although a few non-layered structures have been found by randomised search. We introduce veering Dehn surgery, which can be applied to certain veering triangulations, to produce veering triangulations of a surgered manifold. As an application we find an infinite family of transverse veering triangulations none of which are layered. Until recently, it was hoped that veering triangulations might be geometric, however the first counterexamples were found recently by Issa, Hodgson and me. We also apply our surgery construction to find a different infinite family of transverse veering triangulations, none of which are geometric.

Alex Zupan, University of Texas at Austin

Title: Classifying trisections of 4-manifolds
Abstract: Trisections of 4-manifolds, an analogue of Heegaard splittings, have recently been defined by Gay and Kirby as a way to import 3-dimensional techniques into the study of 4-manifolds. A trisection of X is a splitting of X into three simple pieces which glue together in a prescribed way. Such a decomposition comes equipped with two integer parameters, g and k, which encode the complexity of the pieces and the complexity of the gluing regions, respectively. We will show that for trisections with certain values of g and k, results from classical 3-manifold topology can be used to classify the trisected 4-manifolds. This is joint work with Jeffrey Meier.

Other Invited Speakers (20 minute talks):

Margaret Doig, Syracuse University

Title: A combinatorial proof of the homology cobordism classification of lens spaces.
Abstract: It follows implicitly from recent work in Heegaard Floer theory that lens spaces are homology cobordant exactly when they are oriented homeomorphic. We provide a new combinatorial proof using the Heegaard Floer d-invariants, which themselves may be defined combinatorially for lens spaces. This is joint work with Stephan Wehrli.

Tirason Khandawit, Kavli IPMU, UTokyo

Title: Stable homotopy invariants for 4-manifolds with positive scalar curvature
Abstract: The Bauer-Furuta invariant can be considered as a stable homotopy refinement of the Seiberg-Witten invariant for a closed 4-manifold. Manolescu extended the idea to define a relative invariant for a 4-manifold with boundary. In this paper, we will explicitly compute Bauer-Furuta invariants for 4-manifolds (with and without boundary) possessing a metric of positive scalar curvature. The main technique is to deform the Seiberg-Witten map into its linearization. We will give examples for basic manifolds such as D^4, $D^3 \times S^1$, and $D^2 \times S^2$.

Jeffrey Meier, Indiana University

Title: Bridge trisections of knotted surfaces in the four-sphere
Abstract: Recently, Gay and Kirby introduced a new way of describing a four-manifold called a trisection, which involves decomposing the four-manifold into three four-dimensional handlebodies and serves as a four-dimensional analogue to a Heegaard splitting of a three-manifold. We adapt their approach to the setting of knotted surfaces in the four-sphere; namely, we show that every such surface admits a bridge trisection, which is a decomposition into three pieces, each of which is a collection of trivial disks in the four-ball. A bridge trisection associates a complexity parameter to the surface, which are analogous to the bridge number of a classical knot, and we give a classification of knotted surfaces with low bridge number. We also introduce a new way to describe knotted surfaces diagrammatically in terms of a triple of classical tangles called a tri-plane diagram. This is joint work with Alexander Zupan.

Christian Millichap, Temple University

Title: Constructing Geometrically Similar Knots
Abstract: There are a handful of methods for constructing non-isometric hyperbolic 3-manifolds that have a large amount of geometric data in common. For example, there are only two known methods (one arithmetic and the other involving covering space arguments) to produce hyperbolic 3-manifolds with the same spectrum of closed geodesic lengths. In both cases, they produce commensurable manifolds. Here, we use a topological cut and paste operation known as mutation to create pairwise incommensurable knot complements that are geometrically similar in the following sense: they have the same set of closed geodesic lengths up to length L, where L can be made as large as one likes. This is joint work with David Futer.

Allison Moore, Rice University

Title: Cosmetic crossing changes in thin knots
Abstract: The cosmetic crossing conjecture asserts that the only crossing changes which preserve the oriented isotopy class of knot are nugatory. Knots that are known to satisfy the conjecture included two-bridge and fibered knots. We will prove that Khovanov-thin knots (a class of knots which includes all alternating and quasi-alternating knots) also satisfy the cosmetic crossing conjecture, provided the first homology of the branched double cover decomposes into summands of square-free order. The proof relies on the Dehn surgery characterization of the unknot, a tool coming from Floer homology. This is joint work with Lidman.

Barbara Nimersheim, Franklin and Marshall

Title: Borromean Rings Quilts 1 & 2
Abstract: Inspired by William Thurston's description of the complement of the Borromean rings (Section 3.4, "The Geometry and Topology of Three-Manifolds"), this pair of quilts is designed to demonstrate his construction. The quilts are especially useful in visualizing the spanning 2-complex, as well as how to deform it into the boundary of an octahedron. We will perform this deformation on the quilts by gathering each arc to a point (an ideal vertex). In doing so, each quilt closes up to form an octahedron. The colorings on the faces, edges, and vertices indicate how to identify the resulting octahedra to form the complement of the Borromean rings.

Jesse Prince-Lubawy, University of North Alabama

Title: Equivalence of $\mathbb{Z}_4$-actions on handlebodies of genus g.
Abstract: We consider all orientation-preserving $\mathbb{Z}_4$-actions on 3-dimensional handlebodies V_g of genus $g \geq 1$. We study the graph of groups $(\Gamma, \mathbf{G})$, which determines a handlebody orbifold $V(\Gamma(\mathrm{v}), \mathbf{G}(\mathbf{v})) \simeq V_g/\mathbb{Z}_4$. This algebraic characterization is used to enumerate the total number of $\mathbb{Z}_4$ group actions on such handlebodies, up

to equivalence.

Arunima Ray, Brandeis University

Title: Shake slice and shake concordant knots
Abstract: A crucial step in the surgery-theoretic program to classify smooth manifolds is that of representing a middle–dimensional homology class by a smoothly embedded sphere. This step fails even for the simple 4-manifolds obtained from the 4-ball by adding a 2-handle with framing r along some knot K in S^3. An r-shake slice knot is one for which a generator of the second homology of this 4-manifold can be represented by a smoothly embedded 2-sphere. It is not known whether there exist 0-shake slice knots that are not slice. We define a relative notion of shake sliceness of knots, which we call shake concordance which is easily seen to be a generalization of classical concordance, and we give the first examples of knots that are 0-shake concordant but not concordant; these may be chosen to be topologically slice. Additionally, for each r we completely characterize r-shake slice and r-shake concordant knots in terms of concordance and satellite operators. Our characterization allows us to construct new families of r-shake slice knots. Additionally, we show that the previously known examples of r-shake slice knots satisfy our characterization. (This is joint work with Tim Cochran)

Adam Salz, Boston College

Title: Branched Diagrams and the Ozsváth-Szabó Spectral Sequence
Abstract: Khovanov homology is a combinatorially defined link invariant with roots in representation theory, while Heegaard Floer homology is an invariant of three-manifolds inspired by symplectic topology. Despite these differences in character and origin, the two theories are connected by a spectral sequence first constructed by Ozsváth and Szabó. I will present a fresh set of Heegaard multidiagrams which clarify the correspondence with Khovanov homology. These diagrams may have applications to Szabó's geometric spectral sequence, contact topology and transverse links, and the construction of a spectral sequence over $\mathbb{Z}$.

Trent Schirmer, Oklahoma State University

Title: Trisections and surgery on 3-manifolds
Abstract: I will give a brief sketch of the proof that a large class of "unbalanced" 4-dimensional trisections is standard. The proof relies on major theorems from 3-manifold topology, including Gabai's theorem that Property R is true, and the Gordon-Luecke theorem. I describe further surgery theorems that would prove more about trisections

Pengcheng Xu, Oklahoma State University

Title: P-moves between pants block decompositions of 3-manifolds

Abstract: A pants block decomposition of a compact hyperbolic 3-manifold is a decomposition of the 3-manifold which cuts the manifold into fundamental pieces called pants blocks. This is similar to a triangulation, which cuts the 3-manifold into tetrahedra. In this talk we will discuss how to relate two pants block decompositions of a manifold with a sequences of P-moves, which are similar to Pachner moves between triangulations.