MOAB TOPOLOGY CONFERENCE 2019 - ABSTRACTS

PLENARY SPEAKERS

John Etnyre, Georgia Institute of Technology

Title: Introduction to contact geometry and contact submanifolds

Abstract: Contact geometry is a natural geometric structure that reoccurs over and over again throughout mathematics and its applications. In this talk, I will introduce contact structures and survey some of their history. I will also discuss some modern applications of them to topology. Some highlights of the development of contact geometry in dimension 3, with a focus on "transverse knots" will be discussed, as well as some hints about higher dimensional contact geometry.

Title: Non-isotopic contact submanifolds

Abstract: The study of transverse knots in dimension 3 has been instrumental in the development of 3 dimensional contact geometry. One natural generalization of transverse knots to higher dimensions is contact submanifolds. Embeddings of one contact manifold into another satisfies an h-principle for co-dimension greater than 2, so we will discuss the case of co-dimension 2 contact embeddings. We will give the first pair of non-isotopic contact embeddings in all dimensions (that are formally isotopic).

Slava Krushkal, University of Virginia

Title: Using quantum topology to count colorings and flows in planar graphs

Abstract: This talk will be an introduction to basic algebraic structures, such as the Temperley-Lieb algebra, underlying quantum topology in (2+1) dimensions. Applications will be given to classical polynomial invariants of planar graphs: the chromatic polynomial and the flow polynomial. The general goal of the talk is to show that quantum topology gives a framework for studying the combinatorics of planar graphs.

Title: Applications of TQFT to classical and quantum graph polynomials

Abstract: I will outline applications of (2+1)-dimensional topological quantum field theory, and algebraic structures underlying it, to the combinatorics of planar triangulations, and more generally to the structure of classical and quantum polynomial invariants of graphs. This talk is based on joint works with Ian Agol and with Paul Fendley.

Aaron Lauda, University of Southern California

Title: A new look at quantum knot invariants

Abstract: The Jones polynomial is the simplest of a family of so-called quantum link invariants. This knot polynomial has many manifestations including an elementary diagrammatic description due to Kauffman, a representation theoretic description in terms of the quantum group associated to $\mathfrak{sl}_2$, and a physical interpretation as Wilson loops in Chern-Simons gauge theory. More generally, the Reshetikhin-Turaev construction defines quantum link invariants associated to any simple Lie algebra, but describing these invariants in an elementary diagrammatic way remained a mystery for quite some time.

In this talk we will explain Cautis, Kamnitzer, and Morrison's simple new approach to understanding quantum knot invariants that requires no prior knowledge of gauge theory or quantum groups. Capitalizing on a powerful duality (skew-Howe), this approach leads to an elementary (diagrammatic) construction of a key family of quantum link invariants. It also resolves open conjectures in representation theory and low-dimensional topology. Another advantage of this approach is that it suggests a 'categorification' where knot homology theories, like Khovanov homology, arise in an elementary way from higher representation theory and the structure of 'categorified quantum groups'.

Title: Categorified quantum knot invariants from higher representation theory

Abstract: The "quantum" in quantum topology usually refers to invariants in low-dimensional topology that have a representation theoretic interpretation in the language of quantum groups. These invariants are also closely connected with constructions in theoretical physics emanating from Chern-Simons gauge theory and its generalizations. Representation theory provides the bridge whereby ideas motivated from theoretical physics can be mathematically formulated to study of low-dimensional topology. Even the elementary and combinatorial constructions of link invariants like the Jones polynomial via the Kauffman bracket can be understood as arising through a careful analysis of the representation theory of quantum groups.

Higher representation theory studies the next layer in representation theory by categorifying the objects that generate the symmetries of interest. Categorifying quantum groups and other symmetry algebras gives to richer invariants in low-dimensional topology. In this talk we will provide a primer on higher representation theory and survey some of the ways it has been used in the study of link homology theory. We will also highlight some of the frontiers in the field and the most active areas of current research.

Kevin Walker, Microsoft Station Q

Title: Higher Temperley-Lieb categories, orthogonal polynomials, and $(3+\varepsilon)$-dimensional TQFTs

Abstract: The usual Temperley-Lieb 2-category (embedded strings in a disk modulo some local relations) leads to many things, including (a) a sequence of integers with rich combinatorial properties (Catalan numbers), (b) a family of orthogonal polynomials (Chebyshev polynomials), and (c) a family of TQFTs with applications to low-dimensional topology and quantum computing. I'll introduce a family of n-categories $C(n,k)$ built out of codimension k submanifolds of an n-ball. $C(2,1)$ is the Tempeley-Lieb category, and most of the talk will be about $C(3,1)$ and its quotients. We will see that (a), (b) and (c) above have analogues for $C(3,1)$. Namely, we will obtain (a) a collection of higher dimensional Catalan numbers, indexed by unrooted trees; (b) a family of orthogonal polynomials, with the variables indexed by labeled rooted trees and the polynomials indexed by a different sort of labeled rooted tree; and (c) a $(3+\varepsilon)$-dimensional TQFT, whose Hilbert space is built out of surfaces in a 3-manifold modulo some local relations. When computing this Hilbert space, one is lead to structures reminiscent of weighted branched surfaces and normal surfaces.

INVITED SPEAKERS

Chaim Even-Zohar, University of California Davis

Title: Universal Knot Diagrams

Abstract: We study collections of planar curves that yield diagrams for all knots. We say that a sequence of closed immersed planar curves U is universal if every knot can be obtained from all but finitely many curves in U, by some choice of the overcrossing and undercrossing arcs at each crossing point. This definition includes several well-studied cases.

In particular, we show that a special class called potholder curves carries all knots. This has implications for realizing all knots and links as special types of meanders and braids.

Our work raises quantitative questions about the efficiency of various classes of curves that represent all knots. Another major challenge is to characterize universal families of planar curves by necessary and sufficient conditions. We will discuss these two lines of research.

Joint work with Joel Hass, Nati Linial, and Tahl Nowik.

Matthew Harper, The Ohio State University

Title: Parameter representations of unrolled quantum $\mathfrak{sl}_3$

Abstract: Murakami showed that the Alexander polynomial of links can be obtained from a 1-parameter family of representations for unrolled quantum $\mathfrak{sl}_2$. From a similar family of representations for unrolled quantum $\mathfrak{sl}_3$, we may define a two variable knot invariant, generalizing the Alexander polynomial in some sense. We will mention some properties of the 2-parameter family of representations, which differ drastically from the classical and "usual" quantum settings, as in the rank one case. We will then give the value of the $\mathfrak{sl}_3$ invariant on some low crossing knots and remark that it appears to be a strictly stronger invariant than the Alexander polynomial, but not the Jones polynomial.

Surena Hozoori, Georgia Institute of Technology

Title: Contact dynamics and topology of conformally Anosov contact structures

Abstract: We will use Hofer's work in contact dynamics and certain Conley-Zehnder index computations to give the first contact topological results about conformally Anosov contact structures. In dimension 3, Conformally Anosov flows, introduced by Thurston-Eliashberg and Mitsumatsu, seem to be of more topological interest than their more well studied special case, Anosov flows and it is natural to ask about the consequences of having such dynamical property on the Reeb vector field of a given contact 3-manifold. We will see such contact manifolds are universally tight, irreducible and do not admit exact cobordism to the tight sphere. Such study also serves motivations from Riemannian geomtery of contact structures and in particular Chern-Hamilton conjecture.

Seungwon Kim, National Institute of Mathematical Sciences

Title: Trisections of surface complements and the Price twist

Abstract: In this talk, we will discuss a method to produce a trisection of a surface complement in a 4-manifold. If the time remains, we will discuss how to obtain a Price twist, which changes the manifold by removing a neighborhood of an embedded real projective plane in a 4-manifold and regluing it in a different way.

Sudipta Kolay, Georgia Institute of Technology

Title: Lifting branched covers to braided embeddings

Abstract: An embedding of a manifold M^k in a trivial disc bundle over N^k is called braided if projection onto the first factor gives a branched cover. This notion generalizes closed braids in the solid torus, and gives an explicit way to construct many embeddings in higher dimensions. One could ask which branched covers lift to braided embeddings. This question has been well studied for honest covering maps by Hansen and Petersen. In this talk, we will discuss about this question for branched covers over low dimensional spheres.

Daniel Lopez, Université Paris Diderot

Title: An invariant from involutive Hopf superalgebras and torsion

Abstract: We show that an involutive Hopf super-algebra together with a relative version of the Hopf algebra integral defines an invariant of (balanced) sutured 3-manifolds with Spin^c structure. The invariant is constructed from a Heegaard diagram presentation via a modification of an invariant of G. Kuperberg. We give an explicit Hopf superalgebra for which the invariant is computed via Fox calculus, so it is a renormalisation of the Reidemeister torsion of sutured manifolds defined by Juhsz, Friedl and Rasmussen.

Maggie Miller, Princeton University

Title: Band diagrams of surfaces in 4-manifolds

Abstract: In this talk, I'll demonstrate a new system of depicting surfaces smoothly embedded in an arbitrary 4-manifold, which is a natural extension of a system already in place for surfaces in S^4. I will show that there is a finite set of simple moves (6 plus isotopy) which relate any two diagrams of isotopic surfaces, generalizing work in S^4 of Swenton and Kearton-Kurlin. This implies uniqueness of bridge trisections up to perturbation, confirming a conjecture of Meier and Zupan. This project is joint with Mark Hughes and Seungwon Kim.

Jeffrey Musyt, University of Oregon

Title: The equivariant Khovanov homotopy type

Abstract: In 2011, Lipshitz and Sakar expanded on the work of Khovanov by constructing the Khovanov homotopy type, which is a family of suspension spectra whose reduced cohomology is Khovanov homology. Periodic knots are a class of knots that have some form of rotational symmetry which gives rise to a natural $\mathbb{Z}/n\mathbb{Z}$-action on the knot. In this talk we will briefly describe the construction of the Khovanov homotopy type and how the natural $\mathbb{Z}/n\mathbb{Z}$-action on periodic knots induces a group action on the homotopy type, making it an equivariant knot invariant. Finally, we'll discuss some of the added benefits contained within the equivariant version of the homotopy type.

Nur Saglam, University of California Riverside

Title: Constructions of Lefschetz fibrations using cyclic group actions

Abstract: We construct families of Lefschetz fibrations over S^2 using finite order cyclic group actions on $\Sigma_g \times \Sigma_g$ diagonally. In some cases, we also obtain more families of Lefschetz fibrations by applying rational blow-down operation, which gives rise to some interesting applications. This is joint work with Anar Akhmedov.

Jon Simone, University of Massachusetts Amherst

Title: Rational homology $S^1 \times S^2$s that bound rational homology $S^1 \times D^3$s

Abstract: Rational homology 3-spheres that bound rational homology 4-balls is a widely explored question. There are many well-known families of such rational 3-spheres – e.g. the lens spaces $L(p^2, pq-1)$, where p and q are coprime – but, of course, more is unknown than is known. One way to construct such rational 3-spheres is by attaching a 2-handle to a rational homology $S^1 \times D^3$ in a way that results in a rational homology 4-ball. Recent work of Akbulut-Larson, for example, used this method to find new examples of Brieskorn spheres that bound rational 4-balls. Thus, finding rational homology $S^1 \times S^2$s that bound rational homology $S^1 \times D^3$s can aid in constructing rational 3-spheres that bound rational 4-balls. A simple family of rational $S^1 \times S^2$s consists of the torus bundles over S^1 with first Betti number equal to 1. In this talk, we will construct torus bundles that bound rational homology $S^1 \times D^3$s and use them to construct rational homology 3-spheres that bound rational homology 4-balls. We will then use lattice theory and Heegaard Floer homology correction terms to obstruct other torus bundles from bounding rational homology $S^1 \times D^3$s and discuss the limitations of these obstructions in giving a complete classification of torus bundles that bound rational $S^1 \times D^3$s. Finally, we will discuss constructions of more general families of rational $S^1 \times S^2$s that bound rational $S^1 \times D^3$s. This is a work in progress.