Knots in Washington (KiW) 49.5 December 3-5, 2021

List of Speakers and Abstracts

(1) **Distinguished Graduate Student:** Elaina Aceves
Affiliation: University of Iowa
Advisor: Keiko Kawamuro
Co-authors: Keiko Kawamuro
Zoom
Title: Agol cycles of flype admitting pseudo-Anosov 3-braids
Abstract: Birman and Menasco proved that 3-braids related by a non-degenerate flype must live in distinct conjugacy classes in 1993. In this talk, I will introduce Agol cycles, a conjugacy class invariant for pseudo-Anosov maps, and compare Agol cycles of 3-braids related by a non-degenerate flype. I will also discuss results about the conditions necessary to find braids admitting a flype whose Agol cycles are mirror images. This is joint work with Keiko Kawamuro.

(2) **Speaker:** Rhea Palak Bakshi
Affiliation: Institute for Theoretical Sciences, ETH Zurich
Co-authors: Józef H. Przytycki
Zoom
Title of talk: On the KBSM of the connected sum of two solid tori
Abstract: Skein modules were introduced by Józef H. Przytycki as generalisations of the Jones and HOMFLYPT polynomial link invariants in S^3 to arbitrary 3-manifolds. The Kauffman bracket skein module (KBSM) is the most extensively studied of all. However, computing the KBSM of a 3-manifold is known to be notoriously hard, especially over the polynomial ring $\mathbb{Z}[A^{\pm 1}]$. With the goal of finding a definite structure of the KBSM over this ring, several conjectures and theorems were stated over the years for KBSMs. We show that some of these conjectures, and even theorems, are not true. In this talk I will briefly discuss a counterexample to Marche's generalisation of Witten's conjecture. I will show that a theorem stated by Przytycki in 1999 about the KBSM of the connected sum of two handlebodies does not hold. I will also give the exact structure of the KBSM of the connected sum fo two solid tori.

(3) **Speaker:** Jagdeep Basi
Affiliation: California State University, Fresno
Co-authors (if any): Carmen Caprau
Zoom
Title of talk: Quandle Coloring Quivers of (p,2)-Torus Knots
Abstract: A quandle coloring quiver is a quiver structure, introduced by Karina Cho and Sam Nelson, and defined on the set of quandle colorings of an oriented knot or link with respect to a finite quandle. In this talk, we study quandle coloring quivers of (p,2)-torus knots and links with respect to dihedral quandles.

(4) **Speaker:** Scott Carter
Affiliation: Professor Emeritus at University of South Alabama
Co-authors: Yongyu Bae and Byoerhi Kim
zoom
Title: Amusing permutation representations of finite subgroups of SU(2)
Abstract: This talk will be at an elementary level with an aim towards graduate students. A consequence of an old result, called the Krasner-Kaloujine theorem, allows string diagrams that have decorations upon the strings to represent the elements of a finite group. These representations are useful and pleasant in the cases of the binary octahedral group, the binary tetrahedral group, the quaternions, and other dicyclic groups. Elements in the binary icosahedral group have similar representations as well, but the talk will focus upon the easier examples as well as the permutation group on four letters. There will be a plethora of diagrams as well as methodology for making computations with the diagrams.

(5) **Speaker :** Seonmi Choi
Affiliation : Kyungpook National University
zoom
Title : On invariants for links and surface-links via Kauffman bracket magmas
Abstract : Niebrzydowski and Przytycki defined a Kauffman bracket magma and constructed an invariant of framed links. The invariant is closely related to the Kauffman bracket polynomial. In this talk, we will define its generalization for surface-links and construct invariants via marked graph diagrams. Moreover, we will define a specific map on a Kauffman

bracket magma and construct some invariants for oriented links or oriented surface-links.

(6) **Speaker:** Micah W. Chrisman
Affiliation: The Ohio State University
Co-author: Sujoy Mukherjee
zoom
Title of talk: Algebraic concordance and almost classical knots
Abstract: As is well known, J. Levine classified the algebraic concordance group $\mathscr{G}^{\mathbb{F}}$ of knots in the 3-sphere, where $\mathbb{F}$ is a field of characteristic 0. In this talk, we will define two generalizations of the algebraic concordance group of homologically trivial knots in thickened surfaces $\Sigma \times [0,1]$, where Σ is compact and oriented. The generalizations are called the coupled algebraic concordance group and the uncoupled algebraic concordance group. For the uncoupled algebraic concordance group $\mathscr{VG}^{\mathbb{F}}$, we prove that $\mathscr{VG}^{\mathbb{F}} \cong \mathscr{I}(\mathbb{F}) \oplus \mathscr{G}^{\mathbb{F}}$, where $\mathscr{F}$ is the fundamental ideal of the Witt ring over $\mathbb{F}$. For $\mathbb{F} = \mathbb{Z}/2\mathbb{Z}$, we also define an Arf invariant. Examples will be given in the several cases, with applications to virtual knots.

(7) **Speaker:** Moshe Cohen
Affiliation: State University of New York at New Paltz
Co-authors: Joint work with Adam Lowrance
In person
Title: The average genus of a 2-bridge knot grows linearly with respect to crossing number
Abtract: Dunfield et al provide experimental data to suggest that the Seifert genus of a knot grows linearly with respect to crossing number. We prove this holds among 2-bridge knots using Chebyshev billiard table diagrams developed by Koseleff and Pecker. This work builds on results by the author with Krishnan and Even-Zohar and Krishnan on a random model using these diagrams. This work also uses and improves upon results by the author demonstrating a lower bound for the average genus among a weighted collection of 2-bridge knots.

(8) **Speaker:** Yuanan Diao

Affiliation: Department of Mathematics and Statistics, University of North Carolina at Charlotte, Charlotte, NC 28223

online

Title of talk: The Ropelengths of Alternating Knots

Abstract: The ropelength $R(K)$ of a knot K is the minimum length of a unit thickness rope needed to tie the knot. If K is alternating, it is conjectured that $R(K) \geq a\mathrm{Cr}(K)$ for some constant $a > 0$, where $\mathrm{Cr}(K)$ is the minimum crossing number of K. In this talk I will first give a brief introduction to the ropelength problem. I will then show that there exists a constant $a_0 > 0$ such that $R(K) \geq a_0\mathbf{b}(K)$ for any knot K, where $\mathbf{b}(K)$ is the braid index of K. It follows that if $\mathbf{b}(K) \geq a_1\mathrm{Cr}(K)$ for some constant $a_1 > 0$, then $R(K) \geq a_0a_1\mathrm{Cr}(K) = a\mathrm{Cr}(K)$. However if $\mathbf{b}(K)$ is small compared to $\mathrm{Cr}(K)$ (in fact there are alternating knots with arbitrarily large crossing numbers but fixed braid indices), then this result cannot be applied directly. I will show that this result can in fact be applied in an indirect way to prove that the conjecture holds for a large class of alternating knots, regardless what their braid indices are.

(9) **Speaker:** Roger Fenn

Affiliation: University of Sussex

Co-authors: Andy Bartholomew

zoom

Title: Generalised knots and how they can be braided

Abstract: There are many types of generalised knots. In this talk I will describe which can be braided and which satisfy Markov moves and their generalisations. This is joint work with Andy Bartholomew.

(10) **Speaker:** Charles D. Frohman

Advisor (if you are a graduate student): Allan Edmonds

Affiliation: The University of Iowa

Co-authors: Joanna Kania-Bartoszynska, Thang Le

Zoom

Title of talk: The representation theory of the Kauffman Bracket Skein algebra

Abstract: After reviewing the definition and structure of the Kauffman bracket skein algebra, I will introduce its trace, and then show that the variety of trace preserving representations of the appropriate dimension

has as its GIT quotient the $SL_2\mathbb{C}$-character variety of the fundamental group of the surface. More specifically if F is a finite type surface of genus g with p punctures having negative Euler characteristic, ζ is a primitive nth root of unity where n is not divisible by 4 and $m = \frac{n}{gcd(n,2)}$ then there is exactly one conjugacy class of semisimple trace preserving representations of $K_\zeta(F)$ having dimension $m^{3g-3+2p}$. There will be lots of pictures.

(11) **Speaker:** Mee Seong Im
Affiliation: United States Naval Academy
Co-authors: Mikhail Khovanov, Lev Rozansky
Zoom
Title of talk: Introduction to representations of wreath products and foams
Abstract: I will explain a new perspective of foams with connections to the representation theory of iterated wreath products. If I have time, I will discuss some connections of foams to field extensions, Sylvester sums, and matrix factorizations.

(12) **Speaker:** Joanna Kania-Bartoszynska
Affiliation: NSF
Co-authors: Charles D. Frohman, Thang Le
zoom
Title: Reduced Kauffman bracket skein module of a 3-manifold
Abstract: Kauffman bracket skein module of an oriented 3-manifold is defined by taking linear combinations of isotopy classes of links and dividing by the Kauffman bracket skein relations. When a manifold is a cylinder over an oriented surface, its module has an algebra structure. The representation theory of the Kauffman bracket skein algebra of a surface recapitulates the sl(2,C) representations of the fundamental group of the surface. Given an irreducible representation of the fundamental group of a 3-manifold we show how to construct the reduced Kauffman bracket skein module at that representation and prove some of its properties.

(13) **Speaker:** Louis H Kauffman
Affiliation: University of Illinois at Chicago
Co-author: Neslihan Gugumcu

Talk will be delivered by Kauffman by Zoom.

Title of talk: A State Sum Invariant for Knotoids

Abstract: Knotoids (so named by Vladimir Turaev) are knot diagrams with free ends that can be in different regions. When the ends are in the same region a knotoid is identical with a 1-1 tangle. Knotoids are taken up to Reidemeister moves that do not pass arcs across the ends of the knotoid. Many knot invariants generalize to knotoids. In particular the bracket polynomial is defined for knotoids and one can conjecture that the bracket polynomial detects the unknotted knotoid. In this talk we define a Conway potential function $\nabla_K(s)$ for knotoids K that generalizes the Alexander-Conway polynomial for 1-1 tangles. This Conway potential function is defined as a state summation over connected smoothings of the knotoid diagram. A connected smoothing can be regarded as a path on the diagram that goes from end to end without every crossing at a crossing, and it can be regarded as a generalization of the marker states in "Formal Knot Theory" by Kauffman. We generalize the Clock Theorem in Formal Knot Theory and we give a formula for the new potential function as a Permanent of a matrix associated with the knotoid diagram. The new invariant can distinguish knotoids from their reverses and from their mirror images. We will discuss the categorification of this new invariant of knotoids.

(14) **Speaker:** Mikhail Khovanov

Affiliation: Columbia University

In person

Title of talks: Universal construction and foam evaluation I and II

Abstract: Universal construction leads to topological theories that satisfy a lax version of the Atiyah tensor product axioms. We'll explain the universal construction and foam evaluation, as well as their relation to link homology and the four-color theorem.

(15) **Speaker:** Seongjeong Kim

Affiliation: Jilin University

by zoom

Title of talk: Knots in $S_g \times S^1$ and information for crossings

Abstract: In this talk we consider knots in $S_g \times S^1$, where S_g is an oriented surface of genus g. First we introduce why we are interested in knots in the specific 3-dimensional space $S_g \times S^1$. We introduce basic notions for

knots in $S_g \times S^1$, for example, diagrams, moves for diagrams and so on. For knots in $S_g \times S^1$ technically we lose over/under information, but we have information "how many times a half of the crossing of the knot in $S_g \times S^1$ rotates along S^1", we call it labels of crossings. In the end of the talk, we discuss how to obtain "labels" from diagrams and its properties and its meaning.

(16) **Speaker:** Caitlin Leverson
Affiliation: Bard College
Co-authors: John Etnyre
In person
Title of talk: Lagrangian Realizations of Ribbon Cobordisms
Abstract: Similarly to how every smooth knot has a Legendrian representative (in fact, infinitely many different representatives), in this talk we will discuss why every ribbon cobordism has a Lagrangian representative. Meaning, if C is a ribbon cobordism in $[0,1] \times S^3$ from the link K_0 to K_1, then there are Legendrian realizations Λ_0 and Λ_1 of K_0 and K_1, respectively, such that C may be isotoped to a decomposable Lagrangian cobordism from Λ_0 to Λ_1. We will also give examples of some interesting constructions of such decomposable Lagrangian cobordisms. This is joint work with John Etnyre.

(17) **Speaker:** Adam Lowrance
Affiliation: Vassar College
Co-authors: Danny Beldon, Mia DeStefano, Wyatt Milgrim, Cecilia Villaseñor
In person
Title: Near extremal Khovanov homology of Turaev genus one links
Abstract: The Turaev surface of a link diagram is a closed oriented surface constructed from a cobordism between the all-A and all-B Kauffman states of the diagram. The Turaev genus of a link is the minimum genus of any Turaev surface of the link. A link is Turaev genus zero if and only if it's alternating. Links of Turaev genus one include almost alternating links, non-alternating pretzel links, and non-alternating Montesinos links.

In this talk, we discuss the structure of the Khovanov homology of Turaev genus one links in the extremal and near extremal polynomial gradings. For

certain Turaev genus one links, this leads to a computation of Rasmussen's s-invariant.

(18) **Speaker:** Jeffrey Meier
Affiliation: Western Washington University
Co-author: Alex Zupan (University of Nebraska–Lincoln)
Zoom talk
Title: Classifying fibered, homotopy-ribbon disks
Abstract: I will discuss the classification of fibered, homotopy-ribbon disks bounded by generalized square knots. Up to diffeomorphism rel-boundary, such disks are in bijection with the rational numbers with even numerator. However, there is a unique such disk up to diffeomorphism. This is joint work with Alex Zupan.

(19) **Speaker:** Maggie Miller
Affiliation: Stanford
Co-authors: Mark Hughes and Seungwon Kim
by Zoom
Title: Knotted handlebodies
Abstract: We recently showed that for all $g \geq 2$, there exist smooth 3-dimensional genus-g handlebodies H_1 and H_2 in S^4 with the same boundary that are homeomorphic rel boundary but are not isotopic rel boundary (even when their interiors are pushed into B^5). The isotopy obstruction arises from Ruberman's proof that a certain knotted 2-sphere is not doubly slice. In this talk, I'll talk about some higher dimensional knot theory and how it can be used to create these surprising knotted handlebodies.

(20) **Speaker:** Allison Moore
Affiliation: Virginia Commonwealth University
Co-Authors: Artem Kotelskiy, Tye Lidman, Liam Watson, Claudius Zibrowius
In person
Title of Talk: Cosmetic crossings, cosmetic surgery and Conway spheres
Abstract: A tangle decomposition along a Conway sphere breaks a knot or link into simpler pieces, each of which is a two-string tangle. In this talk,

we'll discuss (one of the ways) in which Khovanov homology can be calculated using tangle decompositions. In particular, the algebraic invariants can be realized geometrically as immersed curves on the four-punctured sphere. This strategy turns out to be quite useful for investigating two classic open problems: the cosmetic surgery conjecture and the cosmetic crossing conjecture. This is joint with Kotelskiy, Lidman, Watson and Zibrowius.

(21) **Speaker:** Sam Nelson
Affiliation: Claremont McKenna College
Zoom talk
Title: Biqiandle Bracket Quivers
Co-author: Pia Cosma Falkenburg
Abstract: Biquandle brackets are skein invariants of biquandle-colored knots. Classical skein invariants as well as quandle and biquandle 2-cocycle invariants can be realized as biquandle brackets. A set of biquandle endomorphisms determines a directed graph or quiver structure on the set of biquandle bracket values, yieldng an infinite family of categorifications of these and other biquandle bracket invariants distinct from the previous homological categorifications.

(22) **Speaker:** Yi, Ni
Affiliation: California Institute of Technology
In person zoom
Title of talk: The second term in knot Floer homology
Abstract: It is well known that the genus g of a knot is the highest Alexander grading for which the knot Floer homology is nontrivial. In recent years, there is evidence suggesting that the knot Floer homology is also nontrivial in the Alexander grading $g - 1$. In this talk, I will describe a proof that the rank of the second-to-top term of the knot Floer homology is greater than or equal to the rank of the topmost term when the topmost term is supported in a single $\mathbb{Z}/2\mathbb{Z}$ Maslov grading.

(23) **Speaker:** Nicholas Owad
Affiliation: Hood College
Co-authors (if any): Felipe Castellano-Macías

In person

Title of talk: Computing tunnel number for low crossing knots

Abstract: Computing tunnel number is a challenging process in general. But for knots with a 12 or fewer crossings, there is a collection of bounds which allow us to find the tunnel number. We will discuss these bounds, and when they are able to be tight, which let us find the tunnel number of all 11 and 12 crossing alternating knots. We will also discuss non-alternating knots and where these bounds fail to give the exact tunnel number.

(24) **Speaker:** Krzysztof Putyra

Affiliation: University of Zurich

Co-authors: Anna Beliakova, Louis-Hadrien Roberts, Emmanuel Wagner

Zoom

Title of talk: Towards a spectral sequence from HOMFLYPT to Heegaard-Floer knot homology

Abstract: The beauty of the HOMFLYPT polynomial is that it generalizes all $sl(N)$ link polynomials as well as the Alexander-Conway polynomial. In the categorified setting the analogous relation has been found by Rasmussen in the form of a spectral sequence from the categorified HOMFLYPT to $sl(N)$ link homology for all $N > 0$. However, a similar relation to the categorified Alexander-Conway polynomial, the Heegaard-Floer knot homology, is currently unknown, although the results of Manolescu and Dowlin suggests that such a spectral sequence should exist. In my talk I will show how to construct a spectral sequence (over a field of characteristic other than 2) from the reduced HOMFLYPT homology to a certain homology of a knot diagram that coincides with HFK over $\mathbb{Z}/2$. This is joint work with Anna Beliakova, Louis-Hadrien Robert and Emmanuel Wagner.

(25) **Speaker:** Ken Perko

Advisor (if you are a graduate student): Ralph Fox

Affiliation: Reviewer for Zbl.

In person

Title of talk: Looking at Linking Numbers

Abstract: We shall show how to extend Heegaard's explicit depictions of branched 3-fold non-cyclic covering spaces of knots as cellular immersions in Euclidean 3-space (set forth for the trefoil in his 1898 thesis) by inserting

twisted rectangles at certain crossings and capping resultant Seifert-like circles with upper hemispherical discs in the covering space. For examples with an integral linking number between branches, this often results in an easily visualizable surface that cobounds the index 2 branch and reveals its linking number with the index 1 branch to be the sum of the signs of the crossings at which no twists have been inserted. We conjecture that such surfaces (which we call "Perko surfaces") exist in all such cases, although sometimes only for certain diagrams, such as those with more than the minimal number of crossings.

(26) **Speaker:** Radmila Sazdanovic
Affiliation: NC State University
Co-authors: M. Khovanov
Title: Bilinear pairings on two-dimensional cobordisms and generalizations of the Deligne category.
Abstract: The Deligne category of symmetric groups is the additive Karoubi closure of the partition category. It is semisimple for generic values of the parameter t while producing categories of representations of the symmetric group when modded out by the ideal of negligible morphisms when t is a non-negative integer. The partition category may be interpreted, following Comes, via a particular linearization of the category of two-dimensional oriented cobordisms. The Deligne category and its semisimple quotients admit similar interpretations. This viewpoint coupled to the universal construction of two-dimensional topological theories leads to multi-parameter monoidal generalizations of the partition and the Deligne categories, one for each rational function in one variable. This is joint work with M. Khovanov.

(27) **Speaker:** Marithania Silvero
Affiliation: Universidad de Sevilla
Co-authors (if any): María Cumplido and Juan González-Meneses
Zoom
Title of talk: k-root extraction problem for generic braids
Abstract: The are several computational problems in braid groups that have been proposed for their potential applications in cryptography. One of them is the k-th root extraction problem. In this talk, we present an algorithm which, given a braid x on n strands and canonical length l, and an integer $k > 1$, computes a k-th root of x, if it exists, or guarantees that such

a root does not exist; we will show that, in the generic case, this algorithm is very fast. More precisely, its generic-case complexity is $O(l(l+n)n^3 logn)$. This is joint work with María Cumplido and Juan González-Meneses.

(28) **Speaker:** Xiao, Wang
Affiliation: Jilin University
Co-authors: Seong Yeop Yang
In person Zoom
Title of talk: Some computations on Yang-Baxter homology
Abstract: Solutions to the Yang-Baxter equation have shown its importance to the study of knot theory.
Many link invariants have been built based on the homology theory of Yang-Baxter operators. For the cyclic biquandles, we give
a basis for the free part of its Yang-Baxter homology, and discuss an annihilation condition of its torsion part.
We will also discuss some minor progress of the computation on Alexander biquandles.

(29) **Speaker:** Emanuele Zappala
Affiliation: Yale University
Zoom
Title of talk: Ternary self-distributive operations and quantum invariants of knots
Abstract: In this talk, I will present an analogue of quandle cocycle invariants for knots based on ternary operations and their cohomology. Starting from the set-theoretic setting, I will discuss the generalization of these notions in symmetric monoidal categories with some (mild) finiteness additional condition. The main step is that of considering a categorical version of (ternary) self-distributive operations and 2-cocycles. I will explain how the quantum invariants associated to this construction naturally coincide with the set-theoretic ones, when considering linearized operations. The main examples that will be described are quantum heaps of (involutory) Hopf monoids (e.g. Hopf algebras), as well as binary and ternary Lie objects (e.g. n-Lie algebras).

(30) **Speaker:**

Advisor (if you are a graduate student):
Affiliation:
Co-authors:
In person
Title of talk:
Abstract:

(31) **Speaker:**
Advisor (if you are a graduate student):
Affiliation:
Co-authors:
In person
Title of talk:
Abstract: