Eastern Illinois Integrated Conference in Geometry, Dynamics, and Topology: Abstracts

April 6-8, 2018

Cameron Gordon (University of Texas)
Cyclic branched covers of L-space knots

Friday, April 6 at 4:30pm in Room 1205.

An L-space is a 3-manifold whose Heegaard Floer homology is as simple as possible. An L-space knot is a knot with a non-trivial L-space surgery; examples are torus knots and Berge knots. Moore asked if the double branched cover of a hyperbolic L-space knot is ever an L-space. We show that if the n-fold cyclic branched cover of an (arbitrary) L-space knot K is an L-space then $n \leq 5$, and obtain strong restrictions on K when $n = 3{,}4$ or 5.

Donald Robertson (University of Utah)
Families of mild mixing interval exchange transformations

Saturday, April 7 at 9:00am in Room 1205.

Almost every interval exchange transformation is rigid. In this talk I will describe recent work showing that the complementary notion - that of mild mixing - has full Hausdorff dimension for an infinite class of permutations.

Puttipong Pongtanapaisan (University of Iowa)
Wirtinger Numbers for Virtual Links

Saturday, April 7 at 10:00am in Room 1205.

Blair et. al., defined the Wirtinger number of a classical link in 3-space to be the minimum number of generators of the link group where all the relations in the group presentation are iterated Wirtinger relations in the link diagram, and also showed that it equals the bridge number of the link. In this talk, we will define the Wirtinger number of a virtual link and show that it equals the virtual bridge number. If time permits, we will explicitly compute the Wirtinger numbers, and therefore the virtual bridge numbers of some virtual knots.

Xinghua Gao (University of Illinois at Urbana-Champaign) Orderability of Dehn fillings

Saturday, April 7 at 10:00am in Room 2120.

Boyer, Gordon, and Watson conjectured that an irreducible rational homology 3-sphere is not an L-space if and only if its fundamental group is left-orderable. In a recent work, Culler and Dunfield showed how to encode information of elliptic $PSL_2(\mathbb{R})$ representations of a one-cusped 3 manifold in the translation extension locus and use it to construct orders on intervals of Dehn fillings. In this talk, I will show how to construct the holonomy extension locus from hyperbolic $PSL_2(\mathbb{R})$ representations and use it to construct orders on some other Dehn fillings.

Ivan Chio (IUPUI) Limiting measures of Lee-Yang zeros for the Cayley tree

Saturday, April 7 at 11:10am in Room 1205.

The Ising Model describes magnetic materials. One considers a sequence of finite graphs Γ_n that provide better and better approximation to your magnetic material and associates to each of them a finite collection of points LY_n on the unit circle, called the Lee-Yang zeros. The actual physics of the material is described by the limiting distribution of these zeros as $n \to \infty$. It is a famous hard problem to characterize their limit when each Γ_n corresponds to the $n \times n$ square in the $\mathbb{Z}^2$ lattice.

Because of the difficulties of studying the Ising model on the $\mathbb{Z}^2$ lattice, Hans Bethe suggested in 1935 to instead work on the Cayley Tree (infinite binary tree). In this case, Γ_n corresponds to the finite Cayley Tree "of level n". He also imposed and additional hypothesis that allowed him to focus on the vertices "deep within" the tree. It is also interesting to consider the binary tree without this additional hypothesis, and, in 1974, Müller-Hartman and Zittartz discovered that the limiting distribution of Lee-Yang zeros for the Cayley Tree can be described in terms of a particular Blaschke product, which is expanding on the unit circle. This connection was pursued further by Barata and Marchetti in 1997 and Barata Goldbaum in 2000. In this talk, I will explain how to use fine properties of the expanding Blaschke products to obtain a rather detailed description of the limiting distribution of Lee-Yang zeros for the Cayley Trees.

This is joint work with Anthony Ji, Caleb He, and Roland Roeder.

Corinne Barnett (Eastern Illiois University)
One-cusped hyperbolic prisms and reflection groups

Saturday, April 7 at 11:10am in Room 2120.

A polygon tiles the Euclidean plane, the sphere, or the hyperbolic plane by reflections if we obtain a tiling by repeatedly reflecting the polygon across its sides, and the sides of the resulting copies. Similarly, a hyperbolic polyhedron tiles hyperbolic 3-space $\mathbb{H}^3$ by reflections if reflecting across faces results in a tiling of $\mathbb{H}^3$. The simplest such polyhedra are tetrahedra, and there are 32 hyperbolic tetrahedra which tile by reflections. I study some of the next simplest, namely the five-sided hyperbolic prisms, with one ideal vertex, which tile by reflections. In this talk, I will describe a combinatorial enumeration of these prisms, as well as how to find the polyhedra explicitly in $\mathbb{H}^3$. This is joint work with Grant Lakeland.

Laura Starkston (Stanford University)
Symplectic surfaces and singularities in the projective plane

Saturday, April 7 at 1:40pm in Room 1205.

Complex curves in the projective plane are given as the zero sets of homogeneous polynomials. The space of these curves and their singularity types can in turn be calculated in terms of the polynomial coefficients. If we look at the larger space of smooth or symplectic submanifolds in projective plane, we no longer have polynomials to work with, but it turns out that some of the properties of complex curves remain true in these larger categories. We will explore similarities and differences, and discuss open questions and interesting phenomena.

Maggy Tomova (University of Iowa)
Tunnel number version 2.0

Saturday, April 7 at 3:00pm in Room 1205.

We define two new families of invariants for knots in 3-manifolds which detect the unknot and are additive under connected sum of pairs. The first of these families is closely related to both bridge number and tunnel number. The second of these families is a variation and generalization of Gabai's width for knots in the 3-sphere.

Allison Moore (University of California, Davis) Knots, bands, and reconnection in circular DNA

Sunday, April 8 at 9:00am in Room 1205.

Band surgery is a topological operation that transforms a link into a new link. When the operation is compatible with the orientations of the links involved, it is called coherent band surgery, otherwise it is called non-coherent. While coherent band surgery is relatively well-understood, non-coherent band surgery is less predictable. We will classify all band surgery operations from the trefoil knot to the $T(2, n)$ torus knots and links, by way of a related three-manifold problem that we solve by studying the Heegaard Floer d-invariants under integral surgery along knots in the lens space $L(3, 1)$. Band surgery on knots is of independent interest in the biological sciences; it is especially important in modeling the action of enzymatic complexes on circular DNA molecules. We will discuss how reconnection by site-specific recombinases is modeled by band surgery on knots and links and give some insight as to why torus knots are of special relevance in this context. Parts of this project are joint work with Lidman and Vazquez.

Fariba Khoshnasib (University of Texas, Dallas) The topology of Liouville Foliations of the Goryachev, Chaplygin, and Poincare case

Sunday, April 8 at 10:00am in Room 2120.

Study of rigid body motion is applied in controlling the dynamics of a satellite on a circular earth orbit, a gyroscope or a pendulum. In order to simplify the analysis, we usually work on models of symmetric rigid bodies. One such example which has a completely integrable system is the Goryachev-Chalpygin top. The stability of periodic solutions of the Goryachev-Chaplygin system is studied and illustrated using its bifurcation diagram and the topological concept of a bifurcation complex is discussed. Also, this idea has been applied Poincare‘s system of motion of solid filled with fluid. The idea of bifurcation complex can be applied to other integrable systems with two degrees of freedom, too. This topological approach can be applied to find non-degenerate solutions of integrable systems.

Malik Obeidin (University of Illinois at Urbana-Champaign)
Volumes of random alternating link diagrams

Sunday, April 8 at 10:00am in Room 1205.

How does one define a random knot? There are a number of possibilities, based on how one thinks of knots. In this talk, I will describe a model based on knot and link diagrams– projections into the plane– and show that a random alternating link has hyperbolic volume roughly proportional to its crossing number. I will also discuss what can be proven when we don't insist the link diagrams are *alternating.* In that case, random link diagrams exhibit "local knotting"; in any region of the diagram, any possible tangle occurs with positive probability. I will demonstrate how this shows that a random link in this model is not hyperbolic.

Jerzy Kocik (Southern Illinois University)
On the Apollonian crossroad of structures: geometry, algebra, and physics

Sunday, April 8 at 11:10am in Room 1205.

The Apollonian disk packing is a tangle of structures and ideas known in physics, geometry, topology and number theory.

I will review some of them, including the relation to the Minkowski space (relativity), spinors (quantum mechanics), tessellations, and some more. The Hausdorff dimension of the Apollonian fractal is known only approximately. Some by-products of the search for its value in a closed algebraic form will be presented.