# SCHEDULE

BYGMAC 2019

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| | *Breakfast* |
| 10:00 - 11:00 | **Faculty Speaker: Ian Agol**<br>Algebraically Fibered Congruence Arithmetic Hyperbolic Lattices |
| 11:10 - 11:40 | **Theo McKenzie**<br>Semirandomness: The Boundary of Polynomial Time Algorithms |
| | *Lunch* |
| 12:50 - 1:20 | **Ka Wai Karry Wong**<br>Conformalized Mean Curvature Flow |
| 1:30 - 2:00 | **Jianping Pan**<br>Virtualization Map for the Littelmann Path Model |
| 2:10 - 2:40 | **Libby Taylor**<br>Enumerative Problems in Algebraic Geometry over Non-algebraically Closed Fields |
| | *Tea* |
| 3:10 - 3:40 | **Madeline Brandt**<br>Voronoi Diagrams of Varieties |
| 3:50 - 4:20 | **"Black" Fushuai Jiang**<br>Whitney Extension Problem and Interpolation of Data |
| 4:30 - 5:00 | **Aaron Brookner**<br>Quantum Groups, the Applied and Theoretical |

All events will be in 1015 Evans

# ABSTRACTS OF TALKS

BYGMAC 2019

**Faculty Speaker: Ian Agol**

Algebraically Fibered Congruence Arithmetic Hyperbolic Lattices

A group $G$ is said to be algebraically fibered if there is a homomorphism $G \to \mathbf{Z}$ with finitely generated kernel. We will discuss a question of Baker and Reid asking whether there are certain congruence arithmetic lattices which algebraically fiber. We resolve this question for many Bianchi groups, and for $O(4, 1; \mathbf{Z})$ making use of a criterion of Kielak. This talk will be a mix of group theory, number theory, geometry and topology. This is joint work with Matthew Stover.

**Theo McKenzie**

Semirandomness: The Boundary of Polynomial Time Algorithms

Semirandom models generalize well known graph models by allowing certain parts of a graph to be adversarial instead of random. We show how well known methods for solving graph problems in polynomial time fail in the semirandom model, and how to create more robust algorithms for these problems. We then discuss how these algorithms let us deduce the necessary information to solve a problem in polynomial time.

**Ka Wai Karry Wong**

Conformalized Mean Curvature Flow

My talk gives an overview on the conformalized mean curvature flow, originally introduced by Kazhdan, Solomon, and Ben–Chen in computational geometry. We are interested in applying mean curvature flow to surface parametrizations, in particular to obtain a conformal from an arbitrary closed surface of genus zero onto a unit sphere. We discuss our own implementation of their algorithm and some limitations. Pictures and animations will be shown.

**Jianping Pan**

Virtualization Map for the Littelmann Path Model

We show the natural embedding of weight lattices from a diagram folding is a virtualization map for the Littelmann path model, which recovers a result of Kashiwara. As an application, we give a type-independent proof that certain Kirillov–Reshetikhin crystals respect diagram foldings, which is a known result on a special case of a conjecture given by Okado, Schilling, and Shimozono.

**Libby Taylor**

Enumerative Problems in Algebraic Geometry over Non-algebraically Closed Fields

It is a classical theorem of Cayley and Salmon that there are 27 lines on a smooth cubic surface over **C.** Over other fields, this result is false: for example, a real cubic surface can have 3, 7, 15 or 27 real lines. In 2017, Kass and Wickelgren produced a beautiful result that gives an arithmetic count of the lines on a smooth cubic surface over an arbitrary field. In particular, they give a count of lines valued in the Grothendieck–Witt ring of the ground field that is independent of the surface, and this count encodes certain arithmetic properties of the lines. I will survey this and other recent results extending classical enumerative problems to non-algebraically closed fields, including some recent joint work with Kadets, Quigley, Srinivasan, Swaminathan and Tseng.

**Madeline Brandt**

Voronoi Diagrams of Varieties

Voronoi diagrams of finite point sets partition space into regions. Each region contains all points which are nearest to one point in the finite point set. Voronoi diagrams (and their generalizations and variations) have been an object of interest for hundreds of years by mathematicians spanning many fields, and they have numerous applications across the sciences. Recently, Cifuentes, Ranestad, Sturmfels, and Weinstein defined Voronoi cells of varieties, in which the finite point set is replaced by a real algebraic variety. Each point $y$ on the variety has a cell of points in the ambient space corresponding to those points which are closer to $y$ than any other point on the variety. In this talk, we present the limiting behavior of Voronoi diagrams of finite sets, where the finite sets are sampled from the variety and the sample size increases. In this setting, we observe that many interesting features of the variety can be seen in a Voronoi Diagram, including its medial axis, curvatures, normals, reach, and singularities.

**"Black" Fushuai Jiang**

Whitney Extension Problem and Interpolation of Data

The classical Whitney extension theorem provides a converse to Taylor's theorem, namely, given Taylor-compatible polynomial data on a closed set in some Euclidean space, one can construct a smooth function whose Taylor expansion agrees with the data on the set. The much harder problem, in which the polynomial data are replaced by only function values, is resolved by C. Fefferman in '06.

In this talk, we consider the following variant of the problem: what if the data given are nonnegative, and we are required to have a nonnegative extension?

**Aaron Brookner**

Quantum Groups, the Applied and Theoretical

I will try and tell the original, physical context in which quantum groups resulted, along with the abstract algebra they thereby motivated.

On the physical side, I will discuss two systems: one showing plainly how the all-important "$R$-matrix" works, and whence braid groups enter into the quantum theory; the other to show how the $R$-matrix aids in calculating physical quantities of interest in so-called "integrable lattice models".

On the mathematical side, I will sketch some themes of the incomprehensibly rich representation theory of Hopf algebras; and examine some special properties that makes a Hopf algebra into a "quantum group", a definition which, as yet, lacks unanimous agreement.