# Weekly Seminar & Events Bulletin

**October 29th, 2017 - November 4th, 2017**

## Monday, October 30, 2017

<table>
<thead>
<tr>
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<tr>
<td>4:00pm-5:00pm</td>
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<td>4:00pm-5:30pm</td>
<td><strong>RTG Seminar on Geometry, Dynamics and Topology</strong> -- Richard Canary (U Michigan) <em>An introduction to Hitchin representations</em> -- 3866 East Hall</td>
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<td><strong>Topology</strong> -- Renaud Detcherry (Michigan State University) <em>Turaev Viro invariants and Gromov norm</em> -- 1866 East Hall</td>
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<td>4:00pm-5:30pm</td>
<td><strong>Logic</strong> -- Danny Nguyen (UCLA) <em>Presburger Arithmetic and its computational complexity</em> -- 3096 East Hall</td>
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<td>4:10pm-5:30pm</td>
<td><strong>Preprint Algebraic Geometry Seminar</strong> -- Eamon Quinlan (UM) <em>Simple D-module components of local cohomology modules (following Polini-Hartshorne)</em> -- 1866 East Hall</td>
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<td><strong>Student AIM Seminar</strong> -- Howard Levinson (University of Michigan) <strong>Inverse Scattering and Super-resolution</strong> -- 1084 East Hall</td>
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Abstracts for the week of October 29th, 2017 - November 4th, 2017

Complex Analysis, Dynamics and Geometry
Monday, October 30, 2017, 4:00pm-5:00pm
3096 East Hall
Jane Hawkins (UNC Chapel Hill)
Iterated Elliptic Functions: Dynamics and Parametrizations

The Weierstrass P function is the classical doubly periodic meromorphic function of a complex variable; iterating it gives surprisingly diverse dynamics. We show that the dynamics of the function P depend on the lattice of periodicity, and within each lattice shape (e.g., square), the dynamics vary greatly by changing lattice generators. We discuss properties of Julia and Fatou sets in this setting, along with maps of the form P+b, where b is a complex constant. Less surprising is that the addition of the constant adds even more dynamical diversity for each fixed lattice. The tools rely on some beautiful classical identities for elliptic functions; we also mention some results about ergodic measures for elliptic functions.

Geometry & Physics
Monday, October 30, 2017, 4:00pm-6:00pm
4096 East Hall
Georg Oberdieck (MIT)
Holomorphic anomaly equations of elliptic fibrations and quasi-Jacobi forms

Generating series of Gromov-Witten invariants of Calabi-Yau threefolds satisfy conjecturally two properties: They live in a finitely generated algebra of quasi-modular forms (finite generation) and satisfy a holomorphic anomaly equation. I will discuss joint work with Pixton which extends (with evidence) this conjecture to elliptic fibrations of any dimension which are possibly non-Calabi Yau. The finitely generated ring here is the algebra of quasi-Jacobi forms.

Student Arithmetic
Monday, October 30, 2017, 4:00pm-5:00pm
4088 East Hall
Aleksander Horawa (UM)
Local-to-global principles and the Tate--Shafarevich group

One of the central goals of number theory is to find rational solutions to polynomial equations. This is often hard and one instead tries to find solutions modulo powers of prime numbers. Surprisingly, in nice cases, the existence of these "local" solutions implies the existence of a "global" (rational) one. In the other cases, Tate--Shafarevich group measures the degree of failure of this principle.
Student Combinatorics Seminar  
Monday, October 30, 2017, 4:00pm-5:00pm  
3866 East Hall  
Francesca Gandini (University of Michigan)  
Playing Combinatorial Games: Who Wins?

In this talk I will introduce some terminology from combinatorial game theory and discuss conditions under which a player can win a game. In particular, we will play the game cutthroat which is a combinatorial game played on a graph. One can wonder what are the connections between the features of the graph and a winning strategy for the game. Some answers are known, but even for path graphs we do not have a complete answer to this problem.

Student Geometry/Topology  
Tuesday, October 31, 2017, 3:00pm-4:00pm  
1866 East Hall  
Patrick Haggerty (Indiana University)  
Mapping class groups and curve complexes

This talk will provide a gentle introduction to the mapping class group of a surface, the group of homotopy classes of orientation-preserving homeomorphisms of the surface. We'll start with a few basic examples and see some familiar groups arise. We will then discuss a particular method of studying these groups: studying mapping class group actions on certain simplicial complexes related to configurations of 1-manifolds on the surface.

Student Commutative Algebra  
Tuesday, October 31, 2017, 3:00pm-4:00pm  
4088 East Hall  
Robert Walker (University of Michigan)  
Some instances of "Life hacking"

To life hack means figuring out how to make some aspect of your daily life easier or more efficient. As mathematicians, we really want to life hack the study of an unwieldy abstract construction, or of some palatable numeric data, or whatever. I'll survey some cases of doing this in the ballpark of my research area, leveraging "ALGECOM" info (algebra-geometry-combinatorics), at the interface between asymptotic and combinatorial commutative algebra. While familiarity with notions in Math 614/631 is helpful, everyone is welcome to attend the talk.
Group, Lie and Number Theory  
Wednesday, November 01, 2017, 3:10pm-4:00pm  
3866 East Hall  
Ofir Gorodetsky (Tel Aviv University)  
*New Results on Shifted Correlation of Functions on F_q[T]*

We present new large-q results on the the number of twin primes in the ring F_q[T], where F_q is the finite field with q elements.

More generally, our results concern shifted correlation of a wide class of arithmetic functions on F_q[T]. Our methods involve L-functions, and some old and new equidistribution results concerning certain Dirichlet L-functions and their zeroes.

This is joint work with Will Sawin.

Financial/Actuarial Mathematics  
Wednesday, November 01, 2017, 4:00pm-5:00pm  
1360 East Hall  
Vathana Ly Vath (ENSIIE)  
*Optimal dividend and investment policy with debt covenants*

We consider a firm that holds a certain amount of debt to which is associated a financial-ratio covenant between the creditors and the firm. Under this debt covenant, the firm may be audited at any time and must prove that it debt to total assets ratio stays below the limit set by the covenant. If not, the firm is given a grace period during which it has the obligation to bring its ratio back below the set limit. The firm may, for instance, inject more capital to correct the situation. Furthermore, the firm may pay out dividend only when it does not violate the debt covenant. Under this setup, we consider an optimal control problem in which the value of the assets is controlled by the capital injections and the dividend payouts. This gives rise to a system of variational inequalities to which there exists a unique viscosity solution. To complete our analysis, some numerical results are provided.

Joint work with Etienne Chevalier and Alexandre Roch.
A representation from a closed surface group into $\text{PSL}(n,\mathbb{R})$ is Hitchin if it can be continuously deformed to the composition of a Fuchsian representation into $\text{PSL}(2,\mathbb{R})$ and the irreducible representation of $\text{PSL}(2,\mathbb{R})$ into $\text{PSL}(n,\mathbb{R})$. Labourie used dynamical techniques to show that Hitchin representations are "geometric." In particular, they are discrete, faithful, quasi-isometric embeddings.

In doing so, Labourie associates to each Hitchin representations a limit map from the boundary of the surface group into the space of $n$-dimensional flags and a splitting into invariant line bundles of the associated flat bundle over the geodesic flow of the surface. Sambarino showed how to associate a family of Anosov flows to a Hitchin representation which record "lengths" associated to simple roots of $\text{PSL}(n,\mathbb{R})$. We will survey this theory and discuss some applications of Labourie and Sambarino’s work. This talk will hopefully provide preparation for the talks of Tengren Zhang and Giuseppe Martone in upcoming weeks.

**Algebraic Geometry**  
**Wednesday, November 01, 2017, 4:10pm-5:30pm**  
**4096 East Hall**  
**Charlie Stibitz (Princeton University)**  
*Etale morphisms and local algebraic fundamental groups*

Suppose that $X$ is a normal noetherian scheme. We consider local obstructions to the map on etale fundamental groups $\pi_1(X^{\text{reg}}) \rightarrow \pi_1(X)$ being an isomorphism. Assuming $X$ has a regular alteration, we prove that these obstructions are finite if and only if $X$ has a finite Galois cover that is etale over the regular locus, where the corresponding map on fundamental groups is an isomorphism.

**Commutative Algebra**  
**Thursday, November 02, 2017, 3:00pm-4:00pm**  
**4088 East Hall**  
**Jonathan Montano (University of Kansas)**  
*Local cohomology of powers of ideals*

Let $R$ be a Noetherian local ring of dimension $d$. In this work, we study the behavior of local cohomology modules of powers of ideals. For homogeneous ideals, we are able to show that after restricting the lower degrees to a linear bound, the sequence of lengths of these modules does not grow faster than $n^d$. Combining this result with Kodaira-like vanishing theorems, we obtain that the sequence grows as expected for several broad classes of ideals. In addition, we study similar vanishing results for powers of modules. This is joint work with Hailong Dao.
According to Chen and Yang's volume conjecture, the asymptotics of the Turaev-Viro invariants of a 3-manifold predicts its hyperbolic volume. We show a compatibility between Turaev-Viro invariants and JSJ-decomposition and get an inequality relating Turaev-Viro invariants and Gromov norm.

Presburger Arithmetic (PA) is a classical topic in logic, with numerous connections to computer science and combinatorics. Formally, is the first order structure on the integers with only additions and inequalities. Despite its long history, many problems in PA have remained unsolved until recently. We study the complexity of decision problems in PA, and classify them according to hierarchy levels. Along the way, connections to Integer Programming and Optimization will be explained. The talk will be self contained and assumes no prior knowledge of the subject. Joint work with Igor Pak.

Colloquium Series  
Thursday, November 02, 2017, 4:10pm-5:00pm  
1360 East Hall  
Alex Wright (Stanford University)  
*Dynamics, geometry, and the moduli space of Riemann surfaces*

The moduli space of Riemann surfaces of fixed genus is one of the hubs of modern mathematics and physics. We will tell the story of how simple sounding problems about polygons, some of which arose as toy models in physics, became intertwined with problems about the geometry of moduli space, and how the study of these problems in Teichmuller dynamics lead to connections with homogeneous spaces, algebraic geometry, dynamics, and other areas. The talk will mention joint works with Alex Eskin, Simion Filip, Curtis McMullen, Maryam Mirzakhani, and Ronen Mukamel.

Applied Interdisciplinary Mathematics (AIM)  
Friday, November 03, 2017, 3:00pm-4:00pm  
1084 East Hall  
Robert Ecke (Los Alamos National Lab)  
*Turbulence and mixing in stably-stratified shear flows*

Oceanic overflows, wind-driven thermocline layers and river estuaries are important geophysical examples of stably-stratified shear flows. Although field measurements are an essential tool in characterizing these complex flows, a combination of laboratory experiments, numerical simulations, and theory is crucial for interpreting the results. We realize a turbulent stably-stratified shear flow in the laboratory and use modern experimental techniques of laser-induced fluorescence and particle image velocimetry to examine the properties of these flows. The controlling dimensionless number that characterizes the competition between shear and buoyancy is the Richardson Number Ri but it is very challenging to relate experimental measurements of Ri with the corresponding parameter in numerical simulations and linear theory. Using conditional averaging, we show how results can be interpreted in such a manner to be consistent with the linear stability results of Miles and Howard. Our analysis suggests a dynamical way to think about evolving mixing layers with potential application to real world oceanographic situations.
Geometry
Friday, November 03, 2017, 3:00pm-4:00pm
3866 East Hall
Alex Wright (Stanford)

Totally geodesic submanifolds of Teichmuller space and the Kontsevich-Zorich cocycle

One of the ways we understand Teichmuller space, endowed with the Teichmuller metric, is by studying Teichmuller discs. They exist in great abundance: There is a Teichmuller disc through any point and in any direction. Typically, their projection to moduli space is dense, and yet infinitely often their projection is a closed subvariety of moduli space called a Teichmuller curve.

Recently, in joint work with Eskin, McMullen, and Mukamel, we discovered the first non-trivial examples of higher dimensional analogues of Teichmuller discs, namely totally geodesic submanifolds.

In this talk, we will explain that such higher dimensional totally geodesic submanifolds are much more rigid and rare than Teichmuller discs: Each must cover a closed subvariety of moduli space, and only finitely many such subvarieties exist in each moduli space. This result is an application of joint work with Eskin and Filip on the Kontsevich-Zorich cocycle. One of the goals of the talk will be to explain what this cocycle is and why it lies at the heart of Teichmuller dynamics.

Student Representation Theory
Friday, November 03, 2017, 3:00pm-4:00pm
1866 East Hall
Bradley Zykoski (University of Michigan)

Link Invariants via Quantum sl2 Representations

The purpose of this talk is to discuss the Kauffman bracket and Jones polynomial from the viewpoint of representation theory. We will see that this is done as a special case of the more general construction of tangle invariants via certain Hopf algebras. A complete exposition of this material (and much more!) can be found in Tomotada Ohtsuki's excellent book “Quantum Invariants” and the references therein.
Student Algebraic Geometry
Friday, November 03, 2017, 3:10pm-4:00pm
3096 East Hall
Francesca Gandini (UM)
*Groebner Bases: A Computational Tool for Algebraic Geometry*

Given an ideal in a polynomial ring, it may have a very complicated set of generators involving polynomials with several terms. On the other hand, monomial ideals are well-studied and they exhibit remarkable combinatorial properties. The theory of Groebner bases allows us to associate to any ideal an appropriate monomial ideal which retains part of the structure of the original ideal. Geometrically speaking, this operation allows to move from a complicated space to the intersection of coordinate subspaces. We will talk about the background needed for the theory of Groebner bases, point out some computations that can be made using this tool, and recover some information about our original ideal from the study of its initial monomial ideal.

Arithmetic Geometry Learning Seminar
Friday, November 03, 2017, 4:00pm-5:30pm
1866 East Hall
Bhargav Bhatt (UM)
*Compactification of Drinfeld modular curves*

Junior Colloquium Series
Friday, November 03, 2017, 4:00pm-5:00pm
3096 East Hall
Trevor Hyde (University of Michigan)
*Factorization statistics and the twisted Grothendieck-Lefschetz formula*

What's the average number of roots of a degree d polynomial? How many irreducible quadratic factors do we expect a degree d squarefree polynomial to have? If the polynomials have coefficients in a finite field F_q, then these questions make sense. In this talk we discuss the surprising connection between the answer to these sorts of question and the representation theoretic structure of the cohomology of configuration spaces.
Combinatorics  
Friday, November 03, 2017, 4:10pm-5:00pm  
4088 East Hall  
Nathan Reading (North Carolina State U.)  
*Dominance phenomena: mutation, scattering and cluster algebras*

An exchange matrix $B$ dominates an exchange matrix $B'$ if they are the same size and if the signs of corresponding entries weakly agree, with the entry of $B$ always having weakly greater absolute value. When $B$ dominates $B'$, interesting things often happen. For example, the mutation fan for $B$ often refines the mutation fan for $B'$. (In finite type, these are g-vector fans.) The scattering (diagram) fan for $B$ often refines the scattering fan for $B'$. And there is often an injective homomorphism from the principal-coefficients cluster algebra for $B'$ to the principal-coefficients cluster algebra for $B$, preserving g-vectors and (less often) sending cluster variables for $B'$ to cluster variables for $B$.

I call these "phenomena" because the scope of the description "often" is not settled in any of these contexts. Indeed, there are some counterexamples. In this talk, I will give background on the phenomena and present theorems that provide examples of the phenomena, with the goal of establishing that something real and nontrivial is happening.

Student AIM Seminar  
Friday, November 03, 2017, 4:10pm-5:00pm  
1084 East Hall  
Howard Levinson (University of Michigan)  
*Inverse Scattering and Super-resolution*

In the first part of the talk, I will survey inverse scattering problems and their importance in imaging applications. Then, I will discuss the idea of super-resolution in fluorescence microscopy and major advances in the field. Possible connections between these two problems will be explored.