

## Weekly Seminar & Events Bulletin

November 12th, 2017 - November 18th, 2017

### Monday, November 13, 2017

- 12:00pm-1:00pm **Mathematical Biology** -- Tim Stasevich (Colorado State University) *Real-time imaging of single mRNA translation dynamics in living cells* -- 335 West Hall
- 3:10pm-4:00pm **Colloquium Series** -- Mark Behrens (Notre Dame University ) *Detectors in homotopy theory* -- 3096 East Hall
- 4:00pm-5:00pm **Complex Analysis, Dynamics and Geometry** -- Chenxi Wu (Rutgers) *An upper bound on the asymptotic translation length on the curve complex* -- 3096 East Hall
- 4:00pm-6:00pm **Geometry & Physics** -- Aaron Pixton (MIT) *Generalized boundary strata classes* -- 4096 East Hall
- 4:00pm-5:00pm **Special Events** -- Robert Griess (University of Michigan) *Distinguished University Professorship Lecture - The sporadic simple groups: 26 characters in search of an oracle* -- Amphitheatre Rackham Graduate School (Horace H.)
- 4:00pm-5:00pm **Integrable Systems and Random Matrix Theory** -- Chaya Norton (Concordia University and Centre de Recherches Mathematiques (CRM), Montreal) *Symplectic aspects of a monodromy map* -- 1866 East Hall
- 4:00pm-5:00pm **Student Combinatorics Seminar** -- () *No meeting this week* -- 3866 East Hall
- 5:30pm-7:00pm **Group, Lie and Number Theory** -- Jayce Getz (Duke University) *A summation formula for triples of quadratic spaces (Note special time and room)* -- 3088 East Hall

### Tuesday, November 14, 2017

- 3:00pm-4:00pm **Student Geometry/Topology** -- Patrick Haggerty (Indiana University) *The Symplectic Representation of Mapping Class Groups* -- 1866 East Hall

### Wednesday, November 15, 2017

- 3:00pm-4:00pm **Student Arithmetic** -- Patrick Lenning (UM) *Varieties over the integers* -- 3866 East Hall
- 4:00pm-5:30pm **RTG Seminar on Geometry, Dynamics and Topology** -- Richard Canary (U Michigan) *An introduction to Hitchin representations II* -- 3866 East Hall
- 4:10pm-5:30pm **Algebraic Geometry** -- Maksym Fedorchuk (Boston College) *GIT for syzygies, with applications* -- 4096 East Hall

### Thursday, November 16, 2017

- 3:00pm-4:00pm **Topology** -- Giuseppe Martone (University of Southern California) *Hitchin representations and configurations of apartments* -- 1866 East Hall
- 3:00pm-4:00pm **Commutative Algebra** -- Sema Gunturkun (University of Michigan) *A Case of Eisenbud-Green-Harris Conjecture* -- 4088 East Hall
- 4:00pm-5:00pm **Differential Equations** -- Nicolas Yunes (Montana State University) *Asymptotic Methods in the General Relativistic Modeling of Inspiring Compact Binaries* -- 4088 East Hall
- 4:10pm-5:30pm **Preprint Algebraic Geometry Seminar** -- Ming Zhang (UM) *Mirror symmetry for moduli spaces of Higgs bundles via  $p$ -adic integration (following Groechening-Wyss-Ziegler)* -- 1866 East Hall

**Weekly Seminar & Events Bulletin**  
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Friday, November 17, 2017

- 3:00pm-4:00pm **Applied Interdisciplinary Mathematics (AIM)** -- Marina Epelman (University of Michigan, Industrial and Operations Engineering) *Analysis of countably-infinite linear programming problems and simplex-type algorithms* -- 1084 East Hall
- 3:00pm-4:00pm **Student Representation Theory** -- Peter Dillery (University of Michigan) *Category O* -- 1866 East Hall
- 3:10pm-4:00pm **Student Algebraic Geometry** -- Yifan Wu (UM) *Affine Algebraic Groups* -- 3096 East Hall
- 4:10pm-5:00pm **Combinatorics** -- Hugh Thomas (UQAM) *Robinson-Schensted-Knuth via quiver representations* -- 4088 East Hall
- 4:10pm-5:00pm **Student AIM Seminar** -- Bobbie Wu (University of Michigan) *Why is scientific computing interesting?* -- 1084 East Hall

**Abstracts for the week of November 12th, 2017 - November 18th, 2017**

**Mathematical Biology**

**Monday, November 13, 2017, 12:00pm-1:00pm**

**335 West Hall**

**Tim Stasevich (Colorado State University)**

*Real-time imaging of single mRNA translation dynamics in living cells*

We are developing technology to image single RNA translation dynamics in living cells. Using high-affinity antibody-based probes, multimerized epitope tags, and single molecule microscopy, we are able to visualize and quantify the emergence of nascent protein chains from single pre-marked RNA1. Here, I'll describe this technology as well as a two color extension useful for comparing translation rates between two different parts of a single open reading frame (ORF) or two different ORFs. Using information from the correlations of fluorescence fluctuations, we can accurately quantify single mRNA translation elongation rates in both tagged and untagged portions of ORFs. By transiently loading probes and reporter DNA into cells in a combinatorial fashion, multiplexed imaging of gene expression is possible. Preliminary application of this technology to the study of viral frameshifting will be discussed.

**Colloquium Series**

**Monday, November 13, 2017, 3:10pm-4:00pm**

**3096 East Hall**

**Mark Behrens (Notre Dame University )**

*Detectors in homotopy theory*

In physics, the detection of certain particles has required working at increasingly high energy. These accelerator experiments have required increasingly elaborate detectors and data analysis to reconstruct events from the production of dozens, sometimes hundreds of resulting particles. I will use this analogy to discuss the increasingly elaborate "detectors" used in homotopy theory to probe the stable homotopy groups of spheres in increasingly large dimensions. These "detectors" are versions of the Adams spectral sequence. To maximize the accessibility of this talk, I will avoid using the language of spectral sequences.

## Weekly Seminar & Events Bulletin

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### Complex Analysis, Dynamics and Geometry

Monday, November 13, 2017, 4:00pm-5:00pm

3096 East Hall

Chenxi Wu (Rutgers)

*An upper bound on the asymptotic translation length on the curve complex*

The curve graph of a closed surface is a simplicial complex where the vertices are simple closed curves and edges are curves that are disjoint. A pseudo-Anosov map induces a map from the curve graph to itself, and a basic question is to study the asymptotic translation length which is known to be a non-zero rational number. I will give an introduction on prior works on the study of this asymptotic translation length, and present an improved upper bound for the asymptotic translation length for pseudo-Anosov maps inside a fibered cone, which generalizes the previous result on sequences with small translation length on curve graphs by Kin and Shin. This is a joint work by Hyungryul Baik and Hyunshik Shik.

### Geometry & Physics

Monday, November 13, 2017, 4:00pm-6:00pm

4096 East Hall

Aaron Pixton (MIT)

*Generalized boundary strata classes*

The Deligne-Mumford moduli space of stable curves of genus  $g$  admits a stratification by topological type. These boundary strata define classes in the Chow ring of the moduli space of stable curves. I will describe a natural generalization of these boundary strata classes to unstable topological types. I will then use the unstable boundary strata classes to define some interesting subrings of the Chow ring. In particular, there is a relatively small subring of the Chow ring that contains every double ramification cycle.

### Special Events

Monday, November 13, 2017, 4:00pm-5:00pm

Amphitheatre Rackham Graduate School (Horace H.)

Robert Griess (University of Michigan)

*Distinguished University Professorship Lecture - The sporadic simple groups: 26 characters in search of an oracle*

Finite simple groups consist of 18 infinite families (mostly groups of Lie type over finite fields) plus 26 sporadic groups. Five Mathieu groups arose in 19th century and 21 sporadic groups were discovered 1965-1975. We discuss history, UM faculty contributions, the Monster, and unexpected sporadic connections with mathematics and physics.

**Weekly Seminar & Events Bulletin**

November 12th, 2017 - November 18th, 2017

**Integrable Systems and Random Matrix Theory**

**Monday, November 13, 2017, 4:00pm-5:00pm**

**1866 East Hall**

**Chaya Norton (Concordia University and Centre de Recherches Mathematiques (CRM), Montreal)**

*Symplectic aspects of a monodromy map*

The monodromy map assigns to an ordinary differential equation on a Riemann surface of the form  $\psi'' - u(z)\psi = 0$  its monodromy group, a representation of  $\pi_1$  into  $\mathrm{PSL}(2, \mathbb{C})$  by noting how a solution transforms when one travels around a handle of the Riemann surface. This correspondence between the differential equation, where  $u(z)$  denotes a holomorphic projective connection, and its monodromy group is a specific example of the Riemann-Hilbert correspondence, and the work of Gallo-Kapovich-Marden states that every non-elementary representation of  $\pi_1$  into  $\mathrm{PSL}(2, \mathbb{C})$  which is liftable to  $\mathrm{SL}(2, \mathbb{C})$  is the monodromy group of some differential equation of the form stated above.

In joint work with Bertola and Korotkin, we study the symplectic properties of the map from the space of such equation, i.e. the moduli space of projective connections, to the character variety of representations of  $\pi_1$  into  $\mathrm{PSL}(2, \mathbb{C})$ . In specific we show that the monodromy map, with various choices of base projective connection, is a symplectomorphism from the moduli space of quadratic differentials with the homological bracket to the character variety with the Goldman bracket.

In our case there are no isomonodromy deformations, the number of parameters in the equation matches the number in the representations. Results showing the symplectic properties of a monodromy map provide a perspective to interpret isomonodromy deformations as the direction transversal to the symplectic leaves, arising from the presence of casimirs, giving an intrinsic explanation for the hamiltonian structure arising in isomonodromy deformations.

**Student Combinatorics Seminar**

**Monday, November 13, 2017, 4:00pm-5:00pm**

**3866 East Hall**

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*No meeting this week*

**Weekly Seminar & Events Bulletin**

November 12th, 2017 - November 18th, 2017

**Group, Lie and Number Theory**

**Monday, November 13, 2017, 5:30pm-7:00pm**

**3088 East Hall**

**Jayce Getz (Duke University)**

*A summation formula for triples of quadratic spaces (Note special time and room)*

(joint work with B. Liu) Let  $V_1, V_2, V_3$  be a triple of even dimensional vector spaces. Assume that each  $V_i$  is equipped with a nondegenerate quadratic form  $Q_i$ . Motivated by ideas of Braverman, Kazhdan, Lafforgue, Ngo, and Sakellaridis we prove a Poisson summation formula for the subscheme of  $V_1 + V_2 + V_3$  consisting of vectors  $(v_1, v_2, v_3)$  such that  $Q_1(v_1) = Q_2(v_2) = Q_3(v_3)$ . The key idea in the proof is to substitute theta functions into Garrett's integral representation of the triple product L function.

**Student Geometry/Topology**

**Tuesday, November 14, 2017, 3:00pm-4:00pm**

**1866 East Hall**

**Patrick Haggerty (Indiana University)**

*The Symplectic Representation of Mapping Class Groups*

In this talk we consider the action of the mapping class group of an orientable closed surface of genus  $g$  on the first homology of that surface. This action leads to a surjective representation onto the symplectic group  $Sp(2g, \mathbb{Z})$ . After describing this representation, I will give some examples of what we can learn about mapping class groups by considering this representation. I will also make some remarks about the kernel of this representation, the Torelli group. This talk has minimal dependence on the talk from 10/31.

**Student Arithmetic**

**Wednesday, November 15, 2017, 3:00pm-4:00pm**

**3866 East Hall**

**Patrick Lenning (UM)**

*Varieties over the integers*

In this talk, we'll define varieties over the integers and discuss how they can be viewed as a family of varieties over various fields. Then we'll explore some examples and see how a variety over the rationals can be stretched into a variety over the integers. Finally, we'll define what it means for a variety over the rationals to have good or bad reduction modulo a prime. If time permits, we'll also talk about elliptic curves over the rationals in more depth.

## Weekly Seminar & Events Bulletin

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### RTG Seminar on Geometry, Dynamics and Topology

Wednesday, November 15, 2017, 4:00pm-5:30pm

3866 East Hall

Richard Canary (U Michigan)

*An introduction to Hitchin representations II*

A representation from a closed surface group into  $PSL(n, \mathbb{R})$  is Hitchin if it can be continuously deformed to the composition of a Fuchsian representation into  $PSL(2, \mathbb{R})$  and the irreducible representation of  $PSL(2, \mathbb{R})$  into  $PSL(n, \mathbb{R})$ . 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  $PSL(n, \mathbb{R})$ . 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 15, 2017, 4:10pm-5:30pm

4096 East Hall

Maksym Fedorchuk (Boston College)

*GIT for syzygies, with applications*

I will introduce geometric invariant theory (GIT) of syzygy points of polarized varieties. A syzygy point is a natural Koszul-theoretic generalization of a Hilbert point, and encodes higher-order relations among generators of the homogeneous ideal of an embedded variety. While GIT for Hilbert points has been classically used to construct moduli spaces of polarized varieties by Mumford, Gieseker, Viehweg, and many others, the GIT of syzygy points is much less explored. In this talk, I will present two cases where the GIT stability analysis of syzygy points is feasible: canonical curves, and polarized K3 surfaces. Applications will include a new construction in the Hassett-Keel program for the moduli space of genus 6 curves and an effectivity result for divisors on the moduli space of K3 surfaces of odd genus.

**Topology**

**Thursday, November 16, 2017, 3:00pm-4:00pm**

**1866 East Hall**

**Giuseppe Martone (University of Southern California)**

*Hitchin representations and configurations of apartments*

Hitchin singled out a preferred component  $\mathrm{Hit}_n(S)$  in the character variety of representations from the fundamental group of a surface  $S$  to  $\mathrm{PSL}_n(\mathbb{R})$ . When  $n=2$ ,  $\mathrm{Hit}_2(S)$  coincides with the Teichmüller space  $\mathcal{T}(S)$  consisting of all hyperbolic metrics on the surface  $S$ . Later Labourie showed that the elements in  $\mathrm{Hit}_n(S)$  share many important differential geometric and dynamical properties.

Morgan and Shalen provided an algebro-geometric interpretation of Thurston's compactification of  $\mathcal{T}(S)$  in terms of valuations on character varieties. Parreau extended this construction to a compactification of  $\mathrm{Hit}_n(S)$  whose boundary points are described by actions of  $\pi_1(S)$  on an  $\mathbb{R}$ -building  $B$ . This generalizes the actions on  $\mathbb{R}$ -trees occurring for the Morgan-Shalen compactification of  $\mathcal{T}(S)$ .

In this talk, we offer a new presentation for the Parreau compactification of  $\mathrm{Hit}_n(S)$ , which is based on certain positivity properties discovered by Fock and Goncharov. More precisely, we use the Fock-Goncharov construction to describe the intersection patterns of apartments in  $\pi_1(S)$ -invariant subsets of  $B$  that arise in the boundary of  $\mathrm{Hit}_n(S)$ .

**Commutative Algebra**

**Thursday, November 16, 2017, 3:00pm-4:00pm**

**4088 East Hall**

**Sema Gunturkun (University of Michigan)**

*A Case of Eisenbud-Green-Harris Conjecture*

Eisenbud-Green-Harris (EGH) conjecture states that, in the polynomial ring  $K[x_1, \dots, x_n]$ , a homogeneous ideal that contains a regular sequence  $f_1, \dots, f_n$  with degrees  $a_i, i=0, \dots, n$  has the same Hilbert function of a lex-plus-powers ideal containing the powers  $x^{a_i}, i=0, \dots, 1$ . We will discuss a case of EGH conjecture for the homogeneous ideals generated by  $n+2$  quadrics containing a regular sequence  $f_1, \dots, f_n$ . This is a joint work with Mel Hochster.



**Differential Equations**

**Thursday, November 16, 2017, 4:00pm-5:00pm**

**4088 East Hall**

**Nicolas Yunes (Montana State University)**

*Asymptotic Methods in the General Relativistic Modeling of Inspiring Compact Binaries*

Compact objects in nature, like neutron stars and black holes, are likely spinning. When such objects are in orbit around each other, the interactions between their spin angular momenta and the orbital angular momentum can cause the orbital plane to precess. Precession also occurs in binaries that are elliptical due to General Relativistic effects. Such precessional effects encode rich information about the dynamics of compact binaries, which, if properly included in an accurate mathematical model, can be used to mine astrophysical and gravitational wave observations. In this talk, I will discuss two new mathematical approaches based on multiple scale-analysis and hyperasymptotics to construct closed-form expressions for the orbital motion and the gravitational waves emitted by spin-precessing, quasi-circular, compact binaries and non-spinning, highly-elliptical binaries. These accurate models may allow for better extraction of astrophysical parameters and more detailed tests of General Relativity in the extreme gravity regime.

**Preprint Algebraic Geometry Seminar**

**Thursday, November 16, 2017, 4:10pm-5:30pm**

**1866 East Hall**

**Ming Zhang (UM)**

*Mirror symmetry for moduli spaces of Higgs bundles via  $p$ -adic integration (following Groechening-Wyss-Ziegler)*

Available at <https://arxiv.org/abs/1707.06417>.

**Applied Interdisciplinary Mathematics (AIM)**

**Friday, November 17, 2017, 3:00pm-4:00pm**

**1084 East Hall**

**Marina Epelman (University of Michigan, Industrial and Operations Engineering)**

*Analysis of countably-infinite linear programming problems and simplex-type algorithms*

Linear Programming (LP) optimization problems, where a linear function on  $\mathbb{R}^n$  is minimized subject to, say,  $m$  linear constraints on the variables, are the workhorse of Operations Research, used as a modeling tool in a vast variety of applications. Not surprisingly, their mathematical properties are well-understood, and several effective algorithms for their solution have been widely studied and implemented. Countably-Infinite Linear Programs (CILPs), i.e., linear programs where the number of variables and constraints is countably infinite, are also useful in modeling --- especially in applications that involve decision making over time, with no pre-specified horizon. However, they are challenging to analyze or solve, since useful properties of finite LPs often fail to extend to general CILPs. In this talk, I'll survey some work on structured CILPs, which do possess some of these properties, including duality, complementary slackness, and a simple analytical representation of extreme points. In addition, I'll discuss an algorithmic approach for solving such CILPs inspired by the simplex method for finite-dimensional LPs, including challenges (and some successes) in implementing it.

**Student Representation Theory**

**Friday, November 17, 2017, 3:00pm-4:00pm**

**1866 East Hall**

**Peter Dillery (University of Michigan)**

*Category O*

In this talk, we will discuss Category O of representations of a semisimple Lie algebra. We cover the basic notions of Category O building up to a discussion of BGG reciprocity and other homological information about Category O.

**Student Algebraic Geometry**

**Friday, November 17, 2017, 3:10pm-4:00pm**

**3096 East Hall**

**Yifan Wu (UM)**

*Affine Algebraic Groups*

In this talk, we will introduce the notion of affine algebraic groups, starting with basic definition and examples. The first half of the talk will focus on the Lie algebras associated with affine algebraic groups. In the second half of the talk, we will present several basic theorems, including Chevalley's theorems on closed and normal subgroups, and Borel's fixed point theorem. Using Chevalley's theorem, we will give a meaningful interpretation of quotients of affine algebraic groups. Based on Borel's fixed point theorem, we will give a quick and dirty proof of Lie-Kolchin theorem. Lecture notes will be distributed at the beginning of the talk.

**Weekly Seminar & Events Bulletin**

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**Combinatorics**

**Friday, November 17, 2017, 4:10pm-5:00pm**

**4088 East Hall**

**Hugh Thomas (UQAM)**

*Robinson-Schensted-Knuth via quiver representations*

The Robinson-Schensted-Knuth correspondence is a multi-faceted jewel of algebraic combinatorics. I will explain a version of RSK which sends arbitrary labellings of a minuscule poset by non-negative integers to order-preserving labellings. This map can be described in terms of quiver representations. It can also be used to give a uniform explanation of the periodicity of a certain promotion operator on the order-preserving labellings of the poset, by relating promotion to Auslander-Reiten translation. I shall not assume familiarity with quiver representations in my talk. This is joint work with Al Garver and Becky Patrias.

**Student AIM Seminar**

**Friday, November 17, 2017, 4:10pm-5:00pm**

**1084 East Hall**

**Bobbie Wu (University of Michigan)**

*Why is scientific computing interesting?*

This talk consists of two parts. The first part is a "proof by examples" that scientific computing is interesting. The second part presents an example of high-order method and its application to my research of simulating viscous particle flows.