

## Weekly Seminar & Events Bulletin

September 15th, 2019 - September 21st, 2019

### Monday, September 16, 2019

- 3:00pm-4:00pm **Student Combinatorics** -- Alana Huszar (UM) *Matroids I* -- 3096 East Hall
- 3:00pm-4:00pm **Student Dynamics** -- Bradley Zykoski (UM) *Rational Billiards* -- 3866 East Hall
- 4:00pm-5:00pm **Complex Analysis, Dynamics and Geometry** -- Sara Lapan (UC Riverside) *Holomorphic dynamics near a fixed point in complex dimensions 2 and 3* -- 3866 East Hall
- 4:00pm-5:00pm **Integrable Systems and Random Matrix Theory** -- Yuchen Liao (University of Michigan) *Number rigidity of eigenvalues of random Schrodinger operators* -- 1866 East Hall
- 4:00pm-6:00pm **Geometry & Physics** -- Rachel Webb (University of Michigan) *Virtual Cycle on the Moduli Space of Maps to a Complete Intersection* -- 4096 East Hall
- 4:00pm-5:00pm **Student Algebraic Geometry** -- Gilyoung Cheong (UM) *The functor of points of a scheme* -- B745 East Hall
- 5:00pm-6:00pm **Operators in Complex Analysis** -- Luke Edholm (University of Michigan) *Spectral analysis of the Leray transform and the Euler-Maclaurin formula* -- 3096 East Hall
- 5:00pm-6:00pm **Student Analysis** -- Yuxin Wang (University of Michigan) *Maximal Operators* -- 2866 East Hall

### Tuesday, September 17, 2019

- 11:30am-1:00pm **IBL Workshops/Lectures** -- () *IBL Lunch* -- 4866 East Hall
- 3:00pm-3:50pm **Student Commutative Algebra** -- Janet Page (University of Michigan) *Some combinatorial objects in commutative algebra* -- 4088 East Hall
- 3:00pm-4:00pm **Student Geometry/Topology** -- Sameer Kailasa (UM) *Circles* -- 3866 East Hall
- 4:00pm-5:00pm **Colloquium Series** -- Charlotte Chan (Princeton University) *Flag varieties and representations of  $p$ -adic groups* -- 1360 East Hall

### Wednesday, September 18, 2019

- 3:00pm-4:00pm **Student Homotopy Theory** -- Ruian Chen (UM) *Invitation to the simplicial world* -- 1372 East Hall
- 3:00pm-4:00pm **Student Arithmetic** -- Alex Horawa (UM) *The BSD Conjecture* -- 3866 East Hall
- 4:00pm-5:00pm **Colloquium Series** -- Alexander Smith (Harvard University) *NT RTG Lectures I:  $2^k$ -Selmer groups and Goldfeld's conjecture.* -- 1360 East Hall
- 4:00pm-5:00pm **Algebraic Geometry** -- Alexander Smith (Harvard) *See colloquium talk* -- 1360 East Hall
- 4:00pm-5:00pm **Financial/Actuarial Mathematics** -- Shuoqing Deng (UM) *Optimal consumption with reference to past spending maximum* -- 4096 East Hall
- 4:00pm-5:00pm **Analysis/Probability** -- Alexander Volberg (Michigan State University) *An unexpected combinatorial property of all planar measures* -- 4088 East Hall

### Thursday, September 19, 2019

- 11:30am-1:30pm **Special Events** -- Grace Ingermanson (UM) *Thesis Defense: Cluster Algebras of Open Richardson Varieties* -- 3088 East Hall
- 3:00pm-4:00pm **Topology** -- Ara Basmajian (CUNY) *Extremal length calculations and applications to the geodesic flow* -- 3866 East Hall
- 3:00pm-4:00pm **Commutative Algebra** -- Janet Page (University of Michigan) *Measuring the Gorenstein property with the trace of the canonical module* -- 4088 East Hall
- 4:00pm-5:30pm **Arithmetic Geometry Learning** -- Alexander Horawa (UM) *Condensed abelian groups* -- 4096 East Hall

**Weekly Seminar & Events Bulletin**  
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Friday, September 20, 2019

- 3:00pm-4:00pm **Applied Interdisciplinary Mathematics (AIM)** -- Zhimin Zhang (Wayne State University) *Construction of  $H^2(\text{curl})$  conforming elements and their application* -- 1084 East Hall
- 3:00pm-4:00pm **Combinatorics** -- Christopher Eur (UC Berkeley) *Simplicial generation of Chow rings of matroids* -- 4096 East Hall
- 3:00pm-4:00pm **Financial/Actuarial Mathematics** -- Steve Kou (Boston University) *A Theory of FinTech* -- 4448 East Hall
- 4:00pm-12:00am **Geometry** -- Krishnan Shankar (U Oklahoma/NSF) *Recent developments in non-negative sectional curvature* -- 3866 East Hall
- 4:00pm-5:00pm **Group, Lie and Number Theory** -- Alexander Smith (Harvard University) *NT RTG Lectures II: Governing fields and statistics for 8-class ranks* -- 2866 East Hall
- 4:00pm-5:00pm **Junior Colloquium Series** -- Brandon Carter (Google) *Life of a Software Engineer (Invitation to Industry Series)* -- 1068 East Hall
- 4:00pm-5:00pm **Student AIM Seminar** -- () *Planning meeting* -- 1084 East Hall

Saturday, September 21, 2019

- 10:30am-8:00pm **Special Events** -- () *Michigan Algebra and Number Theory Intercity Symposium* -- B844 East Hall

**Abstracts for the week of September 15th, 2019 - September 21st, 2019**

**Student Combinatorics**

**Monday, September 16, 2019, 3:00pm-4:00pm**

**3096 East Hall**

**Alana Huszar (UM)**

*Matroids I*

Matroids are a combinatorial structure that allow us to generalize linear independence and dependence to other objects. Major motivating examples come from graphs, where a matroid can be explicitly defined using a graph's cycles. We will explore several equivalent definitions of matroids, and translate tools in the context of vector spaces to tools we can use to study matroids. This talk will be accessible to all graduate students, and will serve as an introduction to Matroids in anticipation of Will Dana's talk next week on representability of Matroids.

**Student Dynamics**

**Monday, September 16, 2019, 3:00pm-4:00pm**

**3866 East Hall**

**Bradley Zykoski (UM)**

*Rational Billiards*

The trajectory of a billiard ball on a table shaped like a polygon whose angles are rational multiples of  $\pi$  gives us a nice example of a dynamical system. I will discuss some results on the long-term behavior of generic trajectories, and then talk about some more modern innovations made possible by recent work on the study of translation surfaces.

**Complex Analysis, Dynamics and Geometry**

**Monday, September 16, 2019, 4:00pm-5:00pm**

**3866 East Hall**

**Sara Lapan (UC Riverside)**

*Holomorphic dynamics near a fixed point in complex dimensions 2 and 3*

In this talk, I will discuss holomorphic self-maps in  $n$  complex dimensions that fix the origin and are tangent to the identity (i.e.,  $f(0)=0$  and  $df(0)=Id$ ). I will give background in this area and discuss some of my new results. In particular, I will introduce a map in 2 complex dimensions that has 3 characteristic directions at the origin, but that does not have a domain of attraction along any of those directions. Instead, it exhibits other interesting dynamical behavior that I will discuss and supplement with pictures. I will then discuss joint work with F. Rong analyzing a family of maps tangent to the identity in 3 complex dimensions that have a characteristic direction whose directors have trivial real part and show that a domain of attraction does exist along that direction. Time permitting, I will show how small changes to both of these types of maps can affect the existence of a domain of attraction.

**Integrable Systems and Random Matrix Theory**

**Monday, September 16, 2019, 4:00pm-5:00pm**

**1866 East Hall**

**Yuchen Liao (University of Michigan)**

*Number rigidity of eigenvalues of random Schrodinger operators*

In this talk, we will consider the eigenvalue point processes of one-dimensional random Schrodinger operators (RSOs). RSOs arise naturally in many problems of mathematical physics, a particularly interesting example to random matrix community is the stochastic Airy operator whose eigenvalues point process (known as Airy beta process) appear as the soft edge scaling limits of beta ensembles.

We will mainly focus on a certain property of the eigenvalue point processes called number rigidity, introduced by Ghosh and Peres, which roughly states that the total number of points inside any compact set is deterministic conditioning on the configuration outside. A large class of random point processes are shown to be number rigid including most point processes arise as the scaling limits of eigenvalues of random matrices with a determinantal/Pfaffian structure. Here we give the first few examples of number rigidity of point processes whose two-point correlations are not known (even asymptotically). The main techniques is the semigroup approach developed by Gorin- Shkolnikov, Gaudreau Lamarre and this work, which express the Laplace transform of eigenvalue point processes of RSOs as functionals of Brownian motion through a Feymann-Kac formula. This is joint work with Pierre Yves Gaudreau Lamarre and Promit Ghosal.

**Weekly Seminar & Events Bulletin**  
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**Geometry & Physics**

**Monday, September 16, 2019, 4:00pm-6:00pm**  
**4096 East Hall**

**Rachel Webb (University of Michigan)**

*Virtual Cycle on the Moduli Space of Maps to a Complete Intersection*

A driving question in Gromov-Witten theory is to relate the invariants of a complete intersection to the invariants of the ambient variety. In genus-zero this can often be done with a "twisted theory," but this fails in higher genus. Several years ago, Chang-Li presented the moduli space of  $p$ -fields as a piece of the solution to the higher-genus problem, constructing the virtual cycle on the space of maps to the quintic 3-fold as a cosection localized virtual cycle on a larger moduli space (the space of  $p$ -fields). Their result is analogous to the classical statement that the Euler class of a vector bundle is the class of the zero locus of a generic section. I will discuss work joint with Qile Chen and Felix Janda where we extend Chang-Li's result to a more general setting, a setting that includes standard Gromov-Witten theory of smooth orbifold targets and quasimap theory of GIT targets.

**Student Algebraic Geometry**

**Monday, September 16, 2019, 4:00pm-5:00pm**  
**B745 East Hall**

**Gilyoung Cheong (UM)**

*The functor of points of a scheme*

Since it is the first talk of the semester, we will discuss some general viewpoints that anybody would (at least implicitly) face when they deal with schemes. Using Yoneda lemma, we will see how we can realize schemes as certain contravariant functors from the category of (commutative unital) rings to the category of sets, which would philosophically emphasize the importance of commutative algebra when it comes to studying schemes. Such a functor is called the "functor of points" represented by each given scheme. When we fix a base scheme  $X$ , we may think of such schemes over  $X$  as "sheaves" over  $X$ , and we will see how this viewpoint will let us classify functors that are representable by schemes over  $X$ . As an application, we will sketch how to construct the fiber product of two schemes over another. If more time permits, we will talk about how to use this viewpoint to show that the twisted cubic is actually "twisted" in the projective 3-space over a field.

**Weekly Seminar & Events Bulletin**  
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**Operators in Complex Analysis**

**Monday, September 16, 2019, 5:00pm-6:00pm**  
**3096 East Hall**

**Luke Edholm (University of Michigan)**

*Spectral analysis of the Leray transform and the Euler-Maclaurin formula*

The Leray (or Cauchy-Leray) transform is a higher dimensional analogue of the familiar one variable Cauchy transform: It builds holomorphic functions on a domain from  $L^2$  data given on the boundary of that domain. This talk will focus on the spectral theory of this transform on a family of hypersurfaces. Following an orthogonal decomposition of the space of  $L^2$  boundary functions, detailed analysis of the operator on each subspace will be performed. This will take us deep into the realm of Gamma function asymptotics, and the celebrated Euler-Maclaurin formula will save the day.

**Student Analysis**

**Monday, September 16, 2019, 5:00pm-6:00pm**  
**2866 East Hall**

**Yuxin Wang (University of Michigan)**

*Maximal Operators*

Maximal operator plays an important role in Harmonic Analysis. In this talk, we will introduce the Hardy-Littlewood maximal operator and the celebrated Calderon-Zygmund decomposition of functions. If time allows, a few important consequences will be discussed, such as Markov inequality, Lebesgue differentiation theorem, and approximation of identity.

**IBL Workshops/Lectures**

**Tuesday, September 17, 2019, 11:30am-1:00pm**  
**4866 East Hall**

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*IBL Lunch*

This is the first IBL lunch of the semester. It will take place in the faculty lounge (4866 EH) from 11:30-1pm. You should feel free to come for any length of time. Lunch will be provided.

**Weekly Seminar & Events Bulletin**  
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**Student Commutative Algebra**

**Tuesday, September 17, 2019, 3:00pm-3:50pm**  
**4088 East Hall**

**Janet Page (University of Michigan)**

*Some combinatorial objects in commutative algebra*

This talk will provide some background for the commutative algebra seminar this week. I will give a brief introduction to some combinatorial objects in commutative algebra, with a focus on Hibi rings and more general toric rings, which can be associated to posets and convex cones, respectively. I will show how the combinatorics of these associated objects can be exploited in order to understand properties of the original ring. Time permitting, I will mention other combinatorial rings which are often studied. This talk is meant to give a flavor of this research rather than serving as a detailed introduction to toric rings/varieties, and should be accessible to students concurrently taking 593.

**Student Geometry/Topology**

**Tuesday, September 17, 2019, 3:00pm-4:00pm**  
**3866 East Hall**

**Sameer Kailasa (UM)**

*Circles*

Sometimes circles like to kiss. Can circles kiss in all the ways?

**Colloquium Series**

**Tuesday, September 17, 2019, 4:00pm-5:00pm**  
**1360 East Hall**

**Charlotte Chan (Princeton University)**

*Flag varieties and representations of  $p$ -adic groups*

In the 1950s, Borel, Weil, and Bott showed that the irreducible representations of a complex reductive group can be realized in the cohomology of line bundles on flag varieties. In the 1970s, Deligne and Lusztig constructed a family of subvarieties of flag varieties whose cohomology realizes the irreducible representations of reductive groups over finite fields. I will survey these stories, explain recent progress towards finding geometric constructions of representations of  $p$ -adic groups, and discuss interactions with the Langlands program.

**Weekly Seminar & Events Bulletin**  
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**Student Homotopy Theory**  
**Wednesday, September 18, 2019, 3:00pm-4:00pm**  
**1372 East Hall**  
**Ruian Chen (UM)**

*Invitation to the simplicial world*

Simplicial sets originate as combinatorial models for topological spaces, extending the more geometric notion of simplicial complexes. Since then, they have become a powerful tool in not only algebraic topology but also related subjects such as algebraic geometry.

In this talk, we introduce the basics of simplicial sets. We give the basic definition and introduce some examples of simplicial sets, following a unified method of constructing them. We will also briefly discuss the homotopy theory on simplicial sets, and finally, if time permits, survey a couple applications of simplicial methods.

**Student Arithmetic**  
**Wednesday, September 18, 2019, 3:00pm-4:00pm**  
**3866 East Hall**  
**Alex Horawa (UM)**

*The BSD Conjecture*

Informally, the Birch--Swinerton-Dyer conjecture identifies the set of rational points on an elliptic curve via the order of vanishing of an associated holomorphic function, called the L-function. In this talk, we will give a precise statement of this conjecture and discuss its relation to the famous Congruent number problem. The talk will be especially useful if you're planning to attend Alexander Smith's RSG lecture series.

**Colloquium Series**  
**Wednesday, September 18, 2019, 4:00pm-5:00pm**  
**1360 East Hall**  
**Alexander Smith (Harvard University)**

*NT RTG Lectures I:  $2^k$ -Selmer groups and Goldfeld's conjecture.*

Take  $E$  to be an elliptic curve over a number field whose four torsion obeys certain technical conditions. In this talk, we will outline a proof that  $100\%$  of the quadratic twists of  $E$  have rank at most one. To do this, we will find the distribution of  $2^k$ -Selmer ranks in this family for every  $k > 1$ . Using this framework, we will also find the distribution of the  $2^k$ -class ranks of the imaginary quadratic fields for all  $k > 1$ .

**Algebraic Geometry**  
**Wednesday, September 18, 2019, 4:00pm-5:00pm**  
**1360 East Hall**  
**Alexander Smith (Harvard)**

*See colloquium talk*



**Weekly Seminar & Events Bulletin**  
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**Financial/Actuarial Mathematics**

**Wednesday, September 18, 2019, 4:00pm-5:00pm**  
**4096 East Hall**

**Shuoqing Deng (UM)**

*Optimal consumption with reference to past spending maximum*

We investigate an infinite-horizon optimal consumption problem under exponential utility, together with nonnegativity constraint on consumption and the behavioral reference point to the consumption peak. The performance is measured by the distance between the current consumption rate and a fraction of the historical consumption maximum, which renders the control problem path dependent. To apply dynamic programming arguments, the consumption running maximum process is chosen as an auxiliary controlled state process. The associate Hamilton-Jacobi-Bellman (HJB) equation can be expressed in a piecewise manner in three different regions. By employing the dual transform of the two dimensional value function, we obtain the fully explicit classical solution of the dual PDE using endogenous boundary conditions and smooth-fit principle. The feedback optimal investment and consumption strategies are provided via a rigorous verification theorem.

**Analysis/Probability**

**Wednesday, September 18, 2019, 4:00pm-5:00pm**  
**4088 East Hall**

**Alexander Volberg (Michigan State University)**

*An unexpected combinatorial property of all planar measures*

We will show a counterintuitive combinatorial property of all positive planar measures which seemingly goes against a known counterexample of Carleson of a quilt of an arbitrary small measure. Of course our property does not contradict Carleson's example, and we will show relations between these two. This is a joint work with Pavel Mozolyako, Pavel Zorin-Kranich and Nicola Arcozzi.

**Special Events**

**Thursday, September 19, 2019, 11:30am-1:30pm**  
**3088 East Hall**

**Grace Ingermanson (UM)**

*Thesis Defense: Cluster Algebras of Open Richardson Varieties*

**Weekly Seminar & Events Bulletin**  
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**Topology**

**Thursday, September 19, 2019, 3:00pm-4:00pm**

**3866 East Hall**

**Ara Basmajian (CUNY)**

*Extremal length calculations and applications to the geodesic flow*

A collar neighborhood of a simple closed geodesic in a hyperbolic surface is an open neighborhood of the geodesic which is topologically an annulus. It is well-known that a simple closed geodesic on a hyperbolic surface has a natural (or standard) collar. The outstanding feature of the natural collar is that its size depends on local data, namely its size depends only on the length of the geodesic. Using this collar one can make extremal length calculations of curve families that are transverse to the geodesic.

In this talk, after defining extremal length and discussing its properties, we define a new type of collar which we call a non-standard collar. Using the non-standard collar we are able to improve estimates on the extremal length of curve families that are transverse to the geodesic and give a number of applications to the geodesic flow on an infinite type hyperbolic surface. This is joint work with Hrant Hakobyan and Dragomir Saric.

**Commutative Algebra**

**Thursday, September 19, 2019, 3:00pm-4:00pm**

**4088 East Hall**

**Janet Page (University of Michigan)**

*Measuring the Gorenstein property with the trace of the canonical module*

Trace ideals can be defined for any module over a ring and have been studied in various contexts. Recently, Herzog, Hibi, and Stamate studied the trace of the canonical module for local Cohen Macaulay rings and showed it can be viewed as a measure of how close the ring is to being Gorenstein. In this talk, I will introduce trace ideals and discuss recent results on the trace of the canonical module for rings in which we can exploit some combinatorial data, including Hibi rings and some other toric rings. This is joint work with Jürgen Herzog and Fatemeh Mohammadi.

**Arithmetic Geometry Learning**

**Thursday, September 19, 2019, 4:00pm-5:30pm**

**4096 East Hall**

**Alexander Horawa (UM)**

*Condensed abelian groups*

**Applied Interdisciplinary Mathematics (AIM)**

**Friday, September 20, 2019, 3:00pm-4:00pm**

**1084 East Hall**

**Zhimin Zhang (Wayne State University)**

*Construction of  $H^2(\text{curl})$  conforming elements and their application*

In 1980 and 1986, Nedelec proposed  $H(\text{curl})$ -conforming elements to solve electromagnetic equations that contain the "curl" operator. It is more or less as the  $H^1$ -conforming elements (or  $C^0$  elements) for elliptic equations that contain the "grad" operator. As is well known in the finite element method literature, in order to solve 4th-order elliptic equations such as the bi-harmonic equation,  $H^2$ -conforming elements (or  $C^1$ -elements) were developed. Recently, there has been some research in solving electromagnetic equations which involve four "curl" operators. Hence, construction of  $H(\text{curl curl})$ -conforming elements becomes necessary. In this work, we construct  $H(\text{curl curl})$ -conforming elements for rectangular and triangular meshes and apply them to solve quad-curl equations as well as related eigenvalue problems.

**Combinatorics**

**Friday, September 20, 2019, 3:00pm-4:00pm**

**4096 East Hall**

**Christopher Eur (UC Berkeley)**

*Simplicial generation of Chow rings of matroids*

We introduce a new presentation of the Chow ring of a matroid whose variables now admit a combinatorial interpretation via the theory of matroid quotients and display a geometric behavior analogous to that of nef classes on smooth projective varieties. We discuss various applications, including the recovery of the Hodge theory of matroids as developed by Adiprasito, Huh, and Katz. This is joint work with Spencer Backman and Connor Simpson.

**Financial/Actuarial Mathematics**

**Friday, September 20, 2019, 3:00pm-4:00pm**

**4448 East Hall**

**Steve Kou (Boston University)**

*A Theory of FinTech*

In this talk I will give a brief overview of current academic research on FinTech by using tools from mathematics and statistics. The topics to be discussed include: (1) Designing stable coins: how to design stable cryptocurrency by using option pricing theory. (2) P2P equity financing: how to design contracts suitable for a P2P equity financing platform with information asymmetry. (3) Data privacy preservation: how to do econometrics based on the encrypted data while still preserving privacy. (4) Crowd wisdom and prediction markets: how to use the collective opinion of a group to make predictions. All the above 4 topics are based on my recent papers.

**Weekly Seminar & Events Bulletin**  
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**Geometry**

**Friday, September 20, 2019, 4:00pm-12:00am**  
**3866 East Hall**

**Krishnan Shankar (U Oklahoma/NSF)**

*Recent developments in non-negative sectional curvature*

In this talk we will present some recent progress in the study of non-negatively curved manifolds. We begin with a survey of some of the main theorems and obstructions in the last several decades as well as statements of some open problems and conjectures. This includes the seminal theorems of Gromov on the total Betti number, the Soul theorem of Cheeger and Gromoll for open manifolds as well as the Bott conjecture on the rational ellipticity of non-negatively curved manifolds. We then present results on recent progress in constructing non-negatively curved manifolds beginning with the work of Grove and Ziller in 2000. We conclude with a recent generalization of the Grove-Ziller construction as well as related results.

**Group, Lie and Number Theory**

**Friday, September 20, 2019, 4:00pm-5:00pm**  
**2866 East Hall**

**Alexander Smith (Harvard University)**

*NT RTG Lectures II: Governing fields and statistics for 8-class ranks*

The following result predates our work: given a positive integer  $d$ , there is a finite Galois extension  $M_d$  of  $\mathbb{Q}$  so that, for any prime  $p$  not dividing  $2d$ , the 2-, 4-, and 8-class ranks of  $\mathbb{Q}(\sqrt{-dp})$  are determined from the Artin symbol of  $p$  in  $\text{Gal}(M_d/\mathbb{Q})$ . Starting from this result, we will give two approaches to finding statistics for 8-class ranks in families of imaginary quadratic fields. The first of these will directly use the governing fields  $M_d$ , while the latter will use a combinatorial trick to replace  $M_d$  with a field of smaller discriminant.

**Junior Colloquium Series**

**Friday, September 20, 2019, 4:00pm-5:00pm**  
**1068 East Hall**

**Brandon Carter (Google)**

*Life of a Software Engineer (Invitation to Industry Series)*

What is it like to be a software engineer at Google? I'll share day-in-the-life stories about the unique experience of working at Google and discuss how my time at Michigan helped prepare me for my role.

[UM Math has recently joined the Erdős Institute (<https://www.erdosinstitute.org>) to help educate PhD students in math about opportunities in industry. Our Invitation to Industry series features PhD alums now working in industry speaking about their work and career.

**Student AIM Seminar**

**Friday, September 20, 2019, 4:00pm-5:00pm**  
**1084 East Hall**

**()**

*Planning meeting*

**Weekly Seminar & Events Bulletin**  
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**Special Events**

**Saturday, September 21, 2019, 10:30am-8:00pm**  
**B844 East Hall**

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*Michigan Algebra and Number Theory Intercity Symposium*

Talks will be at 10:30am, 11:45am, 2:30pm, and 4:00pm in East Hall B844. There will be coffee breaks in the morning and afternoon, and a conference dinner.

See conference webpage for more information: <http://umich.edu/~numbertheory/mantis19/>