

## Weekly Seminar & Events Bulletin

December 9th, 2018 - December 15th, 2018

### Monday, December 10, 2018

- 12:00pm-12:50pm **Mathematical Biology** -- Jeff Dunworth (University of Michigan) *Disruption of excitation/inhibition balance in cortical neuronal networks* -- 335 West Hall
- 3:00pm-4:00pm **Student Dynamics** -- Yueqiao Wu (University of Michigan) *The Earthquake Flow* -- 1060 East Hall
- 3:00pm-5:30pm **Special Events** -- Andrew Melfi (UM) *Dissertation Defense: Theoretical and Numerical Analyses of Deviations between Kingman's Coalescent and the Wright-Fisher Model* -- 2104 Modern Languages Building
- 4:00pm-5:00pm **Complex Analysis, Dynamics and Geometry** -- Wenjuan Peng (UM visitor) *On the cycles of components of disconnected Julia sets* -- 3088 East Hall
- 4:00pm-5:20pm **Group, Lie and Number Theory** -- Yuan Liu (Univ of Wisconsin) *A non-abelian version of Cohen-Lenstra heuristics* -- 4088 East Hall
- 4:00pm-5:00pm **Student Combinatorics** -- Trevor Hyde (University of Michigan) *Categorifying Numbers* -- 3866 East Hall
- 4:00pm-6:00pm **Geometry & Physics** -- Nathan Priddis (BYU) *BHK Mirror symmetry and variants* -- 4096 East Hall

### Tuesday, December 11, 2018

- 2:30pm-5:00pm **Special Events** -- Robert Walker (UM) *Dissertation Defense: Uniform Symbolic Topologies in Non-Regular Rings* -- 3205 Modern Languages Building
- 3:00pm-4:00pm **Student Geometry/Topology** -- Daniel Stoll (University of Michigan) *Triangulating Rotations (and Rotating Triangulations)* -- 1866 East Hall

### Wednesday, December 12, 2018

- 3:00pm-4:00pm **Financial/Actuarial Mathematics** -- Gaoyue Guo (UM) *Robust hedging with local time and Skorokhod embedding* -- 1360 East Hall

### Thursday, December 13, 2018

- 1:00pm-2:30pm **Student Homotopy Theory** -- Montek Gill (University of Michigan) *Introduction to the Goodwillie calculus* -- 1360 East Hall
- 5:00pm-5:30pm **Special Events** -- Jingchuan Xiao (UM) *Math 631 Student Presentations: Elliptic Curves* -- 4088 East Hall
- 5:30pm-6:00pm **Special Events** -- Jack Carlisle (UM) *Math 631 Student Presentations: Sheaves* -- 4088 East Hall
- 6:00pm-6:30pm **Special Events** -- Yuping Ruan (UM) *Math 631 Student Presentations: Riemann Surfaces from an Analytic Perspective* -- 4088 East Hall
- 6:30pm-7:00pm **Special Events** -- Khoa Dang Nguyen (UM) *Math 631 Student Presentations: ADE Singularities* -- 4088 East Hall

**Abstracts for the week of December 9th, 2018 - December 15th, 2018**

**Mathematical Biology**

**Monday, December 10, 2018, 12:00pm-12:50pm**

**335 West Hall**

**Jeff Dunworth (University of Michigan)**

*Disruption of excitation/inhibition balance in cortical neuronal networks*

Cortical neuron spiking activity is broadly classified as temporally irregular and asynchronous. Model networks with a balance between large recurrent excitation and inhibition capture these two features, and are a popular framework relating circuit structure and network dynamics, though are traditionally restricted to a single attractor. We analyze paired whole cell voltage-clamp recordings from spontaneously active neurons in mouse auditory cortex slices (Graupner & Reyes, 2013) showing a network where correlated excitation and inhibition effectively cancel, except for intermittent periods when the network shows a macroscopic synchronous event. These data suggest that while the core mechanics of balanced activity are important, we require new theories capturing these brief but powerful periods when balance fails. Recent work by Mongillo et.al. (2012) showed that balanced networks with short-term synaptic plasticity can depart from strict linear dynamics. We extend this model by incorporating finite network size, introducing strong nonlinearities in the firing rate dynamics and allowing finite size induced noise to elicit large scale, yet infrequent, synchronous events. We identify core requirements for system size and network plasticity to capture the transient synchronous activity observed in our experimental data set. Our model properly mediates between the asynchrony of balanced activity and the tendency for strong recurrence to promote macroscopic population dynamics.

**Student Dynamics**

**Monday, December 10, 2018, 3:00pm-4:00pm**

**1060 East Hall**

**Yueqiao Wu (University of Michigan)**

*The Earthquake Flow*

We will roughly discuss Mirzakhani's work on the ergodicity of the earthquake flow.

## Weekly Seminar & Events Bulletin

December 9th, 2018 - December 15th, 2018

### Special Events

**Monday, December 10, 2018, 3:00pm-5:30pm**

**2104 Modern Languages Building**

**Andrew Melfi (UM)**

*Dissertation Defense: Theoretical and Numerical Analyses of Deviations between Kingman's Coalescent and the Wright-Fisher Model*

In this defense we analyze the differences between two commonly used genetic models for ancestry and genetic variability: the Wright-Fisher (WF) model and Kingman's coalescent.

First, we introduce both models and discuss why they are both employed. We then introduce the concept of the partition distribution and show that that is one area where the two models are distinct. We then prove an asymptotic bound on sample size under which their partition distributions converge. We use numerical methods to show that our asymptotic results apply to real world datasets.

A commonly used summary statistic known as the site frequency spectrum (SFS) differs between the two models. We express the WF SFS as a perturbation of the coalescent's SFS and analyze the perturbing terms to ascertain the sources of this difference. One source is as described above, the disagreement in the partition distributions. Another is a difference in the rates of mergers between the two models. We find that these have opposing effects and, due to cancellation, result in the two models having close agreement in terms of SFS.

To finish, we discuss an area of future research. Two common simplifying assumptions in the coalescent model are that the mutation rate is constant over time and constant between sites. Both of these assumptions are not true in reality, sometimes to a surprising degree. We briefly discuss these model violations and introduce an algorithm for calculating the SFS under the coalescent while incorporating a time-variable mutation rate.

### **Complex Analysis, Dynamics and Geometry**

**Monday, December 10, 2018, 4:00pm-5:00pm**

**3088 East Hall**

**Wenjuan Peng (UM visitor)**

*On the cycles of components of disconnected Julia sets*

For any integers  $d \geq 3$  and  $n \geq 1$ , we construct a hyperbolic rational map of degree  $d$  such that the number of cycles of Julia components which are neither single points nor Jordan curves is equal to  $n$ .

## Weekly Seminar & Events Bulletin

December 9th, 2018 - December 15th, 2018

### Group, Lie and Number Theory

Monday, December 10, 2018, 4:00pm-5:20pm

4088 East Hall

Yuan Liu (Univ of Wisconsin)

*A non-abelian version of Cohen-Lenstra heuristics*

We construct a model of random groups that is a non-abelian version of the random groups that feature in the Cohen-Lenstra heuristics. This random group is obtained from, as  $n$  goes to infinity, the free group on  $n$  generators modulo  $n+u$  random relations. In this talk, we will use this model to define a probability measure on the space of profinite groups and discuss known results about the distribution of non-abelian analogs of class groups that motivate our work. Then we will discuss a random Gamma-group model obtained by the same construction, and provide heuristics regarding the distribution of the Galois groups of the maximal unramified extensions over random Gamma-extensions of  $\mathbb{Q}$ . This is a joint work with Melanie Matchett Wood.

### Student Combinatorics

Monday, December 10, 2018, 4:00pm-5:00pm

3866 East Hall

Trevor Hyde (University of Michigan)

*Categorifying Numbers*

When positive integers show up in mathematics, combinatorialists look for finite sets hiding in the background to explain them. Each equation they hope to replace with a bijection. This process of upgrading from numbers to sets is an example of categorification. I will discuss the problem of categorifying other sorts of numbers like fractions and algebraic integers. Along the way I will explain

- 1) why  $e = 2.718\dots$  is the size of the collection of all finite sets,
- 2) where denominators in generating functions come from, and
- 3) why there's a natural correspondence between binary rooted trees and 7-tuples of binary rooted trees.

### Geometry & Physics

Monday, December 10, 2018, 4:00pm-6:00pm

4096 East Hall

Nathan Priddis (BYU)

*BHK Mirror symmetry and variants*

I will talk about a version of mirror symmetry called BHK mirror symmetry, named after Berglund--Huebsch and Krawitz, and where it applies. Then I will talk about two variations on this form of mirror symmetry, giving us Borcea--Voisin Mirror symmetry and mirror symmetry for non-abelian Landau-Ginzburg models.

## Weekly Seminar & Events Bulletin

December 9th, 2018 - December 15th, 2018

### Special Events

**Tuesday, December 11, 2018, 2:30pm-5:00pm**

**3205 Modern Languages Building**

**Robert Walker (UM)**

*Dissertation Defense: Uniform Symbolic Topologies in Non-Regular Rings*

When does a Noetherian commutative ring  $R$  have uniform symbolic topologies (USTP) on primes -- read, when does there exist an integer  $D > 0$  such that the symbolic power ideal  $P^{(Dc)}$  lies in  $P^c$  for all prime ideals  $P$  in  $R$  and all  $c > 0$ ? Groundbreaking work of Ein -- Lazarsfeld -- Smith, as extended by Hochster and Huneke, and by Ma and Schwede in turn, provides a beautiful answer in the setting of finite-dimensional excellent regular rings. Their work shows that there exists a  $D$  depending only on the Krull dimension: in other words, the exact same  $D$  works for all regular rings as stated of a fixed dimension.

Referring to this last observation, we say in the thesis that the class of excellent regular rings enjoys class solidarity relative to the uniform symbolic topology property (USTP class solidarity), a strong form of uniformity. In contrast, this thesis shows that for certain classes of non-regular rings including rational surface singularities and select normal toric rings, a uniform bound  $D$  does exist but depends on the ring, not just its dimension. In particular, for rational double point surface singularities over the complex numbers, we show that USTP solidarity is plainly impossible.

It is natural to sleuth for analogues of the Improved Ein -- Lazarsfeld -- Smith Theorem where the ring  $R$  is non-regular, or where the above ideal containments can be improved using a linear function whose growth rate is slower. This thesis lies in the overlap of these research directions, working with Noetherian domains.

### Student Geometry/Topology

**Tuesday, December 11, 2018, 3:00pm-4:00pm**

**1866 East Hall**

**Daniel Stoll (University of Michigan)**

*Triangulating Rotations (and Rotating Triangulations)*

A rotation is an operation that can be performed on binary trees - loosely speaking, a child is interchanged with its parent. As rotations act transitively on the set of binary trees with  $n$  internal nodes, we may obtain a connected graph by representing each tree by a vertex and each rotation by an edge. It is natural to ask what the diameter  $d(n)$  of this graph is. I will go through a beautiful argument, due to Sleator, Tarjan, and Thurston, which uses hyperbolic geometry to show that  $d(n) = 2n - 6$  for all sufficiently large  $n$ .

**Weekly Seminar & Events Bulletin**

December 9th, 2018 - December 15th, 2018

**Financial/Actuarial Mathematics**

**Wednesday, December 12, 2018, 3:00pm-4:00pm**

**1360 East Hall**

**Gaoyue Guo (UM)**

*Robust hedging with local time and Skorokhod embedding*

We investigate the robust hedging of options depending on the local time of the underlying process using a stochastic control approach. By means of Vallois' Skorokhod embeddings, we identify the optimal hedging strategies as well as the market models that realize the extremal no-arbitrage prices. In addition, under appropriate conditions, we derive a new solution to the two-marginal Skorokhod embedding as a generalization of the Vallois solution which, to the best of our knowledge, is the first of its kind in the literature.

**Student Homotopy Theory**

**Thursday, December 13, 2018, 1:00pm-2:30pm**

**1360 East Hall**

**Montek Gill (University of Michigan)**

*Introduction to the Goodwillie calculus*

I will give an introduction to the Goodwillie calculus.

**Special Events**

**Thursday, December 13, 2018, 5:00pm-5:30pm**

**4088 East Hall**

**Jingchuan Xiao (UM)**

*Math 631 Student Presentations: Elliptic Curves*

Thirty minute talks on subjects in Algebraic Geometry suitable for people with a single term of background. Pizza will be provided.

**Special Events**

**Thursday, December 13, 2018, 5:30pm-6:00pm**

**4088 East Hall**

**Jack Carlisle (UM)**

*Math 631 Student Presentations: Sheaves*

Thirty minute talks on subjects in Algebraic Geometry suitable for people with a single term of background. Pizza will be provided.

**Weekly Seminar & Events Bulletin**

December 9th, 2018 - December 15th, 2018

**Special Events**

**Thursday, December 13, 2018, 6:00pm-6:30pm**

**4088 East Hall**

**Yuping Ruan (UM)**

*Math 631 Student Presentations: Riemann Surfaces from an Analytic Perspective*

Thirty minute talks on subjects in Algebraic Geometry suitable for people with a single term of background.  
Pizza will be provided.

**Special Events**

**Thursday, December 13, 2018, 6:30pm-7:00pm**

**4088 East Hall**

**Khoa Dang Nguyen (UM)**

*Math 631 Student Presentations: ADE Singularities*

Thirty minute talks on subjects in Algebraic Geometry suitable for people with a single term of background.  
Pizza will be provided.