Monday, April 16, 2018

10:00am-12:00pm **Special Events** -- Charlotte Chan (UM) *Graduate Thesis Defense: Period Identities of CM Forms on Quaternion Algebras* -- 1240 Ross School of Business

11:00am-1:00pm **Special Events** -- Michael Newman (UM) *Graduate Thesis Defense: Some Ins and Outs of Quantum Fault-Tolerance* -- 3088 East Hall

11:30am-2:20pm **Special Events** -- LoG(M) Poster Session -- Math Department Common Room East Hall

12:00pm-2:00pm **Special Events** -- Siddhant Agrawal (UM) *Graduate Thesis Defense: On the Motion of Angled Crested Type Water Waves* -- 2752 School of Social Work Building

4:00pm-5:00pm **Complex Analysis, Dynamics and Geometry** -- Giulio Tiozzo (Toronto) *Random walks on the Cremona group* -- 3096 East Hall

4:00pm-6:00pm **Geometry & Physics** -- Gao Chen (IAS) *Classification of gravitational instanton* -- 4096 East Hall

4:00pm-5:00pm **Special Events** -- Vladimir Druskin (Scientific Advisor, Schlumberger-Doll Research Center) *MICDE Seminar: Reduced order models, networks, and applications to modeling and imaging with waves* -- 1360 East Hall

4:00pm-5:00pm **Student Combinatorics Seminar** -- Alexander Leaf (University of Michigan) *Oriented matroids, zonotopes, and higher Bruhat orders* -- 3866 East Hall

4:10pm-5:30pm **Group, Lie and Number Theory** -- Levent Alpoge (Princeton University) *The average number of rational points on genus 2 curves over Q is bounded* -- 4088 East Hall

Tuesday, April 17, 2018

11:30am-1:00am **Teaching Mathematics** -- Discussion ( ) *Learning Community on Inclusive Teaching Session 5* -- 4866 East Hall

2:00pm-4:00pm **Special Events** -- Ashwath Rabindranath (UM) *Graduate Thesis Defense: Pseudoeffective Cones and Morphisms of Projective Varieties* -- 1436 Mason Hall

3:00pm-4:00pm **Student Geometry/Topology** -- Feng Zhu (University of Michigan) *Non-positive curvature in groups* -- 3866 East Hall

4:10pm-5:00pm **Colloquium Series** -- Jacob Tsimerman (University of Toronto) *Hodge Theory and o-minimal geometry* -- 1360 East Hall

Wednesday, April 18, 2018

4:00pm-5:00pm **Financial/Actuarial Mathematics** -- Maxim Bichuch (Johns Hopkins) *Robust XVA* -- 1866 East Hall

Thursday, April 19, 2018

2:00pm-4:00pm **Special Events** -- Harold Blum (UM) *Graduate Thesis Defense: Singularities and K-stability* -- 3096 East Hall

4:00pm-5:00pm **Topology** -- Dylan Thurston (Indiana University) *Elastic graphs and Ahlfors regular conformal dimension* -- 1866 East Hall

4:00pm-5:30pm **Logic** -- Alexei Kolesnikov (Towson University) *Homology groups in model theory.* -- 3088 East Hall

4:10pm-5:30pm **Preprint Algebraic Geometry Seminar** -- Shubhodip Mondal (UM) *Total p-differentials on schemes over Z/p^2 (following Dupuy-Katz-Rabinoff-Brown)* -- 2866 East Hall
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<td>10:00am-11:00am</td>
<td><strong>Symplectic Reading Group</strong></td>
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<td><em>Inferring topology of quantum phase space (after L. Polterovich and L. Charles)</em></td>
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Special Events

Monday, April 16, 2018, 10:00am-12:00pm
1240 Ross School of Business
Charlotte Chan (UM)

Graduate Thesis Defense: Period Identities of CM Forms on Quaternion Algebras

A few decades ago, Waldspurger proved a groundbreaking identity between the central value of an L-function and the norm of a torus period. Combining this with the Jacquet--Langlands correspondence gives a relationship between the norm of torus periods arising from different quaternion algebras for automorphic forms Hecke characters of CM fields. In this thesis we give a direct proof of the identity of the torus periods themselves.
Quantum computing sounds like something out of a science-fiction novel. If we can exert control over unimaginably small systems, then we can harness their quantum mechanical behavior as a computational resource. This resource allows for astounding computational feats, and a new perspective on information-theory as a whole.

But there's a caveat. The events we have to control are so fast and so small that they can hardly be said to have occurred at all. For a long time after Feynman's proposal and even still, there are some who believe that the barriers to controlling such events are fundamental. While we have yet to find anything insurmountable, the road is so pockmarked with challenges both experimental and theoretical that it is often difficult to see the road at all. Only a marriage of both engineering and theory in concert can hope to find the way forward.

Quantum error-correction, and more broadly quantum fault-tolerance, is an unfinished answer to this question. It concerns the scaling of these microscopic systems into macroscopic regimes which we can fully control, straddling practical and theoretical considerations in its design. We will explore and prove several results on the theory of quantum fault-tolerance, but which are guided by the ultimate goal of realizing a physical quantum computer.

In this thesis, we demonstrate a variety ins and outs of fault-tolerant quantum computing. We introduce novel code families which we use to probe the behavior of thresholds in quantum subsystem codes. We also demonstrate codes in this family that are well-suited to efficiently correct asymmetric noise models, and determine their parameters. Next we prove some outs, showing that quantum error-correcting encodings are incommensurate with transversal implementations of universal classical-reversible computation. Along the way, we resolve an open question concerning information-theoretically secure quantum fully homomorphic encryption, showing that it is impossible. Finally, we augment a framework for transversally mapping between stabilizer subspace codes, and discuss prospects for fault-tolerance.

The Lab of Geometry at Michigan - LoG(M) - is holding an end-of-year poster session next Monday, April 16 from 11:30am to 2:30pm in the Math Department Common Room. Please come check out what our undergraduate researchers have discovered this year!

All members of the Michigan mathematics community are welcome. Refreshments will be available.

For more info on LoG(M), visit our webpage: https://sites.lsa.umich.edu/logm/
Special Events  
**Graduate Thesis Defense: On the Motion of Angled Crested Type Water Waves**

We consider the two-dimensional water wave equation which is a model of ocean waves. The water wave equation is a free boundary problem for the Euler equation where we assume that the fluid is inviscid, incompressible and irrotational and the air density is zero. In the case of zero surface tension, we show that the singular solutions constructed recently by Wu are rigid. In the case of non-zero surface tension, we construct an energy functional and prove an a priori estimate without assuming the Taylor sign condition. This energy reduces to the energy obtained by Kinsey and Wu in the zero surface tension case for angled crest water waves. We show that in an appropriate regime, the zero surface tension limit of our solutions is the one for the gravity water wave equation which includes waves with angled crests.

**Complex Analysis, Dynamics and Geometry**

**Random walks on the Cremona group**

The Cremona group of birational transformations of $\mathbb{P}^2$ is a classical object in algebraic geometry. In the last decade, incredible progress (by Cantat, Lamy and several others) has been made by combining complex dynamics and geometric group theory, using the action of the Cremona group on an infinite dimensional hyperbolic space. In new work with J. Maher, we use these techniques to study random compositions of birational maps. For instance, we prove that the dynamical degree of random Cremona transformations grows exponentially fast, and we give a characterization of the Poisson boundary for finitely generated subgroups of the Cremona group.

**Geometry & Physics**

**Classification of gravitational instanton**

A gravitational instanton is a noncompact complete hyperkahler 4-manifold with faster than quadratic curvature decay. In this talk, I will discuss the classification of gravitational instantons. This is a joint work with Xiuxiong Chen.
Special Events
Monday, April 16, 2018, 4:00pm-5:00pm
1360 East Hall

Vladimir Druskin (Scientific Advisor, Schlumberger-Doll Research Center)

MICDE Seminar: Reduced order models, networks, and applications to modeling and imaging with waves

Geophysical seismic exploration, as well as radar and sonar imaging require the solution of large-scale forward and inverse problems for hyperbolic systems of equations. In this talk, I will show how model order reduction can be used to address some intrinsic difficulties of these problems. In model order reduction, one approximates the response (transfer function) of a large-scale dynamical system using a smaller system, called the reduced order model (ROM). We consider ROMs that capture properties of the large problem that are essential for imaging and that can be realized via sparse graph-Laplacian networks. The ROMs are data-driven, i.e., they learn the underlying PDE problem from the transfer function. One of the better-known applications of our ROMs is the efficient discretization of PDE problems in unbounded domains. Here I will focus on two recent applications: (i) Multiscale modeling of elastic wave propagation via network approximations, with low communication and computational cost; (ii) A direct, nonlinear acoustic imaging algorithm in strongly heterogeneous media, where the ROM is used to manipulate the data in such a way that multiply scattered waves are separated from the single scattered ones.

Student Combinatorics Seminar
Monday, April 16, 2018, 4:00pm-5:00pm
3866 East Hall

Alexander Leaf (University of Michigan)

Oriented matroids, zonotopes, and higher Bruhat orders

Higher Bruhat orders, introduced by Manin and Schechtman, are finite posets generalizing the symmetric group under the weak Bruhat order. In this talk, we study the structure of the higher Bruhat orders. We then interpret these posets in the context of oriented matroid extensions and cubical tilings of zonotopes. No background on oriented matroids or zonotopes is expected.

Group, Lie and Number Theory
Monday, April 16, 2018, 4:10pm-5:30pm
4088 East Hall

Levent Alpoge (Princeton University)

The average number of rational points on genus 2 curves over \( \mathbb{Q} \) is bounded

We prove that, when genus two curves \( C \) over \( \mathbb{Q} \) with a marked Weierstrass point are ordered by height, the limsup of the average number of rational points \( |C(\mathbb{Q})| \) is bounded.
Teaching Mathematics
Tuesday, April 17, 2018, 11:30am-1:00pm
4866 East Hall
Discussion ()
Learning Community on Inclusive Teaching Session 5

Readings for discussion will be posted at http://www.math.lsa.umich.edu/~glarose/dept/teaching/lcit.html.

Special Events
Tuesday, April 17, 2018, 2:00pm-4:00pm
1436 Mason Hall
Ashwath Rabindranath (UM)
Graduate Thesis Defense: Pseudoeffective Cones and Morphisms of Projective Varieties

The cycles on an algebraic variety contain a great deal of information about its geometry. This thesis is concerned with the pseudoeffective cone obtained by taking the closure of the cone of numerical classes of effective cycles on algebraic varieties. Our interest, motivated by different existing lines of research, is in showing when the pseudoeffective cone is not polyhedral in specific examples. We do this by first proving a sufficient criterion for non-polyhedral pseudoeffective cone (also known as Mori cone) for the case of surfaces. We apply this to the case of C x C where C is a smooth curve of genus at least 2. Using induction, we prove that all intermediate cones of cycles on C x ... x C are not polyhedral. Finally, we study the case of surfaces fibered over curve and give a sufficient criterion for when its pseudoeffective cone is not polyhedral.

Student Geometry/Topology
Tuesday, April 17, 2018, 3:00pm-4:00pm
3866 East Hall
Feng Zhu (University of Michigan)
Non-positive curvature in groups

Word-hyperbolicity is a robust notion of negative curvature for groups. Examples of word-hyperbolic groups include natural families such as free groups and surface groups; word-hyperbolic groups have desirable properties such as solvable word and conjugacy problems. It is less clear what a good notion of non-positive curvature for groups is. I will talk about the ideas behind word-hyperbolicity and several candidate notions of non-positive curvature (CAT(0), relatively hyperbolicity, and acylindrical hyperbolicity), and mention a theorem of Genevois which offers support for one of these candidates.
(joint w. Ben Bakker) Hodge theory studies algebraic varieties by studying the periods of its global differential forms. It gives a way to assign to every algebraic variety X a linear algebraic object called a "Hodge Structure", and the famous Hodge conjecture states that one can understand much about the geometry of X by studying the associated hodge structures. One fruitful way of understanding hodge structures is by looking at their moduli space M, which can naturally be given the structure of a complex orbifold. In the case of weight 1 structures, M parametrizes abelian varieties and so is naturally an algebraic variety. However, in the general case it is known that M does not admit an algebraic structure. This creates a difficult situation, since families of algebraic varieties over an algebraic base B give holomorphic maps (known as period mappings) B→M, but holomorphic maps can behave very badly in general (for instance, their asymptotics can be quite unwieldy, as opposed to algebraic maps).

We explain how to provide a partial substitute for the lack of an algebraic structure by equipping M with an o-minimal structure, and show that the period mappings are "definable" with respect to this structure. It turns out that o-minimality gives an extremely useful notion of "tameness"; for instance, a very powerful theorem of Peterzil-Starchenko says that holomorphic maps which are o-minimal have to be algebraic in a wide variety of circumstances. As a consequence of this work, we give an easy proof of a result of Cattani-Deligne-Kaplan giving evidence towards the Hodge conjecture.

The proof of our main theorem relies heavily on work of Kashiwara, Schmid and Cattani-Kaplan-Schmid on asymptotics of Period mappings.
We develop a framework for computing the robust valuation adjustment (XVA) of a credit swap portfolio traded between an investor and a risky counterparty. Based on no-arbitrage arguments, we derive a backward stochastic differential equation (BSDE) associated with the XVA of portfolio under a threshold copula model correlative the default times of investor, counterparty, and reference entities of the credit swaps in the portfolio. We compute the maximum and minimum XVA of the portfolio, which provides the interval in which the true (unknown) XVA lies. In the case that borrowing and lending rates coincide, we provide a fully explicit expression for the robust XVA bounds, and for the corresponding replication strategies in corporate bonds. In the general case of asymmetric funding, repo and collateral rates, we study the nonlinear ordinary differential equations (ODE) characterizing $\text{XVA}$ and show the existence of a unique classical solution to it. To illustrate our results, we conduct a numerical study demonstrating how funding costs, counterparty risk and default risk uncertainty contribute to determine the total valuation adjustment.

This is a joint work with Agostino Capponi (Columbia University) and Stephan Sturm (Worcester Polytechnic Institute).

### Special Events

**Thursday, April 19, 2018, 2:00pm-4:00pm**

**3096 East Hall**

**Harold Blum (UM)**

*Graduate Thesis Defense: Singularities and K-stability*

### Topology

**Thursday, April 19, 2018, 4:00pm-5:00pm**

**1866 East Hall**

**Dylan Thurston (Indiana University)**

*Elastic graphs and Ahlfors regular conformal dimension*

One measure of the complexity of a Julia set is its fractal Hausdorff dimension, or more generally various notions of “conformal dimension”. We show how to estimate the Ahlfors regular conformal dimension of Julia sets from above and below by using certain energies of maps between graphs. This extends an earlier characterization of which topological maps from a sphere to itself are realized by a rational map.
Higher-dimensional amalgamation properties played a key role in settling several questions in classification theory. It turns out that these properties, suitably formulated, are non-trivial even for totally categorical first order theories. The main goal of this project was to understand and characterize the failure of higher-dimensional amalgamation properties in stable theories. We show that the failure of n-dimensional amalgamation is detected by a suitable homology group; this group must be abelian profinite and is isomorphic to a certain automorphism group. Along the way, we establish that the failure of n dimensional amalgamation is witnessed by certain canonical objects, with the higher category-theoretic flavor, that are definable in the models of the theory.

Joint work with John Goodrick and Byunghan Kim.

Preprint Algebraic Geometry Seminar
Thursday, April 19, 2018, 4:10pm-5:30pm
2866 East Hall
Shubhodip Mondal (UM)
Total p-differentials on schemes over Z/p^2 (following Dupuy-Katz-Rabinoff-Brown)
https://arxiv.org/abs/1712.09487

Symplectic Reading Group
Friday, April 20, 2018, 10:00am-11:00am
1866 East Hall East Hall
Montek Gill (UM)
Inferring topology of quantum phase space (after L. Polterovich and L. Charles)

Abstract of the paper:

"Does a semiclassical particle remember the phase space topology? We discuss this question in the context of the Berezin-Toeplitz quantization and quantum measurement theory by using tools of topological data analysis [persistent homology]. One of its facets involves a calculus of Toeplitz operators with piecewise constant symbol developed in an appendix by Laurent Charles."