UNIVERSITY OF MICHIGAN
Department of Mathematics

Seminar & Events Bulletin: Colloquium Series

01-01-2013 to 06-30-2013

Tuesday, January 15, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Horng-Tzer Â Yau (Harvard University) *Ziwet Lectures: Universality of random matrices and log-gases* -- 1360 East Hall

Tuesday, January 22, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Richard Tapia (Rice University) *The Isoperimetric Problem Revisited: Extracting a Short Proof of Sufficiency from Euler's 1744 Proof of Necessity* -- 1360 East Hall

Wednesday, January 23, 2013	
3:10pm-4:00pm	**Colloquium Series** -- Sarah Koch (Harvard University) *An algebraic fingerprint for postcritically finite rational maps* -- B844 East Hall

Tuesday, January 29, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Jean-francois Lafont (Ohio State University) *Isomorphism conjectures in K-theory* -- 1360 East Hall

Tuesday, February 05, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Joel Smoller (Univ of Michigan) *Gravitation* -- 1360 East Hall

Tuesday, February 12, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Ilya Kapovich (University of Illinois at Urbana-Champaign) *(cancelled due to medical reason).* -- 1360 East Hall

Tuesday, February 19, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Joe Silverman (Brown University) *The dynamical complexity of rational maps and an arithmetic analogue* -- 1360 East Hall

Tuesday, February 26, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Guillaume Bal (Columbia University) *Equations with random coefficients and theories of random fluctuations.* -- 1360 East Hall

Tuesday, March 05, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Winter Break () *TBA* -- 1360 East Hall

Tuesday, March 12, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Mike Hopkins (Harvard University) *Ziwet Lectures: Lecture I: The Kervaire invariant problem* -- 1360 East Hall

Tuesday, March 19, 2013	
4:10pm-5:00pm	**Colloquium Series** -- David Fisher (Indiana University) *Quasi-isometric rigidity of polycyclic groups* -- 1360 East Hall

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Tuesday, March 26, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Domingo Toledo (University of Utah) *Geometry of Period Domains* -- 1360 East Hall

Tuesday, April 02, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Max Glick (Univ of Michigan) *Sumner Myers colloquium: The pentagram map and Y-patterns* -- 1360 East Hall

Tuesday, April 09, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Igor Dolgachev (University of Michigan) *Algebra, geometry and topology of Cremona groups* -- 1360 East Hall

Tuesday, April 16, 2013	
3:10pm-4:00pm	**Colloquium Series** -- Richard Thomas (Imperial College) *Algebraic geometry Spring lectures: The Gottsche conjecture* -- 1360 EH
4:30pm-5:30pm	**Colloquium Series** -- Stephen Smale (Toyota Technological Institute at Chicago) *Mathematics of Protein Folding* -- Forum Hall, Palmer Commons (4th floor)

Tuesday, April 23, 2013	
4:10pm-5:00pm	**Colloquium Series** -- Andreas Blass (Univ of Michigan) *The Continuum Hypothesis and Its Enemies* -- 1360 East Hall

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Abstracts

Colloquium Series
Tuesday, January 15, 2013, 4:10pm-5:00pm
1360 East Hall
Horng-Tzer Â Yau (Harvard University)
Ziwet Lectures: Universality of random matrices and log-gases

1. Universality of random matrices and log-gases.
(January 15 at 1360EH)

2. Dyson's Brownian and De Georgi-Nash-Moser theory of parabolic regularity.
(January 16 at 1360EH)

Abstract:

Eugene Wignerâ€™s revolutionary vision predicted that the energy levels of large complex quan- tum systems exhibit a universal behavior: the statistics of energy gaps depend only on the basic symmetry type of the model. These universal statistics show strong correlations in the form of level repulsion and they represent a new paradigm of point processes that are characteristically different from the Poisson statistics of independent points.

Simplified models of Wignerâ€™s thesis have recently become mathematically accessible. For mean field models represented by large random matrices with independent entries, the celebrated Wigner-Dyson-Gaudin-Mehta (WDGM) conjecture asserts that the local eigenvalue statistics are universal. For invariant matrix models, the eigenvalue distributions are given by a log-gas with potential V and inverse temperature $\beta = 1, 2, 4$. For $\beta \not \in \{1, 2, 4 \}$, there is no natural random matrix ensemble behind this model, but the analogue of the WDGM conjecture asserts that the local statistics are independent of V.

In these lectures, we review the recent solution to these conjectures for both invariant and non-invariant ensembles. We will discuss two different notions of universality in the sense of (i) local correlation functions and (ii) gap distributions.

We will demonstrate that the local ergodicity of the Dyson Brownian motion is the intrinsic mechanism behind the universality. Furthermore, we will show that the universality of gap distribution requires to prove a Holder regularity of a discrete parabolic equation with random coefficients. For this purpose, we incorporate the ideas of parabolic regularity via a De Giorgi-Nash-Moser approach.

Colloquium Series
Tuesday, January 22, 2013, 4:10pm-5:00pm
1360 East Hall
Richard Tapia (Rice University)

The Isoperimetric Problem Revisited: Extracting a Short Proof of Sufficiency from Euler's 1744 Proof of Necessity

Our primary objective in this talk is, with the student in mind, to present what we believe to be the shortest, most elementary, and most teachable solution of the isoperimetric problem in history. A secondary objective is to give a brief, but reasonably complete, overview of the remarkable life of the isoperimetric problem, and in the process demonstrate that it has been the most impactful mathematics problem of all time. In 1744 Euler constructed multiplier theory to solve the isoperimetric problem. However, contrary to Euler's belief, satisfaction of his multiplier rule is only a necessary condition and not a sufficient condition to demonstrate that the circle is the solution. Some 135 years later Weierstrass constructed his elegant sufficiency theory for problems in the calculus of variations and used it to provide what is accepted today as the first complete proof that the circle solves the isoperimetric problem. A multitude of sufficiency proofs ensued and in 1995 in a short paper aptly entitled A Short Path to the Shortest Path Peter Lax constructed what is considered to be the shortest and most elementary of all existing proofs. This background material is presented to set the stage for our demonstration that Euler's original necessity proof is but an observation away from establishing a sufficiency proof that we believe to be the shortest and most elementary in the history of the isoperimetric problem. We contemplate to what extend Euler or Lagrange could have, or should have, made our observation. Included is a contrast of our short proof with the Peter Lax short proof and an argument that historically the process of solving the isoperimetric problem was greatly compromised by the fact that the mathematicians of that golden era did not pursue functional convexity and the powerful optimization sufficiency theory that follows directly from this notion.

Colloquium Series
Wednesday, January 23, 2013, 3:10pm-4:00pm
B844 East Hall
Sarah Koch (Harvard University)
An algebraic fingerprint for postcritically finite rational maps

In the 1980s, William Thurston established his topological characterization of rational maps, one of the central results in the field of holomorphic dynamics. This theorem applies to postcritically finite rational maps (a rational map is postcritically finite if the orbit of every critical point is finite). Given such a rational map, one can define a holomorphic endomorphism of a Teichmueller space associated to it; this endomorphism is called the Thurston pullback map. With the exception of one class of examples, this endomorphism has a unique fixed point, and the eigenvalues of the derivative at this fixed point are all *algebraic*. What do these eigenvalues mean? Do they have any geometric significance in the moduli space of rational maps? In the dynamical plane of the map itself? What algebraic numbers arise this way? We establish some facts about these eigenvalues, and we prove there are no "small eigenvalues" in the case of quadratic polynomials. The general situation is still quite mysterious.

Colloquium Series
Tuesday, January 29, 2013, 4:10pm-5:00pm
1360 East Hall
Jean-francois Lafont (Ohio State University)
Isomorphism conjectures in K-theory

I will give a gentle introduction to the Baum-Connes and Farrell-Jones isomorphism conjectures in K-theory. I will assume minimal background, and will start with the definitions of the relevant K-theories. The talk should be accessible to graduate students.

Colloquium Series
Tuesday, February 05, 2013, 4:10pm-5:00pm
1360 East Hall
Joel Smoller (Univ of Michigan)
Gravitation

Gravitation

Abstract: We discuss gravitation from Newton, to Einstein, to present-day.

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Colloquium Series
Tuesday, February 12, 2013, 4:10pm-5:00pm
1360 East Hall
Ilya Kapovich (University of Illinois at Urbana-Champaign)
(cancelled due to medical reason).

Colloquium Series
Tuesday, February 19, 2013, 4:10pm-5:00pm
1360 East Hall
Joe Silverman (Brown University)
The dynamical complexity of rational maps and an arithmetic analogue

Consider a rational map F = (F_1,...,F_N) consisting of an N-tuple of rational functions in N variables. The iterates F, F^2, F^3, ... of F determine a dynamical system whose complexity may be measured by the growth of the degree of F^n. A fundamental, and still quite mysterious, invariant is the dynamical degree D(F) of F, which is defined to be the limiting value of deg(F^n)^{1/n} as n goes to infinity. Recently people have also considered an arithmetic analogue of the dynamical degree in which one looks at the orbit of a point P having rational coordinates and replaces deg(F^n) by the arithmetic size of the coordinates of F^n(P). In this talk I will discuss dynamical degrees, arithmetic degrees, and various results and open problems that relate them. No background in dynamics, algebraic geometry, or number theory will be required.

Seminar & Events Bulletin: Colloquium Series

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Colloquium Series
Tuesday, February 26, 2013, 4:10pm-5:00pm
1360 East Hall
Guillaume Bal (Columbia University)
Equations with random coefficients and theories of random fluctuations.

Problems with small scale structures abound in applied sciences. Their detailed microscopic description is often not available or generates computationally intractable problems. Homogenization theory has then been developed to understand the influence of micro-structures at a macroscopic level. The assumptions on the micro-structure under which homogenization holds, such as, e.g., periodicity, quasi-periodicity, or stationarity and ergodicity, are often not satisfied in practice. However, the homogenization point of view proves to be very fruitful in, e.g., macroscopic parameter estimations and to assess how multi-scale algorithms fare in well-controlled settings.
Equally important in practice, but often much difficult to study, is the analysis of random fluctuations beyond the homogenization limit. These fluctuations model noise in parameter estimation measurements, which limits the reconstruction resolution. In this talk, I will review several recent results obtained on the random fluctuations of solutions of partial differential equations with random coefficients. We then analyze conditions under which multiscale algorithms correctly capture such random fluctuations.

Colloquium Series
Tuesday, March 05, 2013, 4:10pm-5:00pm
1360 East Hall
Winter Break ()
TBA

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Colloquium Series

Tuesday, March 12, 2013, 4:10pm-5:00pm

1360 East Hall

Mike Hopkins (Harvard University)

Ziwet Lectures: Lecture I: The Kervaire invariant problem

Lecture I: The Kervaire invariant problem

Abstract: In this talk I will describe the history of the Kervaire invariant problem and its solution by Mike Hill, myself, and Doug Ravenel.

Lecture II: Equivariant homotopy theory and the solution to the Kervaire invariant problem.

Abstract: Our solution to the Kervaire invariant problem made essential use of group actions in algebraic topology. In this talk I will describe some of the basic ideas in equivariant homotopy theory and how they are used to study the Kervaire invariant problem.

Lecture III: Equivariant multiplicative closure

Abstract: The "multiplicative closure" of a set of elements in a commutative ring is the set of all products of powers of those elements. One of the innovations used in our solution to the Kervaire invariant problem revealed an unexpected subtlety in the analogue of this notion in equivariant homotopy theory. In this talk I will describe this analogy and explain the subtlety and the structures needed to deal with it.

Colloquium Series
Tuesday, March 19, 2013, 4:10pm-5:00pm
1360 East Hall
David Fisher (Indiana University)
Quasi-isometric rigidity of polycyclic groups

In his 1983 ICM address, Gromov proposed a program to classify finitely generated groups up to quasi-isometry. This program is a central part of geometric group theory. A major part of the program consists of showing that various classes of groups are quasi-isometrically rigid, i.e. that any group quasi-isometric to a group in the class is also in the class.

Eskin, Whyte and I conjecture that the class of polycyclic groups is quasi-isometrically rigid and proved quasi-isometric rigidity of the three dimensional polycyclic groups. A key ingredient is a new technique which we call coarse differentiation. This technique allows us to define a kind of derivative of a quasi-isometry despite the fact that quasi-isometries need not even be continuous.

I will discuss current progress towards proving our conjecture. Parts of this are joint with Eskin, Peng and Whyte.

Colloquium Series
Tuesday, March 26, 2013, 4:10pm-5:00pm
1360 East Hall
Domingo Toledo (University of Utah)
Geometry of Period Domains

Period domains are homogeneous complex manifolds that appeared in the study of period of integrals and monodromy groups of families of algebraic varieties. They appear now in many different contexts. I will explain some of this history, including how they can be used to study representations of fundamental groups of algebraic varieties, I will also explain recent joint work with P. Griffiths and C. Robles on geometry of these domains.

Colloquium Series
Tuesday, April 02, 2013, 4:10pm-5:00pm
1360 East Hall
Max Glick (Univ of Michigan)
Sumner Myers colloquium: The pentagram map and Y-patterns

The pentagram map is defined by the following construction: given a polygon as input, draw all of its "shortest" diagonals, and output the smaller polygon which they cut out. This operation was introduced by R. Schwartz in the 1990's and has received considerable attention in the past few years within both the discrete integrable system and cluster algebra communities.

I will explain how expressing the pentagram map in certain cross ratio coordinates makes it possible to realize the map as a sequence of mutations in a cluster algebra. This connection leads to explicit formulas for the iterates of the pentagram map in terms of generating functions. The underlying combinatorial objects driving the formulas are a family of posets which arose in the work of N. Elkies, G. Kuperberg, M. Larsen, and J. Propp on alternating sign matrices.

Colloquium Series
Tuesday, April 09, 2013, 4:10pm-5:00pm
1360 East Hall
Igor Dolgachev (University of Michigan)
Algebra, geometry and topology of Cremona groups

Colloquium Series
Tuesday, April 16, 2013, 3:10pm-4:00pm
1360 EH
Richard Thomas (Imperial College)
Algebraic geometry Spring lectures: The Gottsche conjecture

I will describe a classical problem going back to 1848 (Steiner, Cayley, Salmon,...) and a solution using simple techniques that one would never have thought of without ideas coming from string theory (Gromov-Witten invariants, BPS states) and modern geometry (the Maulik-Nekrasov-Okounkov-Pandharipande conjecture).

In generic families of curves C on a complex surface S, nodal curves - those with the simplest possible singularities - appear in codimension 1. More generally those with d nodes occur in codimension d. In particular a d-dimensional linear family of curves should contain a finite number of such d-nodal curves. The classical problem - at least in the case of S being the projective plane - is to determine this number. The Gottsche conjecture states that the answer should be topological, given by a universal degree d polynomial in the four numbers C.C, c_1(S).C, c_1(S)^2 and c_2(S).

This was proved recently by Yu-Jong Tzeng. I will explain a simpler proof which was joint work with Martijn Kool and Vivek Shende. The treatment will be very low-tech; I won't assume any prior knowledge. The main tool is Euler characteristics (which I will also explain).

Colloquium Series
Tuesday, April 16, 2013, 4:30pm-5:30pm
Forum Hall, Palmer Commons (4th floor)
Stephen Smale (Toyota Technological Institute at Chicago)
Mathematics of Protein Folding

Learning methods in recent science are used to create a geometry on spaces of amino acid sequences. This geometry is used to study immunology, in particular in the peptide binding problem. Then these ideas are used to obtain new results in protein folding.

Colloquium Series
Tuesday, April 23, 2013, 4:10pm-5:00pm
1360 East Hall
Andreas Blass (Univ of Michigan)
The Continuum Hypothesis and Its Enemies

Cantor's continuum hypothesis (CH) has consequences in many parts of mathematics. I'll give a few examples, but most of the talk will be about what can happen if CH is false. By itself, the negation of CH is not very useful, but set theorists have studied more specific principles that contradict CH. I'll describe some of these principles, indicate where they come from, and exhibit some of their consequences.