Colloquium, Academic Year 18-19

Thursdays 4:10 pm in 5211 Stevenson Center, unless otherwise noted
Tea at 3:33 pm in 1425 Stevenson Center
Colloquium Chair (2018-2019): Dechao Zheng

September 27, 2018 (Thursday), 4:10 pm

K-groups and Rings of Integers

Adebisi Agboola, UC Santa Barbara
Location: Stevenson 5211
Suppose that F is a number field and that G is a finite group. The inverse Galois problem asks whether or not there exists an extension of F whose Galois group is isomorphic to G. This question is known to have an affirmative answer in many cases, but is unsolved in general. I shall discuss a conjecture in relative algebraic K-theory (in essence, a conjectural Hasse or local-global principle applied to certain relative algebraic K-groups) that implies an affirmative answer to both the inverse Galois problem and to an analogous problem concerning the Galois module structure of rings of integers in tame extensions of F. The K-theoretic conjecture can be proved in many cases (subject to mild technical conditions) e.g. for groups of odd order, giving an analogue of a classical theorem of Shafarevich in this setting. While this approach does not, as yet, resolve any new cases of the inverse Galois problem, it does yield a quite substantial advance in our knowledge concerning the Galois module structure of rings of integers. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Dietmar Bisch)

October 11, 2018 (Thursday), 4:10 pm

The Combinatorics of RNA Branching

Christine Heitsch, Georgia Tech
Location: Stevenson 5211
Understanding the folding of RNA sequences into three-dimensional structures is one of the fundamental challenges in molecular biology. For example, the branching of an RNA secondary structure is an important molecular characteristic yet difficult to predict correctly, especially for sequences on the scale of viral genomes. However, results from enumerative, probabilistic, analytic, and geometric combinatorics yield insights into RNA structure formation, and suggest new directions in viral capsid assembly. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Mark Ellingham)

October 25, 2018 (Thursday), 4:10 pm

Counting Closed Geodesics: Classical and Non-Classical Behavior

Ilya Kapovich, CUNY Hunter College
Location: Stevenson 5211
The problem of counting closed geodesics of bounded length, originally in the setting of negatively curved manifolds, goes back to the classic work of Margulis in 1960s about the dynamics of the geodesic flow. Since then Margulis' results have been generalized to many other contexts where some whiff of hyperbolicity is present. Thus a 2011 result of Eskin and Mirzakhani shows that for a closed hyperbolic surface S of genus $g\ge 2$, the number $N(L)$ of closed Teichmuller geodesics of length $\le L$ in the moduli space of S grows as $e^{hL}/(hL)$ where $h=6g-6$. The number $N(L)$ is also equal to the number of conjugacy classes of pseudo-Anosov elements ϕ in the mapping class group $MCG(S)$ with $\log\lambda(\phi)\le L$, where $\lambda(\phi)>1$ is the "dilatation" or "stretch factor" of ϕ. We consider an analogous problem in the $Out(F_r)$ setting, for the action of $Out(F_r)$ on a "cousin" of Teichmuller space, called the Culler-Vogtmann outer space X_r. In this context being a "fully irreducible" element of $Out(F_r)$ serves as a natural counterpart of being pseudo-Anosov. Every fully irreducible $\phi\in Out(F_r)$ acts on X_r as a loxodromic isometry with translation length $\log\lambda(\phi)$, where again $\lambda(\phi)$ is the stretch factor of ϕ. We estimate the number $N_r(L)$ of fully irreducible elements $\phi\in Out(F_r)$ with $\log\lambda(\phi)\le L$. We prove, for $r\ge 3$, that $N_r(L)$ grows \emph{doubly exponentially} in L as $L\to\infty$, in terms of both lower and upper bounds. These bounds reveal new behavior not present in classic hyperbolic dynamical systems. The talk is based on a joint paper with Catherine Pfaff. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Denis Osin)

November 1, 2018 (Thursday), 4:10 pm

Catching Monodromy

Andrei Okounkov, Columbia University
Location: Stevenson 5211
Monodromy of linear differential and difference equations is a very old and classical object, which may be seen as a far-reaching generalization of the exponential map of a Lie group. While general properties of this map may studied abstractly, for certain very special equations of interest in enumerative geometry, representation theory, and also mathematical physics, it is possible to describe the monodromy “explicitly”, in certain geometric and algebraic terms. I will explain one such recent set of ideas, following joint work with M. Aganagic and R. Bezrukavnikov. The talk will be aimed at a broad audience and omit the discussion of advanced topics such as the categorification of these monodromy groups. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Vaughan Jones)

November 8, 2018 (Thursday), 4:10 pm

Kolmogorov, Onsager and a Stochastic Model for Turbulence

Susan Friedlander, University of Southern California
Location: Stevenson 5211
We will briefly review Kolmogorov’s (41) theory of homogeneous turbulence and Onsager’s (49) conjecture that in 3-dimensional turbulent flows energy dissipation might exist even in the limit of vanishing viscosity. Although over the past 60 years there is a vast body of literature related to this subject, at present there is no rigorous mathematical proof that the solutions to the Navier-Stokes equations yield Kolmogorov’s laws. For this reason various models have been introduced that are more tractable but capture some of the essential features of the Navier-Stokes equations themselves. We will discuss one such stochastically driven dyadic model for turbulent energy cascades. We will describe how results for stochastic PDEs can be used to prove that this dyadic model is consistent with Kolmogorov’s theory and Onsager’s conjecture. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Giusy Mazzone)

November 29, 2018 (Thursday), 4:10 pm

Gabor Systems and Wilson Bases

Kasso Okoudjou, University of Maryland
Location: Stevenson 5211
The Balian-Low Theorem (BLT) is an uncertainty principle-type result that precludes the existence of a Gabor orthonormal basis (ONB) of the form $\{e^{2\pi i kx/a }g(x-an) \}_{k, n=-\infty}^{\infty},$ where $a>0$, and g is well-localized in phase space. A related ONB with a well-localized generator (hence does not obey the BLT) was numerically introduced by K. Wilson in the 80s and formalized by Daubechies, Jaffard, and Journ\'e. The latter system is called a Wilson basis and was recently featured in the detection of the gravitational waves.
In the first part of the talk, I will review some basic structures as well as the relationship between these two systems. I will then present some recent and ongoing work on constructing Wilson-type systems from more general Gabor families. (This is a joint work with D. Bhimani, M. Bownik, M. Jakobsen, and J. Lemvig).Tea at 3:33 pm in Stevenson 1425. (Contact Person: Akram Aldroubi)

January 21, 2019 (Monday), 3:10 pm

Special Colloquium

Location: Stevenson 5211
Tea at 2:30 pm in Stevenson 1425.

January 24, 2019 (Thursday), 4:10 pm

On Isoperimetric Functions of Finitely Presented Groups

Alexander Olshanskiy, Vanderbilt University
Location: Stevenson 5211
The results recently obtained by Olshanskiy and Sapir solve two well-known problems about isoperimetric functions (or Dehn functions) of finitely presented groups. We have completed the description of the isoperimetric spectrum of finitely presented groups modulo $\bf NP=P$ hypothesis (a problem first proposed by M. Bridson in 1996), and we constructed a finitely presented group with quadratic isoperimetric functions and undecidable conjugacy problem (this problem was first proposed by Rips in 1994). The basic concepts and examples will be provided, no specific knowledge will be assumed. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Dechao Zheng)

January 25, 2019 (Friday), 3:10 pm

Special Colloquium

Location: Stevenson 1206
Tea at 2:30 pm in Stevenson 1425.

January 30, 2019 (Wednesday), 3:10 pm

Special Colloquium

Location: Stevenson 5211
Tea at 2:30 pm in SC 1425.

January 31, 2019 (Thursday), 4:10 pm

Refined Invariants of Algebraic Knots and Number Theory

Ivan Cherednik, University of North Carolina-Chapel Hill
Location: Stevenson 5211
The (uncolored) HOMFLY-PT polynomials H(q,a), are relatively simple to define for any links. We will consider only algebraic knots: intersections of connected plane curve singularities with small 3-dimensional sphere centered at the singularity. Their t-refinements, the Khovanov-Rozansky stable reduced polynomials KhR(q,t,a) attract a lot of attention. This is the most powerful numerical invariant of knots we have, though difficult to calculate. The connection is H(q,a)=KhR(q,q,-a). This talk will be about the motivic superpolynomials which will be defined from scratch; very little knowledge of rings and modules is needed (and finite fields). Conjecturally, they coincide with stable, reduced Khovanov-Rozansky polynomials. Moreover, and this will be explained in full, they are conjectured to coincide with the L-function of the ring of plane curve singularity over the finite field of cardinality “q” (a two-line definition); “t” becomes simply “T” from the theory of local zeta-functions. The implications of this interplay between knot theory (with almost infinite list of applications) and number theory will take time to digest, but this is obviously of fundamental nature. For instance, the Riemann Hypothesis for t-zeros of the motivic superpolynomials holds for sufficiently small “q” (a theorem); presumably for “q” smaller than 1/2 at a=0. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Larry Rolen)

February 7, 2019 (Thursday), 4:10 pm

Poincaré Conjecture: Dynamical & Extended

Dennis Sullivan, Suny at Stony Brook
Location: Stevenson 5211
For each closed three manifold M there is a countable group acting on the three sphere with a compact fundamental domain on some invariant open set whose quotient is M and whose complement is totally disconnected. There is a speculative connection to 3D turbulence. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Marcelo Disconzi)

February 14, 2019 (Thursday), 4:10 pm

Ergodic Methods in Rigidity of Representations

Alex Furman, University of Illinois at Chicago
Location: Stevenson 5211
A surface of genus at least two admits a variety of hyperbolic structures – the Teichmuller space. However, in higher dimensions similar locally symmetric structures turn out to be very rigid, as was shown by Weil, Selberg, Mostow, Margulis. Perhaps surprisingly, in addition to geometry, Lie groups, and number theory, some ideas from ergodic theory – dynamics on measure spaces – play an important role in these developments. In the talk I will discuss some of these rigidity phenomena with the emphasis on the interplay between ergodic theory and algebraic groups. Based on joint works with Uri Bader. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Spencer Dowdall)

February 28, 2019 (Thursday), 4:10 pm

Turbulence Suppression in Navier-Stokes Fluids of Dimension d=3, by Means of Stabilizing, Finite Dimensional, Tangential, Boundary Feedback Controls

Roberto Triggiani, The University of Memphis
Location: Stevenson 5211
The problem of turbulence suppression (technically, uniform stabilization) in a Navier-Stokes fluid originated in a 2004-Indiana paper, where the stabilizing, finite dimensional, feedback control acts on an arbitrarily small subdomain of the bounded domain occupied by the fluid. This was soon followed by studies aimed at obtaining the stabilizing feedback control to act tangentially on a small portion of the boundary (non-invasive control, implemented by jets of air). Results obtained so far left open the question as to whether such stabilizing control can be taken to be finite dimensional also in dimension d=3 in full generality. This talk will give an affirmative answer. To this end, it was necessary to recast prior studies in an altogether different functional setting, where additional technical and conceptual challenges arise, particularly since the control acts on the boundary in a feedback form (the way a thermostat works). The role and impact of unique continuation theorems of over-determined Oseen eigen-problems will be discussed [The “bad guy” is the pressure!]. This is joint work with I.Lasiecka and our PhD student Buddhika Priyasad.
Tea at 3:33 pm in SC 1425. (Contact Person: Gieri Simonett)

March 14, 2019 (Thursday), 4:10 pm

Talk Title TBA

Blane Hollingsworth, Arizona State University
Location: Stevenson 5211
Tea at 3:33 pm in SC 1425.

March 21, 2019 (Thursday), 4:10 pm

Return Probabilities of Random Walks on Non-Amenable Groups

Steven Lalley, University of Chicago
Location: Stevenson 5211
A fundamental theorem of Harry Kesten asserts that the return probabilities of a random walk on a non-amenable group must always decay exponentially with the number of steps. Is there always a sharp asymptotic formula for the return probabilities, analogous to the Local Limit Theorem for random walks on Z^n? If so, is the nature of the formula (in particular, the polynomial correction to the exponential factor) determined by the geometry of the group? We will review recent progress on these questions. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Mark Sapir)

March 28, 2019 (Thursday), 4:10 pm

Classical and Homotopy Group Actions

Alejandro Adem, University of British Columbia
Location: Stevenson 5211
Understanding the symmetries of a topological space is a classical problem in mathematics. In this talk we will discuss how methods from algebraic topology can be used to approach this. After reviewing well-known results about transformation groups, we will consider the notion of group actions up to homotopy. This leads to interesting interactions between topology, group theory and representation theory. A number of examples will be provided to illustrate this. Tea at 3:33 pm in SC 1425. (Contact Person: Anna Marie Bohmann)

April 2, 2019 (Tuesday), 4:10 pm

Atomistic and Multi-scale Material Modelling (A Numerical Analysis Perspective)

Christoph Ortner, University of Warwick
Location: Stevenson 5211
A common problem of atomistic materials modelling is to determine properties of crystalline defects, such as structure, energetics, or mobility, from which meso-scopic material properties or coarse-grained models (e.g., Kinetic Monte-Carlo, Discrete Dislocation Dynamics, Griffith-type fracture laws) can be derived. This leads to a range of atomistic (discrete) models for crystals and defect. In this lecture I will give an overview over different popular multiscale schemes for approximating these models, and in particular their numerical analysis. Finally, I will also discuss how the ML/data-science revolution has affected this field and how this leads to some new high-dimensional approximation problems. Tea at 3:33 pm in SC 1425. (Contact Person: Mike Neamtu)

April 11, 2019 (Thursday), 4:10 pm

Flavors of Bicycle Mathematics

Sergei Tabachnikov, Pennsylvania State University
Location: Stevenson 5211
This talk concerns a naive model of bicycle motion: a bicycle is a segment of fixed length that can move so that the velocity of the rear end is always aligned with the segment. Surprisingly, this simple model is quite rich and has connections with several areas of research, including completely integrable systems. Here is a sampler of problems that I hope to address: 1) The trajectory of the front wheel and the initial position of the bicycle uniquely determine its motion and its terminal position; the monodromy map sending the initial position to the terminal one arises. This circle mapping is a Moebius transformation, a remarkable fact that has various geometrical and dynamical consequences. 2) The rear wheel track and a choice of the direction of motion uniquely determine the front wheel track; changing the direction to the opposite, yields another front track. These two front tracks are related by the bicycle (Backlund, Darboux) correspondence, which defines a discrete time dynamical system on the space of curves. This system is completely integrable and it is closely related with another, well studied, completely integrable dynamical system, the filament (a.k.a binormal, smoke ring, local induction) equation. 3) Given the rear and front tracks of a bicycle, can one tell which way the bicycle went? Usually, one can, but sometimes one cannot. The description of these ambiguous tire tracks is an open problem, intimately related with Ulam's problem in flotation theory (in dimension two): is the round ball the only body that floats in equilibrium in all positions? It turns out that the known solutions are solitons of the planar filament equation. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Mark Sapir)

April 18, 2019 (Thursday), 4:10 pm

On PDE Aspects of the Navier-Stokes Equations and Some Simpler Model Equations

Vladimir Sverak, University of Minnesota
Location: Stevenson 5211
Although the Navier-Stokes equations are widely used, it is not known rigorously whether the mathematical model they represent satisfies one of the basic tenets of the Newtonian mechanics that a complete information about the system at a given time together with the equations of motion should uniquely determine the state of the system at all future times. I will recall what is known about these questions for the Navier-Stokes equations, and will also present examples of relevant model problems for which one can obtain a fairly good understanding of these issues, at least if we are willing to rely on numerical simulations. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Gieri Simonett)

» **Past Colloquia**