SCHEDULE OF TALKS

On Friday afternoon and Sunday morning we will have talks in parallel sessions in rooms 114 and 113 McAllister Building. All other talks will take place in the synergistic room, 114 McAllister Building.

THURSDAY, October 11
Opening session

12:00 - 1:00 Registration
1:00 - 1:10 Opening Remarks
1:15 - 2:05 Anthony Quas
Rectangular Tiling factors of $\mathbb{R}^d$ actions.
2:20 - 3:10 Danijela Damjanovic
Examples of parabolic actions with globally hypoelliptic leafwise Laplacian and rigidity.
3:15 - 3:35 Departmental Tea
3:35 - 4:25 Department of Mathematics Colloquium
John Franks
Low dimensional dynamics with abstract time.
4:40 - 5:30 Keith Burns
Ergodicity of the Weil-Petersson geodesic flow.
**FRIDAY, October 12**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker 1</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:30 - 10:20</td>
<td>Andrew Torok</td>
<td>Memory loss for time-dependent piecewise expanding systems in higher dimension.</td>
</tr>
<tr>
<td>10:20 - 10:50</td>
<td>Coffee break</td>
<td></td>
</tr>
<tr>
<td>11:50 - 12:40</td>
<td>Rafael de la Llave</td>
<td>Geometric/Numerical Approaches to KAM theory for Conformally symplectic systems.</td>
</tr>
<tr>
<td>12:40 - 2:30</td>
<td>Lunch</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Room 114</th>
<th>Room 113</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:30 - 3:00</td>
<td>Jinxin Xue</td>
</tr>
<tr>
<td>3:10 - 3:40</td>
<td>Kiran Parkhe</td>
</tr>
<tr>
<td></td>
<td>Continuous actions of discrete Heisenberg group on surfaces.</td>
</tr>
<tr>
<td>3:40 - 4:10</td>
<td>Coffee break</td>
</tr>
<tr>
<td>4:10 - 4:40</td>
<td>Kurt Vinhage</td>
</tr>
<tr>
<td></td>
<td>A Measure Rigidity Theorem of Einsiedler and Lindenstrauss.</td>
</tr>
<tr>
<td>4:50 - 5:40</td>
<td>Tuyen Truong</td>
</tr>
<tr>
<td></td>
<td>On automorphisms of blowups of $P^3$.</td>
</tr>
</tbody>
</table>

**7:00 - 9:00 Banquet** at Gardens Restaurant at the Penn Stater Conference Center.
SATURDAY, October 13
Special session dedicated to the 70th birthday of Jean-Paul Thouvenot

9:30 - 10:20 Anatole Katok
The rise of French school in dynamics and contributions of Jean-Paul Thouvenot.

10:20 - 10:50 Coffee break

10:50 - 11:40 Francois Ledrappier
Regularity of the entropy for random walks on hyperbolic groups.

11:50 - 12:40 Karl Petersen
Some results and systems related to the super-K property.

12:40 - 2:30 Lunch

2:30 - 3:20 Svetlana Katok
Average entropy for smooth actions of higher rank abelian groups

3:20 - 3:50 Coffee break

3:50 - 4:40 Terry Soo
Ergodic Universality.

4:50 - 5:40 Mike Boyle
Path methods for strong shift equivalence of positive matrices.

SUNDAY, October 14

9:30 - 10:20 Room 114 Pengfei Zhang
Volume of the set of transitive points of partially hyperbolic diffeomorphisms.

10:30 - 11:20 Room 113 Kostya Medynets
Second Order Ergodic Theorem for Self-Similar Tiling Systems.

11:30 - 12:20 Miaohua Jiang
Differentiating Potential Functions of SRB Measures on Hyperbolic Attractors.
ABSTRACTS

Mike Boyle (University of Maryland). Path methods for strong shift equivalence of positive matrices.

Abstract. The classification of matrices up to strong shift equivalence (SSE) over the nonnegative integers ($\mathbb{Z}_+$) is equivalent to the classification of shifts of finite type up to topological conjugacy. This classification problem remains open after 40 years. In a certain precise sense, there are no general positive results at all for this problem over $\mathbb{Z}_+$.

As a probe to this problem and related problems, in the early 1990s Kim and Roush developed “path methods” for studying strong shift equivalence of positive matrices over a dense subring of the reals. Their starting point was to consider a path of positive, conjugate real matrices and deduce matrices on the path are SSE over $\mathbb{R}_+$. Then, in cases, produce results over other dense subrings of the reals.

This talk is based on a long joint paper with Kim and Roush, presenting with detailed proofs and extending their work of 20 years ago. With the path methods, the problem of understanding SSE over $S_+$, for $S$ a dense subring of $\mathbb{R}$, is more open (contrast $\mathbb{Z}_+$) to developed mathematical tools (linear algebra, fiber bundles, semialgebraic geometry). A sample of the new results:

- If positive matrices over the rationals are SSE over $\mathbb{R}_+$, then they are SSE over $\mathbb{Q}_+$.
- All matrices on a path of positive matrices shift equivalent over $\mathbb{R}_+$ must be SSE over $\mathbb{R}_+$.
- Suppose $A$ and $B$ are positive matrices over a dense subring $\mathcal{U}$ of $\mathbb{R}$, and are SSE over $\mathcal{U}$, and each has just one nonzero eigenvalue, and this is the same for $A$ and $B$. Then $A$ and $B$ are SSE over $\mathcal{U}_+$.
- If $\mathcal{U}$ is a dense subring of $\mathbb{R}$ and $A$ is a matrix over $\mathcal{U}$, then the set of positive matrices over $\mathcal{U}$ which are conjugate to $A$ can intersect only finitely many SSE-$\mathcal{U}_+$ classes.

I’ll explain some of the ideas, motivation, context and results, and mention some open problems.

Keith Burns (Northwestern University). Ergodicity of the Weil-Petersson geodesic flow.

Abstract. The Weil-Petersson metric is a Riemannian metric on the moduli space of a surface. It has negative curvature, but is incomplete. Analogy with the results of Hopf and Anosov for complete metrics of negative curvature suggested that the geodesic flow for the Weil-Petersson metric should be ergodic, but the incompleteness of the metric and insufficient knowledge of its geometry delayed a proof. We now know a great deal about the geometry of the Weil-Petersson metric, in large part due to the work of Scott Wolpert, and ergodicity of the geodesic flow has been proved by Burns, Masur and Wilkinson. The proof uses the results of Wolpert and the theory of nonuniformly hyperbolic dynamical systems, in the particular the work of Katok and Strelcyn.

Van Cyr (Northwestern University). Nonexpansive $\mathbb{Z}^2$ subdynamics and Nivat’s conjecture.
**Abstract.** For a finite alphabet \( \mathcal{A} \) and \( \eta : \mathbb{Z} \to \mathcal{A} \), the Morse-Hedlund Theorem states that \( \eta \) is periodic if and only if there exists \( n \in \mathbb{N} \) such that the block complexity function \( P_\eta(n) \) satisfies \( P_\eta(n) \leq n \), and this statement is naturally studied by analyzing the dynamics of a \( \mathbb{Z} \)-action associated with \( \eta \). In dimension two, a conjecture of M. Nivat states that if there exist \( n, k \in \mathbb{N} \) such that the rectangular complexity function, \( P_\eta(n,k) \), satisfies \( P_\eta(n,k) \leq nk \), then \( \eta \) is periodic.

In this talk I will discuss recent joint work with B. Kra in which we associate a \( \mathbb{Z}^2 \)-dynamical system with \( \eta \) and show that if there exist \( n, k \in \mathbb{N} \) such that \( P_\eta(n,k) \leq nk \), then the periodicity of \( \eta \) is equivalent to a statement about the expansive subspaces of this action. As a corollary, we show that if there exist \( n, k \in \mathbb{N} \) such that \( P_\eta(n,k) \leq \frac{nk}{2} \), then \( \eta \) is periodic. This proves a weak form of Nivat’s conjecture.

**Danijela Damjanovic** (Rice University). *Examples of parabolic actions with globally hypoelliptic leafwise Laplacian and rigidity.*

**Abstract.** Unlike the case of vector fields, global hypoellipticity of a system of two or more commuting vector fields is a very weak property. However, global hypoellipticity of the leafwise Laplacian is sufficient to imply finite dimensional first and second cohomology in general, and for particular actions on 2-step nilmanifolds even trivial first cohomology. For the simplest cases on 2-step nilmanifolds this leads towards transversal local rigidity for these parabolic homogeneous actions.

**Rafael de la Llave** (Georgia Institute of Technology). *Geometric/Numerical Approaches to KAM theory for Conformally symplectic systems.*

**Abstract.** We develop KAM theory for conformally symplectic systems. These are systems that transform a symplectic form in a multiple of itself. They appear naturally in Mechanics (friction proportional to the velocity) and as Economics and Control (Euler-Lagrange equations of discounted functionals).

We present an a-posteriori theorem that leads to very efficient numerical algorithms that can work extremely close to breakdown of the tori.

Joint work with R. Calleja and R. Celletti

**Dmitry Dolgopyat** (University of Maryland). *Limit Theorems for Anosov actions.*

**Abstract.** We discuss Central Limit and Poisson limit theorems for Anosov actions of higher rank abelian groups. This is a joint work with Bassam Fayad.

**John Franks** (Northwestern University). *Low dimensional dynamics with abstract time.*

**Abstract.** We consider the dynamics of (non-compact) group actions on surfaces which are conservative and non-chaotic systems (technically with elements having zero topological entropy). A structure theorem for the dynamics of many such elements combined with the much better understood positive entropy case permits us to provide applications to group actions especially in the analytic case and leads to some interesting conjectures. New results represent joint work with Michael Handel.
**Miaohua Jiang** (Wake Forest University). *Differentiating Potential Functions of SRB Measures on Hyperbolic Attractors.*

*Abstract.* The derivation of Ruelle’s derivative formula of the SRB measure depends largely on the calculation of the derivative of the unstable Jacobian. While Ruelle’s derivative formula is correct, the proofs in the original paper and its corrigendum are not complete. In this paper, we re-visit the differentiation process of the unstable Jacobian and provide a complete derivation of its derivative formula. Our approach is to extend the volume form provided by the SRB measure on local unstable manifolds to a system of Hölder continuous local Riemannian metrics on the manifold so that under this system of local metrics, the unstable Jacobian becomes differentiable with respect to the base point and its derivative with respect to the map can be obtained by the chain rule.

**Svetlana Katok** (Penn State). *Average entropy for smooth actions of higher rank abelian groups.*

*Abstract.* In a joint work with A. Katok and F. Rodriguez Hertz we introduce a meaningful numerical entropy invariant for smooth actions of higher rank abelian groups called the *average entropy*. We use algebraic number theory to obtain a lower bound for the average entropy of any Cartan action on an $n$-dimensional torus that goes to infinity with $n$, and prove that the average entropy is bounded away from zero by a constant independent on $n$. Arithmeticity of maximal rank smooth abelian actions proved by A. Katok and F. Rodriguez Hertz implies that the same estimates hold for the average entropy of any such action.

**Francois Ledrappier** (University of Notre Dame). *Regularity of the entropy for random walks on hyperbolic groups.*

*Abstract.* We consider a hyperbolic group $G$ and random walks defined by probability measures $p$ on $G$ with finite support. We study the regularity of the entropy of the random walk as $p$ varies among probabilities with the same support, and connected problems. We present recent results: the entropy is real analytic if $G$ is a free group, $C^1$ among symmetric random walks (P. Mathieu 2012) and Lipschitz in general.

**Elio Mazzeo** (University of Toronto). *On $C^1$ rigidity of circle maps with a break point.*

*Abstract.* In this talk, I will discuss the two main results that were obtained in the rigidity theory of circle maps with a break point, as part of my thesis. The first main result of the thesis was submitted for publication (a preprint is available at http://www.ma.utexas.edu/mp_arc-bin/mpa?yn=11-102). It is a proof that $C^1$ rigidity holds for circle maps with a break point for almost all rotation numbers. The second main result of the thesis is a proof that $C^1$ robust rigidity holds for circle maps in the fractional linear transformation (FLT) pair family. That is, for this family, $C^1$ rigidity holds for all irrational rotation numbers. The approach taken in the thesis of proving a more general theorem, namely that $C^1$ rigidity holds for circle maps with a break point satisfying a ‘derivatives close condition’, allows us to obtain both of the main results as corollaries of this more general theorem.
Kostya Medynets (U.S. Naval Academy). **Second Order Ergodic Theorem for Self-Similar Tiling Systems**

*Abstract.* We consider infinite measure-preserving non-primitive self-similar tiling systems in d-dimensional Euclidean space. We establish the second-order ergodic theorem for such systems. The speed of convergence is determined by the Hausdorff dimension of a graph-directed set associated to the substitution rule.

Sheldon Newhouse (Northwestern University). **The Lorenz equations: Old and New.**

*Abstract.* The familiar Lorenz equations form a three parameter family of vector fields in $\mathbb{R}^3$. In spite of their introduction by E. Lorenz in 1963, and a long detailed numerical study in the book of Colin Sparrow in 1981, relatively little is known about the orbit structure from a (rigorous) mathematical point of view. We describe some old and relatively new results on this system. In particular, recently certain expansion properties near the origin have been proved via a partial linearization result, and the time-one map has topological entropy larger than $\log(2)/4$ for all parameters in a neighborhood of the line segment $\{(s, r, b) : s = 10, b = 8/3, 25 \leq r \leq 83\}$ in parameter space.

Kiran Parkhe (Northwestern University). **Continuous actions of discrete Heisenberg group on surfaces.**

*Abstract.* The (discrete) Heisenberg group is the group

$$H = \langle a, b, c : aba^{-1}b^{-1} = c, ac = ca, bc = cb \rangle.$$  

A continuous (smooth) action of $H$ on a manifold $M$ is a homomorphism $\Phi : H \to \text{Homeo}(M)({\text{Diff}(M)})$; in other words, it is a choice of homeomorphisms (diffeomorphisms) $f, g,$ and $h$ satisfying the Heisenberg group relations.

We study continuous/smooth actions of $H$ on surfaces $S$. We give a $C^\infty$ gluing procedure to produce many smooth examples. We show, however, that under certain hypotheses the situation becomes rigid. Namely, suppose $S = \mathbb{R}^2$ is the plane and $h$ is conjugate to a translation. Suppose there exists a non-central element $k \in H$ and an $h$-invariant line $\ell$ such that $k(\ell)$ is disjoint from $\ell$. Then there exists a non-central $k' \in H$ such that $k'$ and $h$ are "transverse translations": $\mathbb{R}^2/\langle k', h \rangle$ is homeomorphic to the torus. Classifying such actions essentially reduces to classifying torus homeomorphisms.

Karl Petersen (University of North Carolina at Chapel Hill). **Some results and systems related to the super-K property.**

*Abstract.* A process is called super-K if a tail field defined by a symbol-counting cocycle is trivial. This is a stronger property than the Kolmogorov (K) property, which says that the usual tail field is trivial. We review some work with Schmidt and Thouvenot on the existence of super-K generators and describe examples of the dynamical systems that are naturally constructed to display fine tail fields.

Anthony Quas (University of Victoria). **Rectangular Tiling factors of $\mathbb{R}^d$ actions.**

*Abstract.* For a collection $C = R_1, \ldots, R_n$ of d-dimensional rectangles, we consider $Y_C$, the space of tilings of $\mathbb{R}^d$ by tiles in $C$. Rudolph established the existence of an $C$ consisting of $2^d$ tiles such that any free measure-preserving $\mathbb{R}^d$ action factors onto $Y_C$, and
asked what is the smallest collection of tiles with this property. We exhibit a family of sets of $d+1$ tiles with this property.

We classify the invariant measures on $Y_C$, where $C$ is an arbitrary family of 2 rectangles in $\mathbb{R}^2$, and deduce that there are systems that do not factor onto any $Y_C$ with $|C| = 2$, so that the $d+1$ bound is sharp in this case. (Joint work with Bryna Kra and Ayse Sahin)

Terry Soo (University of Victoria). Ergodic Universality.

Abstract. The Krieger generator theorem says that every invertible ergodic measure-preserving system with finite measure-theoretic entropy can be embedded into a full shift with strictly greater topological entropy. In joint work with Anthony Quas, we extend Krieger’s theorem to include toral automorphisms and time-one maps of geodesic flows on compact surfaces of negative curvature.

Andrew Torok (University of Houston). Memory loss for time-dependent piecewise expanding systems in higher dimension.

Abstract. We prove a counterpart of exponential decay of correlations for non-stationary systems. Namely, given two probability measures absolutely continuous with respect to a reference measure, their quasi-H"older distance (and in particular their $L^1$ distance) decreases exponentially under action by compositions of arbitrarily chosen maps close to those that are both piecewise expanding and mixing in a certain sense. The novelty of the result is the higher-dimensional setting. This is joint work with Chinmaya Gupta and William Ott.

Tuyen Truong (Syracuse University). On automorphisms of blowups of $P^3$.

Abstract. We will present a heuristic argument to show that it is difficult to find automorphisms $f : X \to X$ of positive entropies on compact Kahler manifolds $X$ of dimension at least 3, and will discuss in detail the cases when $X$ is a blowup of $P^3$ or $P^2 \times P^1$ or $P^1 \times P^1 \times P^1$.

Kurt Vinhage (Penn State). A Measure Rigidity Theorem of Einsiedler and Lindenstrauss.

Abstract. We will investigate the structure of invariant measures on tori and solenoids under higher-rank automorphism actions. The method of proof relies on the entropy structure, rather than the geometric structure of the Lyapunov foliations. The far-reaching result extends even to partially hyperbolic actions, but relies heavily on the associated algebraic structures.

Jinxin Xue (University of Maryland). Noncollisional singularity in a planar 2-center-2-body problem.

Abstract. In this work we study a model called planar 2-center-2-body problem. In the plane, we have two fixed centers $Q_1 = (-\chi, 0)$, $Q_2 = (0, 0)$ of masses 1, and two moving bodies $Q_3$ and $Q_4$ of masses $\mu$. They interact via Newtonian potential. $Q_3$ is captured by $Q_2$, and $Q_4$ travels back and forth between two centers. Based on a model of Gerver, we prove that there is a Cantor set of initial conditions which lead to solutions of the Hamiltonian system whose velocities are accelerated to infinity within finite time avoiding all early collisions. We consider this model as a simplified model for the planar
four-body problem case of the Painleve conjecture. This is a joint work with Dmitry Dolgopyat.

**Kelly Yancey** (University of Illinois at Urbana-Champaign). *Constructing Generic Homeomorphisms.*

Abstract. In a paper by Glasner and Maon in 1989 they introduce the idea of uniform rigidity as a topological analogue of classical rigidity in ergodic theory. This seems to be the correct topological analogue as similar generic properties hold in both settings. In this talk I will discuss how to produce generic homeomorphisms of the two torus and the Klein bottle that are weakly mixing and uniformly rigid. We will examine the different approaches for each compact manifold and why they are different.

**Pengfei Zhang** (University of Massachusetts Amherst). *Volume of the set of transitive points of partially hyperbolic diffeomorphisms.*

Abstract. We find new bi-essentially saturated sets and give some sufficient conditions for an accessible partially hyperbolic diffeomorphism to be transitive. Moreover we provide some lower bounds for the volumes of the transitive sets of these systems.