SCHEDULE OF TALKS
Semi-annual Workshop in Dynamical Systems and Related Topics
Pennsylvania State University, October 5-8, 2017

THURSDAY, October 5
1:00 - 1:45  Registration
1:45 - 2:00  Opening Remarks
2:00 - 2:50  Enrique Pujals. *Entropy zero and renormalization for dissipative
diffeomorphisms of the disk*
3:00 - 3:30  *DEPARTMENTAL TEA*
3:35 - 4:25  Department of Mathematics Colloquium and
Chernov Memorial Lecture 1.  Carlangelo Liverani
  *The Lorentz gas: where we stand and where I’d like to go*
4:40 - 5:30  Lewis Bowen.  *Pointwise ergodic theorems for hyperbolic groups*

FRIDAY, October 6
Special Session dedicated to Yakov Pesin’s birthday
9:00 - 9:50  Boris Hasselblatt.  *Contact Anosov flows on 3-manifolds*
10:00 - 10:30  *COFFEE BREAK*
10:30 - 11:20  Victoria Sadovskaya
  *Lyapunov exponents of cocycles over non-uniformly hyperbolic systems*
11:30 - 12:20  Domokos Szasz
  *Rare interaction limit in a Hamiltonian system*
12:30 - 2:00  *LUNCH BREAK*
2:00 - 2:50  Sheldon Newhouse
  *On a Differentiable Linearization Theorem of Philip Hartman*
3:00 - 3:30  *COFFEE BREAK*
3:30 - 4:20  Dan Thompson
  *Symbolic dynamics for geodesic flow on CAT(-1) spaces*
4:30 - 5:20  Vaughn Climenhaga.  *Leaf measures via dynamical dimensions*
7:00 - 9:00  Banquet in honor of Michael Brin and Yakov Pesin
at Atherton Hotel.  Cash bar starting at 6 p.m., meal at 7 p.m.
*Please plan to arrive by 6:45 p.m.*
SATURDAY, October 7

9:00 - 9:50  Chernov Memorial Lecture 2
Carlangelo Liverani. The functional analytic approach to billiards

10:00 - 10:30  COFFEE BREAK

10:30 - 11:00  Room 113: Matthew Smith
A condition for unique ergodicity of quadratic differentials
Room 114: Agnieszka Zelerowicz. A geometric approach for constructing equilibrium measures for some partially hyperbolic systems

11:10 - 11:40  Room 113: Changguang Dong. Density of an infinite subset
Room 114: Yaofeng Su. Almost Sure Invariance Principle for sequential intermittent dynamical systems

11:50 - 12:20  Room 113: Osama Khalil. Birkhoff’s Theorem, sparse equidistribution and translates of measures on homogeneous spaces
Room 114: Kasun Fernando. Asymptotic expansions for the Central Limit Theorem for dynamical systems

12:30 - 2:00  LUNCH BREAK

2:00 - 2:50  Amie Wilkinson. Density of local accessibility and its consequences

3:00 - 3:30  Room 113: Shahriar Mirzadeh. Dimension estimates for the set of points with non-dense orbit in homogeneous spaces
Room 114: Alena Erchenko
Flexibility questions in fixed conformal classes

3:30 - 4:00  COFFEE BREAK

4:00 - 4:15  BRIN PRIZE Award Ceremony

4:20 - 5:20  BRIN PRIZE Talk

SUNDAY, October 8

9:00 - 9:50  Chernov Memorial Lecture 3
Carlangelo Liverani. Deterministic walks in random environment

10:00 - 10:20  COFFEE BREAK

10:20 - 11:10  Room 113: Alex Blumenthal
Statistical properties of standard maps with increasing coefficient
Room 114: Clark Butler
Characterizing symmetric spaces by their Lyapunov spectra

11:20 - 12:10  Mark Demers. Hitting times and escape rates
Lecture One: The Lorentz gas: where we stand and where I’d like to go.  
Thursday, 10/5, 3:35-4:25 p.m. in 114 McAllister.

Abstract: The Lorentz gas is a simplified model of a gas of particles in a non homogeneous medium. Many results (old and new) are available for the case in which the inhomogeneities (scatterers) are periodic. I will try to give an idea of the state of the art for the case of high density scatterers and the obstacles that must be overcome to go beyond the periodic Lorentz Gas. In particular, I will comment on the random and the (weakly) interacting case.

Lecture Two: The functional analytic approach to billiards.  
Saturday, 10/7, 9:00-9:50 a.m. in 114 McAllister.

Abstract: After the original approach of Bunimovich - Chernov - Sinai, then substantially improved by Young, Dolgopyat and Chernov, a new approach to the study of decay of correlations in billiards has been developed in the past years based on the direct study of the Transfer Operator on suitable Banach spaces. I will illustrate such an approach and explain some notable results recently obtained by it. Also I will mention the possible relevance of such results to the investigation of weakly interacting particles.

Lecture Three: Deterministic walks in random environment.  
Sunday, 10/8, 9:00-9:50 a.m. in 114 McAllister.

Abstract: A deterministic walk consists in a point with an internal state that moves in an environment according to a deterministic rule. When the environments under consideration are described by a probability distribution, then we call the environment random. I will discuss some simple models of deterministic walk in random environment and show in which sense they are a generalisation of random walks in random environment. Then I will present some recent results in the subject that, hopefully, are relevant for the study of the random Lorentz gas.
Alex Blumenthal  (University of Maryland)
Statistical properties of standard maps with increasing coefficient
Abstract: The Chirikov standard map \{F_L, L > 0\} is a prototypical example of a one-parameter family of volume-preserving maps for which one anticipates chaotic behavior on a non-negligible (positive-volume) subset of phase space on a large set of parameters. Analysis in this direction is notoriously difficult, and it remains an open question whether this chaotic region, the stochastic sea, has positive Lebesgue measure for any value of \(L\).

I will discuss two related results on a more tractable version of this problem. The first is a kind of ‘finite-time mixing estimate, indicating that for large \(L\) and on a suitable timescale, the dynamics of \(F_L\) is strongly mixing. The second pertains to statistical properties of compositions of standard maps with increasing parameter \(L\): when the parameter \(L\) increases at a sufficiently fast polynomial rate, we obtain asymptotic decay of correlations estimates, a Strong Law, and a CLT, all for Hölder observables.

Lewis Bowen  (University of Texas, Austin)
Pointwise ergodic theorems for hyperbolic groups
Abstract: I’ll explain how to prove a pointwise ergodic theorem for the group \(PSL(2, \mathbb{R})\) using sector (and ball) averages. The proof generalizes to simple rank 1 Lie groups, free groups and other Gromov hyperbolic groups. This is joint work with Amos Nevo.

Clark Butler  (University of Chicago)
Characterizing symmetric spaces by their Lyapunov spectra
Abstract: The Lyapunov spectrum of an invariant measure for a geodesic flow describes the asymptotic exponential growth rates of Jacobi fields along almost every geodesic with respect to this measure. We prove that the geodesic flow of a closed negatively curved locally symmetric space is characterized among nearby smooth flows by the structure of its Lyapunov spectrum with respect to volume. We deduce that these locally symmetric spaces are locally characterized up to isometry by the Lyapunov spectra of their geodesic flows.
Vaughn Climenhaga  (University of Houston)

Leaf measures via dynamical dimensions

Abstract: Given a transitive Anosov diffeomorphism and an equilibrium state $\mu$ for a Hölder potential $\phi$, the conditional measures $\mu^u$ on unstable leaves have the property that $\phi$ governs how they transform under iteration and under stable holonomy. I will discuss the problem of going in the other direction, constructing equilibrium states by first producing leaf measures with the right scaling properties.

When $\phi$ is the geometric potential, leaf volume has the right scaling properties, and $\mu$ is SRB measure. When $\phi = 0$, Margulis produced the appropriate leaf measures and used them to build the measure of maximal entropy. In recent work with Yakov Pesin and Agnieszka Zelerowicz, we used the Pesin-Pitskel’ dimensional characterization of topological pressure to define leaf measures with the appropriate scaling behavior for any Hölder potential. I will describe these leaf measures and how they can be used to write down a formula for the unique equilibrium state associated to a Hölder potential, giving a generalization of Margulis’s result. Applying this result to the geometric potential produces an explicit formula for the SRB measure.

Mark Demers  (Fairfield University)

Hitting times and escape rates

Abstract: We discuss a natural connection between two types of recurrence law: hitting times to shrinking targets, and hitting times to a fixed target (often described as escape through a hole). We show that for systems which mix exponentially fast, one can move through a natural parameter space from one law to the other. On the other hand, if the mixing is subexponential, there is a phase transition between the hitting times law and the escape law. This is joint work with Henk Bruin and Mike Todd.

Changguang Dong  (Pennsylvania State University)

Density of an infinite subset

Abstract: We introduce two types of density property for an infinite subset. One is simply called dense iteration, that is, under a series of iterations, the images of the subset gradually become dense. The other one is quantitative density, which measures the density of the orbits of the infinite subset. Among those results, we will prove that, for any infinite subset of the torus, its images under a sequence of toral automorphisms (in certain subgroups) will become dense. We also consider epimorphic group action on homogeneous spaces, which includes parabolic group action. If time permits, I will also discuss some interesting open questions.
Alena Erchenko  (Pennsylvania State University)

*Flexibility questions in fixed conformal classes*

Abstract: Consider a smooth closed surface $M$ of fixed genus $\geq 2$ with a hyperbolic metric $\sigma$ of total area $A$. In this talk, we will discuss the behavior of some geometric and dynamical characteristics (e.g., diameter, Laplace spectrum, Gaussian curvature and entropies) of nonpositively curved smooth metrics with total area $A$ conformally equivalent to $\sigma$. We also describe the first known example showing that the bottom of the $L^2$-spectrum of the Laplacian cannot be bounded from above by a function of the metric entropy. The results are based on a joint work with Thomas Barthelmé.

Kasun Fernando  (University of Maryland)

*Asymptotic expansions for the Central Limit Theorem for dynamical systems*

Abstract: Statistical properties of dynamical systems including Central Limit Theorem and Local Central Limit Theorems have been studied extensively using spectral techniques. Here we present sufficient conditions that guarantee the existence of asymptotic expansions for the CLT (Edgeworth Expansions) for weakly dependent random variables including observations arising from sufficiently chaotic dynamical systems like piecewise expanding maps and strongly ergodic Markov chains. We primarily use spectral techniques to obtain the results. This is a joint work with Carlangelo Liverani.

Boris Hasselblatt  (Tufts University)

*Contact Anosov flows on 3-manifolds*

Abstract: Foulon surgery produces contact Anosov flows of the same topological type as those of Handel and Thurston and hence different from any algebraic system. On one hand, their larger orbit growth implies rapid orbit growth of any Reeb flow for the same contact structure, and on the other hand recent work by Bishop, Hughes, Vinhage and Yang promises a quantification of the gap between the Liouville and topological entropies.

Osama Khalil  (Ohio State University)

*Birkhoff’s Theorem, sparse equidistribution and translates of measures on homogeneous spaces*

Abstract: Many problems in homogeneous dynamics can be cast in terms of the equidistribution of pushforwards of a non-invariant measure by a sequence of transformations towards the Haar volume measure. We will discuss pointwise refinements of some of these results and connections to sparse equidistribution of unipotent flows and diophantine approximation.
Shahriar Mirzadeh  (Brandeis University)

Dimension estimates for the set of points with non-dense orbit in homogeneous spaces

Abstract: In this talk we study the set of points in a homogeneous space whose orbit escapes the complement of a fixed compact subset. We find an upper bound for the Hausdorff dimension of this set. This extends the work of Kadyrov, where he found an upper bound for the Hausdorff dimension of the set of points whose orbit misses a fixed ball of sufficiently small radius in a compact homogeneous space. We can also use our main result to produce new applications to Diophantine approximation. This is joint work with Dmitry Kleinbock.

Sheldon Newhouse  (Michigan State University)

On a Differentiable Linearization Theorem of Philip Hartman

Abstract: A fixed point $p$ of a $C^1$ diffeomorphism $T$ is called bi-circular if the spectrum of $DT(p)$ lies in two disjoint circles, one of which lies inside the unit circle and the other of which lies outside the unit circle. A well known theorem of Philip Hartman states that if $p$ is a bi-circular fixed point of a $C^{1,1}$ diffeomorphism $T$ on $\mathbb{R}^n$ (continuously differentiable with uniformly Lipschitz derivatives) is $C^1$ linearizable near $p$. We generalize this to the case in which $T$ is $C^{1,a}$ with $0 < a < 1$. That is we only assume the $DT$ is $a$-Hölder rather than Lipschitz. The result holds in Banach spaces with $C^{1,a}$ bump functions and has several interesting applications. Known counter-examples show that the spectral and smoothness conditions are essentially the best possible.

Enrique Pujals  (IMPA, Brazil)

Entropy zero and renormalization for dissipative diffeomorphisms of the disk

Abstract: We consider the diffeomorphisms of the disc satisfying a dissipation assumption. (It includes the dynamics of Hénon diffeomorphisms with Jacobian $< 1/4$.) We describe the dynamics of these systems when the topological entropy vanishes, in particular the structure of the periodic set and its renormalizations.

Victoria Sadovskaya  (Pennsylvania State University)

Lyapunov exponents of cocycles over non-uniformly hyperbolic systems

Abstract: We consider a linear cocycle $\mathcal{A}$ over a non-uniformly hyperbolic dynamical system, i.e. a diffeomorphism $f$ preserving a hyperbolic measure $\mu$. The cocycle takes values in $GL(d, \mathbb{R})$ or, more generally, in the group of invertible bounded operators on a Banach space. In the finite-dimensional case we show that the Lyapunov exponents of $\mathcal{A}$ with respect to $\mu$ can be approximated by the exponents at hyperbolic periodic orbits of $f$. In the infinite-dimensional setting we show that the upper and lower Lyapunov exponents of $\mathcal{A}$ can be approximated in terms of the norms of the periodic return values of $\mathcal{A}$, but not necessarily by the exponents at periodic orbits. We also mention applications to estimating growth of the cocycle. This is joint work with B. Kalinin.
Matthew Smith  (University of Utah)

A condition for unique ergodicity of quadratic differentials

Abstract: A holomorphic quadratic differential on a compact Riemann surface determines a flat Riemannian metric with conical singularities and pair of singular transverse foliations. While these foliations generalize billiard trajectories, they are typically not the trajectories of a translation flow on the surface. We can still ask whether leaves of the foliation equidistribute with respect to the natural volume measure, or if there are other measures for which the leaves equidistribute. By investigating the orbit of the flat metric under the Teichmüller geodesic flow, we obtain a new sufficient condition for unique ergodicity of the natural volume measure.

Yaofeng Su  (University of Houston)

Almost Sure Invariance Principle for sequential intermittent dynamical systems

Abstract: We prove that the Almost Sure Invariance Principles (ASIP), a strong form of approximation by Brownian motion, holds for non-stationary time-series arising as observations on sequential maps possessing a common fixed point, provided the variance grows fast enough. The transformations are obtained by perturbing the slope in the Pomeau-Manneville map. In particular, the ASIP holds for nearby maps in this family and random compositions of these maps. Many statistical properties, such as the Central Limit Theorem and the Law of the Iterated Logarithm, follow from the ASIP.

Domokos Szasz  (Budapest University of Technology and Economics)

Rare interaction limit in a Hamiltonian system

Abstract: I am to report on a project joint with P. Bálint, P. Nándori, I.P. Tóth on the piston model, a more tractable variant of that of Gaspard-Gilbert suggested by them for studying heat transfer. (The dynamics is simplified as compared to the Bunimovich-Liverani-Pellegrinotti-Sukhov chain of elastic balls or discs.) Our goal is to show that – when the geometric parameters of the model are tuned in a such a way that the interactions, i.e. collisions of neighboring particles are more and more rare – then the scaling limit of the energies of the particles is a Markov jump process.
Dan Thompson  (Ohio State University)

*Symbolic dynamics for geodesic flow on CAT(-1) spaces*

Abstract: The geodesic flow on a compact locally CAT(-1) metric space, first studied by Gromov, is a far-reaching generalization of the geodesic flow on a closed negative curvature Riemannian manifold. While one expects these flows to exhibit similar behaviour to the classical case, the lack of smooth structure has been a major obstacle to extending many of the finer aspects of the dynamical theory to this setting. Our new approach to this problem is to show that such geodesic flows are Smale flows.

A Smale flow is a topological flow equipped with a continuous bracket operation which is an abstraction of the local product structure from uniform hyperbolicity. In 1987, Pollicott showed that a version of Bowens construction of symbolic dynamics for Axiom A flows can be extended to this setting. By symbolic dynamics, we mean there exists a suspension flow over a shift of finite type which describes the original dynamics. By taking additional care in the construction, we are able to verify that the roof function can be taken to be Lipschitz in our setting. This is achieved by using carefully chosen geometric rectangles as the building blocks for the construction.

With this additional ingredient, the symbolic dynamics machine switches on and ergodic-theoretic results which are true for Axiom A flows are extended to this setting. For example, we obtain that the Bowen-Margulis measure for the geodesic flow is Bernoulli and satisfies the Central Limit Theorem. This is joint work with Dave Constantine and Jean-Francois Lafont.

Amie Wilkinson  (University of Chicago)

*Density of local accessibility and its consequences*

Abstract: A partially hyperbolic invariant set is *bisaturated* if it consists of whole stable and unstable manifolds. A bisaturated set is *locally accessible* if every two points can be connected by a path along leaves of the two foliations. When the invariant set is the whole manifold, local accessibility coincides with the notion of *accessibility* of a partially hyperbolic diffeomorphism, a property that conjecturally implies ergodicity. Dolgopyat and I proved in 2001 that accessibility holds for a $C^1$ open and dense set of partially hyperbolic diffeomorphisms. I will discuss a generalization of this result to partially hyperbolic sets, which implies in particular that the $C^1$ generic symplectomorphism with positive entropy is ergodic. This is joint work with Avila and Crovisier.

Agnieszka Zelerowicz  (Pennsylvania State University)

*A geometric approach for constructing equilibrium measures for some partially hyperbolic systems*

Abstract: We present a geometric construction of equilibrium states for some partially hyperbolic systems. The key step is to produce an appropriate reference measure on strong unstable manifolds. This reference measure is obtained from a Carathéodory dimension structure via an analogue of the construction of Hausdorff measure. This is joint work with Vaughn Climenhaga and Yakov Pesin.