SCHEDULE OF TALKS

All talks will take place in the synergistic room, 114 McAllister Building.

THURSDAY, October 21
Opening session

12:00 - 1:00  Registration

1:20 - 1:30  Opening Remarks

1:30 - 2:20  Svetlana Jitomirskaya
Eigenvalue statistics for ergodic localization

2:25 - 2:55  Daniel Thompson
Subshift factors of the beta-shift are intrinsically ergodic

3:00 - 3:30  Vaughn Climenhaga
SRB measures for non-uniformly hyperbolic systems

3:30 - 4:00  Departmental Tea

4:00 - 5:00  Department of Mathematics Colloquium

Mikhail Lyubich
Renormalization in the Henon family.

5:15 - 6:05  Marc Chaperon
Generalized Hopf bifurcations
FRIDAY, October 22
Hamiltonian dynamics day

9:30 - 10:20  Alfonso Sorrentino
Aubry-Mather theory and integrability of Hamiltonian systems

10:20 - 10:45 Coffee break

10:45 - 11:15 Joseph Galante
Estimating speed of diffusion in the Restricted Planar Circular 3 Body Problem

11:20 - 12:10 Yong Zheng
Arnold diffusion in apriori unstable systems and applications

12:20 - 2:00 Lunch

2:00 - 2:50 Ke Zhang
Arnold diffusion though normally hyperbolic cylinder

3:00 - 3:30 Jinxin Xue
Continuous averaging proof of the Nekhoroshev theorem

3:30 - 4:00 Coffee break

4:00 - 4:30 Marcel Guardia
An asymptotic formula for the splitting of separatrices of nearly integrable Hamiltonian Systems of one and a half degrees of freedom close to a resonance

4:35 - 5:05 Marian Guidea
Transport along Aubry-Mather sets

5:15 - 6:05 Rafael de la Llave
Whiskered tori in Hamiltonian Lattice Dynamical Systems.

7:00 - 9:30 Banquet
SATURDAY, October 23

9:30 - 10:20  John Smillie  
*The complex Henon family*

10:20 - 10:45  Coffee break

10:45 - 11:35  Giovanni Forni  
*A criterion for the non-uniform hyperbolicity of the Kontsevich–Zorich cocycle*

11:40 - 12:10  Rodrigo Trevino  
*On the Non-Uniform Hyperbolicity of the Kontsevich-Zorich Cocycle for Quadratic Differentials*

12:10 - 2:00  Lunch

2:00 - 2:50  Nessim Sibony  
*Ergodic Theorems for Singular Riemann Surfaces laminations.*

2:55 - 3:45  Aaron Brown  
*Rigidity of measures on the torus*

3:45 - 4:15  Coffee break

4:15 - 5:05  Zhenqi Jenny Wang  
*TBA*

5:15 - 6:05  Viorel Nitica  
*Transitivity of Heisenberg group extensions of hyperbolic systems*

SUNDAY, October 24

9:45 - 10:35  Amadeu Delshams  
*A geometric mechanism of diffusion: Rigorous verification in a priori unstable Hamiltonian systems*

10:45 - 11:35  Leonid Koralov  
*Random and Deterministic Perturbations of Dynamical Systems*

11:45 - 12:35  Leonid Polterovich  
*Analysis and geometry of the Poisson bracket*
ABSTRACTS

Aaron Brown (Tufts). Rigidity of measures on the torus

Abstract. We discuss the structure of the group of measure preserving diffeomorphisms for families of singular measures on the torus. In particular, for large families of measures invariant under an Anosov diffeomorphism, we show that the group of measure preserving diffeomorphisms is essentially cyclic.

Marc Chaperon (Paris, Jussieu). Generalized Hopf bifurcations

Abstract. This is joint work with Santiago Lopez de Medrano (UNAM, Mexico). Following Thom’s principle: ”Always look for the organizing center of phenomena”, we were able to prove a general ”birth lemma” for families of dynamical systems at partially elliptic rest points; it implies the birth of normally hyperbolic compact invariant manifolds diffeomorphic to all kinds of so-called moment-angle manifolds in generic families; these manifolds can form a family of matroshkas, providing for example a very simple model for the transition between two periodic regimes.

Vaughn Climenhaga. SRB measures for non-uniformly hyperbolic systems

Abstract. We describe a general procedure for constructing SRB measures, which is well-suited to the case of non-uniform hyperbolicity. This procedure can be carried out for maps with measurable cone families satisfying a certain asymptotic condition, without assuming the existence of a dominated splitting or other uniform geometric structure. There are examples where such uniform structures are not present but where our methods yield the existence of an SRB measure. (This is joint work with D. Dolgopyat and Ya. Pesin.)

Amadeu Delshams (Univ Polytecnica Catalunia). A geometric mechanism of diffusion: Rigorous verification in a priori unstable Hamiltonian systems

Abstract. We consider a representative a priori unstable Hamiltonian system with 2+1/2 degrees of freedom, to which we apply the geometric mechanism for diffusion, and provide explicit, concrete and easily verifiable conditions for the existence of diffusing orbits. The simplification of the hypotheses allows us to perform explicitly the computations along the proof, which contribute to present in an easily understandable way the geometric mechanism of diffusion. In particular,
we fully describe the construction of the scattering map and the combination of two types of dynamics on a normally hyperbolic invariant manifold.


**Giovanni Forni** (Maryland). *A criterion for the non-uniform hyperbolicity of the Kontsevich–Zorich cocycle*

*Abstract* The Rauzy-Veech-Zorich cocycle and its continuous-time counterpart, the Kontsevich–Zorich cocycles, is a fundamental ‘renormalization’ tool in the study of the dynamics of interval exchange transformations and conservative flows on higher genus surfaces with saddle-like singularities. Kontsevich and Zorich conjectured that the Lyapunov spectrum of the cocycle with respect to the canonical volumes on the strata of the space of abelian holomorphic differentials is simple, in particular all Lyapunov exponents are non-zero (the cocycle is symplectic). This conjecture was proved by Avila-Viana (2007) after we had proved the non-uniform hyperbolicity (2002). In this talk we develop our work to give a rather simple criterion for the non-uniform hyperbolicity of the Kontsevich–Zorich cocycle with respect to a large class of SL(2,R) invariant measures on the moduli space of abelian differentials. We will discuss the power and the limits of the criterion by presenting several examples. In short, the criterion accounts for all know cases of non-uniform hyperbolicity of the cocycle, some of them discovered earlier (Moeller, Eskin–Kontsevich–Zorich, Carlos Matheus), some other new, including cases when the spectrum is not simple. The most interesting new application is the proof by Rodrigo Trevino of the non-uniform hyperbolicity for strata of quadratic differentials.

**Joseph Galante** (Maryland). *Estimating speed of diffusion in the Restricted Planar Circular 3 Body Problem*

*Abstract* We consider the dynamics of a Sun-Jupiter-Comet system and under some simplifying assumptions, construct a variational principle to show the existence of instabilities for orbit of the comet. The explicit construction utilizes methods in the spirit of Mathers results as well as computer assistance to provide concrete estimates. The technique allows us to estimate the speed of diffusion of comets, i.e. come up with a realistic lower bound on time it takes a certain class of comets to exit the Solar system. This work relies on results from joint papers with V. Kaloshin which prove that diffusion is possible in the regime we consider.
Marian Gidea (Northeastern Illinois University). Transport along Aubry-Mather sets

Abstract. We describe some topological mechanism for transport along Aubry-Mather sets in conservative systems. We apply this mechanism to the Arnold instability problem in Hamiltonian systems.

Marcel Guardia (PSU). An asymptotic formula for the splitting of separatrices of nearly integrable Hamiltonian Systems of one and a half degrees of freedom close to a resonance

Abstract. We consider nearly integrable Hamiltonian Systems of one and a half degrees of freedom close to a simple resonance. It is a well known fact that generically in the resonance there appear hyperbolic periodic orbits whose stable and unstable invariant manifolds intersect transversally. Nevertheless, the transversality of this intersection is exponentially small with respect to the perturbation parameter and, therefore, Melnikov Theory cannot be applied to obtain quantitative measures of this splitting. In this talk we provide an asymptotic formula for the splitting, which generically differs from what Melnikov Theory predicts.

Svetlana Jitomirskaya (UC Irvine). Eigenvalue statistics for ergodic localization

Abstract. so far eigenvalue statistics for Schrodinger operators with pure point spectrum have been studied and proved only in case of random potentials. In the talk I will describe and sketch a proof of the first deterministic result in this direction (joint with A. Avila) and discuss some numerical evidence towards a conjecture on what the distribution is in the general ergodic situation.

Leonid Koralov (Maryland). Random and Deterministic Perturbations of Dynamical Systems.

Abstract. We study deterministic and stochastic perturbations of incompressible flows. Even in the case of purely deterministic perturbations, the long-time behavior of such systems can be stochastic, in a certain sense. The stochasticity is caused by the instabilities near the saddle point of the non-perturbed system as well as by the ergodic components of the flow.

Rafael de la Llave (Texas at Austin). Whiskered tori in Hamiltonian Lattice Dynamical Systems.
Mikhail Lyubich (Stony Brook). Renormalization in the Henon family.

Abstract. One of the most remarkable phenomena in one-dimensional dynamics is the parameter and dynamical Universality observed in the cascades of doubling bifurcations. Such cascades are also observed in strongly dissipative two-dimensional Henon-like families. However, the 2D picture turns out to be much more subtle than its 1D counterpart. We will describe it in the talk (based on a joint work with Marco Martens).

Viorel Nitica (West Chester University). Transitivity of Heisenberg group extensions of hyperbolic systems

Abstract. We show that among $C^r$ extensions ($r > 0$) of a uniformly hyperbolic dynamical system with fiber the standard real Heisenberg group $H_n$ of dimension $2n + 1$, those that avoid an obvious obstruction to topological transitivity are generically topological transitive. Moreover, if one considers extensions with fiber a connected nilpotent Lie group with compact commutator subgroup (for example, $H_n/Z$), among those that avoid the obvious obstruction, topological transitivity is open and dense.

This is joint work with I. Melbourne and A. Torok

Leonid Polterovich (University of Chicago). Analysis and geometry of the Poisson bracket

Abstract. The Poisson bracket is a basic operation on Hamiltonian functions of classical mechanics. In spite of the fact that this operation involves derivatives, it possesses certain robustness properties with respect to perturbations in the uniform norm. It turns out that the origins of this seemingly analytic phenomenon lie in the geometry of the group of symplectic diffeomorphisms. The talk is based on joint works with Michael Entov.

Nessim Sibony (Orsay, visiting University of Michigan, Ann Arbor). Ergodic Theorems for Singular Riemann Surfaces laminations.

Abstract. Consider the polynomial differential equation in $\mathbb{C}^2$

$$\frac{dz}{dt} = P(z, w), \quad \frac{dw}{dt} = Q(z, w).$$

The polynomials $P$ and $Q$ are holomorphic, the time is complex. We want to study the global behavior of the solutions. It is convenient to consider the extension as a foliation in the projective plane $P^2$. There are however singular points. Generically on the vector field, there is no invariant line and even no invariant algebraic surface as shown
by Jouanolou. This example is a special case of a lamination (with singularities) by Riemann Surfaces. In particular, one can consider similar questions in any number of dimensions.

In order to understand their dynamics we need some analysis on such objects.

We will discuss the following topics.

1. Harmonic currents ($\partial \overline{\partial}$ closed currents) directed by the lamination.

2. Heat equation on a lamination. The directed $\partial \overline{\partial}$ closed current replaces the manifold and we solve the heat equation with respect to the current or harmonic measure.

3. Geometric ergodic theorems. For compact Riemann surface laminations with singularities we get an ergodic theorem with more geometric flavor than the ones associated to a diffusion. Let $(X, \mathcal{L}, E)$ be a lamination by Riemann surfaces. Assume for simplicity that the singularity set $E$ of $\mathcal{L}$ is a finite set of points. Then every hyperbolic leaf $L$ is covered by the unit disc $\Delta$. Let $\phi_a : \Delta \rightarrow L_a$ denote a universal covering map of the leaf $L_a$ passing through $a$ with $\phi_a(0) = a$. We consider the associated measure

$$m_{a,R} := \frac{1}{M_R} (\phi_a)_* \left( \log^+ \frac{r}{|\zeta|} \omega_P \right) \quad \text{with} \quad R := \log \frac{1 + r}{1 - r},$$

which is obtained by averaging until “hyperbolic time” $R$ along the leaves. Here, $M_R$ is a constant to normalize the mass. Recall that $\omega_P$ denotes the Poincaré metric on $\Delta$ and also on the leaves of $X$. The main result is the following.

**Theorem.** Let $(X, \mathcal{L}, E)$ be a compact lamination with isolated singularities in a complex manifold $M$ and $\omega_P$ the Poincaré metric on the leaves. Let $T$ be an extremal positive harmonic current of Poincaré mass 1 on $(X, Lc, E)$ without mass on the union of parabolic leaves. Then for almost every point $a \in X$ with respect to the measure $m_P := T \wedge \omega_P$, the measure $m_{a,R}$ defined above converges to $m_P$ when $R \rightarrow \infty$.

This is joint work with T.C Dinh and V.A Nguyen.

For holomorphic foliations in in the projective plane $\mathbb{P}^2$, with only hyperbolic singularities and without algebraic leaves (this is the generic case) it was shown by J.-E. Fornaess and the author that one has unique ergodicity ,i.e., there is a unique $\partial \overline{\partial}$-closed current, of mass one,
directed by the foliation. So the weighted averages considered above have a unique limit.

**John Smillie** (Cornell). *The complex Henon family*

Abstract. I will review some work on the dynamics of complex Henon maps and describe some new directions for research.

**Alfonso Sorrentino** (Cambridge). *Aubry-Mather theory and integrability of Hamiltonian systems*

**Dan Thompson** (PSU). *Subshift factors of the beta-shift are intrinsically ergodic*

Abstract. This talk is based on joint work with Vaughn Climenhaga (Maryland), in which we show that every subshift factor of a $\beta$-shift has a unique measure of maximal entropy. This provides an affirmative answer to Problem 28.2 of Mike Boyle’s article ‘Open problems in symbolic dynamics’. I’ll explain the problem and its relation to existing results and give some idea of how our approach works. I’ll also discuss some other examples of symbolic spaces where our technique can be applied.

**Rodrigo Trevino** (Maryland). *On the Non-Uniform Hyperbolicity of the Kontsevich-Zorich Cocycle for Quadratic Differentials*

Abstract. Using a recently-developed criterion of Forni (see his talk previous to this one) applied to measures on the moduli space of Abelian differentials supported on points coming from quadratic differentials by a standard, double cover construction, we can prove that the Kontsevich-Zorich cocycle is non-uniformly hyperbolic for this measure. I will discuss applications to the study of deviations in homology of typical leaves of the corresponding non-orientable foliations as well as applications to the study of deviations of ergodic averages, which exhibit phenomena different from the Abelian case.

**Jinxin Xue** (Maryland, visiting PSU). *Continuous averaging proof of the Nekhoroshev theorem*

Abstract.

In this work, Treschev’s continuous averaging is applied to the proof of the Nekhoroshev theorem. The method gives a sharp stability constant $C_2$. This is the first time that the continuous averaging is applied to the simultaneous Diophantine approximation.
Ke Zhang (Toronto). Arnold diffusion through normally hyperbolic cylinder

Abstract. For Hamiltonian systems with $n^{\frac{1}{2}}$ degrees of freedom, using normally hyperbolic structure, we prove that for a “typical perturbation $\epsilon H_1$ the action variable exhibits diffusion for a distance $l(H_1)$ that depends on $H_1$, but is independent of $\epsilon$. Furthermore, we show that for large probability on a class of parameters, the distance of diffusion is uniform and make quantitative estimates on the distance as a function of smoothness $r$ and dimension $n$. This is joint work with Patrick Bernard and Vadim Kaloshin.

Yong Zheng (Maryland). Arnold diffusion in apriori unstable systems and applications

Abstract. Consider a convex time-periodic Hamiltonian system, $H_\epsilon(\theta, x, I, y, t) = h_0(I) + h_1(x, y) + \epsilon P(\theta, x, I, y, t)$, where $(\theta, I) \in \mathbb{T} \times \mathbb{R}$ and $(x, y) ? \mathbb{T}^n \times \mathbb{R}^n$, $t \in \mathbb{T}$. Let $F_\epsilon$ be the time one map of the ow of $H_\epsilon$. We assume that

- $F_\epsilon$ has a normally hyperbolic invariant manifold, denoted $\Lambda_\epsilon$.
- its stable manifold intersects unstable manifold intersect transversally: $W^s(\Lambda_\epsilon) \cap W^u(\Lambda_\epsilon)$. The restriction of $F_\epsilon$ onto $\Lambda_\epsilon$ denes a so-called inner map $F^{in}_\epsilon$. Using stable and unstable manifolds $W^s(\Lambda_\epsilon)$ and $W^u(\Lambda_\epsilon)$ respectively one can dene a so-called scattering map $S : \Lambda_\epsilon \rightarrow \Lambda_\epsilon$ following Delshams-de la Llave-Seara. The main results of this paper are:
  - For any non-contractible invariant curve $\Gamma \subset \Lambda_\epsilon$ of the inner map $F^{in}_\epsilon$, if $\Gamma \neq S(\Gamma)$, then there is Arnold diffusion.
  - Apply this result to the planar ve-body problem considered by Moeckel.