Dynamics Students Days 2025

March 31 - April 3, 2025

About the Meeting

A meeting for students working in all areas of Dynamical Systems to present and discuss their research, among themselves and with the advisors who attend the meeting.

Organizers

Dmitry Dolgopyat, UMD

Spencer Durham, UMD

Bassam Fayad, UMD

Enrique Pujals, CUNY

Speakers

Keagan Callis, Georgia Tech

Emma Dinowitz, CUNY

Reuben Drogin, Yale University

Spencer Durham, UMD

Wentao Fan, Tufts University

Axel Kodat, CUNY

Lukasz Krzywon, University of Houston

Gabriel Lucas Lacerda de Araujo, UFRJ

Amadeus Maldonado, Northwestern University

Thomas O'Hare , Ohio State University

Otto Vaughn Osterman, UMD

James Marshall Reber, Ohio State University

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BRIN MATHEMATICS RESEARCH CENTER

DEPARTMENT OF MATHEMATICS

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Contents

Schedule at a Glance

	Monday	Tuesday	Wednesday	Thursday
9:00				
	Breakfast	Breakfast	Breakfast	Breakfast
10:00	Reber	Maldonado	Durham	Drogin
11:00	Coffee Break	Coffee Break	Coffee Break	Coffee Break
	Osterman	Fan	Krzywon	Paik
12:00				
	Lunch	Lunch	Lunch	Lunch
13:00				
14:00	O'Hare	Kodat	Lacerda de Araujo	
15:00	Coffee Break	Coffee Break	Coffee Break	
	Free Discussion	Dinowitz	Free Discussion	
16:00				
17:00				
18:00				

Workshop Overview

A meeting for students working in all areas of Dynamical Systems to present and discuss their research, among themselves and with the advisors who attend the meeting.

Organizing committee

Dmitry Dolgopyat University of Maryland

Spencer Durham University of Maryland

Bassam Fayad, University of Maryland

Enrique Pujals, University of Maryland

Workshop Schedule

Monday, March 31, 2025

9:30 - 10:00	Breakfast
10:00 - 11:00	James Marshall Reber (Ohio State University) *Dominated Splittings and Conjugate Points of Thermostats*
11:00 - 11:30	Coffee Break
11:30 - 12:30	Otto Vaughn Osterman (University of Maryland) *Stable Motions in the Planar Circular Restricted 3-Body Problem*
12:30 - 2:00	Lunch
2:00 - 3:00	Thomas O'Hare (Ohio State University) *Finite Periodic Data Rigidity For Two-Dimensional Area-Preserving Anosov Diffeomorphisms*
3:00 - 3:30	Coffee Break
3:30 - 4:30	Free Discussion

Tuesday, April 1, 2025

9:30 - 10:00	Breakfast
10:00 - 11:00	Amadeus Maldonado (Northwestern University) *Exponentially Mixing SRB Measures are Bernoulli*
11:00 - 11:30	Coffee Break
11:30 - 12:30	Wentao Fan (Tufts University) *Lemon Billiards, Uniform Hyperbolicity and Ergodicity*
12:30 - 2:00	Lunch
2:00 - 3:00	Axel Kodat (City University of New York) *Generalized Entropy of Density Subshifts*
3:00 - 3:30	Coffee Break
3:30 - 4:30	Emma Dinowitz (City University of New York) *Dimension of Lyapunov Spectrum for Non Uniformly Hyperbolic Settings*

Wednesday, April 2, 2025

9:30 - 10:00 Breakfast

10:00 - 11:00 Spencer Durham (University of Maryland)
The Cohomological Equation and KAM Rigidity for Parabolic Actions

11:00 - 11:30 Coffee Break

11:30 - 12:30 Lukasz Krzywon (University of Houston)
Adapted Measures for Markov Interval Maps

12:30 - 2:00 Lunch

2:00 - 3:00 Gabriel Lucas Lacerda de Araujo (Universidade Federal do Rio de Janeiro)
Complexity and Dimension of Induced Dynamical Systems

3:00 - 3:30 Coffee Break

3:30 - 4:30 Free Discussion

Thursday, April 3, 2025

9:30 - 10:00 Breakfast

10:00 - 11:00 Reuben Drogin (Yale University)
Lyapunov Exponents of Large Transfer Matrices

11:00 - 11:30 Coffee Break

11:30 - 12:30 Joshua Paik (Penn State)

12:30 - 2:00 Lunch

Abstracts of talks

Dominated Splittings and Conjugate Points of Thermostats

James Marshall Reber

Ohio State University

Monday, March 31, 2025 @ 10:00 AM

A thermostat is a model for the motion of a particle on a surface under the influence of some force which is perpendicular to the velocity. These systems generalize the dynamics of magnetic flows and geodesic flows, allowing for dissipative dynamics to appear. While this class of flows allows for more complicated dynamics, we discuss how one can recover many results about geodesic flows on a surface by using appropriate coordinates on the cotangent bundle, provided Anosov is replaced with dominated splitting. We then show how this new flexibility leads to interesting examples on the torus. This is joint work with Javier Echevarra Cuesta.

Stable Motions in the Planar Circular Restricted 3-Body Problem

Otto Vaughn Osterman

University of Maryland

Monday, March 31, 2025 @ 11:30 AM

We consider the planar circular restricted three-body problem, modeling the motion of a massless asteroid in the plane undergoing gravitational attraction toward two bodies, each of which moves in a circular path around their common center of mass. For small mass ratios, the motion of the asteroid is approximated by the Kepler problem when the asteroid is far from a collision. In this case, a large set of Kepler motions in which the paths of the asteroid and the smaller body do not intersect persist as quasi-periodic motions in the perturbed system. However, these quasi-periodic motions with incommensurable frequencies are not possible for Kepler motions in which the paths intersect due to the potential for close interactions between the asteroid and the smaller body. The existence of hyperbolic sets in which the asteroid repeatedly comes close to a collision was proven independently by Bolotin and MacKay and by Font, Nunes, and Simo. My result, currently in preparation, is that there also exists stable motions of the asteroid near resonant Kepler orbits in which the asteroid repeatedly undergoes close interactions with the smaller body.

Finite Periodic Data Rigidity For Two-Dimensional Area-Preserving Anosov Diffeomorphisms

Thomas O'Hare

Ohio State University

Monday, March 31, 2025 @ 2:00 PM

Let f, g be C^2 area-preserving Anosov diffeomorphisms on $\mathbb{T}^2$ which are topologically conjugated by a homeomorphism h. It was proved by de la Llave in 1992 that the conjugacy h is automatically C^{1+} if and only if the Jacobian periodic data of f and g are matched by h for all periodic orbits. We prove that if the Jacobian periodic data of f and g are matched by h for all points of some large period $N \in \mathbb{N}$, then f and g are "approximately smoothly conjugate." That is, there exists a a $C^{1+\alpha}$ diffeomorphism $\overline{h}_N$ that is exponentially close to h in the C^0 norm, and such that f and $f_N := \overline{h}_N^{-1} \circ g \circ \overline{h}_N$ is exponentially close to f in the C^1 norm.

Exponentially Mixing SRB Measures are Bernoulli

Amadeus Maldonado

Northwestern University

Tuesday, April 1, 2025 @ 10:00 AM

The Bernoulli property is the strongest statistical property that a measure preserving system can exhibit. It not only implies other important statistical properties such as ergodicity, mixing and the K-property, but, as shown by Ornstein, Bernoulli systems with the same entropy are measurably conjugate. We prove that, for $C^{1+\alpha}$ diffeomorphisms of compact manifolds, exponentially mixing SRB measures are Bernoulli. This extends a recent result by Dolgopyat, Kanigowski and F. Rodriguez Hertz. Using similar techniques, we also show that if volume is almost exponentially mixing, then the limit SRB measure constructed by Ben Ovadia and F. Rodriguez Hertz is Bernoulli.

Lemon Billiards, Uniform Hyperbolicity and Ergodicity

Wentao Fan

Tufts University

Tuesday, April 1, 2025 @ 11:30 AM

Asymmetric Lemon Billiard is a type of Billiards which strongly violates the Wojtkowski condition thus not a Wojtkowski Billiard. In 2013, Bunimovich, Zhang, Zhang pioneered the study of Lemon Billiards' hyperbolicity. In 2021, Jin, Zhang proved a condition for Lemon billiards to have hyperbolicity for a section return map thus for the collision map itself. The talk will come across the earlier results by Bunimovich, Hong-kun Zhang, Xin Jin and Pengfei Zhang. In their found/proved Wojtkowski invariant cone and conclusions, with the tools by Chernov and Markarian, it will be shown there is a uniform expansion for the Lemon Billiard section return map. And given the uniform expansion and new conclusions, the return map singularity curves satisfy the Sinai-Chernov's conditions of local ergodicity. This is a joint work with Boris Hasselblatt.

Generalized Entropy of Density Subshifts

Axel Kodat

City University of New York

Tuesday, April 1, 2025 @ 2:00 PM

In this talk we answer a question of Correa and Pujals by exhibiting a simple family of subshifts with strictly superpolynomial yet subexponential generalized entropy. We investigate the topological and measurable dynamics of these examples and address the smooth realization question by embedding them inside smooth diffeomorphisms of the 3-sphere with controllable generalized entropy in the wandering set. Finally, we discuss how these examples relate to the problem of formulating a variational principle applicable to generalized entropy.

Dimension of Lyapunov Spectrum for Non Uniformly Hyperbolic Settings

Emma Dinowitz

City University of New York

Tuesday, April 1, 2025 @ 3:30 PM

We study the Hausdorff dimension of the set of points with a fixed lyapunov exponent inside a family of subsets of a 3 dimensional flow with non uniform hyperbolicity properties. Recent work of Sarig, Lima, and others have constructed countable state markov partitions modeling these sets. Using their framework we prove upper bounds analogous to the uniformly hyperbolic situation.

The Cohomological Equation and KAM Rigidity for Parabolic Actions

Spencer Durham

University of Maryland

Wednesday, April 2, 2025 @ 10:00 AM

The cohomological equation is of primary interest in dynamical systems. Solving the cohomological equation is the key to a dynamical cohomology theory that is interesting in its own right, and it also has applications to Livoic type theorems and KAM conjugacy schemes. We examine the case of the cohomological equation over a single affine parabolic action and show an optimal limit on the loss of regularity that the solution may exhibit when it exists. We use similar techniques to show that the cohomological equation over an affine parabolic $\mathbb{Z}^2$-action always has a solution, and in some cases has an even better limit on the loss of regularity than the rank one case. Finally, we discuss applications to the question of local rigidity of such actions and show that while no KAM type rigidity theorem holds for finite regularity, there is one in the smooth category. This is joint work with Bassam Fayad.

Adapted Measures for Markov Interval Maps

Lukasz Krzywon

University of Houston

Wednesday, April 2, 2025 @ 11:30 AM

Adapted invariant measures, such as the natural area measure (Liouville), have a central place in the development of the ergodic theory for billiards. These measures ensure local Pesin charts may be constructed almost everywhere even in the nonuniformly hyperbolic setting. Recently, for Sinai billiards satisfying certain conditions, the unique measure of maximal entropy has been shown to be adapted. However, not all positive entropy measures are. To investigate the connection between entropy and adaptedness, I will discuss Markov interval maps with exactly one singularity. I will show that a condition relating the entropy of the map and the strength of the singularity determines if the measure of maximal entropy is adapted. I will also show that under a Holder condition, recurrence of the singularity is necessary to have nonadapted invariant measures.

Complexity and Dimension of Induced Dynamical Systems

Gabriel Lucas Lacerda de Araujo

Universidade Federal do Rio de Janeiro

Wednesday, April 2, 2025 @ 2:00 PM

In order to study the statistical properties of a collection of points in phase space under the action of a dynamical system, one can consider the measure-induced map given by the push-forward of a probability measure. In this talk, we will explore different approaches to studying collective dynamics, both in the measure-theoretic and topological sense, a line of research that began with the work of W. Bauer and K. Sigmund in the 1970s. Specifically, these maps, known as induced dynamical systems, act on an infinite-dimensional compact metric space. The goal is to discuss some notions of complexity and dimensionality, such as generalized entropy and mean dimension, in the context of these induced maps and, through some original results, conclude that the current tools for describing their properties are not yet the best possible.

Lyapunov Exponents of Large Transfer Matrices

Reuben Drogin

Yale University

Thursday, April 3, 2025 @ 10:00 AM

We show that the top Lyapunov exponent of "sufficiently random" $N \times N$ transfer matrices is universal, in the sense that as N goes to infinity the top Lyapunov exponent converges to a deterministic limit. We explicitly compute the deterministic limit and give a quantitative rate of convergence in N.

TBD

Joshua Paik

Penn State

Thursday, April 3, 2025 @ 11:30 AM

The Brin Mathematics Research Center

The Brin Mathematics Research Center is a research center that sponsors activity in all areas of pure and applied mathematics and statistics. The Brin MRC was funded in 2022 through a generous gift from the Brin Family. The Brin MRC is part of the Department of Mathematics at the University of Maryland, College Park.

Activities sponsored by the Brin MRC include long programs, conferences and workshops, special lecture series, and summer schools. The Brin MRC provides ample opportunities for short-term and long-term visitors that are interested in interacting with the faculty at the University of Maryland and in experiencing the metropolitan Washington DC area.

The mission of the Brin MRC is to promote excellence in mathematical sciences. The Brin MRC is home to educational and research activities in all areas of mathematics. The Brin MRC provides opportunities to the global mathematical community to interact with researchers at the University of Maryland. The center allows the University of Maryland to expand and showcase its mathematics and statistics research excellence nationally and internationally.

List of Participants

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