2016 MWDS – TITLES AND ABSTRACTS

- **Leonid Bunimovich:** Finite Time Dynamics

We were taught that only asymptotic-in-time properties of dynamics of "complex" systems can be studied and understood. In fact all characteristics of such systems in use employ either taking limit when time tends to infinity, or integration over infinite time interval. It turns out that finite time dynamics of strongly chaotic, and of random systems has interesting qualitative features.

- **Tomasz Downarowicz:** Symbolic extension with an embedding

Given a dynamical system (X, T), we are interested in symbolic extensions $\pi : (Y, S) \to (X, T)$ (where (Y, S) is a subshift – this is the essence of the extension being *symbolic*) which contains an *embedding*, i.e., an equivariant selector from preimages: $\psi : X \to Y$ with $\pi \circ \psi = \mathrm{id}_X$. Of special interest is how the structure of periodic points in (X, T) affects the entropy function of any possible such an extension.

This is joint work with David Burguet (Paris).

- **Alex Furman:** Simplicity of the Lyapunov spectrum via Boundary theory

Consider products of matrices in $G = SL(d, R)$ that are chosen using some ergodic dynamical system. The Multiplicative Ergodic Theorem (Oseledets) asserts that the asymptotically such products behave as $\exp(n\Lambda)$ where Λ is a fixed diagonal traceless matrix, called the Lyapunov spectrum of the system.

The spectrum Λ depends on the system in a mysterious way, and is almost never known explicitly. The best understood case is that of random walks, where by the work of Furstenberg, Guivarc'h-Raugi, and Gol'dsheid-Margulis we know that the spectrum is simple (i.e. all values are distinct) provided the random walk is not trapped in a proper algebraic subgroup. Recently, Avila and Viana proved a conjecture of Kontsevich-Zorich that asserts simplicity of the Lyapunov spectrum for another system related to the Teichmuller flow.

In the talk we shall describe an approach to proving simplicity of the spectrum based on ideas from boundary theory that were developed to prove rigidity of lattices. Based on joint work with Uri Bader.

- **Joanna Furno:** Rational Families Converging to an Exponential Family of Maps

There are several examples in the literature of polynomial families that converge uniformly on compact sets to exponential families. In joint work with Jane Hawkins and Lorelei Koss, we study the parameters spaces and limiting dynamics of a family of rational functions that converges to an exponential family. This exponential family contains parameters for which the Fatou set is empty. Since rational functions can have an empty Fatou set but polynomials cannot, this approximation by rational functions is, in a sense, more natural than previous approximations by polynomials.

- **Pat Hooper:** Refraction in the trihexagonal tiling

I will discuss the dynamics of light rays in the trihexagonal tiling in the plane where triangles and hexagons are transparent and have equal but opposite indices of refraction. It turns out that almost every light ray is dense in the plane with a periodic family of disjoint open triangles removed.

The proof involves some elementary observations about invariant subspaces, an orbit equivalence to straight-line flow on an infinite periodic translation surface, and use of relatively recent results on ergodic theoretic questions for such flows. Most of the talk will be elementary. This talk is based on joint work with Diana Davis and is available at `arXiv:1609.00772`.

◦ **Kathryn Lindsey:** Fekete polynomials and shapes of Julia sets

Which planar shapes are totally approximable by polynomial Julia sets? Previously, I found that every Jordan curve could be approximated. However, in recent joint work with M. Younsi, we discovered how to approximate more complicated shapes by polynomial Julia sets. We found a simple classification of the sets that are totally approximable by filled Julia sets. In particular, there exists a polynomial whose filled Julia set spells out your name (with the "holes" of the letters filled in).

◦ **Olga Lukina:** Molino theory for laminations

A foliation of a compact manifold can be considered as a generalized dynamical system, in the sense of Smale. The study of the dynamical properties of foliations has been an active area of research for the past 40 years. A smooth foliation is Riemannian, if the normal bundle of the foliation admits a Riemannian metric invariant under the action of the holonomy pseudogroup of the foliation. Riemannian foliations are very rigid geometric structures, and they are completely classified by Molino theory.

Ghys asked in 1988 whether Molino theory can be generalized to a topological setting. In this setting, one considers foliations of compact topological spaces, which do not admit normal bundles, and where the transversals need not be locally connected. The condition analogous to the existence and invariance of a Riemannian metric in this non-differentiable setting, is the assumption of equicontinuity of the holonomy pseudogroup of the foliation. Alvarez Lopez, Candel, and Moreira Galicia gave a version of a Molino-like theory for foliated spaces under the additional assumption that the closure of the holonomy pseudogroup is strongly quasi-analytic, that is, it satisfies the condition of local generation.

In this talk, we consider foliated spaces with totally disconnected transversals, which we call matchbox manifolds, and use the methods of topological dynamics and continuum theory to develop a Molino-like classification of all such spaces. We show that for matchbox manifolds, the Molino sequence need not be well-defined, and specify the conditions under which it is well-defined. We outline the classes of matchbox manifolds, for which the local generation condition holds or does not hold, and study other properties of these spaces. Inspired by the result of Lubotzky about the existence of torsion in profinite completions of torsion-free groups, we construct a class of examples with well-defined non-trivial Molino sequences, where the non-triviality of the Molino sequence cannot be explained by the holonomy properties of leaves in the matchbox manifold. The examples that we construct and study show that this class of dynamical systems is far from being completely classified.

◦ **Kevin Pilgrim:** Energies of graph maps and a positive characterization of expanding rational maps

A rational map f defines a dynamical system on the Riemann sphere; its chaotic locus is called the Julia set, $J(f)$. If f is expanding on $J(f)$, then for all sufficiently small ϵ, the restriction of f to an ϵ-neighborhood of $J(f)$ looks like a map between planar graphs. This leads to a new, positive characterization of expanding rational maps among topological self-branched covers: a topological map is equivalent to a rational map if and only if there exists an associated graph map for which a certain energy is less than one. Ingredients in the proof include novel graph map energies, relating extremal length on surfaces to similar quantities on graphs, standard quasiconformal surgery, and a characterization of when one compact Riemann surface with boundary conformally embeds inside another. The fact that this is a positive criterion suggests a new algorithm for the decidability of rationality among such topological maps.

The general program is due to Dylan Thurston, with portions joint with Jeremy Kahn, Dylan Thurston, and myself.

◦ **Samuel Roth:** Lipschitz continuity in topological dynamics on the interval

How can we interpret the infimum of Lipschitz constants in a conjugacy class of interval maps? For positive entropy maps, the exponential of the topological entropy gives a well-known lower bound. We show that for piecewise monotone maps, these two quantities are equal, but for countably piecewise monotone maps, the inequality can be strict. Moreover, in the transitive and Markov case, we characterize the infimum of Lipschitz constants as the exponential of the Salama entropy of a certain reverse Markov chain associated with the map. Dynamically, this number represents the exponential growth rate of the number of iterated preimages of nearly any point.

Schedule

Friday

3:00pm *Colloquium refreshments*
4:00pm Bunimovich

Saturday

9:00am *Refreshments*
10:00am Roth
11:00am Downarowicz
12:00pm *Lunch break*
2:00pm Furno
3:00pm Lukina
4:00pm *Coffee break*
4:30pm Furman
6:00pm *Reception/Poster session*

Sunday

9:00am *Refreshments*
9:30am Hooper
10:30am Lindsay
11:30am *Coffee break*
12:00pm Pilgrim

Event Locations

(refer to map in the back)

- Friday Reception at 3pm in the atrium of the new science building **EL**.
- Friday Colloquium at 4pm in room **LD-010**.
- Saturday and Sunday talks in room **BS-2000** of the Business School.
- Reception/poster session at University Tower **HO**.

Other Information

- **Parking:** Please park at the Gateway garage, and bring your ticket to us.
- **WiFi:** Connection for guests is provided through `attwifi`. Connect to the server and accept the terms and conditions (if you are not automatically redirected, open the URL `192.168.1.1` in your browser)
- **Marathon:** Some streets will be closed to foot traffic on Saturday morning. Please refer to the marathon map, and provide ample time to arrive in campus.
- **Time change:** Remember that daylight saving time end this weekend!