ERGODIC THEORY, ALGORITHMS AND RIGOROUS COMPUTATIONS
APRIL 3 - 7, 2017

All talks will take place in the Zeeman Building, room B3.03

	Monday	Tuesday	Wednesday	Thursday	Friday
9:00	Demers (1)	Baladi (1)	Liverani (1)	Gottwald (1)	Sharp (1)
10:00	Tea Break	Tea Break	Tea Break	Tea Break	Lopes (1)
10:30	Todd (1)	Dellnitz (1)	Guihéneuf (1)	Thieullen (1)	
11:30	Discussions	Discussions	Discussions	Nisoli (1/2)	
12:00	Lunch	Lunch	Lunch	Lunch	
14:00	Pène (1)	Vytnova (1)	Tucker (1)	Melbourne (1)	
15:00	Froyland (1)	González-Tokman (1)	Gouëzel (1)	Jenkinson (1)	
16:00	Discussions	Discussions	Discussions	Discussions	
17:00	Discussions	Discussions	Discussions	Discussions	
18:00	Reception+Posters Common Room	Dinner Scarman	Dinner Coombe Abbey	Dinner Scarman	

Notes: (1):= 50 minutes; (1/2) := 25 minutes.

Titles and Abstracts

Viviane Baladi, IMJ-PRG, CNRS

Title: Linear response for discontinuous observables

Abstract: Linear response formulas describe how the physical measure of a dynamical system reacts to perturbations of the dynamics. For hyperbolic dynamics, linear response is usually stated for differentiable observables only. Discontinuous observables involving thresholds (Heaviside functions) appear naturally in extreme value theory. We present our recent results with Kuna and Lucarini giving sufficient conditions, on observables allowing thresholds, ensuring linear response. Our proof uses the fine properties of anisotropic Banach spaces. This will also be an opportunity to give a brief survey on anisotropic spaces suitable for transfer operators of hyperbolic dynamical systems.

Michael Dellnitz, Paderborn

Title: The computation of invariant manifolds for infinite dimensional dynamical systems by set oriented numerics

Abstract: In this talk we present a novel numerical framework for the computation of finite dimensional invariant manifolds for infinite dimensional dynamical systems. With these techniques we extend classical *set oriented* numerical schemes (for the computation of invariant manifolds in finite dimensions) to the infinite dimensional context. The crucial idea is to utilize appropriate *embedding techniques* for the globalization of these manifolds in a related finite dimensional space. We present the underlying analytical framework together with its numerical realization, and we state corresponding convergence results. Finally, we illustrate our approach by the approximation of invariant manifolds in the context of partial differential equations. This is joint work with Adrian Ziessler (Paderborn University).

Mark Demers, Fairfield

Title: 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.

Gary Froyland, UNSW

Title: Aspects of random and time-dependent dynamics

Abstract: I will briefly discuss some recent work concerning (i) a spectral approach to quenched limit theorems for random dynamical systems, (ii) rigorous approximation of random invariant densities for eventually expanding interval map cocycles, and (iii) a fast and reliable numerical method for extracting coherent structures in nonlinear dynamics with very low data requirements. This is joint work with Davor Dragicevic, Cecilia Gonzelez-Tokman, Oliver Junge, Rua Murray, and Sandro Vaienti

Frédéric Faure, Grenoble

Title: Ruelle-Pollicott spectrum of hyperbolic dynamical systems

Abstract: We will consider different models of (partially) hyperbolic dynamics and for each of them we will explain how semiclassical analysis gives the existence and some properties of an intrinsic discrete spectrum that governs decay of time correlation functions. We will show numerical experiments that illustrate these results and emphasize some relations with quantum chaos.

Cecilia González-Tokman, Queensland

Title: An approximation algorithm and limit theorems for non-autonomous dynamical systems via multiplicative ergodic theory

Abstract: Non-autonomous dynamical systems provide very flexible models for the study of forced or time-dependent systems, with driving mechanisms allowed to range from deterministic forcing to stationary noise. In this talk, we discuss a spectral approach to the study of non-autonomous dynamics, developed in the last decade via multiplicative ergodic theory. We present a (rigorous) algorithm for the approximation of the dominant components in this spectral hierarchy, consisting of Lyapunov exponents and Oseledets spaces. We also apply spectral methods to establish limit theorems for non-autonomous dynamical systems. This talk is based on joint works with D. Dragicevic, G. Froyland, A. Quas and S. Vaienti.

Georg Gottwald, University of Sydney

Title: Stochastic parameterizations of deterministic dynamical systems: Theory, applications and challenges

Abstract: There is an increased interest in the stochastic parameterization of deterministic dynamical systems whereby a high-dimensional deterministic dynamical system is reduced to a low-dimensional stochastically driven system. We discuss standard techniques of stochastic model reduction such as homogenization. Recently rigorous results have been obtained justifying this method. The theory relies on an asymptotic limit of infinite time scale separation which is not always satisfied in real world applications. We present a new method to go beyond this asymptotic limit by employing Edgeworth approximations. We then show how homogenization when applied to maps, such as numerical discretizations of ordinary multi-scale differential equations, leads to drift corrections which are neither Itô nor Stratonovich. We explain these corrections using backward error analysis of deterministic multi-scale systems. This is joint work with Jason Frank, Ian Melbourne and Jeroen Wouters.

Sébastien Gouëzel, Nantes

Title: A computer-assisted proof in ergodic theory.

Abstract: Together with Anders Karlsson, we have studied the asymptotic behavior of the random composition of semi-contractions of a metric space, and proved in particular the almost sure directional convergence of such compositions. The main tool in the proof is a refinement of Kingman's ergodic theorem. I will discuss these statements, and computer-checked versions of their proofs.

Pierre-Antoine Guihéneuf, IMJ-PRG

Title: Discretization of generic dynamics

Abstract: What is the long-term effect of roundoff errors? More precisely, is it possible to recover the dynamics of a system from the dynamics of its spatial discretizations? In this talk I will survey some (mainly negative) answers to this question for generic homeomorphisms and diffeomorphisms of manifolds.

Oliver Jenkinson, QM-UL

Title: Rigorous computation of diffusion coefficients for expanding maps

Abstract: Recent work of Bahsoun, Galatolo, Nisoli and Niu has tackled the problem of rigorously approximating diffusion coefficients, in the context of expanding interval maps. In this talk I will explore a different general approach to this problem, illustrating the method with the specific case of Lanfords map. This is joint work with Mark Pollicott and Polina Vytnova.

Carlangelo Liverani, Rome Tor Vergata

Title: Parabolic dynamics and distributions

Abstract: I will illustrate in a simple example the relation between the distributional obstructions to the growth of the ergodic integral in a parabolic flow and the eigendistributions of the hyperbolic dynamics that renormalizes the flow. Such a relation is expected to hold in greater generality whereby providing a new approach to the study of parabolic flow.

Artur Lopes, UFGR

Title: Ergodic transport

Abstract: We will present some recent results on Ergodic Transport: Kantorovich duality, couplings, the role of the involution kernel, twist potentials, graph properties, Thermodynamic Formalism for Gibbs plans and Random Ergodic Optimization.

Ian Melbourne, Warwick

Title: Homogenization of deterministic fast-slow systems

Abstract: Homogenization is a mechanism whereby systems with multiple timescales reduce to a lower dimensional stochastic differential equation comprising only the slow variables. The underlying system may be deterministic or stochastic. Here we describe recent work with various co-authors, especially David Kelly, providing a general and rigorous framework for homogenization of deterministic fas-tslow systems. This includes obtaining the correct interpretation of the stochastic integrals in the reduced equation. The method combines smooth ergodic theory and rough path theory. (Deterministic system in this talk is in the Wikipedia, dare one say classical/usual, sense of the word, so eg all ODEs are deterministic and most SDEs are not. Some ergodic theorists maintain that deterministic means entropy zero, but this one doesn't and none of the systems in this talk have zero entropy.)

Isaia Nisoli, UFRJ

Title: A proof of the existence of noise induced order

Abstract: In this joint work with S. Galatolo and M. Monge we study a dynamical system related to the Belosouv-Zhabotinsky reaction. In our work we investigate the associated RDS with random uniformly distributed noise; approximating rigorously the density of the stationary distribution in L^1 we give rigorous interval bounds on the Lyapunov exponent as the size of the noise grows, showing a transition from positive Lyapunov exponent to negative Lyapunov exponent.

Kathrin Padberg-Gehle, Leuphana Universität Lüneburg

Title: Set-oriented computation in dynamics

Abstract: Twenty years ago, Dellnitz and Hohmann introduced a set-oriented numerical framework for the approximation of invariant objects in dynamical systems. These methods have been widely used and considerably extended in several directions since, e.g. to compute dynamical quantities such as invariant measures, Lyapunov exponents, and topological entropy, or objects such as almost-invariant and coherent sets, which play a crucial rule in the study of transport processes in real-world systems. In this talk, we will report on recent work in set-oriented numerics for the approximation of (i) rotation sets of torus homeomorphisms, and (ii) fractal dimensions. This is joint work with Tobias Oertel-Jäger, Katja Polotzek, and Matthias Wagner.

Françoise Pène, Brest

Title: Limit theorems in infinite measure

Abstract: The motivation of this work is the establishment of "central limit theorems" in the context of ergodic dynamical systems preserving an infinite measure. We prove the convergence in distribution (in the strong sense) of Birkhoff sums of observables with null integral. Our results apply to a wide class of Z^d-extensions (with $d = 1$ or 2), including periodic Lorentz gas with finite horizon and geodesic flows on Z^d-extensions of compact negatively curved surfaces. This is a joint work with Damien Thomine.

Richard Sharp, Warwick

Title: Equidistribution of holonomy in homology classes

Abstract: For a compact group extension of an Anosov flow, we establish conditions under which the holonomies of periodic orbits are equidistributed when the orbits are restricted to a prescribed homology class. In particular, this applies to geodesic flows in negative curvature when the corresponding frame flow is ergodic.

Philippe Thieullen, Bordeaux

Title: A uniform bound from below of the angle between the fast and slow spaces for two-sided sequences of bounded operators in a Banach space

Abstract: We consider a two-sided sequence of bounded operators in a Banach space which are not necessarily injective and satisfy the following two properties (SVG) and (FBI). The "singular value gap" (SVG) property says that the two successive singular values of the cocycle at index d admit a uniform exponential gap, the "fast backward invertibility" (FBI) property says that the cocycle is uniformly invertible on the fastest d-dimensional direction. We show the existence of a uniform equivariant splitting of the Banach space into a fast space of dimension d and a slow space of codimension d. We compute an explicit constant of the bound from below of the angle between these two spaces using solely the constants defining the properties (SVG) and (FBI). These results are extensions of similar results obtained by Bochi-Gourmelon in finite dimension and Blumnethal-Morris in inifinite dimension for injective norm-continuous cocycles over a compact dynamical system. These results are obtained in a collaboration with A. Quas and M. Zarrabi.

Mike Todd, St Andrews

Title: Slow/fast mixing/escape

Abstract: In order to obtain a good statistical theory for a system with a hole in it, the heuristic is that the (exponential) speed of mixing must dominate the (exponential) rate at which mass leaks from the system: so the hole must be appropriately 'small'. I will present joint work with Mark Demers where we analysed this idea for a simple class of systems (Manneville-Pomeau maps with certain 'geometric' equilibrium states), giving a complete picture of how the competition between mixing and escape lead to different statistical behaviour. We show a transition from the usual picture of good statistical properties, through a (non-trivial) zone where mixing and escape match exactly, with a terminal transition to subexponential mixing.

Warwick Tucker, Uppsala

Title: In the search for the Hénon attractor

Abstract: By performing a systematic study of the Hénon map, we find low-period sinks for parameter values extremely close to the classical ones. This raises the question whether or not the well-known Hénon attractor is a strange attractor, or simply a stable periodic orbit. Using results from our study, we conclude that even if the latter were true, it would be practically impossible to establish this by computing trajectories of the map. This is joint work with Zbigniew Galias, AGH University, Krakow, Poland.

Polina Vytnova, Warwick

Title: A study of the zero set of the Selberg Zeta function

Abstract: It is well known (since 1956) that the Selberg Zeta function for compact surfaces satisfies the Riemann Hypothesis: any zero in the critical strip $0 < \mathrm{R}(s) < 1$ is either real or $\mathrm{Im}(s) = 1/2$. The question of location and distribution of the zeros of the Selberg Zeta function associated to a noncompact hyperbolic surface attracted attention of mathematics community in 2014 when numerical experiments by D. Borthwick showed sets of a rich and complex structure. We will give an overview of the computational methods used, present recent results, justifying some old observations as well as state open conjectures.