DUBROVNIK IX – Topology & Dynamical Systems

Inter – University Centre Dubrovnik, Croatia, June 24 – 28, 2019

Previously held Dubrovnik conferences in this series:

Shape Theory and Pro-Homotopy, 1976
(organized by S. Mardešić)

Shape Theory and Geometric Topology, 1981
(organized by S. Mardešić & J. Segal)

Geometric Topology and Shape Theory, 1986
(organized by S. Mardešić & J. Segal)

Geometric Topology, 1998
(organized by I. Ivanšić, J. K. Keesling & R. B. Sher)

Geometric Topology II, 2002
(organized by A. N. Dranishnikov, I. Ivanšić, J. K. Keesling & Š. Ungar)

Dubrovnik VI – Geometric Topology, 2007
(organized by A. N. Dranishnikov, I. Ivanšić, J. K. Keesling & Š. Ungar)

Dubrovnik VII – Geometric Topology, 2011
(organized by M. Bestvina, A. N. Dranishnikov, J. K. Keesling, V. Matijević & Š. Ungar)

Dubrovnik VIII –
– Geometric Topology, Geometric Group Theory & **Dynamical Systems**, 2015
(organized by M. Bestvina, A. N. Dranishnikov, J. Dydak, V. Matijević, J. Sanjurjo, & S. Štimac)

Organizers:

Mladen Bestvina, University of Utah

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Contents

Tentative Schedule (subject to change)

	Monday, June 24, 2019		
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	Coffee Break		
	LR 4 - first floor	**LR 5 - second floor**	**LR 6 - second floor**
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11:30 - 12:15	Brendle	Dowdall	Passeggi
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	Coffee Break		
5:15 - 6:00	Cashen	Koch	

	Tuesday, June 25, 2019		
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	Coffee Break		
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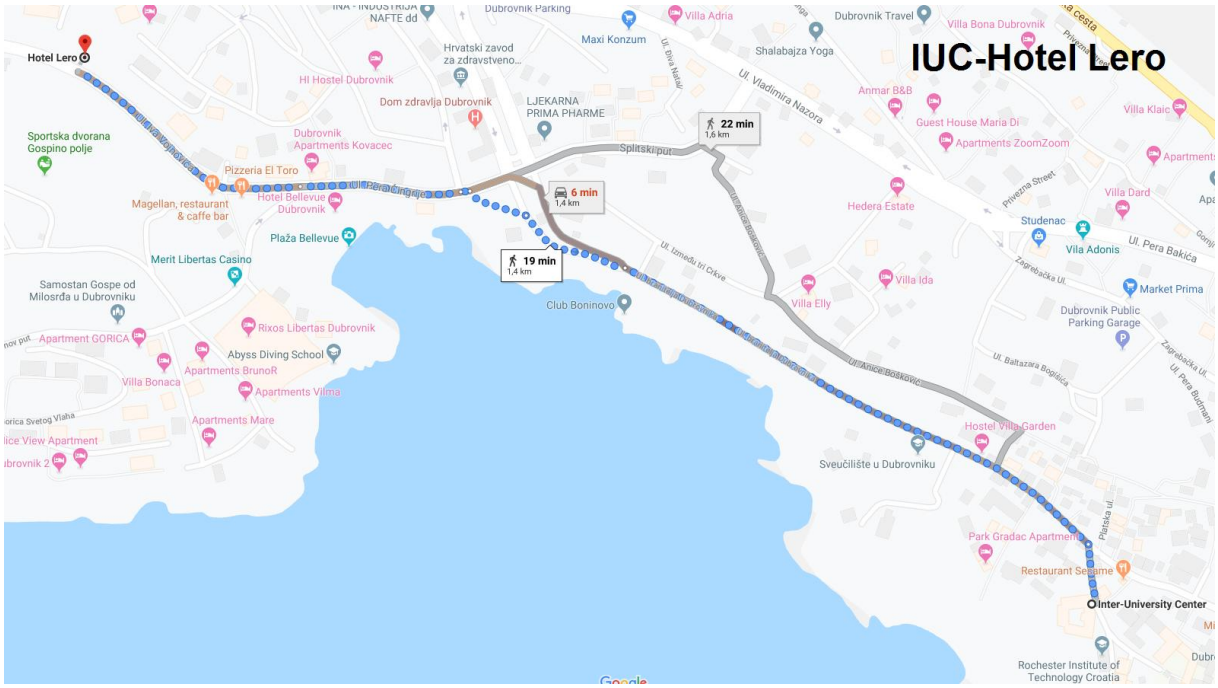
LR = Lecture Room
Conference Hall – Ivan Supek, Ground Floor
IUC = Inter-University Centre, Address: don Frana Bulića 4, 20000 Dubrovnik, Croatia
Hotel Lero, Address: Iva Vojnovića 14, 20000 Dubrovnik, Croatia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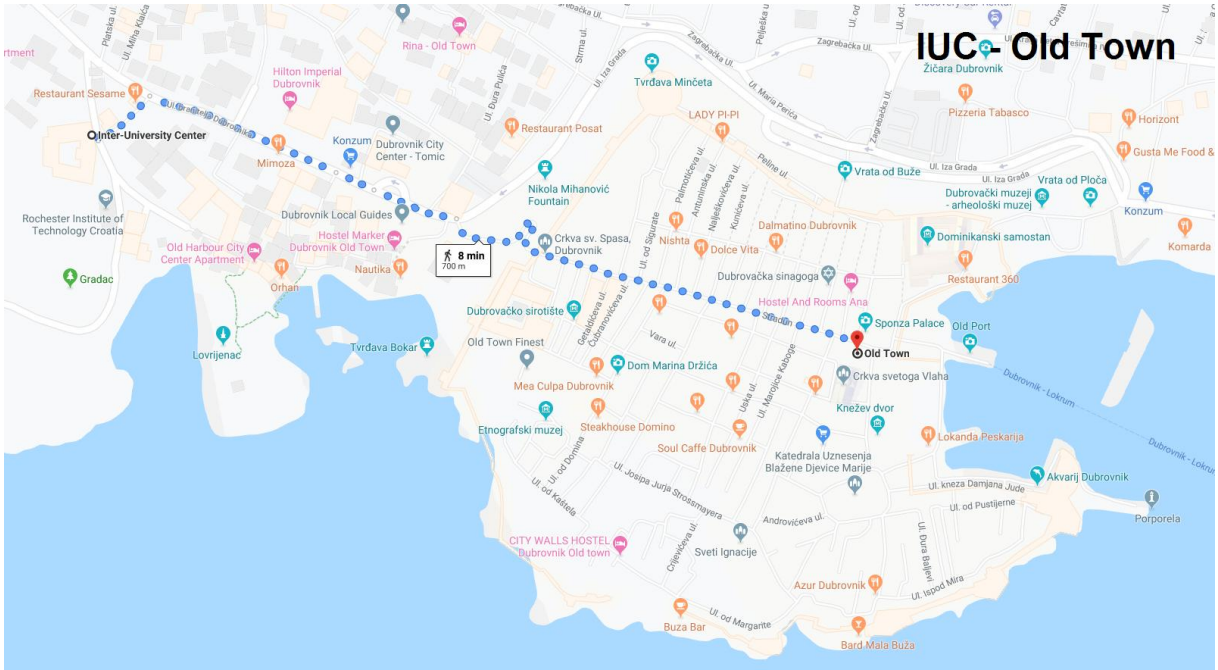
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Žičara Dubrovnik
Pizzeria Tabasco
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Konzum
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Vrata od Buže
Vrata od Ploča
Dubrovački muzeji - arheološki muzej
Nikola Mihanović Fountain
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Dubrovnik Local Guides
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Dominikanski samostan
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Restaurant 360
Dubrovačko sirotište
Hostel And Rooms Ana
Sponza Palace
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Lovrijenac
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Crkva svetoga Vlaha
Mea Culpa Dubrovnik
Knežev dvor
Etnografski muzej
Steakhouse Domino
Soul Caffe Dubrovnik
Katedrala Uznesenja Blažene Djevice Marije
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Akvarij Dubrovnik
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CITY WALLS HOSTEL Dubrovnik Old town
Sveti Ignacije
Azur Dubrovnik
Buza Bar
Bard Mala Buža

Abstracts

Normal generators for mapping class groups are abundant in the fibered cone

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Coauthors: Eiko Kin, Hyunshik Shin, Chenxi Wu

We show that for almost all primitive integral cohomology classes in the fibered cone of a closed fibered hyperbolic 3-manifold, the monodromy normally generates the mapping class group of the fiber. Key idea of the proof is to use Frieds theory of suspension flow and dynamic blow-up of Mosher. If the time permits, we also discuss the non-existence of the analogue of Frieds continuous extension of the normalized entropy over the fibered face in the case of asymptotic translation lengths on the curve complex.

On Rotational Attractors and the Induced Prime Ends Rotation Numbers

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Coauthors: Jernej Činč (Ostrava), Xiao-Chuan Liu (São Paulo)

The prime ends rotation number induced by surface homeomorphisms restricted to open domains is one of the important tools in the study of boundary dynamics. Parametrised families of dynamical systems can provide a clearer view of both the surface dynamics and the boundary dynamics in many situations. Our study serves as a contribution in this direction, by providing new examples in various contexts, by investigating the prime ends rotation numbers arising from parametrized BBM embeddings of inverse limits of topological graphs [BCH13].

First, motivated by a topological version of the Poincaré-Bendixson Theorem obtained recently by Koropecki and Passeggi [KP19], we show the existence of homeomorphisms of $\mathbb{S}^2$ with Lakes of Wada rotational attractors, with an arbitrarily large number of complementary domains, and with or without fixed points, that are arbitrarily close to the identity. This answers a question of Le Roux.

Second, with the help of a reduced Arnold's family we construct a parametrised family of Birkhoff-like cofrontier attractors, where except for countably many choices of the parameters, two distinct irrational prime ends rotation numbers are induced from the two complementary domains. This contrasts with the negative resolution of Walker's Conjecture by Koropecki, Le Calvez and Nassiri [KLN15], and implies that our examples induce Denjoy homeomorphisms on the circles of prime ends.

Third, answering a question of Boyland, we show that there exists a non-transitive Birkhoff-like attracting cofrontier which is obtained from a BBM embedding of inverse limit of circles, such that the interior prime ends rotation number belongs to the interior of the rotation interval of the cofrontier dynamics. There exists another BBM embedding of the same attractor so that the two induced prime ends rotation numbers are exactly the two endpoints of the rotation interval.

References

[BCH13] Boyland, Ph.; de Carvalho, A.; Hall, T.; *Inverse limits as attractors in parameterized families.* Bull. Lond. Math. Soc. 45 (2013), no. 5, 1075–1085
[KLN15] Koropecki, A; Le Calvez, P.; Nassiri, M.; *Prime ends rotation numbers and periodic points.* Duke Math. J. 164 (2015), 403–472.
[KP19] Koropecki, A.; Passeggi, A.; *A PoincarBendixson theorem for translation lines and applications to prime ends.* Comment. Math. Helv. 94 (2019), 141–183
[W91] Walker, R. B.; *Periodicity and decomposability of basin boundaries with irrational maps on prime ends.* Trans. Amer. Math. Soc. 324 (1991), 303–317

The Steinberg module and level structures for surfaces with marked points

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Coauthors: Nathan Broaddus and Andrew Putman

Work of Harer and Ivanov in the 1980s established that the mapping class group of a surface is a virtual duality group, and that its dualizing module is the Steinberg module, that is, the unique nonzero (reduced) homology group of the corresponding complex of curves. In this talk, we will give a new description of the Steinberg module for surfaces with marked points and discuss applications to finding bounds on cohomology in the level L congruence subgroups of the corresponding mapping class groups. This is work in progress with Nathan Broaddus and Andrew Putman; it builds on work of Fullarton-Putman in the case of closed surfaces.

Measurable pseudo-Anosov maps: what they are and what they're good for

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Measurable pseudo-Anosov maps generalize the pseudo-Anosov maps introduced by Thurston in the classification of isotopy classes of surface homeomorphisms. The latter form a countable collection of homeomorphisms (up to conjugacy). In dynamical systems it is often important to have model maps whose dynamics contain the essential features of maps in a given family, say, but which are, at the same time, "easier" to understand. For this purpose it is usually necessary to have an uncountable family of models. We expect that the family of measurable pseudo-Anosov maps will play an analogous role for 2D dynamics of that played by piecewise linear models in 1D dynamics. We will discuss some progress in this program.

Group actions with strongly contracting elements

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Coauthors: Goulnara Arzhantseva

We consider a group acting properly on a geodesic metric space such that at least one element acts with a strongly contracting axis. In many cases we recover growth and cogrowth results analogous to those for groups acting on hyperbolic spaces.

Two results on Nielsen realization problem for homeomorphisms

Lei Chen
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Coauthors: Vladimir Markovic

In this talk, I will discuss some methods in 2-dimensional dynamics including shadowing lemma, Ahlfors trick, Caratheódory's prime end theory, minimal decomposition theory, Poincare-Birkhoff theorem on rotation numbers. I will discuss how to use dynamical methods to solve two versions of the Nielsen realization problem about realizing subgroups of mapping class groups as a subgroup of homeomorphism groups. One of the result is a joint work with Vladimir Markovic.

Twisted Patterson-Sullivan measure and applications to growth problems

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Coauthors: Rhiannon Dougall, Barbara Schapira, Samuel Tapie

Given a group G acting properly by isometries on a metric space X, the exponential growth rate of G with respect to X measures "how big" the orbits of G are. If H is a subgroup of G, its exponential growth rate is bounded above by the one of G. We are interested in the following question: when do H and G have the same exponential growth rate?

This problem has both a combinatorial and a geometric origin. For the combinatorial part, Grigorchuk and Cohen proved in the 80's that a group $Q = F/N$ (written as a quotient of the free group) is amenable if and only if N and F have the same exponential growth rate (with respect to the word length in F). About the same time Brooks gave a geometric interpretation of Kesten's amenability criterion in terms of the bottom of the spectrum of the Laplace operator. He obtained in this way a statement analogue to the one of Grigorchuk and Cohen for the deck automorphism group of the cover of certain compact hyperbolic manifolds. These works initiated many fruitful developments in geometry, dynamics and group theory.

In this talk we are interested in the case where G acts on an arbitrary Gromov hyperbolic space and propose a framework that encompasses both the combinatorial and the geometric point of view. We will see that as soon as the action of G on X is "reasonable" (proper co-compact, cuspidal with parabolic gap, or more generally strongly positively recurrent), then G and H have the same growth rate if and only if H is co-amenable in G. Our strategy is based on a new kind of Patterson-Sullivan measures taking values in a space of bounded operators.

Transition to chaos for surface dynamics (a plenary lecture)

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Coauthors: Enrique Pujals and Charles Tresser

Topological entropy measures the complexity of a dynamical system. In the case of surface diffeomorphisms, a strictly positive entropy is associated with the existence of "horseshoes": the dynamics is then very rich (chaotic). In this talk, I will focus on surface diffeomorphisms with zero entropy: can the dynamics of these 'simple' systems be described? how does it bifurcate to positive entropy systems?

These questions will be answered for a class of volume-contracting surface diffeomorphisms whose dynamics is intermediate between one-dimensional dynamics and general surface dynamics. It includes the dynamics of any Hénon diffeomorphism with Jacobian smaller than 1/4. In particular, with E. Pujals and C. Tresser, we have obtained a two-dimensional version of Sharkovskys theorem about the set of periods of interval maps.

Finite-order lattice point counting in Teichmüller space

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Coauthors: Howard Masur

I will discuss a counting problem for the orbit of the mapping class group in Teichmüller space. Athreya, Bufetov, Eskin, and Mirzakhani have shown that the number of orbit points in a Teichmüller ball of radius R grows like e^{hR}, where h is the dimension of Teichmüller space. In an effort to quantify the prevalence of different types of mapping classes, we refine this counting problem and prove that approximately $e^{hR/2}$ of these orbit points are translates by finite-order elements of the mapping class group. Thus the finite-order elements have exactly half the exponential growth rate as the full group. In contrast, Maher has shown that the proportion of orbit-points that are translates by pseudo-Anosov elements tends to 1 as R tends to infinity. As a main technical tool, we introduce a new notion of complexity length in Teichmüller space that incorporates Teichmüller distance in subsurfaces and is tailored to such counting problems.

Mirzakhani's curve counting

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Mirzakhani proved two theorems about the asymptotic growth of the number of curves in a mapping class group orbit on a surface: one for simple curves and another for general curves. In this talk I will discuss a new unified approach to proving both results, using very different methods to those of Mirzakhani.

Arithmeticity, superrigidity and totally geodesic submanifolds
David Fisher
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Coauthors: Uri Bader, Nick Miller, Matthew Stover

We prove that a finite volume hyperbolic manifold that admits infinitely many closed totally geodesic hypersurfaces is necessarily arithmetic. The proof relies on a new super-rigidity theorem and on an equidistribution result from homogeneous dynamics.

Negative curvature in automorphism groups
Anthony Genevois
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In this talk, we will be interested in the following vague and naive question: Does negative curvature survive from a group to its automorphism group? After discussing motivations and examples, I will explain how to show that the automorphism group of a one-ended hyperbolic group is acylindrically hyperbolic.

A sphere is not the inverse limit of set-valued functions on intervals
Sina Greenwood
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Coauthors: Rolf Suabedissen

We outline a proof that if the inverse limit of set-valued functions on intervals is a 2-manifold then it is a torus. We also discuss 2-manifolds-with-boundary in this setting.

Homomorphisms to 3-manifold groups

Daniel Groves
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Coauthors: Michael Hull and Hao Liang

We are interested in the structure of the set of homomorphisms from a fixed (but arbitrary) finitely generated group to the set of all fundamental groups of (compact) 3-manifolds.

I will explain the basic structure theory for this collection of homomorphisms, including a descending chain condition which answers a question of Reid, Wang and Zhou, and the positive answer to a question of Agol and Liu.

How good is the homological representation theory of mapping class groups?

Asaf Hadari
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We will discuss the homological representation theory of the mapping class group, and explain several results that show that this representation theory is sensitive enough to detect topological information associated to subgroups of the mapping class group.

Homotopy Hubbard trees and automata

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Coauthors: John Smillie (Warwick)

In the well-known Orsay Notes of Douady and Hubbard, the Hubbard tree for a polynomial map with periodic critical points is defined as the legal hull of its critical orbit inside the filled Julia set. In this joint work with John Smillie, we discuss an algorithm to compute the "homotopy class" of the Hubbard tree for an expanding polynomial in terms of iterated pull-backs of loops (a closely related result has been independently obtained by Belk-Lanier-Margalit-Winarski). As an application, we construct an automaton which describes the combinatorics of the corresponding Julia set.

Some Applications of Generalized Covering Spaces
James Keesling
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Coauthors: Louis Block, Ross Ptacek

Covering spaces have great value in topology and geometry. There is a certain natural generalization of covering spaces that has recently been shown to have significant applications. We cover two such applications. The first is to the analysis of free actions of a compact 0-dimensional group on a space. The other produces an invaluable pseudorandom number generator to be used in stochastic simulation.

A construction of Mary Rees
Judy Kennedy
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Coauthors: Jan Boronski, Piotr Oprocha, Xiaochuan Liu, Ivon Vidal Escobar

Mary Rees made a construction (also called the Denjoy-Rees construction) around 1980 that allowed her to modify a minimal homeomorphism on a torus to produce one with positive entropy. There has been much recent interest in her construction and quite a few new examples of homeomorphisms produced using it. Most recently J. Boronski, Jernej Činč, and P. Oprocha used it to produce a homeomorphism on a pseudoarc with positive non-infinite entropy. We would like to generalize the Rees construction further and really figure out what makes it work, as well as use it to produce more examples. This is work in progress.

Milnor curves in moduli space
Sarah Koch
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Coauthors: X. Buff A. Epstein

In complex dynamics, the moduli space of quadratic rational maps is isomorphic to $\mathbb{C}^2$. The "Milnor curves" are dynamically defined algebraic curves in this space. It is unknown if these curves are irreducible in general. Using arithmetic techniques, we exhibit an infinite collection of them that are irreducible.

Thurston's Master Teapot
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W. Thurston plotted the set of all Galois conjugates of growth rates of postcritically finite tent maps; this visually stunning image revealed that this set has a rich and mysterious geometric structure. Thurston's Master Teapot is a closely related 3D set. This talk will present some of the basic topological and geometrical properties of these sets. Based on joint work with H. Bray, D. Davis and C. Wu.

Finitely generated simple left orderable groups
Yash Lodha
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Abstract: In 1980 Rhemtulla asked whether there exist finitely generated simple left orderable groups. In joint work with Hyde, we construct continuum many such examples (up to isomorphism), thereby resolving this question. In recent joint work with Hyde, Navas, and Rivas, we demonstrate that among these examples are also so called "left orderable monsters". This means that all their actions on the real line are of a certain desirable dynamical type. This resolves Question 4 from Navas's 2018 ICM proceedings article. In this talk I will describe these groups and discuss their striking features.

Convex hulls of quasicircles in hyperbolic and anti-de Sitter space
Sara Maloni
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Coauthors: Francesco Bonsante, Jeff Danciger and Jean-Marc Schlenker

Thurston conjectured that quasi-Fuchsian manifolds are determined by the induced hyperbolic metrics on the boundary of their convex core and Mess generalized those conjectures to the context of globally hyperbolic AdS spacetimes. In this talk I will discuss a generalization of these conjectures to convex hulls of quasicircles in the boundary at infinity of hyperbolic and anti-de Sitter space, and, more generally, to surfaces spanning those quasicircles. This result corresponds to a universal version of Thurston and Mess' conjectures. (This is joint work with Bonsante, Danciger and Schlenker.)

RAAGs as normal subgroups of mapping class groups
Johanna Mangahas
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Coauthors: Matt Clay, Dan Margalit

Free normal subgroups of mapping class groups abound, by the result of Dahmani, Guirardel, and Osin that the normal closure of a pseudo-Anosov is often free. At the other extreme, a mapping class supported on too small a subsurface has normal closure the entire mapping class group, by Brendle and Margalit. I'll talk about joint work with Matt Clay and Dan Margalit finding both free and non-free right-angled Artin groups as normal subgroups of mapping class groups.

Growth, distortion, and isoperimetry in topology
Fedor Manin
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Growth of groups, distortion of group elements, and the Dehn function are some examples of topological invariants of spaces – they depend only on the fundamental group! – which nevertheless give geometric information (about free loop spaces). Since the 1970s, Gromov has emphasized a program of quantitative homotopy theory which studies similar invariants of higher homotopy groups as well as mapping spaces in general. I will outline the questions and some recent progress, as well as some applications to quantitative problems in geometric topology.

Structure theorems for actions of homeomorphism groups (a plenary lecture)
Kathryn Mann
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Coauthors: Lei Chen

The groups Homeo(M) and Diff(M) of homeomorphisms or diffeomorphisms of a manifold M have many striking parallels with finite dimensional Lie groups. In this talk, I'll describe some of these, explaining new joint work with Lei Chen. We give an orbit classification theorem and a structure theorem for actions of homeomorphism and diffeomorphism groups on other spaces, analogous to some classical results for actions of locally compact Lie groups. As applications, we answer many concrete questions towards classifying all actions of Diff(M) on other manifolds (many of which are nontrivial, for instance Diff(M) acts

naturally on the unit tangent bundle of M...) and resolve several threads in a research program initiated by Ghys.

Dehn filling and the boundary of a relatively hyperbolic group

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I'll survey what is known about the way the boundary of a relatively hyperbolic group is affected by relatively hyperbolic Dehn filling. I'll talk both about geometric and algebraic topological properties of the boundary. Parts of this talk will be based on joint works with Groves, Groves-Sisto, and Wang.

Bounding the length of the principal term of a Poincaré displacement function

Pavao Mardešić
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Coauthors: Dmitry Novikov, Laura Ortiz-Bobadilla, Jessie Pontigo-Herrera

We study deformations of polynomial Hamiltonian systems in the plane having a nest of periodic orbits. We are interested in the principal term of the Poincaré displacement function of such deformations. It is given by an iterated integral.

We bound the length of this iterated integral in terms of the topology of the initial Hamiltonian system.

Recognizing topological polynomials by lifting trees (a plenary lecture)

Dan Margalit
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Coauthors: James Belk, Justin Lanier, Rebecca Winarski

In joint work with James Belk, Justin Lanier and Rebecca Winarski, we give a simple geometric algorithm that can be used to determine whether or not a post-critically finite topological polynomial is Thurston equivalent to a polynomial. If it is, the algorithm produces the Hubbard tree for the polynomial, hence determining the polynomial. If it is not, the algorithm produces a Levy cycle, certifying that the map is not equivalent to a polynomial. Our methods are rooted in geometric group theory: we consider a complex of isotopy classes of trees and a simplicial map of this complex to itself that we call the lifting map. Similar work has recently been announced by Ishii-Smillie.

As an application, we give a self-contained solution to Hubbard's twisted rabbit problem, which was originally solved by Bartholdi–Nekrashevych using iterated monodromy groups. We also state and solve a generalization of the twisted rabbit problem to the case where the number of post-critical points is arbitrarily large.

Dynamics of irregular model sets

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Coauthors: Gabriel Fuhrmann, Eli Glasner, Christian Oertel

Model sets are relatively dense and uniformly discrete point sets that arise from Meyer's cut and project method and can be seen as mathematical models of quasicrystals. Depending on the ingredients in the construction, there is a fundamental distinction between regular and irregular model sets. While the dynamical and diffractive properties of regular model sets are well-understood, many questions about irregular model sets are still open. We construct examples of irregular model sets whose dynamical hulls are uniquely ergodic and have zero topological entropy, thus providing negative answers to questions by Schlottmann and Moody. Conversely, we show that the dynamics of irregular model sets cannot be tame, thus providing a lower bound for the dynamical complexity of such systems. Finally, we extend the latter result to more general topological dynamics and show that any tame minimal action of an amenable group is a regular extension of its maximal equicontinuous factor.

On the Entropy Conjecture of Marcy Barge

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Coauthors: Jan Boroński and Jernej Činč

I shall discuss a positive solution to the following problem, obtained in a joint work with J. Boroński and J. Činč.

Question (M. Barge, 1989, [8]) Does there exist, for every $r \in [0, \infty]$, a pseudo-arc homeomorphism whose topological entropy is r?

Until now all known pseudo-arc homeomorphisms have had entropy 0 or ∞. Recall that the pseudo-arc is a compact and connected space (continuum) first constructed by Knaster in 1922 [6]. It can be seen as a pathological fractal. According to the most recent characterization [5] it is topologically the only, other than the arc, continuum in the plane homeomorphic to each of its proper subcontinua. The pseudo-arc is homogeneous [2] and played a crucial role in the classification of homogeneous planar compacta [4]. Lewis showed that for any n the pseudo-arc admits a period n homeomorphism that extends to a rotation of the plane, and that any P-adic Cantor group action acts effectively on the pseudo-arc [7] (see also [10]). We adapt Lewis inverse limit constructions, by combining them with a Denjoy-Rees scheme [1] (see also [9], [3]). The positive entropy homeomorphisms that we obtain are periodic point free, except for a unique fixed point. I am going to present various results related to the problem, to conclude with a discussion of its solution.

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Topological and rotational aspects of dissipative homoclinical bifurcations

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The Rotation set of an annular homeomorphism is a natural invariant from which one aims to describe the dynamic. In the dissipative case, when considered for annular attractors, this invariant given by compact intervals of $\mathbb{R}$ in general fails to be continuous. The first part of this talk is intended to discuss this fact, and present results ensuring the continuity of the map depending on the topological properties of the attractor.

Then, we study the developed criteria on C^2 one-parameter families of annular attractors undergoing homoclinical bifurcations. We show that under suitable C^2 open conditions for the homoclinic bifurcations, the rotation set will vary continuously. Moreover, for these families, we obtain that the prime-end rotation number coincide with $\max \rho(F_t)$, and hence depends continuously upon the parameter t.

Kissing numbers of hyperbolic manifolds

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The kissing number of a hyperbolic manifold is the number of closed geodesics realizing its systole - the shortest length of such a geodesic. This is a natural generalization of the kissing number of a Euclidean lattice. I will discuss how the kissing number of a hyperbolic manifold relates to other geometric and topological properties of the manifold.

On the solution of the 33-rd Palis-Pugh problem for gradient-like diffeomorphisms of the two-dimensional sphere

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The problem of the existence of an arc with no more than a countable (finite) number of bifurcations connecting structurally stable systems (Morse-Smale systems) on manifolds is included in the list of fifty Palis-Pugh problems [1] with number 33. Here we present the solution this problem for gradient-like diffeomorphisms of the two-dimensional sphere. Recall that a diffeomorphism f given on a 2-sphere S^2 is *a gradient-like* if its non-wandering set Ω_f consists of a finite number of hyperbolic periodic points and invariant manifolds of different saddle points do not intersect. Denote by G the set of such orientation-preserving diffeomorphisms.

Diffeomorphisms $f_0, f_1 \in G$ are smoothly isotopic to the identity map of the 2-sphere and, therefore, can be connected by some arc $\{f_t : S^2 \to S^2, t \in [0,1]\}$. However, *a stability* of such an arc with a finite number of bifurcation values $0 < b_1 < \cdots < b_k < 1$ is characterized by the fact that 1) all invariant manifolds of periodic points of the diffeomorphism f_t intersect transversally; 2) the diffeomorphism f_{b_i} has no cycles and its finite non-wandering set contains exactly one non-hyperbolic periodic orbit that is a flip or non-degenerate saddle-node, while the bifurcation passes typically [2].

We say that diffeomorphisms $f_0, f_1 \in G$ belong to the same *stable isotopic connectedness class* if in the space of diffeomorphisms they can be connected by an arc with the properties described above.

From the point of view of the introduced equivalence relation, classification is already nontrivial on the circle S^1, where a countable set of such classes appears, each of which is uniquely determined by the rotation number $\frac{k}{m}$, $(k,m) = 1$, of a rough circle transformations. Consider S^1 as the equator of the sphere S^2. Then a diffeomorphism of a circle with exactly two periodic orbits of period m and a rotation number $\frac{k}{m}$ can be extended to a diffeomorphism $F_{\frac{k}{m}} : S^2 \to S^2$, having two fixed sources in the north and south poles.

The main result of the report is the following theorem.

Theorem. 1. Any diffeomorphism $F_{\frac{k}{m}}, m < 3$, is connected by a stable arc with the identity transformation of a 2-sphere. 2. Diffeomorphisms $F_{\frac{k}{m}}, F_{\frac{k'}{m'}}, m, m' \geq 3$, lie in the same class of stable isotopic connectedness if $m = m'$ and either $k = k'$ or $m - k = k'$. 3. Diffeomorphisms $F^{-1}_{\frac{k}{m}}, F_{\frac{k'}{m'}}, m, m' \geq 3$, are not connected by a stable arc. 4. Any diffeomorphism $f \in G$ is connected by a stable arc with either the identity map or one of the diffeomorphisms $F_{\frac{k}{m}}$, $F^{-1}_{\frac{k}{m}}, m \geq 3$.

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An overview of the theory of complex dimensions and fractal zeta functions

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We will give an overview of the main results of the new higher-dimensional theory of complex dimensions valid for arbitrary subsets of Euclidean spaces of any dimension. This theory has been developed in a series of papers and in a research monograph "Fractal Zeta Functions and Fractal Drums: Higher-Dimensional Theory of Complex Dimensions" coauthored by M. L. Lapidus, G. Radunović and D. Žubrinić. The theory gives a far-reaching generalization of the one-dimensional theory (for fractal strings) developed by M. L. Lapidus, M. van Frankenhuijsen and their numerous collaborators.

The complex dimensions of a given set are defined as the poles (or more general singularities) of the (distance or tube) fractal zeta function associated with the given set and they generalize the well-known notion of the Minkowski dimension. We will define and give the main properties and results for the distance fractal zeta function. Although the complex dimensions are defined analytically, we will show that they have a deep geometric meaning connected to the fractal nature of the given set and the intrinsic oscillations in its geometry. Namely, this can be seen from the so-called fractal tube formulas which, under appropriate assumptions, give an asymptotic expansion of the Lebesgue measure of the delta-neighborhood of the given set (when delta is close to zero) in terms of its complex dimensions. We will also reflect on some of the possible applications of the theory in studying dynamical systems and their bifurcations.

Classifications of Dulac germs

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The study of Dulac (almost regular) germs is motivated by first return maps of hyperbolic polycycles. We discuss formal and analytic invariants (in the sense of Ecalle-Voronin) for Dulac germs. The formal classification is given in the class of power-logarithmic transseries.

Random trees in the boundary of Outer space
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We prove that for the harmonic measure associated to a random walk on Out(Fr) satisfying some mild conditions, a typical tree in the boundary of Outer space is trivalent and nongeometric.

Ping-pong lemma: old and new
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The classical ping-pong lemma, first discovered by Felix Klein, is a fundamental tool in group theory to detect free subgroups in a given group. For instance, it is central in the celebrated Tits' Alternative. Generalizations to amalgamated products and HNN extensions were formulated by Fenchel and Nielsen in unpublished notes that were circulating in the 50s, and were used in later important developments of geometric and combinatorial group theory, such as Stallings's theory or Maskit combination theorems for Kleinian groups. Motivated by a long-term project which aims at a classification of group actions on the circle, we formulate a generalization of the ping-pong lemma for fundamental groups of graph of groups, and discuss applications.

Hausdorff dimension and critical exponent (a plenary lecture)
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The critical exponent and the Hausdorff dimension of the limit set are two asymptotic invariants of discrete group actions. In a seminal paper in 1979 Sullivan proved that for groups acting convex cocompactly on the hyperbolic n-space, the two invariant coincide. We discuss results on the relation between critical exponents and Hausdorff dimension of limit sets for Anosov representations, a rich class of discrete subgroups of Lie groups that will be introduced in the talk.

The Steinberg module of the special linear group of a number ring
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In this talk I will describe a project, joint with Peter Patzt, Jeremy Miller, and Dan Yasaki, concerning the top-degree cohomology of $SL_n(O)$, where O is a number ring. I will explain our main result: assuming the generalized Riemann hypothesis, the Steinberg module of $SL_n(O)$ is generated by integral apartments if and only if the ring O is Euclidean. We also construct new cohomology classes in the top cohomology group of the special linear groups of some quadratic imaginary number rings.

Nearly Fuchsian surface subgroups of finite covolume Kleinian groups
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We will present joint work with Jeremy Kahn proving that any complete cusped hyperbolic three manifold contains many "nearly isometrically immersed" closed hyperbolic surfaces.

Self-similar solutions to extension and approximation problems
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Kaufman constructed a remarkable surjective Lipschitz map from a cube to a square whose derivative has rank 1 almost everywhere. In this talk, we will present some higher-dimensional generalizations of Kaufman's construction that lead to Lipschitz and Hölder maps with wild properties, including: topologically nontrivial maps from S^m to S^n with derivative of rank $n-1$, $(\frac{2}{3}-\delta)$–Hölder approximations of surfaces in the Heisenberg group, and Hölder maps from the disc to the disc that preserve signed area but approximate an arbitrary continuous map. This is joint work with Stefan Wenger and Larry Guth.

Poster session

On topological classification of Morse-Smale cascades by means of combinatorial invariants (poster)

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A diffeomorphism $f : M^n \to M^n$ of smooth closed manifold M^n is called *a Morse-Smale* if its non-wandering set Ω_f is finite, consists of hyperbolic points, and for any points $p,\ q \in \Omega_f$ an intersection of the stable manifold of p with the unstable manifold of q is transversal (see for instance [1]).

Thanks to the finiteness of the set of non-wandering orbits it is possible to obtain topological classification in wide classes of Morse-Smale systems by means of combinatorial invariants describing the mutual arrangement of invariant manifolds. In first time this approach was applied by E. Leontovich and A. Mayer for clasification of flows with finite nimber of singular trajecoties on the two-dimensional sphere. Further this idea was developed by M. Peixoto, A. Oshemkov, V. Sharko, Y. Umanskii who solved similar problem for Morse-Smale flows on manifolds of dimension 2, 3 and greater, and by Ch. Bonatti, A. Bezdenezhnyich, V. Grines, V. Medvedev, R. Langevin, O. Pochinka, E. Gurevich for Morse-Smale cascades (see a review [2] for references).

In the report we establish that Morse-Smale cascades without heteroclinical intersections defined on the sphere S^n, $n \geq 4$, also admit the complete topological classification in a combinatorial language. This result contrasts with a case of Morse-Smale cascades on three-dimensional manifolds ([2],[3]).

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Kirby diagrams of general Cappell-Shaneson 4-spheres (poster)

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Since the '70s, Cappell-Shaneson 4-spheres have been considered to be possible counterexamples to the differentiable Poincare conjecture in dimension 4. Over the years, increasingly larger subfamilies of these 4-spheres have been

shown to be diffeomorphic to the standard 4-sphere, some by simplifying their Kirby diagram (so far available only for a special class), and some by other means. By representing a Cappell-Shaneson 4-sphere as the result of a side-pairing of the 4-cube, we obtain a Kirby diagram for the general case and simplify it to two 1-handles and two 2-handles. While this does not show the 4-spheres are standard, we believe our approach shows promise, since it resolves the special class much more easily than the previous solution.

Symplectic coordinates on $\mathrm{PSL}_3(\mathbb{R})$-Hitchin components (poster)

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Goldman parametrizes the $\mathrm{PSL}_3(\mathbb{R})$-Hitchin component of a closed oriented hyperbolic surface of genus g by $16g-16$ parameters. Among them, $10g-10$ coordinates are canonical. We prove that the $\mathrm{PSL}_3(\mathbb{R})$-Hitchin component equipped with the Atiyah-Bott-Goldman symplectic form admits a global Darboux coordinate system such that the half of its coordinates are canonical Goldman coordinates. This is the refined version of the previous work of the third author H. Kim. To this end, we establish a version of the action-angle principle and show that the Hitchin component can be decomposed into a product of smaller Hitchin components. We remark that Sun-Wienhard-Zhang recently constructed a global Darboux coordinate system on general $\mathrm{PSL}_n(\mathbb{R})$-Hitchin components. Their method is based on the deformation theory of Frenet curves which is different from our approach.

On moduli for gradient flows of the surface height function (poster)

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In 1978 J. Palis [1] invented continuum of topologically non-conjugate systems in a neighbourhood of a system with a heteroclinic contact (moduli). W. de Melo and C. van Strien [2] in 1987 proved that a diffeomorphism with a finite number of moduli may have a chain of saddles taking part in the heteroclinic contact including not more than three saddles. But such effect does not happen in flows. Here the gradient flows of the height function for an orientable surface of genus $g > 0$ are considered. Such flows have a chain of $2g$ saddles. We proved that the number of moduli for such flows is $2g-1$ which is the straight consequence of the sufficient topological conjugacy conditions for such systems given in our paper. A complete topological equivalence invariant

for such systems is four-colour graph carrying the information about its cells relative position. Equipping the graph's edges with the analytical parameters – moduli, connected with the saddle connections, gives the sufficient conditions of the flows topological conjugacy. The study was implemented with the support of Russian Science Foundation (project 17-11-01041).

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