GEODESICS ON REAL HYPERBOLIC MANIFOLDS
AKA ARA FEST

CONNECTICUT COLLEGE
AUG 9-11, 2018

Schedule

All talks will take place in the Brown Auditorium in the Chemistry Building.
Coffee breaks and registration will be in the lobby of the Olin Science Center.

	Thursday	Friday	Saturday
9:00-10:00	*Registration + Coffee*	*Coffee*	*Coffee*
10:00-10:50	Martin Bridgeman	Peter Buser	Jenya Sapir
10:50-11:20	*Coffee*	*Coffee*	*Coffee*
11:20-12:10	Federica Fanoni	Virginie Charette	Jeff Brock
12:10-2:00	*LUNCH*	*LUNCH*	Dick Canary*
2:00-2:50	Ser Peow Tan	Mary He	*12:20-1:10
3:00-3:50	Priyam Patel	Bill Goldman	
3:50-4:20	*Coffee*	*Coffee*	
4:20-5:10	Moira Chas	Nick Vlamis	
	Reception (6 pm)	*Banquet (7 pm)*	

Abstracts

Martin Bridgeman (Boston College)

Title: SCHWARZIAN DERIVATIVES, PROJECTIVE STRUCTURES, AND THE WEIL-PETERSSON GRADIENT FLOW FOR RENORMALIZED VOLUME

Abstract: We consider complex projective structures and their associated locally convex pleated surface. We relate their geometry in terms of the L_2 and L_∞ norms the Schwarzian derivative. We show that these give a unifying approach that generalizes a number of well-known results for convex cocompact hyperbolic structures including bounds on the Lipschitz constant for the retract and the length of the bending lamination. We then use these bounds to study the Weil-Petersson gradient flow of renormalized volume on the space $CC(N)$ of convex cocompact hyperbolic structures on a compact manifold N with incompressible boundary. This leads to a proof of the conjecture that the renormalized volume has infimum given by one-half the simplicial volume of DN, the double of N. Joint work with Jeffrey Brock and Kenneth Bromberg.

Jeff Brock (Yale)

Title: HYPERBOLIC VOLUME, RENORMALIZED

Abstract: Much of the mathematical appeal of Thurston's work on the geometrization of 3-manifolds lies in its hands-on nature: synthetic and combinatorial constructions involving geodesic loops, simplicial surfaces, and quasi geodesics gain their power from rigidity theorems due to Mostow and Sullivan that guarantee that rough geometric estimates ensure spot-on control. But considerable analytic work of Ahflors, Bers, and others, lies at the foundation. Recently new clues have emerged to an analytic framework for understanding Thurston's intuition and conjectures. In this talk, I will describe some historical context and recent developments that use Graham and Witten's notion of "renormalized volume", as elaborated by Krasnov and Schlenker, to provide a satisfying analytic explanation for the connection between volumes of hyperbolic 3-manifolds and Weil-Petersson lengths of geodesics in moduli space. I'll discuss applications to Weil-Petersson geometry as well as some new results. This talk describes joint work with Ken Bromberg and Martin Bridgeman.

Peter Buser (EPFL)

Title: VISUALISATION OF SIMPLE CLOSED GEODESICS ON A HYPERBOLIC SURFACE

Abstract: By a result of Joan Birman and Caroline Series the union set BS of all simple closed geodesics on a compact hyperbolic surface R is nowhere dense. We call the open connected components of $R \setminus BS$ the *forbidden regions*. In joint work with Hugo Parlier we have shown that forbidden regions with inradius explicitly bounded from below are distributed evenly over the surface. To see how accurate the bounds are we aim to visualise BS by computer. In the talk we discuss an algorithm for the generation of the simple closed geodesics on R and an idea for an algorithm that yields graphically representable sets BS' that contain BS and have small Hausdorff distance to it.

Dick Canary (University of Michigan)

Title: SIMPLE LENGTH RIGIDITY FOR HITCHIN REPRESENTATIONS

Abstract: It is a classical result that the geometry of a closed hyperbolic surface is completely determined by the lengths of finitely many simple closed geodesics on the surface. One may reformulate this in algebraic language, as saying that a discrete, faithful representation of the fundamental group G of a closed surface S into $\mathrm{PSL}(2,\mathbb{R})$ is determined, up to conjugacy, by the spectral radii of the images of finitely many elements which are represented by simple closed curves on S.
Hitchin discovered a component of the space of representations of G into $\mathrm{PSL}(n,\mathbb{R})$, which bears many resemblances to the Teichmuller space of discrete, faithful representations of G

into $\mathrm{PSL}(2,\mathbb{R})$. We will discuss the geometry of these representations and show that they are similarly determined by the spectral radii of the images of elements represented by simple closed curves. If time permits, we will discuss implications of this result for a natural metric on the Hitchin component. (These results are joint work with Martin Bridgeman and Francois Labourie.)

Virginie Charette (University of Sherbrooke)

Title: MCSHANE-TYPE IDENTITIES FOR AFFINE DEFORMATIONS

Abstract: We derive an identity for Margulis invariants of affine deformations of a complete orientable one-ended hyperbolic surface following the identities of McShane, Mirzakhani, Tan-Wong-Zhang and Basmajian. As a corollary, a deformation of the surface which infinitesimally lengthens all interior simple closed curves must infinitesimally lengthen the boundary. (Joint work with Bill Goldman.)

Moira Chas (Stony Brook)

Title: Computer Driven Questions, Theorems and Pre-theorems in Low Dimensional Topology

Abstract: Consider an orientable surface S with negative Euler characteristic, a minimal set of generators of the fundamental group of S, and a hyperbolic metric on S. Then each unbased homotopy class C of closed oriented curves on S determines three numbers: the word length (that is, the minimal number of letters needed to express C as a cyclic word in the generators and their inverses), the minimal geometric self-intersection number, and finally the geometric length. Also, the set of free homotopy classes of closed directed curves on S (as a set) is the vector space basis of a Lie algebra discovered by Goldman. This Lie algebra is closely related to the intersection structure of curves on S. These three numbers, as well as the Goldman Lie bracket of two classes, can be explicitly computed (or approximated) using a computer. These computations led us to counterexamples to existing conjectures, to formulate new conjectures and (sometimes) to subsequent theorems.

Federica Fanoni (Heidelberg/CNRS Strasbourg)

Title: CURVE GRAPHS FOR INFINITE TYPE SURFACES

Abstract: There are various graphs associated to surfaces (of finite topological type), constructed using curves or arcs, which have been very useful in the study of the mapping class group and of Teichmueller space. If the surface has infinite topological type (e.g. it has infinite genus), these graphs turn out to be not as interesting. I will discuss why and present an alternative construction which gives graphs with better properties. This is joint work with Matt Durham and Nick Vlamis.

Bill Goldman (University of Maryland)

Title: DYNAMICS ON MODULI SPACES FOR TWO-GENERATOR HYPERBOLIC ISOMETRY GROUPS

Abstract: The SL(2)-character variety X for two-generator free groups is a rich and fascinating object. In 1889 Vogt proved that X is 3-dimensional affine space using traces of 2x2 matrices. Representing $F2$ as the fundamental group of a one-holed torus endows X with an algebraic Poisson structure, whose symplectic leaves are level sets of the trace of the boundary of a one-holed torus. These are cubic surfaces in X whose structure is preserved by the mapping class group. In this talk I will describe the relationship between the dynamics of the mapping class group action and the geometry of these affine cubics.

Yan Mary He (Toronto/Luxembourg)

Title: A REAL APPLICATION OF BASMAJIAN IDENTITY

Abstract: Basmajian identity expresses the length of the boundary of a compact hyperbolic surface as a sum over the orthogeodesics on the surface. In this talk, I will introduce Basmajian-type identities on limit sets associated to familiar complex dynamical systems and discuss their applications to Hausdorff dimension of Julia sets, counting (complex) orthospectrum and orbit counting in complex dynamics.

Priyam Patel (UC Santa Barbara)

Title: LIFTING CURVES ON SURFACES VIA 3-MANIFOLDS AND THE CURVE COMPLEX

Abstract: Given two simple closed curves alpha and beta intersecting many times on an orientable surface S, we are interested in studying the minimal degree of a finite cover of S such that there is a lift of alpha disjoint from a lift of beta. In joint work with Tarik Aougab and Sam Taylor, we use the geometry of hyperbolic 3-manifolds to obtain lower bounds on this degree in terms of curve complex distance between the curves alpha and beta. After describing some of the techniques we use, I will highlight an interesting application of our work that gives lower bounds on the degrees of special covers for certain cube complexes associated to surfaces.

Jenya Sapir (MPI & SUNY Binghamton)

Title: A COMBINATORIAL APPROACH TO CURVE COUNTING

Abstract: We present a combinatorial model for geodesics on a hyperbolic surface S. We will then use this model to bound the number of orbits of closed geodesics with at most K self-intersections, under the action of the mapping class group of S. We also describe recent improvements to the methods that have significantly lowered our upper bound. This result is similar to a result of Aougab and Souto, but uses very different methods, which are of individual interest. Moreover, it complements work of Mirzakhani that gives the asymptotic growth of the number of geodesics of length at most L inside a single mapping class group orbit.

Ser Peow Tan (National University of Singapore)

Title: IDENTITIES FOR LENGTHS OF GEODESICS ON HYPERBOLIC SURFACES REVISITED

Abstract: In 2010 I gave a talk at a program in Singapore where I described how the Basmajian, Bridgeman and McShane identities could be obtained from essentially the same point of view, and also described Bowditch's combinatorial proof of the McShane identity for the punctured torus. Several questions arose, for example, were there deeper connections between the various identities, was there an identity for closed surfaces, could the Basmajian and Bridgeman identities be extended to surfaces with cusps, could one extend the Bowditch method to higher genus etc. In this talk, we will survey some of the recent progress and results towards answering some of these questions.

Nick Vlamis (CUNY Queens College)

Title: QUASI-CONFORMAL HOMOGENEITY OF RIEMANN SURFACES

Abstract: A Riemann surface is quasi-conformally homogeneous, or QCH, if it admits a family of quasi-conformal homeomorphisms with uniformly bounded dilatation acting transitively on the surface. This definition naturally extends to hyperbolic manifolds in higher dimensions. In this setting, Bonfert-Taylor, Canary, Martin, and Taylor gave a complete characterization of QCH hyperbolic manifolds of dimension at least 3. This motivates us to search for a characterization of QCH Riemann surfaces. Building on the existing literature, we will explain why there are only four homeomorphism classes of surfaces to consider in order to give a complete characterization. We give an answer for one such class. This is joint work with Ara Basmajian.
