

Workshop Schedule

Events for:
Monday, February 4th - Friday, February 8th

Monday, February 4th

9:30am **Simion Filip - SCGP 102**

Title: Discrete groups, Lyapunov exponents, and Hodge theory

Abstract: Families of algebraic manifolds give interesting examples of discrete subgroups of Lie groups, via their monodromy. They also lead to differential equations, such as the hypergeometric ones, whose solutions have an arithmetic significance. After providing the necessary background I will explain a connection to dynamical invariants called Lyapunov exponents, which reveals special geometric features of the discrete groups and the corresponding differential equations.

10:30am **Coffee break - SCGP Cafe**

11:00am **Pietro Longhi - SCGP 102**

Title: A combinatorial approach to saddle-counting invariants for quadratic differentials

Abstract: Counts of special trajectories of quadratic differentials on Riemann surfaces are an example of "generalized" Donaldson-Thomas invariants, they exhibit wall-crossing phenomena over the moduli space of differentials. I will describe a combinatorial construction of the Kontsevich-Soibelman invariant for this counting problem based on ribbon graphs of degenerate Jenkins-Strebel differentials. Time permitting, I will also sketch generalizations to motivic wall-crossing invariants, and to collections of k -differentials in the context of Hitchin systems.

12:00pm **Lunch - SCGP Cafe**

2:15pm **Samuel Grushevsky - SCGP 102**

Title: Compactifying moduli of curves with a differential

Abstract: "The "stratum" is the moduli space of curves together with a differential with prescribed multiplicities of zeroes; it is the phase space of the action of $GL(2, \mathbb{R})$ in Teichmüller dynamics. We construct a smooth geometric compactification of the stratum that carries a universal family. Based on joint work with Matt Bainbridge, Dawei Chen, Quentin Gendron, Martin Moeller."

3:30pm **Tea time - SGCP Cafe**

4:00pm **Dylan Allegretti - SCGP 102**

Title: The monodromy of meromorphic projective structures

Abstract: The notion of a complex projective structure is fundamental in low-dimensional geometry and topology. The space of projective structures on a surface is closely related to the space of holomorphic quadratic differentials, and there is a natural map from the space of projective structures to the character variety of the surface, sending a projective structure to its monodromy representation. In this talk, I will describe joint work with Tom Bridgeland in which we introduced the notion of a "meromorphic projective structure" with poles at a discrete set of points. In the case of a meromorphic projective structure, the monodromy can be viewed as a point in a moduli space introduced by Fock and Goncharov in their work on cluster varieties. This appears to be a manifestation of a general relationship between cluster varieties and spaces of stability conditions on 3-Calabi-Yau triangulated categories.

Tuesday, February 5th

9:30am **Brian Collier - SCGP 102**

Title: Stratifications and conformal limits

Abstract: Both the Higgs bundle moduli space and the moduli space of flat connections have a natural stratification induced by a C^* action. In both of these stratifications, each stratum is a holomorphic fibration over a connected component of complex variations of Hodge structure. While the nonabelian Hodge correspondence provides a homeomorphism between Higgs bundles and flat connections, this homeomorphism does not preserve the respective strata. The closed stratum on the Higgs bundle side is the image of the Hitchin section and the closed stratum in the space of flat connections is the space of opers. In this talk, we will show how many of the relationships between opers and the Hitchin section extend to general strata. In particular, we will show that the conformal limit identifies certain holomorphic Lagrangian subspaces of the stratifications.

10:30am **Coffee break - SCGP Cafe**

11:00am **Michael Wolf - SCGP 102**

Title: Limiting Configurations, Pleated Surfaces and Harmonic Maps

Abstract: A recent work by Mazzeo-Swoboda-Weiss-Witt describes a stratum of the frontier of the space of $SL(2, \mathbb{C})$ surface group representations in terms of 'limiting configurations' which solve a degenerated version of Hitchin's equations on a Riemann surface. We interpret these objects in (a mapping class group invariant way in) terms of the hyperbolic geometric objects of shearings of pleated surfaces. We study limits of opers in this perspective. (Joint with Andreas Ott, Jan Swoboda, and Richard Wentworth).

12:00pm **Lunch - SCGP Cafe**

1:00pm **Andrew Neitzke - SCGP 102**

Title: BPS states and hyperkahler metrics: an update

Abstract: The physics of $N=2$ supersymmetric quantum field theory leads to a conjectural explicit recipe for constructing metrics on certain hyperkahler moduli spaces, in terms of a relatively small amount of input data: just some holomorphic functions ("central charges") and integer invariants ("BPS state counts / Donaldson-Thomas invariants"). I will describe how this scheme works in some specific examples of moduli spaces of Higgs bundles, and some recent progress toward proving that it actually gives the correct metric. The original conjecture appears in my joint work with Gaiotto-Moore, and the more recent progress involves work of Mazzeo-Swoboda-Weiss-Witt, my joint work with Dumas, and work of Fredrickson.

2:15pm **Chaya Norton - SCGP 102**

Title: Variational Formulas for the Period Matrix and Shimura-Teichmuller Curves

Abstract: We will introduce a parametric jump problem used to study how differentials degenerate at the boundary of the moduli space of Riemann surfaces in terms of plumbing parameters. In joint work with David Auricino we are able to use these variational formulas to study Shimura-Teichmuller curves in genus 5. This is the only case left open in Moller's work.

3:30pm **Tea time - SGCP Cafe**

4:00pm **Subhojoy Gupta - SCGP 102**

Title: Meromorphic quadratic differentials and geometric structures

Abstract: let X be a compact Riemann surface of genus greater than one, and let S denote its underlying smooth surface. Holomorphic quadratic differentials on X parametrize the space of hyperbolic structures, as well as the space of measured foliations, on S . These correspondences between holomorphic objects on one side, and certain geometric structures on the other, are theorems of Wolf and Hubbard-Masur, respectively. I shall discuss these, and talk of their generalizations to the case of a punctured surface when the quadratic differential has poles of higher order. The proofs involve the theory of harmonic maps between surfaces, and in particular, infinite-energy maps that arise in degenerations of the usual correspondence. Part of this work is joint with Michael Wolf.

Wednesday, February 6th

9:30am **Richard Wentworth - SCGP 102**

Title: Conformal blocks and Higgs bundles for spin groups

Abstract: This will be a two part talk based on joint work with Swarnava Mukhopadhyay. In the first part, I will briefly discuss the problem of level-rank and strange duality for orthogonal groups. I will mention the proof of the Oxbury-Wilson conjecture on the Verlinde formula for spin groups, and the existence of a Hitchin connection on the space of generalized theta functions for "twisted" spin bundles. This leads to the main part of the talk which addresses spectral data for spin Higgs bundles. A key point is the relation between Abe's Hecke transformations of orthogonal bundles and Hitchin's spectral data. A direct proof of Langlands duality for the fibers of the Hitchin integrable system follows from this description.

10:30am **Coffee break - SCGP Cafe**

11:00am **Gregory Moore - SCGP 102**

Title: Categorified Wall-Crossing With Twisted Masses

Abstract: The talk will discuss "categorification," or more accurately, "braneification" of wall-crossing formulae (wcf). We review the general statement of the 2d4d wcf. Then we review and refine the Cecott-Vafa wcf in 2d Landau-Ginzburg models. We further refine it in the context of the A-infinity category of interfaces using "S wall interfaces" for "S-wall-crossing." Finally, we discuss the effect of twisted masses, which lead to some novel new phenomena, including K-wall interfaces, closely related to Koszul duality of algebras. Most of the talk is a review of work done with D. Gaiotto and E. Witten pre-2015. Some of the material presented comes from unpublished work with T. Dimofte and D. Gaiotto from 2016, together with more recent work in progress with Rutgers graduate student Ahsan Khan. The subject is closely related to spectral networks, hence relevant to this workshop on holomorphic differentials. However, the practice run at a Rutgers group meeting took over 2 hours, so much material, including the relation to spectral networks will have to be omitted.

12:00pm **Lunch - SCGP Cafe**

3:30pm **Tea time - SGCP Cafe**

6:00pm **Banquet - SCGP Cafe**

Thursday, February 7th

9:30am **Philip Engel - SCGP 102**

Title: The elliptic orbifold of order 5

Abstract: A group acting on an elliptic curve must have order 1, 2, 3, 4, or 6. We call the quotient an elliptic orbifold. Certain branched covers of the order N elliptic orbifold are in bijection with tiled surfaces, and form a lattice in the moduli space of N -ic differentials on Riemann surfaces. Following Eskin-Okounkov, generating functions of these Hurwitz numbers can be computed as the q -trace of operators on Fock space. These operators naturally generalize to all orders $N > 1$, suggesting a phantom "elliptic orbifold of order 5." I will discuss work-in-progress with Peter Smillie, proposing a definition for the Hurwitz theory of this non-existent object, and relating it to quasi-crystals in the moduli space of quintic differentials and the enumeration of Penrose-tiled Riemann surfaces.

10:30am **Coffee break - SCGP Cafe**

11:00am **Dawei Chen - SCGP 102**

Title: Volume and intersection theory on moduli spaces of holomorphic differentials

Abstract: I will explain that the Masur-Veech volumes can be computed as intersection numbers on moduli spaces of holomorphic differentials. If time permits, I will also talk about an interesting connection to the proofs of Witten's conjecture by Kontsevich, Mirzakhani, and Okounkov-Pandharipande. This is joint work with Moeller, Sauvaget, and Zagier (arXiv:1901.01785).

12:00pm **Lunch - SCGP Cafe**

1:30pm **Yu-Wei Fan**

Title: Systolic inequality for K3 surfaces via stability conditions

Abstract: The connection between flat surfaces and stability conditions has been established by Gaiotto-Moore-Neitzke, Bridgeland-Smith and Haiden-Katzarkov-Kontsevich. Motivated by this connection, we define a categorical analogue of 'systole' in terms of stability conditions. We prove that the systoles of stability conditions on certain K3 surfaces are bounded above by the square roots of the volumes of K3 surfaces. This is a generalization of Loewner's torus systolic inequality from the perspective of Calabi-Yau geometry.

2:45pm **Aaron Fenyes**

Title: A bumpy ride through the space of half-translation structures

Abstract: As you deform a half-translation surface with non-compact ends, its combinatorial features jump whenever a vertical saddle connection appears. The associated shear coordinates on the Teichmüller space of the surface jump too, giving the algebra of shear coordinates its celebrated cluster structure. When you deform a compact half-translation surface, you get an even bumpier ride, with jumps at a dense set of times. I'll set out some ideas for keeping track of these jumps, and show hints of a generalized cluster structure on the algebra of shear coordinates.

3:45pm **Tea time - SGCP Cafe**

Friday, February 8th

9:30am **Du Pei - SCGP 102**

Abstract: We propose a new link between the geometry of the moduli space of wild Higgs bundles and quantum invariants of 3-manifolds. The construction goes through a class of four-dimensional quantum field theories known as Argyres-Douglas theories. Every such theory realizes a wild Hitchin space as its Coulomb branch and defines a VOA on the Higgs branch. The latter can be used to construct a non-unitary modular tensor category, which leads to 3d TQFTs that are generically non-unitary. This is based on joint work with Mykola Dedushenko, Sergei Gukov, Hiraku Nakajima and Ke Ye.

10:30am **Coffee break - SCGP Cafe**

11:00am **Laura Schaposnik - SCGP 102**

Title: Geometric correspondances between singular fibres of the Hitchin fibration

Abstract: Higgs bundles are pairs of holomorphic vector bundles and holomorphic 1-forms taking values in the endomorphisms of the bundle, and their moduli spaces carry a natural hyperkahler structure, through which one can study Lagrangian subspaces (A-branes) or holomorphic subspaces (B-branes). Notably, these A and B-branes have gained significant attention both within mathematics and string theory. In this talk we shall consider novel correspondences between branes lying completely within the singular fibres of the Hitchin fibration, which can be understood through group isomorphisms. The talk is based on work in progress with Steve Bradlow and Lucas Branco, and with Sebastian Schulz.

12:00pm **Lunch - SCGP Cafe**

3:30pm **Tea time - SCGP Cafe**