Gauge Theory and Floer Homology in Low Dimensional Topology: April 28 - May 2, 2025

Events for:
Monday, April 28th - Friday, May 2nd

Monday, April 28th

8:30am **Workshop: Breakfast - SCGP Cafe**

Title: Breakfast

9:30am **Workshop: Jen Hom - SCGP 102**

Speaker: Jen Hom

Title: New tools for studying homology cobordism

Abstract: We will discuss a new family of homology cobordism invariants coming from Pin(2)-equivariant Floer homology. Our construction relies on Koszul duality and constructions inspired by the concordance invariants epsilon and upsilon. This is joint work in progress with I. Dai, M. Stoffregen, and L. Truong.

10:30am **Workshop: Coffee Break - SCGP Cafe**

Title: Coffee Break

11:00am **Workshop: Deeparaj Bhat - SCGP 102**

Speaker: Deeparaj Bhat

Title: Surgery Exact Triangles in Instanton Theory

Abstract: We prove an exact triangle relating the knot instanton homology to the instanton homology of surgeries along the knot. As the knot instanton homology is computable in many instances, this sheds some light on the instanton homology of closed 3-manifolds. We illustrate this with computations in the case of some surgeries on the trefoil. In particular, we show the Poincaré homology sphere is not an instanton L-space (with Z/2 coefficients), in contrast with Heegaard Floer and monopole Floer theories. Finally, we sketch the proof of the triangle inspired by the Atiyah-Floer conjecture and results from symplectic geometry.

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

Title: Lunch

1:00pm **Workshop: Mike Miller Eismeier - SCGP 102**

Speaker: Mike Miler Eismeier

Title: Naturality in HF^oo

Abstract: There is an algebraic approximation to the group HF^oo(Y; Z) called the "cup homology" of Y. They are known to have the same dimension over F_2, they can be shown to agree (up to extension problems) for b_1(Y) = 8, and one gets the same result over Z in millions of computer calculations on examples with 9 = b_1(Y) = 14. One is led to guess there should be a good reason for this; perhaps the functors are naturally isomorphic. I will prove they are not by comparing them as MCG(Y)-modules for Y = Sigma_4 x S^1. To study these examples, we develop a version of the Lefschetz decomposition over Z which may be of independent interest.

2:30pm **Workshop: Zhenkun Li - SCGP 102**

Speaker: Zhenkun Li

Title: 2-torsion in instanton Floer homology

Abstract: Instanton Floer homology, introduced by Floer in the 1980s, has become a power tool in the study of 3-dimensional topology. Its application has led to significant achievements, such as the proof of the Property P conjecture. While instanton Floer homology with complex coefficients is widely studied and conjectured to be isomorphic to the hat version of Heegaard Floer homology, its counterpart with integral coefficients is less understood. In this talk, we will explore the abundance of 2-torsion in instanton Floer homology with integral coefficients and demonstrate how this 2-torsion encodes intriguing topological information about relevant 3-manifolds and knots. This is a joint work with Fan Ye.

3:30pm **Workshop: Tea Time - SCGP Cafe**

Title: Tea Time

4:00pm **Workshop: Anubhav Mukherjee - SCGP 102**

Speaker: Anubhav Mukherjee

Title: Complete Riemannian 4-manifolds with uniformly positive scalar curvature metric

Abstract: In three dimensions, geometry plays a crucial role in classifying the topology of manifolds. Inspired by this, we set out to explore the intricate world of smooth 4-manifolds through the lens of geometry. Specifically, we aim to understand under what conditions a contractible 4-manifold admits a uniform positive scalar curvature metric. In collaboration with Otis Chodosh and Davi Maximo, we demonstrated that in certain cases, the existence of such a metric can provide insight into the topology of 4-manifolds. Moreover, by utilizing Floer theory, we identified obstructions to the existence of such metrics in 4-manifolds.

Tuesday, April 29th

8:30am **Workshop: Breakfast - SCGP Cafe**

Title: Breakfast

9:30am **Workshop: Lenny Ng - SCGP 102**

Speaker: Lenny Ng

Title: Braid varieties from several perspectives

Abstract: Braid varieties, a family of algebraic varieties associated to any positive braid, have recently emerged in several distinct areas of mathematics. They've appeared in symplectic topology through Floer theory and Legendrian contact homology, but also in algebraic geometry through flags and constructible sheaves, and in algebraic combinatorics through cluster theory. I'll discuss the surprising interrelations between these areas, and especially the way that cluster theory provides some new insight into a well-studied low-dimensional symplectic problem: classifying Lagrangian fillings of Legendrian links.

10:30am **Workshop: Coffee Break - SCGP Cafe**

Title: Coffee Break

11:00am **Workshop: Kenji Fukaya - SCGP 102**

Speaker: Kenji Fukaya

Title: Monotone A infinity category and Atiyah-Floer functor

Abstract: In this talk I will explain a work in progress with A. Daemi. We formulate the notion of Monotone A infinity category which for example can be used to study monotone (Immgersed) Lagrangian Floer theory. (It uses different kind of filtration from Floer theory of more general Lagrangian submanifold.) Then I will explain Atiyah-Floer conjecture can be formulated as a functorial equivalence between certain monotone A infinity categories.

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

Title: Lunch

12:00pm **Workshop: Group Photo - SCGP Lobby**

Title: Group Photo

1:00pm **Workshop: Chris Scaduto - SCGP 102**

Speaker: Chris Scaduto

Title: The mapping class group action on the odd character variety is faithful

Abstract: The moduli space of holomorphic rank 2 bundles of odd degree and fixed determinant over a given Riemann surface is a symplectic manifold which has an interpretation as a certain PU(2) character variety. There is a homomorphism from a finite extension of the mapping class group of the surface to the symplectic mapping class group of this moduli space. When the genus is 2 or more, we prove that this homomorphism is injective. The proof uses Floer's instanton homology for 3-manifolds. This is joint work with Ali Daemi.

2:30pm **Workshop: Akram Alishahi - SCGP 102**

Speaker: Akram Alishahi

Title: Compressing surface diffeomorphisms via bordered Floer homology

Abstract: Let F be a closed surface, and \psi be a diffeomorphism of F. An interesting question with nice topological implications for detecting homotopy ribbon fibered knots is whether \psi extends over some handlebody with boundary F. In 1985, Casson-Long gave an algorithm for answering this question. In this talk, first we will discuss how bordered Floer homology can be used to detect whether \psi extends over a specific handlebody. Then, we will outline how to adapt ideas of Casson-Long to use bordered Floer homology to detect whether \psi extends over any compression body. This is a joint work with Robert Lipshitz.

3:30pm **Workshop: Tea Time - SCGP Cafe**

Title: Tea Time

Wednesday, April 30th

8:30am **Workshop: Breakfast - SCGP Cafe**

Title: Breakfast

9:30am **Workshop: Jiakai Li - SCGP 102**

Speaker: Jiakai Li

Title: Monopoles and webs

Abstract: Webs are embedded trivalent graphs in the 3-sphere and foams are singular cobordisms between webs. I will talk about a construction of monopole Floer homology for webs that is functorial under foam cobordisms. Our approach is based on Kronheimer and Mrowka's monopole Floer homology; the ingredients include both real and orbifold Seiberg-Witten theory. There is an interesting analogy between this monopole web homology and the instanton web homology J^?, introduced by Kronheimer and Mrowka.

10:30am **Workshop: Coffee Break - SCGP Cafe**

Title: Coffee Break

11:00am **Workshop: Tom Mrowka - SCGP 102**

Speaker: Tom Mrowka

Title: SU(3) instanton homology for knots and webs

Abstract: I describe some work with Peter Kronheimer on a few variants of SU(3)-instanton homology for knots and webs and potential connections to the corresponding SO(3) groups.

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

Title: Lunch

1:00pm **Workshop: Allison Moore - SCGP 102**

Speaker: Allison Moore

Title: Series valued invariants and plumbed 3-manifolds

Abstract: Given a plumbing tree and a spin-c structure, I will discuss how to construct a plumbed 3-manifold invariant in the form of a Laurent series twisted by a root lattice. Such a series is invariant under the Neumann moves on plumbing trees and the action of the Weyl group. For irreducible root lattices of rank at least 2, there is a collection of such series depending on the combinatorics of the root lattice. These families of invariants generalize the Z-hat series of Gukov-Pei-Putrov-Vafa, Gukov-Manolescu, Park and Ri. They are motivated by the study of the WRT invariants, and the work of Akhmechet-Johnson-Krushkal which found connections with lattice cohomology. Time permitting, I will also discuss a multivariable generalization of the root lattice-twisted series for knot complements and gluing formulas. This is joint work with N. Tarasca.

2:30pm **Workshop: Greg Moore - SCGP 102**

Speaker: Greg Moore

Title: Field Theory and Four-Manifolds: Topological Twisting, K-Theoretic Invariants, and Family Invariants

Abstract: We will review some recent progress in the application of quantum field theory to four-manifold invariants. The talk will begin with a review of some aspects of 2411.14396, written with V. Saxena and R. Singh, on topological twisting of arbitrary d=4, N=2 quantum field theories. We then give an update on a project with J. Manschot, H. Kim, R. Tao, and X. Zhang on evaluation of ``K-theoretic Donaldson Invariants" using 5d supersymmetric Yang-Mills path integrals to reproduce and generalize results of N. Nekrasov and of Gottsche-Nakajima-Yoshioka. Finally, we comment on 2311.08394, written with J. Cushing, M. Rocek, and V. Saxena where coupling d=4 N=2 field theories to background conformal N=2 supergravity gives a generalization of Donaldson invariants of a 4-manifold X to invariants valued in the cohomology of BDiff(X).

3:30pm **Workshop: Tea Time - SCGP Cafe**

Title: Tea Time

4:00pm **Workshop: John Baldwin - SCGP 102**

Speaker: John Baldwin

Title: Instanton Floer homology from Heegaard diagrams

Abstract: Heegaard Floer homology and monopole Floer homology are known to be isomorphic thanks to the monumental work of Taubes et al. But is there a simpler, more axiomatic explanation? And how is instanton Floer homology related to these other theories? I'll talk about work in progress with Zhenkun Li, Steven Sivek, and Fan Ye motivated by these questions. In particular, I'll sketch the construction of a chain complex that computes sutured instanton homology, which is isomorphic as a vector space to the Heegaard Floer chain complex of the sutured manifold. We are currently trying to prove that the differentials on the two sides agree.

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

Title: Banquet Dinner

Thursday, May 1st

8:30am **Workshop: Breakfast - SCGP Cafe**

Title: Breakfast

9:30am **Workshop: Abhishek Mallick - SCGP 102**

Speaker: Abhishek Mallick

Title: Families-version of Donaldson's diagonalization theorem and its applications

Abstract: In this talk, I will discuss various families-version of Donaldson's diagonalization theorem and explore their applications to studying exotic 4-manifolds, surfaces, and diffeomorphisms. Some of these applications answer open questions in the aforementioned fields. This is joint work with Hokuto Konno and Masaki Taniguchi.

10:30am **Workshop: Coffee Break - SCGP Cafe**

Title: Coffee Break

11:00am **Workshop: Hokuto Konno - SCGP 102**

Speaker: Hokuto Konno

Title: On exotic diffeomorphisms of 4-manifolds

Abstract: A diffeomorphism is said to be exotic if it is topologically isotopic to the identity but not smoothly. In this talk, I will explain several new types of exotic diffeomorphisms of 4-manifolds, including the first examples of exotic diffeomorphisms of irreducible 4-manifolds, which is joint work with David Baraglia.

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

Title: Lunch

1:00pm **Workshop: Haochen Qiu - SCGP 102**

Speaker: Haochen Qiu

Title: The Dehn twist on a connected sum of two homology tori

Abstract: Kronheimer and Mrowka showed that the Dehn twist along a 3-sphere in the neck of the connected sum of two K3 surfaces is not smoothly isotopic to the identity. The tool they used is the nonequivariant family Bauer-Furuta invariant, and their result requires that the manifolds are simply connected and the signature of one of them is 16 mod 32. We generalize the S^1-equivariant family Bauer-Furuta invariant to nonsimply connected manifolds, and construct a refinement of this invariant. We use it to show that if X_1, X_2 are two homology tori whose determinants r_1, r_2 are odd, then the Dehn twist along a 3-sphere in the neck of X_1 # X_2 is not smoothly isotopic to the identity.

2:30pm **Workshop: Roberto Ladu - SCGP 102**

Speaker: Roberto Ladu

Title: On the complexity of non-inertial h-cobordisms

Abstract: Morgan-Szabó in '99 defined a notion of complexity for h-cobordisms between 1-connected 4-manifolds and constructed a family of h-cobordisms of diverging complexity. Their examples are all inertial, i.e. the cobordisms have the same ends.
I will show how to construct h-cobordisms of diverging complexity between exotic 4-manifolds. Furthermore, I will refine the result of Morgan-Szabó obtaining a lower-bound on the number of blow-ups needed to find h-cobordisms of non-minimal complexity.
This talk is based on https://arxiv.org/abs/2501.08750

3:30pm **Workshop: Tea Time - SCGP Cafe**

Title: Tea Time

4:00pm **Workshop: Steven Sivek - SCGP 102**

Speaker: Steven Sivek

Title: L-spaces and knot traces

Abstract: Given a knot K in S^3, Gabai proved that the zero-surgery S^3_0(K) determines the Seifert genus of K and whether or not K is fibered. One might hope that in many cases the zero-surgery would uniquely determine the knot K, but this is not known to be true for even a single knot of genus greater than 1. I'll talk about an attempt to address this for higher-genus knots, using a relationship between the knot Floer homology of a fibered knot and the dynamics of its monodromy, in which we understand just enough about zero-surgeries on L-space knots to show that they can all be detected by their zero-traces. This is joint work with John Baldwin.

Friday, May 2nd

8:30am **Workshop: Breakfast - SCGP Cafe**

Title: Breakfast

9:30am **Workshop: Juan Muñoz-Echaniz - SCGP 102**

Speaker: Juan Muñoz-Echaniz

Title: Counting SL(2,C) connections on Seifert-fibered spaces

Abstract: In the recent years, there has been an surge in interest for developing new invariants of 3- and 4-manifolds based on SL(2,C) generalizations of the anti-self-duality equation: in dimension 3, Abouzaid and Manolescu have introduced a sheaf-theoretic SL(2,C) Floer homology; in dimension 4, Tanaka and Thomas have defined Vafa--Witten invariants for complex projective surfaces. These are defined using algebraic techniques (derived critical loci, perverse sheaves, virtual localisation), and it remains unknown how to interpret these invariants from the viewpoint of differential geometry. I will describe an approach to counting flat SL(2,C) connections on Seifert-fibered 3-manifolds using techniques from gauge theory. Namely, I will describe a perturbation of the SL(2,C) Chern--Simons functional which has the effect of `localising' its critical points around a compact set. As an application, we obtain new formulae for the Euler characteristic and Poincaré polynomial of the irreducible locus in the SL(2,C) character variety of a Seifert-fibered homology 3-sphere: in particular, we show that the Euler characteristic equals the Milnor number (divided by four) of any weighted-homogeneous isolated complete intersection singularity whose link is the given 3-manifold--which suggests an SL(2,C) analogue of the Casson Invariant Conjecture of Neumann and Wahl.

10:30am **Workshop: Coffee Break - SCGP Cafe**

Title: Coffee Break

11:00am **Workshop: Kristen Hendricks - SCGP 102**

Speaker: Kristen Hendricks

Title: Equivariant surgery formulas in Heegaard Floer theory

Abstract: A core computational feature of Ozsvath and Szabo's Heegaard Floer theory is its possession of a surgery formula; that is, given a knot K in S^3, the Heegaard Floer three-manifold invariants of Dehn surgery on K can be computed from the knot Floer homology of K, and similarly (albeit more complicatedly) for surgeries on links. In this talk we prove an equivariant version of the Heegaard Floer knot surgery formula for symmetric knots in S^3; that is, given a symmetry on a knot, we compute the induced action on the surgery complex. The proof goes by way of showing naturality of certain bimodules constructed by I. Zemke to encode the data of the link surgery formula. As an application, we show that the kernel of the forgetful map from the equivariant homology cobordism group to the homology cobordism group contains a Z^infty summand. This is joint work with A. Mallick, M. Stoffregen, and I. Zemke.

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

Title: Lunch

1:00pm **Workshop: Tye Lidman - SCGP 102**

Speaker: Tye Lidman

Title: Instanton Floer homology and cosmetic surgeries

Abstract: The Cosmetic Surgery Conjecture predicts two different Dehn surgeries on the same knot always gives different three-manifolds. We discuss how the Chern-Simons filtration on instanton Floer homology can help approach this problem. This allows us to reduce the conjecture to essentially one case. This is joint work with Ali Daemi and Mike Miller Eismeier.

3:30pm **Workshop: Tea Time - SCGP Cafe**

Title: Tea Time