

# Physics and mathematics of knot homologies workshop Talk Schedule

Events for:  
Monday, June 1st - Friday, June 5th

## Monday, June 1st

9:30am **Paul Wedrich - SCGP 102**

**Title:** Deformations of type A link homologies.

**Abstract:** I will start by explaining how deformations help to answer two important questions about the family of (colored)  $sl(N)$  link homology theories: What geometric information about links do they contain? What relations exist between them? I will recall Lee's deformation of Khovanov homology and sketch how it generalizes to the case of colored  $sl(N)$  link homology. The result is a decomposition theorem for deformed colored  $sl(N)$  link homologies, which leads to new spectral sequences between various type A link homologies and to new concordance invariants in the spirit of Rasmussen's  $s$ -invariant. Part of this is joint work with David E. V. Rose.

10:30am **Coffee Break**

11:00am **Lenny Ng - SCGP 102**

**Title:** Knot contact homology, string topology, and the knot group

**Abstract:** Knot contact homology is a Floer-theoretic knot invariant that counts holomorphic curves with boundary on the conormal bundle to a knot. I'll describe a topological interpretation for a specialization of knot contact homology, via "string homology", which is defined using operations from string topology. I'll then discuss how one can use this to prove that knot contact homology detects the unknot and (by work of Tye Lidman) torus knots. This is joint work in progress with Kai Cieliebak, Tobias Ekholm, and Janko Latschev

2:15pm **Ed Witten - SCGP 102**

**Title:** The Jones Polynomial and Khovanov Homology From Gauge Theory

**Abstract:** I will describe the gauge theory approach in which the Jones polynomial and Khovanov homology are described by counting the solutions of certain partial differential equations. I will especially describe the Nahm pole boundary condition that plays an important role in this story.

4:00pm **Clay Cordova - SCGP 102**

**Title:** Experimental Results in Quiver Representation Theory

**Abstract:** A will present recent results from quiver representation theory relevant to computing BPS degeneracies in four-dimensional field theories. First I will discuss the asymptotics of Euler characteristics of quiver moduli spaces, and second I will describe a connection to two-dimensional chiral algebras.

**Tuesday, June 2nd**

9:30am **Raphael Rouquier - SCGP 102**

**Title:** Tensor structures for 2-representations

**Abstract:** I will discuss the construction of tensor products of 2-representations of Lie algebras, and the extra structures (braidings, twists...) coming into play. This is aimed at constructing five dimensional topological quantum field theories categorifying the Witten-Reshetikhin-Turaev theories. as advocated by Crane and Frenkel.

10:30am **Coffee Break**

11:00am **Mohammed Abouzaid - SCGP 102**

**Title:** Khovanov Homology from Floer cohomology

**Abstract:** Seidel and Smith constructed a Floer theoretic knot invariant which they conjectured to agree with Khovanov homology. I will explain joint work with Ivan Smith, which has been recently completed, leading to a proof of this conjecture. Time permitting, I will comment on the fact that we can construct a second grading on Floer theory, and on the remaining work needed to establish that it yields a knot invariant.

1:00pm **Mina Aganagic - SCGP 102**

**Title:** Knots and String Duality

**Abstract:** String theory is changing the nature of the relationship between mathematics and physics. I will try to explain why, through the example of knot theory.

4:00pm **Albrecht Klemm - SCGP 102**

**Title:** Knot Invariants from Topological Recursion on Augmentation Varieties

**Wednesday, June 3rd**

9:30am **Satoshi Nawata**

**Title:** Knot invariants and knot homology: extensions to colored cases

**Abstract:** I will start by explaining the TQFT methods to study colored quantum knot invariants. Especially, the focus is put on how HOMFLY polynomials colored by non-rectangular representations distinguish mutant knots. Then, I will describe the properties and the relationships of colored HOMFLY and Kauffman homology. Furthermore, I also mention the properties of links and its relation to modular transformations in 3d/3d correspondence.

10:30am **Coffee Break**

11:00am **Amer Iqbal - SCGP 102**

**Title:** Hopf link and instanton calculus

**Abstract:** I will discuss the relation between Hopf link invariant obtained from topological open strings and instanton calculus. The relation together with properties of Hopf link invariant will allow us to write down the refined topological string partition function of local  $P^2$ .

1:15pm **Lev Rozansky**

**Title:** 2d defects in  $D=4$ ,  $N=4$  YM and triply graded link homology

**Abstract:** This is an introduction to the forthcoming talk of A. Oblomkov about our joint work on constructing the HOMFLY-PT link homology by using a matrix factorization presentation of a category related to the 2d defect appearing in the paper of S. Gukov and E. Witten on tame ramifications in Langlands theory.

2:30pm **Robert Lipshitz - SCGP 102**

**Title:** Khovanov homotopy types and the Burnside category

**Abstract:** We will give a simplified construction of the Khovanov homotopy types previously defined by L-Sarkar and Hu-Kriz-Kriz. We will also discuss the combinatorial structures underlying the construction, and some modest topological applications. This is joint work with Tyler Lawson and Sucharit Sarkar.

**Thursday, June 4th**

9:30am **Eric Zaslow - SCGP 102**

**Title:** Knot Clusters

**Abstract:** Given a Legendrian knot in the cosphere bundle of a Riemann surface, I will define an isotopy-invariant category. It is a category of constructible sheaves on the surface, or equivalently the unwrapped Fukaya category of Lagrangian "fillings" of the knot. The moduli space of "rank-one" objects in this category is a cluster variety, with each geometric filling giving rise to a cluster chart. For judicious choices of Legendrian, we recover many familiar cluster varieties. This is joint work with Vivek Shende, David Treumann and Harold Williams.

10:30am **Coffee Break**

11:00am **Alexander Shumakovitch - SCGP 102**

**Title:** Knot invariants arising from homological operations on Khovanov homology.

**Abstract:** There are several homological operations that can be defined between even and odd Khovanov homology theories using the unified even/odd Khovanov homology theory developed by Putyra. We discuss these homological operations and show how they can give rise to new knot invariants with interesting properties. This is a joint work with Krzysztof Putyra.

2:15pm **Junya Yagi - SCGP 102**

**Title:** Quiver gauge theories and integrable lattice models

**Abstract:** I will discuss connections among supersymmetric quiver gauge theories, topological quantum field theories (TQFTs), and integrable lattice models in statistical mechanics. This work combines ideas from (1) the correspondence between class-S theories and TQFTs; (2) "gauge/YBE correspondence" between  $N=1$  supersymmetric indices and solutions of the Yang-Baxter equation; and (3) Costello's construction of integrable lattice models from TQFTs equipped with line operators.

4:00pm **Tudor Dimofte - SCGP 102**

**Title:** Moduli spaces, boundary conditions, and interfaces in 3d  $N=4$  theory

**Abstract:** Three-dimensional gauge theories with  $N=4$  supersymmetry have moduli spaces of great geometric interest. They are typically hyperkahler cones, whose deformation quantization produces (e.g.) universal enveloping algebras of type ADE. I will discuss boundary conditions and interfaces in these theories, which provide (respectively) modules and bimodules for the quantum algebras. Some special classes of interfaces correspond to Hecke correspondences and braid actions, which can be used to give a construction of knot homology in 3d  $N=4$  theory.

**Friday, June 5th**

9:30am **Peter Samuelson - SCGP 102**

**Title:** Hecke algebras, the torus, and knots

**Abstract:** Double affine Hecke algebras have recently been used to construct 2-variable polynomials  $P(K;q,t)$  for algebraic knots that are conjecturally related to knot homology, and are therefore conjectured to specialize to Witten-Reshetikhin-Turaev invariants. In work with Morton we showed that the Homflypt skein algebra of the torus is isomorphic to the elliptic Hall algebra (i.e. the  $\mathfrak{gl}(\infty)$  DAHA). This identification provides a simple topological interpretation for the formula for  $P(K;q,t)$  and gives a proof that  $P(K;q,t)$  specializes to the Homfly polynomial of  $K$ .

10:30am **Coffee Break**

11:00am **Alexei Morozov - SCGP 102**

**Title:** Advances in knot polynomials

**Abstract:** Review of recent computational advances for ordinary and virtual knots and of the "experimental results" extracted from this new data.

1:00pm **Marco Stosic - SCGP 102**

**Title:** Colored HOMFLY-PT homology of knots and links, and recursion relations

**Abstract:** We shall describe the properties of the colored HOMFLY-PT homology of knots and links, and how that can be used to determine the recursion relations between colored superpolynomials. We shall also describe some of the powerful information that is contained in the classical limit of such recursion relations - the (super)-A-polynomial - and in the algebraic curve that it determines.

2:30pm **Alexei Oblomkov**

**Title:** Knot homology of torus knots

**Abstract:** Joint work with Lev Rozansky. We propose a method for computing triply graded homology of knots that allows us to compute explicitly the homology of torus knots and match the answer with the Hilbert scheme of  $\mathbb{C}^2$  formulas for the superpolynomial.