

From Representation Theory to Mathematical Physics and Back

Events for:
Tuesday, May 31st - Saturday, June 4th

Tuesday, May 31st

9:00am **Breakfast - Simons Center Cafe**

10:00am - **SCGP 103**

Speaker: Anna Lachowska

Title: New developments on the small quantum group

Abstract: In 2017 Igor Frenkel proposed a formula for the dimension of the center of the small quantum group $u_q(\mathfrak{sl}_n)$ associated to the Lie algebra \mathfrak{sl}_n odd integer l , coprime to n . I will describe the progress made since then in establishing this formula and more generally in understanding the structure of the center of $u_q(\mathfrak{g})$. This is a joint work with Nicolas Hemelsoet and Oscar Kivinen.

11:00am **Lunch - Simons Center Cafe**

1:00pm **SCGP Weekly Talk: Alistair Savage - SCGP 103**

Speaker: Alistair Savage

Title: Diagratisation

Abstract: We will explain how one can construct diagrammatic presentations of categories of representations of Lie groups and their associated quantum groups using only a small amount of information about these categories. To illustrate the technique in concrete terms, we will focus on the exceptional Lie group of type F_4 .

2:00pm **Coffee - Simons Center Cafe**

2:30pm - **SCGP 103**

Speaker: Anton Zeitlin

Title: q-opers and the geometric aspects of the Bethe ansatz

Abstract: The relation between the spectra of Gaudin models and the special type of connections on the projective line, called opers, is known for already around 20 years, serving as an example of the geometric Langlands correspondence. In this talk, I will review the recently constructed q-deformation of this example, which describes the correspondence between integrable models based on Yangians and quantum groups (XXX and XXZ models) and the q-difference generalization of opers (q-opers). In addition, I will talk about applications of q-opers in various aspects of integrable models, including quantum/classical duality and ODE/IM correspondence, as well as their use in the enumerative geometry of quiver varieties.

This talk is based on joint work with E. Frenkel, P. Koroteev, and D. Sage.

3:30pm **Tea Time - Simons Center Cafe**

4:00pm **- Zoom**

Speaker: Mikhail Kapranov

Title: Fourier transform for perverse schobers and the Algebra of the Infrared.

Abstract: The Algebra of the Infrared (AIR) of Gaiotto, Moore and Witten is an algebraic structure involving convex geometry that relates various categorical data of a massive 2d supersymmetric theory. The talk, based on joint work with Y. Soibelman and L. Soukhanov, will argue that the natural mathematical framework for this structure is the concept of perverse schobers, categorical analogs of perverse sheaves. More precisely, many constructions of the AIR can be seen, in our approach, as providing the analog (categorification) of the geometric Fourier transform for perverse schobers on the complex line \mathbb{C} .

5:00pm **- SCGP Cafe**

Wednesday, June 1st

9:00am **Breakfast - Simons Center Cafe**

9:30am **- Zoom**

Speaker: Nicolai Reshetikhin

Title: Quantum spin Calogero-Moser systems and the 2D Yang-Mills theory revisited again.

Abstract: In the first part of the talk I will define quantum N-point spin Calogero-Moser (CM) systems. In the second part I will show that the partition function for the 2D Yang-Mills model on a surface with corners is a solution to quantum CM evolution with special initial conditions and will introduce point observables. The relation of these topics to quantum Chern-Simons theory and invariants of 3-manifolds will be outlined in the third part of the talk.

10:30am **Coffee Break - Simons Center Cafe**

11:00am - **SCGP 103**

Speaker: Samson Shatashvili

Title: On Scientific Interactions with Igor: New Developments

Abstract: TBA

12:00pm **Lunch - Simons Center Cafe**

1:45pm - **SCGP 103**

Speaker: Lev Rozansky

Title: Symplectic algebraic geometry and 2-categorification

Abstract: This is a joint work with A. Oblomkov. It often happens that (1) an algebra A is categorified by coherent sheaves over a symplectic variety, (2) its generators are represented by sheaves supported on Lagrangian subvarieties and (3) the cones in the r.h.s. of the structure relations split. We conjecture that in this case the algebra admits a 2-categorification and present an outline of its construction.

2:45pm - **Simons Center Cafe**

3:00pm - **SCGP 103**

Speaker: Ed Witten

Title: Algebras and Black Holes

Abstract: I will try to explain the idea that "black hole entropy," which can be understood as the entropy of a state of a Type II von Neumann algebra.

4:00pm **Tea Time - Simons Center Cafe**

4:30pm **- SCGP 103**

Speaker: Sergei Gukov

Title: Exotic VOAs and Quantum Topology at generic q

Abstract: The goal of this talk is to share three surprises. One is related to a categorification of Witten-Reshetikhin-Turaev (WRT) invariants of 3-manifolds. The other two are about the relation of this problem to Vertex Operator Algebra (VOA).

Thursday, June 2nd

9:30am **Breakfast - Simons Center Cafe**

10:30am **- Zoom**

Speaker: Boris Feigin

Title: Fermionic formulas for the triplet-like algebras

Abstract: In the talk I will try to explain how to write the fermionic formulas for the characters that arise from geometry and representation theory. I also explain how to get fix-point type expressions for the characters from fermionic formulas

11:30am **Lunch - Simons Center Cafe**

1:15pm **- SCGP 103**

Speaker: Pavel Etingof

Title: Symmetric tensor categories in positive characteristic

Abstract: A celebrated theorem of Deligne (2002) says that every symmetric tensor category of moderate growth over \mathbb{C} is super-Tannakian (i.e., admits a fiber functor to the category of supervector spaces, which means that it is the representation category of a supergroup). But in characteristic p the situation is a lot more complicated and interesting. Namely, the (braided) Verlinde category of integrable representations of the affine Lie algebra $\widehat{\mathfrak{sl}}_2$ at level p^n-2 which occurs in the Wess-Zumino-Witten conformal field theory has a reduction modulo p such that the braiding becomes symmetric. The resulting category Ver_{p^n} is semisimple for $n=1$ and was defined in this case by Gelfand-Kazhdan and Georgiev-Mathieu in early 1990s, but for $n>1$ it is not semisimple and was constructed only 2 years ago. The categories Ver_{p^n} form a nested sequence and are incompressible (do not admit fiber functors into smaller categories). We conjecture that any symmetric tensor category of moderate growth in characteristic p has a fiber functor into $\mathrm{Ver}_{p^\infty} = \bigcup_n \mathrm{Ver}_{p^n}$. We also show that such a category has a fiber functor to Ver_p if and only if it is Frobenius exact, i.e. its Frobenius functor is exact. In particular, this includes semisimple categories, which has powerful applications to modular representation theory of finite groups. Also this reduces the study of Frobenius exact categories of moderate growth to Lie theory in Ver_p , an exciting new subject of future research already having a number of very interesting results but even more open problems. The talk is based on joint work with D. Benson, K. Coulembier and V. Ostrik, arXiv:2003.10499, arXiv:2107.02372.

2:15pm - **Simons Center Cafe**

2:30pm - **SCGP 103**

Speaker: Nikita Nekrasov

Title: TBA

Abstract: TBA

3:30pm **Tea Time - Simons Center Cafe**

4:00pm - **SCGP 103**

Speaker: Yongchang Zhu

Title: Unitary Representations of Simple Groups over Semifields

Abstract: totally nonnegative matrices with determinant 1 can be considered as $SL(n)$ over the semifield of non-negative real numbers. In this talk, we will discuss unitary representations of simple groups over semifields. We will give a classification of irreducible representations of $SL(2)$ over the discrete tropical field and give a new family of dual pairs. Relations with scattering systems and zeta functions will also be discussed.

6:00pm - **SCGP Cafe**

Friday, June 3rd

9:00am **Breakfast - Simons Center Cafe**

9:30am - **SCGP 103**

Speaker: Ivan Losev

Title: Springer, Procesi, and Cherednik.

Abstract: The talk is based on a joint work with Pablo Boixeda Alvarez. We study equivariant Borel-Moore homology of certain affine Springer fibers and relate them to global sections of suitable vector bundles arising from Procesi bundles on \mathbb{Q} -factorial terminalizations of symplectic quotient singularities. We use this relation to derive some information on the center of the principal block of the small quantum group. Our main technique is based on studying bimodules over Cherednik algebras.

10:30am **Coffee Break - Simons Center Cafe**

11:00am - **Zoom**

Speaker: Gregory Moore

Title: Three Birthday Nuggets For Igor

Abstract: I will briefly sketch four projects, all still in progress, closely related to topics which have been of interest to Igor Frenkel: 1. We show how to construct a superconformal generator in the ``Beauty & Beast" spin lift of the Frenkel-Lepowsky-Meurman VOA whose automorphism group is the Monster. 2. We classify time-reversal-invariant spin Abelian Chern-Simons-Witten theories, and conjecture a general criterion for time-reversal invariance of arbitrary Chern-Simons-Witten theories. 3. We discuss, very briefly, two generalizations of the physical approach to Donaldson invariants of four-dimensional smooth manifolds: (a) Generalizations to families of manifolds and (b) ``K-theoretic" generalizations of Donaldson invariants, as formulated via 5d SYM.

12:00pm **Lunch - Simons Center Cafe**

1:45pm - **SCGP 103**

Speaker: Nora Ganter

Title: Codes, Vertex operators and Topological modular forms - a report on joint work with Gerd Laures

Abstract: TBA

2:45pm - **Simons Center Cafe**

3:00pm - **SCGP 103**

Speaker: Tomoyuki Arakawa

Title: 4D/2D duality and representation theory

Abstract: Vertex (operator) algebra (VOA) is an algebraic object introduced by Borchers and Frenkel-Lepowsky-Meurman, which provides a mathematical framework for two-dimensional chiral conformal field theory. Therefore, as a matter of course, it was not originally expected that VOAs have anything to do with quantum field theories in dimension higher than two. However, it has been recently observed that VOAs do appear in higher dimensional quantum field theories. I will talk about a remarkable example of such appearance of VOAs, more precisely the 4D/2D duality by Beem-Lemos-Liendo-Peelaers-Rastelli-van Rees, from representation theoretic perspective.

4:00pm **Tea Time - Simons Center Cafe**

4:30pm **- SCGP 103**

Speaker: Andrei Okounkov

Title: The Eisenstein spectrum

Abstract: TBA

Saturday, June 4th

9:00am **Breakfast - Simons Center Cafe**

9:30am **- SCGP 103**

Speaker: Mikhail Khovanov

Title: Link homology: from categories to foams

Abstract: We review the development of link homology, including the appearance of various categories, including highest weight categories and those of matrix factorizations in link homology, and the more recent combinatorial approach to the $GL(N)$ link homology due to Louis-Hadrien Robert and Emmanuel Wagner via foam evaluation.

10:30am **Coffee Break - Simons Center Cafe**

11:00am - **ZOOM**

Speaker: Mina Aganagic

Title: Knot categorification from homological mirror symmetry

Abstract: Khovanov showed in '99 that the Jones polynomial arises as the Euler characteristic of a homology theory. The knot categorification problem is to find a general construction of knot homology groups and to explain their meaning: what are they homologies of? Homological mirror symmetry, formulated by Kontsevich in '94, naturally produces hosts of homological invariants. Sometimes, it can be made manifest, and then its striking mathematical power comes to fore. Typically though, it leads to invariants which have no particular interest outside of the problem at hand. I will explain that there is a vast new family of mirror pairs of manifolds for which homological mirror symmetry does lead to interesting invariants, and solves the knot categorification problem.

12:00pm **Lunch - Simons Center Cafe**

1:30pm - **SCGP 103**

Speaker: Andrei Negut

Title: Quantum loop groups for general types

Abstract: We define quantum loop groups for general symmetrizable Cartan matrices, by imposing relations that generate the kernel of the natural Hopf pairing (analogous to q -Serre relations for the usual quantum groups).

2:30pm - **Simons Center Cafe**

2:45pm - SCGP 103

Speaker: Hyun Kyu Kim

Title: A deformation quantization of moduli spaces of 3-dimensional gravity

Abstract: In this talk, I will present a deformation quantization of the moduli space of maximal globally hyperbolic Lorentzian metrics on $S \times \mathbb{R}$ with constant sectional curvature Λ , for a punctured surface S . Although this moduli space is known to be symplectomorphic to the cotangent bundle of the Teichmüller space of S regardless of the value of Λ , the deformation quantization we provide depends on Λ . Using special coordinate systems, this moduli space can be viewed as the set of points of a cluster X -variety valued in the ring of generalized complex numbers $\mathbb{R}_\Lambda = \mathbb{R}[\ell]/(\ell^2 + \Lambda)$. We first review quantum theory of Teichmüller spaces and cluster X -varieties, and then develop an \mathbb{R}_Λ -version of it by establishing \mathbb{R}_Λ versions of the quantum dilogarithm function, which yields a sought-for quantization. As a consequence, we obtain three families of projective unitary representations of the mapping class group of S . For $\Lambda < 0$ these representations recover those of Fock and Goncharov, while for $\Lambda \geq 0$ the representations seem to be new. This is based on 2112.13329, joint with C. Scarinci.

3:45pm - Simons Center Cafe

4:00pm - SCGP 103

Speaker: Igor Frenkel

Title: On representation theory and mathematical physics: some remarks

Abstract: