RGM 2022 Poster Session Abstracts

Rhea Palak Bakshi (Institute for Theoretical Studies, ETH Zurich)

Title: The KBSM of the connected sum of handlebodies

Abstract: Skein modules were introduced by Józef H. Przytycki as generalisations of the Jones and HOMFLYPT polynomial link invariants in the 3-sphere to arbitrary 3-manifolds. The Kauffman bracket skein module (KBSM) is the most extensively studied of all. However, computing the KBSM of a 3-manifold is known to be notoriously hard, especially over the ring of Laurent polynomials. With the goal of finding a definite structure of the KBSM over this ring, several conjectures and theorems were stated over the years for KBSMs. We show that some of these conjectures, and even theorems, are not true. In this talk I will briefly discuss a counterexample to Marche's generalisation of Witten's conjecture. I will show that a theorem stated by Przytycki in 1999 about the KBSM of the connected sum of two handlebodies does not hold. I will also give the exact structure of the KBSM of of the connected sum of two solid tori and show that it is isomorphic to the KBSM of a genus two handlebody modulo some specific handle sliding relations. Moreover, these handle sliding relations can be written in terms of Chebyshev polynomials.

Aleksander Cianciara (Brown University)

Title: N-extended Supersymmetry, Polytopic Representation theory, and Homological Quantum Error Correction

Abstract: We propose an algorithm for recursively generating N-extended supermultiplets given minimal representations of off-shell, N = 1 supermultiplets. Using hopping operators, it is shown that the 8! vertices of the permutahedron of order 8 can be uniquely mapped to 5040 octets that are constrained in location on the permutahedron by a magic number rule. These constructions using the hopping operators match the construction obtained by tensoring elements of lower dimensional supermultiplets together. It is shown that N-extended supermultiplets (represented by higher dimensional permutahedra) may be recursively constructed using lower dimensional permutahedra as the building blocks. Since the faces of an arbitrary order permutahedron contain supercharges of lower dimensional theories, this hints towards the possibility of developing a polytopic representation theory of supersymmetry.

Sally Collins (Georgia Tech)

Title: The Mazur pattern, the figure eight knot, and smooth concordance

Abstract: In this poster, we give a pair of rationally slice knots which are not smoothly concordant, but whose 0-surgery manifolds are homology cobordant rel meridians. One knot in the pair is the figure eight knot, which has concordance order 2; all previous examples of such pairs of knots have been infinite order.

Gianluca Faraco (University of Bonn)

Title: Realizing period characters on connected components of strata.

Abstract: Let S be an oriented surface of genus g and n punctures. The periods of any meromorphic differential on S, with respect to a choice of complex structure, determine a representation $\chi:\Gamma_{g,n} \to\mathbb C$ where $\Gamma_{g,n}$ is the first homology group of S. Chenakkod-F.-Gupta recently characterize the representations that thus arise, that is, lie in the image of the period map $\textsf{Per}:\Omega\mathcal{M}_{g,n}\to \textsf{Hom}(\Gamma_{g,n},\Bbb C)$. This generalizes a classical result of Haupt in the holomorphic case. Moreover, we determine the image of this period map when restricted to any stratum of meromorphic differentials, having prescribed orders of zeros and poles. Strata generally fail to be connected and in fact they may exhibits connected components parametrised by some additional invariants. In collaboration with D. Chen we extend the earlier result by Chenakkod-F.-Gupta to connected components of strata.

Christopher Guevara (Tufts University)

Title: Moduli of finite-codimensional subalgebras of (k[[t]])^m

Abstract: In 1980, Shihoko Ishii constructed the moduli space of delta-codimensional k-subalgebras of k[[t]], and called this the delta-territory of k[[t]]. These subalgebras arise as the complete local rings at unibranch curve singularities, so in a sense this moduli space encodes how singularities can be "glued" to smooth curves. It is natural to want to find an analogous moduli space for m-branch curve singularities, since the complete local rings at these points are subalgebras of the direct sum (k[[t]])^m. In this poster, I recursively construct the "glued" territories of (k[[t]])^m, and show that they are connected schemes.

Yangrui Hu (Brown University)

Title: Geometrization of 1D, N-extended Super-Poincaré algebra and SUSY holography conjecture

Abstract: Deciphering the mathematical structures in the one-dimensional supersymmetric models that secretly encode the information of higher-dimensional counterparts is one of the key tasks in the SUSY holography conjecture. The graphical representations of 1D, N-extended Super-Poincaré algebra provide a powerful tool.

In this work, a conjecture is made that the weight space for 4D, N-extended supersymmetrical representations is embedded within the permutohedra associated with permutation groups $\mathbb{S}_d$. The fact that Klein's Vierergruppe of $\mathbb{S}_4$ plays the role of Hopping operators provides strong evidence supporting this conjecture. It is shown that the appearance of the mathematics of 4D, N = 1 minimal off-shell supersymmetry representations is equivalent to solving a four-color problem on the truncated octahedron. This observation suggests an entirely new way to approach the off-shell SUSY auxiliary field problem based on IT algorithms probing the properties of $\mathbb{S}_d$.

Xiaobin Li (Southwest Jiaotong University)

Title: When Nekrasov partition function meets orientifold 5-plane in the thermodynamic limit

Abstract: In this talk, I will discuss new dualities appearing in 5d N = 1 Sp(N) gauge theory with N_f (≤ 2N + 3) flavors based on 5-brane web diagram with O5-plane. On the one hand, I will introduce Seiberg-Witten curve based on the dual graph of the 5-brane web with O5-plane. On the other hand, I will

briefly explain the computations about the Nekrasov partition function based on the topological vertex formalism with O5-plane. Rewriting it in terms of profile functions, we obtain the saddle point equation for the profile function after taking thermodynamic limit. By introducing the resolvent, the corresponding Seiberg-Witten curve and boundary conditions are derived and the relations with the prepotential in terms of the cycle integrals are discussed. They coincide with those directly obtained from the dual graph of the 5-brane web with O5-plane. This agreement gives further evidence for mirror symmetry which relates Nekrasov partition function with Seiberg-Witten curve in the case with orientifold plane and shed light on the non-toric Calabi-Yau 3-folds including D-type singularities. This is joint work with Futoshi Yagi.

Yeqin Liu (University of Illinois at Chicago)

Title: Higher Rank Brill-Noether theory on $\mathbb{P}^{2}$

Abstract: In this poster I will use very visual way to exhibit fundamental geometric properties of Brill-Noether loci in the moduli space of stable sheaves on $\mathbb{P}^{2}$, primarily focusing on (non)emptiness and (ir)reducibility. For the first part, I will introduce an upper bound and a lower bound on the maximal possible h^{0} of a stable sheaf in terms of its given Chern character, and point out the range where the bounds are sharp. For the second part, I will introduce a large collection of both irreducible and reducible Brill-Noether loci, and we shall see that in some sense "most" Brill-Noether loci are reducible. This poster is based on joint work with Benjamin Gould and Woohyung Lee.

Daniel López Neumann (Indiana University)

Title: Genus bounds from twisted Drinfeld doubles

Abstract: We propose a general construction of ``non-semisimple" quantum invariants of knots whose degrees give lower bounds to the Seifert genus. Our genus bound recovers known bounds, such as Friedl-Kim's bound for twisted Alexander polynomials, but also produces new ones, such as for the so called ADO invariants (of any simple Lie algebra at any root of unity). Our construction relies on Turaev's G-graded extension of the Reshetikhin-Turaev construction at the twisted Drinfeld double of a Hopf algebra.

Khanh Nguyen Duc (University at Albany)

Title: A Murnaghan-Nakayama Rule for Grothendieck Polynomials of Grassmannian Type

Abstract: The Grothendieck polynomials appearing in the K-theory of Grassmannians are analogs of Schur polynomials. We establish a version of the Murnaghan-Nakayama rule for Grothendieck polynomials of the Grassmannian type. This rule allows us to express the product of a Grothendieck polynomial with a power sum symmetric polynomial into a linear combination of other Grothendieck polynomials.

Shubham Sinha (UC San Diego)

Title: Euler characteristics of tautological bundles over Quot scheme of curves.

Abstract: We find explicit formulas for the Euler characteristics of tautological bundles over punctual Quot schemes of smooth projective curve C that parameterize zero-dimensional quotients of a vector bundle E over C. The formulas suggest analogies between the Quot schemes of curves and the Hilbert scheme of points of surfaces. Our proofs rely on Atiyah-Bott localization, universality results (of Ellingsrud, Gottsche, and Lehn), and the combinatorics of Schur functions. For higher rank quotients, we obtain expressions in genus 0. This is joint work with Dragos Oprea.

Gregory Taylor (University of Illinois at Chicago)

Title: Asymptotic Syzygies of Secant Varieties of Curves

Abstract: We analyze the minimal free resolution of secant varieties of high degree curves. In particular, we study the Boij-Soderberg decomposition of these resolutions and conclude normal distribution of the Betti numbers. These results generalize results of Erman and Ein-Erman-Lazarsfeld.

Misha Tyomkin (Dartmouth)

Title: On numbers associated with a strong Morse function

Abstract: Morse function f on a manifold M is called strong if all its critical points have different critical values. Given a strong Morse function f and a field F we construct a bunch of elements of F, which we call Bruhat numbers (they're defined up to sign). More concretely, Bruhat number is written on each bar in the barcode of f (a.k.a. Barannikov decomposition). It turns out that if homology of M over F is that of a sphere, then the product of all the numbers is independent of f. We then construct the barcode and Bruhat numbers with twisted (a.k.a. local) coefficients and prove that the mentioned product equals to the Reidemeister torsion of M. In particular, it's again independent of f. This way we link Morse theory to the Reidemeister torsion via barcodes. Based on a joint work with Petya Pushkar, https://arxiv.org/abs/2012.05307.

David White (North Carolina State University)

Title: Symplectic Instanton Knot Homology

Abstract: There have been a number of constructions of Lagrangian Floer homology invariants for 3-manifolds defined in terms of symplectic character varieties arising from Heegaard splittings. We develop a relative variant of one of these, due to H. Horton, for a knot $K \subset Y$ in a closed, oriented 3-manifold, which we call \emph{symplectic instanton knot homology} (SIK). This work draws upon the already extensive study done on the symplectic properties of character varieties with suitable holonomy restrictions. The nature of our construction is motivated in large part by the prospect of its extension to a quilted Floer homology associated to Cerf decomposition of Y and concomitant tangle decomposition of K, building on the Floer field theory for tangles created by Wehrheim and Woodward.