RICHMOND GEOMETRY MEETING 2024
POSTER SESSION

1. Titles and Abstracts

(1) Ishan Banerjee (The Ohio State University) —*Cancelled*

Title: *Geometric monodromy of algebraic curves in algebraic surfaces*

Abstract: Let X be an algebraic surface and L an ample line bundle on it. I am interested in understanding the monodromy associated to the family of all smooth curves lying in the linear system $|L|$, in particular I am interested in the image of the monodromy homomorphism to the mapping class group. I will first discuss some context and known results. I will then describe two sets of new results- the first involving what constraints arise due to X having a nontrivial fundamental group and the second (joint with Nick Salter) describing the image completely in the case of complete intersections.

(2) Nilangshu Bhattacharyya (Louisianna State University)

Title: *Lipschitz-Sarkar stable homotopy type for planar trivalent graph with perfect matchings*

Abstract: Lipschitz-Sarkar constructed stable homotopy types for the Khovanov homology of links in S^3. Following that, Kauffman-Nikonov-Ogasa found a family of stable homotopy types for the homotopical Khovanov homology for links in thickened surfaces. Baldridge gave a cohomology theory which categorifies 2-factor polynomial of planar trivalent graphs with perfect matchings. In this presentation, I will construct stable homotopy type for the Baldridge cohomology theory and show that the stable homotopy type is invariant of the planar trivalent graphs with perfect matchings.

(3) Devin Brown (Northeastern University)

Title: *Crystals and the Cactus Group*

Abstract: Kashiwara crystals, visualized as directed graphs with colored edges, arise in the study of representations of quantum groups. They have numerous applications across mathematics as well as in statistical mechanics and particle physics. The cactus group acts on crystals by Lusztig's involutions which generalize the Schützenberger involution in type A in which the action is well understood. We study the cactus action for crystals in type D corresponding to multiples of minuscule weights using so-called combinatorial toggles which are defined using heaps and reverse plane partitions. We show that the action is generated by one

and two element subsets of the type D_m Dynkin diagram for the crystals associated to multiples of the first fundamental weight.

(4) Alan Du (Caltech)

Title: *Heegaard Floer Surgery Formula and Cosmetic Surgeries*

Abstract: Two Dehn surgeries on a knot are called cosmetic if they yield homeomorphic three-manifolds. We show for a certain family of null-homologous knots in any closed orientable three-manifold, if the knot admits cosmetic surgeries with a pair of positive surgery coefficients, then the coefficients are both greater than 1. In addition, for this family of knots, we show that 1/q Dehn surgery for q at least 2 is not homeomorphic to the original three-manifold. The proofs of these results use the mapping cone formula for the Heegaard Floer homology of Dehn surgery in terms of the knot Floer homology of the knot.

(5) Zengrui Han (Rutgers University)

Title: *GKZ Hypergeometric Systems and Their Applications to Mirror Symmetry*

Abstract: Homological mirror symmetry predicts the existence of an isotrivial family of triangulated categories over the stringy Kahler moduli space associated to an affine toric Gorenstein singularity. The fibers of the family in the neighborhood of the large volume limits are given by the derived categories of crepant resolutions of the singularity. While the construction of such a family is currently unknown, its de-categorification is known as the GKZ hypergeometric system and is relatively well-understood.

In this project, we obtained duality theorem and studied the "analytic continuation = Fourier-Mukai" phenomenon for such systems. Furthermore, we demonstrated the importance of these systems by using them to prove the equality of A-brane and B-brane central charges for Hori-Vafa mirrors, thereby settling a conjecture of Hosono in 2004.

(6) Irit Huq-Kuruvilla (Virginia Tech)

Title: *Quantum K-Rings of Partial Flag Varieties*

Abstract: Based on physical predictions coming from the theory of 3d gauged linear sigma models, Gu-Mihalcea-Sharpe-Xu-Zhang-Zhou conjectured a presentation of the equivariant quantum K-theory of partial flag varieties in type A was given by a certain deformation of the Whitney relations for the classical equivariant K-theory.

We prove the conjecture for any partial flag variety by introducing a quantum product involving twisted Gromov-Witten invariants, and proving an abelian-nonabelian correspondence relating the quantum K-ring of the partial flag variety to

the twisted quantum K-ring of its associated toric GIT quotient. This procedure also gives a mathematical interpretation of the appearance of the Bethe Ansatz in the corresponding GLSM.

(7) Alexandros Kafkas (Purdue University)

Title: *Residues of logarithmic connections and equivariant Riemann-Roch corrections terms.*

Abstract: Given a smooth surface X with a finite group action, we have the notion of a G-equivariant line bundle on X. The virtual Euler characteristic of the equivariant line bundle is the virtual representation of the alternating sum of the representations of G on the cohomology groups. We will give an approach to calculating equivariant Riemann-Roch correction terms using logarithmic connections and residue formulas.

(8) Amit Kumar (Louisiana State University)

Title: *Graph Coloring: A defect TFT approach*

Abstract: We first notice that the combinatorial matter of graph coloring is actually quantum in nature: satisfying the sum over the intermediate state property of a Quantum Field Theory. It turns out that there is indeed a topological field theory of certain kind that gives meaning to it. This TFT has the property that when evaluated on a planar trivalent graphs, it gives the number of Tait-Coloring of it. This certain kind is called defects and can be thought as a generalisation of groups. With the Klein-four group as 1-defect condition, we redefine graph coloring, and for a general finitely presented group, we interpret the word problem as a cobordism problem.

(9) Ruoxi Li (The University of Pittsburg)

Title: *Motivic classes of stacks in finite characteristic and applications to stacks of Higgs bundles and bundles with connections*

Abstract: Let X be a smooth projective curve over a field k. The following additive categories associated with X will be of primary interest to us: the category of Higgs bundles and the category of vector bundles with connections. The moduli stacks of objects of these categories are Artin stacks locally of finite type. Furthermore, these categories have homological dimensions two. Hence one can apply to them the theory of motivic Donaldson–Thomas invariants developed by Kontsevich and Soibelman and ask about explicit formulas for the motivic DT-series.

We will first give some background of the motivic classes of varieties and stacks. Then we will introduce a generalized Hua's formula to compute the motivic classes for bundles with endomorphisms. In particular, we highlight the motivic classes for bundles with connections.

(10) Haggai Liu (Simon Fraser University)

Title: *Moduli Spaces of Weighted Stable Curves and their Fundamental Groups*

Abstract: The Deligne-Mumford compactification, $\overline{M_{0,n}}$, of the moduli space of n distinct ordered points on $\mathbb{P}^1$, has many well understood geometric and topological properties. For example, it is a smooth projective variety over its base field. Many interesting properties are known for the manifold $\overline{M_{0,n}}(\mathbb{R})$ of real points of this variety. In particular, its fundamental group, $\pi_1(\overline{M_{0,n}}(\mathbb{R}))$, is related, via a short exact sequence, to another group known as the cactus group. Henriques and Kamnitzer gave an elegant combinatorial presentation of this cactus group. In 2003, Hassett constructed a weighted variant of $\overline{M_{0,n}}(\mathbb{R})$: For each of the n labels, we assign a weight between 0 and 1; points can coincide if the sum of their weights does not exceed one. We seek combinatorial presentations for the fundamental groups of Hassett spaces with certain restrictions on the weights. In particular, we express the Hassett space as a blow-down of $\overline{M_{0,n}}$ and modify the cactus group to produce an analogous short exact sequence. The relations of this modified cactus group involves extensions to the braid relations in S_n. To establish the sufficiency of such relations, we consider a certain cell decomposition of these Hassett spaces, which are indexed by ordered planar trees.

(11) Yuze Luan (University of California Davis) **Title:** *Components of the nested Hilbert scheme of points on non-reduced plane curves*

Abstract: We classify all the components of the nested Hilbert scheme of n and $n+1$ points on a non-reduced plane curve. All the components have dimension n, and are labeled by some multi-partition of n. Parallel to Nakajima's construction, we propose a potential correspondence and induced maps from the homology of the Hilbert scheme of n points to the Hilbert scheme of $n+1$ points on a non-reduced plane curve.

(12) Patrick Martin (North Carolina State University)

Title: *Torsion in Magnitude Homology of Graphs*

Abstract: Recent developments have been made in the magnitude homology of graphs. Giusti and Menara developed a theory of Eulerian and discriminant magnitude homology just this year. In 2018 Kaneta and Yoshinaga answered the question, "is there a graph with torsion in its magnitude homology," by using the face poset of RP^2. And in 2021 Sazdanovic and Summers expounded upon this by extending Kaneta and Yoshinaga's technique to lens spaces. Here we asnwer the question, "is there torsion in eulerian/discriminant magnitude homology and is there a graph with less edges and vertices than the example given by Kaneta and Yoshinaga (RP^2) which has torsion in its magnitude homology?"

(13) Everett Meike (North Caroline State University) and John Carney (Virginia Commonwealth University)

Title: *Cataloguing 2-adjacent Knots*

Abstract: Generalizing unknotting number, we call a knot K n-adjacent to the unknot if there exists a diagram D of K containing n crossings such that changing any subset of them results in unknotting the knot. For results of $n > 2$, Askitas and Kalfagianni (2002) construct all n-adjacent knots. In their study, they found that many invariants of n-adjacent knots disappear. In this study, we give methods for constructing 2-adjacent knots and catalog all of them with 12 or fewer crossings in a minimal crossing diagram via various knot invariants.

(14) William Newman (The Ohio State University)

Title: *Chow Groups of Moduli Spaces Via Higher Chow Groups*

Abstract: In this poster, I show how one can use Bloch's higher Chow groups to compute the Chow groups of some moduli spaces. This involves first computing the necessary higher Chow groups, and then computing the connecting homomorphism of the localization exact sequence. The main examples will be computations of integral Chow rings of moduli spaces of genus 1 curves with a few marked points.

(15) Yu Shen (Michigan State University)

Title: *Derived category of certain maximal order on $\mathbb{P}^2$.*

Abstract: We show moduli space of A-line bundles with the minimal second Chern class is a fine moduli space, where A is a maximal quaternion order on $\mathbb{P}^2$ ramified along a smooth quartic. Moreover, we prove that there is a fully faithful embedding from the derived category of this moduli space into the derived category of A-modules. This is a new direction in studying derived categories of maximal orders.

(16) Kevin Summers (Virginia Tech)

Title: *A dual basis for the equivariant quantum K-theory of cominuscule varieties*

Abstract: The equivariant quantum K-theory ring of a flag variety is a Frobenius algebra equipped with a perfect pairing called the quantum K- metric. It is known that in the classical K-theory ring for a given flag variety the ideal sheaf basis is dual to the Schubert basis with regard to the sheaf Euler characteristic. We define a quantization of the ideal sheaf basis for the equivariant quantum K-theory of cominuscule flag varieties. These quantized ideal sheaves are then dual to the Schubert basis with regard to the quan- tum K-metric. We prove explicit type-uniform combinatorial formulae for the quantized ideal sheaves in terms of the Schubert basis for any cominuscule flag variety. We also provide an application

ultilizing the quantized ideal sheaves to calculate the Schubert structure constants associated to multiplication by the top exterior power of the tautological quotient bundle in $QK_T(Gr(k,n))$.