



Representation Theory, Calabi–Yau Manifolds, and Mirror Symmetry

Nov. 28–Dec.1, 2022

Monday November 28, 2022

8:30am – 8:55am	Refreshments	
8:55am – 9:00am	Opening remarks by Horng-Tzer Yau	
9:00am – 9:45am	Shing-Tung Yau (via Zoom)	<p>Title: The Hull-Strominger system through conifold transitions</p> <p>Abstract: In this talk I discuss the geometry of CY manifolds outside of the Kähler regime and especially describe the Hull-Strominger system through the conifold transitions.</p>
10:00am – 10:45am	Chenglong Yu (via Zoom)	<p>Title: Commensurabilities among Lattices in $PU(1,n)$</p> <p>Abstract: In joint work with Zhiwei Zheng, we study commensurabilities among certain subgroups in $PU(1, n)$. Those groups arise from the monodromy of hypergeometric functions. Their discreteness and arithmeticity are classified by Deligne and Mostow. Thurston also obtained similar results via flat conic metrics. However, the classification of the lattices among them up to conjugation and finite index (commensurability) is not completed. When $n = 1$, it is the commensurabilities of hyperbolic triangles. The cases of $n = 2$ are almost resolved by Deligne-Mostow and Sauter’s commensurability pairs, and commensurability invariants by Kappes-Möller and McMullen. Our approach relies on the study of some higher dimensional Calabi-Yau type varieties instead of complex reflection groups. We obtain some relations and commensurability indices for higher n and also give new proofs for existing pairs in $n = 2$.</p>
11:00am – 11:45am	Thomas Creutzig (via Zoom)	<p>Title: Shifted equivariant W-algebras</p> <p>Abstract: The CDO of a compact Lie group is a family of VOAs whose top level is the space of functions on the Lie group. Similar structures appear at the intersections of boundary conditions in 4-dimensional gauge theories, I will call these new families of VOAs shifted equivariant W-algebras. I will introduce these algebras, construct them and explain how they can be used to quickly prove the GKO-coset realization of principal W-algebras.</p>
11:45am – 1:30 pm	Lunch	
1:30pm – 2:15pm	Cumrun Vafa	<p>Title: Reflections on Mirror Symmetry</p>

		<p>Abstract: In this talk I review some of the motivations leading to the search and discovery of mirror symmetry as well as some of the applications it has had.</p>
2:30pm – 3:15pm	Jonathan Mboyo Esole	<p>Title: Algebraic topology and matter representations in F-theory</p> <p>Abstract: Recently, it was observed that representations appearing in geometric engineering in F-theory all satisfy a unique property: they correspond to characteristic representations of embedding of Dynkin index one between Lie algebras. However, the reason why that is the case is still being understood. In this talk, I will present new insights, giving a geometric explanation for this fact using K-theory and the topology of Lie groups and their classifying spaces. In physics, this will be interpreted as conditions on the charge of instantons and the classifications of Wess-Zumino-Witten terms.</p>
3:15pm – 3:45 pm	Break	
3:45pm – 4:30pm	Weiqiang Wang	<p>Title: A Drinfeld presentation of affine i-quantum groups</p> <p>Abstract: A quantum symmetric pair of affine type (U, U^i) consists of a Drinfeld-Jimbo affine quantum group (a quantum deformation of a loop algebra) U and its coideal subalgebra U^i (called i-quantum group). A loop presentation for U was formulated by Drinfeld and proved by Beck. In this talk, we explain how i-quantum groups can be viewed as a generalization of quantum groups, and then we give a Drinfeld type presentation for the affine quasi-split i-quantum group U^i. This is based on joint work with Ming Lu (Sichuan) and Weinan Zhang (Virginia).</p>
4:45pm – 5:30pm	Tony Pantev	<p>Title: Decomposition, anomalies, and quantum symmetries</p> <p>Abstract: Decomposition is a phenomenon in quantum physics which converts quantum field theories with non-effectively acting gauge symmetries into equivalent more tractable theories in which the fields live on a disconnected space. I will explain the mathematical content of decomposition which turns out to be a higher categorical version of Pontryagin duality. I will examine how this duality interacts with quantum anomalies and secondary quantum symmetries and will show how the anomalies can be canceled by homotopy coherent actions of diagrams of groups. I will discuss in detail the case of 2-groupoids which plays a central role in anomaly cancellation and will describe a new duality operation that yields decomposition in the presence of anomalies. The talk is based on joint works with Robbins, Sharpe, and Vandermeulen.</p>

Tuesday, November 29, 2022

8:30am – 9:00am	Refreshments	
9:00am – 9:45am	Robert MacRae (via Zoom)	<p>Title: Rationality for a large class of affine W-algebras</p> <p>Abstract: One of the most important results in vertex operator algebras is Huang’s theorem that the representation category of a “strongly rational” vertex operator algebra is a semisimple modular tensor category. Conversely, it has been conjectured that every (unitary) modular tensor category is the representation category of a strongly rational (unitary) vertex operator algebra. In this talk, I will describe my results on strong rationality for a large class of affine W-algebras at admissible levels. This yields a large family of modular tensor categories which generalize those associated to affine Lie algebras at positive integer levels, as well as those associated to the Virasoro algebra.</p>
10:00am – 10:45am	Bailin Song (via Zoom)	<p>Title: The global sections of chiral de Rham complexes on compact Calabi-Yau manifolds</p> <p>Abstract: Chiral de Rham complex is a sheaf of vertex algebras on a complex manifold. We will describe the space of global sections of the chiral de Rham complexes on compact Calabi-Yau manifolds.</p>
11:00am – 11:45am	Carl Lian (via Zoom)	<p>Title: Curve-counting with fixed domain</p> <p>Abstract: The fixed-domain curve-counting problem asks for the number of pointed curves of fixed (general) complex structure in a target variety X subject to incidence conditions at the marked points. The question comes in two flavors: one can ask for a virtual count coming from Gromov-Witten theory, in which case the answer can be computed (in principle) from the quantum cohomology of X, or one can ask for the “honest” geometric count, which tends to be more subtle. The answers are conjectured to agree in the presence of sufficient positivity, but do not always. I will give an overview of some recent results and open directions. Some of this work is joint with Alessio Cela, Gavril Farkas, and Rahul Pandharipande.</p>
11:45am – 01:30pm	Lunch	
1:30pm – 2:15pm	Chin-Lung Wang	<p>Title: A blowup formula in quantum cohomology</p> <p>Abstract: We study analytic continuations of quantum cohomology $QH(Y)$ under a blowup $\phi: Y \rightarrow X$ of complex projective manifolds along the extremal ray variable q^{ℓ}. Under $H(Y) = \phi^* H(X) \oplus K$ where $K = \ker \phi_*$, we show that (i) the restriction of quantum product along the $\phi^* H(X)$ direction, denoted by $QH(Y)_X$, is meromorphic in $x := 1/q^{\ell}$, (ii) K deforms uniquely to a quantum ideal \widetilde{K} in $QH(Y)_X$, (iii) the quotient ring $QH(Y)_X / \widetilde{K}$ is regular over x, and its restriction to $x = 0$ is isomorphic to $QH(X)$. This is a joint work (in progress) with Y.-P. Lee and H.-W. Lin.</p>

2:30pm – 3:15pm	Ivan Loseu	<p>Title: Quantizations of nilpotent orbits and their Lagrangian subvarieties</p> <p>Abstract: I'll report on some recent progress on classifying quantizations of the algebras of regular functions of nilpotent orbits (and their covers) in semisimple Lie algebras, as well as the classification of quantizations of certain Lagrangian subvarieties. An ultimate goal here is to understand the classification of unitary representations of real semisimple Lie groups.</p>
3:15pm – 3:45pm	Break	
3:45pm – 4:30pm	Mauricio Romo	<p>Title: Networks and BPS Counting: A-branes view point</p> <p>Abstract: I will review the countings of BPS invariants via exponential/spectral networks and present an interpretation of this counting as a count of certain points in the moduli space of A-branes corresponding to degenerate Lagrangians.</p>
4:45pm – 5:30pm	Flor Orosz Hunziker	<p>Title: Tensor structures associated to the N=1 super Virasoro algebra</p> <p>Abstract: We have recently shown that there is a natural category of representations associated to the N=1 super Virasoro vertex operator algebras that have braided tensor structure. We will describe this category and discuss the problem of establishing its rigidity at particular central charges. This talk is based on joint work in progress with Thomas Creutzig, Robert McRae and Jinwei Yang.</p>

Wednesday, November 30, 2022

8:30am – 9:00am	Refreshments	
9:00am – 9:45am	Tomoyuki Arakawa	<p>Title: 4D/2D duality and representation theory</p> <p>Abstract: This talk is about the 4D/2D duality discovered by Beem <i>et al.</i> rather recently in physics. It associates a vertex operator algebra (VOA) to any 4-dimensional superconformal field theory, which is expected to be a complete invariant of thl theory. The VOAs appearing in this manner may be regarded as chiralization of various symplectic singularities and their representations are expected to be closely related with the Coulomb branch of the 4D theory. I will talk about this remarkable 4D/2D duality from a representation theoretic perspective.</p>
10:00am – 10:45am	Shashank Kanade	<p>Title: Combinatorics of principal W-algebras of type A</p> <p>Abstract: The combinatorics of principal $W_r(p,p')$ algebras of type A is controlled by cylindric partitions. However, very little seems to be known in general about fermionic expressions for the corresponding characters. Welsh’s work explains the case of Virasoro minimal models $W_2(p,p')$. Andrews, Schilling and Warnaar invented and used an A_2 version of the usual (A_1) Bailey machinery to give fermionic characters (up to a factor of $(q)_{\infty}$) of some, but not all, $W_3(3,p')$ modules. In a recent joint work with Russell, we have given a complete set of conjectures encompassing all of the remaining modules for $W_3(3,p')$, and proved our conjectures for small values of p'. In another direction, characters of $W_r(p,p')$ algebras also arise as appropriate limits of certain sl_r coloured Jones invariants of torus knots $T(p,p')$, and we expect this to provide further insights on the underlying combinatorics.</p>
11:00am – 11:45am	Gufang Zhao	<p>Title: Quasimaps to quivers with potentials</p> <p>Abstract: This talk concerns non-compact GIT quotient of a vector space, in the presence of an abelian group action and an equivariant regular function (potential) on the quotient. We define virtual counts of quasimaps from prestable curves to the critical locus of the potential. The construction borrows ideas from the theory of gauged linear sigma models as well as recent development in shifted symplectic geometry and Donaldson-Thomas theory of Calabi-Yau 4-folds. Examples of virtual counts arising from quivers with potentials are discussed. This is based on work in progress, in collaboration with Yalong Cao.</p>
11:45am – 1:30pm	Lunch	
1:30pm – 2:15pm	Yaping Yang	<p>Title: Cohomological Hall algebras and perverse coherent sheaves on toric Calabi-Yau 3-folds</p> <p>Abstract: Let X be a smooth local toric Calabi-Yau 3-fold. On the cohomology of the moduli spaces of certain sheaves on X, there is an action of the cohomological Hall algebra (COHA) of Kontsevich and Soibelman via “raising operators.” I will discuss the “double” of the COHA that acts on the cohomology of the moduli space by adding the “lowering operators.” We</p>

		associate a root system to X . The double COHA is expected to be the shifted Yangian of this root system. We also give a prediction for the shift in terms of an intersection pairing. We provide evidence of the aforementioned expectation in various examples. This is based on my joint work with M. Rapcak, Y. Soibelman, and G. Zhao.
2:30pm – 3:15pm	Fei Han	<p>Title: Graded T-duality with H-flux for 2d sigma models</p> <p>Abstract: T-duality in string theory can be realised as a transformation acting on the worldsheet fields in the two-dimensional nonlinear sigma model. Bouwknegt-Evslin-Mathai established the T-duality in a background flux for the first time upon compactifying spacetime in one direction to a principal circle by constructing the T-dual maps transforming the twisted cohomology of the dual spacetimes. In this talk, we will describe our recent work on how to promote the T-duality maps of Bouwknegt-Evslin-Mathai in two aspects. More precisely, we will introduce (1) graded T-duality, concerning the graded T-duality maps of all levels of twistings; (2) the 2-dimensional sigma model picture, concerning the double loop space of spacetimes. This represents our joint work with Mathai.</p>
3:15pm – 3:45pm	Break	
3:45pm – 4:30pm	Matt Kerr (via Zoom)	<p>Title: K_2 and quantum curves</p> <p>Abstract: The basic objects for this talk are motives consisting of a curve together with a K_2 class, and their mixed Hodge-theoretic invariants.</p> <p>My main objective will be to explain a connection (recently proved in joint work with C. Doran and S. Sinha Babu) between (i) Hodge-theoretically distinguished points in the moduli of such motives and (ii) eigenvalues of operators on $L^2(\mathbb{R})$ obtained by quantizing the equations of the curves.</p> <p>By local mirror symmetry, this gives evidence for a conjecture in topological string theory (due to M. Marino, A. Grassi, and others) relating enumerative invariants of toric CY 3-folds to spectra of quantum curves.</p>
4:45pm – 5:30pm	Shinobu Hosono	<p>Title: Mirror symmetry of abelian fibered Calabi-Yau manifolds with $\rho = 2$</p> <p>Abstract: I will describe mirror symmetry of Calabi-Yau manifolds fibered by $(1,8)$-polarized abelian surfaces, which have Picard number two. Finding a mirror family over a toric variety explicitly, I observe that mirror symmetry of all related Calabi-Yau manifolds arises from the corresponding boundary points, which are not necessarily toric boundary points. Calculating Gromov-Witten invariants up to genus 2, I find that the generating functions are expressed elliptic (quasi-)modular forms, which reminds us the modular anomaly equation found for elliptic surfaces. This talk is based on a published work with Hiromichi Takaki (arXiv:2103.08150).</p>
6:00pm	Banquet at Royal East Restaurant, 782 Main St, Cambridge, MA 02139	

Thursday, December 1, 2022

8:30am – 9:00am	Refreshments	
9:00am – 9:45am	Conan Nai Chung Leung (via Zoom)	<p>Title: Quantization of Kahler manifolds</p> <p>Abstract: I will explain my recent work on relationships among geometric quantization, deformation quantization, Berezin-Toeplitz quantization and brane quantization.</p>
10:00am – 10:45am	Cuipo Jiang (via Zoom)	<p>Title: Cohomological varieties associated to vertex operator algebras</p> <p>Abstract: We define and examine the cohomological variety of a vertex algebra, a notion cohomologically dual to that of the associated variety, which measures the smoothness of the associated scheme at the vertex point. We study its basic properties. As examples, we construct a closed subvariety of the cohomological variety for rational affine vertex operator algebras constructed from finite dimensional simple Lie algebras. We also determine the cohomological varieties of the simple Virasoro vertex operator algebras. These examples indicate that, although the associated variety for a rational \mathbb{C}_2-cofinite vertex operator algebra is always a simple point, the cohomological variety can have as large a dimension as possible. This talk is based on joint work with Antoine Caradot and Zongzhu Lin.</p>
11:00am – 11:45am	Anne Moreau (via Zoom)	<p>Title: Action of the automorphism group on the Jacobian of Klein's quartic curve</p> <p>Abstract: In a joint work with Dimitri Markouchevitch, we prove that the quotient variety of the 3-dimensional Jacobian of the plane Klein quartic curve by its full automorphism group of order 336 is isomorphic to the 3-dimensional weighted projective space with weights 1,2,4,7.</p> <p>The latter isomorphism is a particular case of the general conjecture of Bernstein and Schwarzman suggesting that a quotient of the n-dimensional complex space by the action of an irreducible complex crystallographic group generated by reflections is a weighted projective space.</p> <p>In this talk, I will explain this conjecture and the proof of our result. An important ingredient is the computation of the Hilbert function of the algebra of invariant theta-functions on the Jacobian.</p>
11:45am – 11:50am	Closing remarks	
11:50am	Free discussions and departure	