The 3rd KTGU Mathematics Workshop for Young Researchers

Title and Abstract

Plenary Talk

Tomoyuki Arakawa (RIMS, Kyoto University)

Title: *Chiralization of Moore-Tachikawa $2d$ TQFTs*

Abstract: Recently it was conjectured in physics that the Higgs branches of four-dimensional $N=2$ superconformal field theories coincide with the associated varieties of the corresponding vertex algebras. We confirm this conjecture for the theory of class S by upgrading the Moore-Tachikawa $2d$ TQFTs, whose existence was recently proved by Braverman, Finkelberg and Nakajima, to the setting of vertex algebras.

Algebra Session

Shih-Yu Chen (National Taiwan University, Taiwan)

Title: *Pullback formula for nearly holomorphic Saito-Kurokawa lifts*

Abstract: Period integral of automorphic forms often related to critical values of L-functions. It has important application to the analytic and algebraic theory of L-functions. In this talk we concern with a special case, namely the pullback of Saito-Kurokawa lifts. We generalize the explicit formula of Ichino to higher level modular forms and lift the condition on weights. It turns out that we need to consider nearly holomorphic Saito-Kurokawa lifts. As an application, we obtain new cases for Deligne's conjecture for central critical values of certain automorphic L-functions for $GL_3 \times GL_2$.

Chun Yin Hui (Tsinghua University, China)

Title: *Maximality of Galois actions for abelian varieties*

Abstract: Let A be a non-CM elliptic curve defined over a number field K. A well-known theorem of Serre states that when l is sufficiently large, the Galois action on the l-adic Tate module of A is as large as possible, i.e., equal to $GL_2(Z_l)$. In this talk, I will describe a joint work with Michael Larsen, generalizing Serre's theorem to all abelian varieties.

Myungho Kim (Kyung Hee University, Korea)

Title: *Generalized quantum affine Schur-Weyl duality*

Abstract: Generalized quantum affine Schur-Weyl duality is a way to construct functors between a category of finite dimensional graded modules over a quiver Hecke algebras and a category of finite dimensional integrable modules over a quantum affine algebras. It is a generalization of the quantum affine Schur-Weyl duality, on which the affine Hecke algebra and the quantum affine algebra of untwisted type A are the players. In this talk, I will explain the construction of the functors and show some interesting examples. This is a joint work with S.-J. Kang, M. Kashiwara, S.-J. Oh.

Koichiro Sawada (RIMS, Kyoto University)

Title: *Finiteness of isomorphism classes of hyperbolic polycurves with prescribed fundamental groups*

Abstract: A hyperbolic polycurve is a successive extension of families of hyperbolic curves, which have been regarded as a typical example of "an anabelian variety". In other words, roughly speaking, a hyperbolic polycurve over a certain type of a field may be completely determined by its arithmetic fundamental group. In this talk, I will first review some known results on the anabelian geometry of hyperbolic polycurves and then show that a hyperbolic polycurve is determined by its arithmetic fundamental group up to finitely many possibilities.

Gufang Zhao (Institute of Science and Technology, Austria)

Title: *Quiver varieties and elliptic quantum groups*

Abstract: In this talk I will define a sheafified elliptic quantum group for any symmetric Kac-Moody Lie algebra, based on my joint work with Yaping Yang. This definition is naturally obtained from the elliptic cohomological Hall algebra of a preprojective algebra. The sheafified elliptic quantum group is an algebra object in a certain monoidal category of coherent sheaves on the colored Hilbert scheme of an elliptic curve. This monoidal structure is related to the factorisation structure of Beilinson-Drinfeld. I will show that the elliptic quantum group acts on the equivariant elliptic cohomology of Nakajima quiver varieties. Taking suitable rational sections provides Drinfeld currents, which satisfy the commutation relations of the dynamical elliptic quantum group studied by Felder and Gautam-Toledano Laredo. In type-A, the sheafified elliptic quantum group is Schur-Weyl dual to the elliptic affine Hecke algebra of Ginzburg-Kapranov-Vasserot. If time permits, I will also talk about the representations of the latter, based on my joint work with Changlong Zhong.

Geometry Session

Huai-Liang Chang (Hong Kong University of Science and Technology, Hong Kong)

Title: *MSP theory: counting curves in quintic Calabi-Yau threefolds*

Abstract: Gromov-Witten theory counts complex curves in a Calabi-Yau (CY) manifold. In many cases the manifold admits Landau-Ginzburg phases, and the (LG) counting also enjoys symplectic and algebro-geometric constructions. Recently a new moduli space, called Mixed Spin P field (MSP), is provided to quantize the parameter linking CY to LG phases. One of its consequence is recovery of Zinger's formula on $g=1$ quintic GW invariants. We will report on the MSP constructions and its applications.

Atsushi Kanazawa (Kyoto University)

Title: *Calabi-Yau fibrations and Landau-Ginzburg models*

Abstract: I will propose a new construction of Landau-Ginzburg models by splitting Calabi-Yau fibrations. The motivation comes from the Doran-Harder-Thompson conjecture, which builds a bridge between mirror symmetry for Calabi-Yau manifolds and that for quasi-Fano manifolds. A rational elliptic surface will be studied as supporting evidence of my proposal.

Jack Smith (University College London, UK)

Title: *Quantum cohomology of toric varieties*

Abstract: Toric varieties provide a rich source of examples in symplectic topology and algebraic geometry. One of the earliest predictions of mirror symmetry is that the quantum cohomology of such a variety should be isomorphic to the Jacobian ring of a superpotential, which counts holomorphic discs with boundary on a Lagrangian torus fibre. I will describe a new algebraic approach to (re)proving this conjecture, building on the pioneering work of Fukaya-Oh-Ohta-Ono.

Hiro Lee Tanaka (Harvard University, USA)

Title: *Morse theory and a stack of broken lines*

Abstract: I'll talk about recent progress in re-formulating Morse theory as a deformation problem. A central player is a stack classifying broken Morse trajectories, over which all Morse theory seems to live. This is joint work with Jacob Lurie.

Tony Yue Yu (Paris University, France)

Title: *The Frobenius structure conjecture in dimension two*

Abstract: The Frobenius structure conjecture is a conjecture about the geometry of rational

curves in log Calabi-Yau varieties proposed by Gross-Hacking-Keel. It was motivated by the study of mirror symmetry. It predicts that the enumeration of rational curves in a log Calabi-Yau variety gives rise naturally to a Frobenius algebra satisfying nice properties. In a joint work with S. Keel, we prove the conjecture in dimension two. Our method is based on the enumeration of non-archimedean holomorphic curves developed in my thesis. We construct the structure constants of the Frobenius algebra directly from counting non-archimedean holomorphic disks. If time permits, I will also talk about compactification and extension of the algebra.

Analysis Session

Sebastian Herr (Bielefeld University, Germany)

Title: *Nonlinear Dirac equations*

Abstract: The focus of this talk will be on the longtime behavior of solutions of cubic Dirac equations (Soler model) and of the Dirac-Klein-Gordon system. After an introduction, recent results on global existence and scattering will be presented. Further, connections to Euclidean harmonic analysis will be outlined.

Elena Luca (University of California San Diego, USA)

Title: *A new transform approach to biharmonic boundary value problems in circular domains with applications to Stokes flows*

Abstract: Motivated by modelling challenges arising in microfluidics and low-Reynolds-number swimming, we present a new transform approach for solving biharmonic boundary value problems in two-dimensional polygonal and circular domains. The method is an extension of earlier work by Crowdy & Fokas [Proc. Roy. Soc. A, 460, (2004)] and provides a unified general approach to finding quasi-analytical solutions to a wide range of problems in low-Reynolds-number hydrodynamics and plane elasticity.

Mathav Murugan (University of British Columbia, Canada)

Title: *Heat flow on snowballs*

Abstract: Quasisymmetric maps are fruitful generalizations of conformal maps. Quasisymmetric uniformization problem seeks for extensions of uniformization theorem beyond the classical context of Riemann surfaces. The goal of this talk is to show that

quasisymmetric uniformization problem is closely related to random walks and diffusions. I will explain how the existence of quasisymmetric maps is equivalent to heat kernel estimates for the simple random walk on a family of planar graphs. The same methods also apply to diffusions on a class of fractals homeomorphic to the 2-sphere. These ideas will be illustrated using snowballs and their graph approximations. Snowballs are high dimensional analogues of Koch snowflake.

Chikara Nakamura (RIMS, Kyoto University)

Title: *Cutoff Phenomenon for Lamplighter Chains on Fractals*

Abstract: Suppose that a given graph G is equipped a lamp for each vertex of G. A lamplighter random walk on G is a random walk which not only moves on the graph G but also switches a lamp randomly. The cutoff phenomenon is one of the central topic in the theory of finite Markov chain. In this talk, we consider the lamplighter random walks in the case where the underlying graphs are fractals, and discuss the cutoff phenomenon for the lamplighter random walks. All necessary notions such as the cutoff phenomenon and fractals will be explained in the talk. Based on a joint work with Amir Dembo and Takashi Kumagai.

Poster Session

Hirotaka Kakuhama	Dept. of Math.	(Algebra)
Akira Sarashina	RIMS	Reconstruction of one-punctured elliptic curves in positive characteristic by their geometric fundamental groups
Ryo Fujita	Dept. of Math.	Geometric realization of Dynkin quiver type quantum affine Schur-Weyl duality
Yuki Hirano	Dept. of Math.	(Geometry)
Yota Shamoto	RIMS	(Geometry)
Kei Noba	Dept. of Math.	(Analysis)
Toru Sera	Dept. of Math.	Limit theorem for occupation ratio measures of infinite ergodic transformations
Takahiro Mori	RIMS	(Analysis)