Mathematics and Superstring Theory

-Unlocking the Mysteries of the Accelerating Universe through Superstring Theory and Astrophysical Observations –

Date: 21 -23 March, 2017

Venue: Seminar room B, Kavli IPMU, The University of Tokyo

< Title and Abstract >

・Atsushi Kanazawa (Kyoto U)

Title: On recent progress of Doran-Harder-Thompson conjecture

Abstract: I will discuss Doran-Harder-Thompson conjecture from the view point of SYZ mirror symmetry. The conjecture claims that when a Calabi-Yau manifold X degenerates to a union of two quasi-Fano manifolds (Tyurin degeneration), a mirror Calabi-Yau manifold of X can be constructed by ”gluing” the two mirror Landau-Ginzburg models of the quasi-Fano manifolds. This remarkable conjecture builds a bridge between mirror symmetry for Calabi-Yau manifolds and that for quasi-Fano manifolds. I will show a few examples and discuss a possible application to produce new mirrors.

・Georg Oberdieck (MIT)

Title : Enumerative geometry of elliptic fibrations and modular forms

Abstract : The enumerative geometry of Calabi-Yau threefolds is expected to be related to modular forms, and to reflect geometric properties of the underlying variety. A beautiful example arises for elliptically fibered Calabi-Yau threefold.

Physics arguments by Huang, Katz and Klemm predict here that curve counting invariants form Jacobi forms. On the mathematics side the origin of the modularity is becoming clearer.

Part of the modularity arises from sheaf theory. Fourier-Mukai transforms with respect to the Poincare line bundle of the fibration yield modular constraints.

The other part has origins in Gromov-Witten theory. After sketching these ideas, the talk will discuss new progress in the Gromov-Witten theory of elliptic fibrations, in particular with a focus on holomorphic anomaly equation.

The leading example we discuss is the product of a K3 surface and an elliptic curve, and the relation of its invariants to the Igusa cusp form, a Siegel modular form.

The sheaf theory part is joint work with Junliang Shen, the Gromov-Witten part is joint work with Aaron Pixton.

・**Yinbang Lin (Tsinghua U)**

Title : Moduli spaces of stable pairs

Abstract : A stable pair is a coherent sheaf with a section, under a stability condition, which I will define. I will review Thaddeus' method to compute Verlinde numbers over curves using moduli spaces of stable pairs. I will then generalize the notion of stable pair and construct the corresponding moduli space. I will also talk about related deformation-obstruction theory.

・**Kyoung-Seog Lee (IBS Center for Geometry and Physics)**

Title : Triangulated subcategories in derived categories of coherent sheaves on Fano orbifolds

Abstract : When a triangulated category is embedded in the derived category of coherent sheaves on a variety or stack then there are interesting relations between the category and geometry. I will discuss some examples of such situations. Then I will discuss which triangulated categories can be embedded in derived categories of coherent sheaves on Fano orbifolds.

・**Akishi Ikeda (Kavli IPMU)**

Title : Homological and monodromy representations of framed braid groups

Abstract : In this talk, we introduce two new classes of representations of the framed braid groups. One is the homological representation constructed as the action of a mapping class group on a certain homology group. The other is the monodromy representation of the confluent KZ equation, which is a generalization of the KZ equation to have irregular singularities.

We also give a conjectural equivalence between these two classes of representations.

・**Mauricio Romo (IAS)**

Title : Aspects of B-twisted (2,2) and (0,2) hybrid models

Abstract : I will talk about properties and definition of certain sphere correlators for elements on the chiral ring of B-twisted hybrid models for the case they posses (2,2)

and (0,2) supersymmetry. I will review these models and their B-chiral ring. Invariance of these correlators under the extended Kahler moduli allows us to make predictions about Landau-Ginzburg correlators involving twisted fields and interesting properties of residue-type integrals.

・**Nezhla Aghaee (U Bern)**

Title : The topic of my talk is "Quantization of Super Teichmueller spaces

Abstract : We construct a quantisation of the Teichmueller spaces of super Riemann surfaces using coordinates associated to ideal triangulations of super Riemann surfaces. A new feature is the non-trivial dependence on the choice of a spin structure which can be encoded combinatorially in a certain refinement of the ideal triangulation. By constructing a projective unitary representation of the groupoid of changes of refined ideal triangulations we demonstrate that the dependence of the resulting quantum theory on the choice of a triangulation is inessential.

・**Ivan Ip (Kyoto U)**

Title : Generalized Teichmüller Spaces, Spin Structures, and Ptolemy Transformations

Abstract : Teichmüller space is a fundamental space that is important in many areas of mathematics and physics. In recent times generalizations of this space have been intensely studied. Examples of such higher Teichmüller spaces are given by the so-called super-Teichmüller spaces, with structural groups given by supergroups. These appear as a natural object when studying a combinatorial approach to spin structures on Riemann surfaces and the generalization to supermanifolds. In this talk, we give a substantial simplification of the formulation of the spin structures and describe the N=1 and N=2 super-Teichmüller space using the analogue of Penner coordinates. (Joint work with Robert Penner and Anton Zeitlin.)

・**Shamil Shakirov (Harvard U)**

Title : Integrability of refined Chern-Simons theory

Abstract : It is known that Chern-Simons topological quantum field theory admits a one-parameter continuous deformation -- refinement -- in the genus 1 sector. I will describe a genus 2 generalization of this fact. Just like in the torus case, the crucial role is played by an interesting quantum-mechanical integrable system. This system

is a genus 2 generalization of trigonometric Ruijsenaars-Schneider model.

・**Pietro Longhi (Uppsala U)**

Title : BPS Graphs of Class S Theories

Abstract : BPS quivers and Spectral Networks are two powerful tools for computing BPS spectra in 4d N=2 theories. On the Coulomb branches of these theories, the BPS spectrum is well-defined only away from walls of marginal stability, where wall-crossing occurs.

What happens to networks and quivers at marginal stability? Surprisingly, a lot of information is hidden in spectral networks at maximal intersections of MS walls. In this talk I will describe how they give rise to BPS graphs, and how the relation of the latter to BPS quivers emerges naturally. I will also present a novel construction of the wall-crossing invariant of Kontsevich and Soibelman known as ``BPS monodromy" based entirely on topological data of BPS graphs.

・**Bruno Le Floch (Princeton U)**

Title : Surface operators and instanton--vortex interactions

Abstract : The infrared behavior of 4d N=2 gauge theories is controlled by a limit of the Nekrasov partition function of instantons. We worked out the Nekrasov partition function when the 4d theory is enriched with 2d N=(2,2) matter defining a surface operator. This partition function describes the interaction of instantons of the 4d theory and vortices of the 2d theory. We test our conjecture by comparing it to other constructions of surface operators: Higgsing a larger 4d theory using a non-trivial vortex profile, and orbifolding a 4d theory. These two constructions are expected to give equivalent surface operators and our results may shed light on this equivalence.

・**Zheng Hua (U Hong Kong)**

Title : Shifted Poisson structure and elliptic deformation

Abstract : In their seminal paper, Pantev, Toen, Vaquie and Vezzosi introduced the notion of shifted symplectic structure on derived stacks. Later PTVV+Calaque further introduced the shifted Poisson structure. In this talk, I will present my recent work joint with Alexander Polishchuk. We prove that the moduli space of complexes of vector bundles (up to chain isomorphisms) on CY d-fold carries a (1-d)-shifted Poisson

structure. This generalises various interesting Poisson structures in algebraic geometry and integrable systems. Finally, I will explain how to use our theorem to classify the symplectic leaves of elliptic deformation of Hilbert scheme of points on P^2.

・**Dongmin Gang (Kavli IPMU)**

Title：All-order Volume conjecture for closed 3-manifolds

Abstract：I will talk about an extension of the recently-proposed volume conjecture (VC) for closed hyperbolic 3-manifold. The conjecture says that the leading order behavior of an asymptotic limit of Witten–Reshetikhin–Turaev (WRT) invariant is determined by the hyperbolic volume. The VC can be naturally extended to all orders: the asymptotic expansion of WRT invariant is determined by the perturbative expansion of SL(2) Chen-Simons theory.

After introducing technical tools for the perturbative expansion, I will give some numerical evidences for the conjecture.

・**Taizan Watari (Kavli IPMU)**

Title：Heterotic-IIA duality map of discrete data

Abstract：The duality between compactifications of Heterotic string and Type IIA string theory has been studied for more than two decades, but there will still be a lot of things yet to be understood in its 8-SUSY (4D) version. In this presentation, I will discuss i) Heterotic string interpretation of Type IIA compactifications on Calabi--Yau 3-folds where K3-fibration in the Calabi--Yau exhibits degenerations, and also ii) the duality dictionary of discrete data for cases only with Type I degenerations.