# TSUDA COLLEGE–OIST JOINT-WORKSHOP

# CALABI–YAU MANIFOLDS:ARITHMETIC, GEOMETRY AND PHYSICS

## AUGUST 1–3, 2016

## ABSTRACTS

**Carnahan, Scott** (Tsukuba University)

**Rationality of orbifold CFTs and Generalized Moonshine**

**Abstract**: I will describe the recent proof of Norton's generalization of the Monstrous Moonshine conjecture using the Borcherds-Hoehn program.

**Hashimoto, Kenji** (University of Tokyo)

**Some examples of symplectic automorphisms of K3 surfaces with infinite order**

**Abstract**: An automorphism of K3 surface X is called symplectic if it acts on $H^{2,0}(X)$ trivially. In this talk, we discuss about some examples of such automorphisms with infinite order and consider their fixed points.

**Hikami, Shinobu** (OIST)

**Intersection numbers of the moduli space of $p$-spin curves from matrix models**

**Abstract**: The intersection numbers of the moduli space of $p$-spin curves is the Gromov–Witten invariants for points. The expression for the case of one marked point is evaluated up to genus 9 for arbitrary $p$. The interesting relation between the large $p$ limit and $p = -1$ (Euler characteristics) is observed. The comparison with Abelian variety is made. The analysis is extended to simply laced Lie algebra and to open boundary Riemann surfaces. This is a joint work with E. Brezin based on arXiv: 1502.01416.

**Hosono, Shinobu** (Gukushuin University)

**Looking geometry from the moduli spaces of CICYs II**

**Abstract**: Having applications to BCOV (Bershadsky-Cecotti-Ooguri-Vafa) holomorphic anomaly equations in mind, I will study the moduli spaces of certain CICYs (complete intersection Calabi-Yau spaces) in toric varieties in detail. BCOV holomorphic anomaly equation is a differential equation which is defined on the moduli space of Calabi-Yau manifolds, and determines higher genus Gromov-Witten invariants of the mirror Calabi-Yau manifold. However, because of the so -called holomorphic ambiguities, revealing its mathematical structure is still an open problem. I will focus on this problem looking some global properties of a certain family of CICYs and the birational geometry in the mirror CICYs.

**Ito, Hiroyuki** (Tokyo University of Science, Noda)

**Wild group scheme quotient singularities**

**Abstract**: Since studying quotient singularities by finite groups is one-sided viewpoint in positive characteristic, we always need to study group scheme quotient singularities in other-side. As usual in positive characteristic, most difficult and essential case is wild case, that is, quotient by a finite group whose order is divisible by the characteristic or a finite group scheme of length divisible by the characteristic. In my talk, we consider such quotients for various cases with explicit calculations. Even for the rational double points, we can find very interesting phenomena.

**Kanazawa, Atshushi** (Harvard University)

**Geometric transitions and SYZ mirror symmetry**

**Abstract**: I will speak about two conjectures about mirror symmetry. One is Morrison's conjecture, which says geometric transitions of Calabi-Yau manifolds are reversed under mirror symmetry. The other is the Strominger-Yau-Zaslow conjecture, which says mirror Calabi-Yau manifolds admit dual torus Lagrangian fibrations. I will demonstrate by examples these two conjectures are compatible in a sense. This is joint work with Siu-Cheong Lau.

**Katsura, Toshiyuki** (Hosei University)

**Enriques surfaces with finite automorphism groups in characteristic 2**

**Abstract**: Complex Enriques surfaces with finite automorphism groups are classified into seven types. In this talk, we determine which types of such Enriques surfaces exist in characteristic 2. In particular we give a one dimensional family of classical and supersingular Enriques surfaces of type VII. This is a joint-work with S. Kondo.

**Kuwata, Masato** (Chuo University, Economics)

**Elliptic normal curves of degree $2N$ and modular groups**

**Abstract**: An elliptic normal curve of degree $n$ is an elliptic curve $E$ in $\mathbf{P}^{n-1}$ of degree $n$ contained in no hyperplane. If $n \geq 4$, $E$ lies on $n(n-3)/2$ quadrics. If $n$ is odd, the universal elliptic curve with full level $n$ structure can be realized as a family of elliptic normal curves of degree $n$. If $n = 2N$ is even, the situation is a little more complicated. In this talk we will discuss the differences between odd and even cases.

**Oda, Takayuki** (Okinawa Institute of Science and Technology)

**Cohomological representations of $SO(2, q)$ in quantum field theory and in the theory of automorphic forms**

**Abstract**: In this talk, we recall some fundamental results on cohomological representations of $SO(p+, q-)$ $(p = 2)$ in two different contexts: one is quantum field theory and the other in the theory of automorphic forms.

The former one is related to the irreducible decomposition of the quasi-regular representation of the Lie group $SO(p, q)$ on the $L^2$-space $L^2(SO(p, q)/SO(p-1, q))$. When $p = 2$, $SO(2, q)/SO(1, q)$ is a semi-simple symmetric space, which is an example of anti de Sitter space. This has been investigated by both mathematicians and physicists from 50's. But general general results were obtained by Strichart and Rossmann in 70's. Their results are considered as examples of AdS/CFT correspondance in the free field. In the discrete spectrum of the above representation there appears cohomoloigcal representations.

In the latter part we recall the cohomological representations which show up in Matsushima isomorphism of arithmetic quotients $\Gamma\backslash SO_0(2, q)/SO(2)\times SO(q)$ of a BD-type symmetric domain $SO_0(2, q)\times SO(q)$. These are very important representations to understand this kind of arithmetic quotients. But we still know very little. I try to explain some examples quite explicitly.

**Ohashi, Hisanori** (Tokyo University of Science, Noda)

**On some families of Enriques surfaces parametrized by rational modular curves**

**Abstract**: We discuss two families of Enriques surfaces, namely Kondo's surfaces of type II and the family given in the work of Mukai and the speaker. They have pleasant presentations of automorphism groups and curve configurations. We will exhibit a new explicit equation for the former and give a relationship to the elliptic modular surfaces.

**Sano, Taro** (Kobe University)

**Deformations of cones over K3 surfaces**

**Abstract**: Deformations of cones over projective varieties have been studied by many people. In particular, Pinkham proved that a cone over an elliptic curve is smoothable if and only if it is contained in a smooth del Pezzo surface. In this talk, I will talk about the analogue of this result for cones over K3 surfaces.

**Shepheard–Barron, Nicholas** (Kings College London)

**The stable Schottky problem for some special loci of curves**

**Abstract**: It is known (Codogni and S.) that the moduli space $M_g$is highly tangent to the Satake boundary of $A_g$. In this talk we explain how this tangency persists for some special subvarieties of $M_g$.

**Terasoma, Tomohide** (University of Tokyo)

**Periods of certain open Fermat hypersurfaces**

**Abstract**: Fermat hypersurfaces contain many lines. By deleting certain configuration of lines, we get mixed Hodge structures on their cohomologies. The extension classes arising from these mixed Hodge structures are given by the regulator maps from the K-theory of these surfaces. We give some interesting example for which these class can be written explicitly. This is joint work with Asakura and Ohtsubo.

**Tokunaga, Hiroo** (Tokyo Metropolitan University)

**On the topology of reducible plane curves**

**Abstract**: Let $B$ be a reduced reducible plane curve. In this talk, we consider the topology of $(\mathbf{P}^2, B)$ through a different viewpoint, by which we are able to construct examples of Zariski pairs whose irreducible components are a cubic and its infelctional tangent. This is a joint work with S. Bannai, B. Guerville - Balle and T. Shirane.

**Tumenbayar, Khulan** (Tokyo Metropolitan University)

**Geometry of weak contact conics to irreducible quartics with 2 nodes and 1 cusp via rational elliptic surface and Zariski pairs**

**Abstract**: Let $\mathcal{Q}$ be an irreducible quartic with two nodes and one cusp as its singularities and let $\mathcal{C}$ be a conic such that the intersection multiplicity at each point of $\mathcal{C} \cap \mathcal{Q}$ is even and $\mathcal{C} \cap \mathcal{Q}$ contain at least one smooth point $z_o$ of $\mathcal{Q}$. In this talk, for every $\mathcal{Q}$ we find all possible conics $\mathcal{C}$ as above via studying geometry of $\mathcal{C}$ and $\mathcal{Q}$ through that of integral sections of a rational elliptic surface which canonically arises from $\mathcal{Q}$ and $z_o \in \mathcal{C} \cap \mathcal{Q}$. As an application, we construct Zariski pairs of degree 7 and degree 8, whose irreducible components consist of $\mathcal{Q}$, $\mathcal{C}$ and line passing through two of the singular points of $\mathcal{Q}$ .

**Wakatsuki, Satoshi** (Kanazawa University)

**The dimensions of spaces of Siegel cusp forms of general degree**

**Abstract**: In this talk, we give a dimension formula for spaces of Siegel cusp forms of general degree with respect to neat arithmetic subgroups. The formula was conjectured before by several researchers. The dimensions are expressed by special values of Shintani zeta functions for spaces of symmetric matrices at non-positive integers. This formula was given by Shintani for only a small part of the geometric side of the trace formula. To be precise, it is the contribution of unipotent elements corresponding to the partitions $(2^j, 1^{2n-2j})$, where $n$ denotes the degree and $0 \leq j \leq n$. Hence, our work is to show that all the other contributions vanish. In addition, one finds that Shintani's formula means the dimension itself. Combining our formula and an explicit formula of the Shintani zeta functions, which was discovered by Ibukiyama and Saito, we can derive an explicit dimension formula for the principal congruence subgroups of level greater

than two. In this explicit dimension formula, the dimensions are described by degree, weight, level, and the Bernoulli numbers.

**Yui, Noriko** (Queen's University)

**Automorphy of Calabi–Yau of CM type**

**Abstract**: I will report on recent progress on modularity/automorphy of certain Calabi–Yau varieties defined over the rationals, with special emphasis on CM type Calabi–Yau varieties.