# East Asian Conference on Gauge Theory and Related Topics

**Date**: September 11–15, 2018
**Place**: Room 110, Science Building No.3(Department of Mathematics), North campus, Kyoto university

## Abstracts[1]

**Shinichiroh Matsuo (Nagoya Universtity)**
*Asymptotic diameter growth of instanton moduli spaces*

We will talk about diameter growth of instanton moduli spaces over the four-sphere.

**Kyungbae Park (Korea Institute for Advanced Study)**
*Irreducible* 3*-manifolds that cannot be obtained by* 0*-surgery on a knot*

We give two infinite families of examples of closed, orientable, irreducible 3-manifolds $M$ such that $b_1(M) = 1$ and $\pi_1(M)$ has weight 1, but $M$ is not the result of Dehn surgery along a knot in the 3-sphere. This answers a question of Aschenbrenner, Friedl and Wilton, and provides the first examples of irreducible manifolds with $b_1 = 1$ that are known not to be surgery on a knot in the 3-sphere. One family consists of Seifert fibered 3-manifolds, while each member of the other family is not even homology cobordant to any Seifert fibered 3-manifold. None of our examples are homology cobordant to any manifold obtained by Dehn surgery along a knot in the 3-sphere. To this end, we make use of Heegaard Floer correction terms, analogous to Frøyshov's invariants in Seiberg-Witten theory. This is a joint work with Matt Hedden, Min Hoon Kim, and Tom Mark.

**Ki-Heon Yun(Sungshin Women's University)**
*Various aspects of knot surgery* 4*-manifold*

A study of exotic smooth structures on a given smooth 4-manifold has been very actively studied since the discovery of Seiberg-Witten invariants. One of main technical tools in such constructions is the Fintushel-Stern's knot surgery operation.

In the talk we will discuss various aspects of knot surgery 4-manifold, especially for $E(2)_K$, including (1) a classification of Lefschetz fibration up to isomorphism, (2) nondiffeomorphic 4-manifolds which share the same Seiberg-Witten invariants, and (3) dissolving properties of knot surgery 4-manifold. Most of these results are co-worked with Prof. Jongil Park.

[1] 2018/9/15

**Hakho Choi (Korea Institute for Advanced Study)**
*A Lefschetz fibration structure on minimal symplectic fillings of a quotient surface singularity.*

In this talk we construct a genus-0 or genus-1 positive allowable Lefschetz fibration structure on any minimal symplectic filling of the link of non-cyclic quotient surface singularities. As by-product, we also show that any minimal symplectic filling of the link of quotient surface singularities can be obtained by a sequence of rational blowdowns from its minimal resolution. This a joint work with Jongil Park.

**Hokuto Konno (University of Tokyo)**
*Gauge theory for families of* 4*-manifolds*

I will explain gauge theory for families of 4-manifolds. In particular, I will explain characteristic classes of 4-manifold bundles defined via gauge theory.

**Bo Dai (Peking University)**
*Minimal genus for* 3*- and* 4*-manifolds*

Any 2-dimensional homology class in a smooth oriented manifold is represented by a connected embedded surface. The minimal genus problem is a basic problem in low dimensional topology and has a long history. The Seiberg-Witten equations on 3- and 4-manifolds played an important role in the study of minimal genus problem. I'll review some methods and results in this direction.

**Ko Ohashi (University of Tokyo)**
$\mathrm{Pin}(2)$*-equivariant maps between vector bundles over tori and* $KO$*-degree*

For a closed connected spin 4-manifold with indefinite intersection form, a finite dimensional approximation of the monopole map gives a proper $\mathrm{Pin}(2)$-equivariant stable map between finite dimensional vector bundles over the Jacobian torus. The existence of the stable map implies an equality involving its equivariant $KO$-theoretical degree and the $KO$-theoretical Euler classes of the vector bundles. In this talk, we determine the $KO$-degree in the localization of the $KO$-ring of the torus with respect to the $KO$-Euler class of $\mathbb{H}$. Here $\mathbb{H}$ stands for the quaternions viewed as a $\mathrm{Pin}(2)$-representation. This is a joint work with Mikio Furuta and Yukio Kametani.

**Dong Heon Choe (Seoul National University)**
*On intersection forms of definite* 4*-manifolds bounded by a rational homology* 3*-sphere*

We show that, if a rational homology 3-sphere $Y$ bounds a positive definite smooth 4-manifold, then there are finitely many negative definite lattices, up to the stable-equivalence, which can be realized as the intersection form of a smooth 4-manifold bounded by $Y$ . To this end, we make use of constraints on definite forms bounded by $Y$ induced from Donaldson's diagonalization theorem, and correction term invariants due to Ozsvath and Szabo. In particular, we prove that all spherical 3-manifolds satisfy such finiteness property. This is a joint work with Kyungbae Park.

**Minkyu Kim (University of Tokyo)**
*A $K$-theoretical Dijkgraaf-Witten theory*

We construct a version of Dijkgraaf-Witten theory from an element in $K$-theory of the classifying space of a finite group. The main feature of our construction is that we use a symmetric-categorical-group-version of KK-theory. In particular, our classical field theories are straightforward to establish via Kasparov product.

**Youlin Li (Shanghai Jiao Tong University)**
*Hyperbolic 3-manifolds admitting no fillable contact structures*

In this talk, we exhibit infinitely many hyperbolic 3-manifolds that admit no weakly symplectically fillable contact structures, using tools in Heegaard Floer theory. This is joint work with Yajing Liu.

**Jongil Park (Seoul National University)**
*A rational blowdown surgery on 4-manifolds*

Since gauge theory was introduced in 1982, people working on 4-manifolds have developed various techniques and surgeries and they have obtained many fruitful and remarkable results on 4-manifolds in last 35 years. Among them, a rational blowdown surgery technique initially introduced by R. Fintushel and R. Stern and later generalized by J. Park turned out to be one of the simple but powerful techniques to construct a new family of 4-manifolds.

In this talk, first I'd like to briefly review what we have obtained in 4-manifold topology by using a rational blowdown surgery. And then I'll explain in some details that any minimal symplectic filling of the link of a quotient suface singularity can be obtained by a sequence of rational blowdowns and blowing-ups from the minimal resolution the corresponding quotient surface singularity.

**Yuanyuan Bao (University of Tokyo)**
*A topological interpretation of Viro's $gl(1|1)$-Alexander polynomial of a graph*

Viro generalized the multi-variable Alexander polynomial (Conway function) of a knot to an invariant for a trivalent graph and found a face model for his generalization. His definition is based on the irreducible representations of quantum (super)groups $U_q(gl(1|1))$ and $U_q(sl(2))$. Costantino and Jun Murakami further generalized Viro's construction to colored Alexander invariant of a trivalent graph and showed a relation to the hyperbolic volume of a truncated tetrahedron. In this talk, we give a topological interpretation of Viro's construction and discuss its relation with the Heegaard Floer homology of a graph.

**Fuquan Fang (Beijin Capital Normal University)**
*Dual submanifolds in rational homology spheres*

**Masaki Taniguchi (University of Tokyo)**
*Instantons for* 4*-manifolds with periodic end and an obstruction to embeddings of* 3*-manifolds*

For a certain class of pairs of 3- and 4-manidfolds, we construct an obstruction in the filtered instanton Floer homology of the existence of an embedding with some homological conditions between them. We give a new calculation of these invariants. In the proof of main theorem, we study the compactness of the ASD-moduli spaces over 4-manifolds with periodic ends. This compactness result is a generalization of the Taubes's in 1987.

**Zhongtao Wu (The Chinese University of Hong Kong)**
*On Contact Surgery along Legendrian Links*

In this talk, we introduce the contact invariant due to Ozsvath-Szabo and then use algebraic methods to prove various vanishing results of the invariant for 3-manifolds obtained from contact surgeries. In addition, we use contact-geometric methods to give sufficient conditions for the contact 3-manifold obtained from the standard contact 3-sphere by contact $(+1)$ surgery along a Legendrian two-component link being overtwisted. This is a joint work with Fan Ding and Youlin Li.

**Yohsuke Imagi(Nagoya University)**
*Singularities of Special Lagrangians*

special Lagrangians are a certain class of area-minimizing Lagrangians in Calabi–Yau manifolds which is discovered by Harvey and Lawson about 1980 and has been playing an important role in geometry and string theory. One fundamental question about special Lagrangians is to find such a nice compactification of moduli spaces of special Lagrangians as in the counting of Yang–Mills anti-self-dual instantons or pseudo-holomorphic curves. Geometry measure-theory provides a natural notion of singular special Lagrangians and compact moduli-spaces but the treatment of singularities in this sense is considerably more difficult than those of Yang–Mills instantons or holomorphic curves. On the other hand the recent progress on Fukaya-categories in symplectic geometry helps indeed to study the singularities of special Lagrangians. These aspects will be explained in the talk.

**Hang Wang (East China Normal University)**
*Higher Nahm transform in noncommutative geometry*

Anti-self-dual (ASD) connections for a compact smooth four manifold arise as critical values for the Yang-Mills action functional. Nahm transform is a nice correspondence between a vector bundle with ASD connections and vector bundle with ASD connections over Picard torus associated to X. In this talk we propose a noncommutative geometric version of the Nahm transform that generalises the Connes-Yang-Mills action functional formulated using Dixmier trace. This is joint work with Tsuyoshi Kato and Hirofumi Sasahira.

**Yi-Jen Lee (Hong Kong Chinese University)**
*Holomorphic curves and Seiberg-Witten cobordism maps*

Taubes, sometimes with collaborators, proved various equivalence theorems between invariants from Seiberg-Witten theory and their counterparts defined via counting holomorphic-curves. These include the original "$SW = Gr$" theorem for closed symplectic 4-manifolds; the "$HM = ECH$" theorem equating the Seiberg-Witten-Floer homology (with exact perturbation) $HM$ to the "embedded contact homology" $ECH$; its sister version, $HM = PFH$ (joint with L.) relating a Seiberg-Witten-Floer homology (with non-exact perturbation) to the "periodic Floer homology" for mapping tori, and less directly, "$HM = HF$" (joint with Kuluthan-L.). The first and the the most essential part of the proof of such a "$SW = Gr$" -type theorem, which we refer to as "$SW \to Gr$" type results, produces (weighted) holomorphic curves from sequences of Seibert-Witten solutions associated to increasingly large perturbations. Intermediate steps of the argument also leads to various useful positivity results (parallel to the positive intersection property for holomorphic curves). For example, a partial result towards "$SW \to Gr$" in the setting of exact symplectic cobordisms leads to the aforementioned sort of positivity, which enabled Hutchings-Taubes to define $ECH$ cobordism maps via $HM$ cobordism maps.

We will discuss a variant of $SW \to Gr$ theorem in the context of a 4-manifold with cylindrical ends, equipped with a nontrivial harmonic 2-form. This harmonic 2-form is allowed to be asymptotic to 0 on some (but not all) of its ends, and may have nondegenerate zeros along 1-submanifolds. Positivity results associated to some simple special cases constitute a key ingredient in the proof of $HM = HF$. The aforementioned general theorem is motivated by (potential) generalizations of the $HM = HF$ and the $HM = PFH$ theorems.

**Kouki Sato (University of Tokyo)**
*A partial order on $\nu^+$ equivalence classes*

In Heegaard Floer theory, the knot complex is a doubly filtered chain complex associated to a knot in the 3-sphere. The $\nu^+$ equivalence is a stable homotopy equivalence on knot complexes. Hom proves that if two knots are concordant, then their complexes are $\nu^+$ equivalent. In this work, we introduce a partial order on $\nu^+$ equivalence classes, and study its algebraic and geometrical properties. As an application, we prove that for any 4-genus one knot, its complex is $\nu^+$ equivalent to the knot complex of one of the unknot, the trefoil and its mirror.

**Chung-I Ho (National Kaohsiung Normal University )**
*Non-orientable Lagrangian surfaces in symplectic 4-manifolds and symplectic packing problem*

We will talk about some recent result in the existence of Lagrangian $\mathbb{R}\mathrm{P}^2$ in a symplectic 4-manifolds and use symplectic rational blowdown to study the relative symplectic packing problem.

**Tirasan Khandhawit (OIST)**
*Gluing theorems for Bauer-Furuta invariants*

Bauer-Furuta invariant can be regarded as stable homotopy refinement of classical Seiberg-Witten invariant. The gluing theorem was first proved for connected sum of 4-manifolds by Bauer.

Manolescu later introduced relative Bauer-Furuta invariant for 4-manifold whose boundary is homology spheres and proved corresponding gluing theorem for 4-manifolds gluing along homology sphere. I will describe extension of Manolescu' s results from homology spheres to general 3-manifolds (joint with Jianfeng Lin and Hirofumi Sasahira).

If time permitted, I will also talk about recent gluing theorem for family version of Bauer-Furuta invariant (joint with Hokuto Konno).

**Yoshihiro Fukumoto(Ritsumeikan University)**
*Instantons and uniformization of orbifolds*

If a finite group $G$ acts on a manifold $M$ smoothly then the quotient space $X = M/G$ is a smooth orbifolds and $M$ is called a finite uniformization of $X$. Not all orbifolds are obtained in this way. The following problem is called the uniformization problem.

Problem: Let $X$ be an orbifold with a singularity $S$. Give a good condition for $(X, S)$ to have a finite uniformization $M$ i.e. $(X, S) = M/G$.

Here a "good condition" means that without referring to the fundamental group $\pi_1(X \setminus S)$.

In this talk, we consider smooth 4-orbifolds $X$ with isolated singular points $S$. In particular we show that if a compact oriented smooth orbifold $X$ is negative-definite with some homological condition and $S$ consists of two points which are cones over spherical space forms of certain types then $(X, S)$ admits a finite uniformization $M$. In fact we use instanton moduli spaces to prove an existence of a flat connection over 4-orbifolds.