MAthematics New GOals

June 30–July 4, 2014

NCTS(South), NCKU, Tainan, Taiwan

	Monday	Tuesday	Wednesday	Thursday	Friday
10:00 – 11:00			Irie		
11:15 – 12:15	Frauenfelder	Yoshida	Tseng	Tanaka	van Koert
12:30 – 14:00	Lunch				
14:00 – 15:00	Ohta	Ho	Nohara	Akaho	Nishinou
15:15 – 16:15	Ueda	Ono	Gao	Yoshinaga	Tsui
16:30 – 17:30	Lekili				
18:00	Dinner				

Manabu Akaho (Tokyo Metropolitan University, Japan)

Title: *On intersection products on Morse homology of manifolds with boundary*

Abstract: In this talk we explain intersection products on Morse homology of manifolds with boundary, motivated by some variants of Lagrangian Floer theory. First we observe Riemannian metrics and Morse functions on manifolds with boundary whose gradient vector fields are tangent to the boundary, and define our Morse homology, which is isomorphic to the absolute singular homology. Moreover we introduce product structures on our Morse complexes, which satisfies the Leibnitz rule.

Urs Frauenfelder (Seoul National University, Korea)

Title: *Global surfaces of section for the restricted three body problem*

Abstract: A global surface of section allows one to store the dynamics on a three dimensional energy hypersurface in an area preserving map from a two dimensional disk to itself. Such a device does not need to exist always. In the talk I explain how global methods from the theory of holomorphic curves can be used to address the question of existence of global surfaces of section for the restricted three body problem and how this is related to its contact topology.

Peng Gao (Harvard University, USA & TIMS, NTU, Taiwan)

Title: *The geometry of winding strings and trace formula*

Abstract: We will discuss a recent picture, motivated by considerations in string theory, proposed jointly with Michael Douglas that stable closed geodesics on Ricci flat Kahler manifolds corresponds to (instanton-like) winding states in the Hilbert space of the nonlinear sigma model. This is different from the topological sigma models, where for example similar states come from pseudo-holomorphic maps. Our proposal can be considered as a generalization of various classical forms of Trace formulas. It implies the existence of length minimizing closed geodesics on Calabi-Yau threefolds, which is so far not proven rigorously. In this talk, I will recall the main arguments and show how one can relate the sigma model partition function to a dynamical zeta function.

Chung-I Ho (National Tsing Hua University, Taiwan)

Title: *Minimal genus for 4-manifolds with* $b+=1$

Abstract: The Thom conjecture states that a smooth algebraic curve in CP^2 has minimal genus within its homology class. It was first proved by Kronheimer and Mrowka using Seiberg- Witten invariant. Later, Ozsvath and Szabo showed that embedded symplectic surfaces in symplectic 4-manifolds are genus minimizing within its homology class. In this talk, we will study this problem for smooth 4-manifolds with $b+=1$.

Kei Irie (RIMS, Kyoto University, Japan)

Title: *Transversality problems in string topology and de Rham chains*

Abstract: We propose a new approach to resolve transversality problems in string topology. For this purpose, we introduce a notion of de Rham chain complex, which is a hybrid of the singular chain complex and the usual de Rham complex. Using this machinery, we define a chain complex of the loop space, on which one can define string topology operations without any perturbations. All operations are defined so that they respect the length filtration on the loop space.

Yanki Lekili (King's College London, UK)

Title: *Floer cohomology and the platonic solids*

Abstract: We consider Fano threefolds on which $SL(2,C)$ acts with a dense open orbit. This is a finite list of threefolds whose classification follows from the classical work of Mukai-Umemura and Nakano. Inside these threefolds, there sits a Lagrangian space form given as an orbit of $SU(2)$. I will discuss the interesting case of a Lagrangian $SU(2)/D_6$ in CP^3 that was noticed by R. Chiang. We prove this Lagrangian is non-displaceable by Hamiltonian isotopies via computing its Floer cohomology over a field of characteristic 5 and that it (strongly) generates the Fukaya category of CP^3 (which in particular implies that it is non-displaceable from any other object of the Fukaya category, such as the Clifford torus). The computation depends on a general theory, true for all homogeneous Lagrangians, and a certain explicit count of holomorphic disks involving the specific geometry of CP^3 related to the twisted cubic. This is joint work with Jonny Evans.

Takeo Nishinou (Rikkyo University, Japan)

Title: *On Brill-Noether loci of graphs*

Abstract: It is classical to regard a graph as a dual intersection complex of a nodal Riemannian surface. As such, there is a theory of divisors on graphs, and Baker and Norine proved the Riemann-Roch theorem for graphs. There is also a refined theory, the Brill-Noether theory for graphs. I will give an affirmative answer to a conjecture posed by Caporaso on Brill-Nother loci of trivalent graphs.

Yuichi Nohara (Kagawa University, Japan)

Title: *Floer Cohomologies of Nontorus Fibers of the Gelfand-Cetlin System*

Abstract: The Gelfand-Cetlin system has non-torus Lagrangian fibers on some faces of the momentum polytope. We compute Floer cohomologies of such non-torus Lagrangian fibers in the cases of the three dimensional full flag manifold and the Grassmannian of two-planes in a four dimensional vector space.

Hiroshi Ohta (Nagoya University, Japan)

Title: *Generation of Fukaya category and potential function*

Abstract: I will talk about generation of Fukaya category and some aspect of potential function and Floer cohomology, together with some examples. This is based on my joint work with Abouzaid, Fukaya, Oh, Ono.

Kaoru Ono (RIMS, Kyoto University, Japan)

Title: *Floer complex and covering spaces*

Abstract: Arnold's conjecture for fixed points of Hamiltonian diffeomorphisms has stimulated the development of symplectic geometry. It was a motivation of Floer to initiate what is now called Floer cohomology. Although the Betti number version of the conjecture was settled, the original form of the conjecture is still open. In particular, whether the non-triviality of the fundamental group implies some additional lower bound or not. Recently, there are some progress, though not so much. I will explain an approach based on a joint work with Andrei Pajitnov. If time allows, I may touch another direction of study.

Yuuji Tanaka (NCTS (South), National Cheng Kung University, Taiwan)

Title: *A construction of Spin(7)-instantons*

Abstract: This talk describes a construction of Spin(7)-instantons on examples of compact Spin(7)-manifolds by Joyce. Spin(7)-instantons are elliptic Yang-Mills connections on eight-dimensional manifolds with holonomy Spin(7), which minimize the Yang-Mills energy. Analytic properties of Spin(7)-instantons have been studied by Gang Tian and others, but little was known about the existence of examples of Spin(7)-instantons on compact Spin(7)-manifolds other than an Oxford Ph.D thesis by Christopher Lewis in 1998.
There are two kinds of known examples of compact Spin(7)-manifolds both obtained by Dominic Joyce. The first one is a construction of the metrics on the resolution of a torus orbifold of a special kind with non-isolated singularities. The second one is a construction of the metrics on the resolution of a Calabi-Yau four-orbifold with isolated singular points of a special kind and an anti-holomorphic involution fixing only the singular points. Lewis' example of Spin(7)-instantons was on compact Spin(7)-manifolds coming from Joyce's first construction. More recently, Thomas Walpuski proved a general construction of Spin(7)-instantons as well as constructions of G2-instantons in his Ph.D thesis, which includes the example obtained by Lewis.
This talk gives a construction of Spin(7)-instantons on compact Spin(7)-manifolds coming from Joyce's second construction. The Spin(7)-manifold is obtained by gluing ALE Spin(7)-manifolds at each singular point of a Calabi-Yau four-orbifold with finitely many singular points, and an anti-holomorphic involution fixing only the singular points. Assuming that there are Hermitian-Einstein connections with certain conditions on both the Calabi-Yau four-orbifold and the ALE Spin(7)-manifolds, we glue them together to obtain a Spin(7)-instanton on the manifold.

Li-Sheng Tseng (University of California, Irvine, USA)

Title: *Differential Forms and Symplectic Structures*

Abstract: I will discuss some recent developments in using differential forms to probe symplectic structures.

Mao-Pei Tsui (University of Toledo, USA)

Title: *Deformation of Lagrangian Submanifolds*

Abstract: In this talk, I will discuss some recent developments in using geometric evolution equations to study the deformation of Lagrangian submanfolds in different ambient manifolds.

Kazushi Ueda (Osaka University, Japan & KIAS, Korea)

Title: *Mirror symmetry and K3 surfaces*

Abstract: Mirror symmetry for K3 surfaces is not just a toy model for mirror symmetry for Calabi-Yau 3-folds, but an interesting subject in its own right. In the talk, we will discuss various aspects of mirror symmetry for K3 surfaces and their relation to other fields of mathematics.

Otto van Koert (Seoul National University, Korea)

Title: *Dynamics of the restricted 3-body problem via global surfaces of section*

Abstract: Inspired by holomorphic curve theory, we discuss applications of global surfaces of section to the dynamics of the restricted three-body problem. We show how various dynamical features such as periodic orbits, invariant tori, homoclinics and chaos can be detected with this tool.

Takahiko Yoshida (Meiji University, Japan)

Title: *Torus fibrations and localization of index*

Abstract: We report a recent progress of the joint work with H. Fujita and M. Furuta on a localization of index of a Dirac-type operators on possibly non-compact Riemannian manifolds. We also describe some applications to the torus actions.
We make use of a structure of torus fibration on the end, but the mechanism of the localization does not rely on any group action. In the case of Lagrangian fibration, we show that the index is described as a sum of the contributions from Bohr-Sommerfeld fibers and singular fibers.
To show the localization we introduce a deformation of a Dirac-type operator for a manifold equipped with a fiber bundle structure which satisfies a kind of acyclic condition. The deformation allows an interpretation as an adiabatic limit or an infinite dimensional analogue of Witten deformation.
Joint work with Hajime Fujita and Mikio Furuta.

Masahiko Yoshinaga (Hokkaido University, Japan)

Title: *Milnor fibers of real line arrangements*

Abstract: The Milnor fiber of a line arrangement is a certain cyclic covering space of the complexified complement equipped with monodromy action. Topology of the Milnor fiber can be described in terms of real combinatorial structures of the line arrangements. We will formulate an algorithm computing eigen spaces of the first cohomology group with respect to the monodromy action. I will also give some applications and several conjectures.