TFC Program 2015:

Fundamental Problems in Quantum Physics: Strings, Black Holes and Quantum Information

Workshop on Strings, Membranes and Topological Field Theory

Date: March 5(Thursday) – March 7 (Saturday), 2015

Venue: Tohoku University, Aobayama Campus, Faculty of Science, Godo C building 2F Room N204

(東北大学大学院理学研究科理学部キャンパス合同 C 棟２階 N204　多目的室)

Speakers

Chong-Sun Chu (National Tsing Hua University)

Noriaki Ikeda (Ritsumeikan University)

Jae-Suk Park (IBS Center for Geometry and Physics)

Jeehoon Park (Pohang University of Science and Technology)

Siye Wu (National Tsing-Hua University)

Akifumi Sako (Tokyo University of Science)

Hisayoshi Muraki (Tohoku University)

Program

March. 5

13:30-14:30

Noriaki Ikeda (1)

“Supergeometry of Topological Sigma Models, Higher Structures and Physical Applications” (1)

14:45-15:45

Chong-Sun Chu (1)

"The theory of non-abelian tensor of multiple 5-branes " (1)

16:00-17:00

Hisayoshi Muraki

“A Construction of Gravity Theory based on Poisson Generalized Geometry”

March. 6

10:00-11:00

Noriaki Ikeda

“Supergeometry of Topological Sigma Models, Higher Structures and Physical Applications” (2)

11:15-12:15

Siye Wu

“Hitchin's equations on a non-orientable space and duality” (1)

14:00-15:00

Chong-Sun Chu

"The theory of non-abelian tensor of multiple 5-branes" (2)

15:15-16:15

Jae-Suk Park

“Homotopy Theory of Quantum Fields” (1)

March. 7

10:00-11:00

Akifumi Sako

“Some physics of noncommutative gauge theories on K¥"ahler manifolds”

11:15-12:15

Siye Wu

“Hitchin's equations on a non-orientable space and duality” (2)

14:00-15:00

Jae-Suk Park

“Homotopy Theory of Quantum Fields” (2)

15:15-16:15

Jeehoon Park

“Period integrals of hypersurfaces and a (0+0)-dimensional Quantum Field theory”

Abstract

The theory of non-abelian tensor of multiple 5-branes

Chong-Sun Chu (National Tsing Hua University)

Abstract: In this talk I will focus on the physics of M5-branes. In particular I will discuss a proposal for the non-abelian self-duality equation on the worldvolume of a system of multiple M5-branes. Properties of the solitonic solutions will be described and compared with supergravity results. Various other proposals will also be mentioned and commented on.

Supergeometry of Topological Sigma Models, Higher Structures and Physical Applications

Noriaki Ikeda (Ritsumeikan University)

Abstract: We talk an active topic which appears in both geometry and quantum field theories, string theories. In topological sigma models and topological membranes in any dimension, exotic structures so called the higher structures natually appear which include higher algebroids, n-categories, n-groupoids, etc.

Supergeometry is an useful technique to analyze the above structures. This formulation is closely connected to the BRST-BV formalism in physics, the moment map and symplectic reduction in symplectic geometry.

We discuss physical applications such as flux vacua in string theories, membranes, topological field theories and current algebras. If we have time, we discuss the quantization problem.

Homotopy Theory of Quantum Fields.

Jae-Suk Park (IBS Center for Geometry and Physics)

Abstract: Inability of defining measure for Feynman path integral is regarded as the greatest obstacle in understanding quantum field theory mathematically, while many mathematically ill-defined statements from theoretical physics such as “two quantum field theories are physically equivalent” turned out extremely useful in formulating mathematical conjectures relating different mathematical subjects.

In this series of talks I would like to explain a program to characterize path integral in terms of certain algebraic homotopy theory by exploiting "symmetry of quantum expectation" as well as the natural requirement that every quantum observable should be independent in the classical limit so that quantum correlations disappear in the classical world.

1. Homotopy Theory of Probability Spaces
We introduce the notion of independence of random variables in algebraic probability theory as well as the homotopy theoretic enhancement of probability theory based on symmetry of expectation map such that the distribution of random variables are invariants of certain homotopy types.

2. Category of CQFT algebras and quantum deformation theory:
We introduce and study category of commutative quantum field theory (CQFT) algebras to define quantum correlation functions as certain invariants of certain quantum homotopy types. We then define quantum deformation functor and its classical remnants, such as Frobeius-Saito manifold structure, on the classical moduli space.

Period integrals of hypersurfaces and a (0+0)-dimensional Quantum Field theory

Jeehoon Park (Pohang University of Science and Technology)

Abstract: We explain how to attach a Battalion-Vilkovisky(BV) algebra to a smooth projective hypersurface and how to put the Hodge-theoretic informations on such a BV algebra. We also interpret the Griffiths period integral as a version of Feynman path integral. Moreover, as an application of our theory, we provide an explicit algorithm to compute the period integrals of a formal deformation of smooth projective hypersurfaces via homotopy Lie theory. This is a joint work with Jae-Suk Park.

Hitchin's equations on a non-orientable space and duality

Siye Wu (National Tsing Hua University, Taiwan)

Abstract: In joint work with Ho and Wilkin, we considered Hitchin's equations on a compact non-orientable manifold. It was found that the moduli space maps via a local diffeomorphism to part of the moduli space associated to the oriented double cover. In this talk, I will review this work and discuss ite relation to electric-magnetic duality and

mirror symmetry.

Some physics of noncommutative gauge theories on K¥"ahler manifolds

Akifumi Sako (Tokyo University of Science)

Abstract: IKKT(Type IIB) matrix theory is one of the candidates of non-perturbative string theory.This matrix theory contains classical solutions as noncommutative gauge theories,for example, a gauge theory on the the Moyal plane, the one on the fuzzy ${¥mathbb C}P^¹$, and so on.The gauge theories on the Moyal spaces have been studied in detail,but research of gauge theories on the noncommutative ${¥mathbb C}P^N$ or, more generally, gauge theories on noncommutative K¥"ahler manifolds are not so much as the ones on Moyal spaces. One of the reasons is difficulty to construct concreate calculable models of noncommutative gauge theories on such spaces.
So, we study gauge theories on noncommutative homogeneous K¥"ahler manifolds.
To construct the noncommutative manifolds, we use the deformation quantization with separation of variables for K¥"ahler manifolds.The models of noncommutative gauge theories that connect with usual Yang-Mills theories in the commutative limits are given, and they are expected that the models having such connection with commutative gauge theories are uniquely determined.As examples, we give noncommutative ${¥mathbb C}P^N$ and noncommutative ${¥mathbb C}H^N$ and gauge theories on them. We construct their Fock space representations. We also track the phenomena that local gauge symmetry on a homogeneous K¥"ahler manifold breaks down under noncommutative deformation by an observation of concreate model and explicit geometrical calculations. The noncommutative deformation also gives higher order quantum collections to topological terms in gauge theories and topological invariance does not hold under the process.

A Construction of Gravity Theory based on Poisson Generalized Geometry

Hisayoshi Muraki (Tohoku University)

Abstract: A construction of gravity theory based on Poisson generalized geometry is investigated. The Poisson-generalized geometry is a variant of the generalized geometry in the sense that the roles of tangent and the cotangent bundle are interchanged. Its symmetry is a semi-direct product of β-transformations and β-

diffeomorphisms. Analogues of generalized connection, generalized curvature, Ricci tensor and Ricci scalar are defined.