International Workshop on Non-commutativity in Strings, Gravity and Field Theory
Tokyo Metropolitan University, Hachioji-shi, Tokyo, Japan
November 16–18, 2006

Titles and Abstracts of Talks

November 16, TMU International House, Small Meeting Room, 1st floor

Morning session:

[10:00–10:45] O. Lechtenfeld (ITP, Leibniz University, Hannover, Germany)

Quiver Gauge Theories and Noncommutative Vortices

We construct explicit BPS and non-BPS solutions of the Yang-Mills equations on noncommutative spaces $R^{2n}_\theta \times G/H$ which are manifestly G-symmetric. Given a G-representation, by twisting with a particular bundle over G/H, we obtain a G-equivariant $U(k)$ bundle with a G-invariant connection over $R^{2n}_\theta \times G/H$. The $U(k)$ Donaldson-Uhlenbeck-Yau equations on these spaces reduce to vortex-type equations in a particular quiver gauge theory on R^{2n}_θ. The Seiberg-Witten monopole equations are particular examples. The noncommutative BPS configurations are formulated with partial isometries, which are obtained from an equivariant Atiyah-Bott-Shapiro construction. They can be interpreted as D0-branes inside a space-filling brane-antibrane system.

[11:10–11:55] K. Fujikawa (Nihon University, Tokyo, Japan)

Unitarity Issue of Space-time Non-commutative Theory

A general path integral for space-time noncommutative theory is formulated by means of Schwinger's action principle. The resulting path integral has essentially the same physical basis as the Yang-Feldman formulation. It is first shown that higher derivative theories are neatly dealt with by the path integral formulation, and the underlying canonical structure is recovered by the Bjorken-Johnson-Low (BJL) prescription. A simple theory which is non-local in time is then analyzed for an illustration of the complications related to quantization, unitarity and positive energy conditions. We then show that the perturbative unitarity and the positive energy condition, in the sense that only the positive energy flows in the positive time direction for any fixed time-slice in space-time, are not simultaneously satisfied for space-time noncommutative theory by the known methods of quantization, such as the Yang-Feldman formulation.

[12:15–13:00] N. Sakai (Tokyo Institute of Technology, Japan)

Abelian and Non-Abelian Webs of Walls

Domain wall junctions are studied in $\mathcal{N} = 2$ supersymmetric $U(N_{\rm C})$ gauge theory with $N_{\rm F}(> N_{\rm C})$ flavors. We find that all three possibilities are realized for positive, negative and zero junction charges. The positive junction charge is found to be carried by a topological charge in the Hitchin system of an $SU(2)$ gauge subgroup. We establish rules of the construction of the webs of walls. Webs can be understood qualitatively by grid diagram and quantitatively by associating moduli parameters to web configurations.

Lunch 13:00–14:30

Afternoon session:

[14:30–15:00] S. Petersen (ITP, Leibniz University, Hannover, Germany)

Solitons in the Noncommutative Ward Model

In this talk, aspects of solitons in a noncommutative modified sigma model are discussed. After a brief exposition of the known solutions to that Ward model, we present our results about stability of the static solutions and applicability of the adiabatic approach.

[15:00–15:30] C. Albertsson (YITP, Kyoto, Japan)

World-sheet Boundary Conditions in Poisson-Lie T-duality

The Poisson-Lie T-duality is a generalisation of traditional T-duality, allowing the nonlinear sigma model to be defined on target spaces without isometries. We apply the corresponding canonical transformations to bosonic open string worldsheet conformal boundary conditions, showing that the form of those conditions is invariant at the classical level; hence the dual model is again conformal. The boundary conditions are defined in terms of the gluing matrix which encodes the properties of D-branes. We derive the duality map for that matrix. We explicitly demonstrate the implications of the duality map for D-branes in a simple non-Abelian Drinfel'd double.

[16:00–16:30] M. Wolf (Imperial College, London, UK)

Hidden Symmetries in N=4 SYM Theory

I describe an infinite-dimensional algebra of hidden symmetries of N=4 SYM theory. The derivation is based on a generalization of the supertwistor correspondence. Using the latter, I describe the construction of an infinite sequence of flows on the solution space of the N=4 SYM equations. The dependence of the SYM fields on the parameters along the flows can be recovered by solving the equations of the hierarchy. The N=4 SYM equations are embedded into the infinite system of the hierarchy equations and, in addition, the SYM hierarchy is associated with an infinite set of graded symmetries recursively generated from supertranslations.

[16:30–17:00] H. Takai (TMU Mathematics, Tokyo, Japan)

Geometry of the Moduli Spaces of Instantons on Noncommutative 4-manifolds

Studied are moduli spaces of self-dual or anti-self-dual connections on noncommutative 4-manifolds, especially deformation quantization of compact spin Riemannian 4-manifolds and their isometry groups that have 2-torus subgroup. Such moduli spaces of irreducible modules associated with highest weights of compact connected semisimple Lie groups are smooth manifolds with dimension determined by their weights. It is a generalization of Atiyah-Hitchin-Singer's classical result, as well as of Landi-Suijlekom's noncommutative 4-sphere case.

November 17, TMU International House, Small Meeting Room, 1st floor

Morning session:

[10:00–10:45] S. Sugimoto (Nagoya University, Japan)

Mesons and Baryons from String Theory

Recently, we proposed a holographic description of 4-dim QCD by using a D4/D8-brane system in type IIA string theory. It was shown that the model nicely catches a lot of features of QCD and hadron physics. In this talk, I will give an overview of the model and present some new results about construction of baryons in this framework.

[11:10–11:55] S. J. Gates, Jr. (University of Maryland at College Park, USA)

1D Supersymmetry, Adinkras, and Clifford Algebras

The structure of the representation theory of off-shell supersymmetrical theories has remained largely unkown for the most of the history of the subject. This presentation describes an attempt to make progress on this unsolved problem by a careful investigation of relationships between one dimensional supersymmetry, a special class of Clifford algebras and Adinkras - a graph-theoretical technique.

[12:15–13:00] H. Itoyama (Osaka State University, Japan)

$AdS_5 \times S^5$ Superstrings in the Generalized Light-cone Gauge

The κ-symmetry-fixed Green-Schwarz action in the $AdS_5 \times S^5$ background is treated canonically in a version of the light-cone gauge. After reviewing the generalized light-cone gauge for a bosonic sigma model, we present the Hamiltonian dynamics of the Green-Schwarz action consisting of the transverse degrees of freedom alone. The remaining fermionic constraints are all second class and they can be treated by the Dirac bracket.

Lunch 13:00–14:30

Afternoon session:

[14:30–15:00] R. Wimmer (Stony Brook University, USA)

D0-D4 brane tachyon condensation and T-duality in noncommutative super-YM theory

The D0-D4-brane system for different B-field backgrounds including the small instanton singularity is investigated in SYM theory on noncommutative R^4. The excitation spectrum of the unstable states, as well as the BPS D0-D4 bound state, and the tachyon potential are computed. For the special case of a self-dual B-field background the excitation spectrum is found to be equal to the one of the fluxon solution on noncommutative R^2. It is shown that it is due to T-duality.

[15:00–15:30] T. Suzuki (Ochanomizu University, Tokyo, Japan)

Seiberg-Witten Monopole Equation on Non-commutative R^4

We investigate the relation between the Nekrasov formula for the prepotential of N=2 supersymmetric non-Abelian $SU(2)$ gauge theory and the partition function of N=2 supersymmetric $U(1)$ gauge theories with massless hypermultiplet on non-commutative (N.C.) R^4, i.e. Abelian Seiberg-Witten monopole theory on N.C. R^4.

To give the expression of the prepotential in terms of N=2 $U(1)$ theory, we investigate the partition function of non-Abelian $SU(2)$ Seiberg-Witten monopole theory. The partition function of this theory receives contributions from two classes of vacua, one is characterized by solutions of the $SU(2)$ instanton equation and the other by those of the Abelian Seiberg-Witten monopole equation. By a mass-deformation, we obtain the expression of the prepotential in terms of N=2 $U(1)$ theory.

It is known that after topological twisting partition functions of $N > 1$ supersymmetric theories on N.C. R^D are invariant under N.C. parameter shift, then the partition functions can be calculated by its dimensional reduction. At the large N.C. parameter limit, the Abelian Seiberg-Witten monopole equations are reduced to ADHM equations with the Dirac equation reduced to zero dimension. These equations are equivalent to the dimensional reduction of non-Abelian U(N) Seiberg-Witten monopole equations in $N \to \infty$.

The theory has global symmetries under torus actions originated in space rotations and gauge symmetries. It is known that solutions of the Seiberg-Witten monopole equation reduced to zero dimension and the fixed point equation of the torus actions are isolated, being classified by the Young diagrams. So we use the well-known localization techniques to carry out the path integral. Then we obtain the relation between the Nekrasov formula and the partition function of the Abelian Seiberg-Witten monopole theory on N.C. R^4.

[15:30–16:00] R. Grimm (CPT, University of Marseille, France)

Is simple supersymmetry really simple?

A number of properties of not-so-well-known structures in the framework of N=1 supersymmetry will be reviewed.

[16:30–17:00] M. Nitta (Keio University, Tokyo, Japan)

Non-Abelian Vortices

The $U(N)$ gauge theory with N Higgs fields in the fundamental representation admits BPS vortices. These vortices carry non-Abelian orientational moduli CP^{N-1} in addition to usual position moduli. (i) We completely determine the moduli space $M_{N,k}$ of k-vortices. Its open subset for separated k-vortices is the symmetric product $(C \times CP^{N-1})^k/S_k$. Orbifold singularities of this space correspond to coincident vortices, and they are resolved, resulting in a smooth moduli manifold. (ii) The submanifold for the two ($k = 2$) coincident vortices is found to be CP^2/Z_2 in the case of N=2. (iii) By investigating the moduli dynamics of two ($k = 2$) non-Abelian vortices, we discuss the problem of the reconnection of non-Abelian cosmic strings, showing their universal reconnection. (iv) I would also like to explain the matching between vortex moduli space and monopole moduli space.

[17:00–17:30] M. Irisawa (TMU Physics, Tokyo, Japan)

Drinfel'd Twisted Hopf Algebra and Structure of Unbroken Symmetries on Noncommutative Spaces

We investigate the non(anti)commutative (super)space from the viewpoint of Hopf algebra, and focus on the relation between the structure of unbroken symmetries on the noncommutative space and the Hopf algebra. As regards the four-dimentional N=1 superconformal algebra, we classify all the noncommutative products created by two generators.

November 18, TMU building 11, Meeting Room 204, 2nd floor

Morning session:

[10:00–10:45] S. Terashima (YITP, Kyoto, Japan)

Noncommutative Geometry from Unstable D0-branes and ADHM Construction

We study the noncommutative Dp-branes in terms of infinitely many unstable D0-branes. We show that the tachyon condensation of the unstable D0-branes induces noncommutativity. By the tachyon condensation most of the unstable D0-branes disappear and remaining D0-branes are actually the BPS D0-branes with the correct noncommutative coordinates. The zero modes of the tachyon, which is identical to the Dirac operator, play the crucial role for this construction. In a similar way, we also provide the D-brane realization of the inverse ADHM construction and the matrix model realization of the supertube.

[11:10–11:55] Y. Sugawara (University of Tokyo, Japan)

Recent Progress in Superstrings on Non-compact Calabi-Yau Manifolds - Elliptic Genera

I report on a recent progress in the study of superstring vacua of non-compact Calabi-Yau manifolds, which generically includes conical singularities and are realized as soluble irrational superconformal models. After reporting some important features of the 'extended characters' (including the small/large N=4 characters) and the Appell functions, I mainly argue on the structure of elliptic genera for these superstring vacua, which was questionable in our previous study due to the lack of good modular properties. I give an improved proposal of elliptic genera for these models, which are invariant under the $\Gamma(2)$-modular group (that preserves the spin structure) and, hence, show good modular behavior suitable for topological invariants.

[12:15–13:00] K. Ito (Tokyo Institute of Technology, Japan)

Non(anti)commutative Superspace and Superstrings in Graviphoton Background

I review some developments in non(anti)commutative deformation of superspace and deformed supersymmetric gauge theories. I also discuss its realization on D-branes in superstrings with RR backround. In particular, I discuss deformed N=2 super Yang-Mills theory in graviphoton background.

Lunch 13:00–14:30

Afternoon session:

[14:30–15:15] K. Hashimoto (University of Tokyo, Japan)

Solitons in Supersymmetry-breaking Meta-stable Vacua

In recently found supersymmetry-breaking meta-stable vacua of the supersymmetric QCD, we examine possible exsitence of solitons. Homotopy groups of the moduli space of the meta-stable vacua show that there is no nontrivial soliton for $SU(N_c)$ gauge group. When $U(1)_B$ symmetry present in the theory is gauged, we find non-BPS solitonic (vortex) strings whose existence and properties are predicted from brane configurations. We obtain explicit classical solutions which reproduce the predicitions. The strings are meta-stable as they live in the meta-stable vacua.

[15:40–16:10] S. Sasaki (YITP, Kyoto, Japan)

Deformation of $N = 4$ Super Yang-Mills Theory in Graviphoton Background

We study a deformed $N = 4$ SYM theory defined on D-brane world volume in the presence of Ramond-Ramond background. The corrections to the $N = 4$ SYM theory are obtained by calculating the open string disk amplitudes with the insertion of RR vertex operators. The background effects are treated perturbatively, namely, iterative insertions of several RR vertex operators. For a self-dual RR 5-form field strength background with specific zero-slope scaling, it is expected that the deformation originates from non(anti)commutative $N = 4$ superspace $\{\theta^{\alpha A}, \theta^{\beta B}\} = C^{(\alpha\beta)(IJ)}$. By turning on part of self-dual RR 5-form field strength, we find that the deformed Lagrangian coincides with the $N = 4$ SYM theory defined on $N = 1$ non(anti)commutative superspace $\{\theta^{\alpha}, \theta^{\beta}\} = C^{\alpha\beta}$ at the first order of deformation parameter C. We also comment on the deformation that cannot be explained by the non(anti)commutative superspace.

[16:10–16:40] T. Hatanaka (TMU Physics, Tokyo, Japan)

N=1/2 non-anticommutative deformation of N=1 scalar potential

We perform the so-called 'non-anticommutative' deformation of $N = 1$ supersymmetric theory in all orders of the deformation parameter. It shows, in general, that the deformed scalar potential is complex, and it is not positively definite.

Conclusion.