Towards construction of IKKT-like matrix model for type IIB string theory on $AdS_5 \times S^5$ background

Hidehiko Shimada   Yukawa Institute for Theoretical Physics
E-mail: shimada@yukawa.kyoto-u.ac.jp

The AdS/CFT correspondence, which states that type IIB string theory on $AdS_5 \times S^5$ background are equivakent to four dimensional $\mathcal{N} = 4$ super Yang-Mills theory, has enjoyed remarkable successes. However its fundamental mechanism has not been clarified; in particular we do not know how the degree of freedom of closed strings are hidden in gauge theory.

Here I wish to initiate a new approach to this problem; I wish to study this problem by constructing a new matrix model for type IIB string theory on $AdS_5 \times S^5$ background. The basic strategy to construct the matrix model is close to that of the IKKT matrix model, namely to matrix-regularise the GS action of the type IIB string theory on $AdS_5 \times S^5$ background. If this construction succeeds, it may be possible to make a direct study of the correspondence, by comparing Schwinger-Dyson equations of the matrix model and four-dimensional Yang-Mills.

The main problem one shoud face in constructing these types of models is the difficulty of maintaining the isometry of the background. Using ten coordinates, as is usually done, some of the isometry of the background is non-linearly realised. It follows that, in matrix models using ten matrices for these ten coordinates, these non-linearly realised symmetry are broken.

In order to overcome this difficulty I shall embed the manifold into a linear representation of the symmetry group and impose constraint. If we for the moment neglect fermionic degrees of freedom, it is clear that $AdS_5 \times S^5$ can be embedded into twelve-dimensional flat space by two quadratic constraints on the twelve coordinates. After the matrix-regularisation these constraints becomes constraints on twelve matrices. It is easy to write down the action for the theory and show that it has full $SO(4,2) \times SO(6)$ symmetry as is desired.

I have further found that fermionic degrees of freedom can be introduced in the exactly analogous manner if we use the full-supersymmery group $PSU(2,2|4)$ instead of its bosonic part $SO(4,2) \times SO(6)$. I have found that the appropriate linear representation is the direct sum of the representations which are anti-(super)symmetrised and (super)symmetrised tensor product of the fundamental (ray) representation of $PSU(2,2|4)$. I have further identified quadratic constraints on the representation which recovers the correct superspace $\frac{PSU(2,2|4)}{SO(4,1)\times SO(5)}$ (except for two overall $U(1)$ factors). Although these constraints have simple quadratic forms, they work quite non-trivially on the new representation to eliminate unwanted components. The Nambu-Goto term in this representation which has manifest supersymmetry is also constructed.

Works are in progress to complete this construction of the marix models, i.e. (i) explicit construction of the Wess-Zumino term, (ii) analytic continuation of fermionic coordinates needed for the fixing of κ-symmetry, (iii) application of the matrix regularisation.