Perturbative versus Nonperturbative Dynamics of the Fuzzy $S^2 \times S^2$

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Various matrix models have been proposed as a nonperturbative formulation of the superstring theory. IKKT matrix model(hep-th/9511117) is one of such proposals and various properties have been investigated. In the matrix model the eigenvalues of bosonic matrices can be interpreted as space-time, and a possibility of the dynamical generation of four dimensional space-time has been examined from various view points. One of the approaches to study how the matrix model can describe space-time or gravity is to investigate the dynamics of various matrix models which have curved space-time as its classical solutions.

A 3-dimensional bosonic matrix model with the Chern-Simons (CS) term(hep-th/0101102) is one of the simplest matrix models which have curved space-time as their classical solutions. Indeed this matrix model has fuzzy S^2 solutions. In the paper hep-th/0401038 we studied this model nonperturbatively. We thus found that there exist two phases depending on the coefficient of the CS term. One is the fuzzy sphere phase where a fuzzy S^2 is stabilized nonperturbatively, and an abelian gauge group is generated. The other is the Yang-Mills phase where fuzzy spheres cannot survive and only a crashed ball lives. We observed the first phase transition between the two phases. These behaviors can be understood partly also by perturbative studies. Based on this observation, we got interested in how the dynamical behaviors change if we consider some other matrix models which have a 4-dimensional fuzzy manifold as their classical solution. Can the 4-dimensional fuzzy manifold stable? Is a nonabelian gauge group generated? Especially, from a phenomenological point of view, it would be intriguing if we could obtain a nonabelian gauge group dynamically.[1]

This is our motivation to have performed similar studies on a 6-dimensional bosonic matrix model with the CS terms which has 4-dimensional fuzzy $S^2 \times S^2$ solutions(hep-th/0506205). Our result is as follows. Also in this model, there exist two phases, namely, the fuzzy sphere phase and the Yang-Mills phase, and observed the first phase transition between them. In the former the true vauume is realized by a fuzzy S^2, which is another solution of this matrix model. The dynamically generated gauge group is $U(1)$. In the latter only a crashed ball lives. Further investigation of these kinds of study is necessary to find some mechanisms to realize a nonabelian gauge group in the true vacuum. We hope to report some progress in the future.

This talk is based on the paper hep-th/0506205, which was accomplised in collaboration with Takehiro Azuma, Subrata Bal and Jun Nishimura.

[1]If we have k-coincident fuzzy manifolds as the true vacuum, the dynamically generated gauge group is interpreted as $U(k)$.