

## Matrix Model

The matrix model is given as one of the models which formulate non-perturbatively superstrings. There are three kinds of matrix model for the superstring theory, which are called as matrix theory, IIB matrix model and USp matrix model.

- Compactification

Because the superstring theory is defined on ten-dimensional spacetime, so are the matrix models. In conclusion, if we would like to obtain the models which describe realistic world, the compactification of spacetime to four-dimensions are required. In particular, We studied about the USp matrix model which defines non-perturbatively type I superstrings, compactified by  $\mathbb{C}^3/\mathbb{Z}_3$  and then I succeeded in enumerating all possibilities to be able to be consistently defined.

- Calculation of partition function

We calculated the partition functions of reduced matrix models for various gauge groups by using the prescription of Moore-Nekrasov-Schatchashvili(MNS). Here, the word “reduced ” means that the matrix models are given by the dimensional reduction of higher dimensional supersymmetric Yang-Mills theory to zero-dimension.

- Effects of matrix orientifolding and four-dimensional spacetime

In matrix model, Spacetime points are described by the eigenvalues of the bosonic matrices and then the coordinates are treated as dynamical variables. The distribution of the eigenvalues is, therefore, a very interesting research object and the matrix model has possibility to describe the spacetime where we live. By calculating the one-loop effective action for the eigenvalues We studied the effect of orientifolding to matrix model and showed that the spacetime directional asymmetry of attractive force between eigenvalues appears. The spacetime points are eventually attractive to an imaginary four-dimensional surface. Moreover We calculated two-loop corrections and found that in the case of short distance the interaction between eigenvalues is turned to repulsive. In the USp matrix model, the spacetime points are stabilized near above mentioned four-dimensional plane and then the four-dimensional spacetime are produced.

## AdS superstring

The superstring theory in curved spacetime can be described by Green-Schwartz action. In order to carry out the research of this action, We adapted the generalized light-cone gauge as the gauge fixing. In addition, the theory is the constrained system and one must solve the some constrain conditions. We succeeded in converting the Lagrangian to that in the Lagrange formalism, and We obtained the Lagrangian written by the fields and their derivatives. Moreover, we confirmed that the obtained Lagrangian becomes the correct form in flat space limit.

## AGT

The relations between four-dimensional gauge theory and two-dimensional conformal field theory are capturing the spotlight. Four-dimensional  $\mathcal{N} = 2$  gauge theory can be constructed by using NS5-branes and D4-branes which are ended on the former branes. Those two kinds of branes are obtained both by compactifying appropriately M5-branes in M theory. The stack of M5-branes has six-dimensional world volume and its four-dimensional part realizes a supersymmetric gauge theory. On the other hand, the remaining two-dimensional part plays role of Seiberg-Witten curve and it decides the low energy effective theory of the gauge theory. We studied the correspondence between gauge theories under  $90^\circ$  rotation of the curve.