Research Results

Reiji Yoshioka

● 2d-4d connection

The relations between four-dimensional gauge theory and two-dimensional conformal field theory are been studied successfully. 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 branes are obtained by compactifying approapriately 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. I have studied the correspondence between gauge theory under 90° rotation of the curve. The clear correspondence between WZW model and XYZ spin chain have been constructed by using Ward-Takahashi identity and Baxter TQ equation.

I have considered q-deformation of the integral representation of the conformal block in 2d CFT and obtained its general expression. Due to AGT relation, the q-deformed conformal block agrees with 5-dimensional Nekrasov's instanton partition function. Furthermore, I have studied this conformal block in the root of unity limit of the parameter q and confirmed the correspondence with ALE instanton partition function at lower level. On the other hand, the conformal block for q-Virasoro algebra can be constructed. It is expected that we can derive the conformal blocks for $\mathcal{N} = 1$ super Virasoro and parefermion. At present, these studies are in progress.

● 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, I 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

I calculated the partition functions of reduced matrix models for various gauge groups by using the prescription of Moore-Nekrasov-Schatashvili.

● Effects of matrix orientifolding and four-dimensional spacetime

In matrix model, Spacetime points are describe ed 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 I 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 I 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.