Research Results

Reiji YOSHIOKA

My principal research object is as for superstring theory, in particular, its non-perturbative description. In the framework of the superstring theory, each elementary particle is described as not point-particle but the oscillation of a string. Then, the graviton which is the gauge particle mediating the gravity is naturally included in the theory as one of the oscillation modes and therefore the superstring theory can become the principal candidate of the unified theory.

• Matrix Model

The matrix model is given as one of the models which formulate non-perturbatively superstrings. There exist three types of matrix models as those for superstring theory, so called matrix theory, IIB matrix model and USp matrix model, respectively. Hence, it is very important to research the matrix models.

• Compactification

Because the superstring theory is defined only 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 models which define non-perturbatively type I superstrings, compactified by $\mathbb{C}^3/\mathbb{Z}_3$ and then I succeeded in enumerating all the possibilities to be able to be consistently defined.

• Calculation of partition function

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

• AdS/CFT correspondence

The AdS/CFT correspondence, which was proposed by Maldacena in 1997, shows that there exist the deep relation between the type IIB superstring theory in $AdS_5 \times S^5$ background and the four-dimensional $\mathcal{N} = 4$ supersymmetric Yang-Millls theory. According this correspondence, both are related by exchanging strong and weak coupling each other. Therefore, it enables us to understand the theory beyond the perturbative theory. In particular, I studied the AdS side, that is the superstring theory in $AdS_5 \times S^5$ background. Here, $AdS_5 \times S^5$ is the product space with the Anti de Sitter spacetime (AdS_5) and the five-dimensional sphere (S^5).

• Lagrangian in the generalized light-cone gauge

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

• Giant magnon and its scaling

Recently, a classical solution, so called giant magnon, is proposed by Hofman-Maldacena. I considered the giant magnon in flat space limit and near flat space limit and concretely constructed the solutions. Moreover, we obtained the scaled action that lead to the giant magnon solution in the near flat space limit.