Research Plan

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The nonperturbative features of superstrings are studied based on my research that has been done so far. Matrix model is very interesting because it is constructive formulation of superstring theory and treats nonperturbatively superstrings. The principal aim is to find out the informations for the nonperturbative nature of superstrings by using the matrix model. Emergence of four-dimensional spacetime and unifed treatment of elementary particles are consequently the central target. The content is indicated as follows.

• Emergence of four-dimensional spacetime and the stability

USp matrix model was proposed as the constructive definition of T^6/Z_2 compactified type I superstring theory. The model is given from IIB matrix model by matrix orientifolding that preserves the maximal supersymmetries. From my current research, the four-dimensional spacetime emerges by the attractive force between the spacetime points in the USp matrix model

First, for clarification of the local structure of the spacetime, I study the behavior of the spacetime points in the lower rank USp matrix model. So far, I studied the interactions between two spacetimes points in the case of USp(2) and USp(4) model. I will promote this study further. In particular, the USp(4) case is very interest and the distribution of the spacetime points becomes "seed" of the four-dimensional spacetime in general USp matrx model.

In addition, I will calculate the partition function (free energy) of the USp matrix model by using the prescription of Moore-Nekrasov-Shatashvili. In this procedure in which the USp matix model is described as the cohomological field theory the calculation of partition function becomes more easy. Then I varify the role of the orientifolding to the stability of the emerging four-dimensional spacetime by the comparison between the partition functions (free energy) of IIB and USp matrix model.

• Spontaneous compactification

My interest is to generate four-dimensional spacetime in the matrix model. Since the matrix models are usually defined in ten-dimensional spacetime, we must compactify the spacetime to four dimensions. Then, we must demand the conditions for compactifications from outside. So far, I have studied about the matrix models compactified by $\mathbb{C}^3/\mathbb{Z}_3$-orbifolding. On the other hand, I will study spontaneous breaking of ten-dimensional Lorentz symmetry for the matrix models without compactifing spacetime by hand. In the IIB matrix model, the Lorentz symmetry is spontaneously broken to the one of eight-dimension or less by the effect of fermionic part of the action. I will study the case of the USp matrix model in which the Lorentz symmetry is broken to $4+6$-dimensional from beginning. This study relates closely to the stability of emerging spacetime, too.

• Behavior of matter

The above studies aim purely to clarify the spacetime structure in the USp matrix model. In addition, I will study the behavior of the matter in this spacetime. In order to introduce the matter, it is necessary to add the matrices belonging to the fundamental representation of the usp algebra to the model. The matter and spacetime are described in the same standpoint. That is, both relate mutually and intimately and then the matters affect spacetime and vice versa. After adding the matter fields, I will study the eigenvalue distribution and calculate the partiton function etc. and then I want to study the influence of matter to spacetime structure.