Research Plan

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I will develop my research further. In particular, I will study about the 2d-4d(5d) connection and its relation with the integrable model.

2d-4d connection

I would like to progress the research for 2d-4d(5d) connection. I will consider the root of unity limit ($q \to -1, t \to 1$ or $q \to 1, t \to -1$) of the 2d-5d connection. In this limit, the connection becomes one between the partition functions of the four dimensional supersymmetric $U(n)$ gauge theory in the presence of the surface operators and the affine $sl(n)_k$ blocks deformed in some way. I try to derive the integral representation of the deformed $sl(n)_k$ block by using our limiting procedure and study what kind of effects its deformation has on the KZ equation which the usual $sl(n)_k$ block should satisfy. I would like to reveal the roles of the surface operator in CFT side.

In a classical limit of the theory of the both side in 2d-4d connection, two different integrable models, the Gaudin model form 2d side(CFT) and the Heisenberg model from 4d side(gauge theory), are obtained. Therefore the 2d-4d connection suggests that there exists a relation between these integrable models. I would like to consider the classical limit of the parafermionic coset CFT and the supersymmetric gauge theory in ALE spacetime and study the corresponding integrable model.

Matrix Model

The USp matrix model is given from IIB matrix model by matrix orientifolding that preserves the maximal supersymmetries. My current research suggests that the four-dimensional spacetime emerges by the attractive force acting between the spacetime points in the USp matrix model. I will study spontaneous breaking of Lorentz symmetry for the matrix models by studying the the effect of fermionic part of the action, which has no physical meaning clearly. This study relates closely to the stability of emerging spacetime.

In addition, I would like to make the natural interpretation for the origin of usp algebras obvious. For this purpose, I will discuss the physical process from IIB matrix model to USp matrix model.

The above studies aim purely to clarify the spacetime structure in the USp matrix model. In addition, We 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, We will study the eigenvalue distribution and calculate the partition function etc. and then I want to study the influence of matter to spacetime structure.