Research Plan

Reiji Yoshioka

I will develop my research further. About 2d-4d connection, I will study the q-deformation in CFT and gauge theory. In the studies for matrix model, the central target is about the emergence of four-dimensional spacetime and the unified treatment of elementary particles.

2d-4d connection

I try to progress the research of the q-deformation of Virasoro algebra. The free field representation for the q-Virasoro algebra will be completed and then I will study its root of unity limit of the parameter q. In this limit, a q-deformed free bosonic field behaves as some independent fields which have different property each other. It is expected that the conformal blocks constructed by these fields agree with those for parafermions according to 2d-4d connection. So I would like to confirm this agreement by studying root of unity limit. If this correspondence was accomplished, various conformal blocks for parafermions could be derived from that for q-Virasoro algebra by taking the appropriate root of unity limit. Because it is conjectured that the conformal block in this limit corresponds to ALE instanton partition function in gauge theory side, I will confirm this correspondence. Furthermore, I will extend to q-W_n algebra from q-Virasoro.

I will also study about the connection between the conformal block in similar root of unity limit and the instanton partition function of four-dimensional $\mathcal{N} = 2$ gauge theories in the presence of surface operators.

On the other hand, in two-dimensional conformal field theory, Virasoro algebra generating the conformal symmetry has the deep relation with the Calogero-Thutherland(CS) model. Because it is suggested that this CS model extends to spin-CS model in the above-mentioned root of unity limit, I will develop the connection with the integrable system.

Matrix Model

- Emergence of Four-Dimensional Spacetime

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.

- Behavior of Matter

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.