Plan

In 2009, Alday-Gaiotto-Tachikawa pointed out that a "two dimensional conformal field theory" relates to a "instanton part of four dimensional $\mathcal{N} = 2$ super Yang Mills-theory" [1]. This relation is called AGT conjecture, whose extension was proposed by [2] and [3] and which has been studied in various positions after that. H. Itoyama and T. Oota have proposed the matrix model corresponding to the "two dimensional conformal field theory" and the "instanton part of four dimensional N=2 super Yang Mills-theory"[4]. This model can perform practical calculation easily, in this meanings, it is a useful model.

In 2010, we calculated Scaling Limit using the matrix model in [4] and confirmed that calculation coincides with Yang-Mills side [5]. I am calculating the genus expansion of the Free Energy now. We aim to show not only many useful results but also the usefulness of the matrix model proposed by [4]. The research targets in the 2011 fiscal year are to continue such direct calculation, and to extend the model of [4]. On the former, I plan to perform higher order perturbation calculation of the matrix model in [4] by using the *Mathematica* than the result obtained by human power. Regrettably, there is still no strict proof of [1]. Since there is still no strict proof of [1], regrettably, I think, although many people believe AGT conjecture, it is meaningful to confirm the conjecture by using first thousands terms. On the latter, we expect the existence of the matrix model in [4] because the extensions of [1] are shown in [2] and [3]. I plan to study and find such extensions.

I also plan the research on generalized function-type potentials and boundary conditions in quantum mechanics. I especially aim at one-dimensional system whose Hamiltonian is given by second-order differential operator as follows:

$$H = -\frac{\hbar^2}{2m}\frac{d^2}{dx^2} + V(x).$$

It is known that the system with the generalized function-type interaction, for example delta-function potential, result in boundary problems at the support of the generalized function. Kurasov [1] considered 4-parameter family of generalized functions and showed that an element of the family corresponds to a boundary condition that is permitted physically [(1)]. But the correspondence in [1] is not complete; there exist boundary conditions that do not correspond to any generalized functions proposed in [1]. Moreover, I find the class of generalized functions have extension characterized by 16-parameters[(2)]. Since the boundary conditions permitted physically are characterized by 4 real numbers [2], there exists redundancy in the correspondence of the generalized function-type potentials to the boundary conditions. In order to clarify the situation, I plan to investigate the complete correspondence of a boundary condition to the class of generalized function-type potentials. I already find a class of generalized function-type potentials that corresponds to the smooth boundary condition, in other words, no generalized function-type potential case. The smooth boundary class of the generalized functions includes generalized functions with arbitrary size coupling constant. This fact implies that a strong coupled generalized function and a weak one give an identity boundary condition. It implies explicit strong-weak correspondence in quantum mechanics.

In order to carry out this research, I would like to go to Czech Technical University and have a discussion with Prof. Pavel Exner who is the authority of this field.

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