Research Plan

1 S-duality in the presence of the toric A-brane and new Hofstadter model

The correspondence that I studied in [3] is the consequence of the S-duality in the non-perturbative topological string theory without the toric A-brane. However, the S-duality should be maintained even in the presence of the toric A-brane from my previous study [5]. Therefore, I expect that the topological string theory with the toric A-branes describes a novel Hofstadter model. This project is important since I can study the S-duality through this correspondence. In order to see the S-dual structure, I try to obtain the Hofstadter butterfly in the non-perturbative topological string theory side.

2 Superconformal index of multiple M5-branes with the defect

It is suggested that the superconformal index of multiple M5 branes is given by integrating the partition function of M-string over the distance of the M5-branes. By using my previous studies [4, 6], I expect to define the superconformal index of multiple M5-branes with the codimension-2 defect. Since the integration is complicated, I try to integrate the partition function numerically in various values of the parameters. As an application of this result, I try to find a gravity dual theory which is predicted by the AdS/CFT correspondence.

3 Non-perturbative refined topological string theory

I plan to study the non-perturbative refined topological string theory. Based on my previous study [2], I expect that the two-parameter deformation of the Seiberg–Witten curves is related to the non-perturbative refined topological string theory. In order to consider the non-perturbative contribution, I use the fact that the quantization of the mirror curve is related to the non-perturbative topological string theory. First, I define the two-parameter deformation of the Seiberg–Witten curve in the operator formalism. Then, I calculate the expectation value of the operator. In this espression, I take the Nekrasov–Shatashvili limit in order to compare my result with the known results. This project is challenging, however, it enables to provide the non-perturbative definition of the B-model refined topological string theory.

References

[1] M. Nishida, M. Nozaki, Y. Sugimoto, and A. Tomiya "Entanglement Spreading and Oscillation," arXiv:1712.09899 [hep-th].

[2] T. Kimura, H. Mori and Y. Sugimoto, "Refined geometric transition and qq-characters," JHEP01(2018)025, arXiv:1705.03467 [hep-th].

[3] Y. Hatsuda, Y. Sugimoto and Z. Xu, "Calabi-Yau geometry and electrons on 2d lattices," Phys. Rev. D **95**, no. 8, 086004 (2017),

[4] H. Mori and Y. Sugimoto, "Surface Operators from M-strings," Phys. Rev. D **95**, no. 2, 026001 (2017),

[5] Y. Sugimoto, "Geometric transition in the nonperturbative topological string," Phys. Rev. D **94**, no. 5, 055010 (2016),

[6] Y. Sugimoto, "The Enhancement of Supersymmetry in M-strings," Int. J. Mod. Phys. A **31**, no. 16, 1650088 (2016),