Circular Wilson loop operator and master field

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In this talk, I have reported the recent study on the supersymmetric Wilson loop operators in four-dimensional $\mathcal{N} = 4$ super Yang-Mills theory in the context of AdS/CFT correspondence, based on the collaboration with T. Kuroki and A. Miwa which will appear[1]. In the gauge theory side, it is known that the expectation value of BPS circular Wilson loops with winding number k, $W_k(C)$, is calculable by use of a Gaussian one matrix model and then is governed by the eigenvalue distribution of this matrix model. In the large-N limit, this eigenvalue distribution, or the resolvent, can be calculated exactly and once this is known, one can compute any other observables by use of it. In this sense, the eigenvalue distributions are called the large N *master fields.* When the winding number k is of order N, the distribution consists of an interval $[-\sqrt{\lambda}, \sqrt{\lambda}]$ made out of $N-1$ eigenvalues and an isolated one located at $\sqrt{\lambda}\sqrt{1+\kappa^2}$ where λ is the 't Hooft coupling and $\kappa = k\sqrt{\lambda}/(4N)$ is a parameter of order 1. Through the detailed study of the resolvent we find that the contribution of the isolated eigenvalue to the resolvent is obtained from the Laplace transformation of $k+p$ winding Wilson loop expectation value with respect to p.

On the other hand, in the gravity side, it was proposed [2] that the Wilson loop expectation value is given by the classical value of the action S_{D3} of a probe D3-brane with k units of the electric flux, as $\langle W_k(C)\rangle = \mathrm{e}^{-S_{\mathrm{D3}}}$. Given such correspondence, we investigated the gravitational interpretation of the resolvent of the matrix model based on this relation. From the observation of the matrix model we are lead to consider the D3-brane solution with $k+p$ flux and its Laplace transformation. On the way of the analysis, we need to determine an appropriate boundary condition for the D3-brane solution and we propose one which seems plausible in various aspects. We then carried out the calculation and find that in the gravity side, an eigenvalue appears as the integrated flux on the D3-brane.

We then conclude that a part of the master field of the matrix model corresponds to the electric flux on D3-brane solution. The validity of the proposed boundary condition is also checked by demonstrating that the position of the isolated eigenvalue is correctly reproduced.

References

[1] S. Kawamoto, T. Kuroki and A. Miwa, to appear

[2] N. Drukker and B. Fiol, JHEP **0502** (2005) 010