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Evidence for Weak-Coupling Holography from the Gauge/Gravity Correspondence for Dp-branes

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Gauge/gravity correspondence is regarded as a powerful tool for the study strongly-coupled quantum systems, but its proof is not available. An unresolved issue that should be closely related to the proof is what kind of correspondence exists, if any, when gauge theory is weakly coupled. We report progress about this limit for the case associated with Dp-branes ($0 \leq p \leq 4$), namely, the duality between the $(p+1)$-dimensional maximally supersymmetric Yang-Mills theory and superstring theory on the near-horizon limit of the Dp-brane solution. It has been suggested by supergravity analysis that the two-point functions of certain operators in gauge theory obey power law with the power different from the free-field value for $p \neq 3$. We show for the first time that the free-field result can be reproduced by superstring theory on the strongly curved background. The operator that we consider is of the form $\mathrm{Tr}(Z^J)$, where Z is a complex combination of two scalar fields. We assume that the corresponding string has the worldsheet spatial direction discretized into J bits, and use the fact that these bits become independent particles when string tension is zero.

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