On Effective Action of Multiple M5-branes and ABJM Action[1]

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Abstract

We calculate the fluctuations from the classical multiple M5-brane solution of ABJM action which we found before. We obtain D4-brane-like action but the gauge coupling constant depends on the spacetime coordinate. This is consistent with the expected properties of M5-brane action, although we will need to take into account the monopole operators in order to fully understand M5-branes. We also see that the Nambu-Poisson bracket is hidden in the solution.

Understanding the dynamics of M5-branes is one of the most important problems in M-theory or string theory. For the D-branes, the low energy effective actions were found and they are essentially the Yang-Mills action. However, the effective action for the multiple M5-branes is not known yet. Recently, the effective action of multiple M2-branes on $\mathbf{C^4/Z_k}$, called the ABJM action, was suggested. Because the D4-brane action is constructed from the D2-brane action by the Matrix theory like construction using the non-commutative space, we expect that this ABJM action will be useful to study M5-branes. In this work, we uplift this situation to M-theory in order to obtain an M5-brane action from an M2-brane action, which we expect to be the ABJM action

Very recently, we found a classical solution of M5-branesin the ABJM action. This solution is an uplift of the flat D4-brane solution with a constant magnetic flux, which is constructed from infinitely many D2-branes satisfying $[X^1, X^2] = const.$ where X^1 and X^2 are the adjoint scalar fields corresponding to the transverse direction of the D2-branes. The three-algebra structure was also found in this solution. In this work, we expand ABJM action around our classical solution. We obtain D4-brane like action, which contains only the zero modes of the S^1 direction on which the $\mathbf{Z_k}$ of the $\mathbf{C^4/Z_k}$ acts. This is because the non-zero modes should have the vortex charge through the Chern-Simons term. In order to include them, we should take into account the monopole operators.

However, it would be remarkable that the gauge coupling constant of our D4-brane like action depends on the spacetime coordinate. We would like to stress that such an action is not obtained from the D2-branes. This dependence reflects the geometry $\mathbf{C^4/Z_k}$ in which the radius of the S^1 increases as we go away from the orbifold fixed point. In this sense, our action includes the information of M5-brane, which is not included in the D4-brane constructed from D2-branes. We hope this work will be helpful for the understanding of the M5-branes.

[1]This talk was based on the paper: "On Effective Action of Multiple M5-branes and ABJM Action" Seiji Terashima and Futoshi Yagi (IHES, Bures-sur-Yvette) JHEP 1103 (2011) 036, arXiv:1012.3961 [hep-th].