

論文 / 著書情報  
Article / Book Information

題目(和文)	AdS/CFT 対応を用いた M-brane 理論の超共形指数についての研究
Title(English)	Superconformal indices of M-brane theories via the AdS/CFT correspondence
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

# 論文要旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	物理学 物理学	系 コース	申請学位 (専攻分野)： Academic Degree Requested	博士 Doctor of	(理学)
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## 要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

Superstring theory is thought to be a candidate for theory including quantum gravity. There are five types of superstring theories in ten dimensions: Type I superstring theory, Type IIA superstring theory, Type IIB superstring theory,  $E_8 \times E_8$  heterotic superstring theory, and  $SO(32)$  heterotic superstring theory.

A unifying theory underlying these five superstring theories is thought to exist and the theory is called M-theory. M-theory is defined in eleven-dimensional spacetime and contains two fundamental objects. One is called an M2-brane, and the other is called an M5-brane. The M2-brane is a 2+1 dimensional object, and the M5-brane is a 5+1 dimensional object. As in the case of D-branes in superstring theory, in the low energy limit, superconformal field theories (SCFTs) are realized on M2-/M5- branes. The theory realized on M2-branes is called the 3d Aharony-Bergman-Jafferis-Maldacena (ABJM) theory. On the other hand, the theory realized on M5-branes is called the 6d  $\mathcal{N} = (2,0)$  theory.

The purpose of this thesis is to investigate those SCFTs by using a quantity called the superconformal index. Here, the superconformal index is a kind of partition function defined in a supersymmetric field theory, which exhibits a spectrum of the local operators. We propose a new method of calculating the superconformal indices of theories realized on M2- /M5- branes. In our method, we calculate the index from the dual gravity theory by using the Anti-de Sitter (AdS)/Conformal Field Theory (CFT) correspondence. The AdS/CFT correspondence is a conjecture that states a certain CFT is equivalent to the corresponding gravity system. Especially for the M-brane theories, AdS/CFT argues that the 3d ABJM theory with Chern-Simon level  $k = 1$  corresponds to M-theory on  $AdS_4 \times S^7$ , and the 6d  $\mathcal{N} = (2,0)$  theory corresponds to M-theory on  $AdS_7 \times S^4$ .

It is already well known that in the large- $N$  limit, where  $N$  is the number of M-branes, the superconformal index is calculated from the bulk Kaluza-Klein modes. In our study, we calculate the superconformal indices in the finite- $N$  region. So far, the study of AdS/CFT in the finite- $N$  region has been thought to be difficult due to quantum gravity effects. However, if we utilize the robust nature of supersymmetry, there is a possibility to avoid this problem. We assume that at the level of the superconformal index the quantum gravity effects are not required. Further, in the finite- $N$  region, we need additional contributions to the indices. At finite- $N$ , the contribution of M-branes becomes effective, and to calculate finite- $N$  corrections we have to include the contribution of M-branes wrapped on the internal space. Actually, calculating the contribution of the M-branes to the indices is the main work in this thesis.

For the ABJM theory, the finite- $N$  corrections to the index are given by M5-branes wrapped on a large  $S^5$  in the internal space  $S^7$ . We confirm the validity of our formula by comparing the results of our formula with the localization results of the ABJM indices.

For the 6d  $\mathcal{N} = (2,0)$  theory, the finite- $N$  corrections to the index are given by M2- branes wrapped on a large  $S^2$  in  $S^4$ . We give new results of superconformal indices of the six-dimensional theories by using our method and decompose them in terms of the superconformal representations. In addition, we analyze a special limit of the superconformal index called the Schur-like index.

We also analyze the M-brane theories in the presence of the  $\mathbb{Z}_k$  orbifolds. For the orbifold cases, the AdS/CFT correspondence claims that the 3d ABJM theory with Chern-Simon level  $k$  corresponds to M-theory on  $AdS_4 \times S^7/\mathbb{Z}_k$ , and the 6d  $\mathcal{N} = (1,0)$  theory corresponds to M-theory on  $AdS_7 \times S^4/\mathbb{Z}_k$ . We analyze the indices of these SCFTs from the dual gravity theories. For 6d  $\mathcal{N} = (1,0)$  theories, in particular, we confirm strange flavor symmetries of the theories via the superconformal indices.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note: Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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