

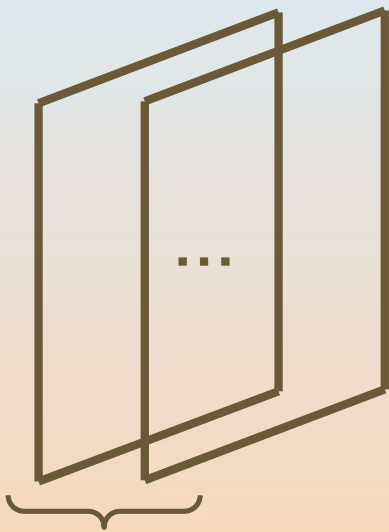
Orbifolding the Membrane Action

Seiji Terashima, F.Y (YITP, Kyoto U.)
ArXiv: 0807.0368

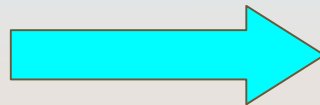


Question

What is the low energy effective theory on multiple M2 branes (membranes) ?



N M2 branes



$$l_p \rightarrow 0$$

**World volume
theory of
Membranes**

Cf. N D3 branes on flat space \rightarrow 4dim $\mathcal{N}=4$ $U(N)$ SYM



Hopeful Candidate

World volume theory of membranes suggested by ABJM

By **A**harony, **B**ergman, **J**affris, **M**aldacena

ArXiv: 0806.1218 [hep-th]

- 3dim $\mathcal{N}=6$ Chern-Simons matter theory
- M2 branes probing C^4/Z_k (k : level of Chern-Simons term)



Different from the method of
orbifolding the theory of D branes !!

Douglas and Moore
(hep-th/9603167)

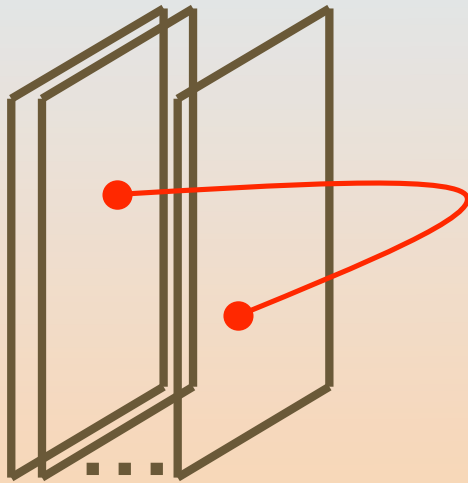
Orbifolding by the Z_n action $\rightarrow U(N)^n$ Quiver gauge theory

Orbifolding is non-trivial for membrane theory !!

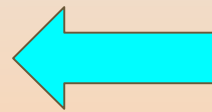
Chan-Paton factors

- ~ Which D-branes the open string attached.
- ~ Gauge indices

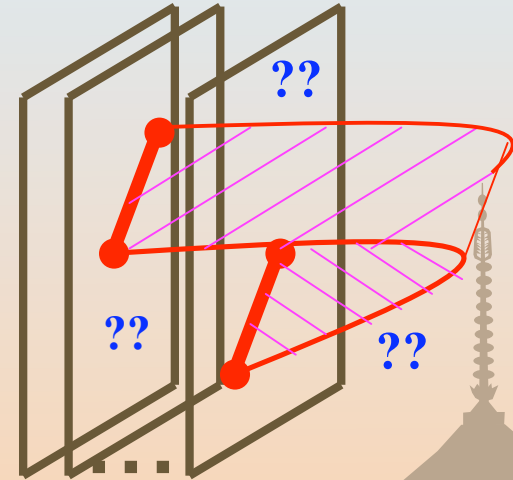
Structure of the counterpart of Chan-Paton factor is not clear



Method of orbifolding D branes is based on this picture.



Compactify on S^1



Systematic method of orbifolding membranes is not clear *a-priori*

They should be somehow related to each other.

Theme

▪ **What is the relationship between orbifold structure naturally encoded in the **ABJM theory** and the method of orbifolding for **D-branes**?**

- They are actually equivalent?
- The orbifold action Z_k encoded in the ABJM theory can be reproduced from the method of orbifolding for D-branes? → **No!**

▪ **Does the method for D-branes applicable for membranes for other orbifold actions?**

- Always applicable (Actually equivalent ?)
- Method for D-branes are not applicable for membranes?
- **Methods of orbifolding depends on the orbifold action ?**



Conclusion

- We constructed the theory which we suggest to the world volume theory of M2 branes probing

$$(C^4/Z_k)/Z_n \quad (k = nk')$$

$$Z_k : (y^1, y^2, y^3, y^4) \rightarrow \left(e^{\frac{2\pi i}{k}} y^1, e^{\frac{2\pi i}{k}} y^2, e^{\frac{2\pi i}{k}} y^3, e^{\frac{2\pi i}{k}} y^4 \right)$$

← Already incoded in the ABJM theory

$$Z_n : (y^1, y^2, y^3, y^4) \rightarrow \left(e^{\frac{2\pi i}{n}} y^1, e^{\frac{2\pi i}{n}} y^2, e^{\frac{2\pi i}{n}} y^3, e^{\frac{2\pi i}{n}} y^4 \right)$$

← Further orbifolding

by using the method for D-branes.

- We checked that its moduli space is

$$[(C^4/Z_k)/Z_n]^N/S_N$$

Which is consistent with the picture that M2 branes are probing

$$(C^4/Z_k)/Z_n$$

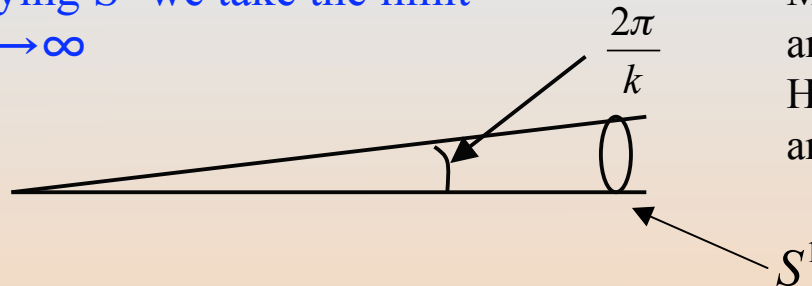
Cf. Imamura, Kimura
arXiv: 0806.3727

We discussed that we cannot use the method for D-branes for orbifold action to reproduce one which is encoded in ABJM theory.

Discussion

▪ Method of orbifolding similar to the case of D branes are applicable for some cases.

▪ When compactifying S^1 we take the limit
 $k \rightarrow \infty$ $\langle Z \rangle, \langle W \rangle \rightarrow \infty$



Mhuki, Papageorgakis

arXiv: 0803.3218

Honma, Iso, Sumitomo, Zhang

arXiv: 0806.3498

▪ It is not applicable if orbifolding structure vanishes when taking this limit.

