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) ?

World volume theory of Membranes

N M2 branes

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 Aharony, Bergman, Jaffris, Maldacena
ArXiv: 0806.1218 [hep-th]

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

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

Orbifolding by the $\mathbb{Z}_n$ action $\rightarrow$ $U(N)^n$ Quiver gauge theory

Douglas and Moore (hep-th/9603167)
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 \textit{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

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

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

\[ (C^4/Z_k)/Z_n \]

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

Cf. Imamura, Kimura
arXiv: 0806.3727
Discussion

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

- When compactifying $S^1$ we take the limit $k \to \infty \quad <Z>, <W> \to \infty$

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

Mhuki, Papageorgakis
arXiv: 0803.3218
Honma, Iso, Sumitomo, Zhang
arXiv: 0806.3498