Continuous symmetry defects and brane/anti-brane systems

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Outline



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Branes as topological operators and holography

Why do we care about symmetry?

Symmetry plays a fundamental role in physics for several reasons:

- Conserved quantities (energy, charge, etc)
- Constrains on physics
- Symmetry breaking

Generalized symmetry

Generalized symmetry is a modern framework that helps us understand symmetries in a more general and unified context.

- *p*-dimensional charged objects
- Codimension p+1 topological operators



Figure: [BBFT⁺23]

Local operators \rightarrow Extended operators!

Example: Maxwell Theory

Electric 1-form symmetry: $U = \exp\left(i\alpha \int_{\Sigma_2} \star F\right)$ Wilson line: $\mathcal{W} = \exp\left(2\pi iq \int_L A\right)$



Figure: [BBFT⁺23]

Continuous symmetry defects in QFT

Consider a U(1) scalar field: $S = \int d^d x \left(\partial_\mu \phi^* \partial^\mu \phi + V(|\phi|) \right)$

It enjoys a U(1) symmetry: $\phi \rightarrow e^{i\alpha}\phi$

The conserved current is: $j_{\mu} = \phi \partial_{\mu} \phi^* - \phi^* \partial_{\mu} \phi$

So the topological operator is: $U_{\alpha}(M_{d-1}) = e^{i\alpha \int_{M_{d-1}} \star j}$

What happens when we insert this operator inside a correlation function?

$$\langle ...e^{i\alpha \int_{M_{d-1}} \star j} ... \rangle$$

Defect regularization

It doesn't behave nicely, the correlation function diverges.

We have to regularize it.



In [BJRW24], they propose regularization by thickening.

Figure: [BJRW24]

Holography



Dp-branes as topological operators

In [BGVMRG24], *Dp*-branes located at the boundary are associated to topological operators.



Figure: [BGVMRG24]. O_n is a charged object, U_{α} is the topological operator measuring its charge.

But now, these picture should also have a relation to the thickening regularization scheme.

Dp/\overline{Dp} brane system

This issue was solved using the well known Dp/\overline{Dp} brane system [Sen98].

A brane/antibrane system collapses into the non-BPS brane that behaves as a topological operator.

The depth into AdS behaves precisely as the thickening explored in [BJRW24].



Outlook

- Symmetries in field theories are captured by topological operators (defects)
- When inserted in correlation functions, they need to be regularized
- In a holographic setup, this regularization has a neat dual as collapsing Dp/\overline{Dp} branes.

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