

String Dualities

what they mean,
and what we want to prove

- What are string dualities?

I. A non-pert. realized gauge symmetry

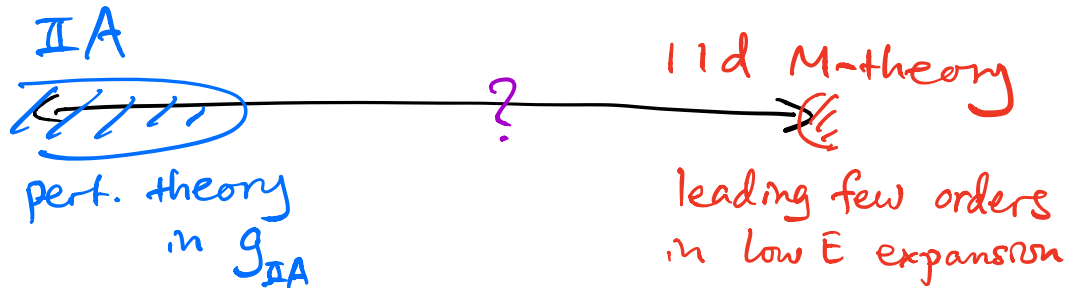
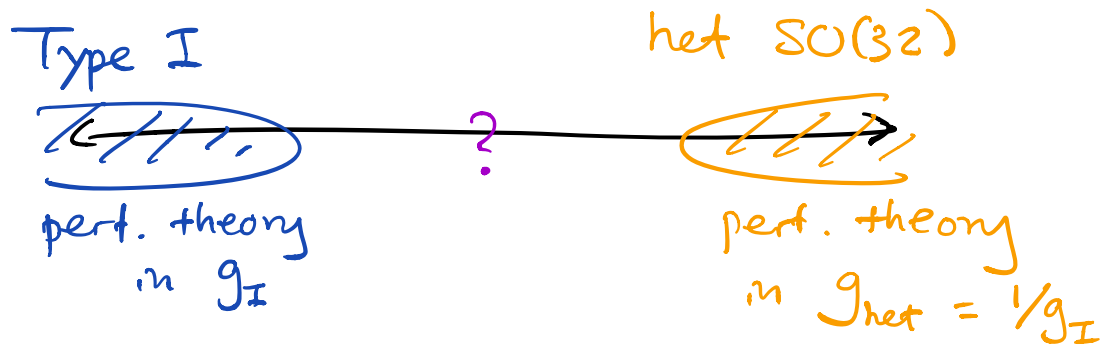
e.g. T-duality / mirror symmetry

S-duality

The "duality symmetry" is essential
for the existence of certain non-pert.
objects (e.g. monodromy branes)
and classes of string vacua
(e.g. F-theory vacua)

II. Different (weak coupling) limits of the moduli space of string vacua

e.g.



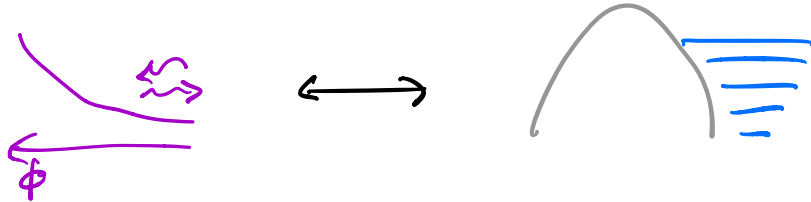
III. Holography / string - gauge duality

e.g. IIB $AdS_5 \times S^5 \simeq \mathcal{N}=4$ SYM

$c=1$ string \simeq scaling limit of MQM

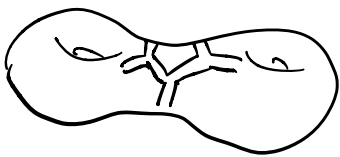
- Improving standards of "derivation"

$c=1$ string / MQM duality



~ '90 discretization of worldsheet

~ diagrammatic expansion of MQM

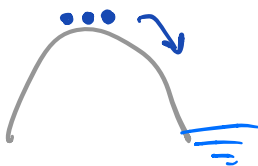


- schematic, does not explain the specific WS CFT and MQM involved.

- In fact, WS CFT strongly coupled, only formulated precisely '94-'01

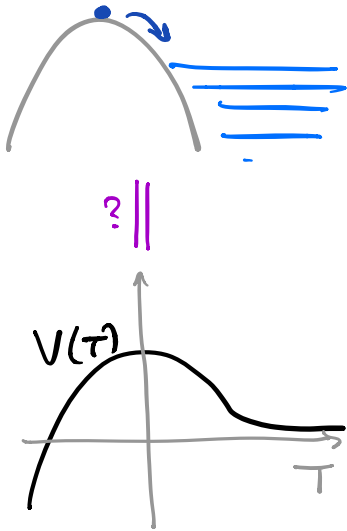
~ '03 ZZ -branes \rightsquigarrow MQM

a holographic duality?



- no actual decoupling limit that explains the specific MQM.

- What we actually want:



To show that the OSFT of $\mathbb{Z}\mathbb{Z}$ -brane is equivalent to eigenvalue/fermion dynamics in the presence of the fermi sea.

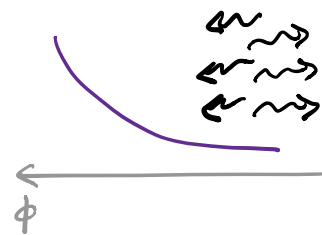
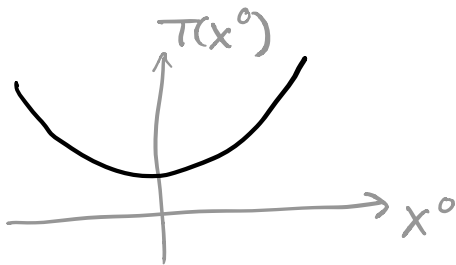
Of particular interest:



rolling OS tachyon
on $\mathbb{Z}\mathbb{Z}$ -brane

?

closed string radiation



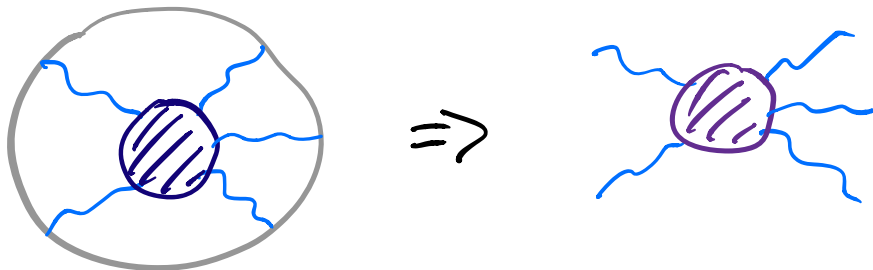
Derivation from open+closed SFT
on $\mathbb{Z}\mathbb{Z}$ -brane?

“mostly open” \longleftrightarrow “mostly closed”
string field redefinition

- “Shouldn't we view $\mathcal{N}=4$ SYM as a non-perturbative definition of type IIB superstring (in $AdS_5 \times S^5$)?”

- If so, how does the former reproduce everything we already know about IIB:
 perturbative strings and D-branes
 in flat spacetime
 + bkgd-independent low E effective theory?

- can in principle produce non-pert. graviton S-matrix of IIB by taking a certain $N \rightarrow \infty$, finite $g_{\text{YM}}^2 = g_s^2$ limit...



Do we know whether this prescription results in a unitary S-matrix?

If so, we are (sort of) done!

- To what extent are the two sides defined?

$$\text{IIB } \text{AdS}_5 \times S^5 \longleftrightarrow \mathcal{N}=4 \text{ SYM.}$$



What is IIB string
in $\text{AdS}_5 \times S^5$?

non-pert. defined ✓

in principle:

- lattice
- Hamiltonian truncation
- bootstrap correlators

- GS eff. string + integrability?

- RNS closed superstring field theory
(based on PCO + vertical integration)

in $\mathbb{R}^{1,9}$ bkgnd deformation \rightarrow $\text{AdS}_5 \times S^5$ as a SF sol'n
perturbatively in $1/R$.

- expand around this sol'n
to extract string spectrum and interaction

- pure spinor worldsheet CFT

- BRST cohomology in $1/R$ expansion?

- add D-branes and D-instanton effects
via open + closed SFT

- black holes and gravitational instanton effects
only understood at the level of low E expansion.