AdS/CFT and ABJM Wilson Loops

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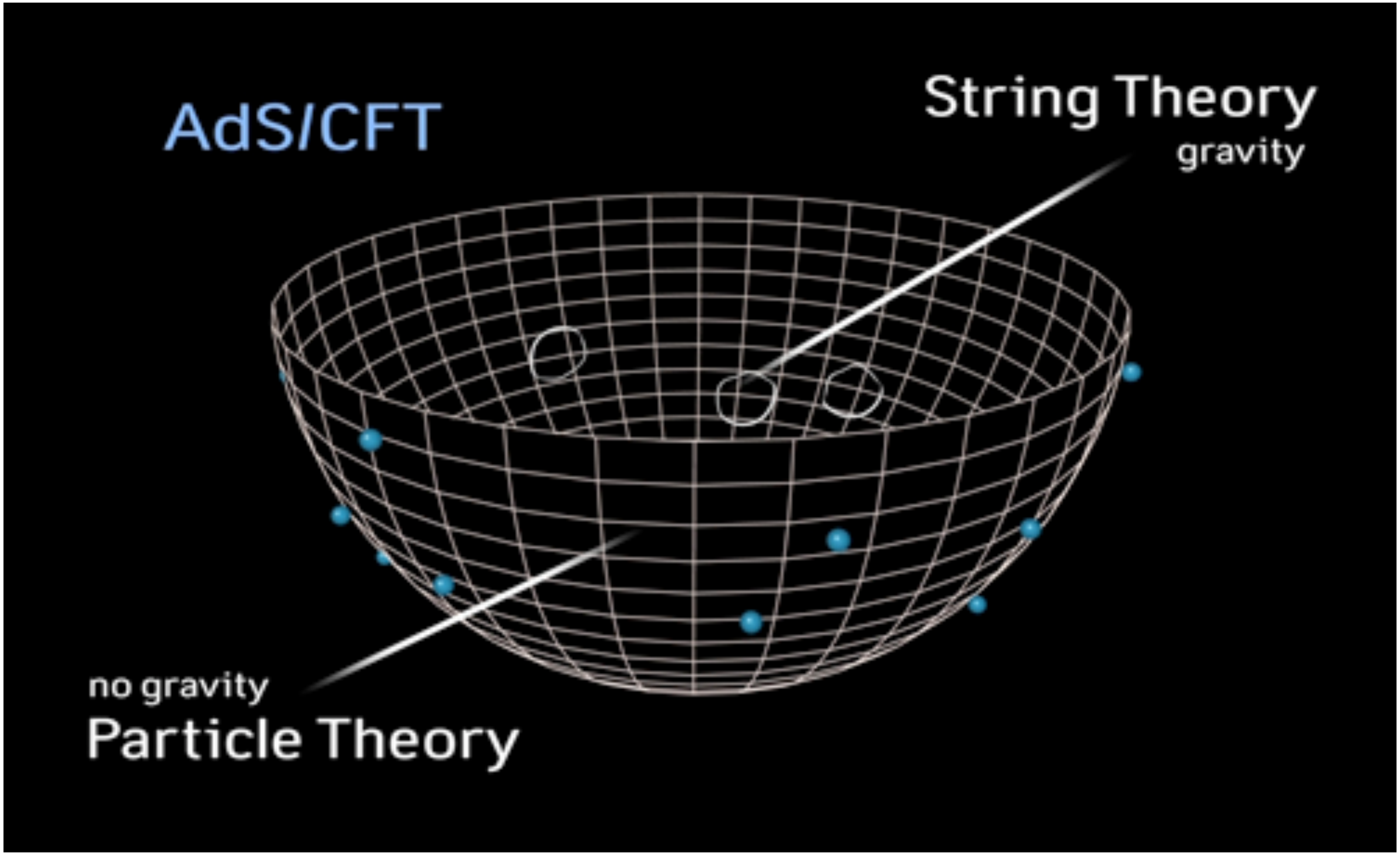
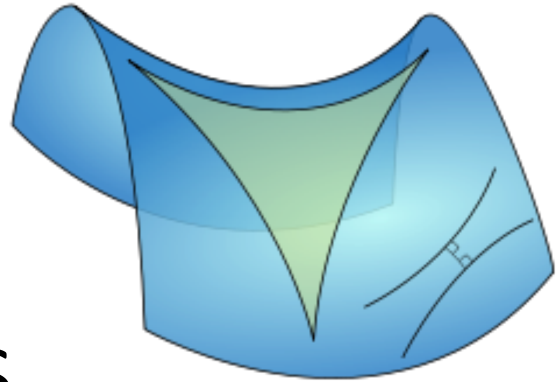
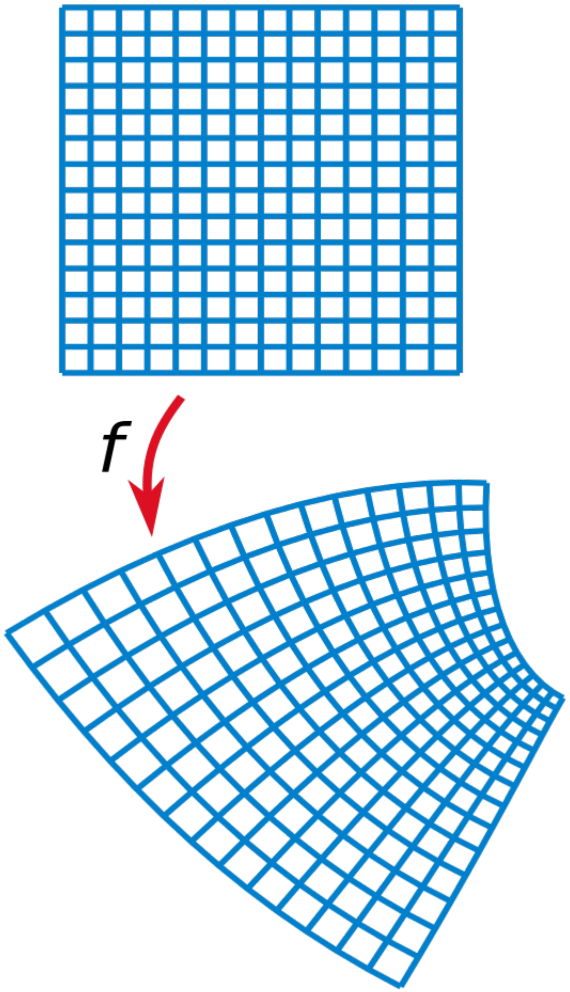


- Anti-de Sitter space (AdS)
- Conformal Field Theory (CFT)



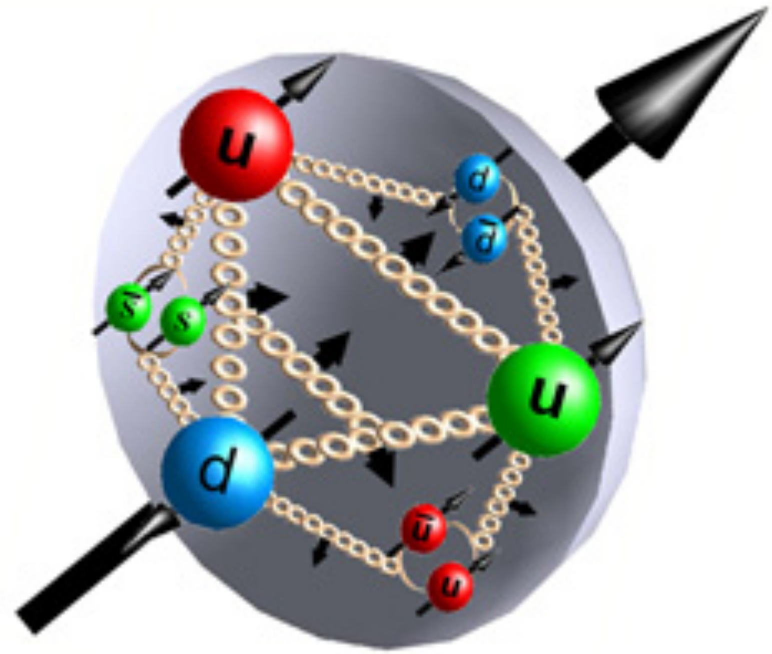
AdS/CFT continued

- AdS
  - String theory
  - Negative curvature
- CFT
  - Quantum Field Theory
  - No gravity
  - Conformal transformations
- Not proven.



Why is AdS/CFT useful?

- Strongly coupled
  - (e.g. QCD)



$$\alpha = \frac{e^2}{4\,\pi\epsilon_0\hbar c} \approx \frac{1}{137}$$

- Understand string theory through a field theory (and vice-versa).

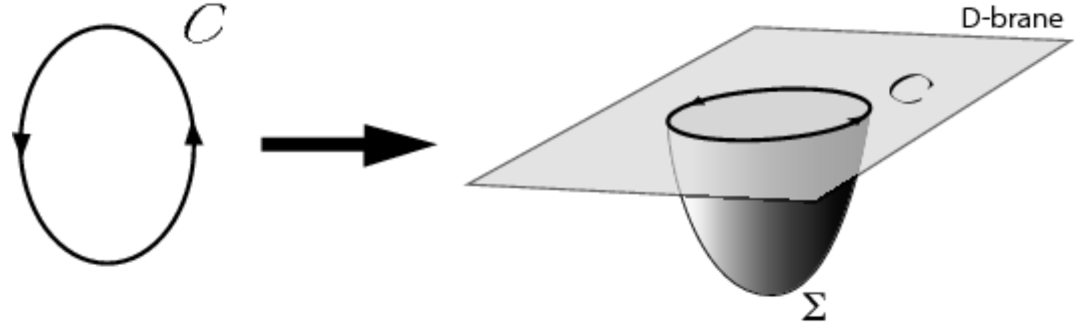
ABJM

- 2+1 dimensional CFT.
- Dual to M-theory
- Localizes to partition function:

$$Z = \int dM e^{-E(M)}$$

- M is a Hermitian matrix; E is “energy”

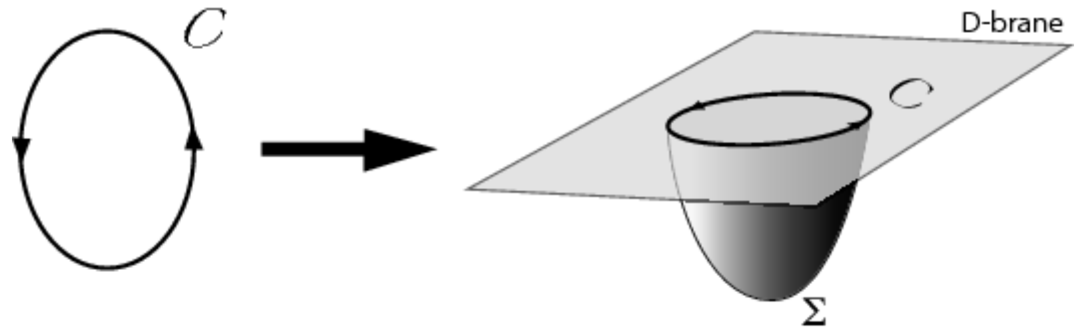
Wilson Loops



- Observable
- Calculate expectation value

$$\langle W \rangle = \frac{1}{Z} \int dM \, \widehat{W}(M) \, e^{-E(M)}$$

Wilson Loops



- Observable
- Calculate expectation value

$$\langle W \rangle = \frac{1}{Z} \int dM \, \widehat{W}(M) \, e^{-E(M)}$$

- $\langle W_n \rangle$ is n times wound
- Interested in certain combinations of $\langle W_{n_i} \rangle$
- $\langle W^{S_2/A_2} \rangle = \frac{\langle W_1 \rangle^2 \pm \langle W_2 \rangle}{2}$; $\langle W^{S_3/A_3} \rangle = \frac{\langle W_1 \rangle^3 \pm 3\langle W_2 \rangle \langle W_1 \rangle + 2\langle W_3 \rangle}{6}$

Results:

$$\langle W^{S_m} \rangle \sim \exp\left[m\,\pi\sqrt{2\,\lambda}\right] \sim \langle W_m \rangle$$

$$\langle W^{A_m} \rangle \sim \exp\left[\frac{m(N-m)}{N}\pi\sqrt{2\,\lambda}\right]$$

- M is an $2N{\times}2N$ matrix; λ is a coupling parameter of ABJM.
- $m \gg 1;\ N \gg 1;\ \lambda \gg 1;$

Acknowledgements

- Dr. Jim Liu, Dr. Leo Pando Zayas
- Myron Campbell, Angela Germaine
- NSF REU #PHY-1559988

Pictures

- Slide 2: https://www.learner.org/courses/physics/visual/visual.html?shortname=AdSCFT
- Slide 3:
- https://en.wikipedia.org/wiki/Hyperbolic_geometry#/media/File:Hyperbolic_triangle.svg
- https://en.wikipedia.org/wiki/Conformal_map
- Slide 4: https://www.bnl.gov/rhic/RHIC2.asp
- Slide 6: https://inspirehep.net/record/1260585/plots