

UV-cutoffs For Studying Entanglement on the Fuzzy Sphere

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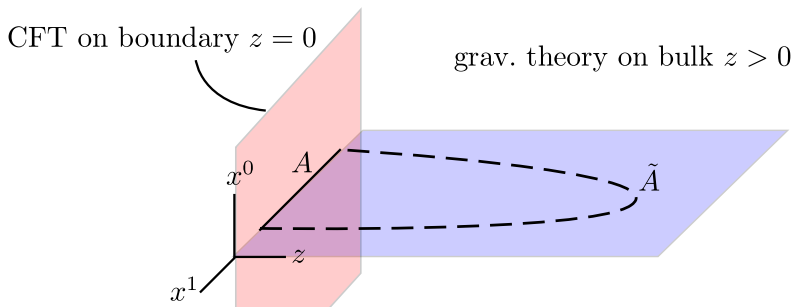
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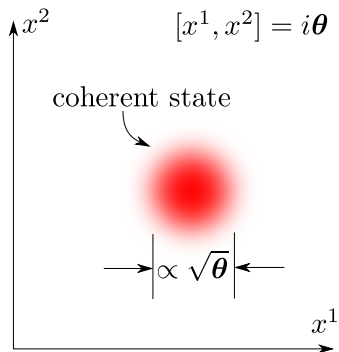
Why Study Entanglement?

- Quantum gravity from string theory
- Emergent gravity
- AdS/CFT correspondence links gravity to entanglement



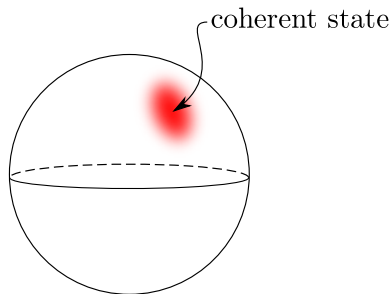
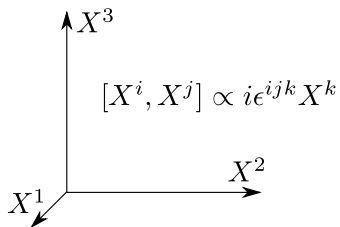
Why Study Non-Commutative Geometry?

- Holographic dual to flat space is non-local
- Non-commutative coordinates \implies non-locality



Fuzzy Sphere

- 2-dimensional sphere embedded in 3 dimensions
- Coordinates obey commutation relations like angular momentum operators



Entanglement Entropy

- Entanglement entropy S quantifies the loss of information when one part of the system is hidden

$$\frac{|\uparrow_C\rangle \otimes |\downarrow_{\bar{C}}\rangle + |\downarrow_C\rangle \otimes |\uparrow_{\bar{C}}\rangle}{\sqrt{2}}$$

$\sqrt{2}$

particle C

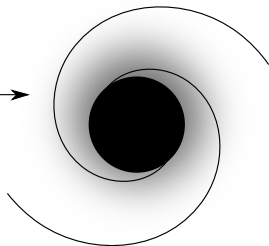
$|\uparrow_C\rangle$ probability $1/2$

$|\downarrow_C\rangle$ probability $1/2$

$$S = -\frac{1}{2} \log\left(\frac{1}{2}\right) - \frac{1}{2} \log\left(\frac{1}{2}\right)$$

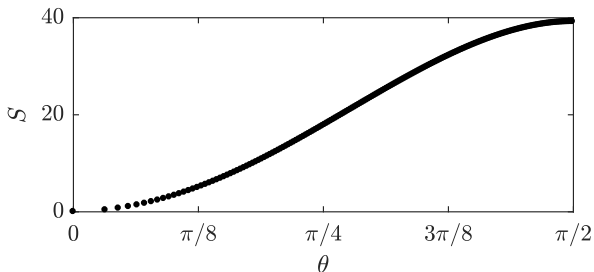
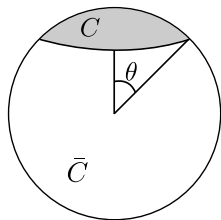
particle \bar{C}

black hole



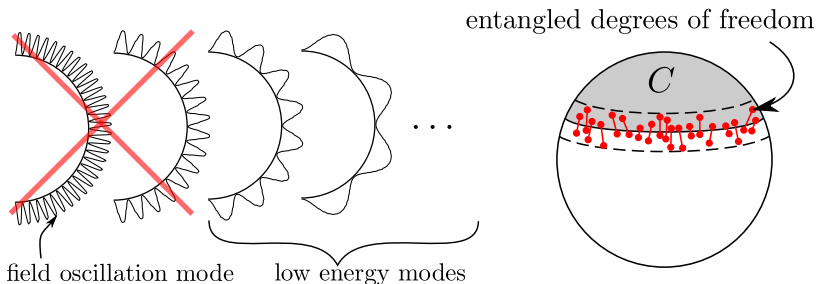
Entanglement Entropy on Fuzzy Sphere

- Previous work calculated entanglement entropy between cap C and its complement \bar{C}



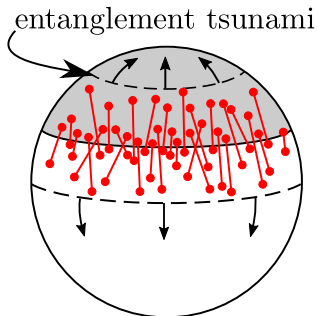
UV-Cutoff

- Check if ultraviolet cutoff affects length scale over which entanglement occurs



Energy Quench

- Consider the impact of a sudden energy dump, i.e. quench
- e.g. Does locality of entanglement affect speed at which information propagates?



Resources and Schedule

- Calculations to be done numerically using MATLAB (efficient with large matrices)

Task	Date
Implementing time-independent S -calculation	May
Initial calculations with imposed UV-cutoff	Jun
Finalizing time-independent analysis for pre-print	Sep-Nov
Implementation of quench calculation	Dec
Quench analysis	Jan-Feb
Thesis write-up	Mar

Summary

- want to study entanglement because AdS/CFT links it to emergent gravity
- want to study non-commutative geometries because holographic dual to flat space is nonlocal
- we will study entanglement on the fuzzy sphere with applied UV-cutoff
 - (static) vacuum case
 - (time-dependent) aftermath of energy quench

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