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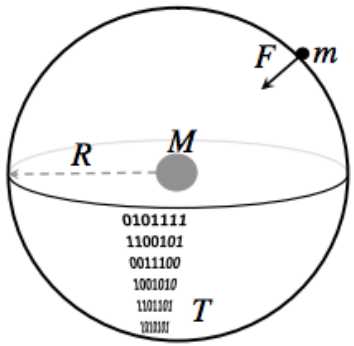
Gravity as an entropic force.(E. Verlinde 2010)

- $T\Delta S = \Delta x\, F$.
  Main postulates;

  $\Delta S = 2\pi k_B$
  $\Delta x = \frac{\hbar}{mc}$



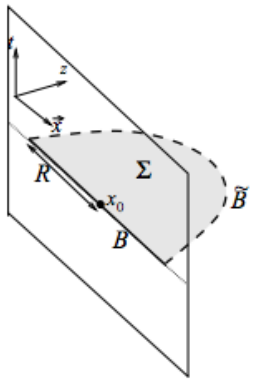
$\Delta S = -\frac{k_B N}{2c^2}\Delta\Phi$

The Newton force law follows when one uses equipartition theorem.
$\frac{1}{2}Nk_B T = Mc^2 \implies F = ma$.

Linearized Einstein eqs through AdS/CFT. (Myers et al. 2013)

- First law on the boundary CFT $\Longrightarrow$ First law on the bulk.

  $\delta S_B = \delta E_B$



Following Wald formalism,

$\delta E_B^{grav} = \int_B \chi$

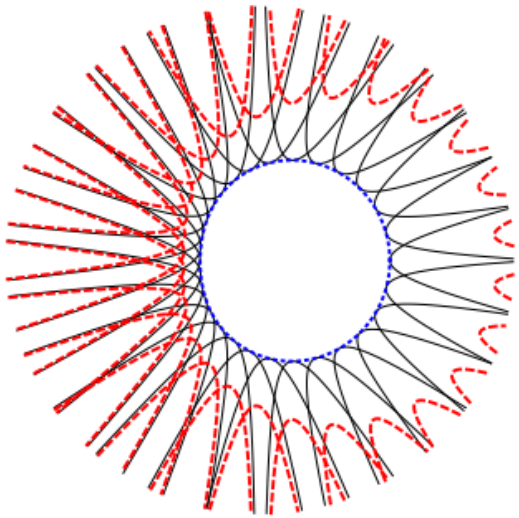
$\delta S_B^{grav} = \int_{\tilde{B}} \chi$

$\delta E_B^{grav} = \delta S_B^{grav} \Longrightarrow \int_\Sigma d\chi = 0 \Longrightarrow \delta E_{ab}^{g} = 0$

Entanglement entropy of a hole. (de Boer et al. 2014)

- Entanglement entropy of arbitrary bulk regions.

$$S_{\text{residual}} = \frac{1}{2}\int d\theta \frac{dS(\alpha)}{d\alpha}$$



Entropy=Area!

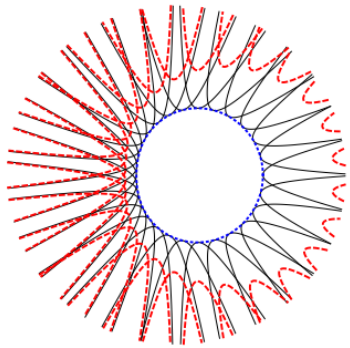
$$S_{\text{residual}} = \frac{\mathcal{A}}{4G_N}$$

First law for residual entropy in AdS_3. (work in progress)

- Apply the first law for each region on the boundary which together constructs the region in the bulk.

$$\frac{1}{2}\int_0^{2\pi} d\theta \frac{d}{d\alpha}\delta S_\alpha = \frac{1}{2}\int_0^{2\pi} d\theta \frac{d}{d\alpha}\delta\langle H_A\rangle$$

$$H_A = \int_A d\Sigma^\mu \xi^\nu T_{\mu\nu}$$



This change is identified with the change in the area due to a conical defect. Comparing two geometries by keeping proper length from the origin fixed, we found.

$$\delta S_{\text{residual}} = \frac{2\pi R_{hole} m_{defect}}{4G_N} = \frac{A}{4G_N}\delta\Phi$$

Summary

- $\delta S_{EE} \sim A\,\delta\Phi$
- Matter-spacetime entanglement?
- How can we derive full Einstein equations via AdS/CFT ?