Recent Developments in 3d Flat Space Holography

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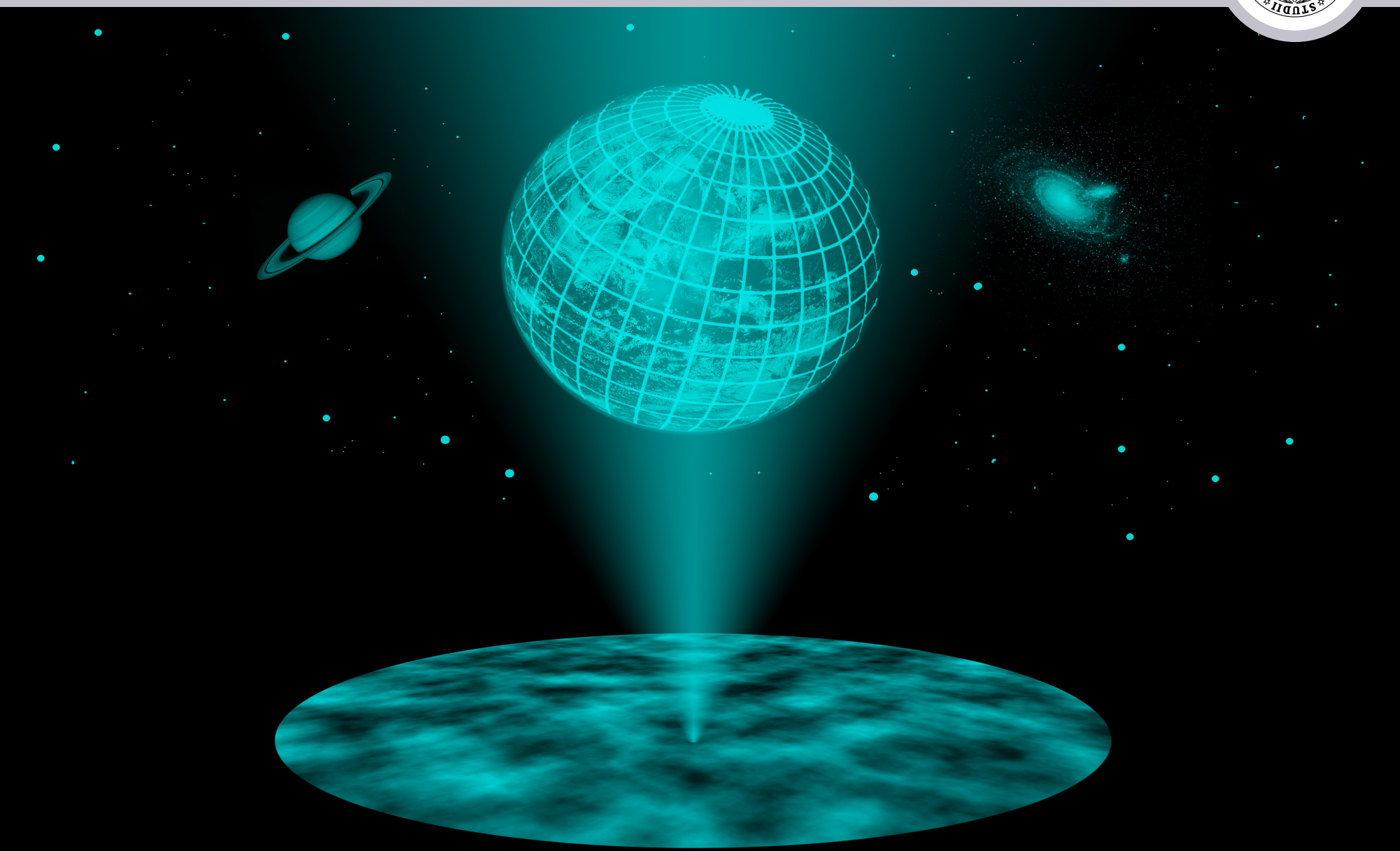
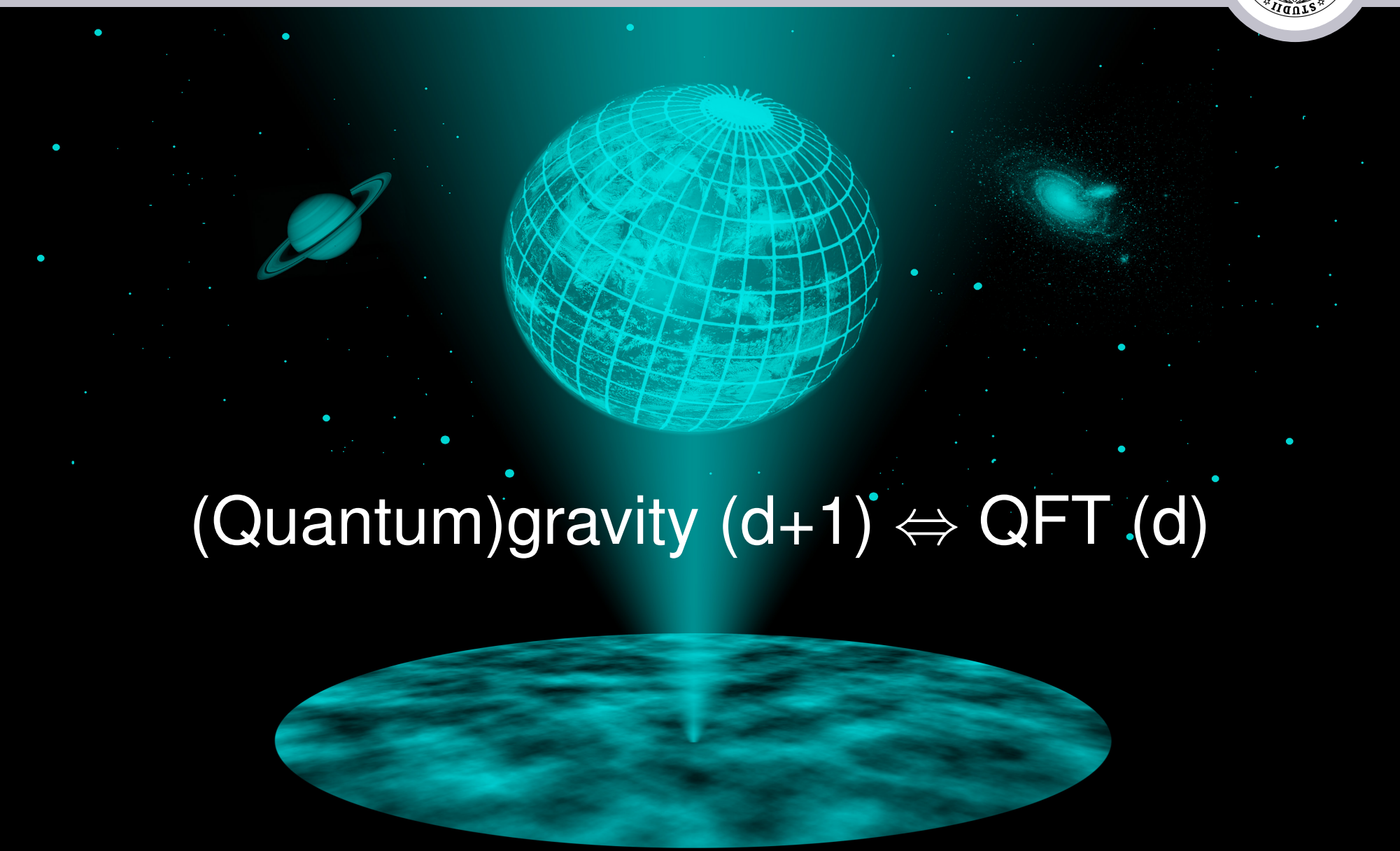
Based on [2106.07649]

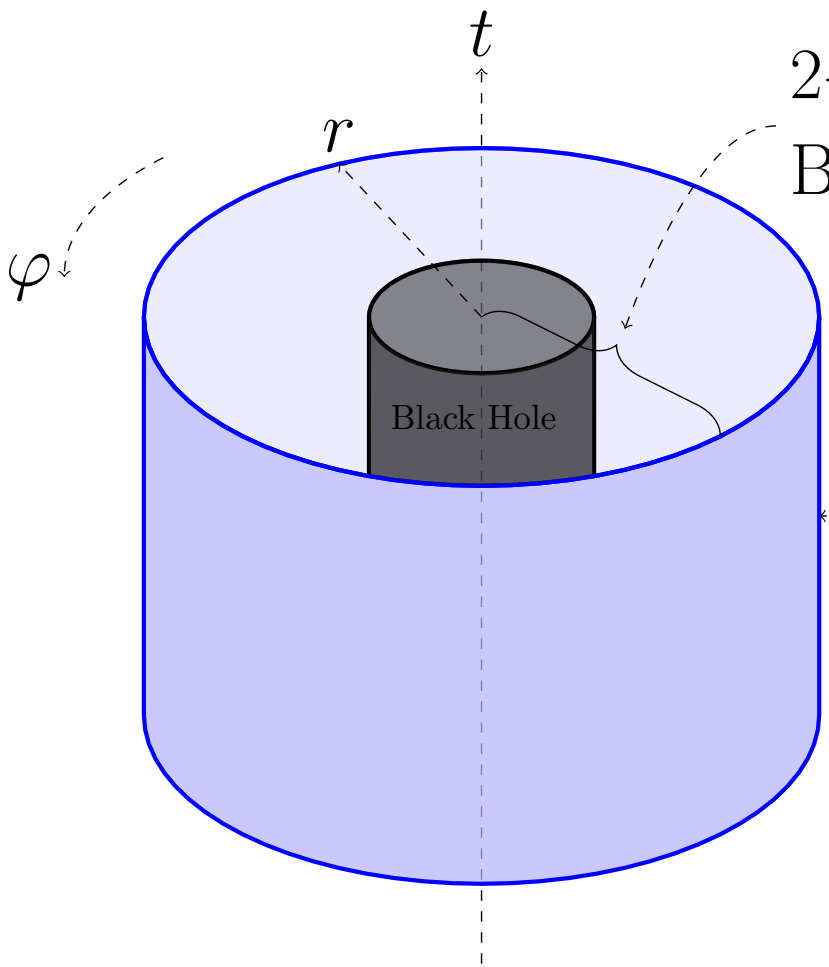
Introduction
The Holographic Principle





(Quantum)gravity (d+1) $\Leftrightarrow$ QFT (d)

Introduction
AdS_3/CFT_2



2+1 Dimensional
Bulk Spacetime

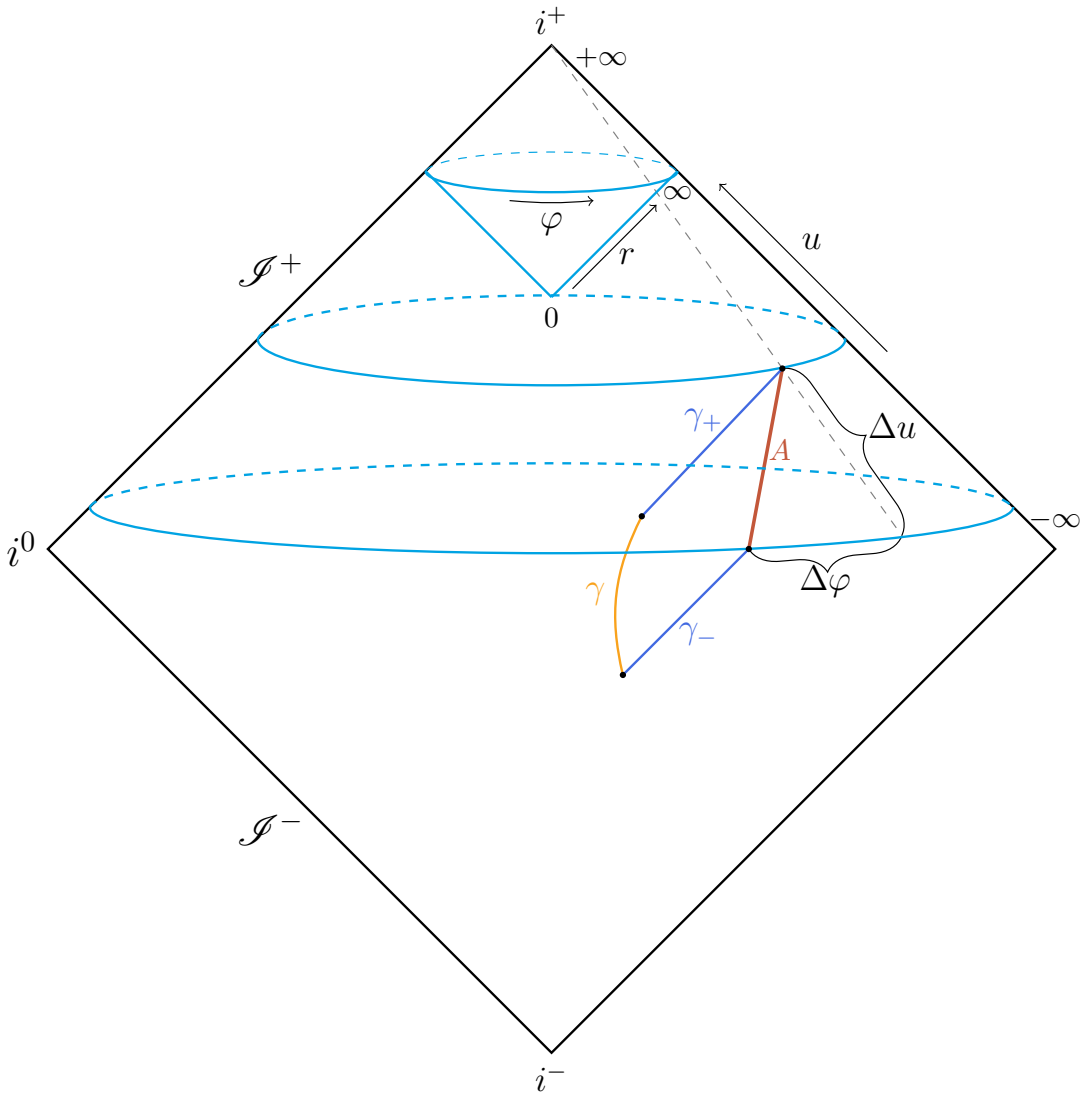
1+1 Dimensional
Quantum Field Theory

Introduction
Realistic Black Holes

Go beyond AdS/CFT!

Flat Space Holography

Example: Holographic Entanglement Entropy



Chaos and Cosmological Holography

Chaos in Classical Systems

$$\{x(t), p(0)\} = \frac{\partial x(t)}{\partial x(0)} \sim \sum_n e^{\lambda_L^{(n)} t}$$

Chaos and Cosmological Holography

System in Thermal Equilibrium at Inverse Temperature β

$$-\left\langle [W(t), V(0)]^2 \right\rangle_\beta \sim \sum_n e^{\lambda_L^{(n)} t}$$

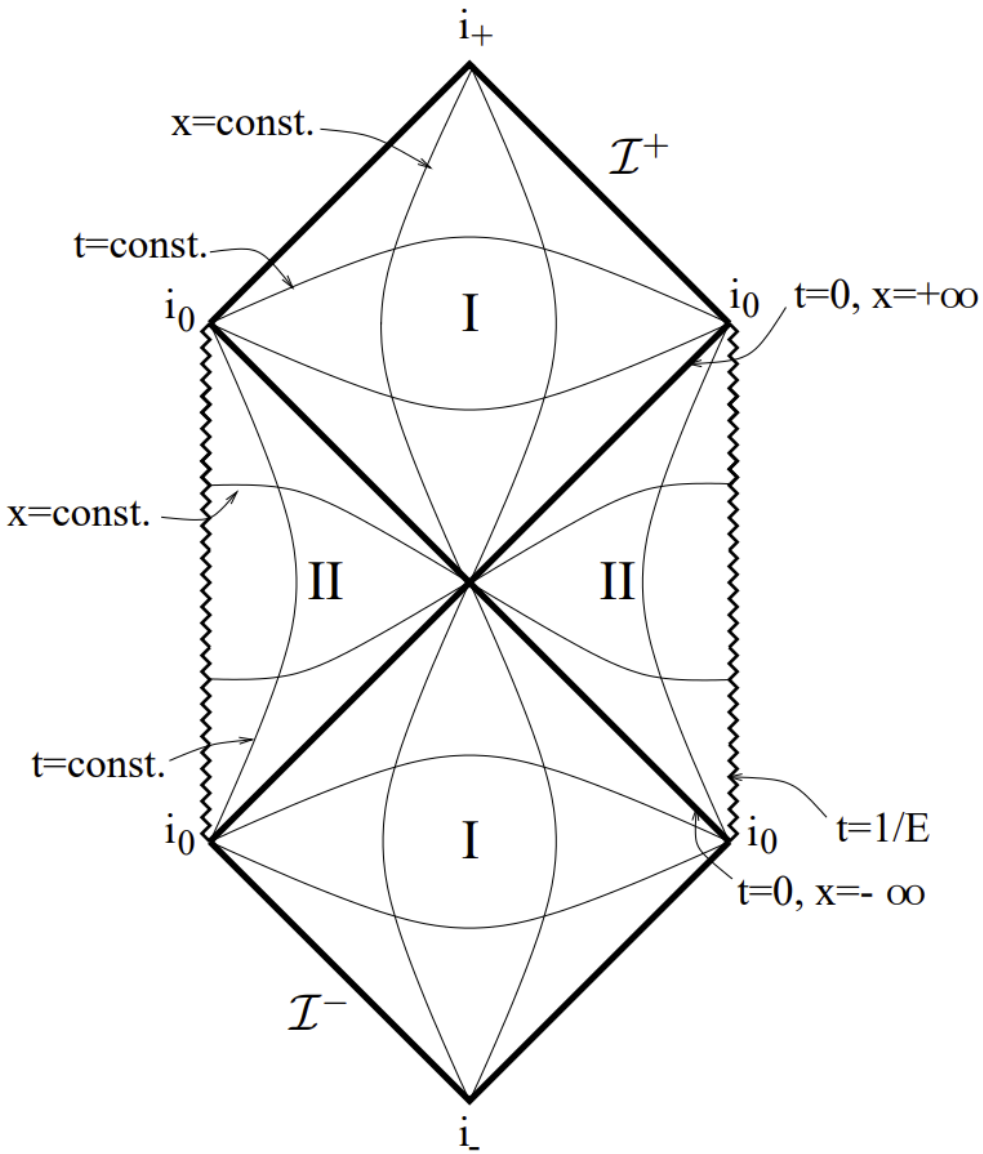
Chaos and Cosmological Holography

Lyapunov Exponent

$$\lambda_L = \frac{2\pi}{\beta}$$

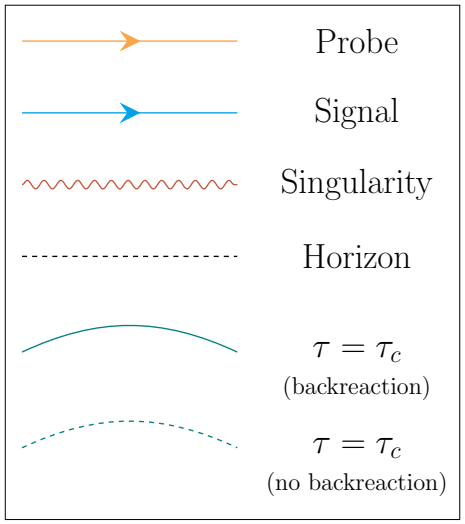
Chaos and Cosmological Holography

Flat Space Cosmologies



Chaos and Cosmological Holography

Shockwaves in a Contracting and Expanding Universe



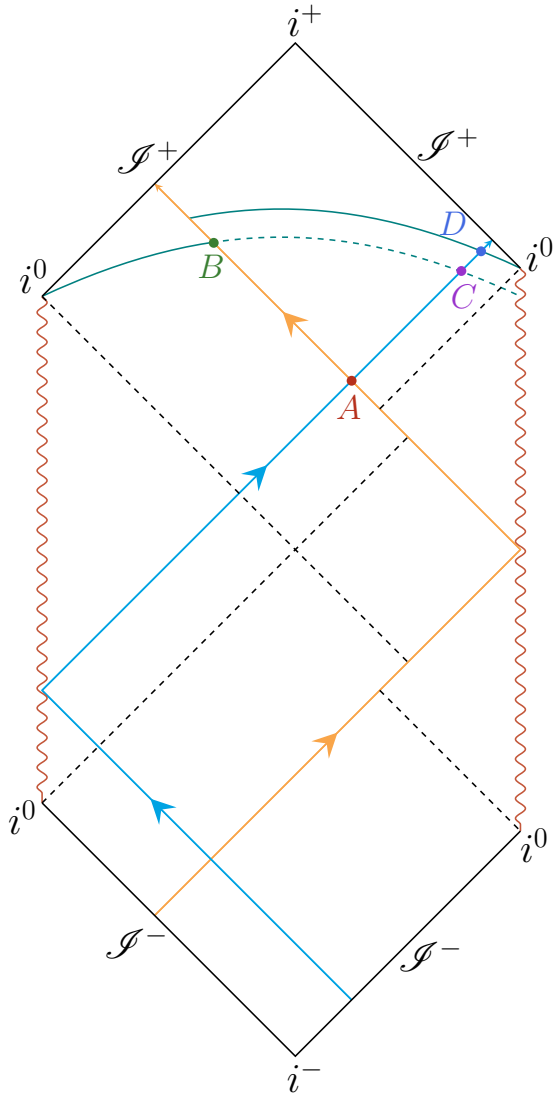
$\mathscr{I}^+$: Future null infinity

$\mathscr{I}^-$: Past null infinity

i^+: Future timelike infinity

i^-: Past timelike infinity

i^0: Spacelike infinity



Shift

$$\Delta_{C\to D} \approx e^{\frac{2\pi}{\beta}\Delta_{B\to C}}$$

Shift

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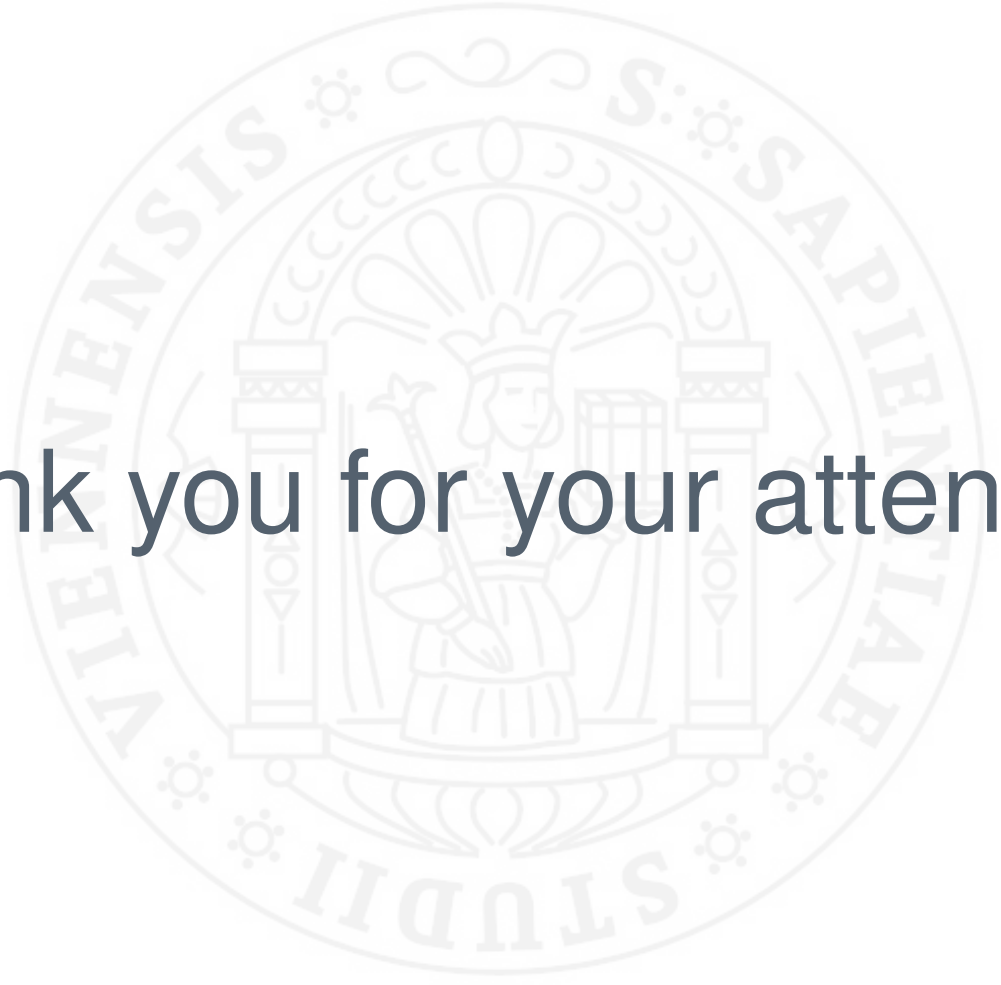
Lyapunov Exponent

$$\lambda_L = \frac{2\pi}{\beta}$$



Thank you for your attention!