

Title: Uptunneling to de Sitter

Speakers: Mehrdad Mirbabayi

Series: Cosmology & Gravitation

Date: February 23, 2021 - 11:00 AM

URL: <http://pirsa.org/21020034>

Abstract: Motivated by the question of how inflation started, we propose a Euclidean preparation of an asymptotically AdS₂ spacetime that contains an inflating dS₂ bubble. The setup can be embedded in a four dimensional theory with a Minkowski vacuum and a false vacuum. AdS₂ times 2-sphere approximate the near horizon geometry of a 4d near-extremal RN wormhole. Likewise, in the false vacuum the near-horizon geometry of a near-extremal black hole is approximately dS₂ times 2-sphere. We interpret the Euclidean solution as describing the decay of an excitation inside the wormhole to a false vacuum bubble. The result is an inflating region inside a non-traversable asymptotically Minkowski wormhole.

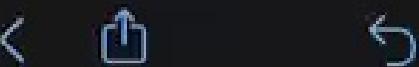


Note 23 Feb 2021
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Uptunneling to dS

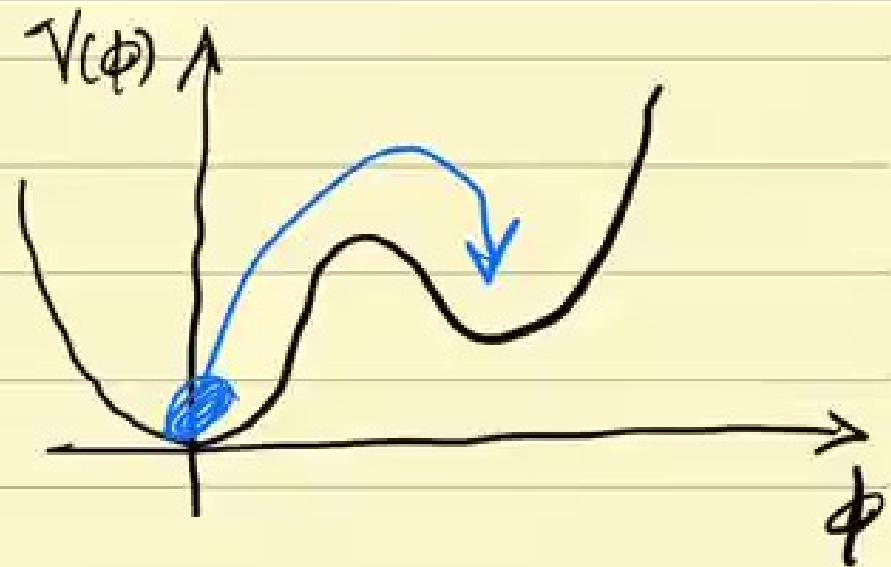
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* Λ -dominated

$$\frac{\Lambda}{M_P^4} \sim 10^{-120}$$



* We had inflation in our past.

1) Why

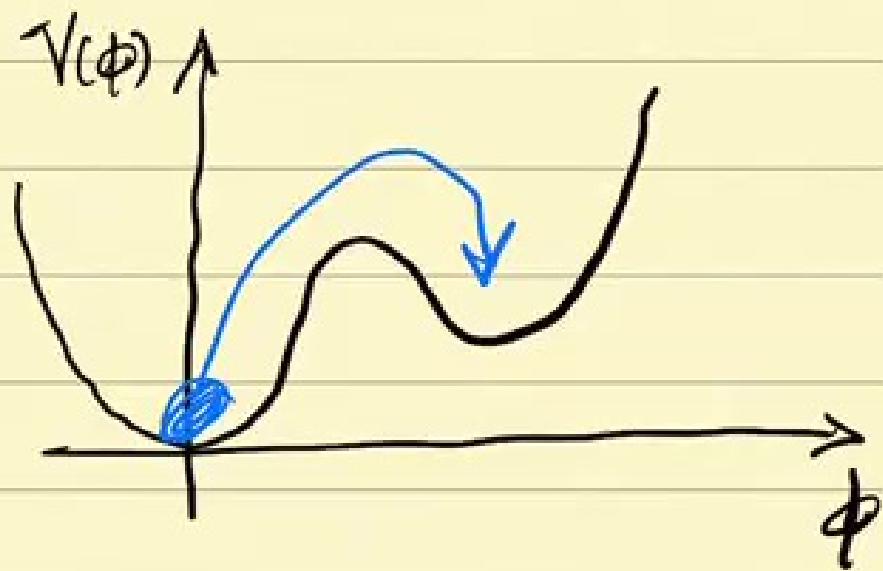


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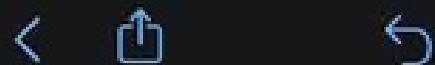
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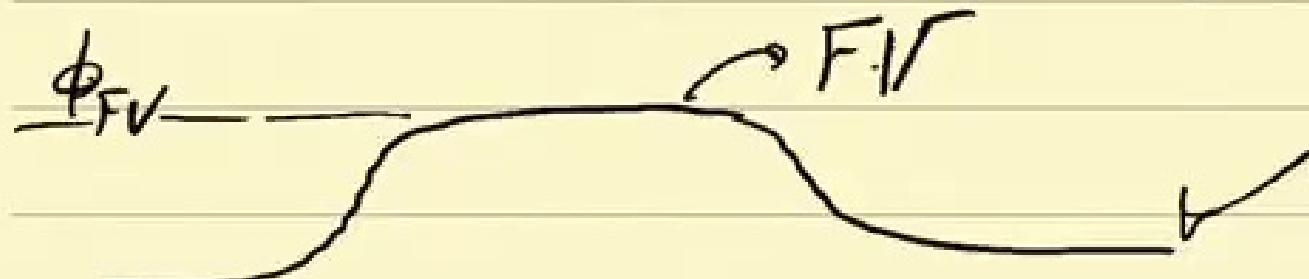
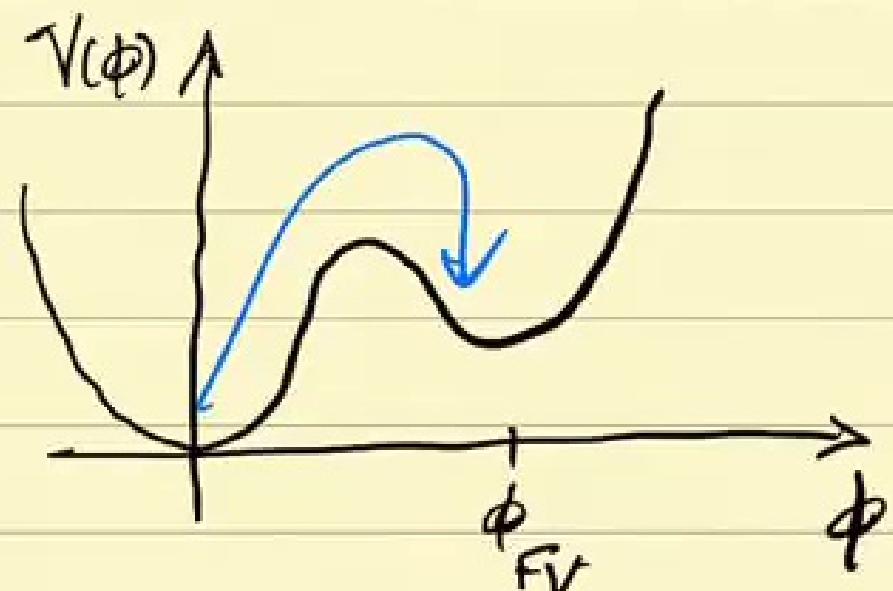
QFT (Without gravity)



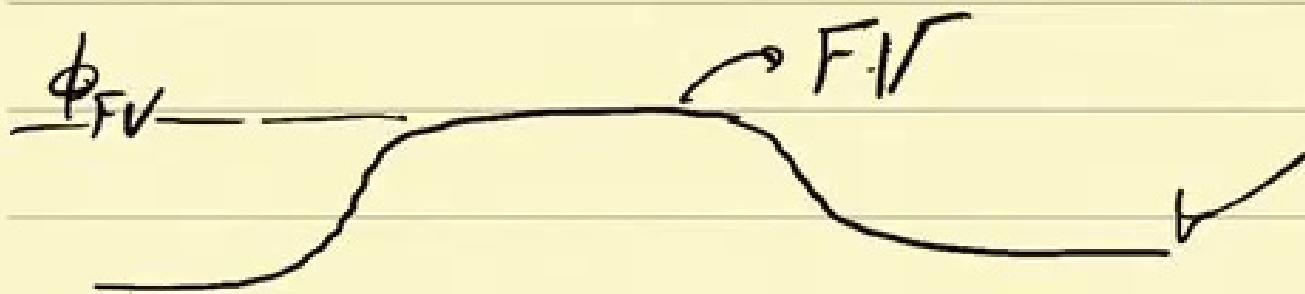
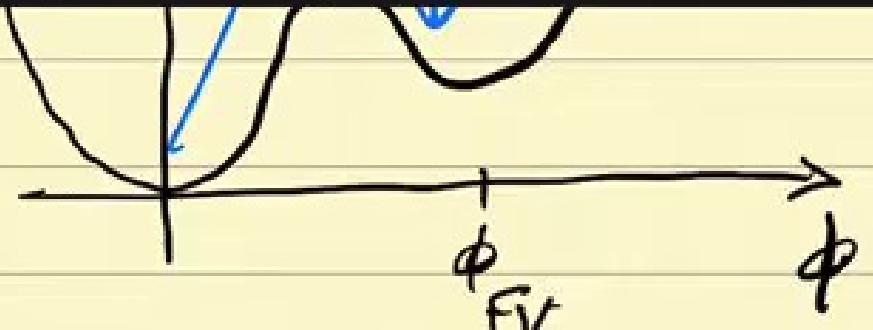


QFT (Without gravity)

Uptunneling is
allowed.

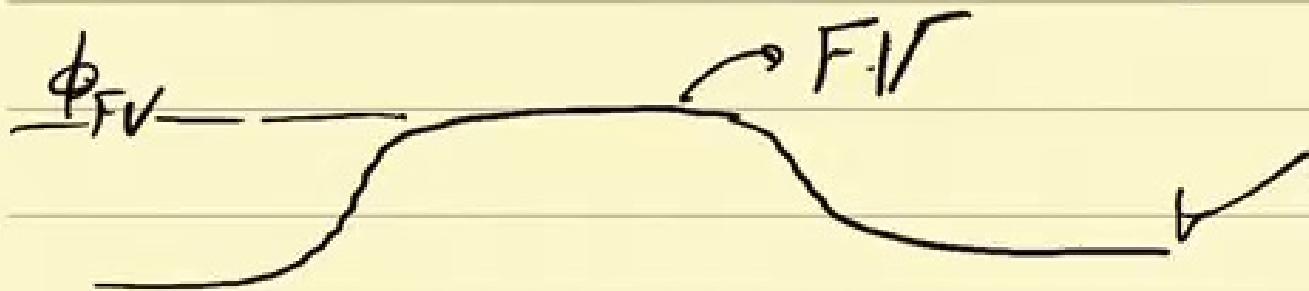
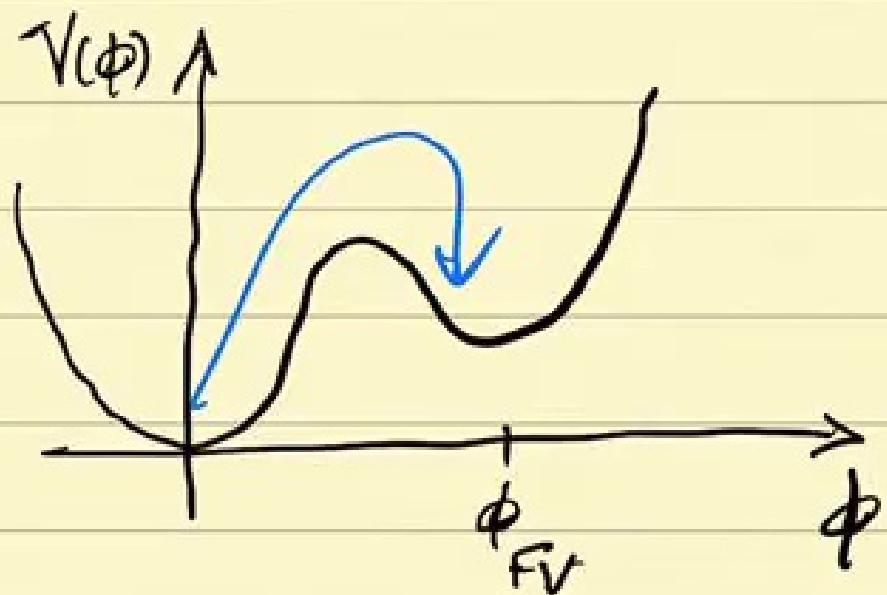


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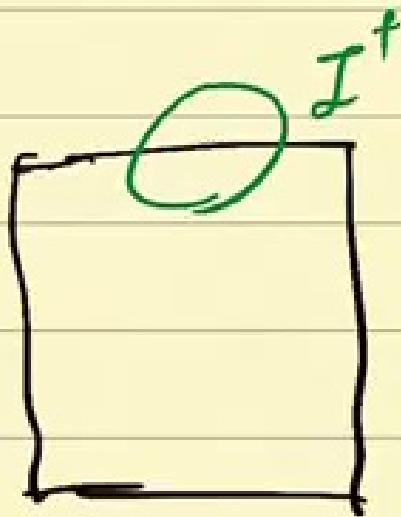
t-evolve

II



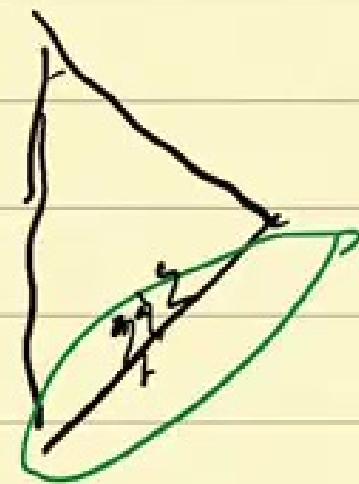
Classical Gravity

Future

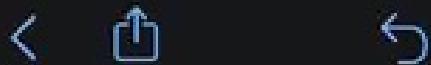




Past

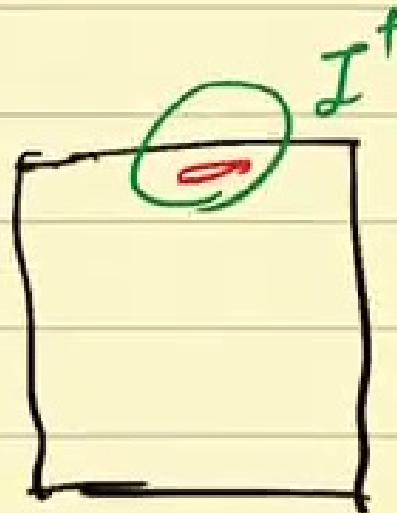


Penrose forbids this scenario
if NEC



Cherry

Future



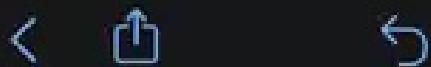
Past





Quantum Gravity

Is it possible to create a Universe in the lab via quantum tunneling?



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* spherical symmetry

* thin wall approximation: $\phi(x) \rightarrow \chi_{DM}^\mu(\tau)$



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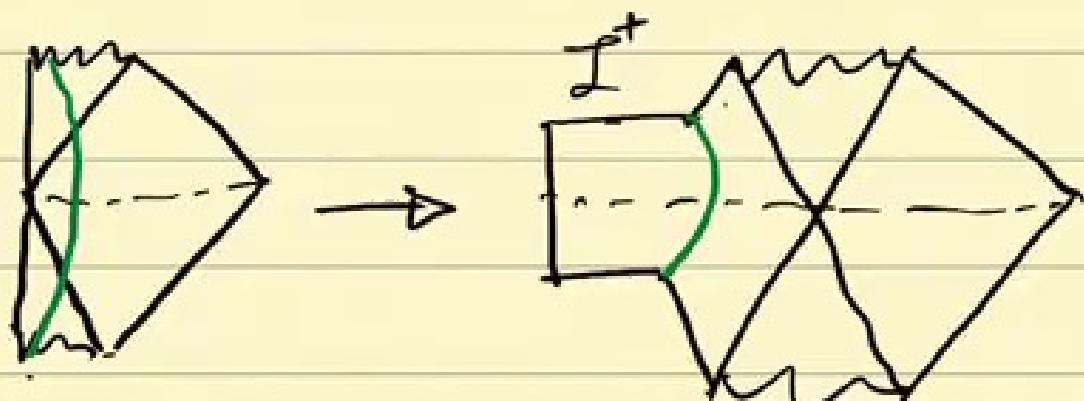
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→ "Is it possible to create a universe in the

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$$\sigma_{DM} > 0$$

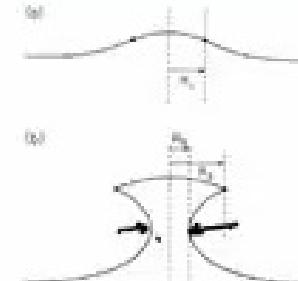
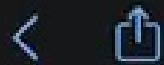


FIG. 1. Turning-point geometry: de Sitter interior, Schwarzschild exterior, with a kink produced by the bubble wall. These figures are obtained embedding the three-geometry in Euclidean four-space, and drawing a slice at fixed θ . (a) The bubble geometry; the bubble subsequently collapses. (b)

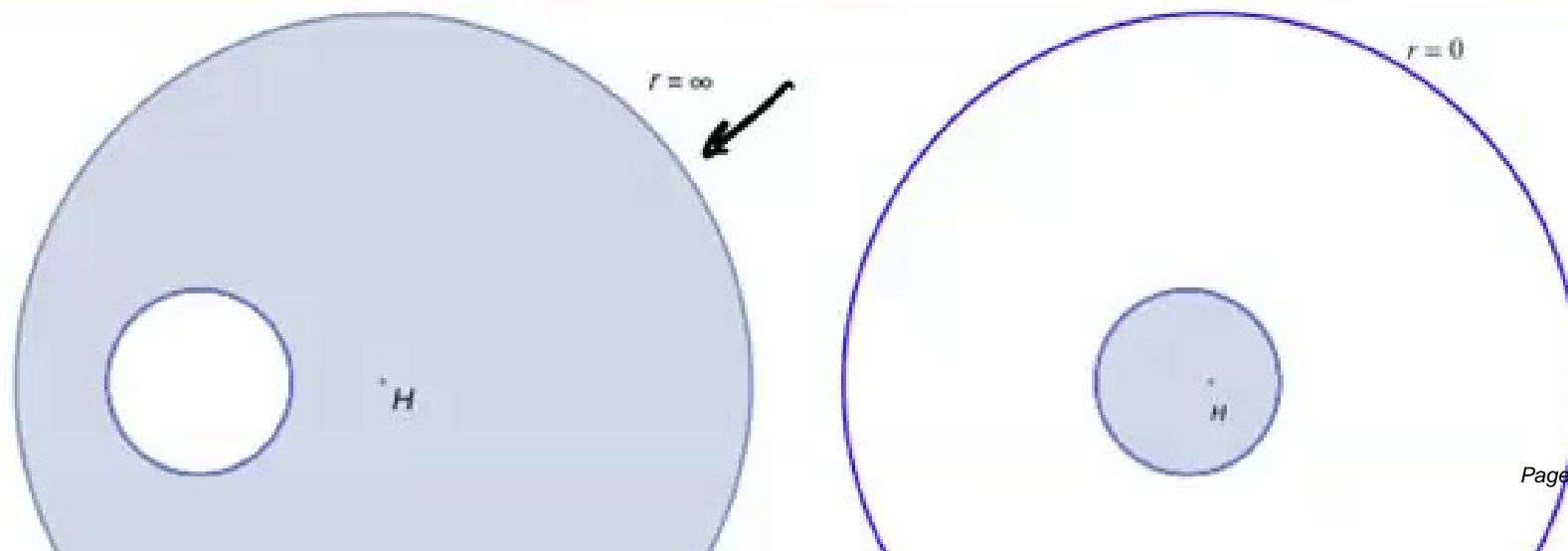
dS in AdS (Marolf & Fu)

Can we produce an inflating bubble
in asymptotically AdS

in AdS

(Marolf & Fu)

n we produce an inflating bubble asymptotically AdS.





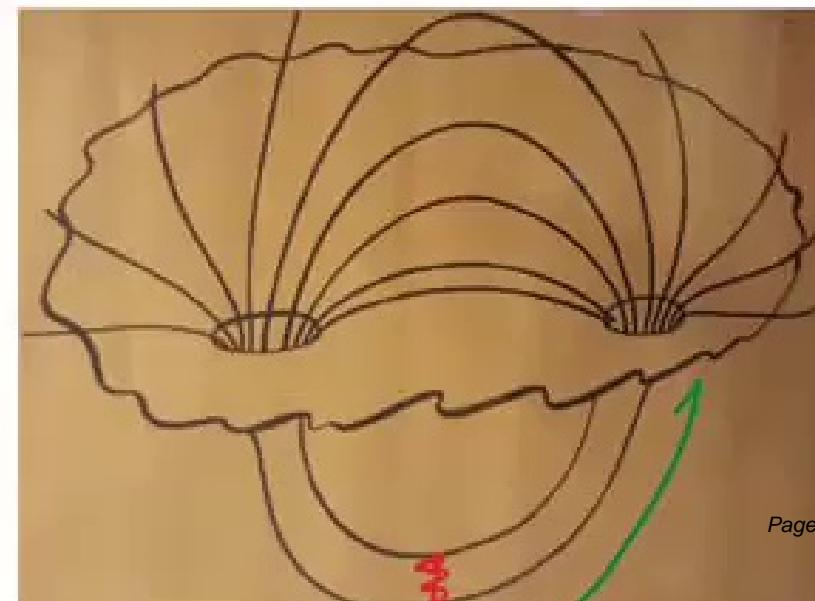
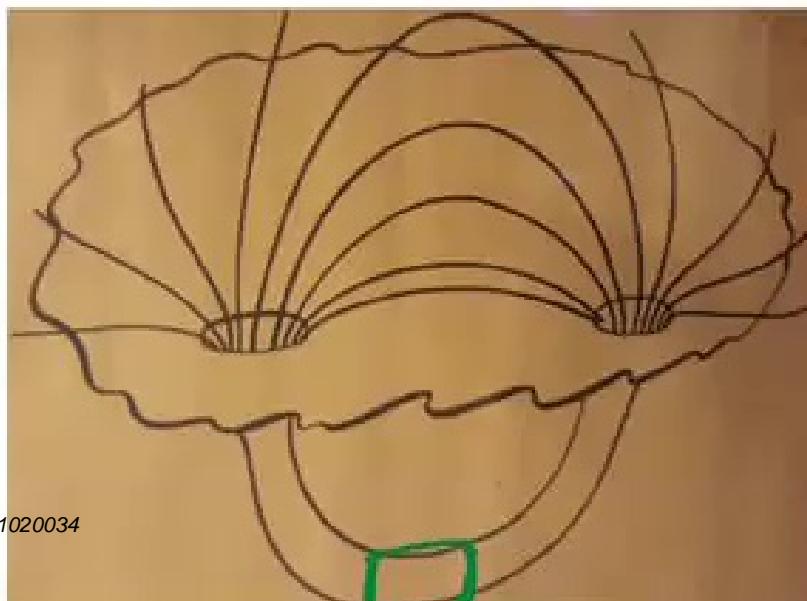
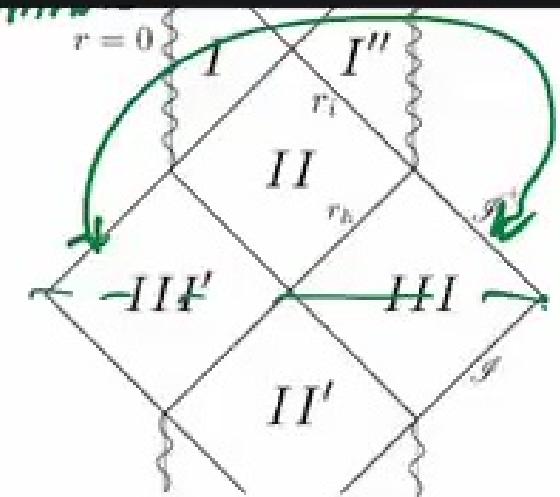
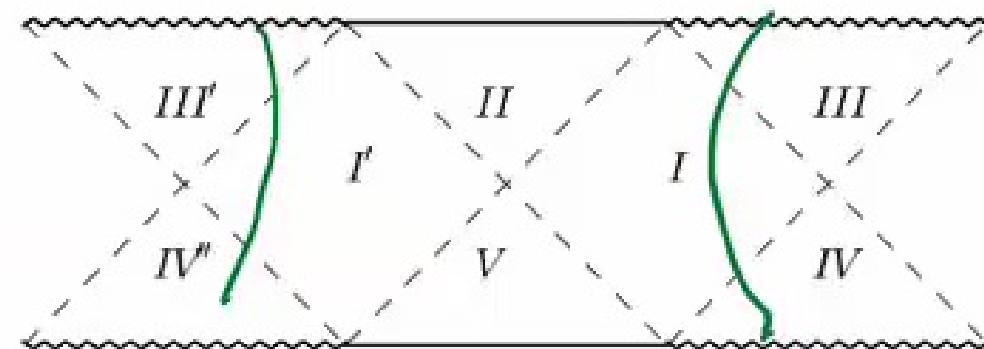
Near extremal geometries

$$ds^2 = -f(r)dt^2 + \frac{dr^2}{f(r)} + r^2 d\Omega^2$$

where $d\Omega^2$ is the line element on unit 2-sphere S^2 (if $d \neq 4$, then S^{d-2}).

$$f_{\text{SdS}}(r) = 1 - \frac{8\pi G}{3}\Lambda r^2 - \frac{2GM_i}{r}, \quad f_{\text{RN}}(r) = 1 - \frac{2GM_e}{r} + \frac{4\pi GQ^2}{r^2}.$$







T



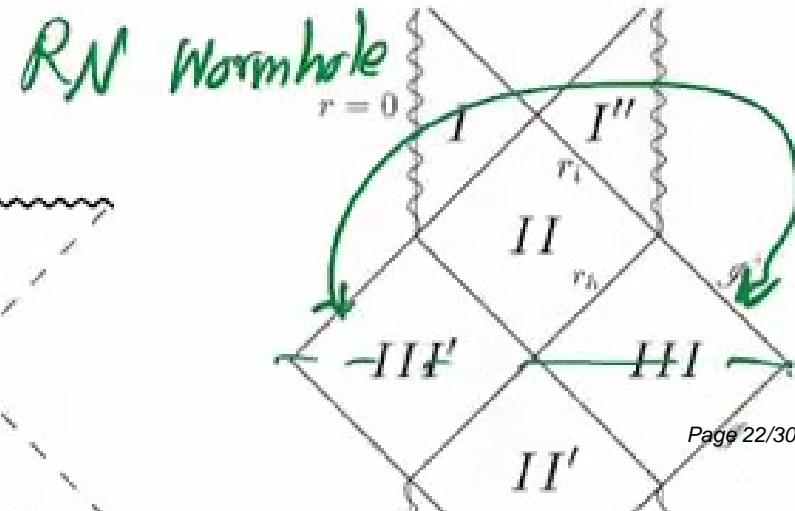
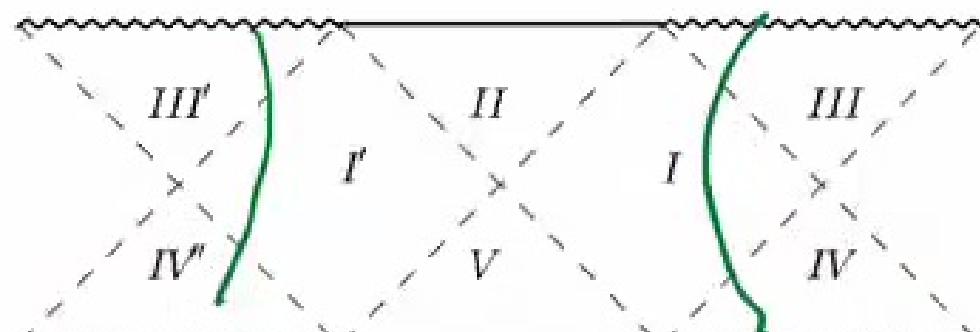
schwarzschild coordinates

$$ds^2 = -f(r)dt^2 + \frac{dr^2}{f(r)} + r^2 d\Omega^2$$

where $d\Omega^2$ is the line element on unit 2-sphere S^2 (if $d \neq 4$, then S^{d-2}).

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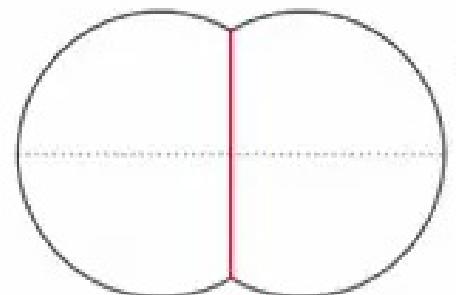
$$f_{\text{RN}}(r) = 1 - \frac{2GM_e}{r} + \frac{4\pi GQ^2}{r^2}.$$



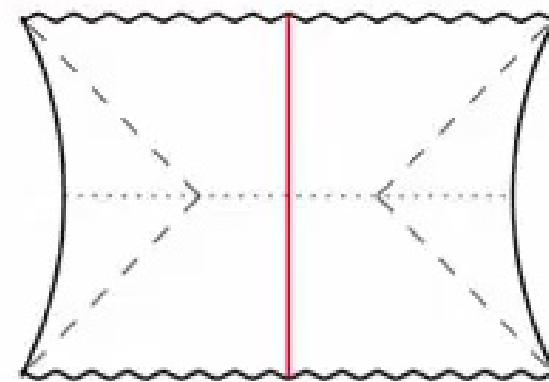


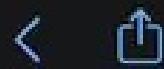
Euclidean

Lorentzian

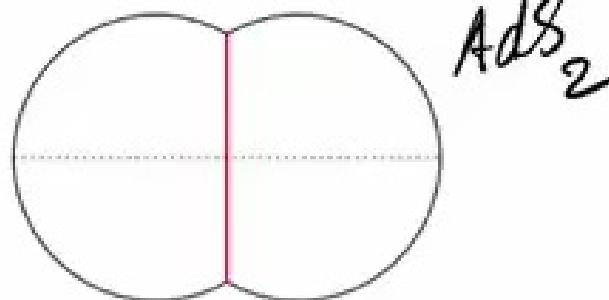


AdS_2

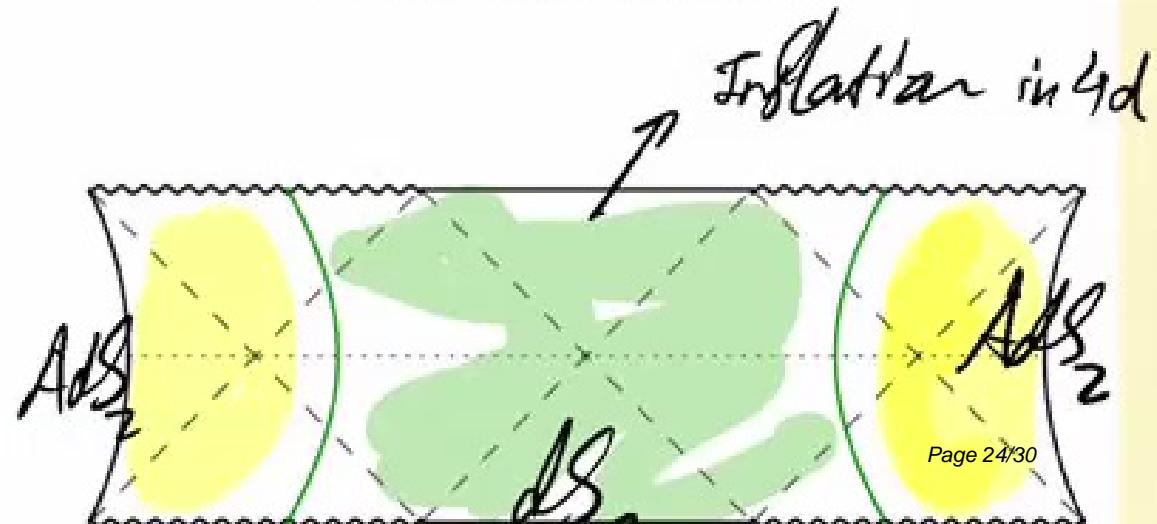
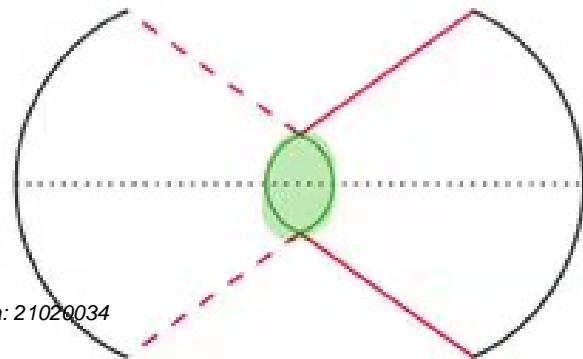
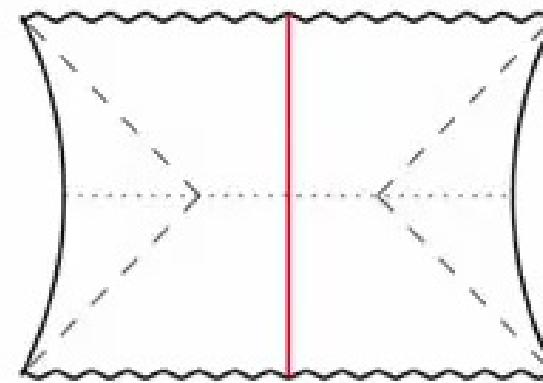




Euclidean

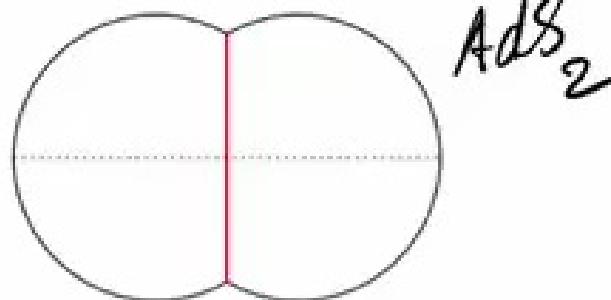


Lorentzian



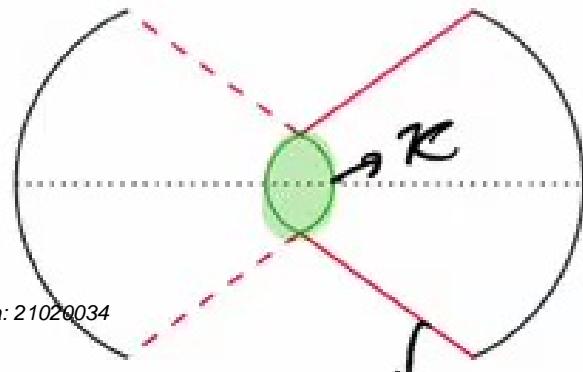
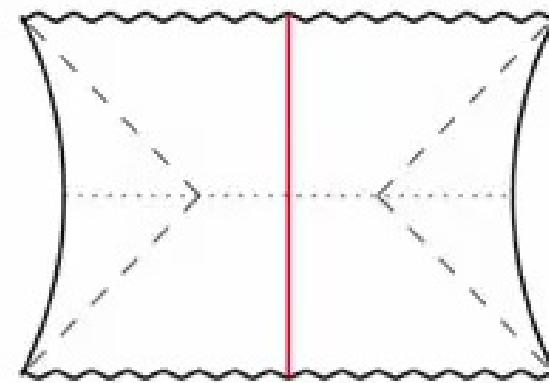


Euclidean

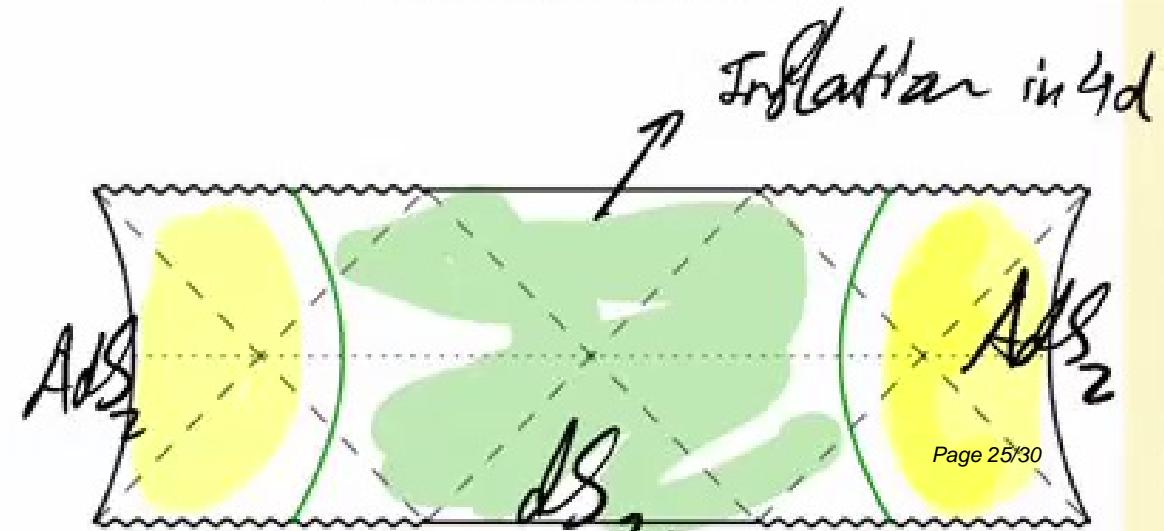


AdS_2

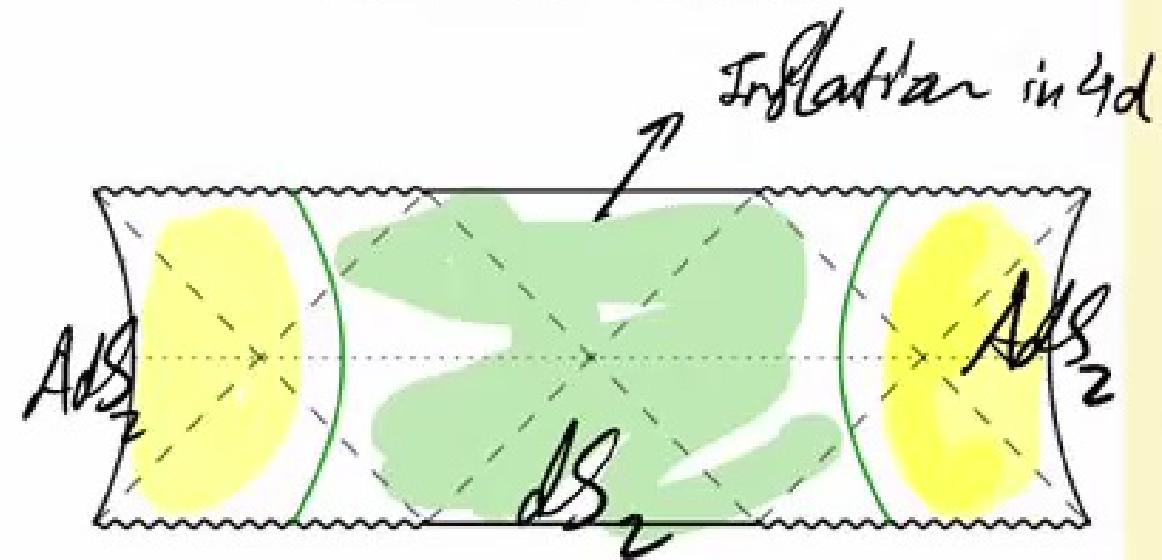
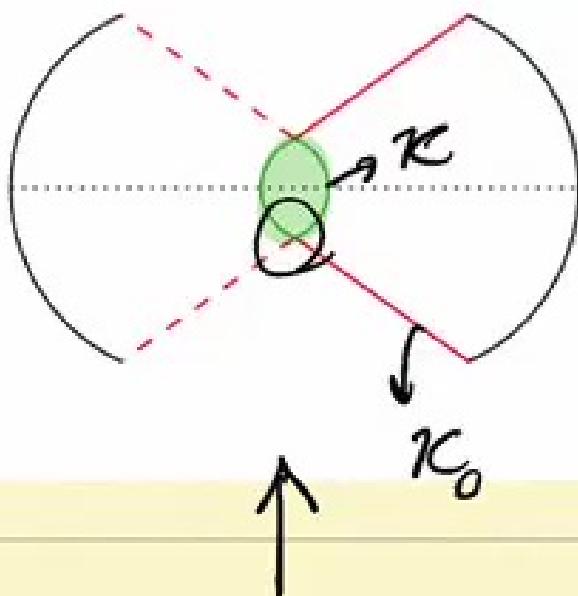
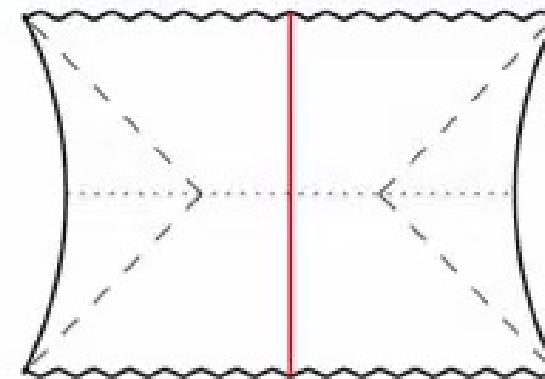
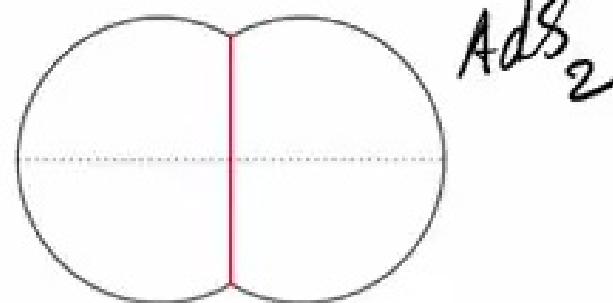
Lorentzian



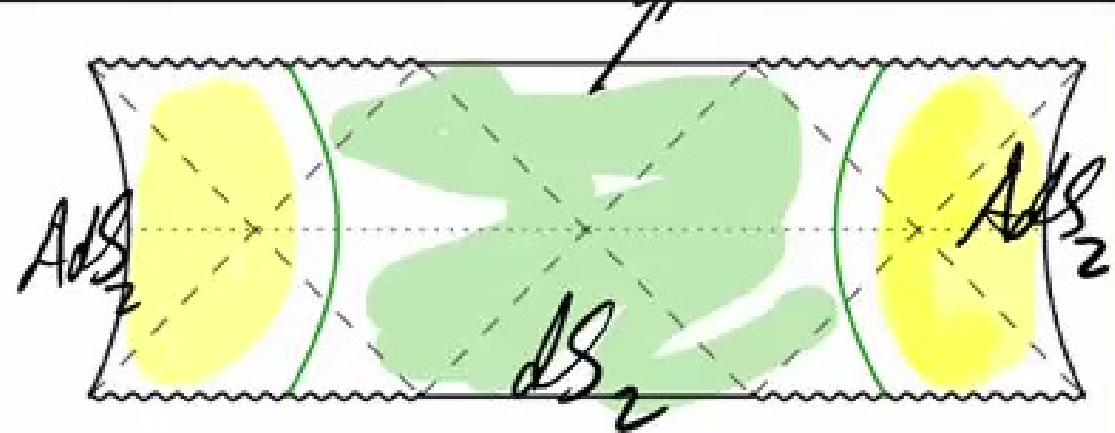
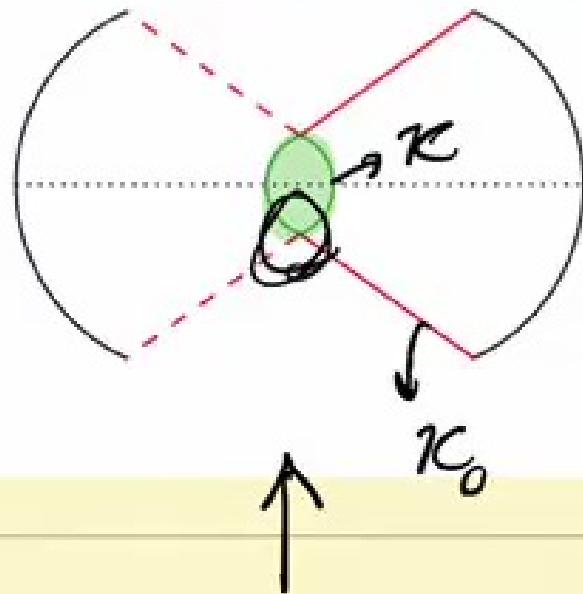
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Page 25/30



ϕ dilaton = size of S^2



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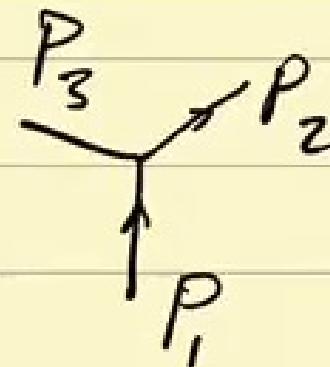
$$\textcircled{1} \quad \phi_L = \phi_R$$

$$\textcircled{2} \quad \xi'' \partial_\mu \phi / L = \kappa$$



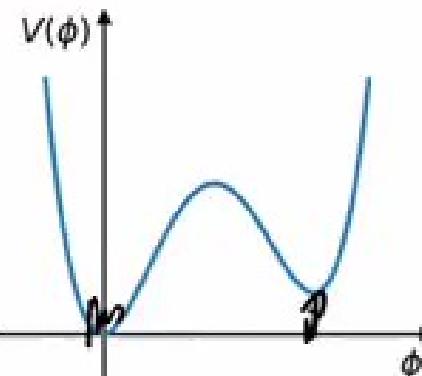
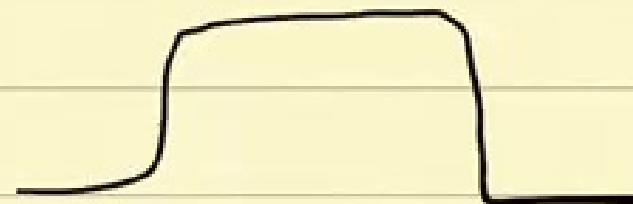


$$\textcircled{3} \quad \sum_i P_i'' = 0$$



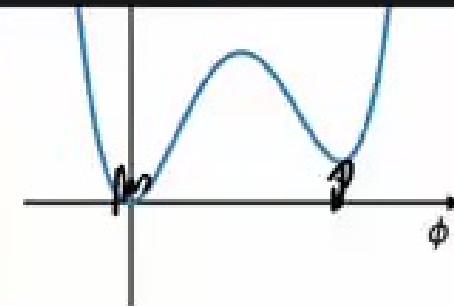
Microscopic model

$K\bar{K}$





FP

 $\phi K\bar{K}$ 

$FP \rightarrow K\bar{K}$ is forbidden at weak coupling

\Rightarrow is allowed in Euclidean

Axion

 $m_a < 2m_e$



$F\bar{P} \rightarrow K\bar{K}$ is forbidden at weak
coupling

\Rightarrow is allowed in Euclidean

Axiom

$$m_a < 2m_e$$

$a \rightarrow e^+ e^-$ forbidden

allowed if $\exists E$