

Title: Is Eternal Inflation in Our Past?

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Abstract: TBA

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Argue

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Today: Conservative assumptions

⑥ Landscape contains  $\geq 1$  fine scale  
 $\lambda > 0 \quad \Gamma < H^{-4}$



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VS 25 At 4

⑥ Landscape contains  $\geq 1$  false vacua  
 $\lambda > 0$        $R < H^{-4}$

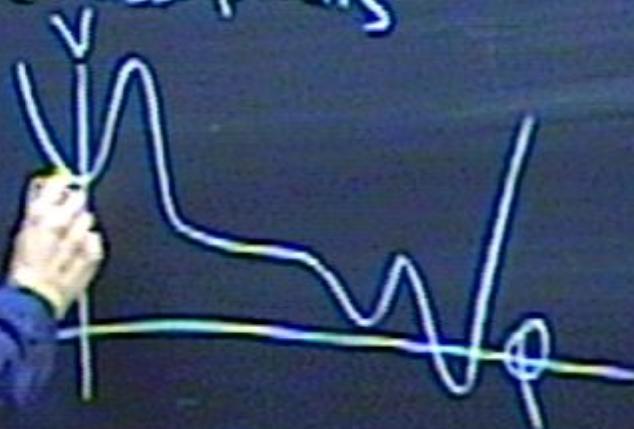
VB 25   N: 4

⑥ Landscape contains  $\geq 1$  false vacuum  
 $\lambda > 0$        $\Gamma < H^{-4}$        $\Psi_0 \approx 25$        $N \approx 1$

Data suggests stable or metastable  $\lambda > 0$

## Is Eternal Inflation in or Past?

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- II. Does theory agree w/ obs.? Add'l Assumptions  $\rightarrow$  YES  
Need Today's desc of EI.  
Sensitive assumptions



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Consequence:

Classically, If start with  $\dot{\phi} = 0$  on  $S_3$   
 $\rightarrow$  de Sitter  $k^2 = -\partial\tau^2 + \bar{H}^2 \cosh^2(H\tau) d\Omega_3$ ,

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$$V_F \sim e^{(\beta-\delta)H\tau} \quad \gamma = P\bar{H}^{-4}$$

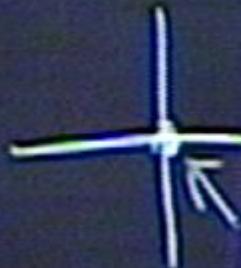
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QM: Decays by  $b^+$ 's

$$V_F \sim e^{(\beta-\delta)\bar{H}\tau} \quad \gamma = 1$$

Produce  $\infty$  # of packets.  
Classically: Finite Vol, UV cutoff



Consequence:

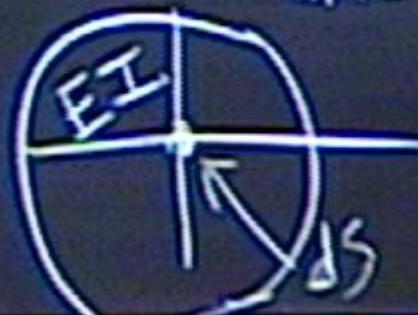
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Produce  $\mathcal{O}$  # of pockets.  
Classically: Finite Vol, UV cutoff

initial cond's



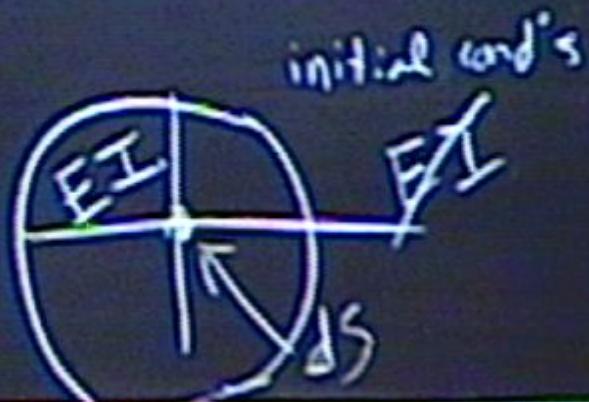
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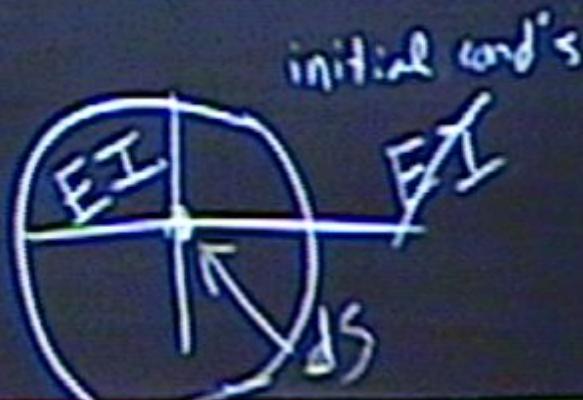
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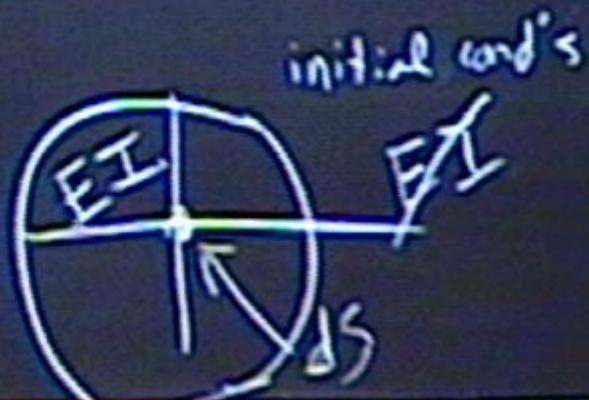
QM: Decays by bubbles

$$V_F \sim e^{(\beta-\delta)\bar{H}\tau} \quad \gamma = P\bar{H}^{-4}$$

Produce  $\propto$  # of pockets.

Classically: Finite Vol, UV cutoff

QM: Finite IC  $\rightarrow$  finite probability for EI



① Landscape contains  $\geq 1$  false vaccine  
 $\lambda > 0$     $R < R^*$

8/25 11:18

- ② Initial cond's:
- Finite prob for  $EI$
  - Only  $co$ 's come from  $EI$

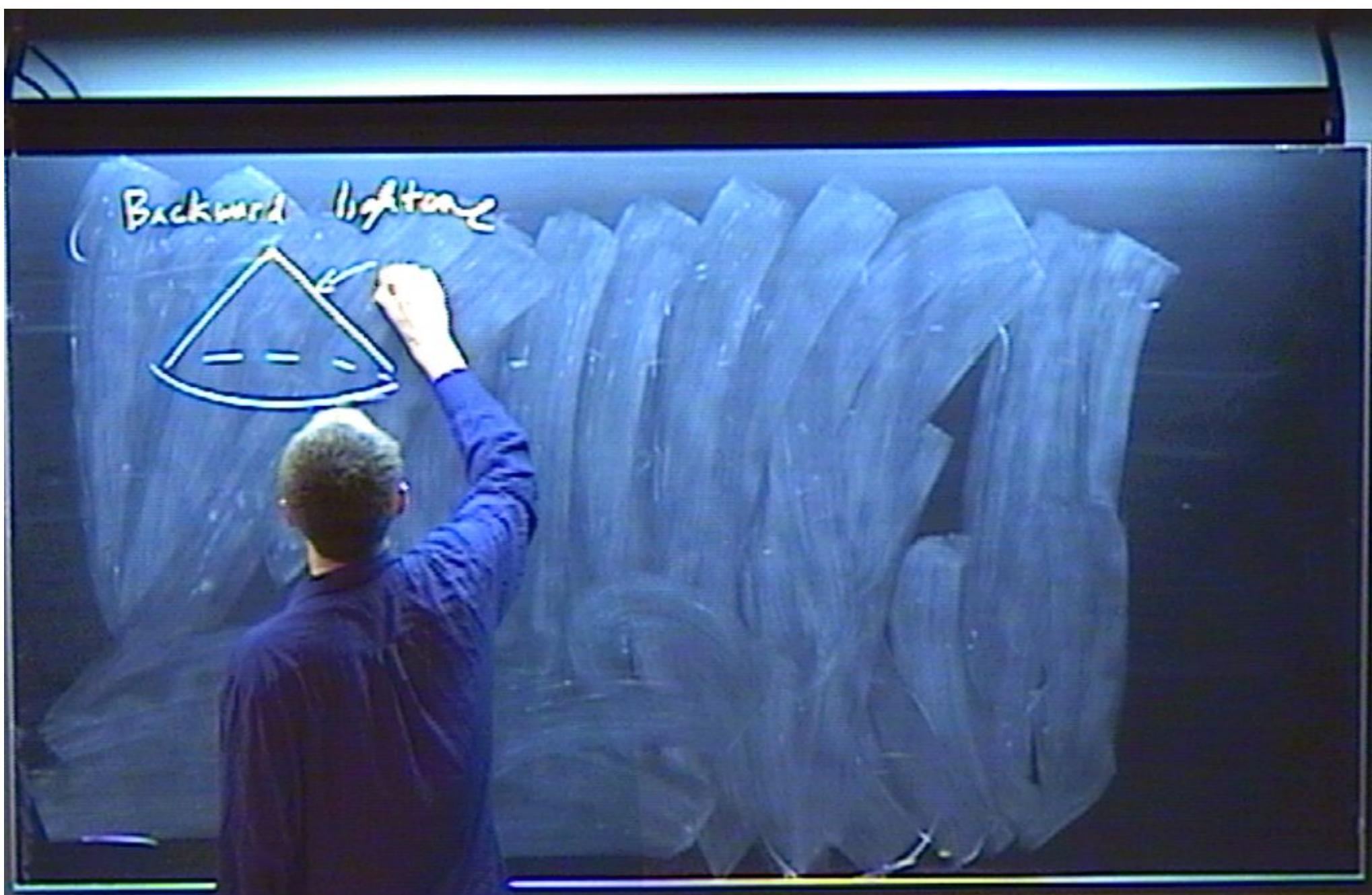
① Landscape contains  $\geq 1$  false vacua  
 $\lambda > 0$     $R < \bar{H}^{-4}$     $y_0 = 25$     $N:R$

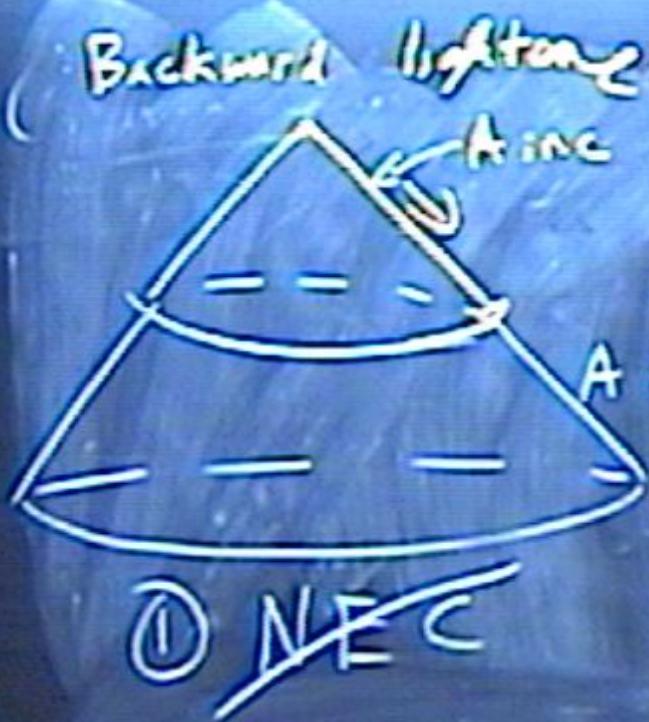
② Initial cond's:  
• Finite prob for EJ    $y:30$     $N:6$   
• Finite volume initial conditions.

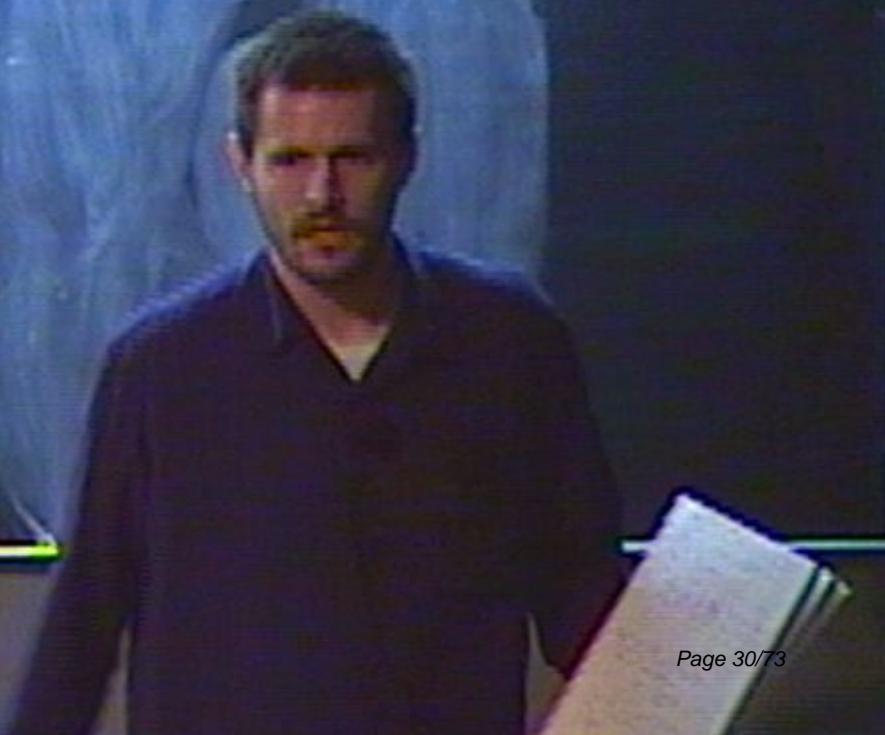
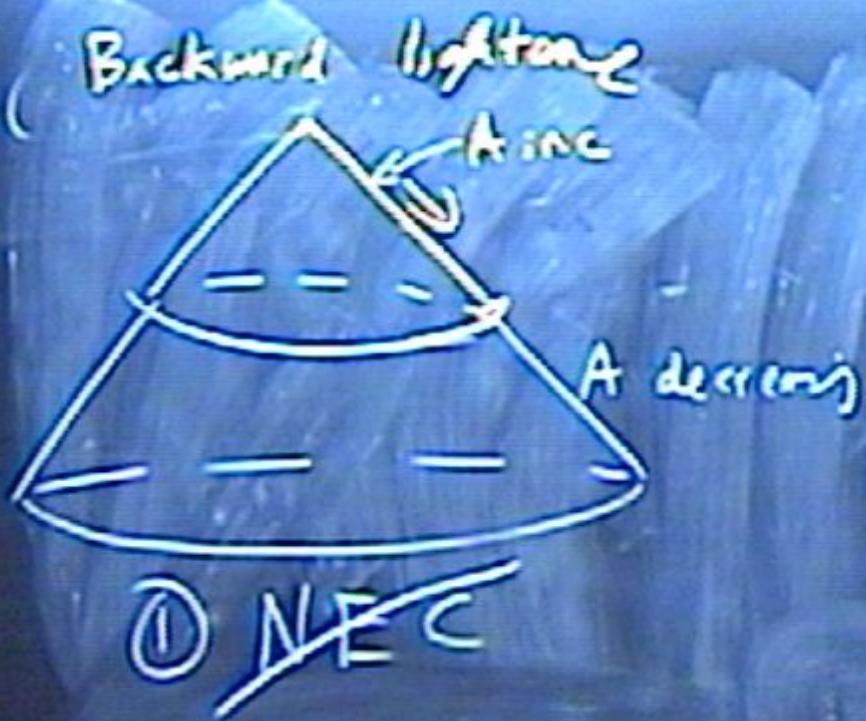
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 $\lambda > 0$        $R < R^*$       Y:25      N:P

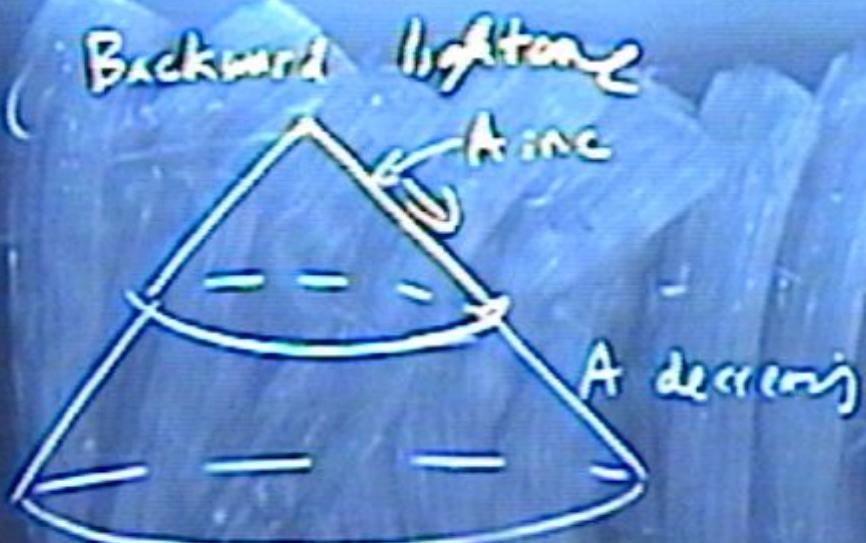
- ② Initial cond's:
- Finite prob for E/I      Y:30      N:6
  - Finite value initial conditions.      Y:12      N:6

Backward lightning





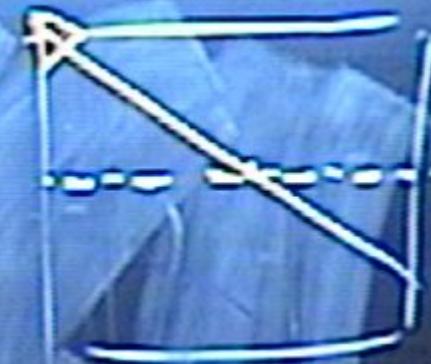
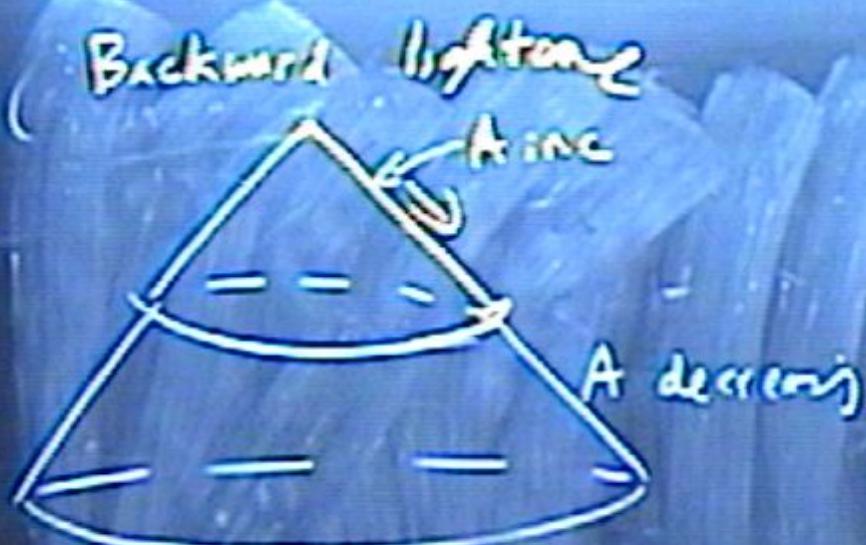




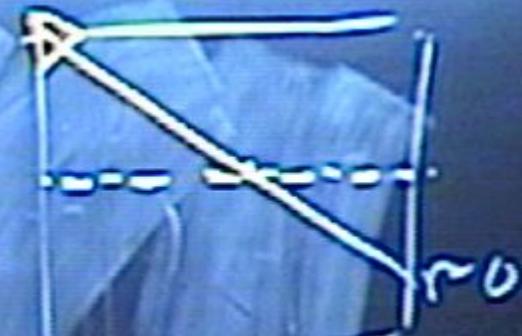
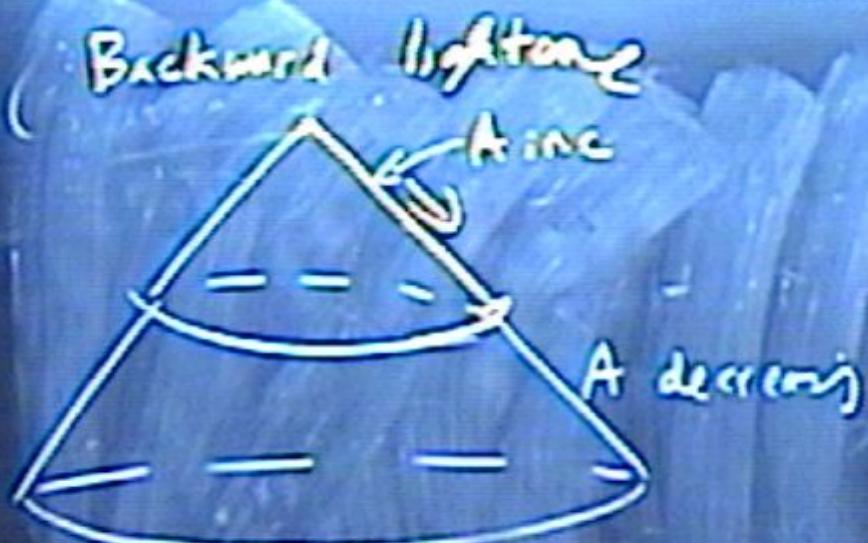
① NEC

② Singularity in past  $\rightarrow$  { I.C. on singularity }  
Resolve singularity

③



- ① NEC
- ② Singularity in past  $\rightarrow \begin{cases} \text{I.C. on sing.} \\ \text{Resolve sing} \end{cases}$
- ③ Origin of polar curves / IC surface



① ~~NEC~~

② Singularity in past  $\rightarrow$  { I.C. on sing.  
Resolve sing}

③ Origin of polar curves / IC surface

⑥ Landscape contains  $\geq 1$  finite values  
 $\lambda > 0$        $r < h^{-4}$        $y_0.25$        $N:8$

- ⑦ Initial cond's:  
• Finite prob for ET  $y:30$   $N:6$   
• Finite value initial conditions.  $y:12$   $N:6$

$A_s, A_{sfS}$

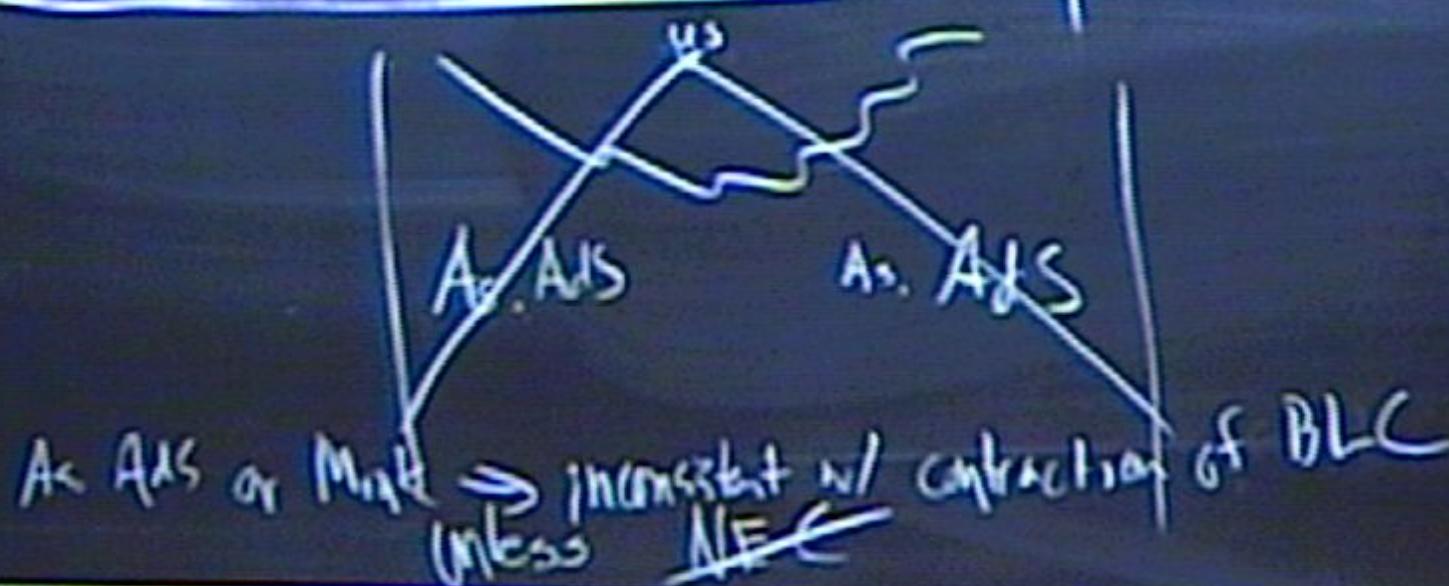
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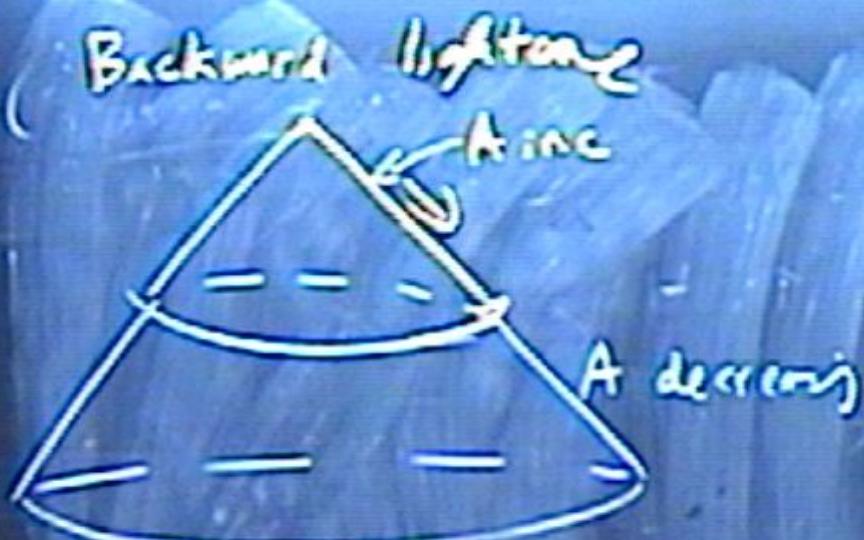
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② Initial cond's:

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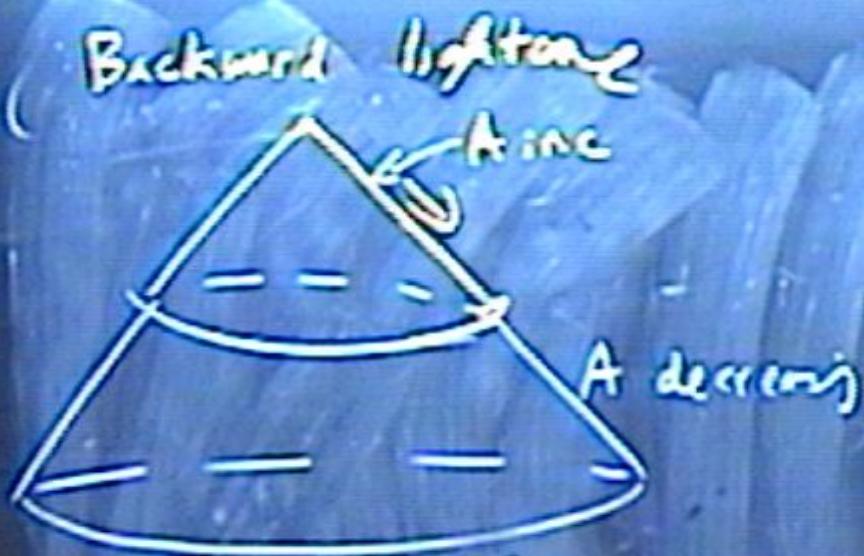
$\lambda < 0$  negotiable?  
when does

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I.C. on sing  
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③ Origin of polar curves / IIC surface

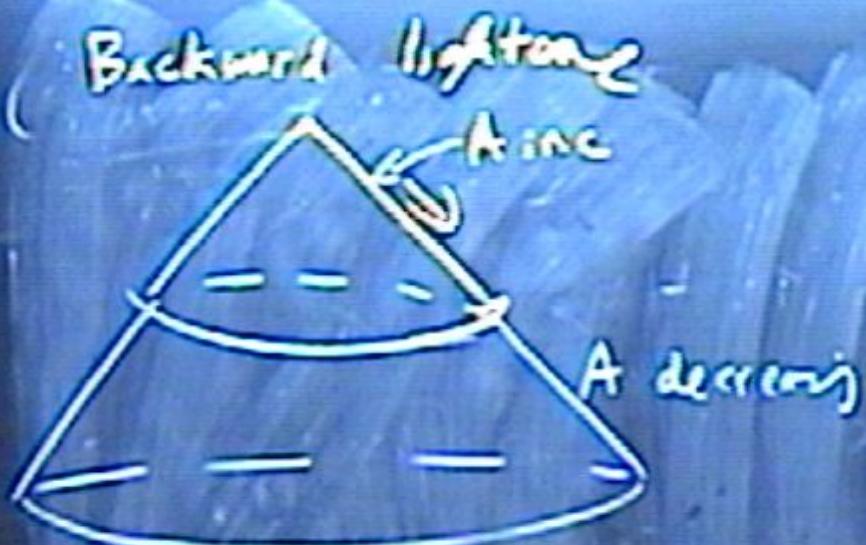


$\ddot{A} < 0$  negotiable?  
When does  $\ddot{A} = 0$ ?

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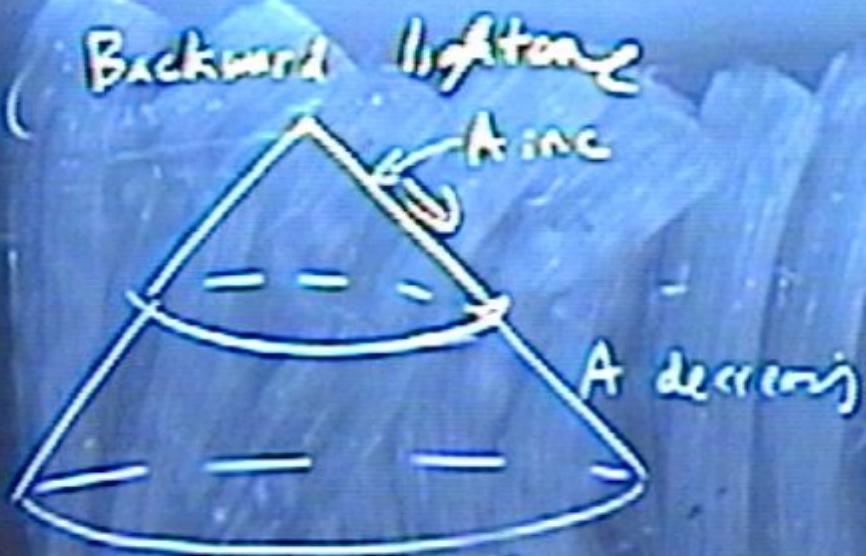
③ Origin of polar comets / IC surface

$\ddot{A} < 0$  negotiable?

When does  $\ddot{A} = 0$ ?

$$t \approx \frac{t_0}{27}$$

$$a \approx \frac{a_0}{9}$$



① NEC

② Singularity in past  $\rightarrow$

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$\ddot{A} < 0$  negotiable?  
when does  $\ddot{A} = 0$ ?

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Resolve sing

## Predictions?

V. Large classical Unruh

125 GeV

141 GeV

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$m_A = 125 \text{ GeV}$

$141 \text{ GeV}$

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① Landscape contains  $\geq 1$  false vacuna  
 $\lambda > 0$        $R < R^*$        $\gamma = 25$        $N:R$

② Initial cond's:

- Finite prob for EI       $\gamma:30$        $N:6$

- Finite volume initial cond's.       $\gamma:12$        $N:6$

Typically       $\frac{P_A}{P_E} = \frac{N_A}{N_B}$

① Landscape contains  $\geq 1$  finite vacuna  $\lambda > 0 \quad \Gamma < \bar{H}^+$   $\gamma; 25 \text{ N.P}$

② Initial cond's:

• Finite prob for EJ  $\gamma: 30 \text{ N}: 6$

• Finite volume initial cond's.  $\lambda: 12 \text{ N}: 6$

Typically  $\frac{P_A}{P_E} = \frac{N_A}{N_B}$   $\gamma:$

① Landscape contains  $\geq 1$  finite vacuna  $\lambda > 0 \quad \Gamma < \bar{H}^+$   $\gamma: 25 \quad N: 8$

- ② Initial cond's:
- Finite prob for E/I  $\gamma: 30 \quad N: 6$
  - Finite value initial cond's.  $\lambda: 12 \quad N: 6$

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## Predictions?

V. Large classical vacuum

$$m_{\tilde{H}} = 125 \text{ GeV}$$

$$141 \text{ GeV}$$

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Non QM.

Prob 50%

Prob 50%

$$125 \text{ GeV}$$

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## Predictions?

V. Large classical minima  $\rightarrow$

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New QM.

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① Landscape contains  $\geq 1$  false vacuna  
 $\lambda > 0$   $\Gamma < \bar{H}^+$  Y:25 N:P

- ② Initial cond's:
- Finite prob for E/I Y:30 N:6
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Typicality  $\frac{P_A}{P_E} = \frac{N_A}{N_B}$  Y:30 N:6

Q. Typicality

## Predictions?

V. Large classical Unruh  $\rightarrow$

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Global/Local Duality  
Bousso  
Yang

① Landscape contains  $\geq 1$  finite reservoir  
 $\lambda > 0$     $R < R^*$    Y: 25   N: 8

② Initial cond's:

• Finite prob for E/I   Y: 30   N: 6

• Finite volume initial conditions   Y: 12   N: 6

Typicality

$$\frac{P_A}{P_B} = \frac{N_A}{N_B} \quad Y: 30 \quad N: 6$$

Q. Typicality

$$\frac{P_A}{P_B} = \frac{\langle N_A \rangle}{\langle N_B \rangle}$$

① Landscape contains  $\geq 1$  false vacuna  
 $\lambda > 0$        $\Gamma < \bar{H}^{-4}$       Y: 25 At P

② Initial cond's:

• Finite prob for E/I      Y: 30 N: 6

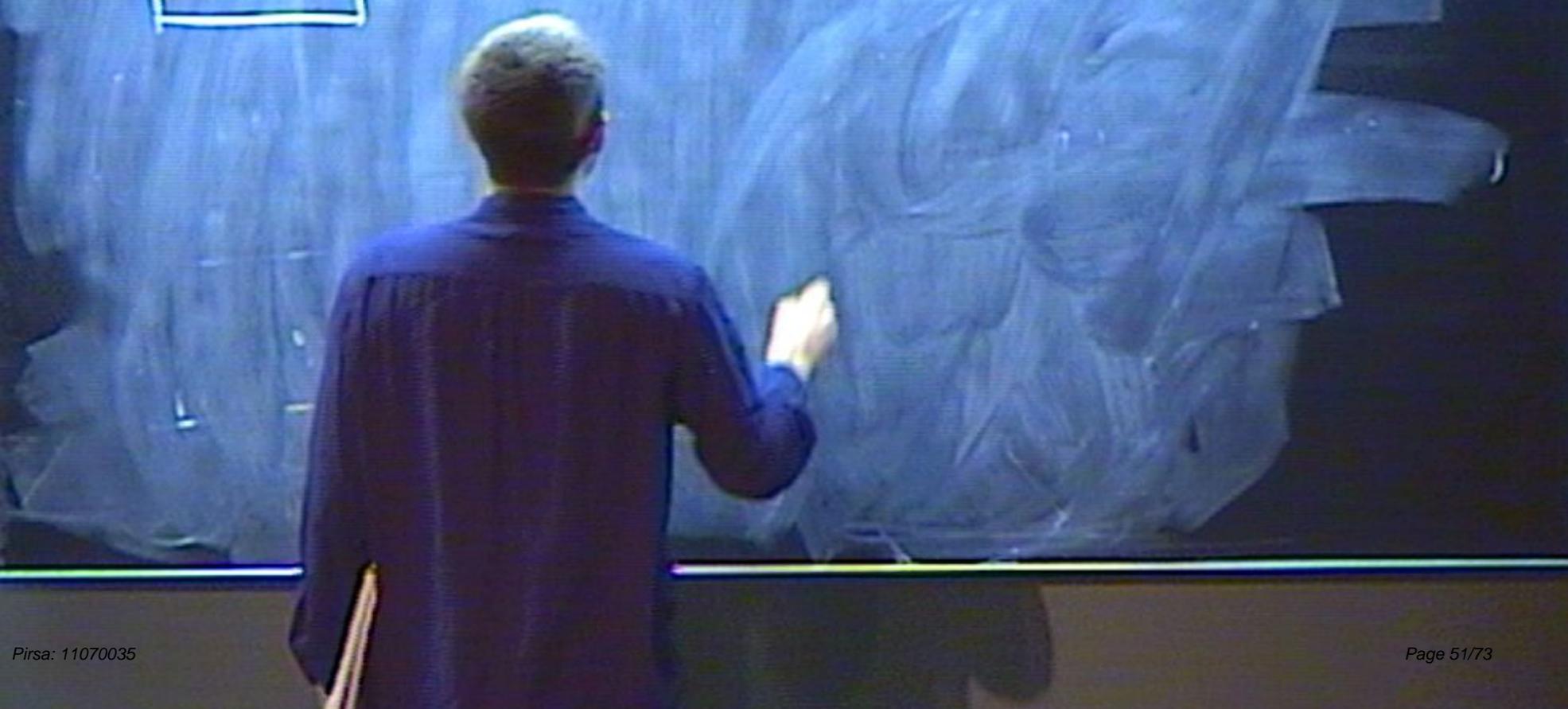
• Finite volume initial conditions. Y: 12 N: 6

Typically       $\frac{P_A}{P_E} = \frac{N_A}{N_B}$       Y: 30 N: 6

Q.       $\frac{P_A}{P_B} = \frac{\langle N_A \rangle}{\langle N_B \rangle}$       Y: 13 N: 4

Conclude: At late time in EI process

Final U

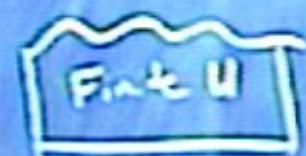


Conclude: At late time in EI process

Finite U

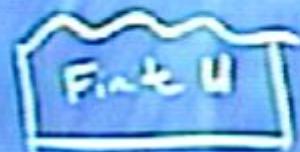


Conclude: At late time in EI process



EI

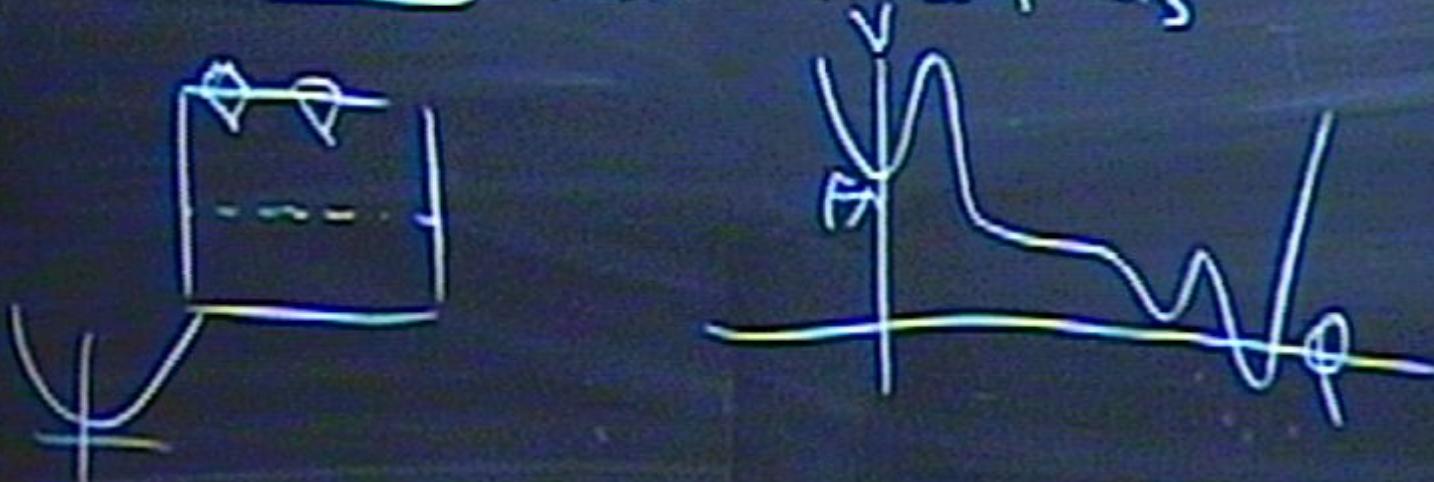
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EI

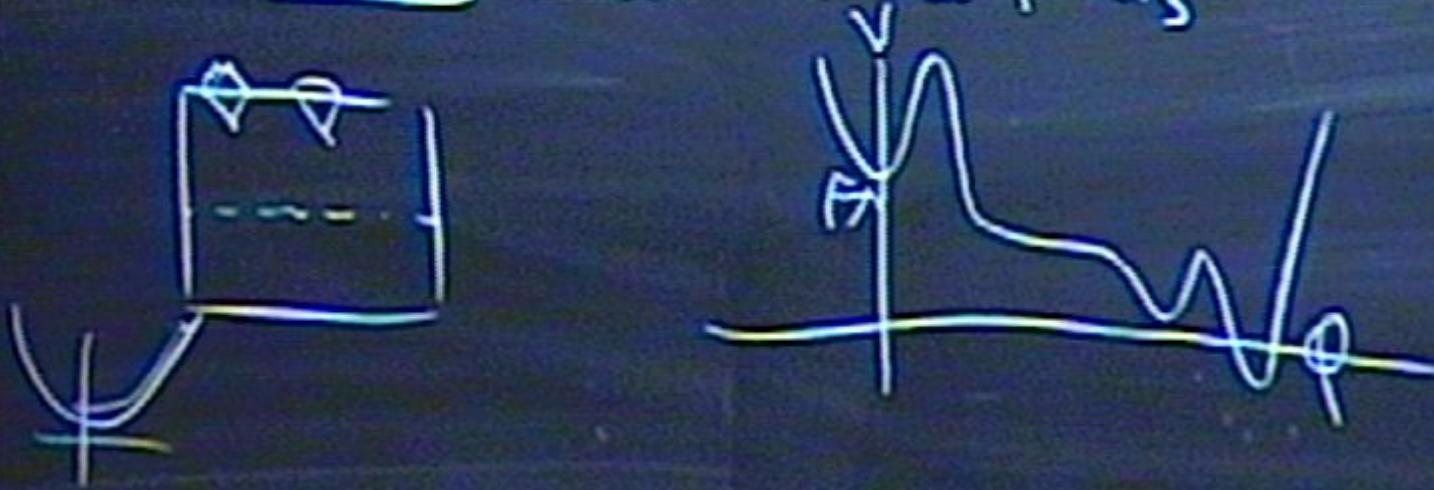
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II Agree w/ '05'

I. Agree w/ WIS.

Dangerous!

D) Need a measure

I. Agree w/ OIS

D) Need a measure

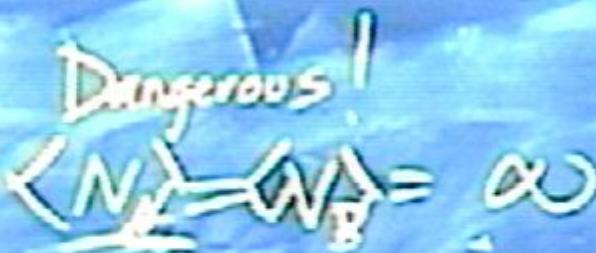
Dangerous!

$$\langle N \rangle_{WA} = \infty$$

$$\frac{N_A}{N_B} \text{ needs to be regulated.}$$

I Agree w/ OIS

① Need a measure



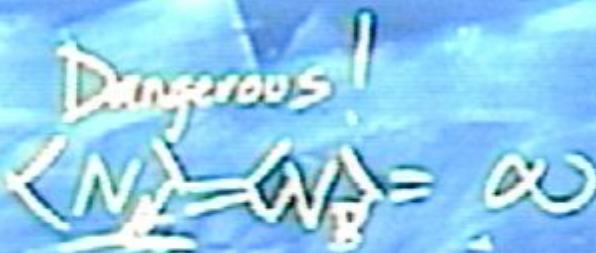
$\frac{N_A}{N_B}$  needs to be regulated.

Per + ~~QG~~

$\frac{N_A}{N_B}$  not well-defined

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① Need a measure



$\frac{N_A}{N_B}$  needs to be regulated.

Per + ~~QG~~

$\frac{N_A}{N_B}$  not well-defined

Landscape contains  $\geq 1$  finite volume  
 $\lambda > 0 \quad \Gamma < h^{-4}$

Y: 25 N: 1

Initial cond's:

• Finite prob for EI Y: 30 N: 6

• Finite value initial conditions. Y: 12 N: 6

QG regulates  
do's &  
defines  $\frac{\langle N_A \rangle}{\langle N_B \rangle}$

Typicality

$$\frac{P_A}{P_B} = \frac{N_A}{N_B}$$

Y: 30 N: 6

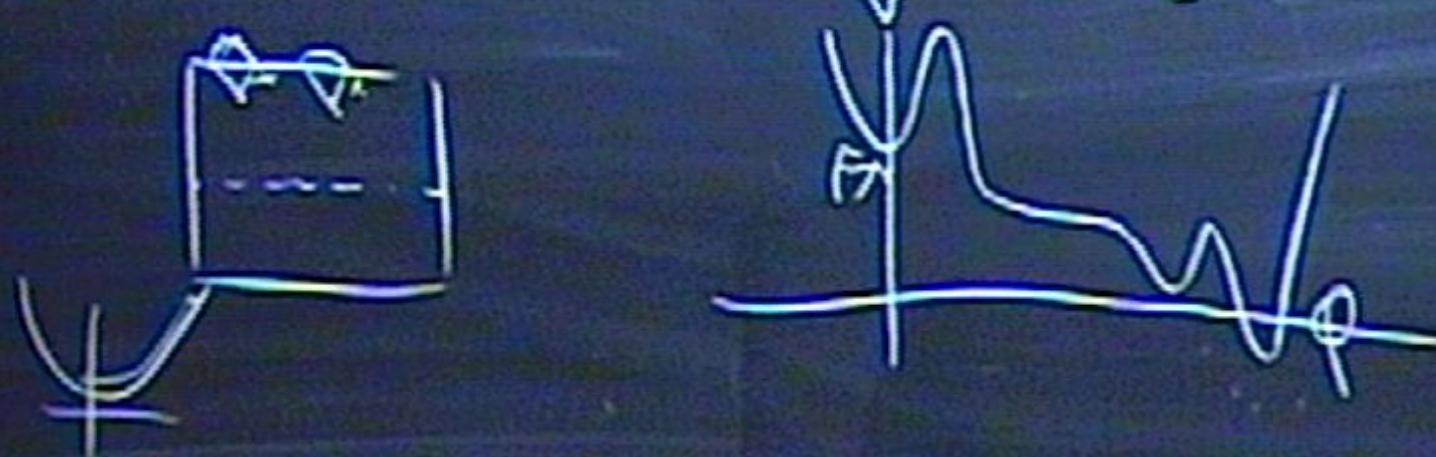
Q. Typicality

$$\frac{P_A}{P_B} = \frac{\langle N_A \rangle}{\langle N_B \rangle}$$

Y: 13 N: 4

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- I. Argue: Reasonable assumptions: YES
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Today: Conservative assumptions



① Landscape continues  $\geq 1$  finite vacua  
 $\lambda > 0 \quad \Gamma < H^{-4}$

Y: 25 N: 8

- ② Initial cond's:  
• Finite prob for EI Y: 30 N: 6  
• Finite value initial conditions. Y: 12 N: 6

QG regulates  
DO's &  
defines  $\frac{\langle N_A \rangle}{\langle N_B \rangle}$

Y: 17 N: 7

Typicality  $\frac{P_A}{P_B} = \frac{N_A}{N_B}$  Y: 30 N: 6

Q. Typicality  $\frac{P_A}{P_B} = \frac{\langle N_A \rangle}{\langle N_B \rangle}$  Y: 13 N: 4

II. Agree w/ "Obis"



pc contains  $\geq 1$  false vacuum

$$\lambda > 0$$

$$T < H^{-4}$$

Y: 25 N: 8

Cond's:

prob for ET

Y: 30 N: 6

finite volume initial conditions.

Y: 12 N: 6

QG regulates

$\infty$ 's &  
defines  $\frac{\langle N_A \rangle}{\langle N_B \rangle}$

Y: 17 N: 7

Timing of potentials

$$\frac{dP}{dN_e} \sim \frac{1}{N_e^{\#}}$$

$$\frac{P_A}{P_B} = \frac{N_A}{N_B} \quad Y: 30 N: 6$$

$$\frac{P_A}{P_B} = \frac{\langle N_A \rangle}{\langle N_B \rangle} \quad Y: 13 N: 4$$

I. Agree w/ DSS

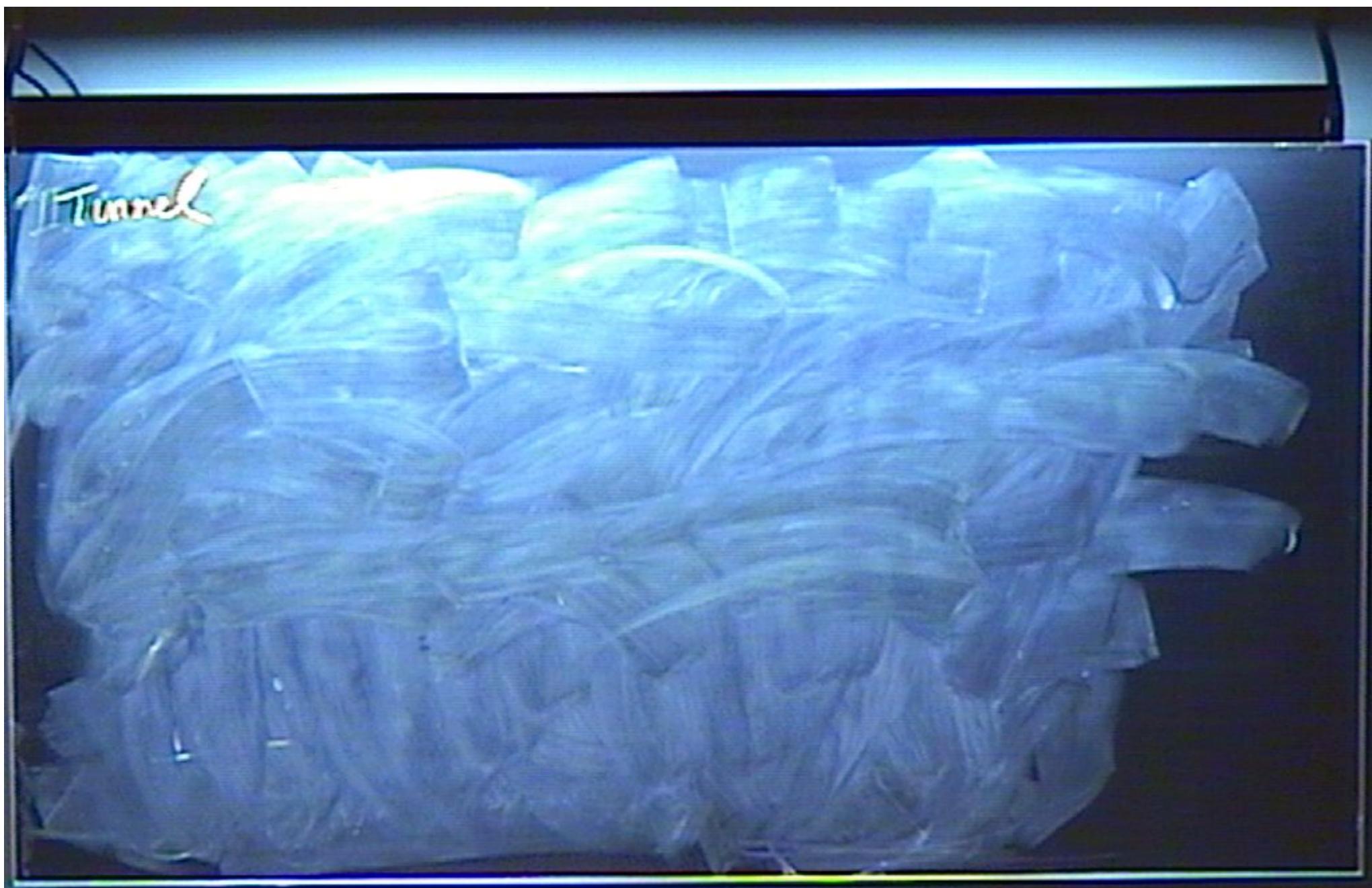
$$\frac{\Delta P}{\Delta N_e} \sim \frac{1}{N_e^4}$$

$$V = A + B\varphi + C\varphi^2 + D\varphi^3 + E\varphi^4$$

II Agreez w/ '03'

$$\frac{dP}{dN_e} \sim \frac{1}{N_e^4}$$

$$V = A + B\varphi + C\varphi^2 + D\varphi^3 + E\varphi^4$$





Turned into stationary plateau?

Timing of instabilities

$$\frac{dP}{dN_e} \sim \frac{1}{N_e^{\beta}}$$

Turned into stationary plateau?

Timing of stationary

$$\frac{dP}{dN_e} \sim \frac{1}{N_e^2}$$

Y: 4

N: 1

Appears to work well

Tunnel into stationary plateau?

Timing of instabilities

$$\frac{dp}{dN_e} \sim \frac{1}{N_e^2}$$

Y: #  
N: |

Appears to work well

ET in our post?  
Agree w/ all my assumptions?