Title: Entropic Focussing

Date: Aug 19, 2015 11:00 AM

URL: http://pirsa.org/15080071

Abstract: TBA

ENTROPY FOCUSSES

Bousso, Fisher, Leichenauer, Wall "A quantum focussing conjecture"

Wall, "A Second Law for Higher Curvature Gravity"

Bhattacharjee, Sarkar, Wall, "The holographic entropy increases in higher curvature gravity"

Wall, "The Generalized Second Law implies a Quantum Singularity Theorem

ENTROPY FOCUSSES

Bousso, Fisher, Leichenauer, Wall "A quantum focussing conjecture"

Wall, "A Second Law for Higher Curvature Gravity"

Bhattacharjee, Sarkar, Wall, "The holographic entropy increases in higher curvature gravity"

Wall, "The Generalized Second Law implies a Quantum Singularity Theorem

Area Focusses

v affine

$$\theta = \frac{1}{A}\frac{dA}{dv} \qquad \sigma_{ab}$$

$$\frac{d\theta}{dv} = -\frac{\theta^2}{D-2} - \sigma_{ab}\sigma^{ab} - R_{vv}$$

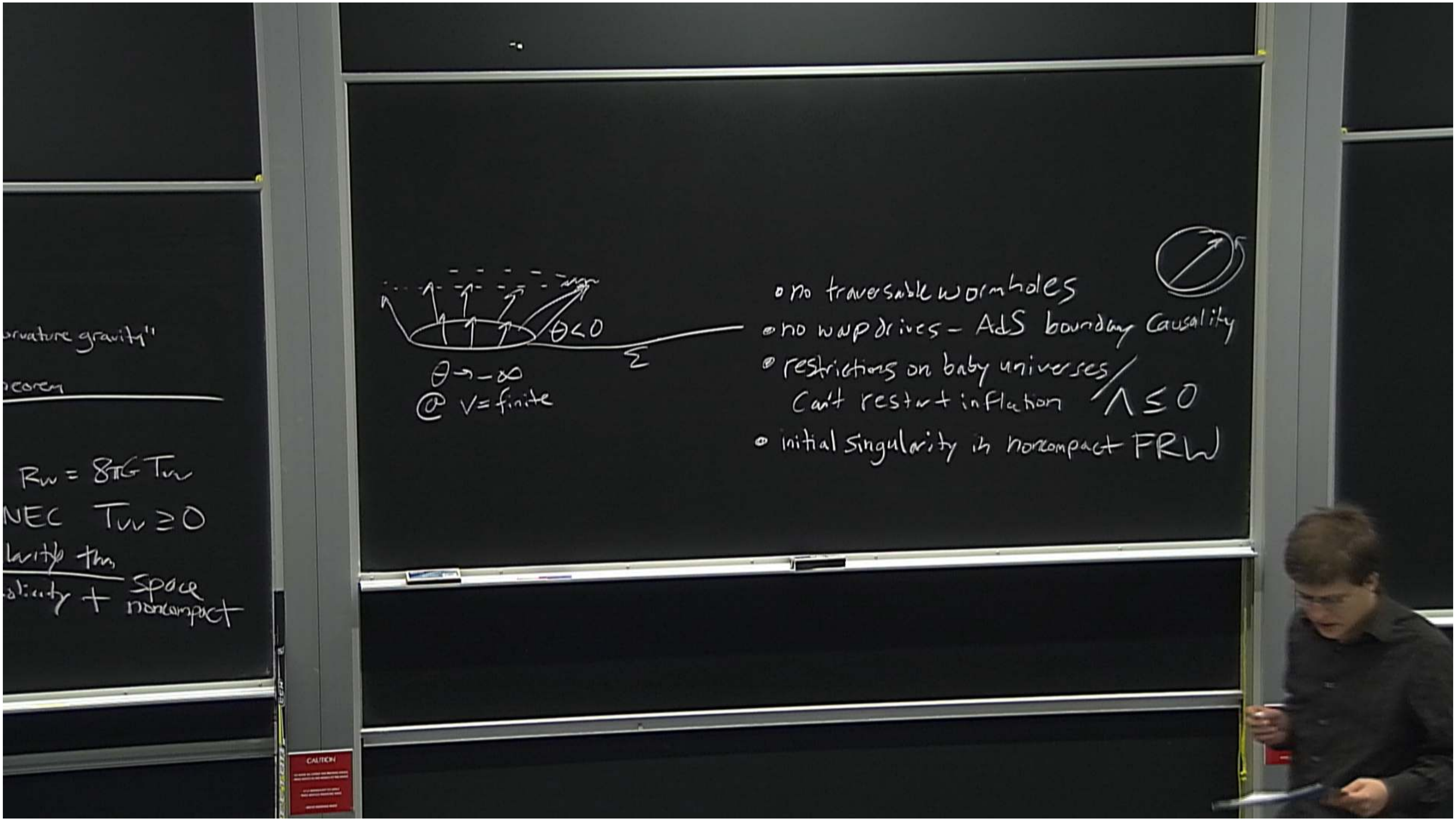
$$\dot{\theta} \leq 0$$

$R_{vv} = 8\pi G\, T_{vv}$

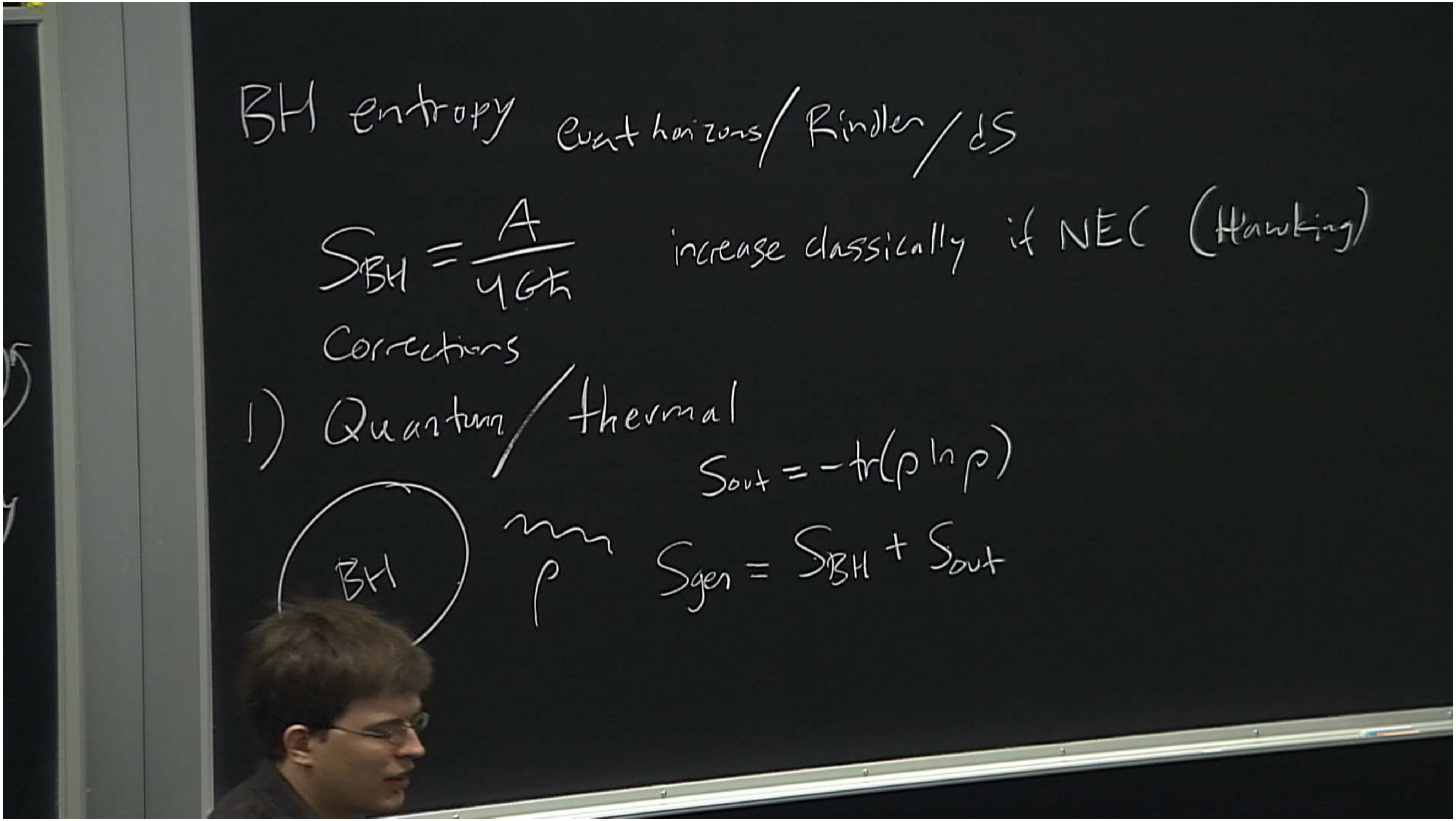
NEC $T_{vv} \geq 0$

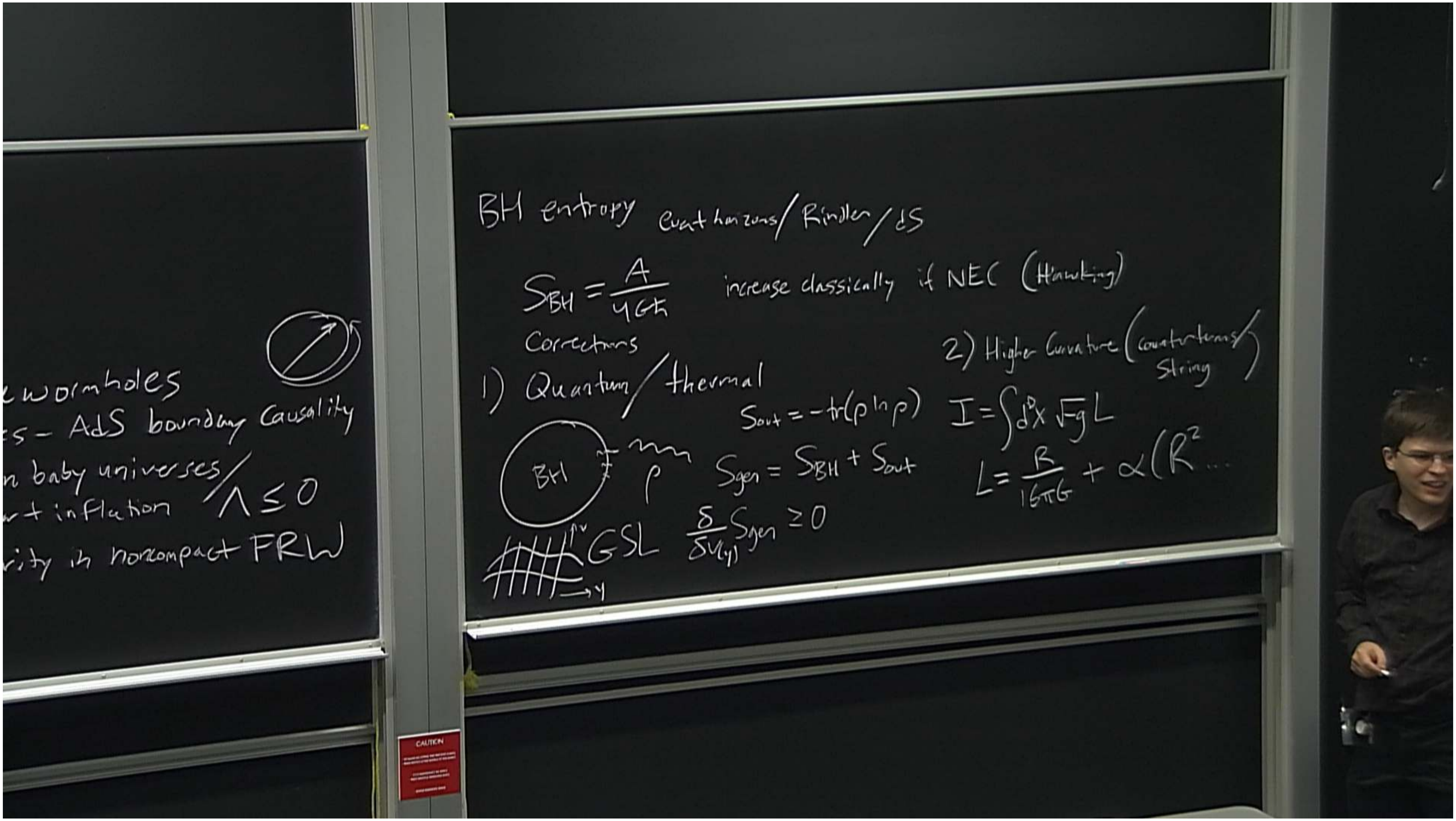
Penrose singularity thm

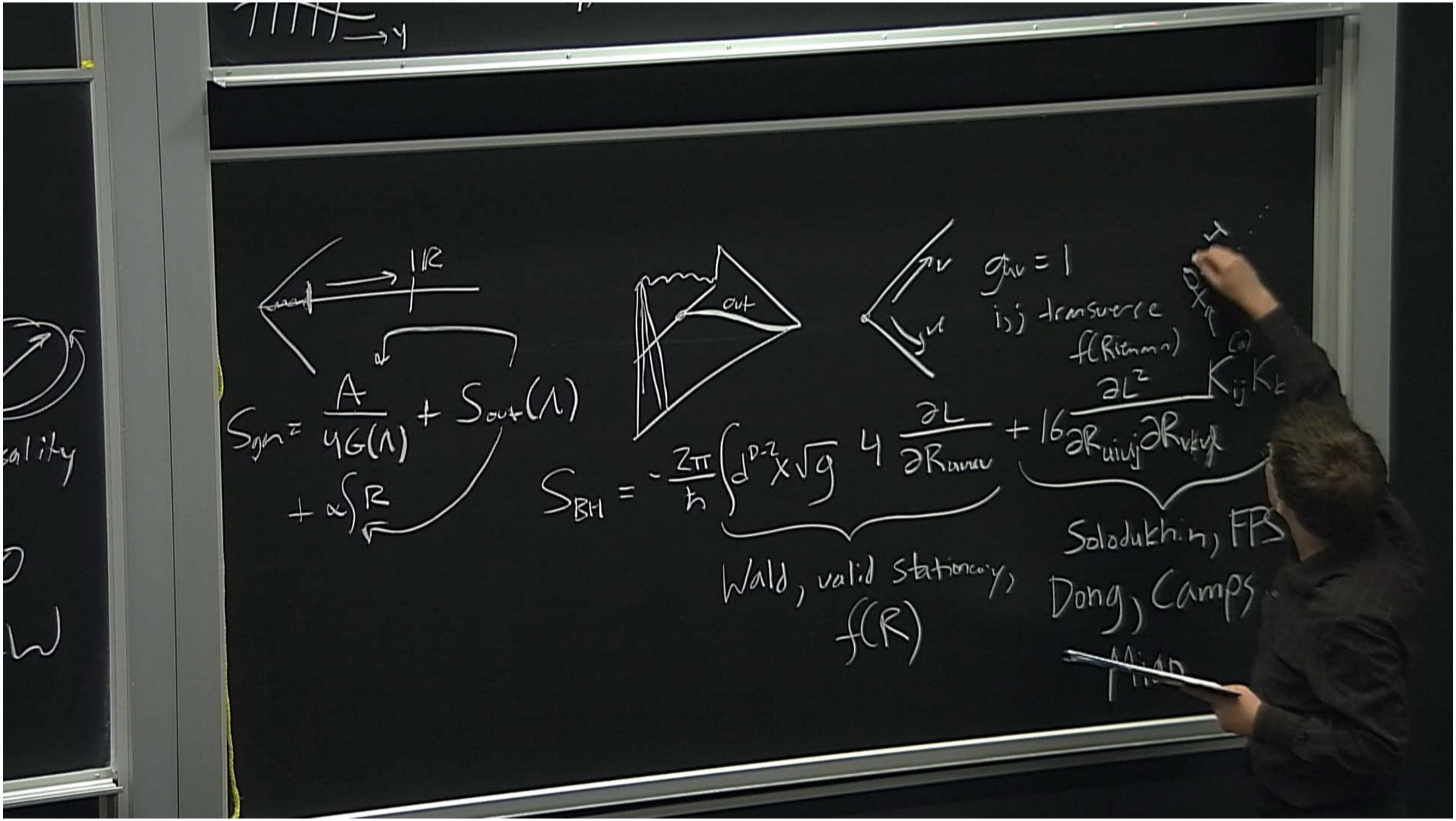
+ global hyperbolicity + space noncompact

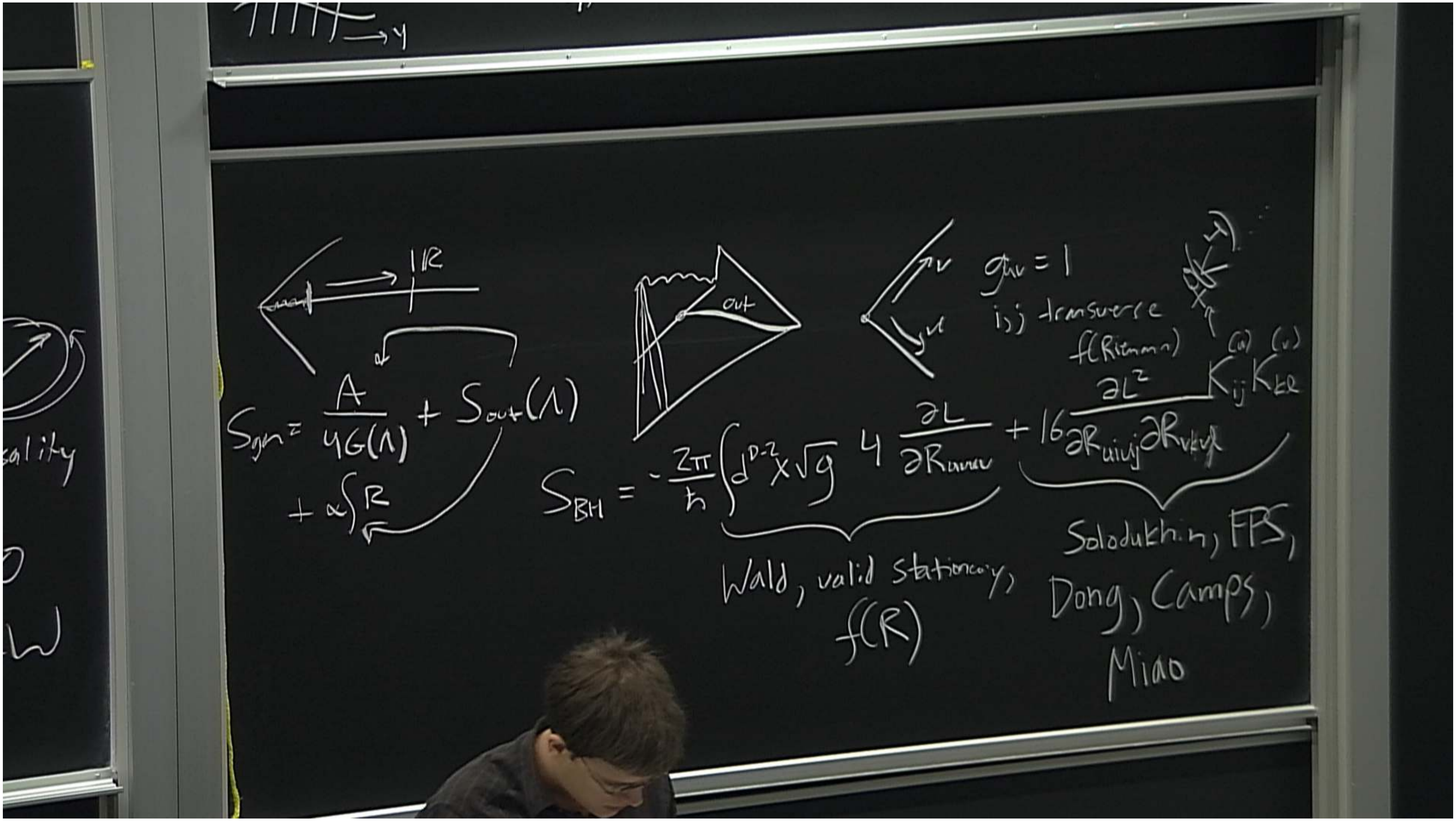


$\theta<0$
Σ
$\theta\to-\infty$
@ $v=$finite
• no traversable wormholes
• no warp drives – AdS boundary causality
• restrictions on baby universes /
Can't restart inflation
$\Lambda\le 0$
• initial singularity in noncompact FRW
$R_{\mu\nu} = 8\pi G T_{\mu\nu}$
NEC $T_{\mu\nu}\ge 0$
space noncompact


BH entropy
event horizons / Rindler / dS
$S_{BH} = \frac{A}{4G\hbar}$
increase classically if NEC (Hawking)
Corrections
1) Quantum / thermal
$S_{out} = -\mathrm{tr}(\rho \ln \rho)$
BH
ρ
$S_{gen} = S_{BH} + S_{out}$


e wormholes
s – AdS boundary causality
n baby universes / $\Lambda \leq 0$
t inflation
ity in noncompact FRW
BH entropy event horizons / Rindler / dS
$S_{BH} = \frac{A}{4G\hbar}$ increase classically if NEC (Hawking)
Corrections
1) Quantum / thermal
2) Higher Curvature (counterterms / String)
$S_{out} = -\mathrm{tr}(\rho \ln \rho)$
$I = \int d^D x \sqrt{-g}\, L$
$L = \frac{R}{16\pi G} + \alpha (R^2 \ldots$
BH
ρ
$S_{gen} = S_{BH} + S_{out}$
GSL $\frac{\delta}{\delta V(y)} S_{gen} \geq 0$


S_gen = A / 4G(Λ) + S_out(Λ)
+ α∫R
out
g_uv = 1
i, j transverse
f(Riemann)
S_BH = - 2π/ħ ∫ d^{D-2}x √g 4 ∂L/∂R_uvuv + 16 ∂L²/∂R_uiuj ∂R_vkvl K_ij K_kl
Wald, valid stationary,
f(R)
Solodukhin, FPS
Dong, Camps



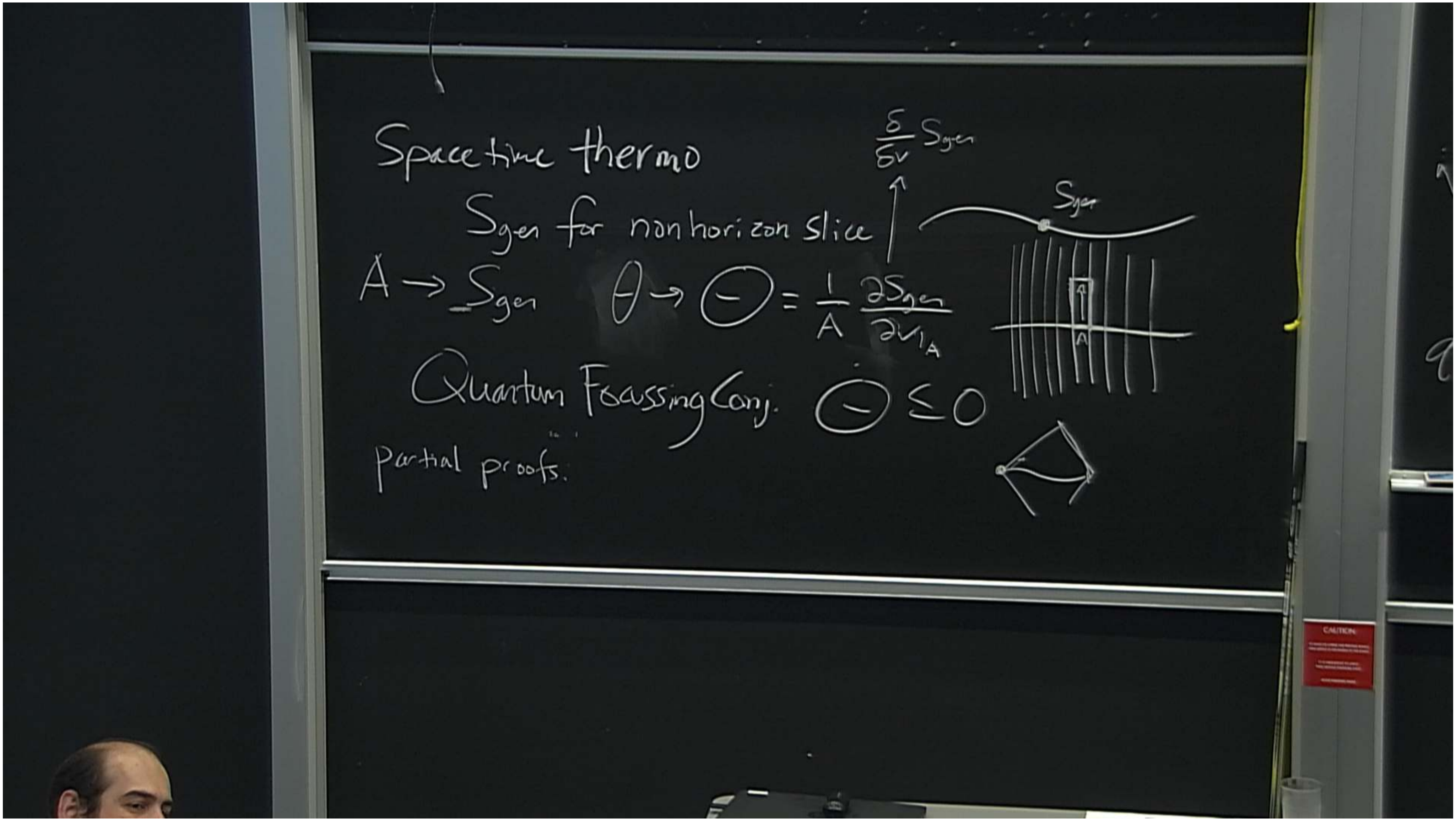
$\mathbb{R}$
out
$g_{uv} = 1$
i, j transverse
f(Riemann)
$S_{gen} = \frac{A}{4G(\Lambda)} + S_{out}(\Lambda)$
$+ \alpha \int R$
$S_{BH} = -\frac{2\pi}{\hbar} \int d^{D-2}x \sqrt{g} \, 4 \frac{\partial L}{\partial R_{uvuv}} + 16 \frac{\partial L^2}{\partial R_{uiuj} \partial R_{vkvl}} K^{(u)}_{ij} K^{(v)}_{kl}$
Wald, valid stationary,
$f(R)$
Solodukhin, FPS,
Dong, Camps,
Miao

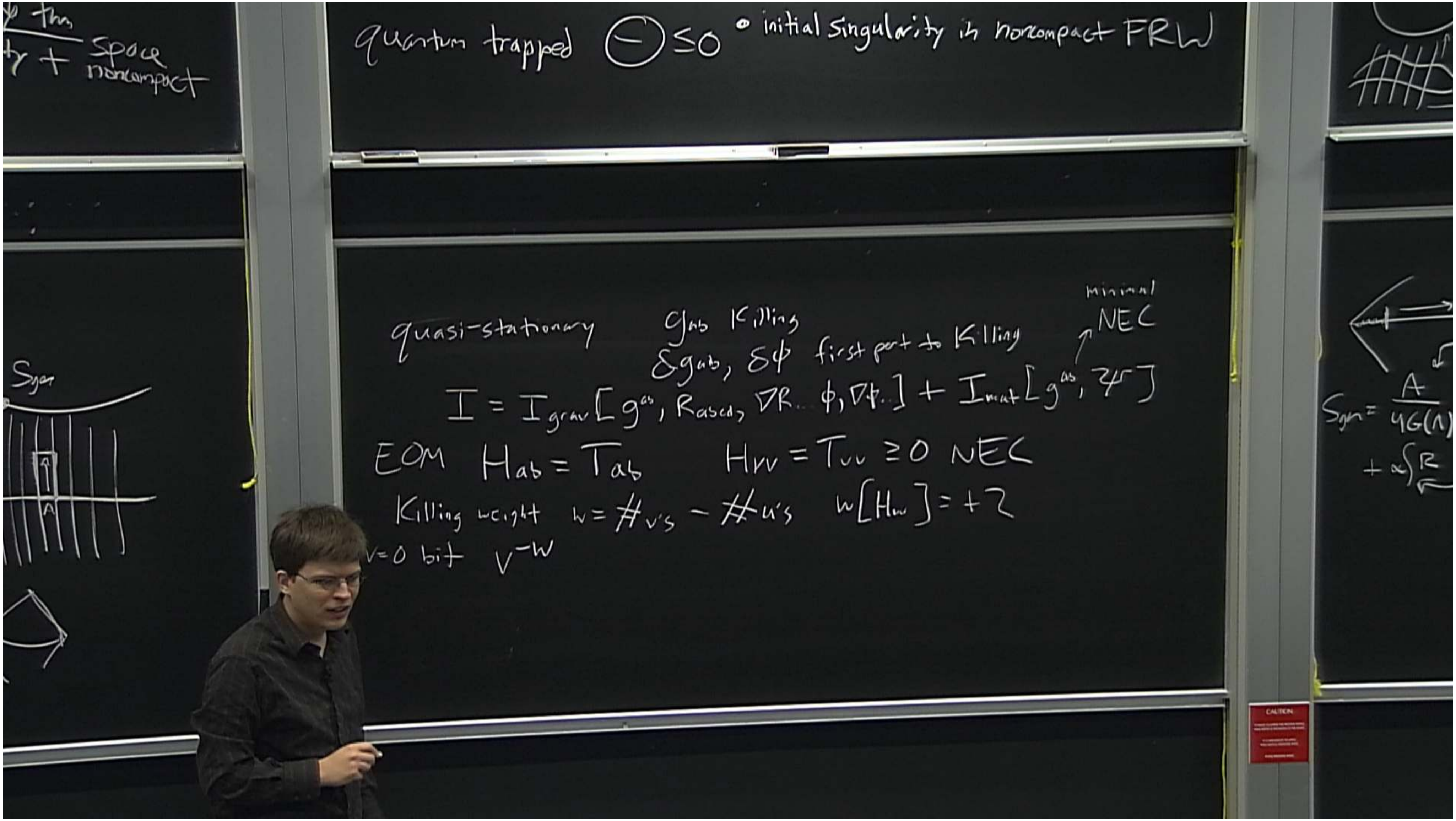
Spacetime thermo

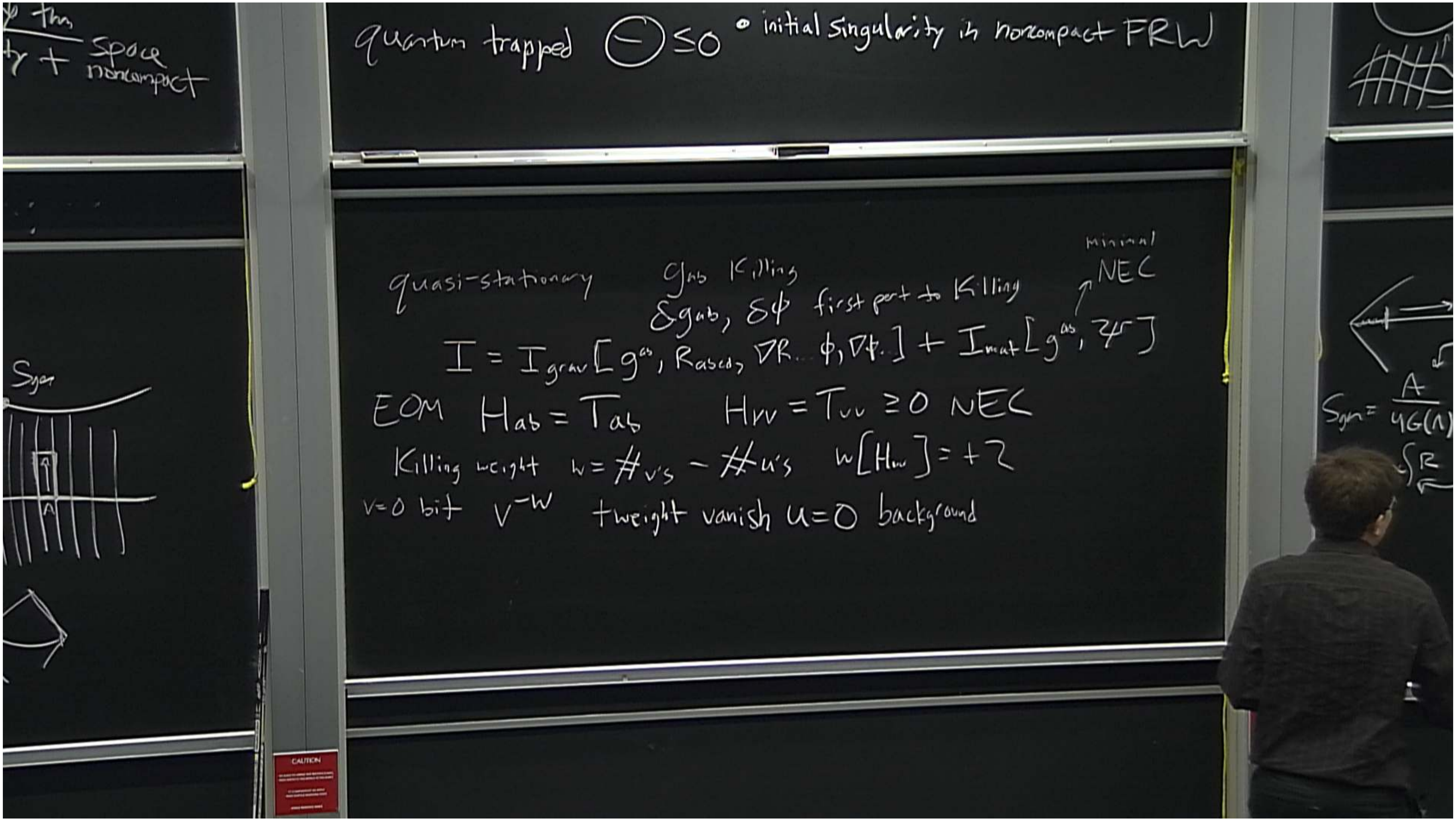
S_{gen} for nonhorizon slice

$$A \to S_{gen} \qquad \theta \to \Theta = \frac{1}{A}\frac{\partial S_{gen}}{\partial v}$$

Quantum Focussing Conj. $\dot{\Theta} \le 0$


Spacetime thermo
$\frac{\delta}{\delta v} S_{gen}$
S_{gen} for nonhorizon slice
$A \to S_{gen}$
$\theta \to \Theta = \frac{1}{A} \frac{\partial S_{gen}}{\partial v_A}$
Quantum Focussing Conj. $\dot{\Theta} \leq 0$
partial proofs:
S_{gen}
A
A


quantum trapped $\Theta \le 0$ • initial singularity in noncompact FRW
minimal NEC
quasi-stationary g_{ab} Killing
δg_{ab}, $\delta\phi$ first part to Killing
$I = I_{grav}[g^{ab}, R_{abcd}, \nabla R \ldots \phi, \nabla\phi \ldots] + I_{mat}[g^{ab}, \psi]$
EOM $H_{ab} = T_{ab}$ $H_{vv} = T_{vv} \ge 0$ NEC
Killing weight $w = \#v\text{'s} - \#u\text{'s}$ $w[H_{vv}] = +2$
$v=0$ bit v^{-w}
Space noncompact
S_{gen}
$S_{gen} = \frac{A}{4G(\Lambda)} + \alpha \int R$


quantum trapped Θ ≤ 0
• initial singularity in noncompact FRW
quasi-stationary
g_{ab} Killing
δg_{ab}, $\delta\phi$ first pert to Killing
minimal NEC
$I = I_{grav}[g^{ab}, R_{abcd}, \nabla R \ldots \phi, \nabla\phi \ldots] + I_{mat}[g^{ab}, \psi]$
EOM $H_{ab} = T_{ab}$ $H_{vv} = T_{vv} \geq 0$ NEC
Killing weight $w = \#v\text{'s} - \#u\text{'s}$ $w[H_{vv}] = +2$
v=0 bit v^{-w} +weight vanish $u=0$ background
$S_{gen} = \frac{A}{4G(\Lambda)}$

$$\delta H_{vv} = \sum_n X^{(-n)} \cdot \delta Y^{(2+n)} \qquad n \geq 0$$

$$= \frac{\hbar}{2\pi} \partial_v \partial_v \varsigma[g_{\alpha\nu}, \delta g_{\alpha\alpha}]$$

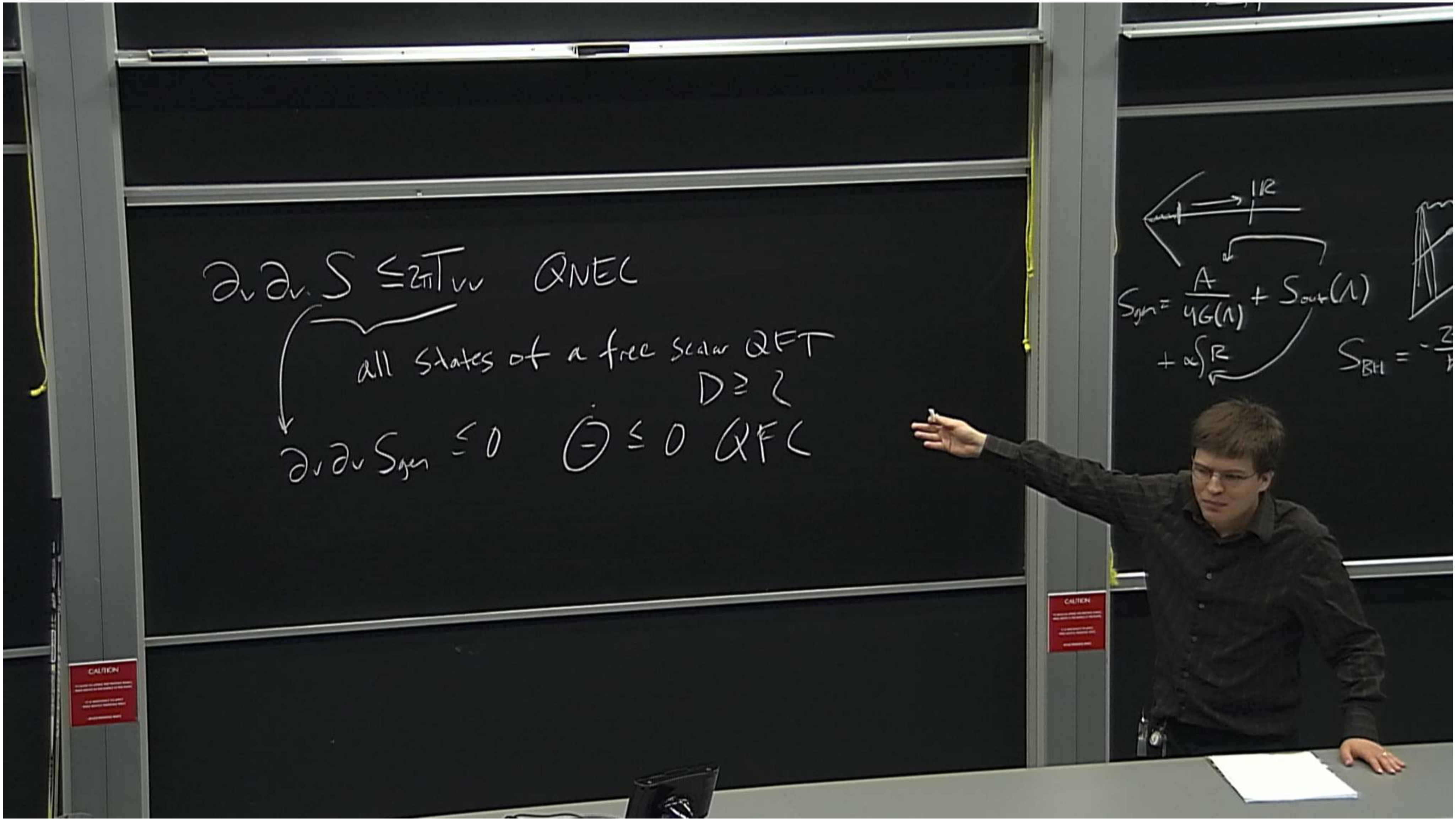
- gauge fix metric $g_{vv}, g_{vi}, g_{vv,u} = 0$

$$\partial_v \varsigma \big|_{v=+\infty} = 0$$

$$\varsigma = \delta S[g_{ab}]$$

$$\partial_v \varsigma \geq 0 \quad \text{2nd law}$$

$$f(\text{Riemann}) \Rightarrow S = S_{\text{Dong}} + \text{total deriv} + \mathcal{O}(K^4)$$


$\partial_v \partial_v S \leq 2\pi T_{vv}$ QNEC
all states of a free scalar QFT
$D \geq 2$
$\partial_v \partial_v S_{gen} \leq 0$
$\dot{\Theta} \leq 0$ QFC
$S_{gen} = \frac{A}{4G(\Lambda)} + S_{out}(\Lambda)$
$+ \alpha \int R$
$S_{BH} =$