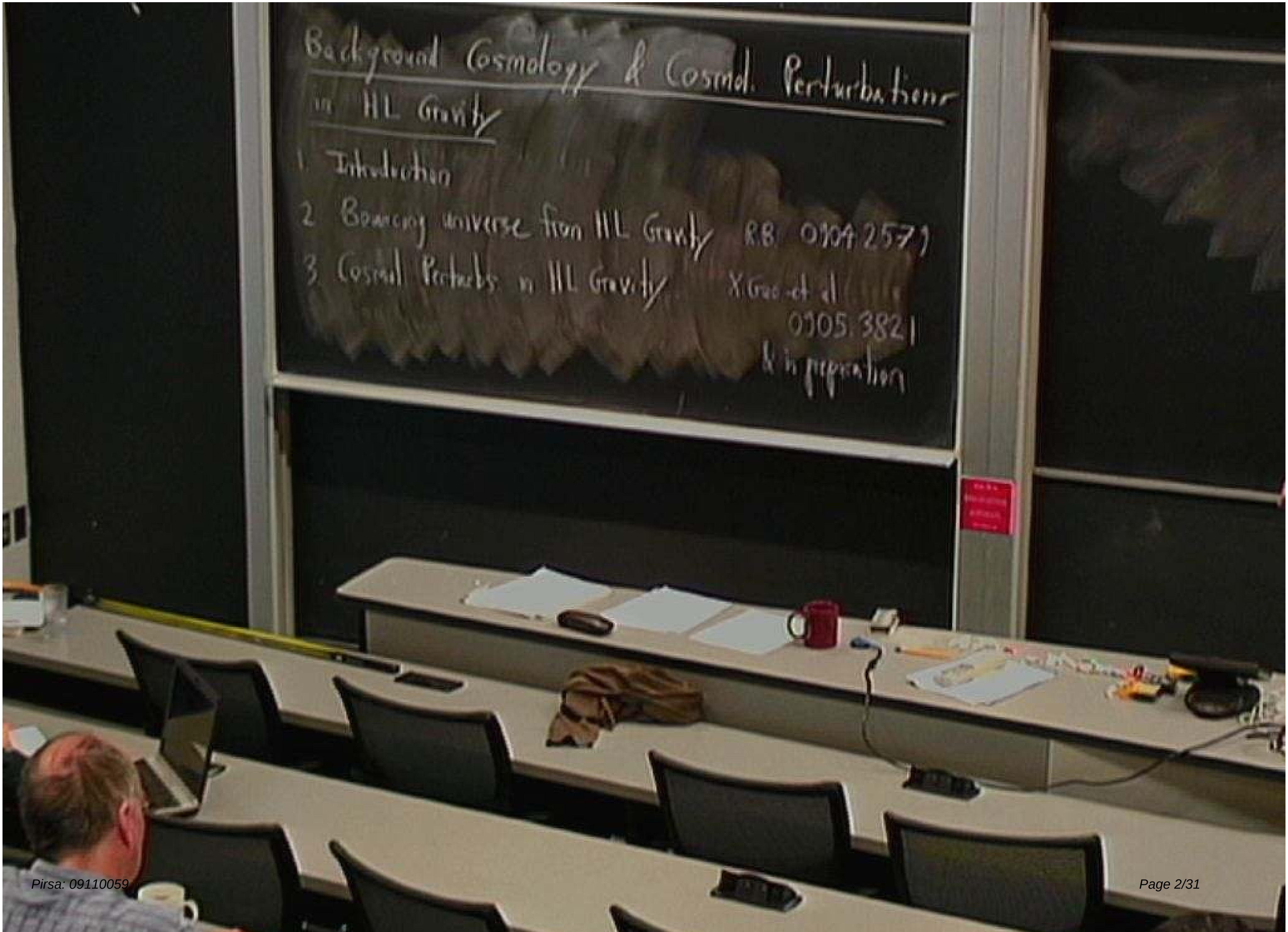
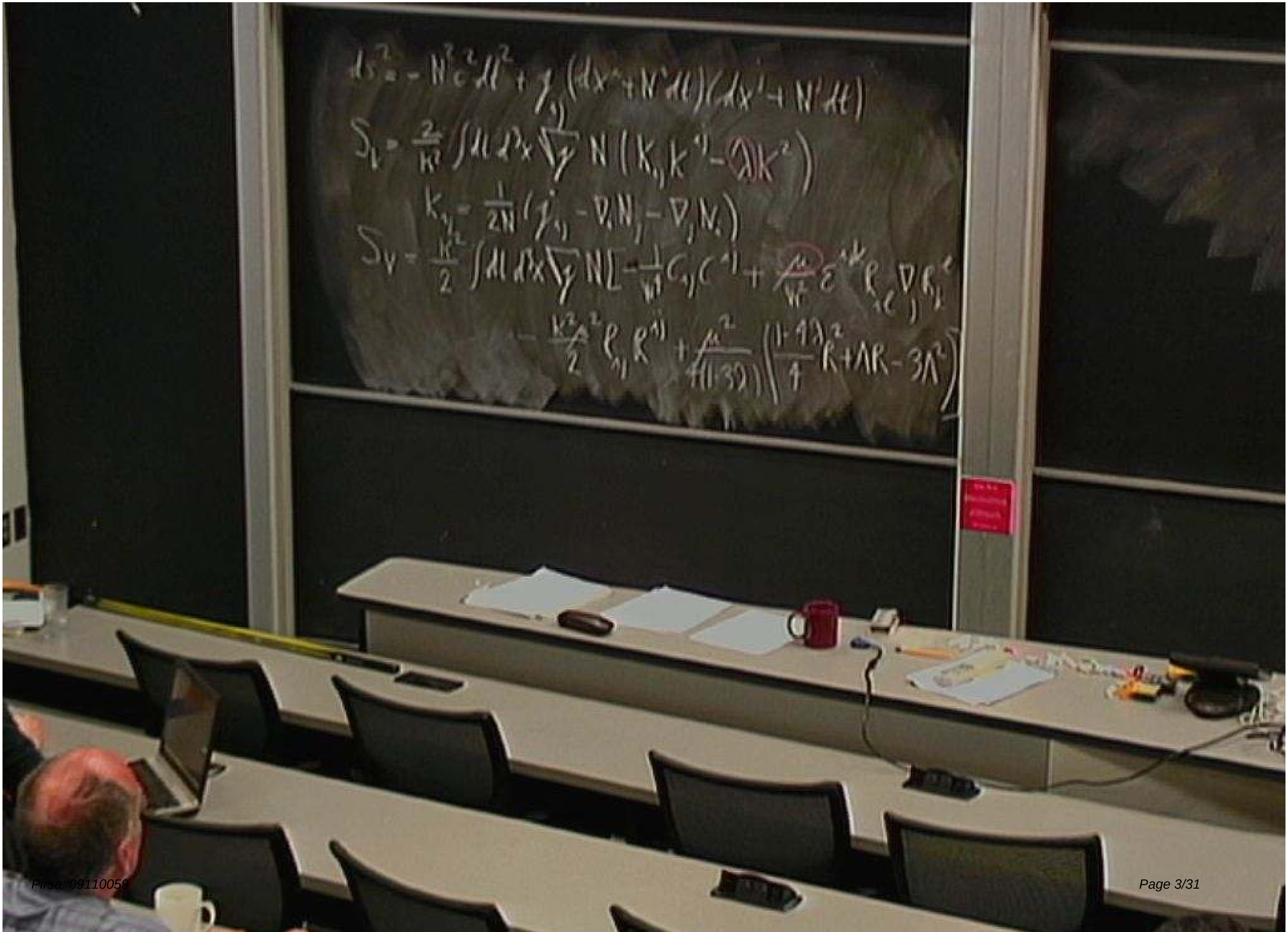
Title: Background Cosmology and Cosmological Perturbations in Horava-Lifshitz Gravity

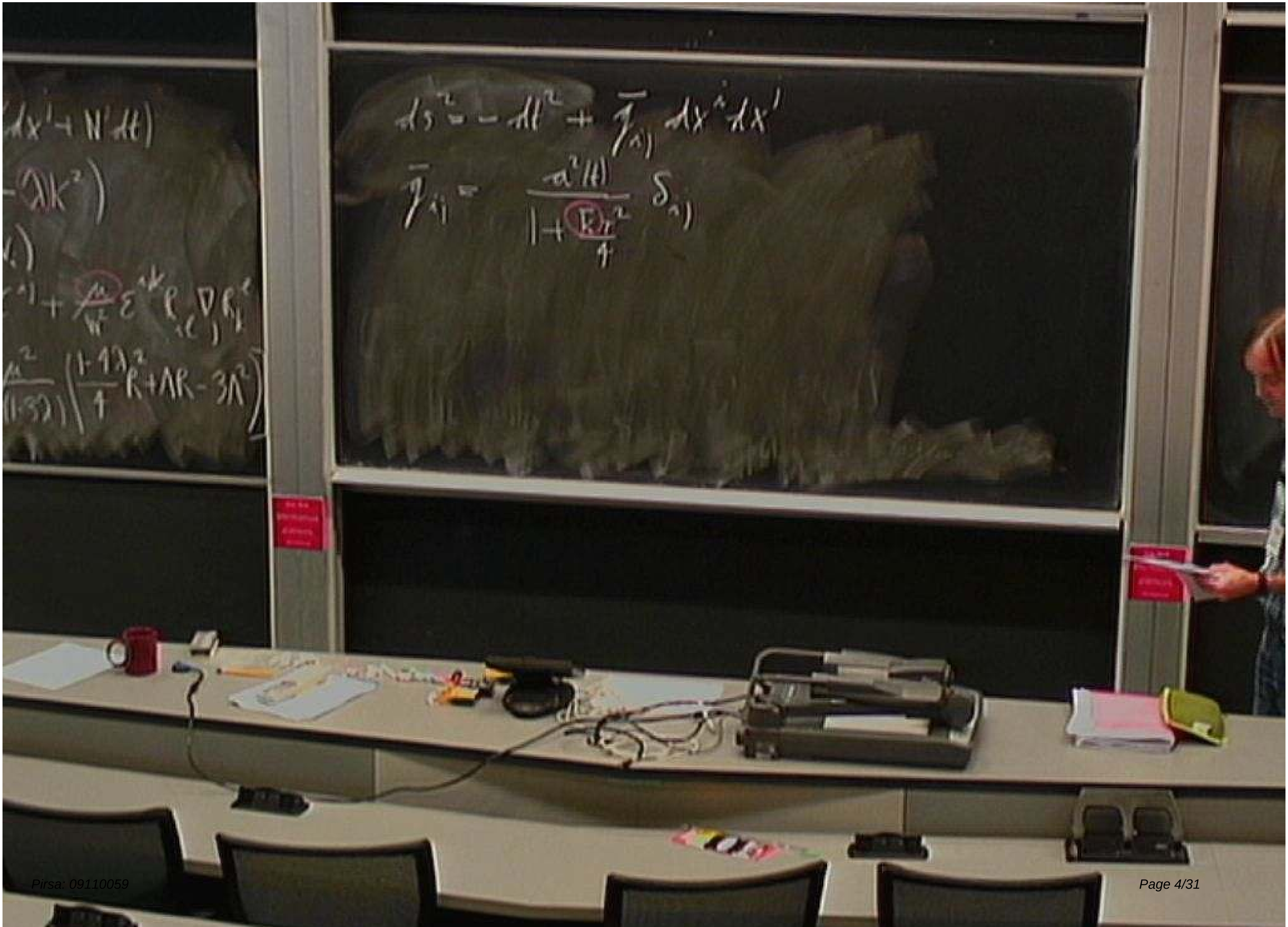
Date: Nov 09, 2009 02:00 PM

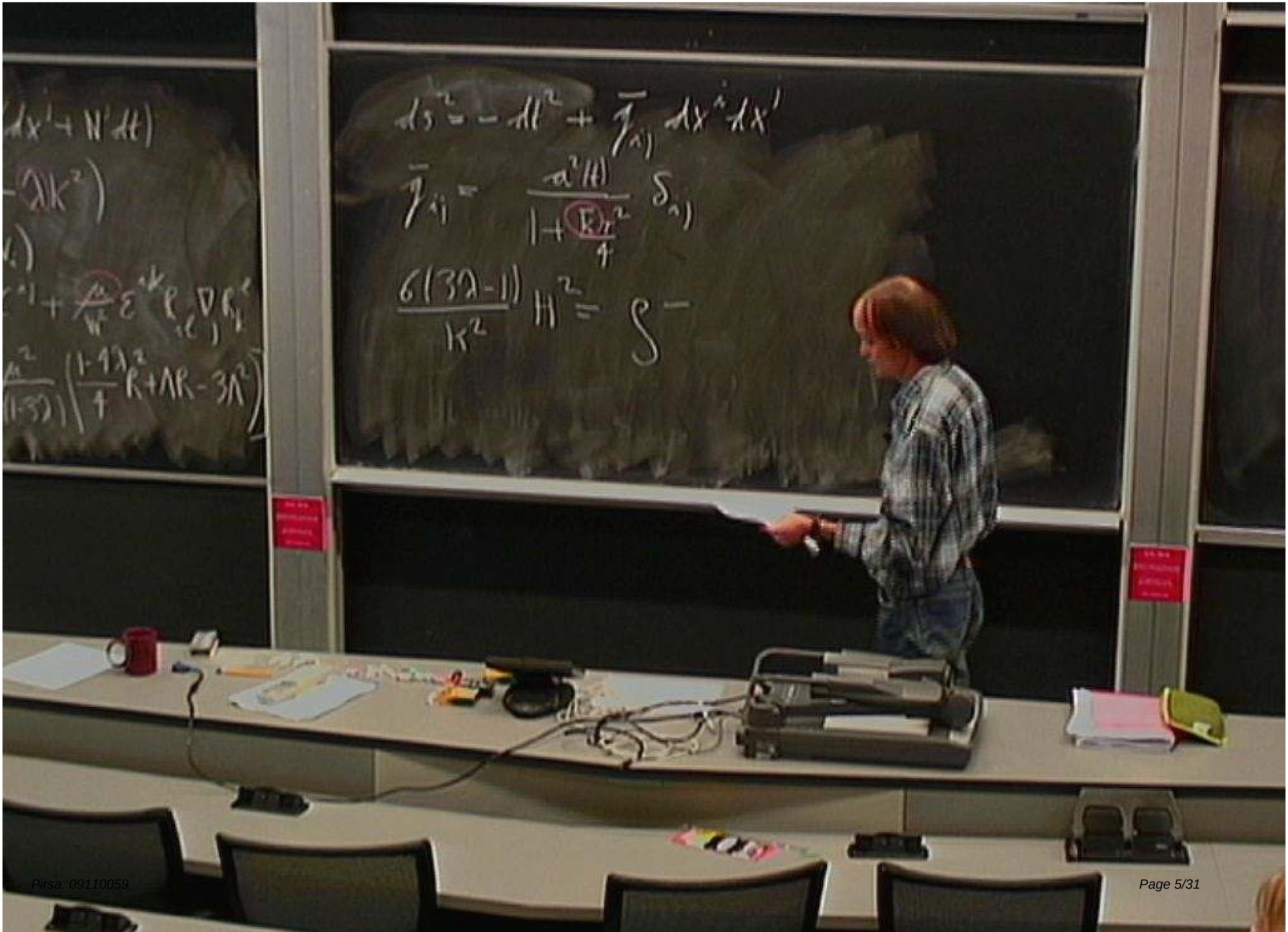
URL: http://pirsa.org/09110059

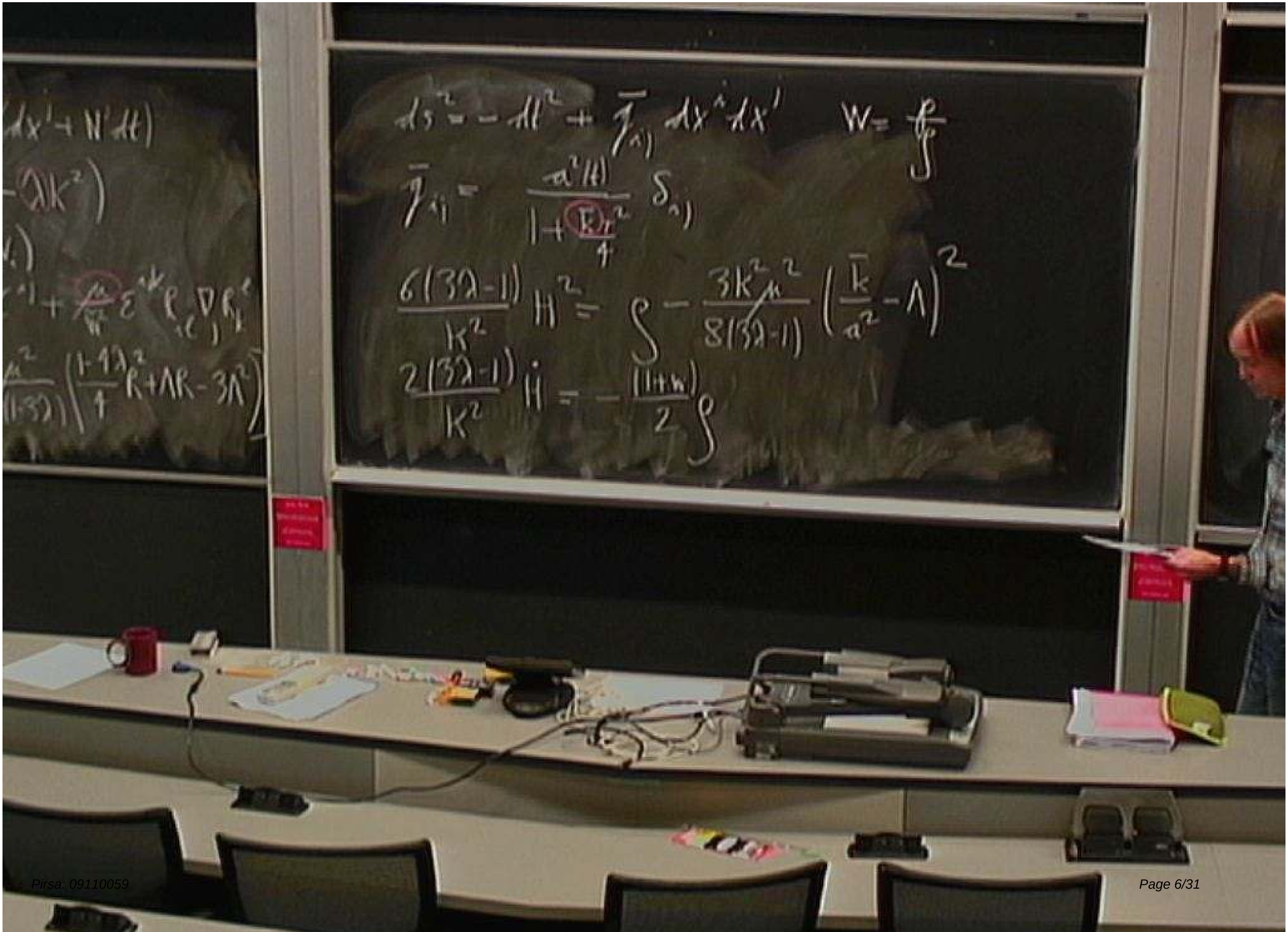
Abstract:


Background Cosmology & Cosmol. Perturbations
in HL Gravity
1. Introduction
2. Bouncing universe from HL Gravity R.B. 0904.2571
3. Cosmol. Perturbs in HL Gravity X. Gao et al
0905.3821
& in preparation

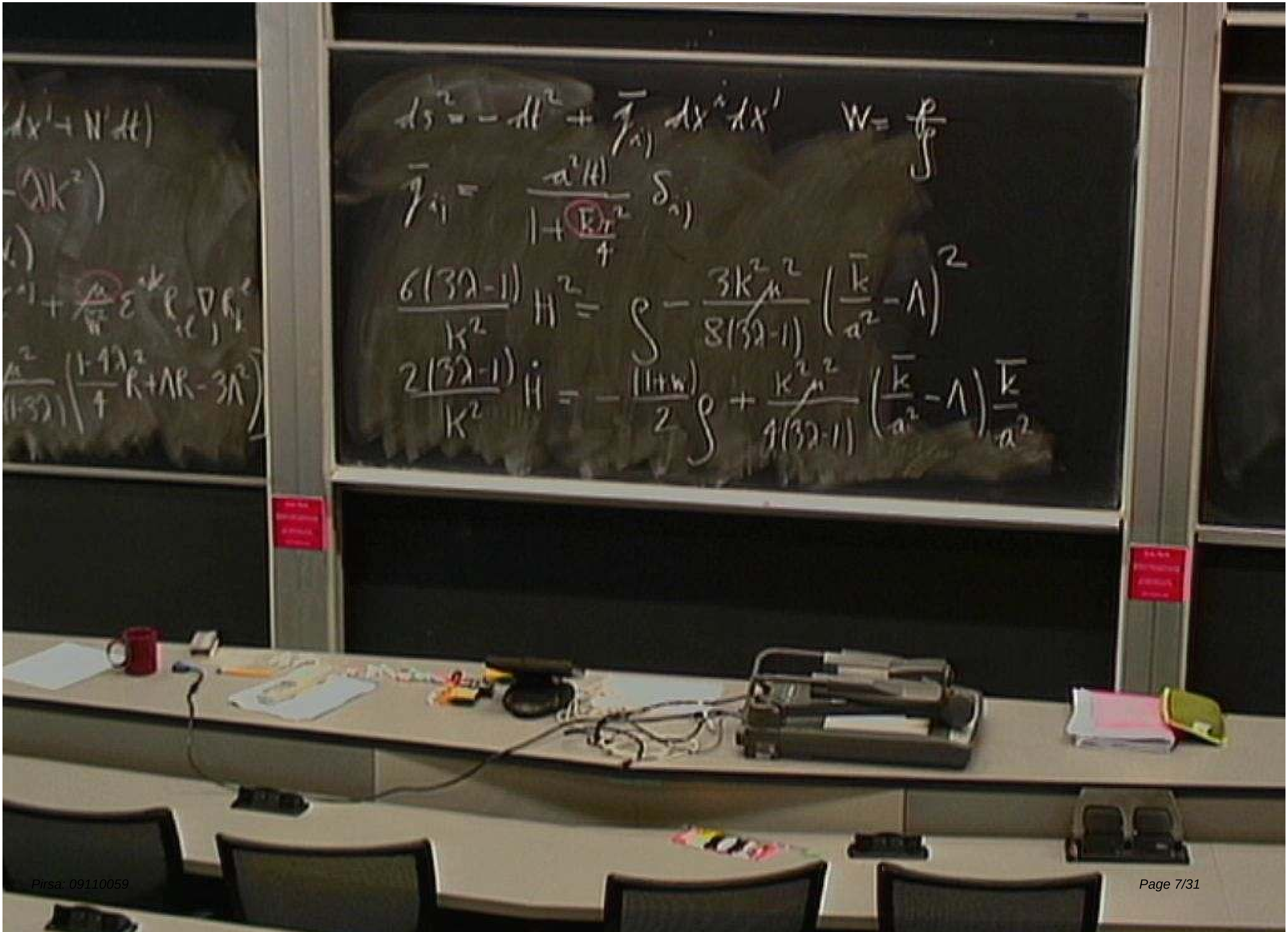


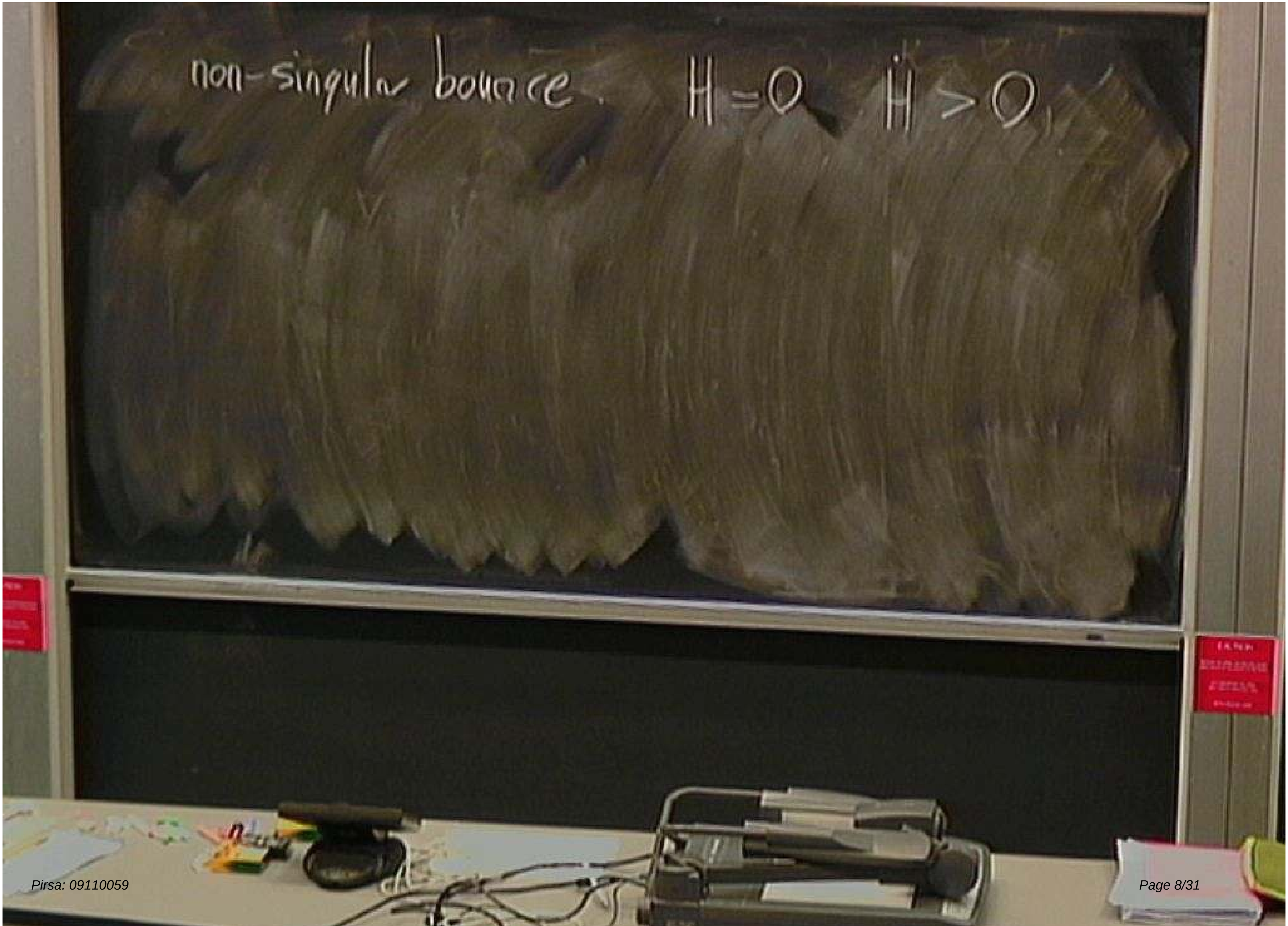


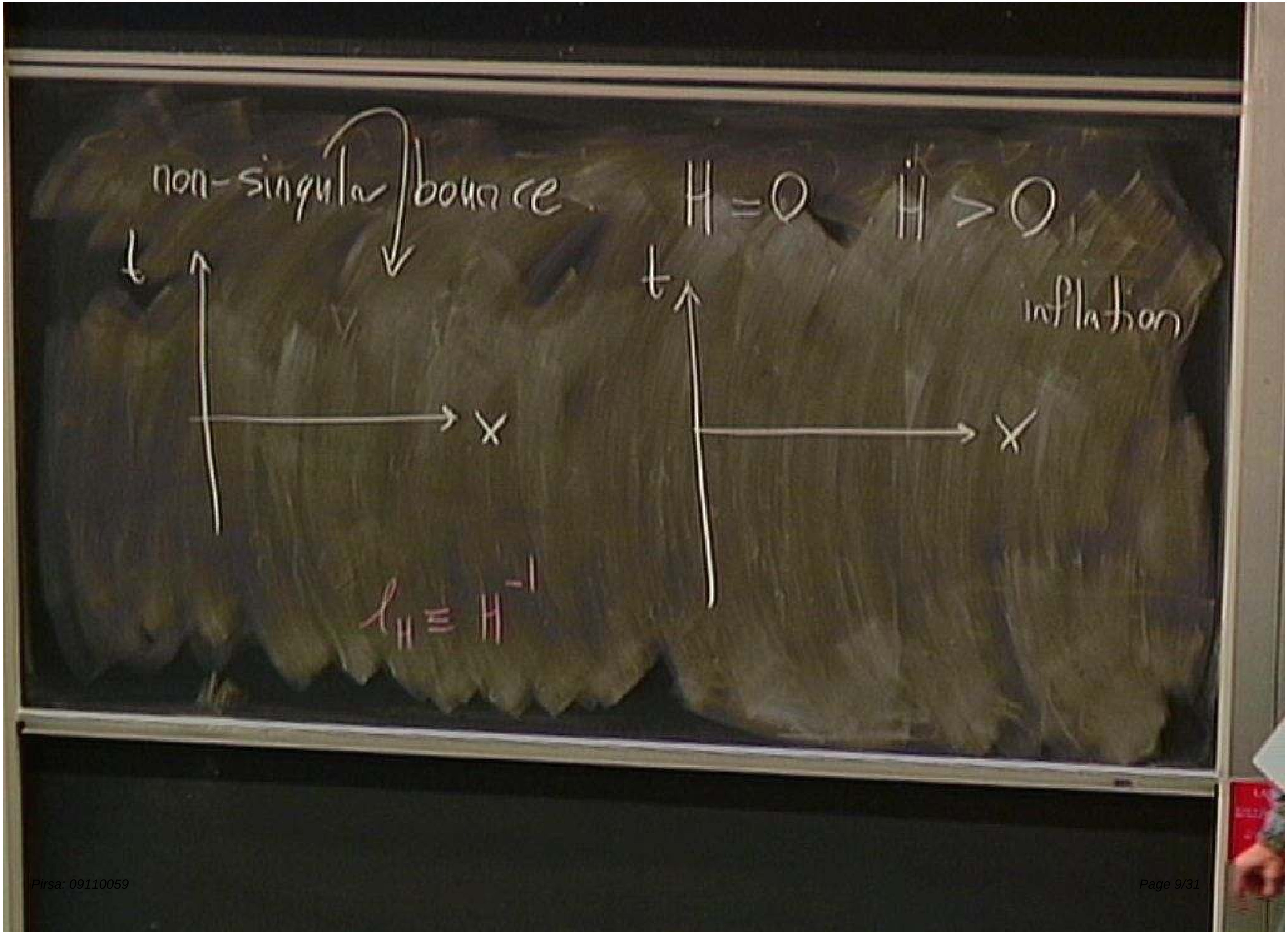


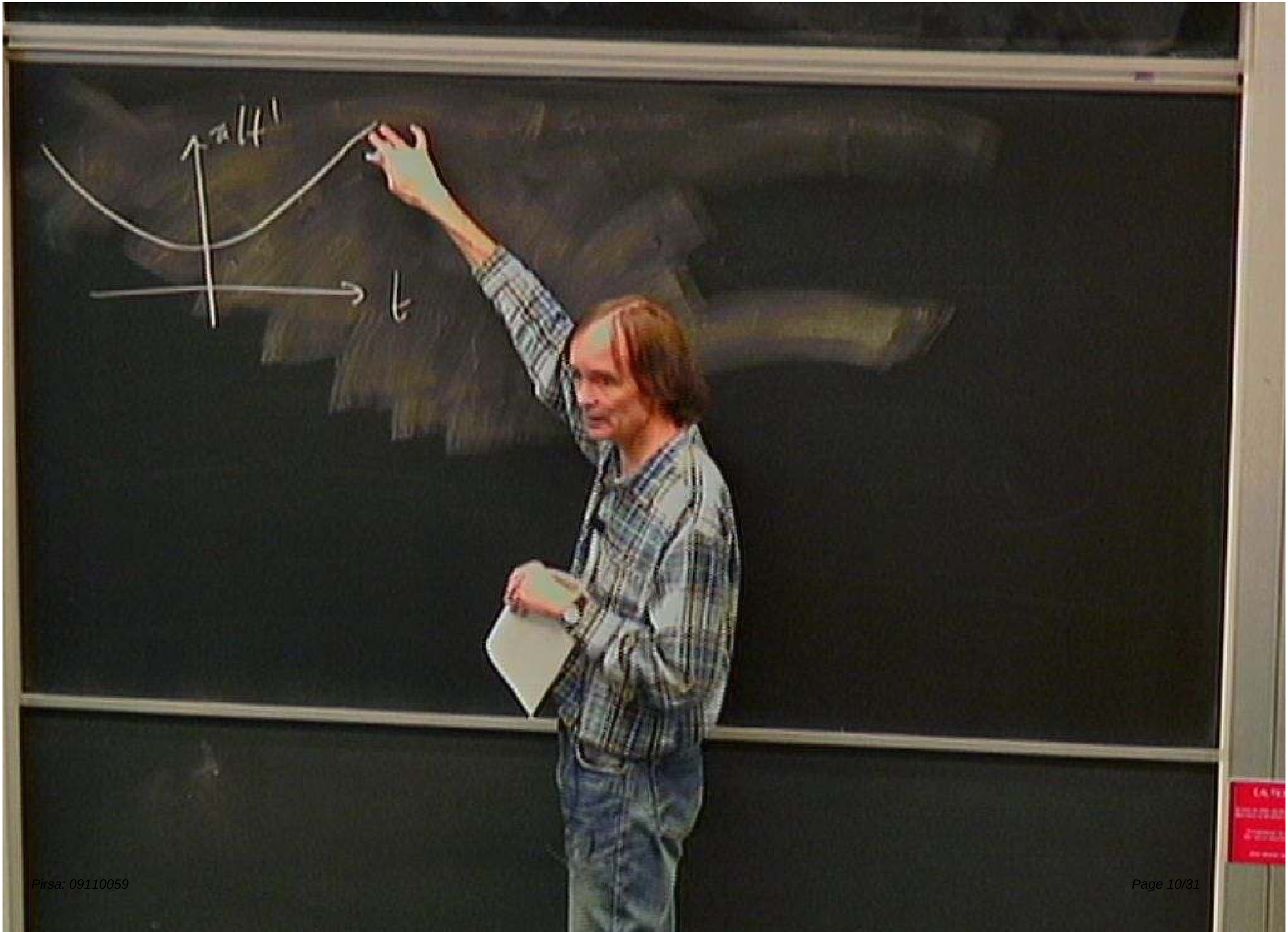


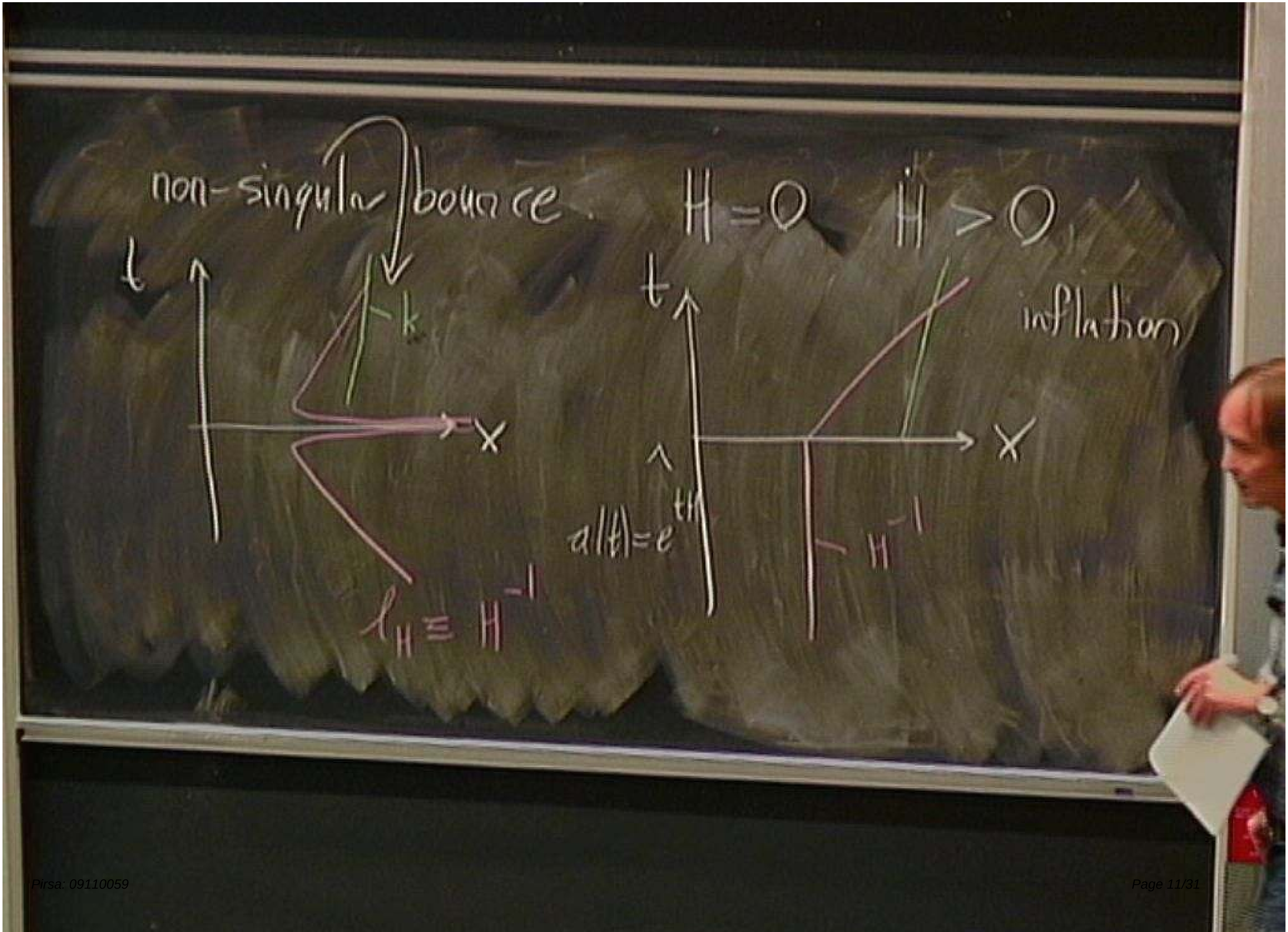
$ds^2 = -dt^2 + \bar{g}_{ij}\, dx^i dx^j$
$W = \frac{p}{\rho}$
$\bar{g}_{ij} = \frac{a^2(t)}{1 + \frac{k r^2}{4}} \delta_{ij}$
$\frac{6(3\lambda - 1)}{\kappa^2} H^2 = \rho - \frac{3\kappa^2 \mu^2}{8(3\lambda - 1)} \left(\frac{\bar{k}}{a^2} - \Lambda\right)^2$
$\frac{2(3\lambda - 1)}{\kappa^2} \dot{H} = -\frac{(1+w)}{2} \rho$

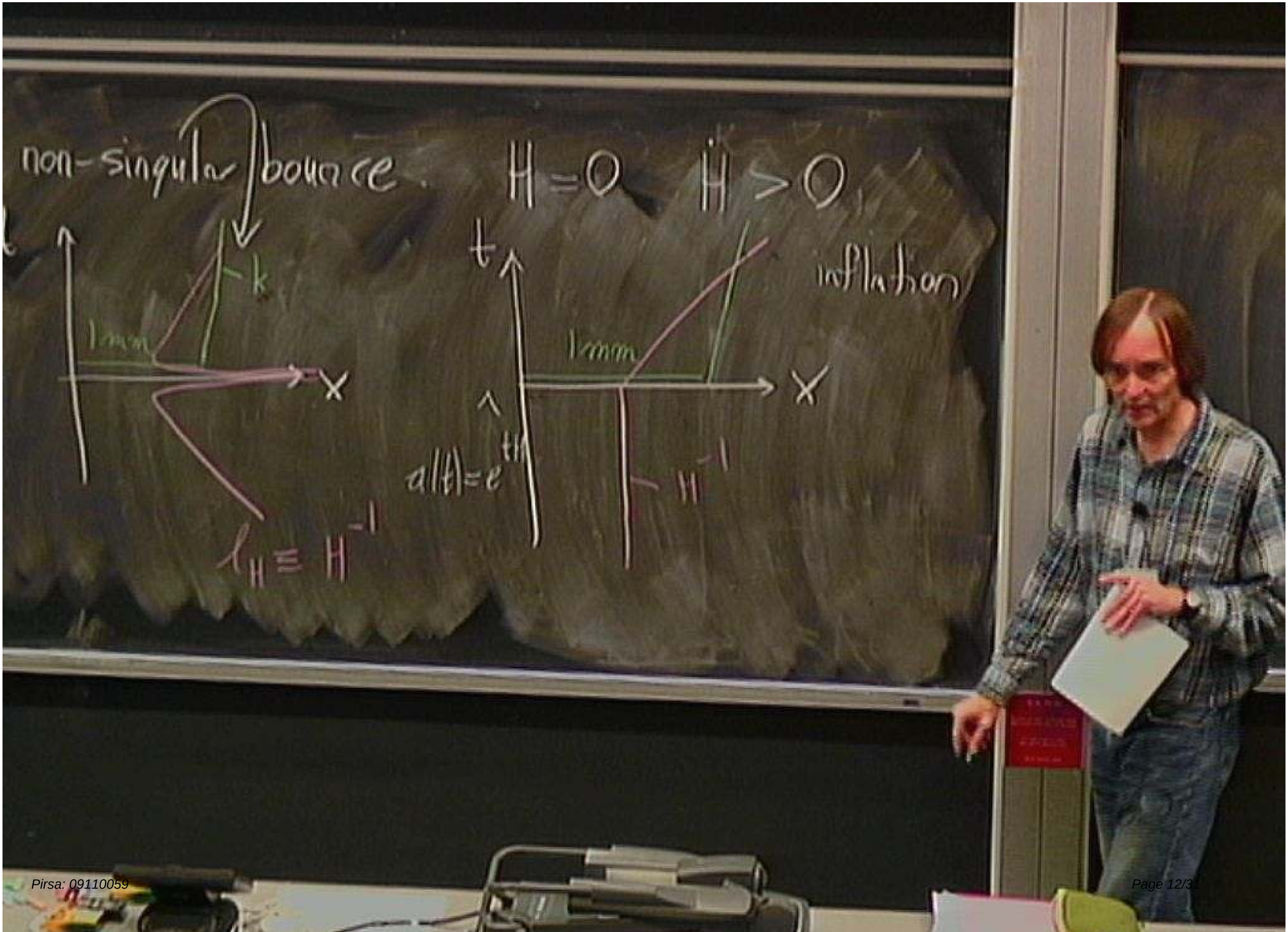



non-singular bounce
$H = 0$
$\dot{H} > 0$

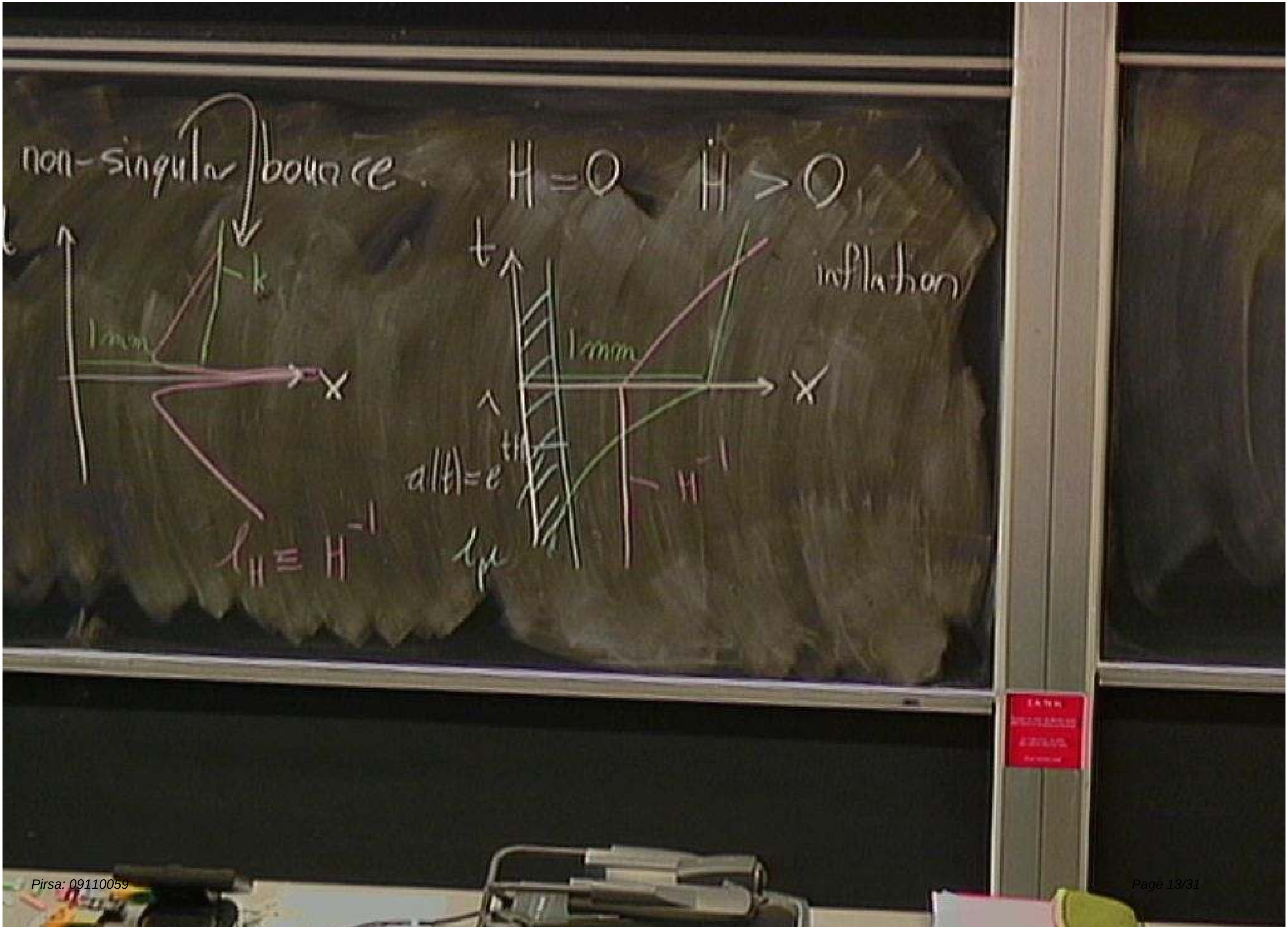

non-singular bounce
$H=0$ $\dot{H}>0$
t
x
inflation
$\ell_H \equiv H^{-1}$



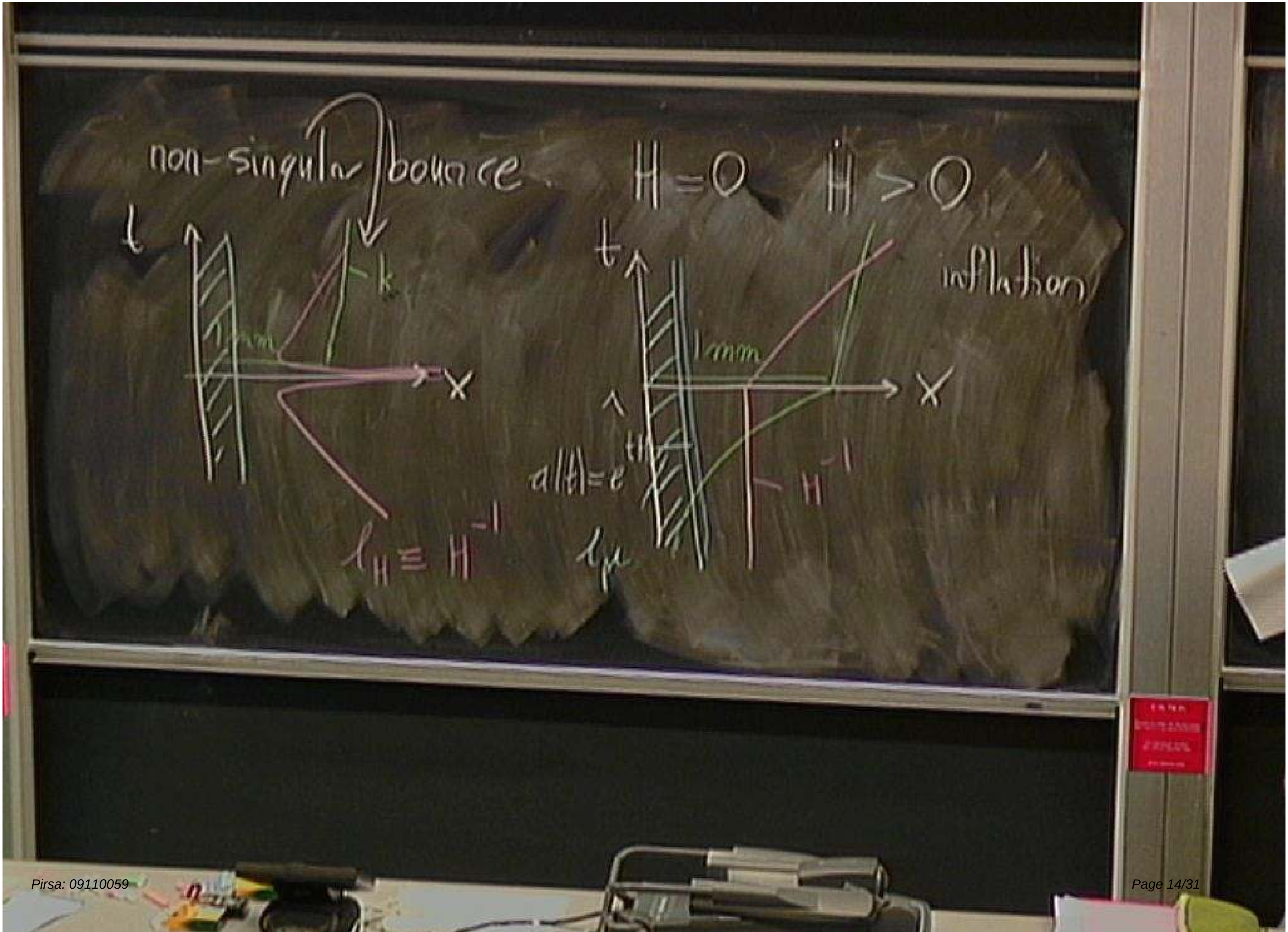

non-singular bounce
t
k
x
$l_H \equiv H^{-1}$
$H = 0$
$\dot{H} > 0$
inflation
t
x
$a(t) = e^{tH}$
H^{-1}



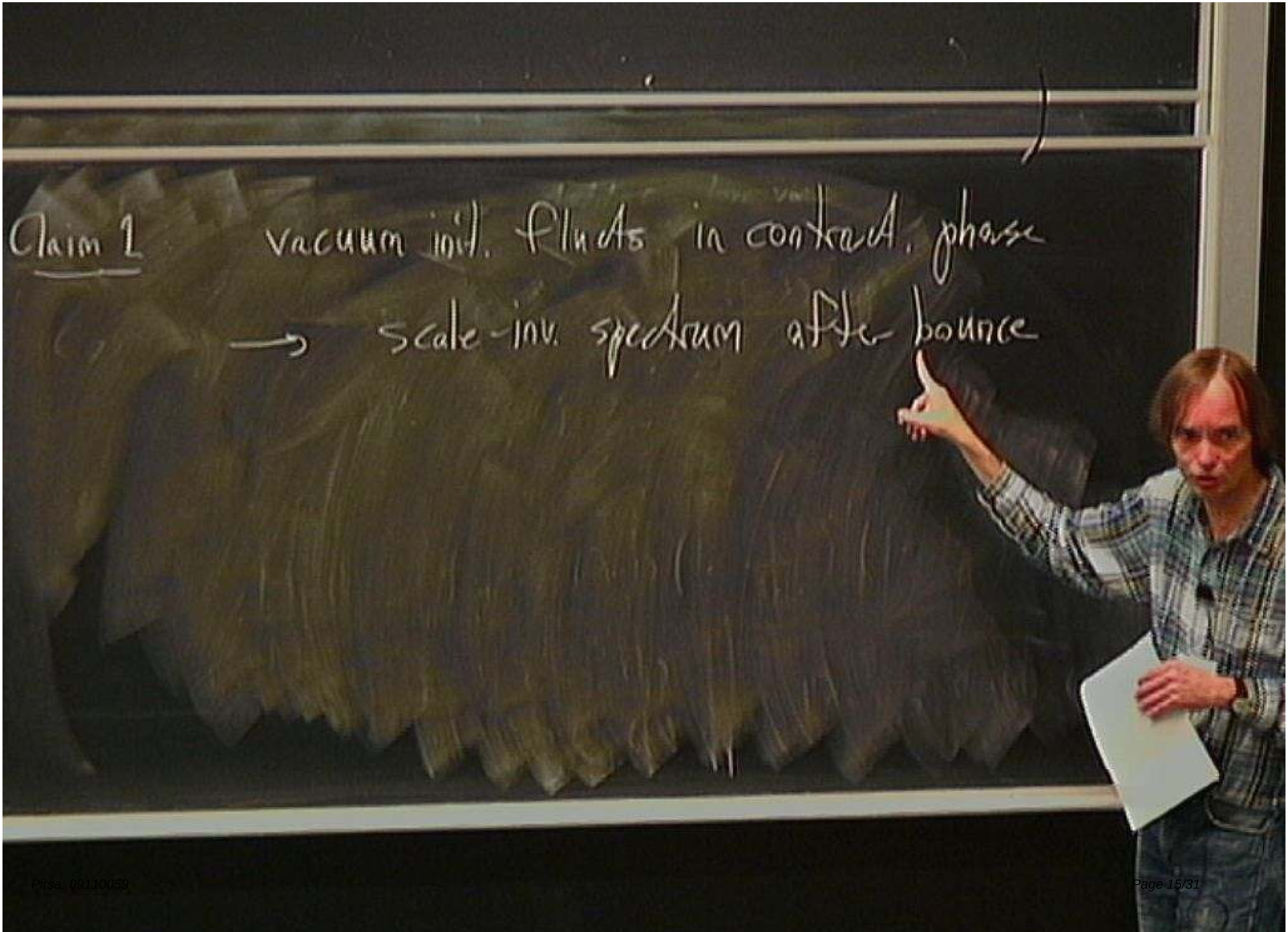
non-singular bounce
H = 0 Ḣ > 0
t
x
1mm
k
l_H ≡ H^-1
a(t) = e^tH
H^-1
inflation

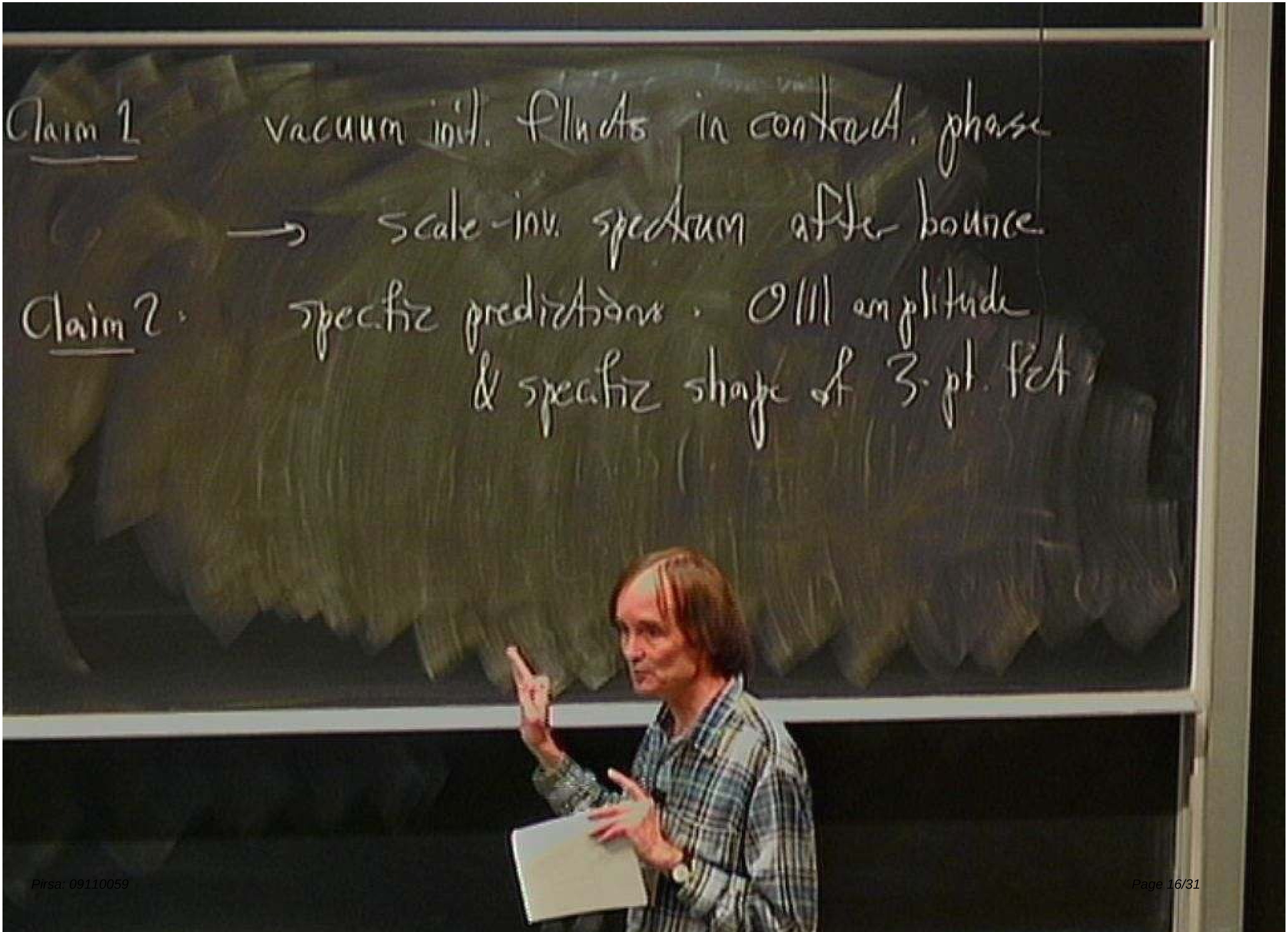


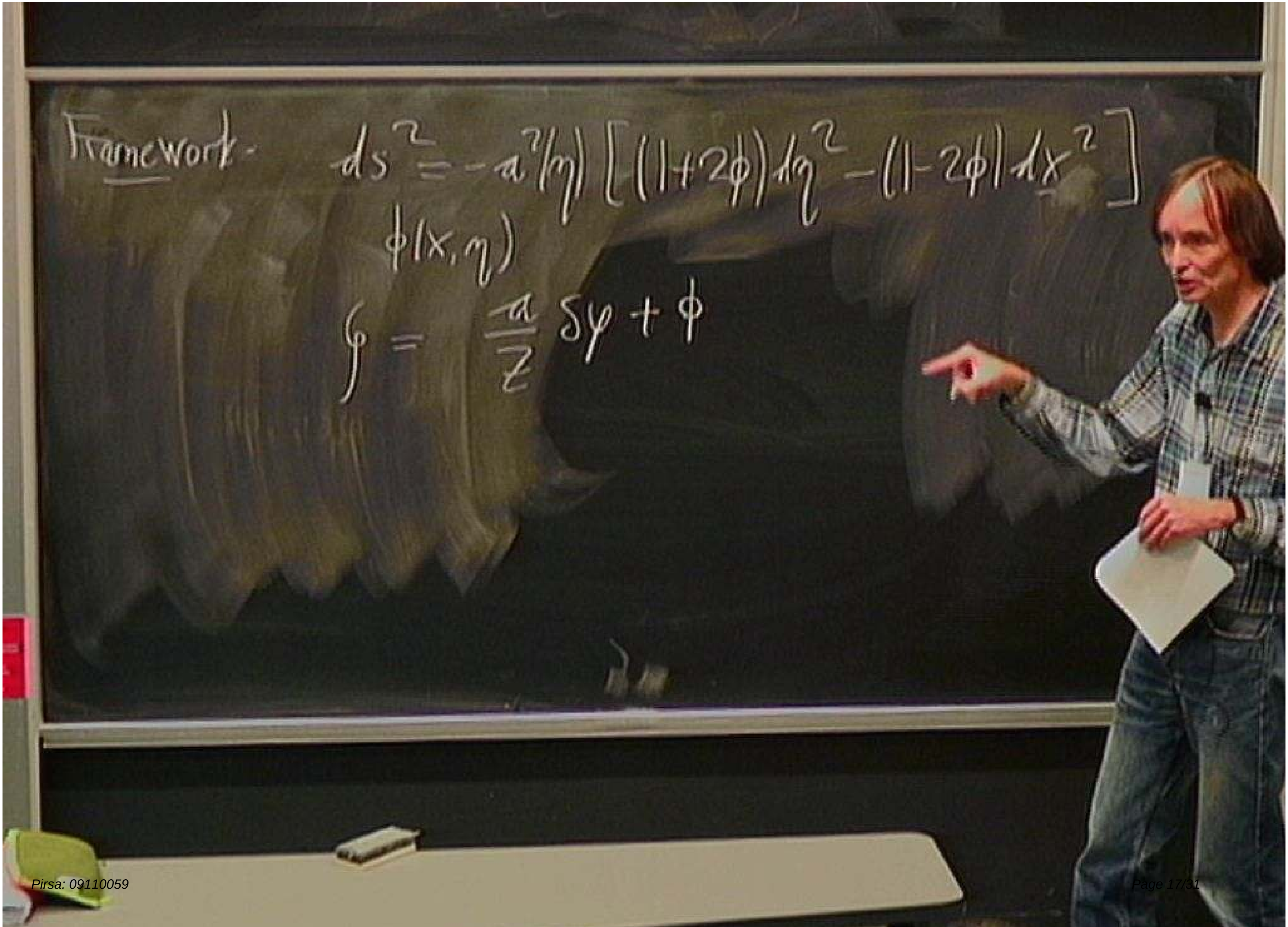
non-singular bounce
H = 0
Ḣ > 0
inflation
t
x
k
1mm
$l_H \equiv H^{-1}$
$a(t) = e^{Ht}$
H^{-1}



non-singular bounce
$\dot{H} = 0$
$\dot{H} > 0$
t
k
1 mm
x
$l_H \equiv H^{-1}$
t
inflation
1 mm
x
$a(t) = e^{tH}$
H^{-1}
l_{pl}


Claim 1
vacuum init. flucts in contract. phase
→ scale-inv. spectrum after bounce


Claim 1 vacuum init. flucts in contract. phase
→ scale-inv. spectrum after bounce
Claim 2. specific predictions. O(1) amplitude
& specific shape of 3-pt. fct.


Framework -
$ds^2 = -a^2(\eta)\left[(1+2\phi)d\eta^2 - (1-2\phi)dx^2\right]$
$\phi(x,\eta)$
$\zeta = \frac{a}{z}\delta\varphi + \phi$

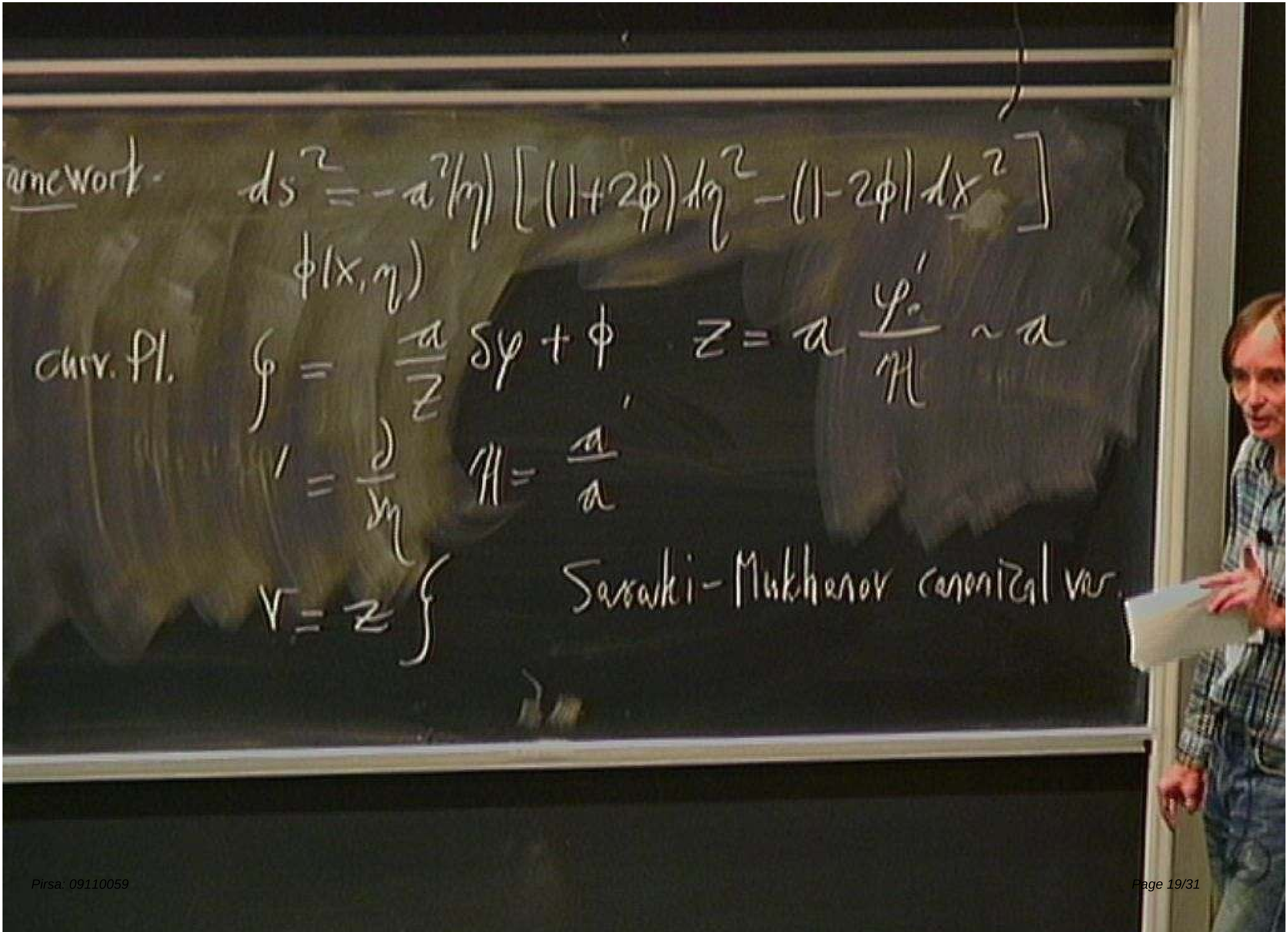
Framework:

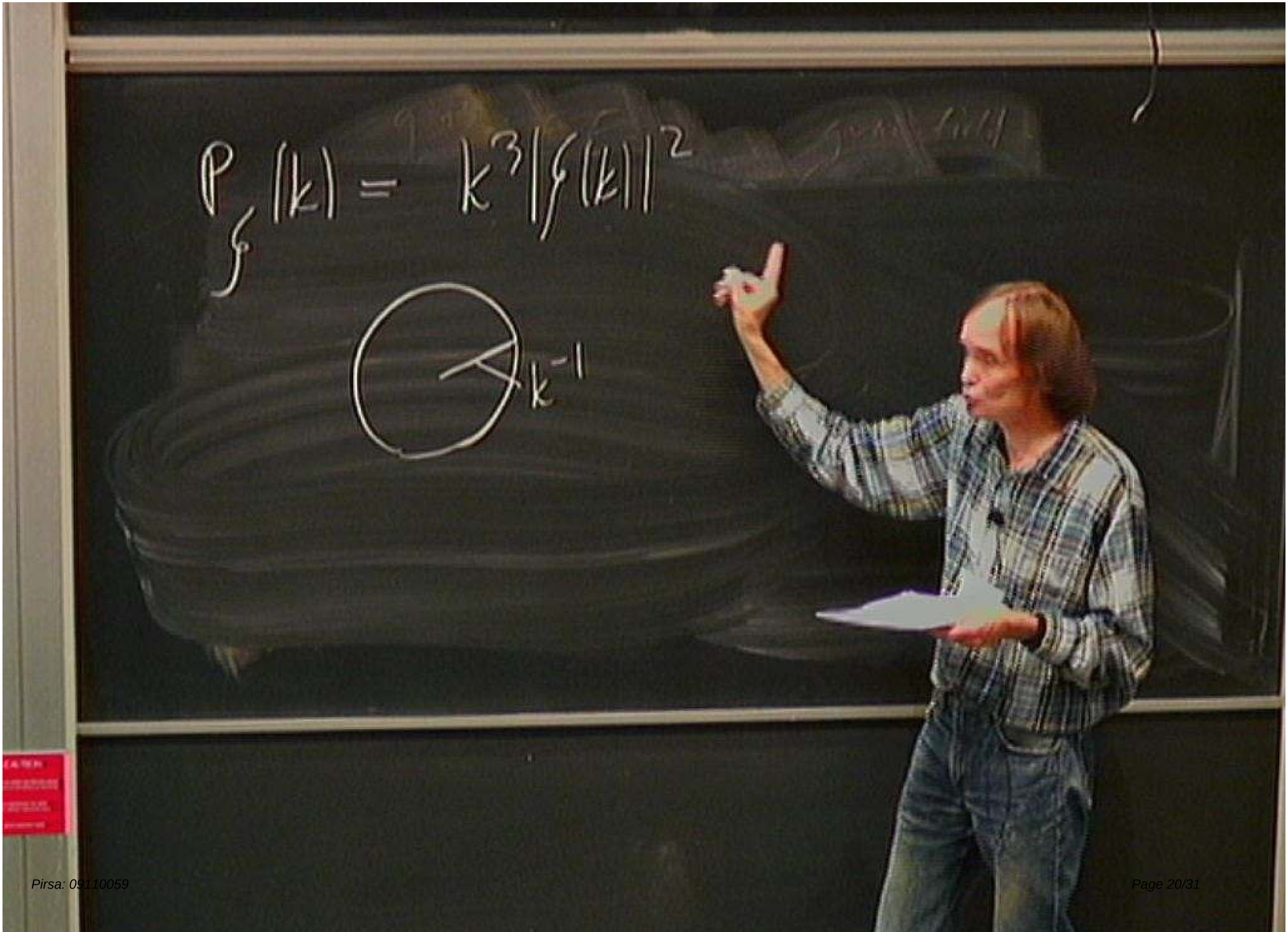
$$ds^2 = -a^2(\eta)\left[(1+2\phi)\,d\eta^2 - (1-2\phi)\,dx^2\right]$$

$$\phi(x,\eta)$$

$$\zeta = \frac{a}{z}\,\delta\varphi + \phi \qquad z = a\,\frac{\varphi_0'}{\mathcal{H}}$$

$$' = \frac{\partial}{\partial\eta} \qquad \mathcal{H} = \frac{a'}{a}$$


amework.
ds² = −a²(η) [(1+2φ) dη² − (1−2φ) dx²]
φ(x, η)
curv. Pl.
ζ = (a/z) δφ + φ
z = a φ₀′/ℋ ~ a
′ = ∂/∂η
ℋ = a′/a
v = z ζ
Sasaki-Mukhanov canonical var.


P_ζ(|k|) = k³|ζ(|k|)|²
k⁻¹

$$P_\zeta(k) = k^3 |\zeta(k)|^2 \sim k^0 \quad \text{scale-inv}$$

vacuum spectrum

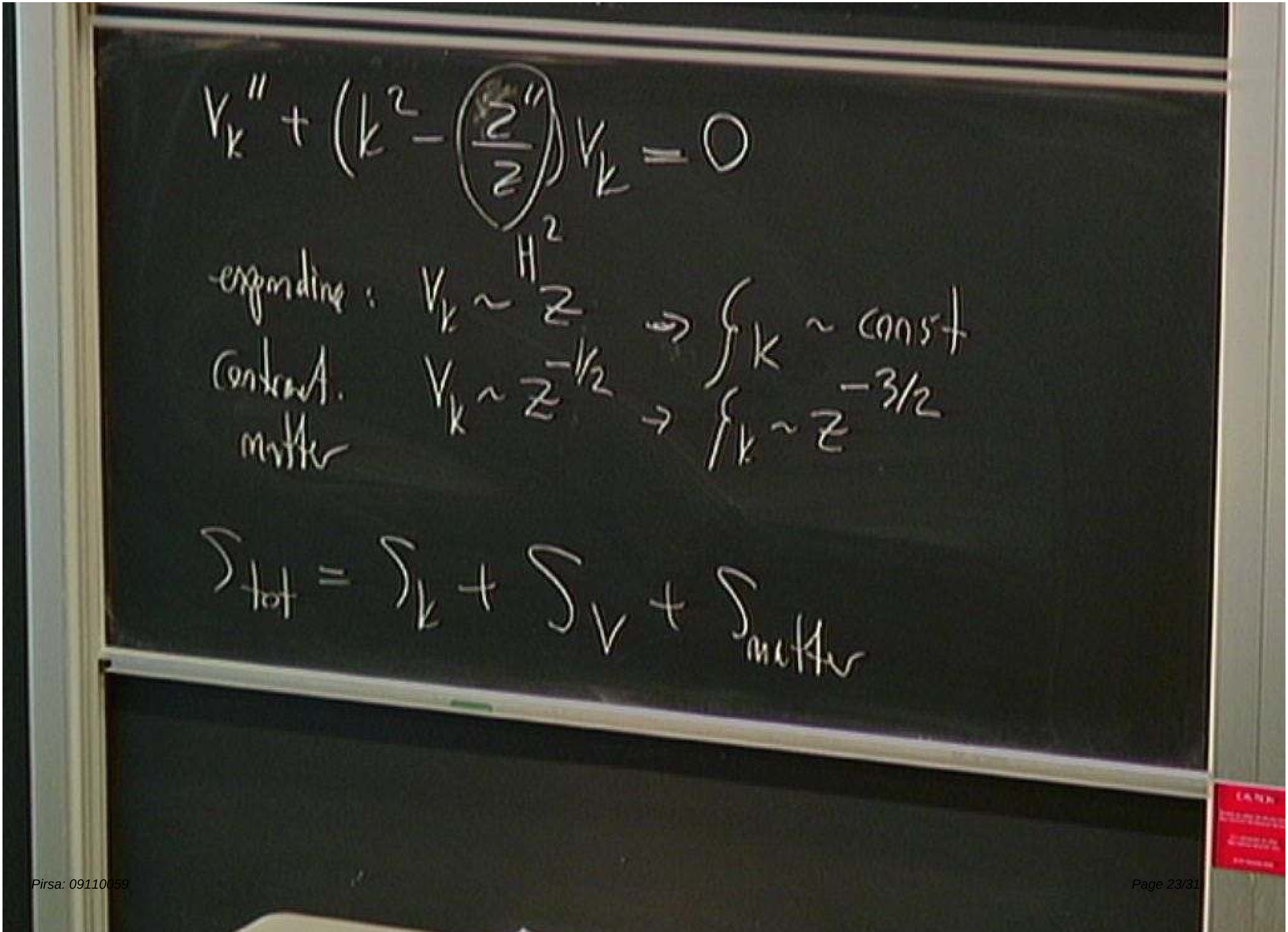
$$P_\zeta(k) \sim k^3 k^{-1} \sim k^2$$

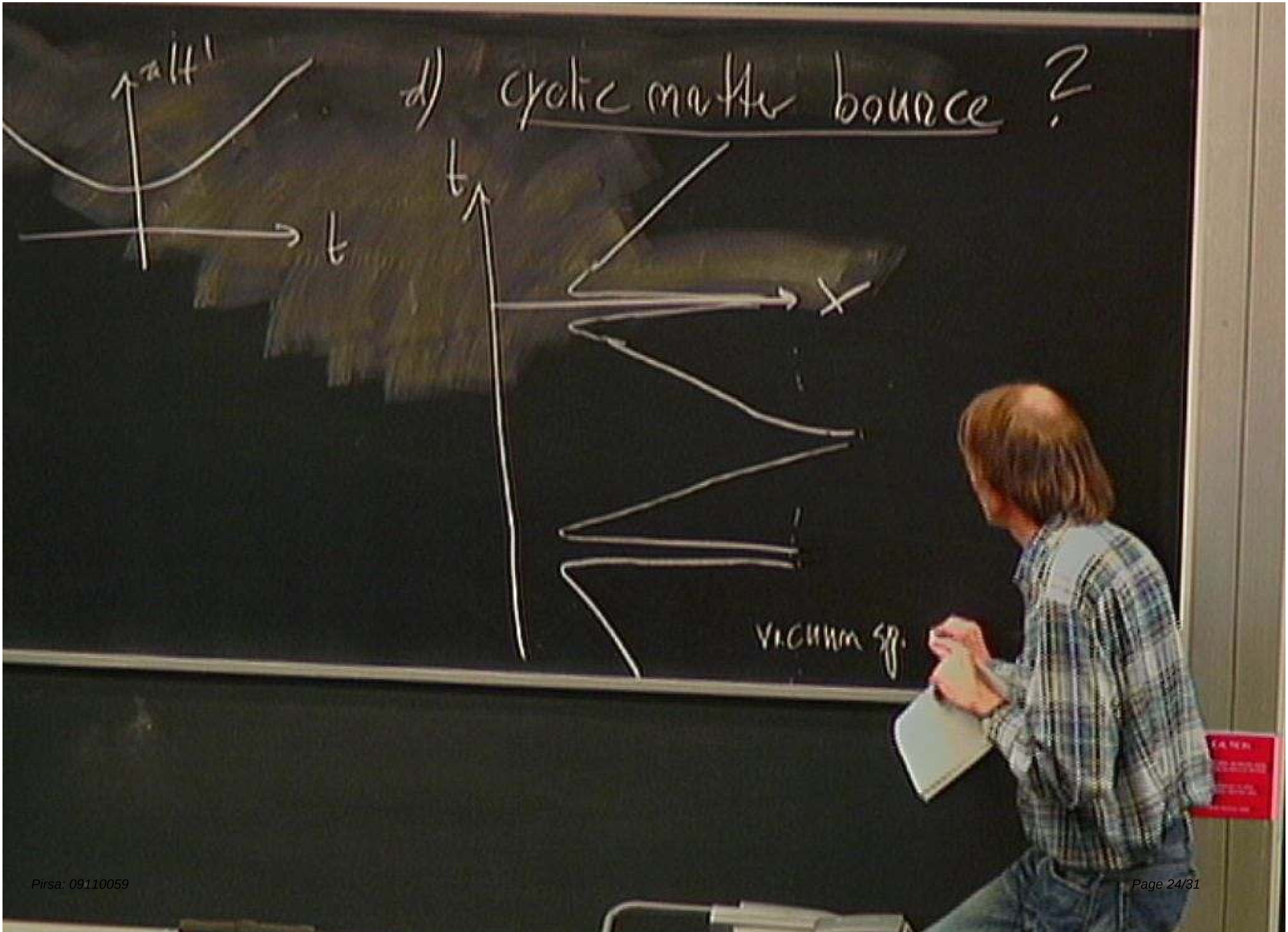
$$v_k'' + \left(k^2 - \frac{z''}{z}\right) v_k = 0$$

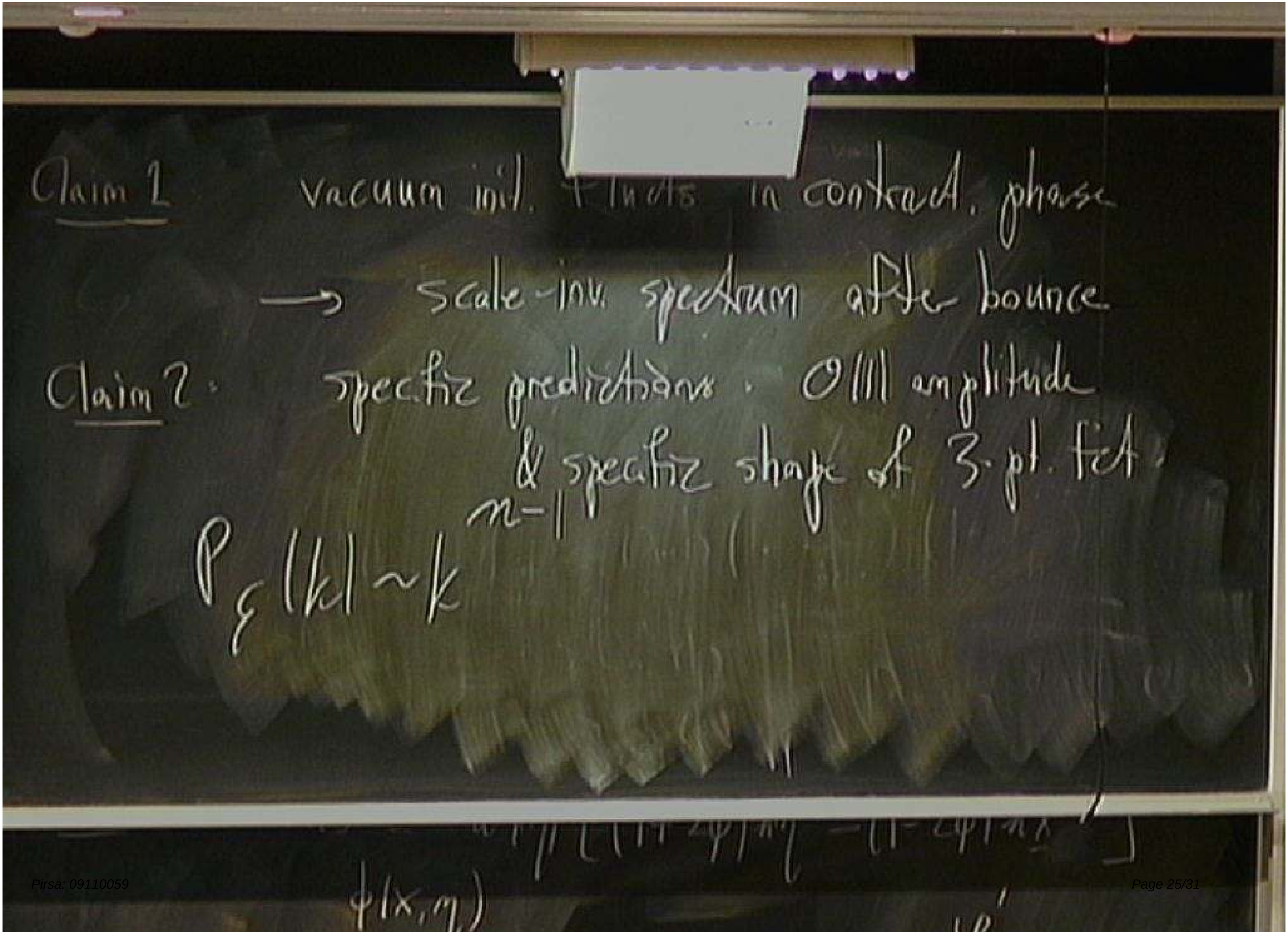
H^2

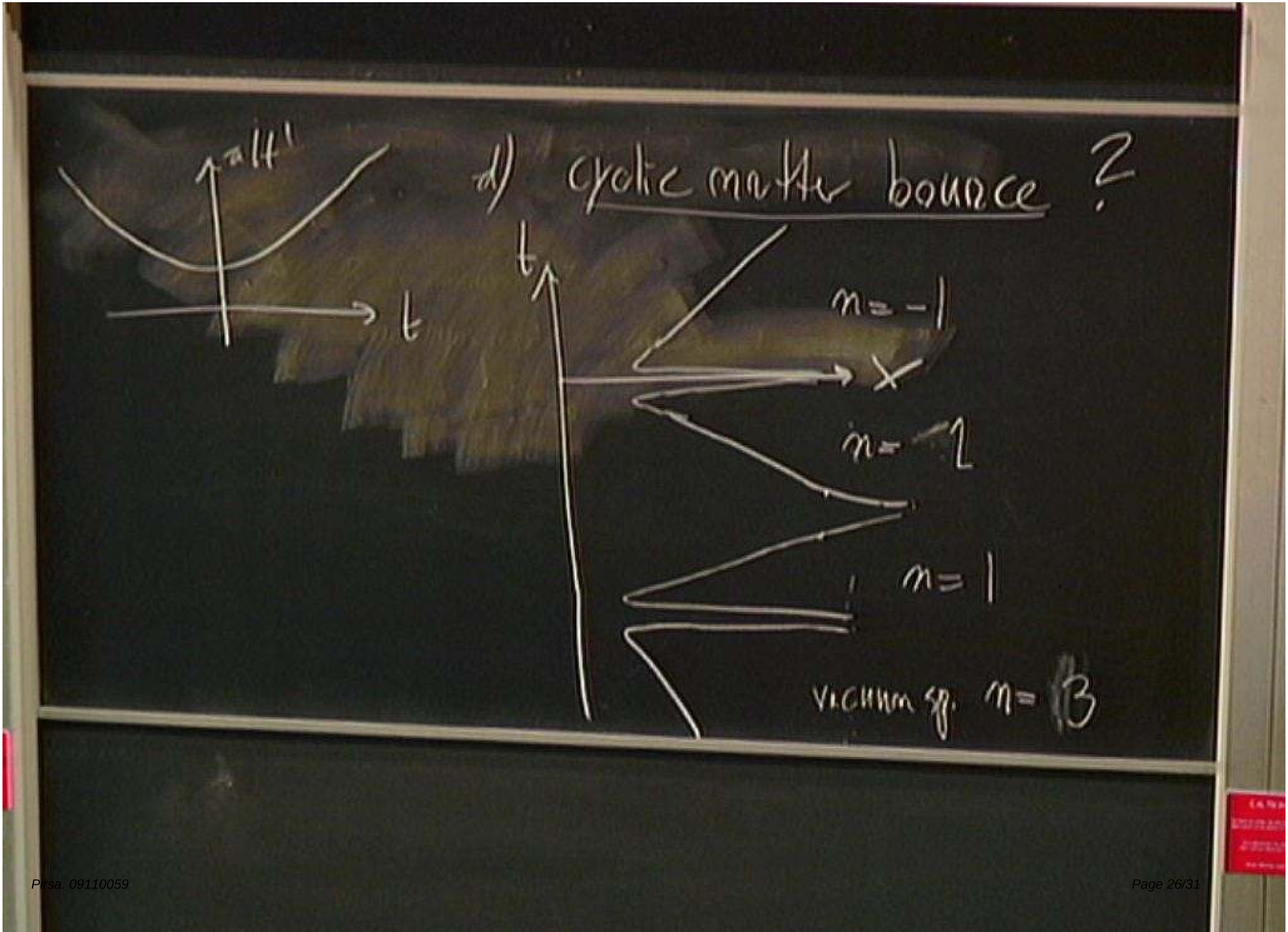
expanding: $v_k \sim z \Rightarrow \zeta_k \sim \text{const}$

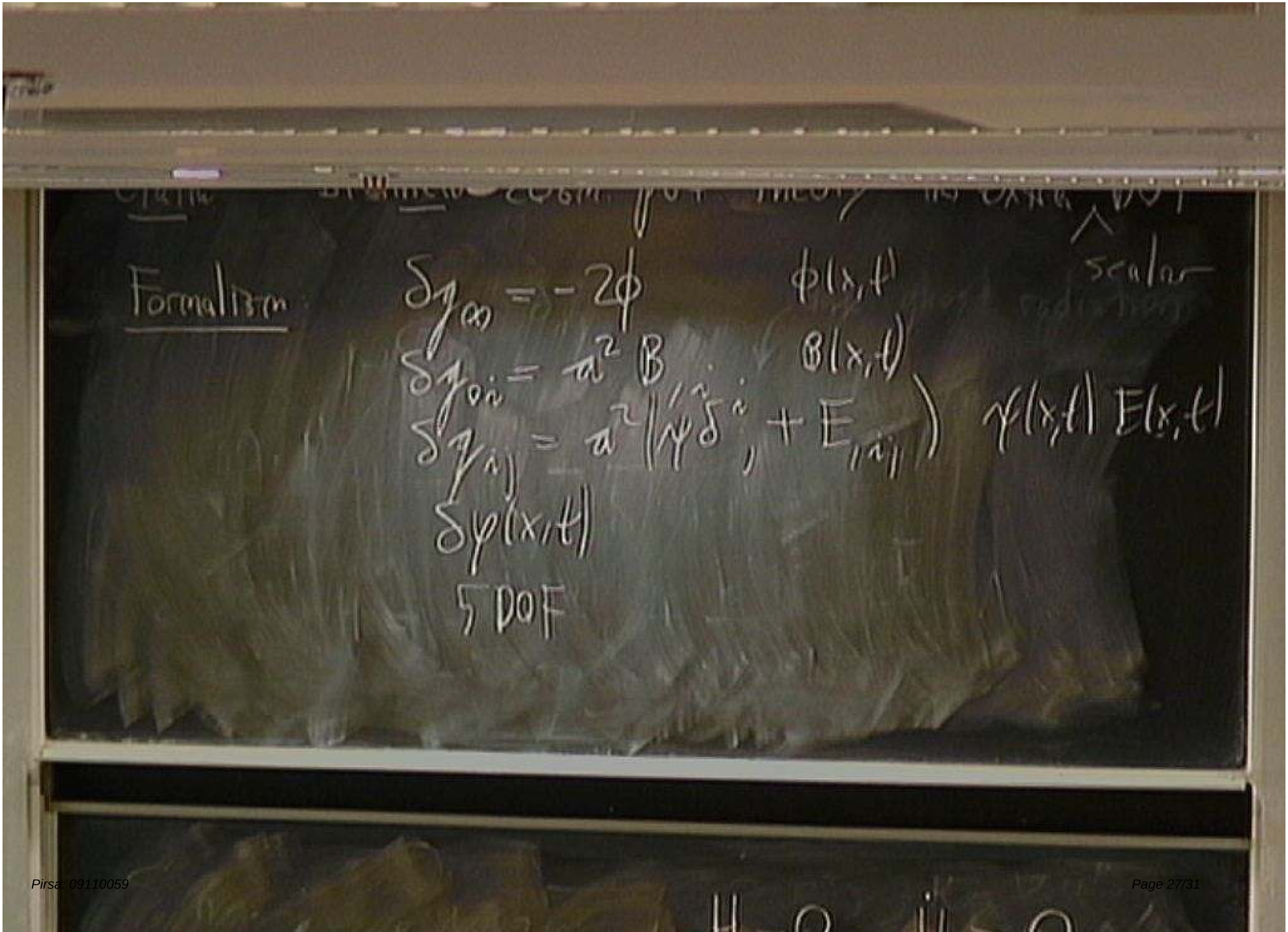
$$S_{tot} = S_k + S_V + S_{matter}$$

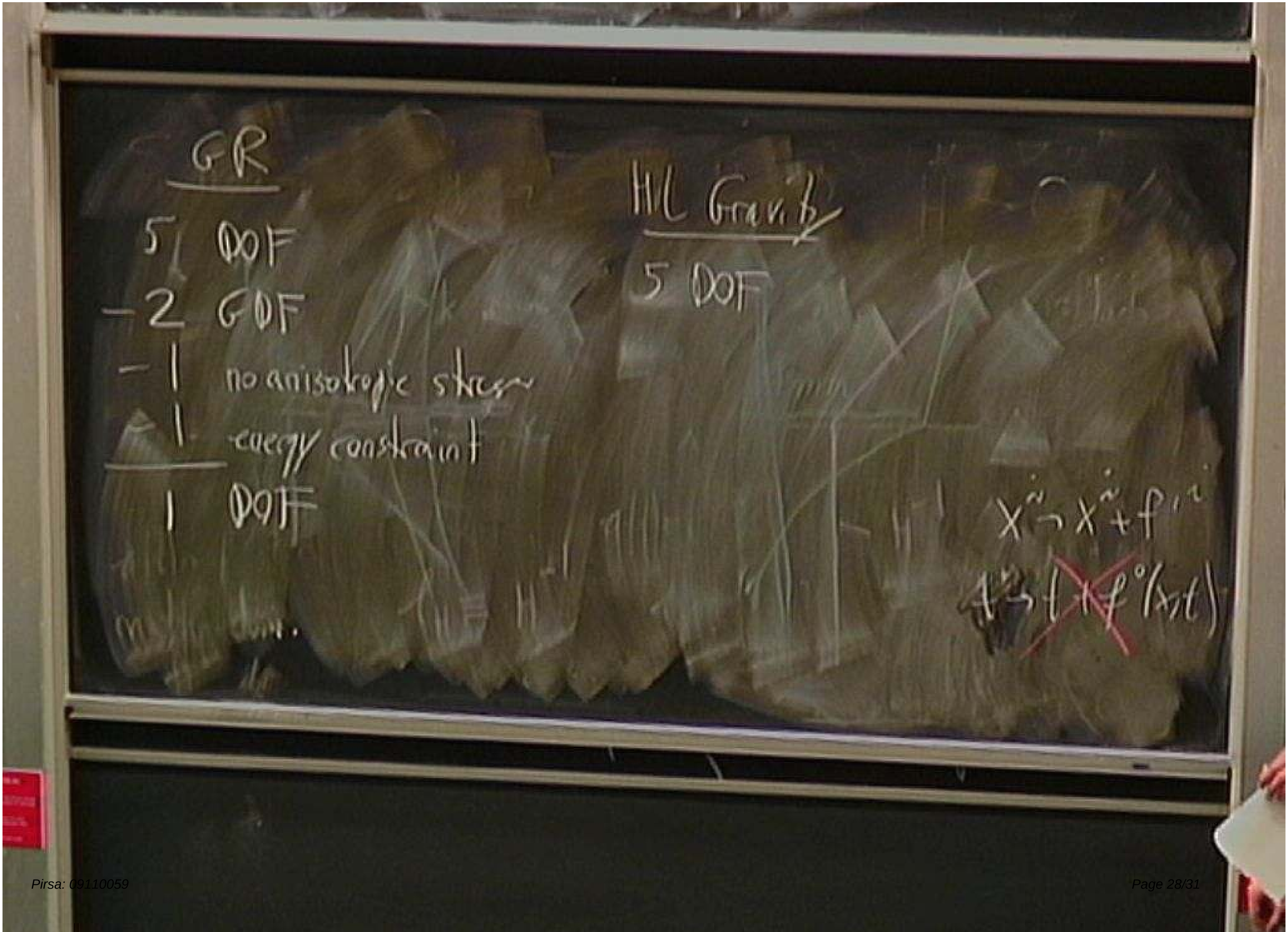

$V_k'' + \left(k^2 - \frac{z''}{z}\right) V_k = 0$
H^2
expanding: $V_k \sim z \Rightarrow \zeta_k \sim const$
contract. matter $V_k \sim z^{-1/2} \rightarrow \zeta_k \sim z^{-3/2}$
$\zeta_{tot} = \zeta_k + \zeta_V + \zeta_{matter}$

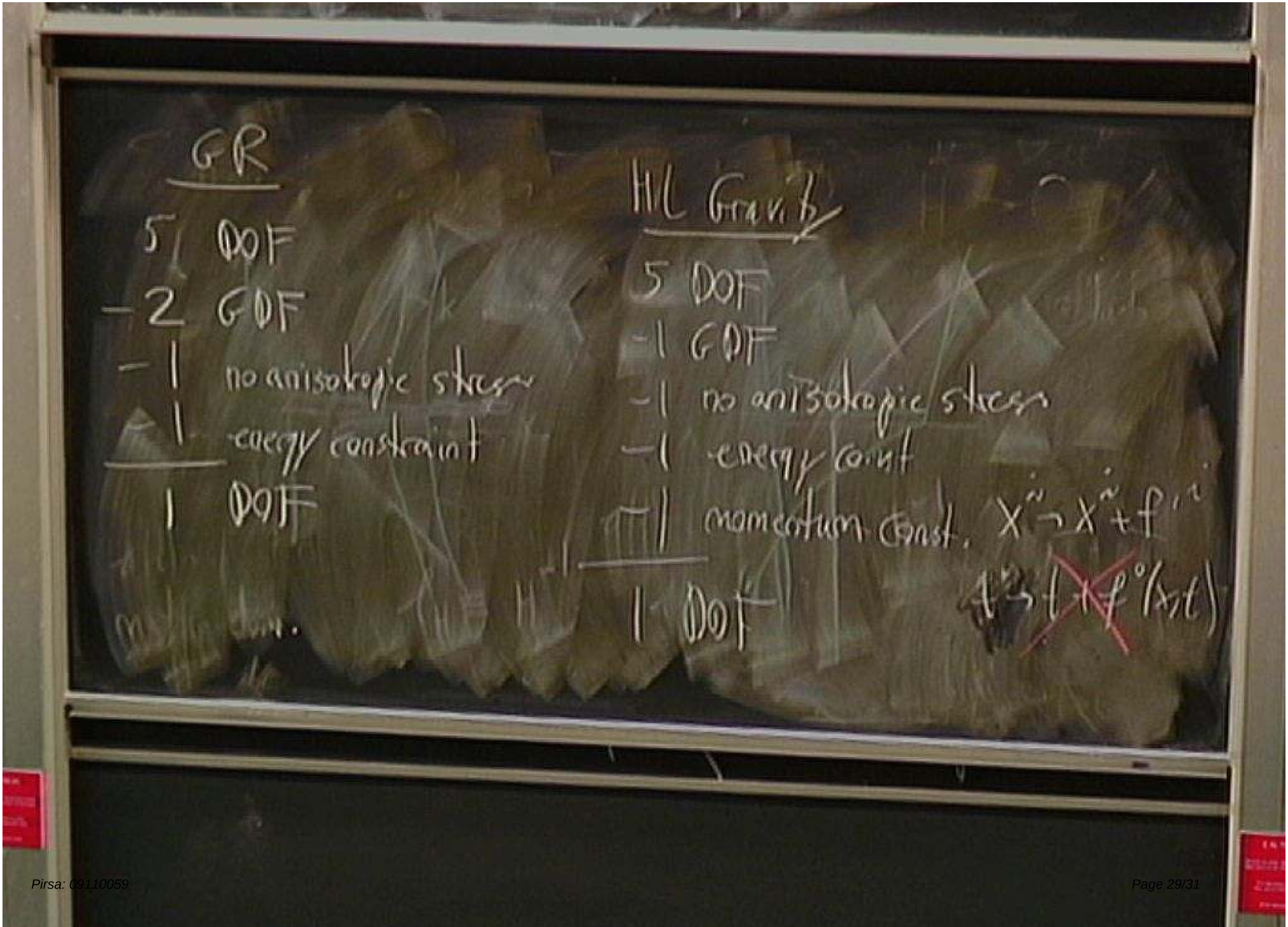

a(t)
t
d) cyclic matter bounce ?
t
x
vacuum eq.


Claim 1 vacuum init. fluct. in contract. phase
→ scale-inv. spectrum after bounce
Claim 2: specific predictions: O(1) amplitude
& specific shape of 3-pt. fct.
$P_\xi(k) \sim k^{n-1}$


d) cyclic matter bounce ?
t
x
n = -1
n = 1


Formalism
δg00 = -2φ
φ(x,t)
δg0i = a² B
B(x,t)
δgij = a²(ψδij + E,ij)
ψ(x,t) E(x,t)
δφ(x,t)
5 DOF
scalar

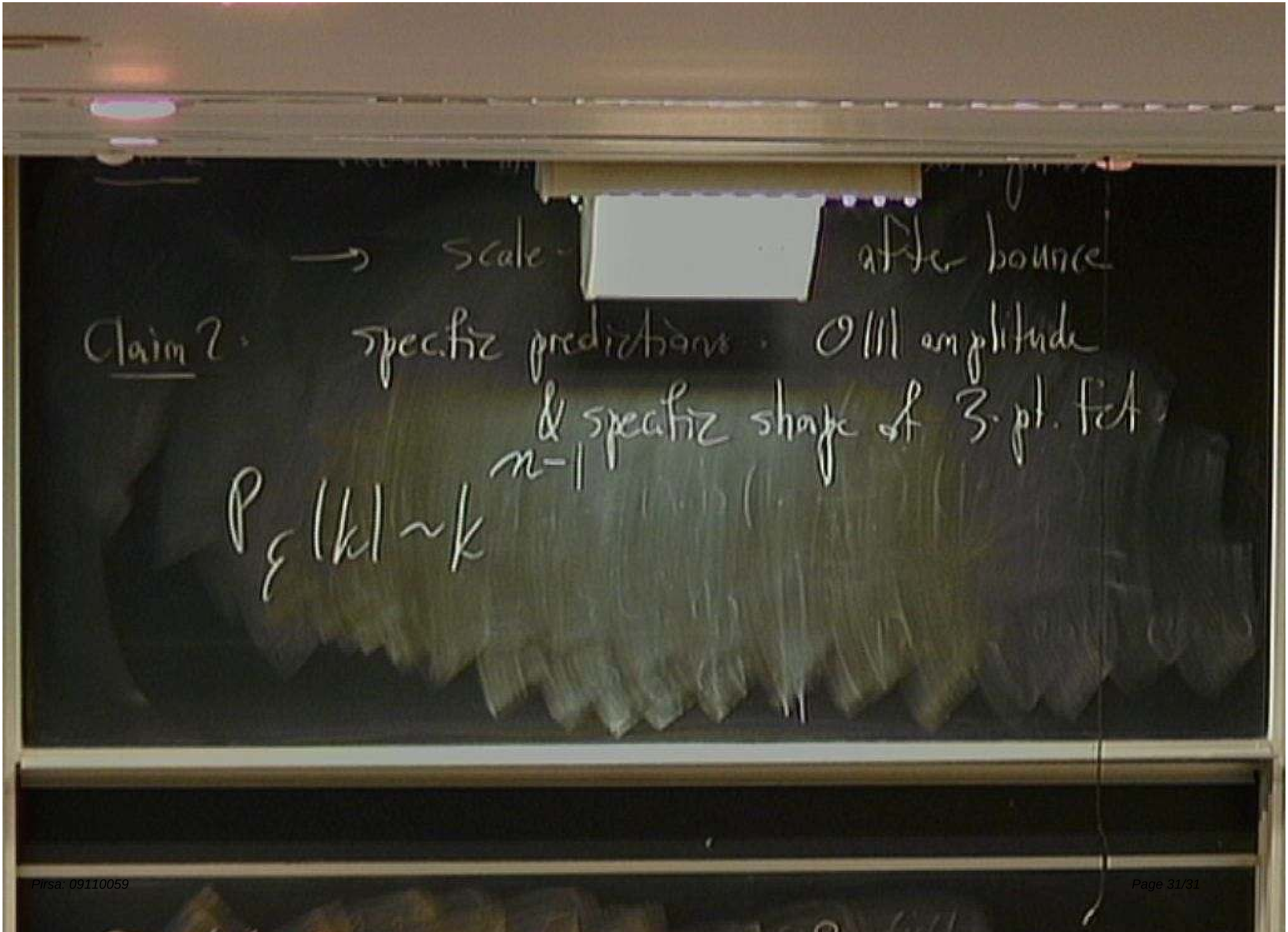

GR
5 DOF
−2 GDF
−1 no anisotropic stress
1 energy constraint
1 DOF
HL Gravity
5 DOF


GR
5 DOF
− 2 GDF
− 1 no anisotropic stress
− 1 energy constraint
1 DOF
H-L Gravity
5 DOF
−1 GDF
−1 no anisotropic stress
−1 energy const
−1 momentum const. X → X + f
t → t + f⁰(x,t)
1 DOF

step 1 gauge choice $E=0$

step 2 $\phi =$

$$B = \frac{f(\psi, \delta\varphi)}{32H^2(3\lambda-1) - 4K^2(\lambda-1)\dot{\varphi}_0^2}$$


→ scale-
after bounce
Claim 2: specific predictions: O(1) amplitude
& specific shape of 3-pt. fct.
$P_\xi(k) \sim k^{n-1}$