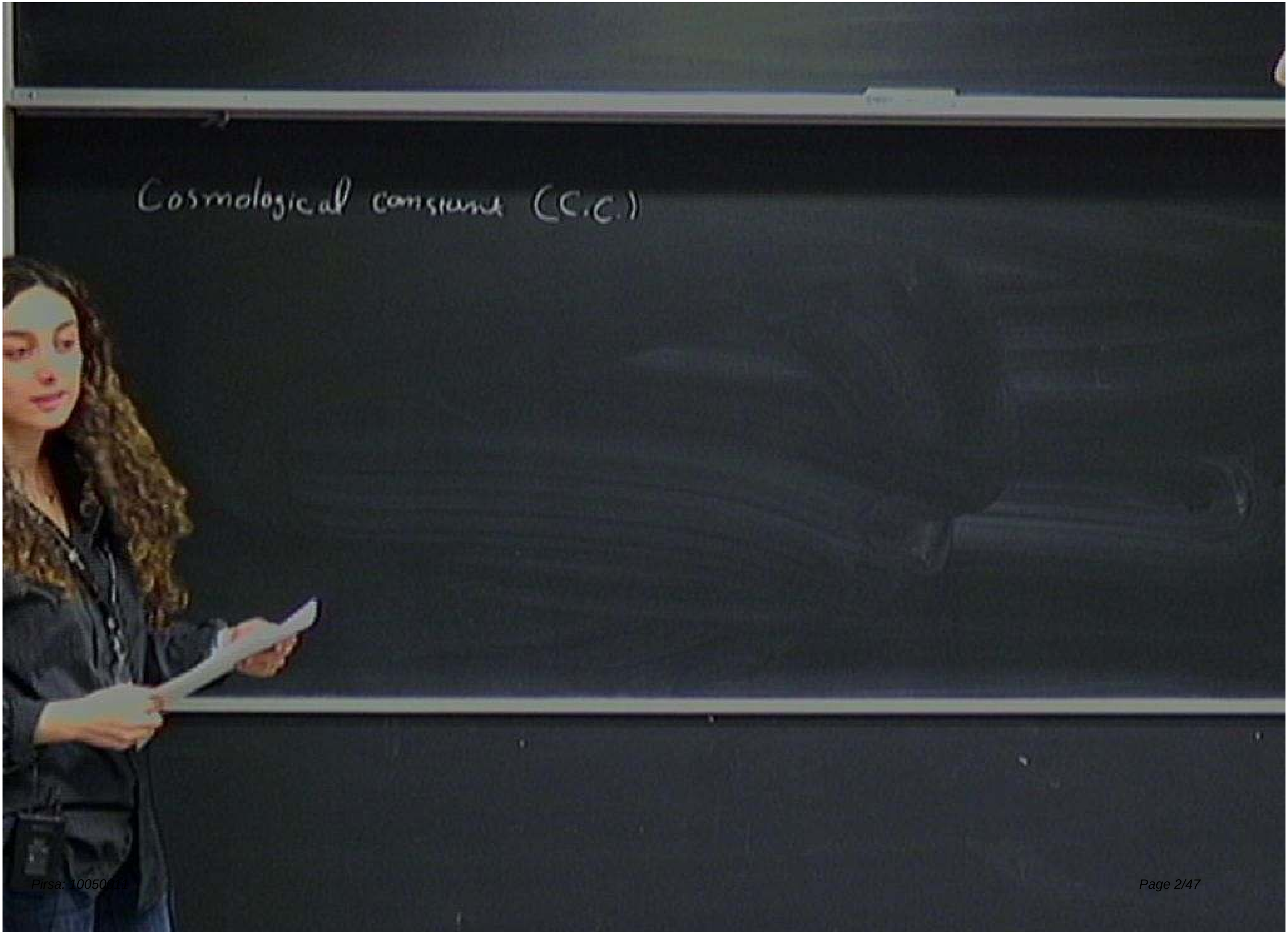
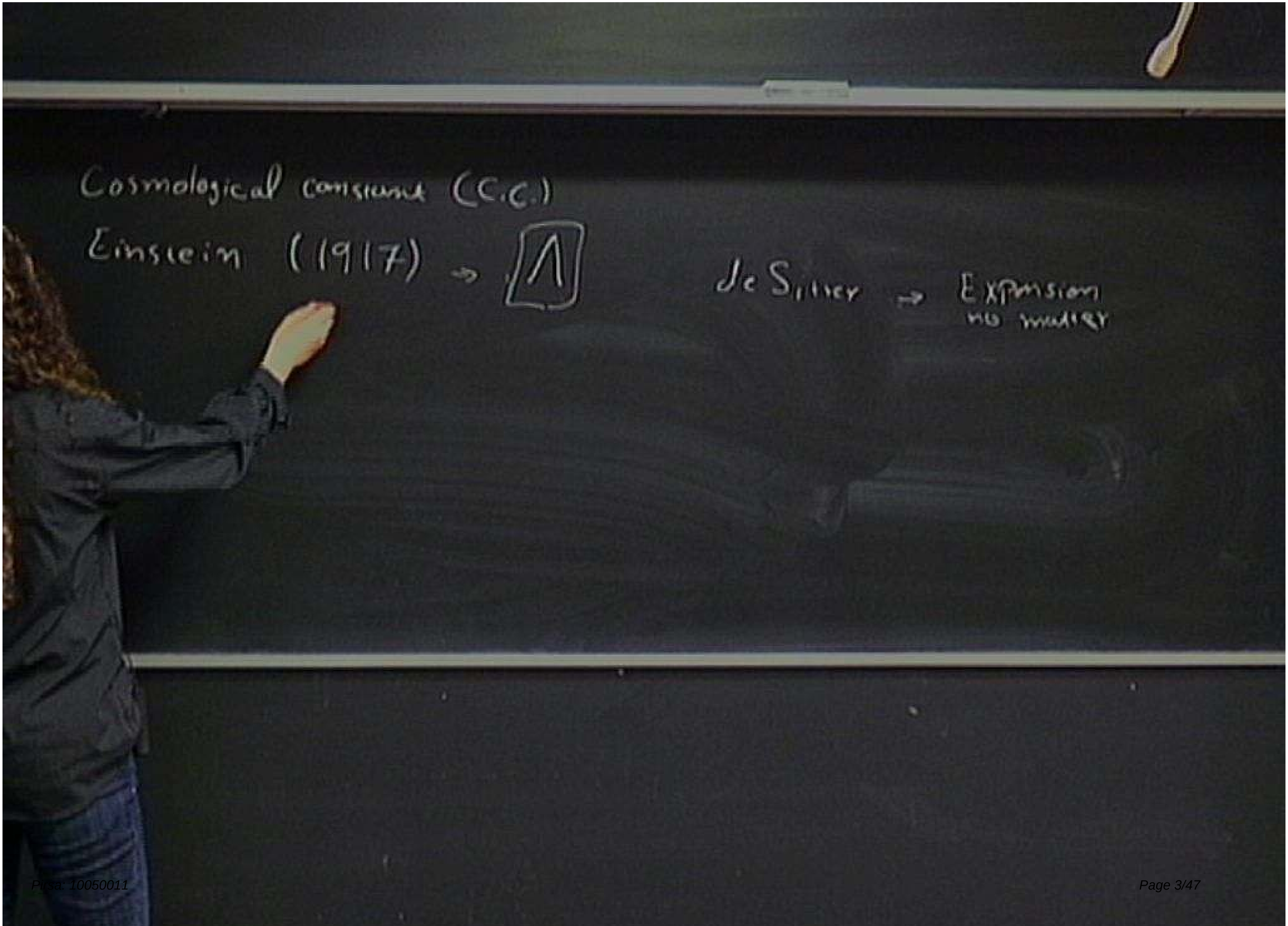
Title: Review on Proposed Models for Dark Energy 1

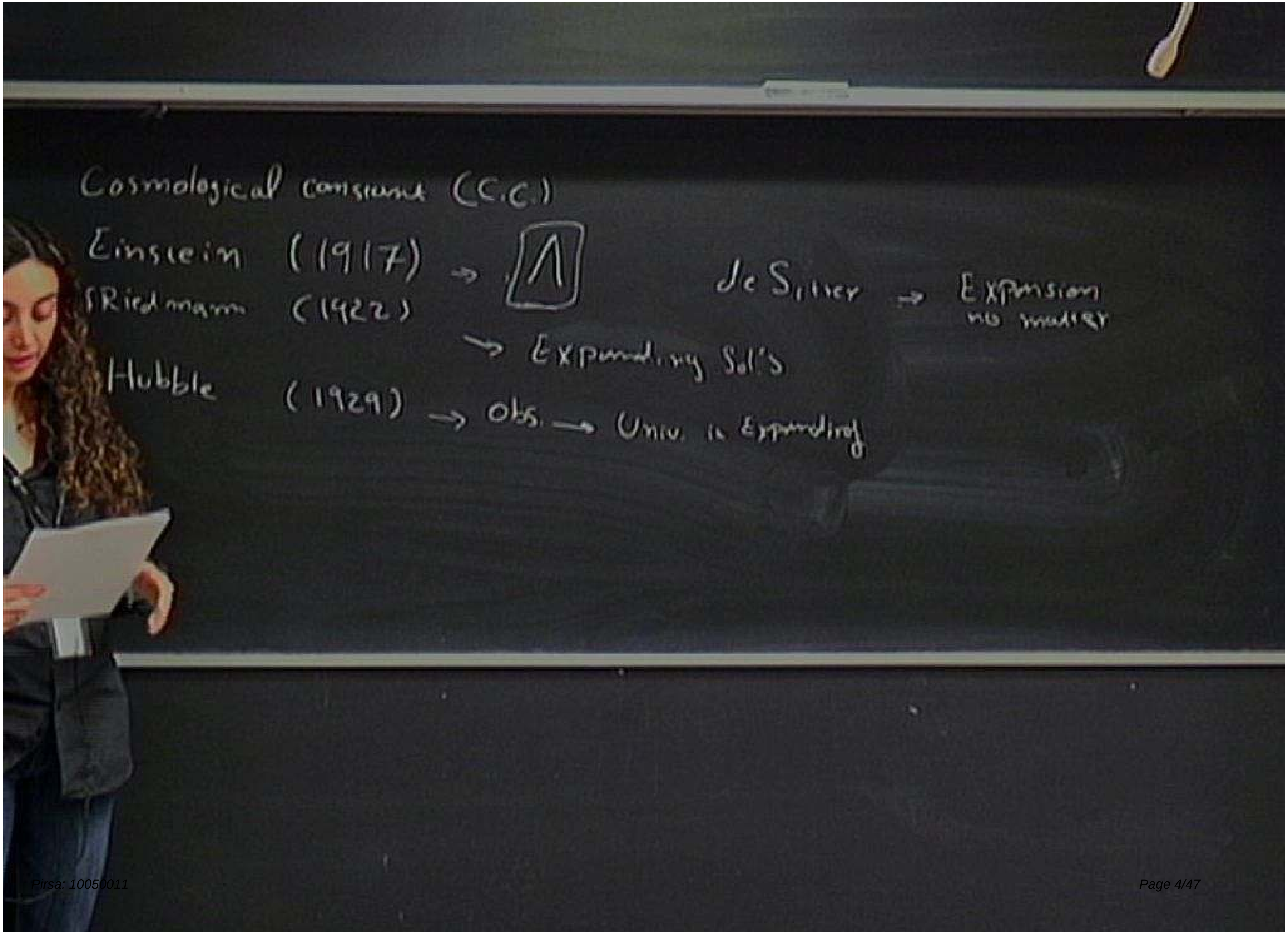
Date: May 05, 2010 10:30 AM

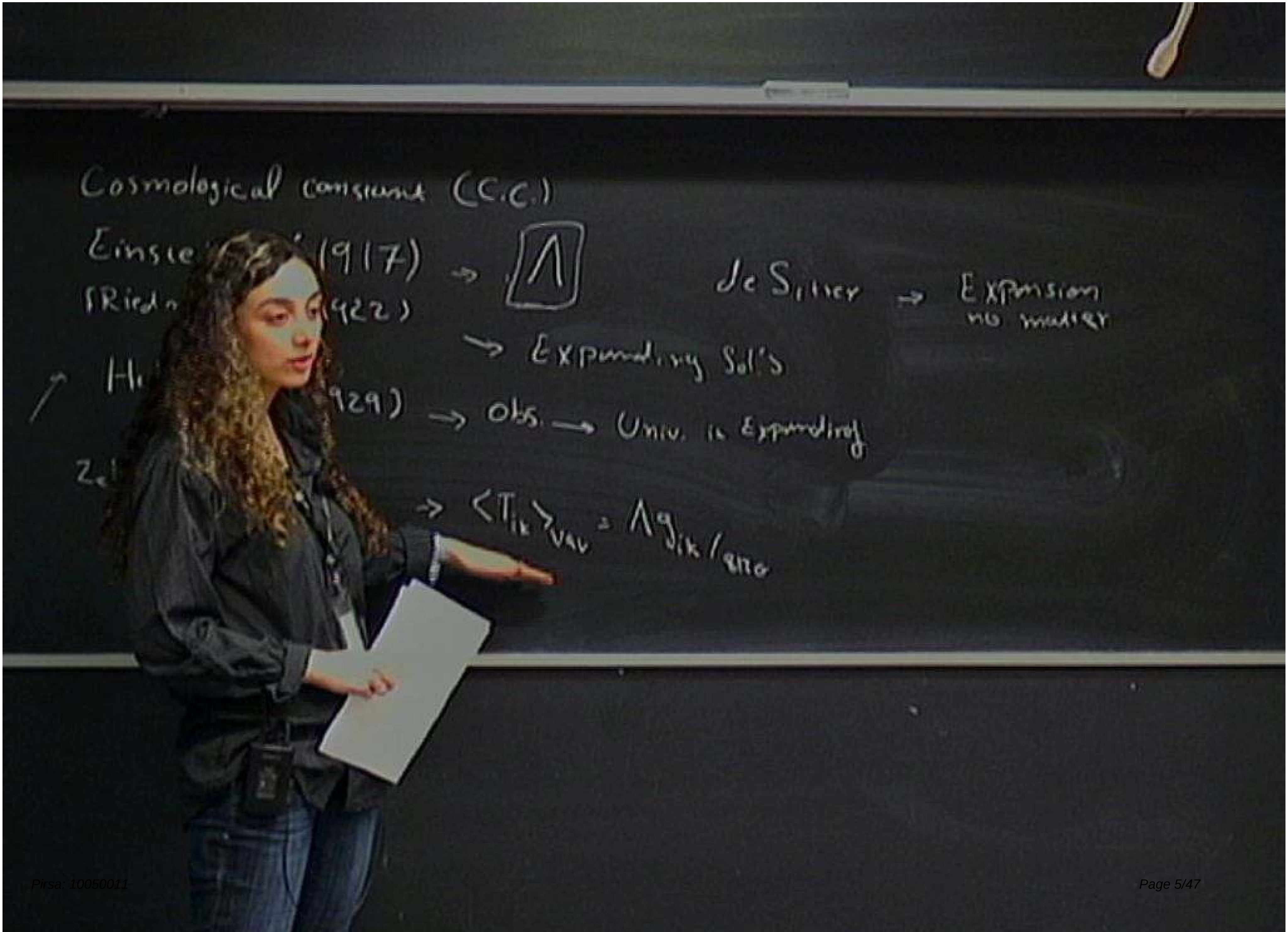
URL: http://pirsa.org/10050011

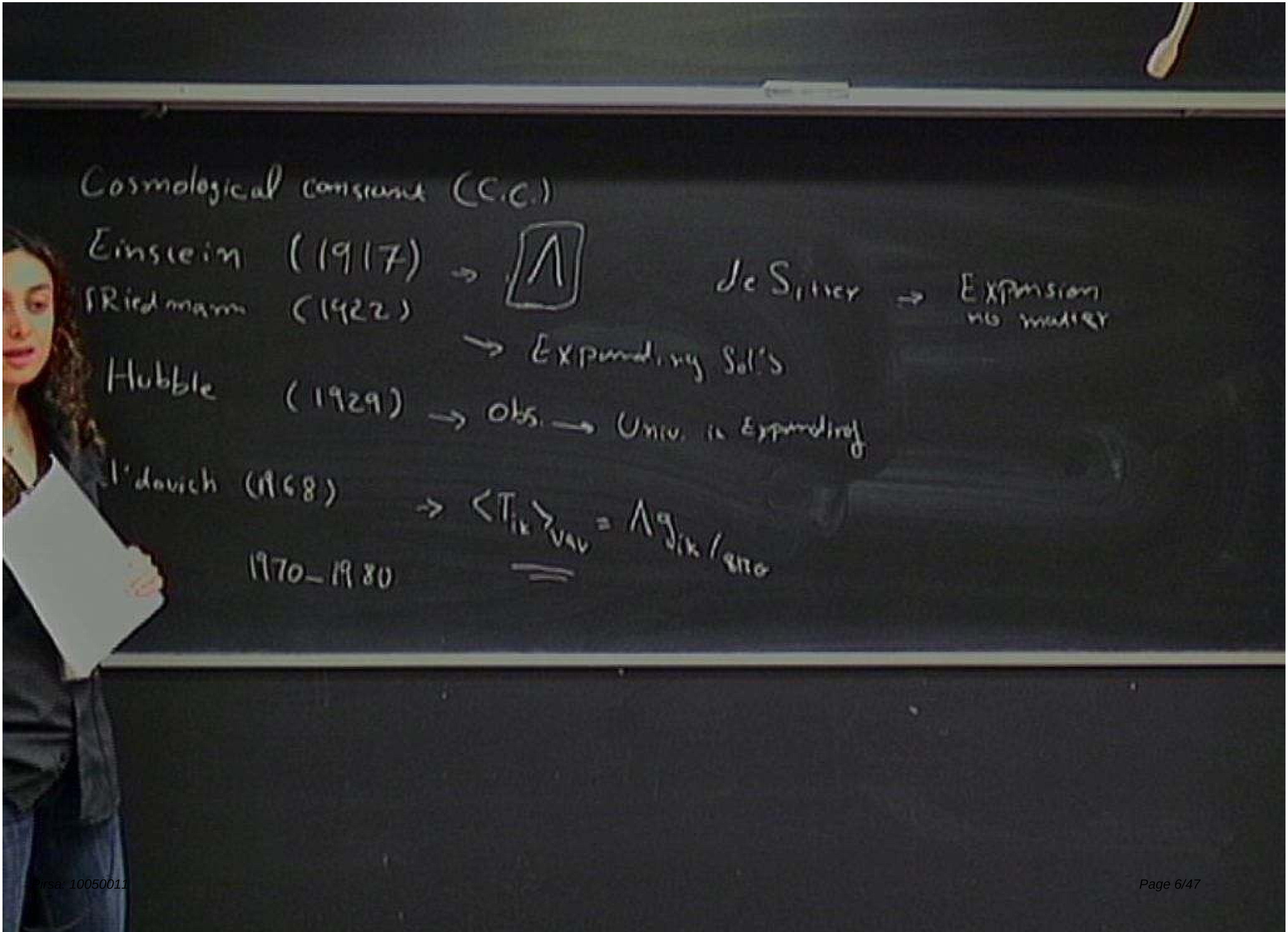
Abstract:

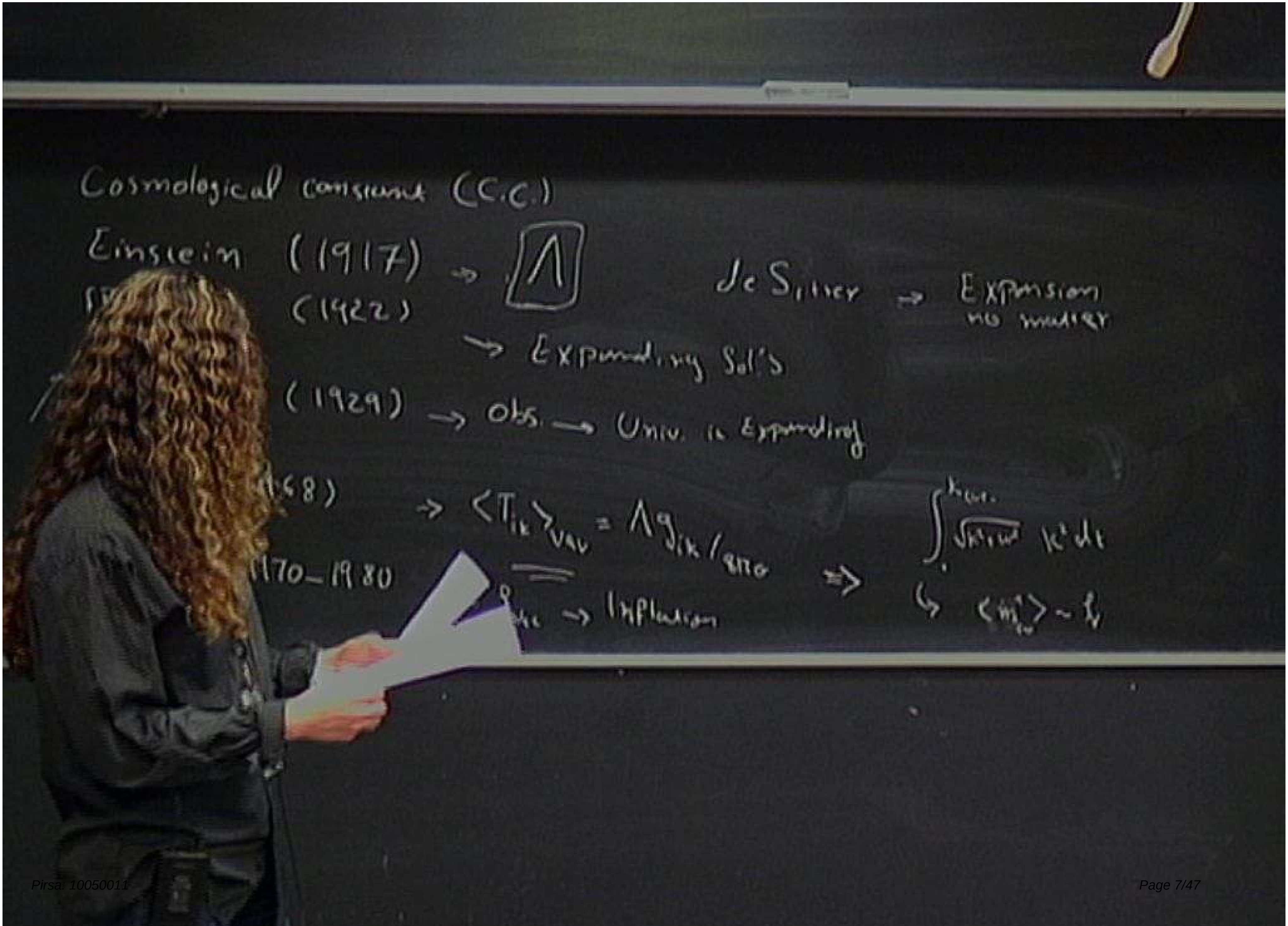

Cosmological constant (C.C.)

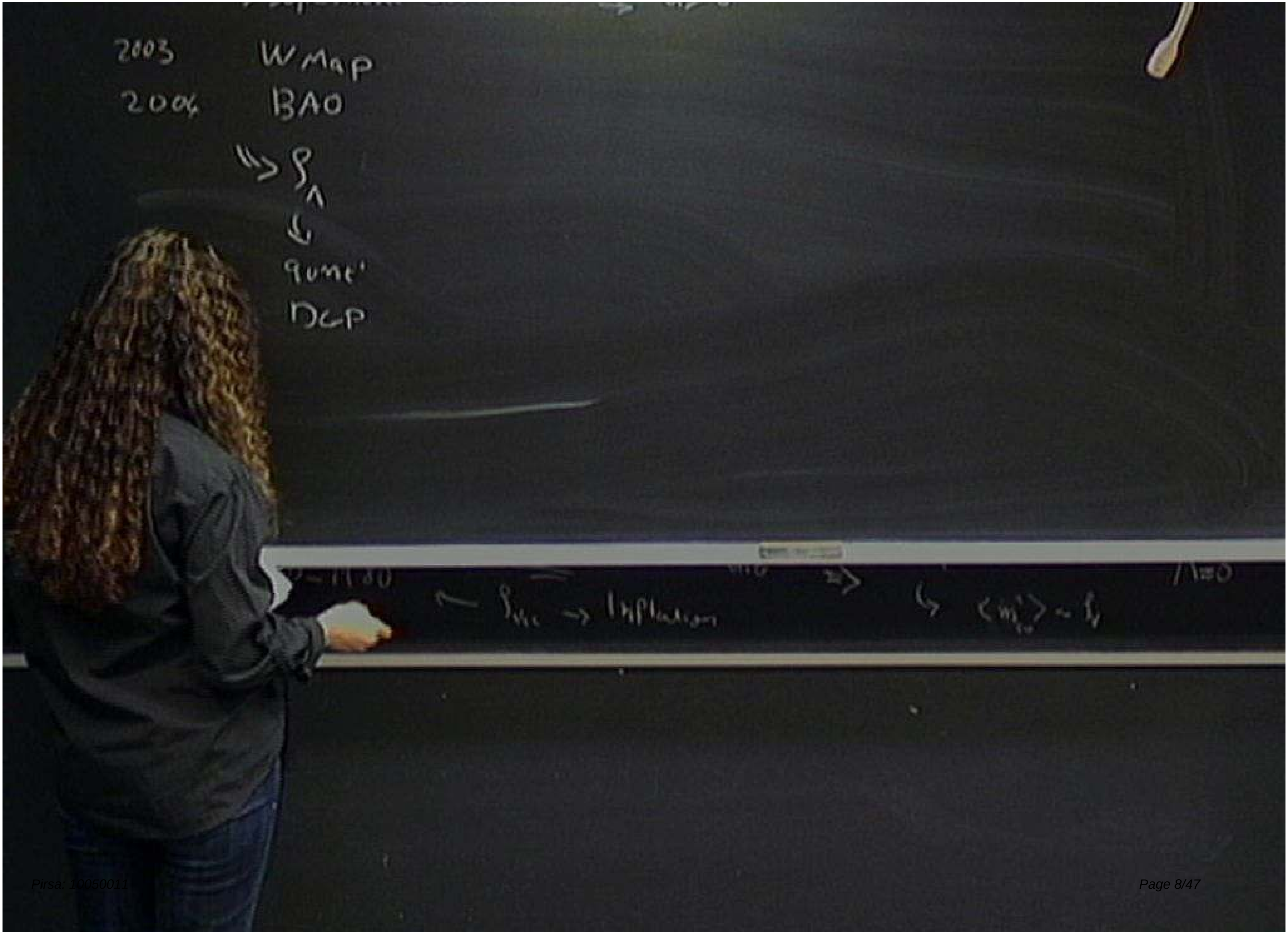

Cosmological constant (C.C.)
Einstein (1917) → Λ
de Sitter → Expansion
no matter

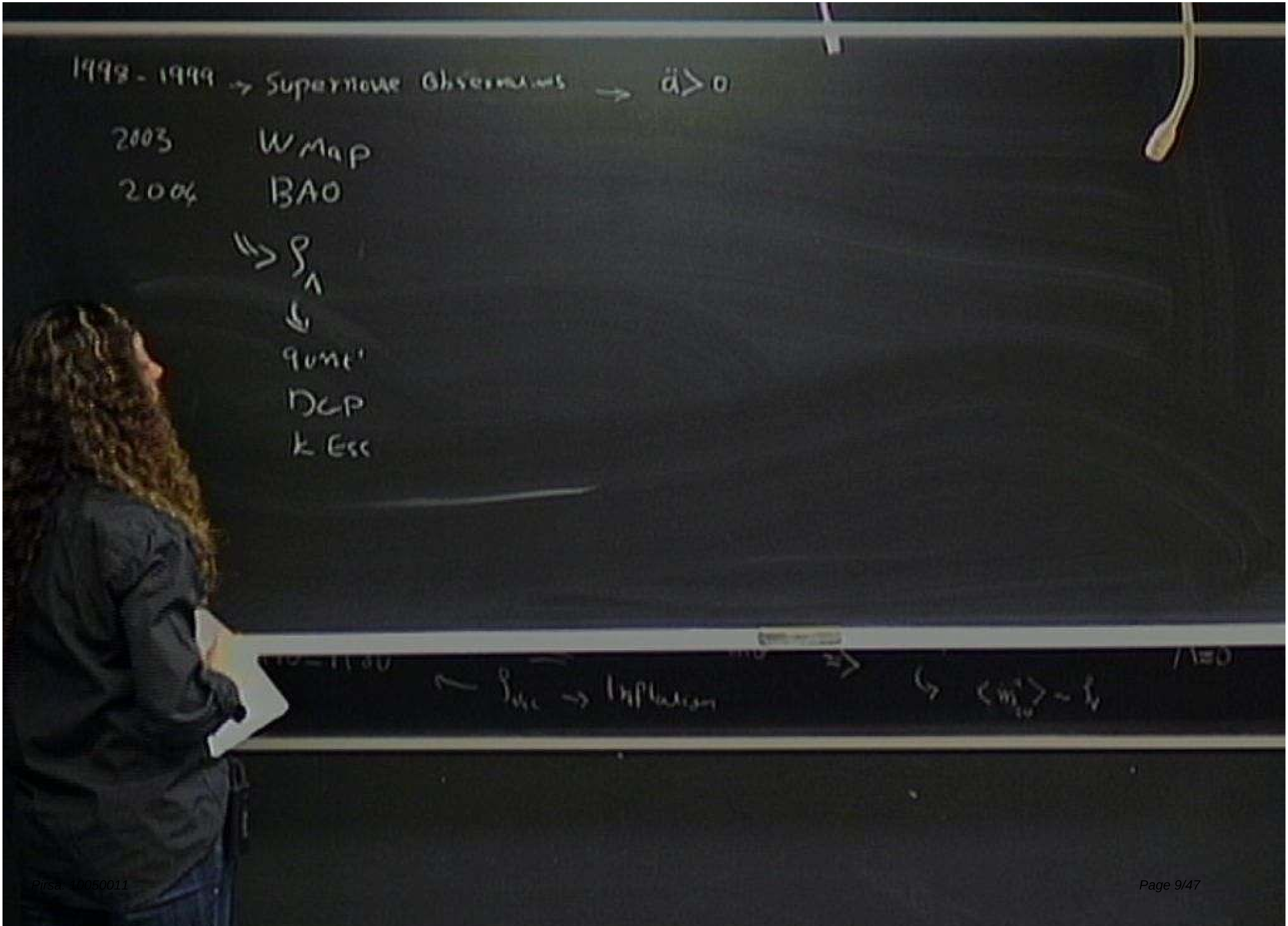

Cosmological constant (C.C.)
Einstein (1917) → Λ
Friedmann (1922)
→ Expanding Sol's
Hubble (1929) → Obs. → Univ. is Expanding
de Sitter → Expansion
no matter

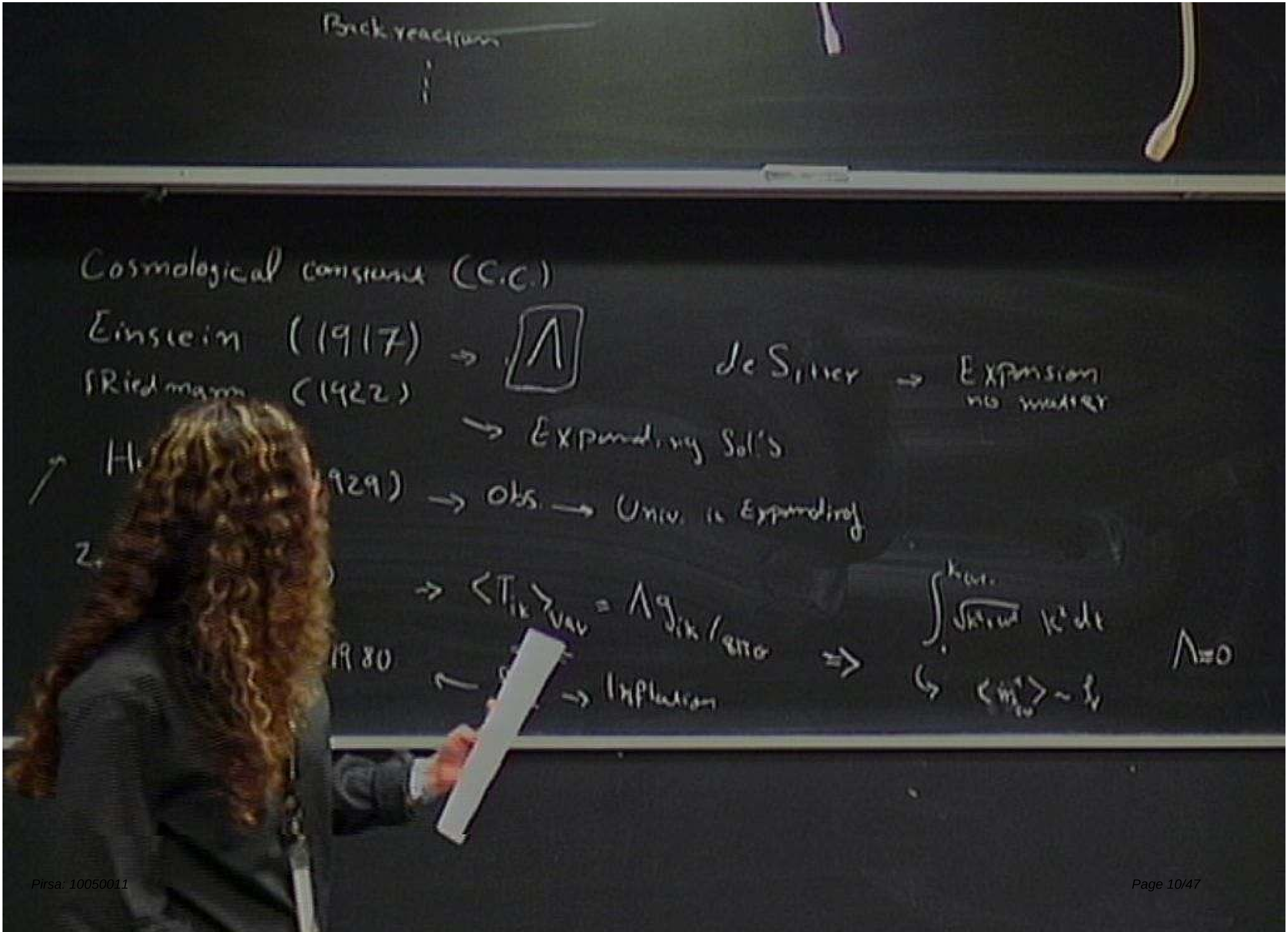

Cosmological constant (C.C.)
Λ
de Sitter → Expansion
no matter
→ Expanding Sol's
→ Obs. → Univ. is Expanding
→ <T_ik>_VAC = Λ g_ik / 8πG

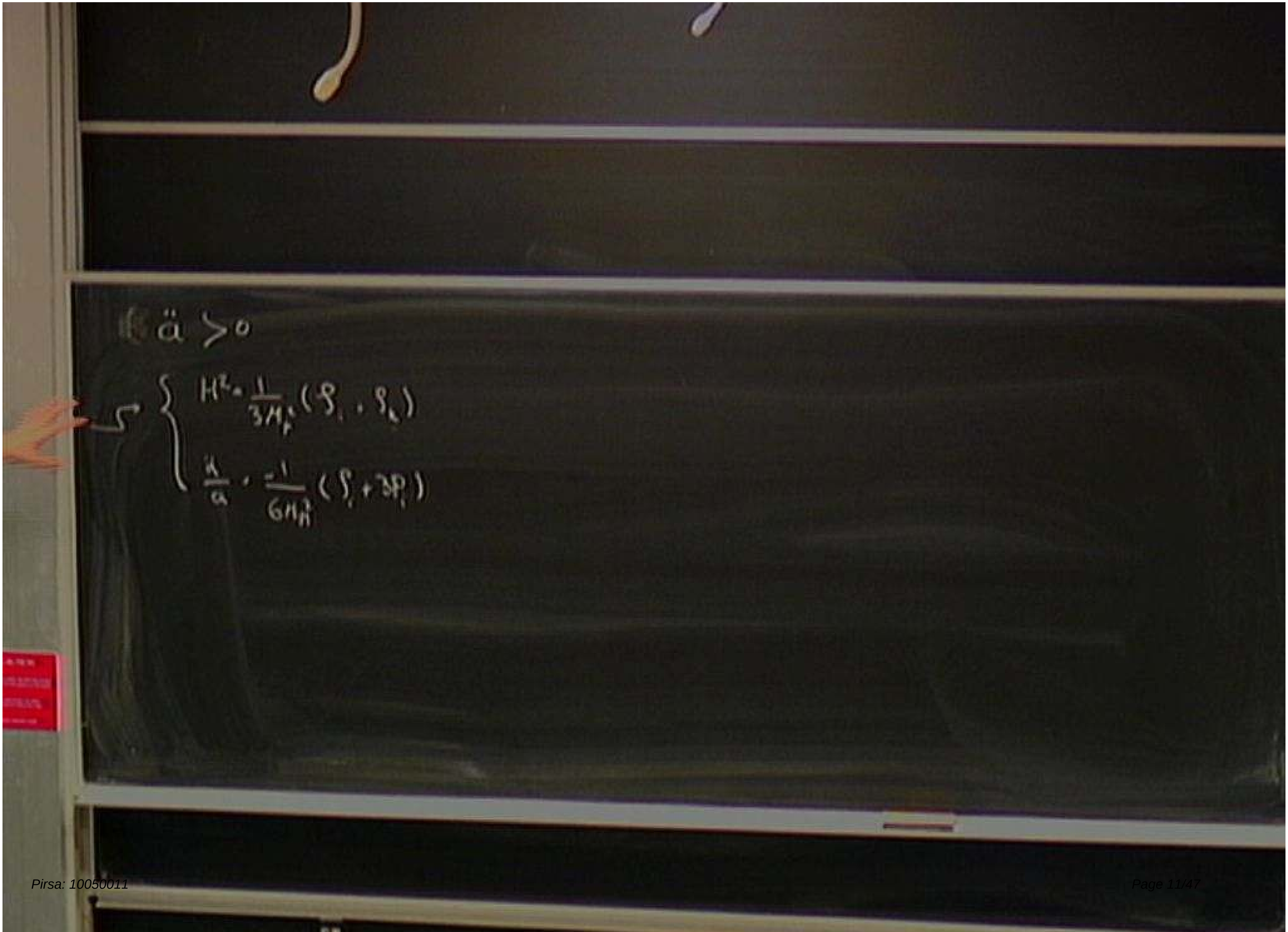

Cosmological constant (C.C.)
Einstein (1917) → Λ
de Sitter → Expansion
no matter
Friedmann (1922)
→ Expanding Sol's
Hubble (1929) → Obs. → Univ. is Expanding
l'dovich (1968)
→ <T_ik>_vac = Λ g_ik / 8πG
1970–1980

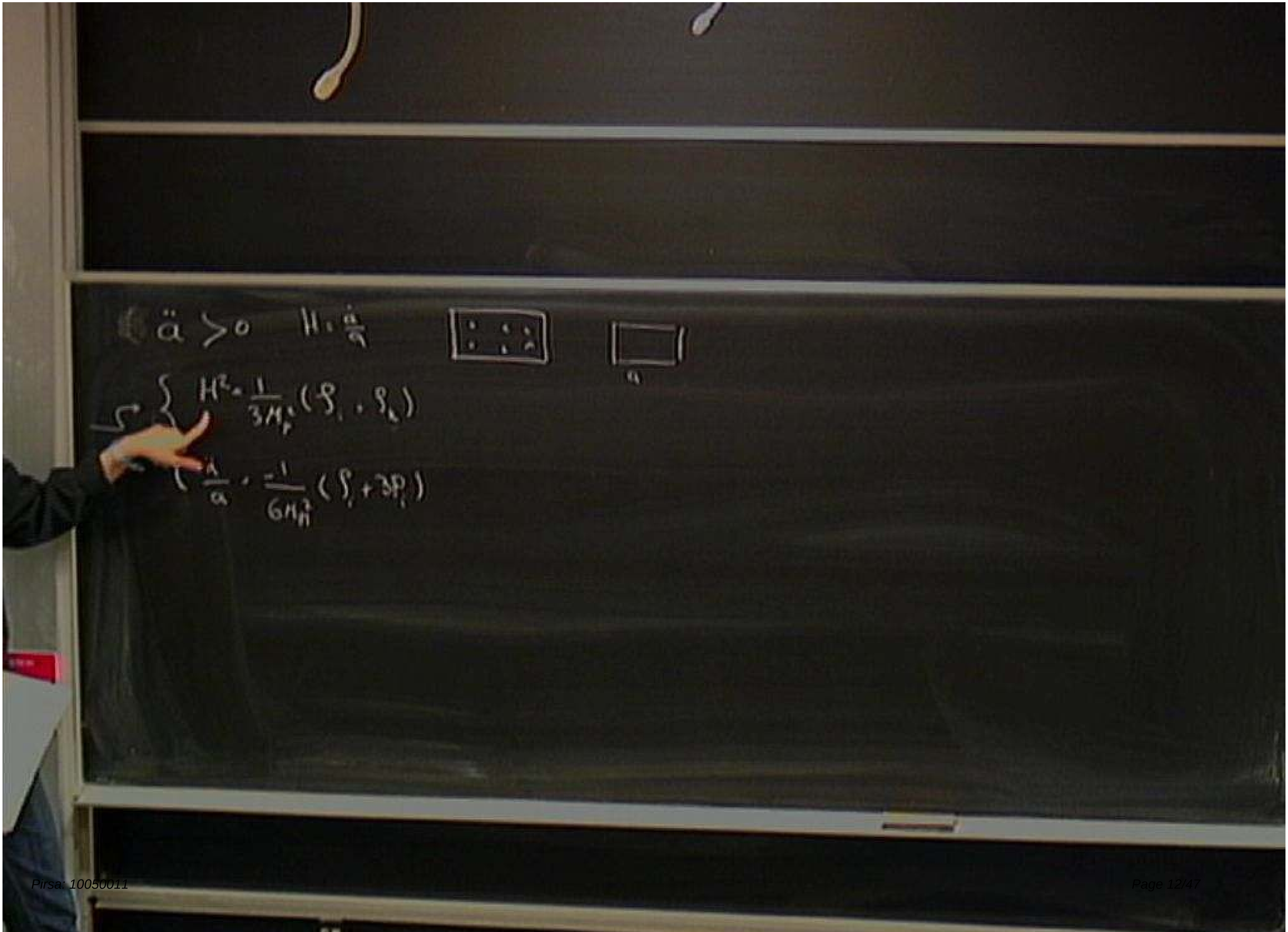

Cosmological constant (C.C.)
Einstein (1917) → Λ
de Sitter → Expansion
no matter
(1922)
→ Expanding Sol's
(1929) → Obs. → Univ. is Expanding
1970–1980

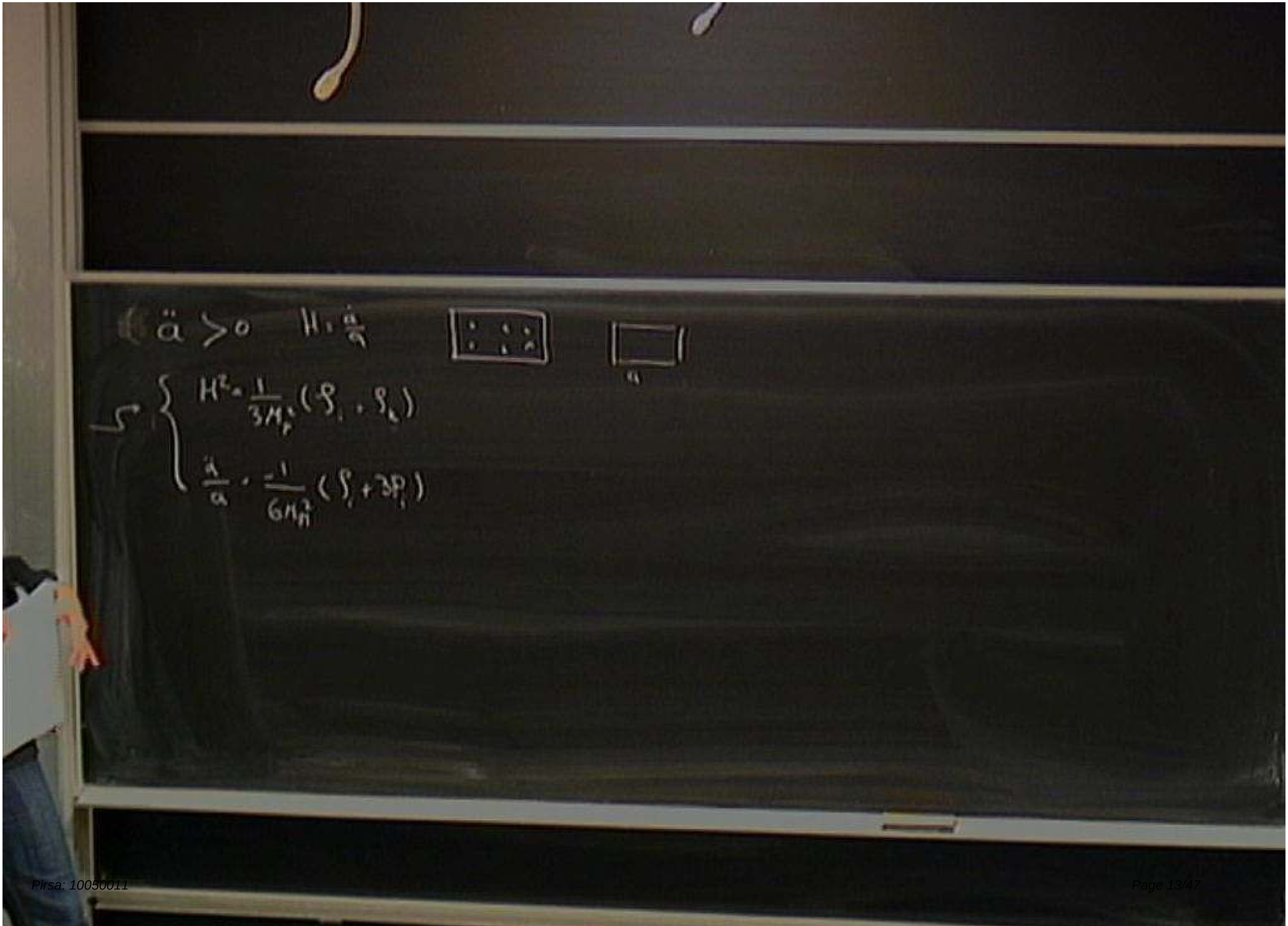

2003 WMap
2004 BAO
DGP
Inflation


1998 - 1999 → Supernova Observations → ä > 0
2003 WMAP
2004 BAO
⇒ ρ_Λ
Inflaton

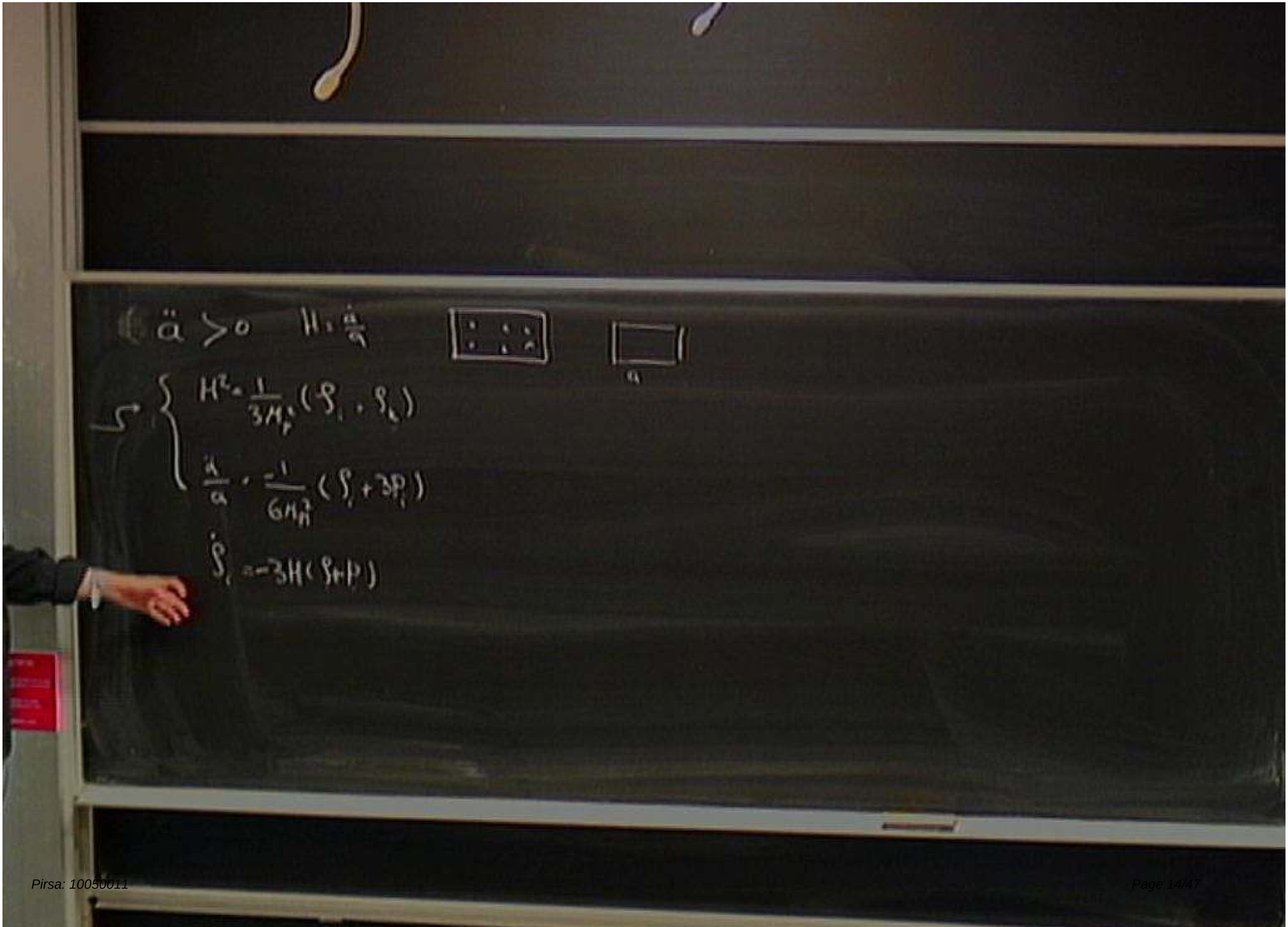

Back reaction
Cosmological constant (C.C.)
Einstein (1917) → Λ
Friedmann (1922)
→ Expanding Sol's
de Sitter → Expansion
no matter
→ Obs. → Univ. is Expanding
→ Inflation
Λ=0


ä > 0
H² = 1/(3M_P²) (ρ_i + ρ_k)
ä/a = −1/(6M_P²) (ρ_i + 3P_i)

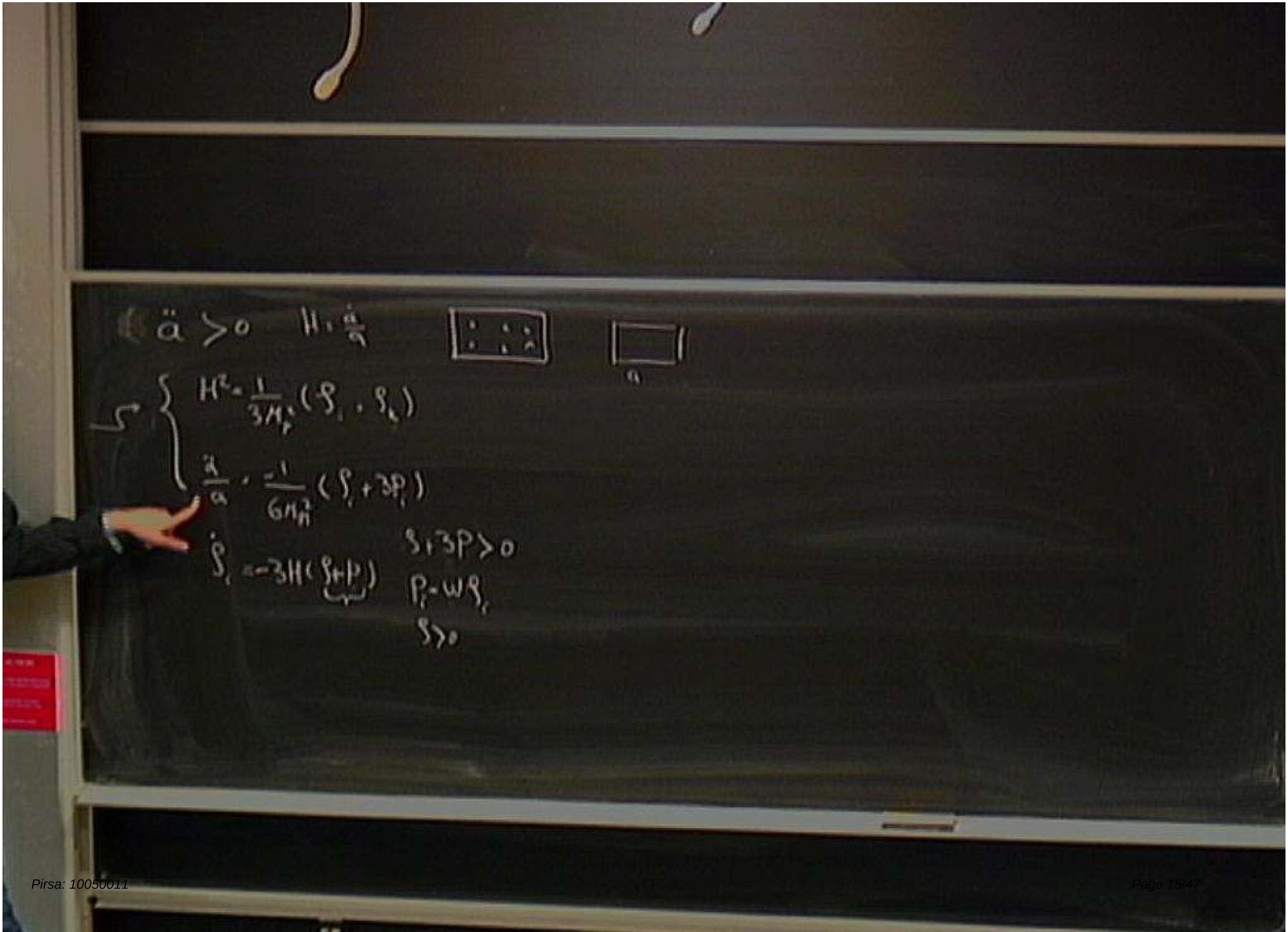

ä > 0
H = ȧ/a
H² = 1/(3M_p²) (ρ_i + ρ_k)
ä/a = −1/(6M_p²) (ρ_i + 3p_i)
a

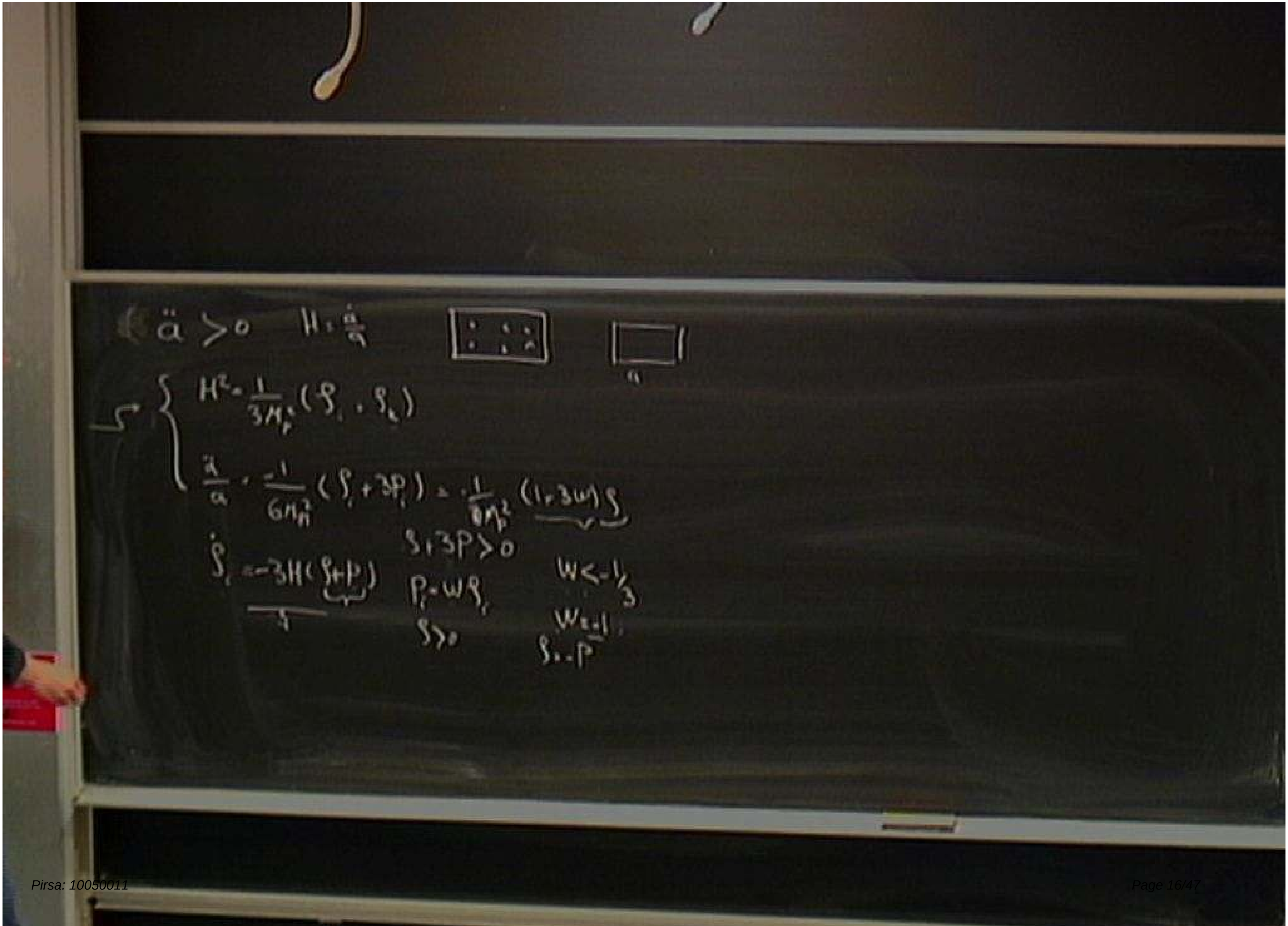


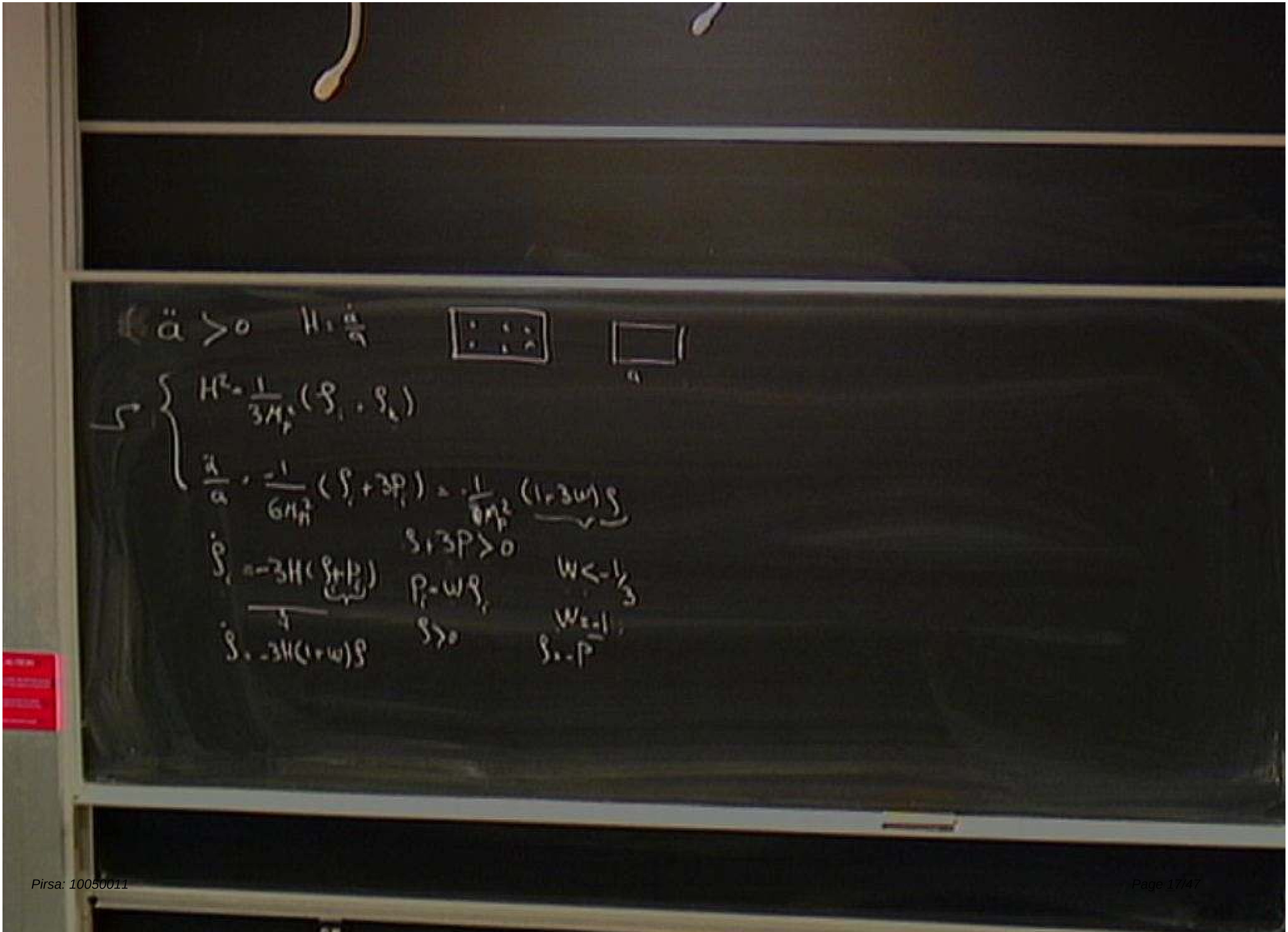
ä > 0
H = ȧ/a
H² = 1/(3M_p²) (ρ_i + ρ_k)
ä/a = −1/(6M_p²) (ρ_i + 3p_i)
a



$\ddot{a} > 0$
$H = \frac{\dot{a}}{a}$
$H^2 = \frac{1}{3M_p^2}(\rho_i + \rho_k)$
$\frac{\ddot{a}}{a} = \frac{-1}{6M_p^2}(\rho_i + 3P_i)$
$\dot{\rho}_i = -3H(\rho + P)$


$\ddot{a} > 0$
$H = \frac{\dot{a}}{a}$
$H^2 = \frac{1}{3M_p^2}(\rho_i + \rho_k)$
$\frac{\ddot{a}}{a} = \frac{-1}{6M_p^2}(\rho_i + 3P_i)$
$\dot{\rho}_i = -3H(\rho + P)$
$\rho + 3P > 0$
$P_i = w\rho_i$
$\rho > 0$
a


ä > 0
H = ȧ/a
H² = 1/(3M_p²) (ρ_i + ρ_k)
ä/a = -1/(6M_p²) (ρ_i + 3P_i) = -1/(6M_p²) (1+3w)ρ
ρ̇_i = -3H(ρ+P)
ρ+3P > 0
P_i = wρ_i
ρ > 0
w < -1/3
w = -1
ρ = -P


ä > 0 H = ȧ/a
H² = 1/(3M_p²) (ρ_i + ρ_r)
ä/a = −1/(6M_p²) (ρ_i + 3P_i) = −1/(6M_p²) (1+3w) ρ
ρ̇_i = −3H(ρ_i + P_i)
ρ + 3P > 0
P_i = w ρ_i
w < −1/3
ρ̇ = −3H(1+w) ρ
ρ > 0
w = −1
ρ = −P

$\ddot{a} > 0 \qquad H = \frac{\dot{a}}{a}$

$$H^2 = \frac{1}{3M_p^2}\left(\rho_i + \rho_k\right)$$

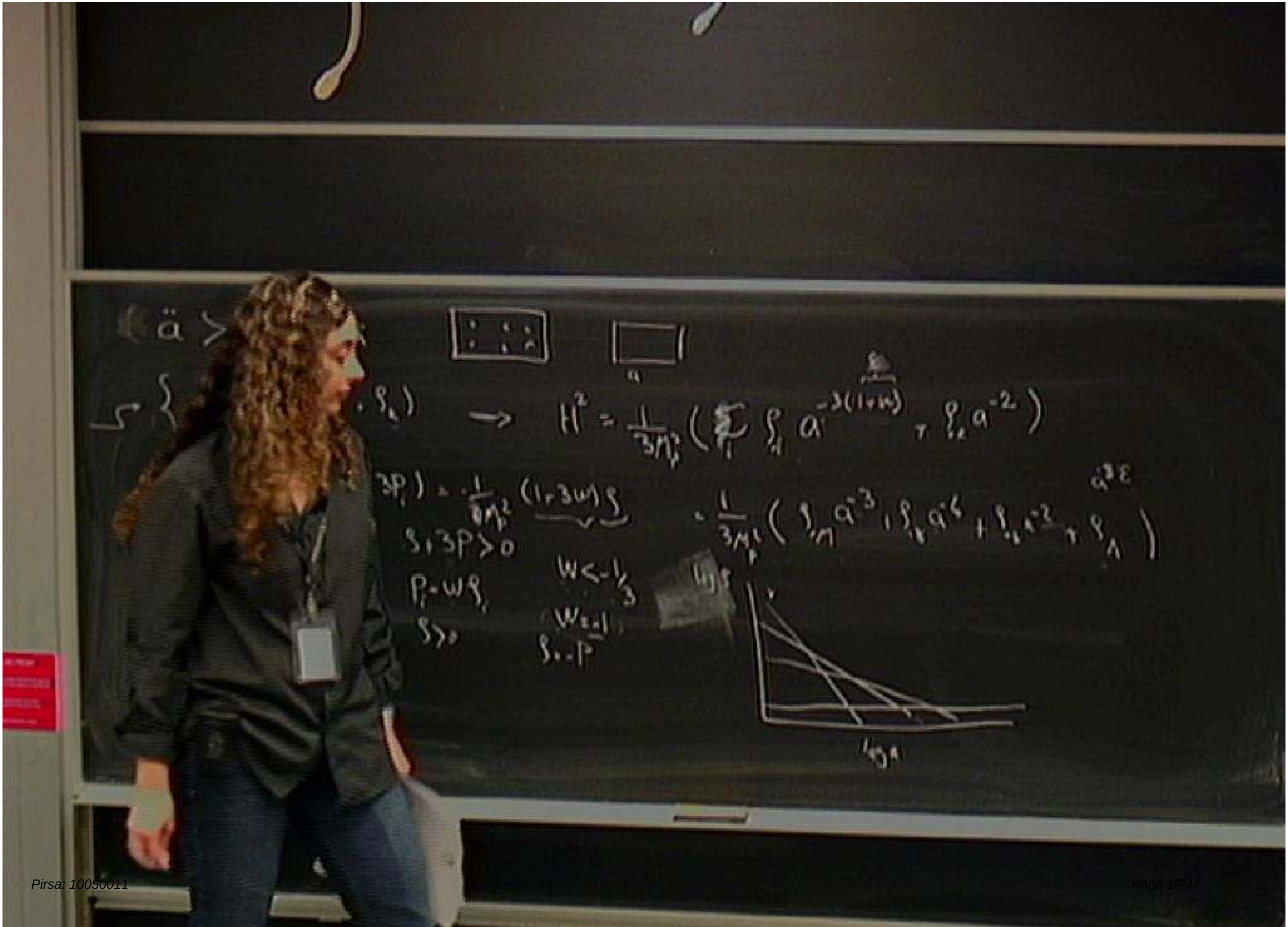
$$\frac{\ddot{a}}{a} = \frac{-1}{6M_p^2}\left(\rho_i + 3P_i\right) = -\frac{1}{6M_p^2}(1+3w)\rho$$

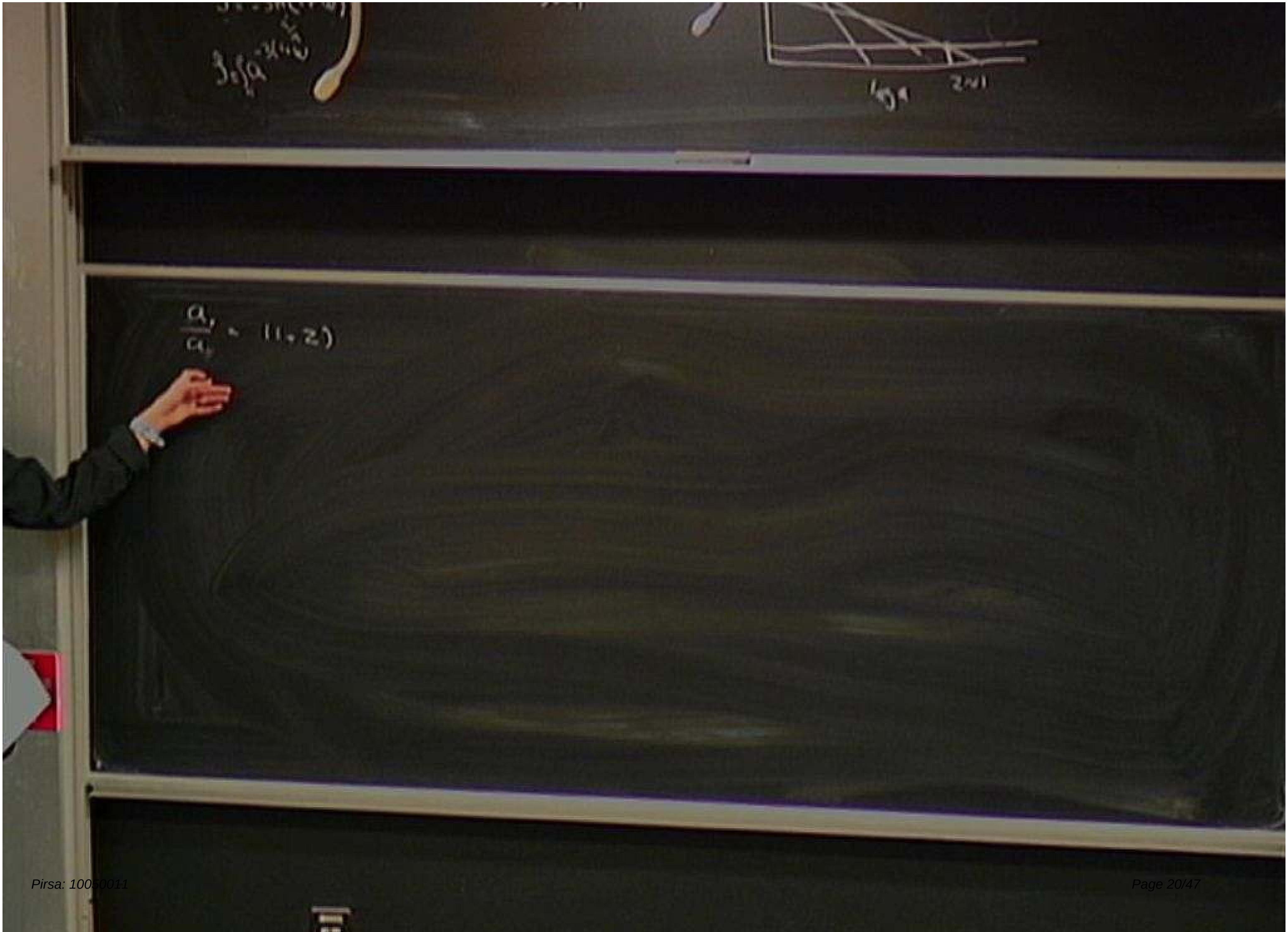
$$\dot{\rho}_i = -3H(\rho_i + P_i) \qquad \rho + 3P > 0 \qquad w < -\tfrac{1}{3}$$

$$P_i = w\rho_i$$

$$\dot{\rho} = -3H(1+w)\rho \qquad \rho > 0 \qquad w = -1$$

$$\rho = \rho_0 a^{-3(1+w)} \qquad \rho = -P$$





$\rho_i a^{-3(1+w)}$

$\log a$ $\quad z \sim 1$

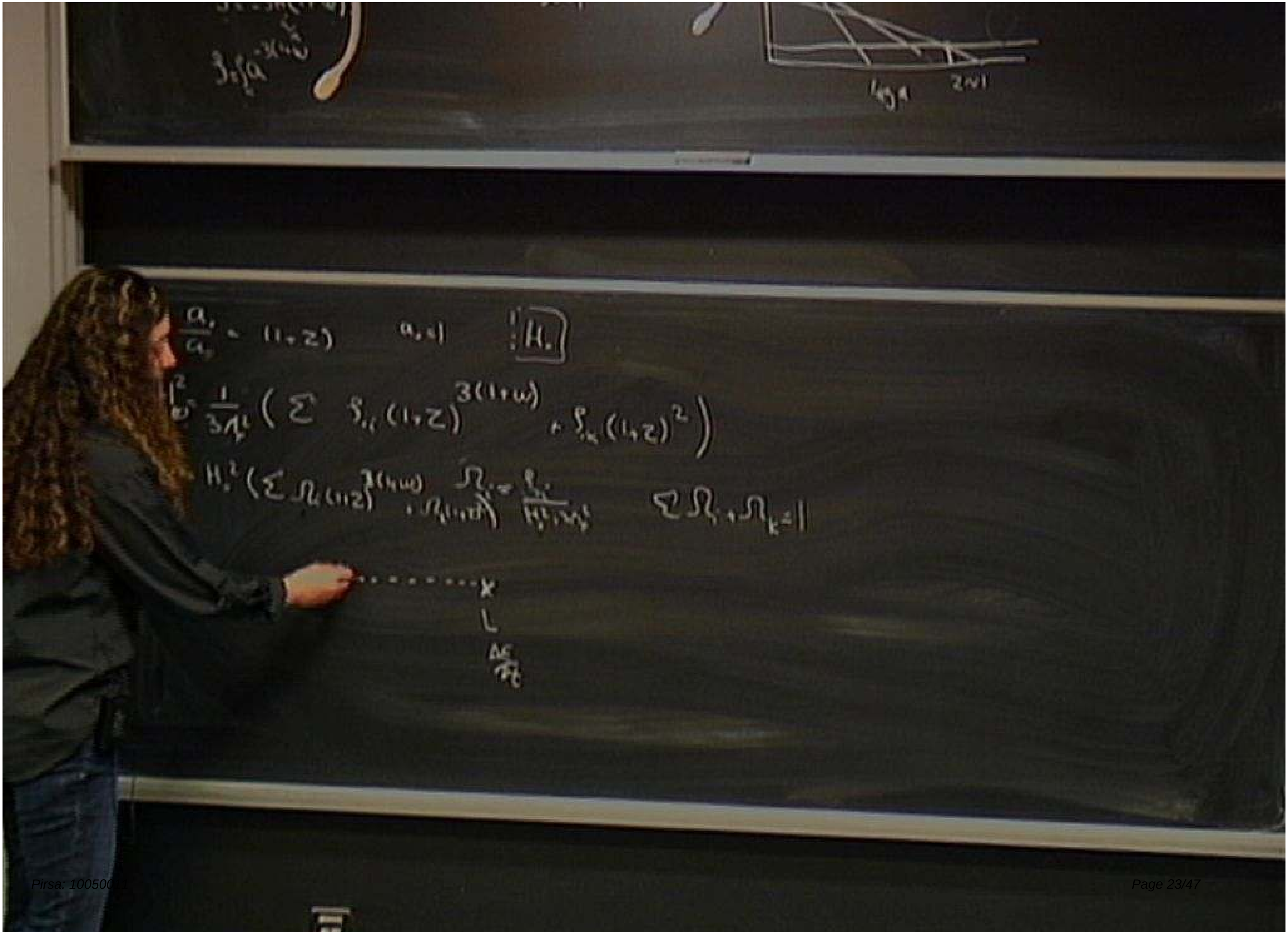
$$\frac{a_0}{a_e} = (1+z) \qquad a_0 = 1$$

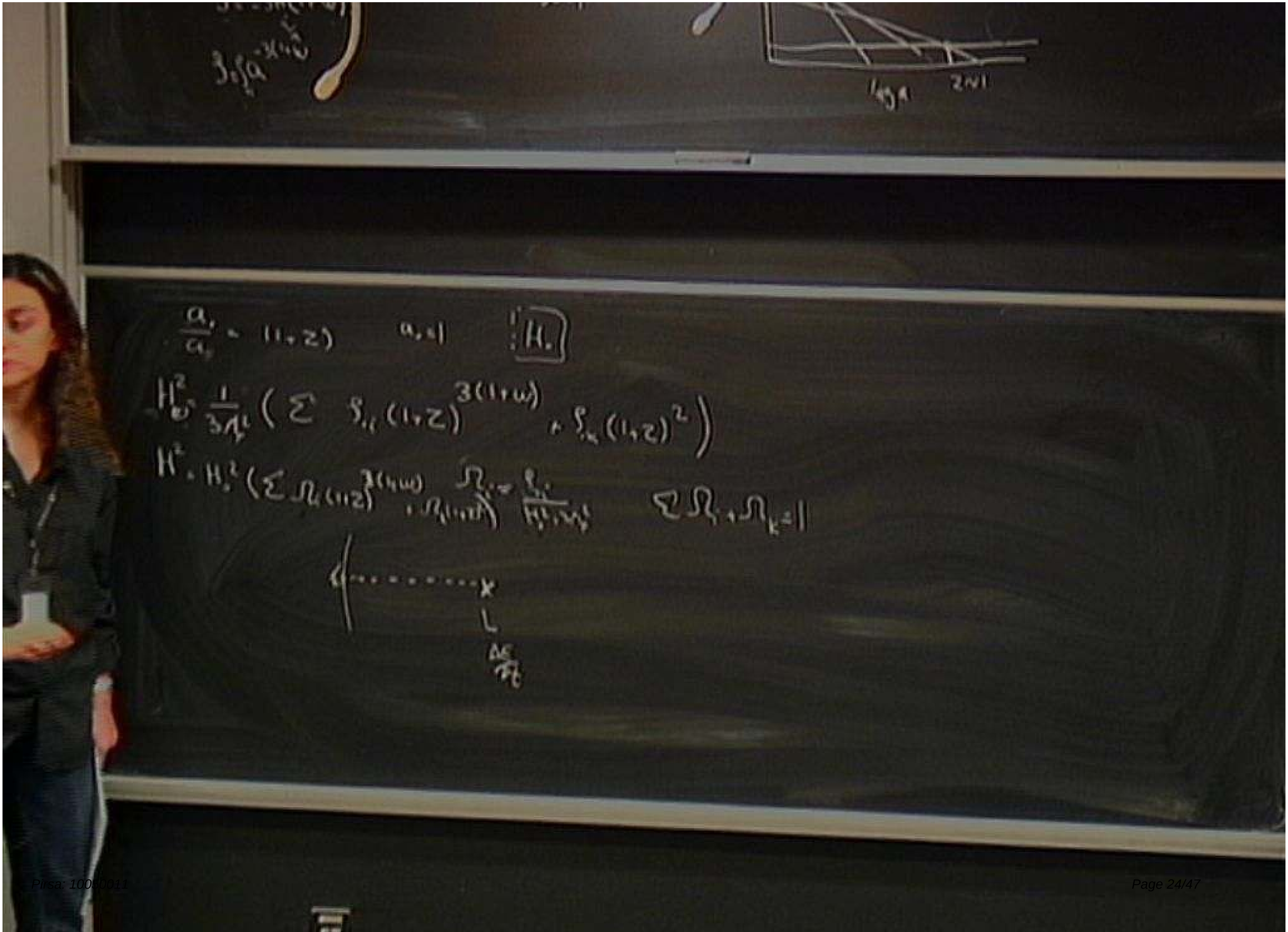
$$H^2 = \frac{1}{3 M_p^2}\left(\sum \rho_i (1+z)^{3(1+w)} + \rho_k (1+z)^2 \right)$$

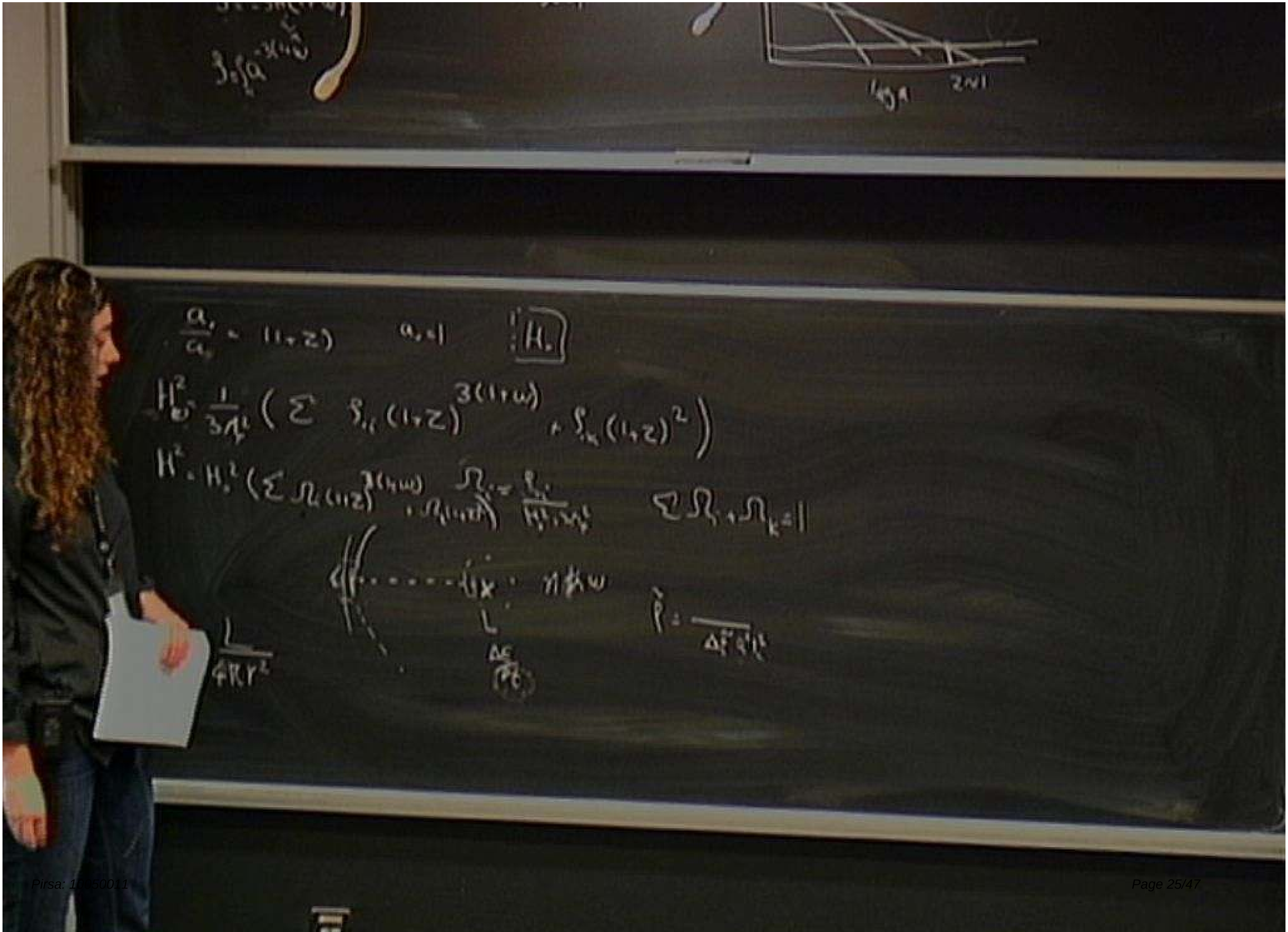
$$\frac{a_0}{a_e} = (1+z) \qquad a_0 = 1 \qquad H_0$$

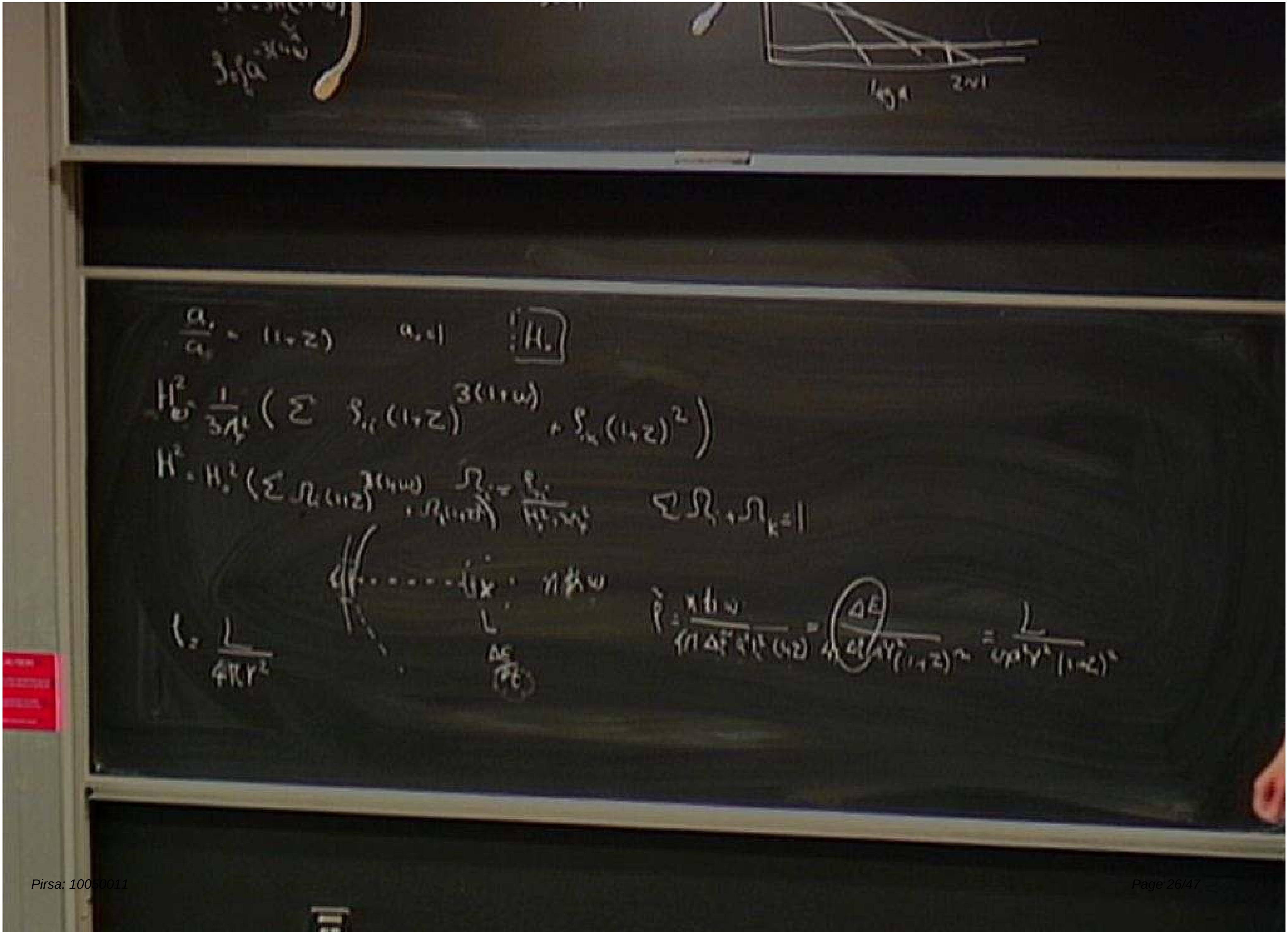
$$H^2 = \frac{1}{3M_p^2}\left(\sum \rho_i (1+z)^{3(1+w)} + \rho_k (1+z)^2\right)$$

$$H^2 = H_0^2\left(\sum \Omega_i (1+z)^{3(1+w)} + \Omega_k (1+z)^2\right) \qquad \Omega_i = \frac{\rho_i}{H_0^2 \, 3M_p^2}$$




a0/ae = (1+z)
a0 = 1
H0
ΣΩi + Ωk = 1




a0/a = (1+z)
a0 = 1
H0
H^2 = H0^2 (Σ Ω (1+z)^3(1+w) + Ω_k (1+z)^2)
Σ Ω + Ω_k = 1
l = L/4πr^2
ΔE

$$\frac{a_0}{a} = (1+z) \qquad a_0 = 1 \qquad \boxed{H_0}$$

$$H^2 = \frac{1}{3M_p^2}\left(\sum \rho_{0i} (1+z)^{3(1+w)} + \rho_{0k} (1+z)^2 \right)$$

$$H^2 = H_0^2 \left(\sum \Omega_i (1+z)^{3(1+w)} + \Omega_k (1+z)^2 \right) \qquad \Omega_i = \frac{\rho_{0i}}{H_0^2\, 3M_p^2} \qquad \sum \Omega_i + \Omega_k = 1$$

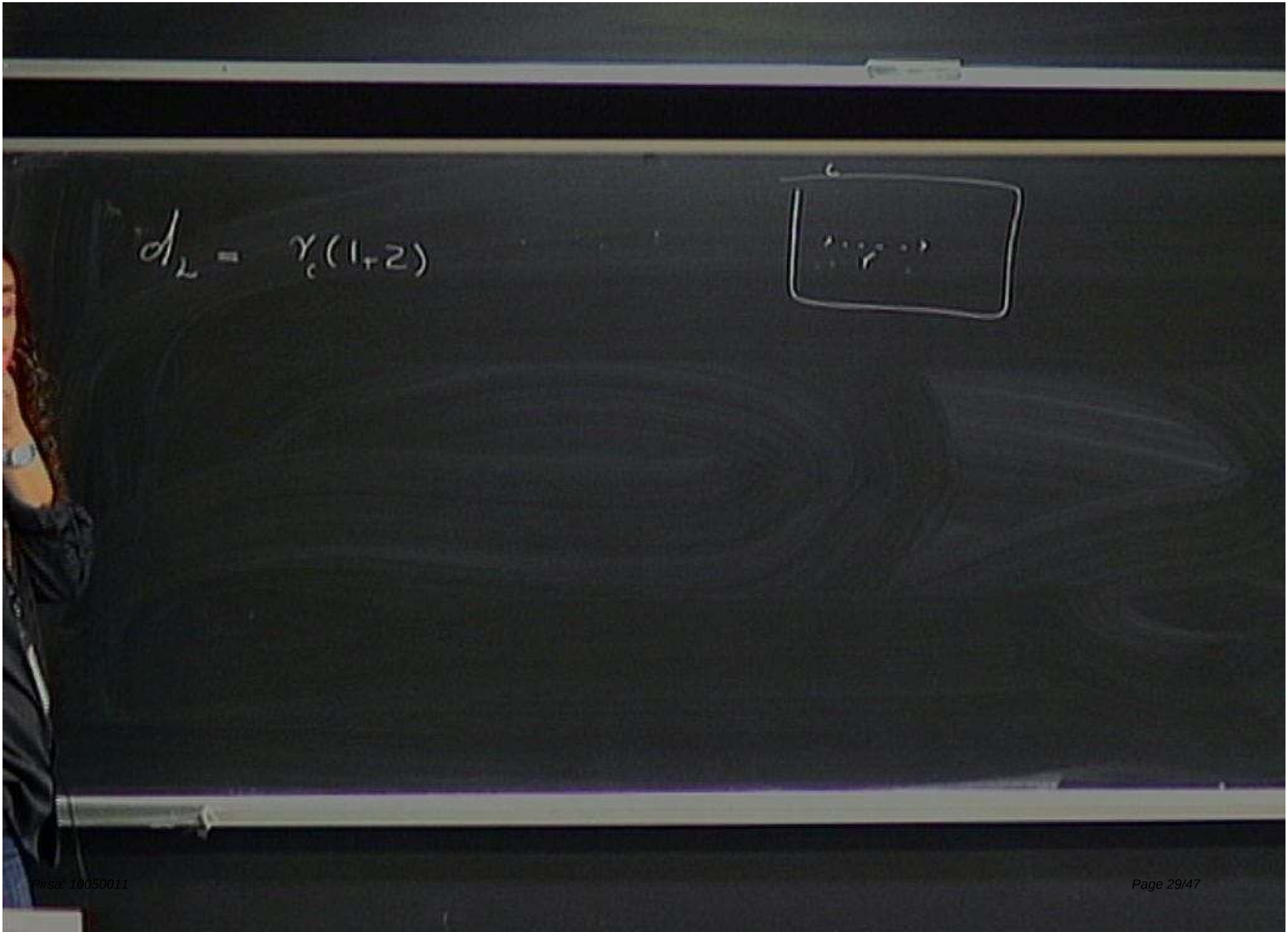
$$dx : \; n\hbar\omega$$

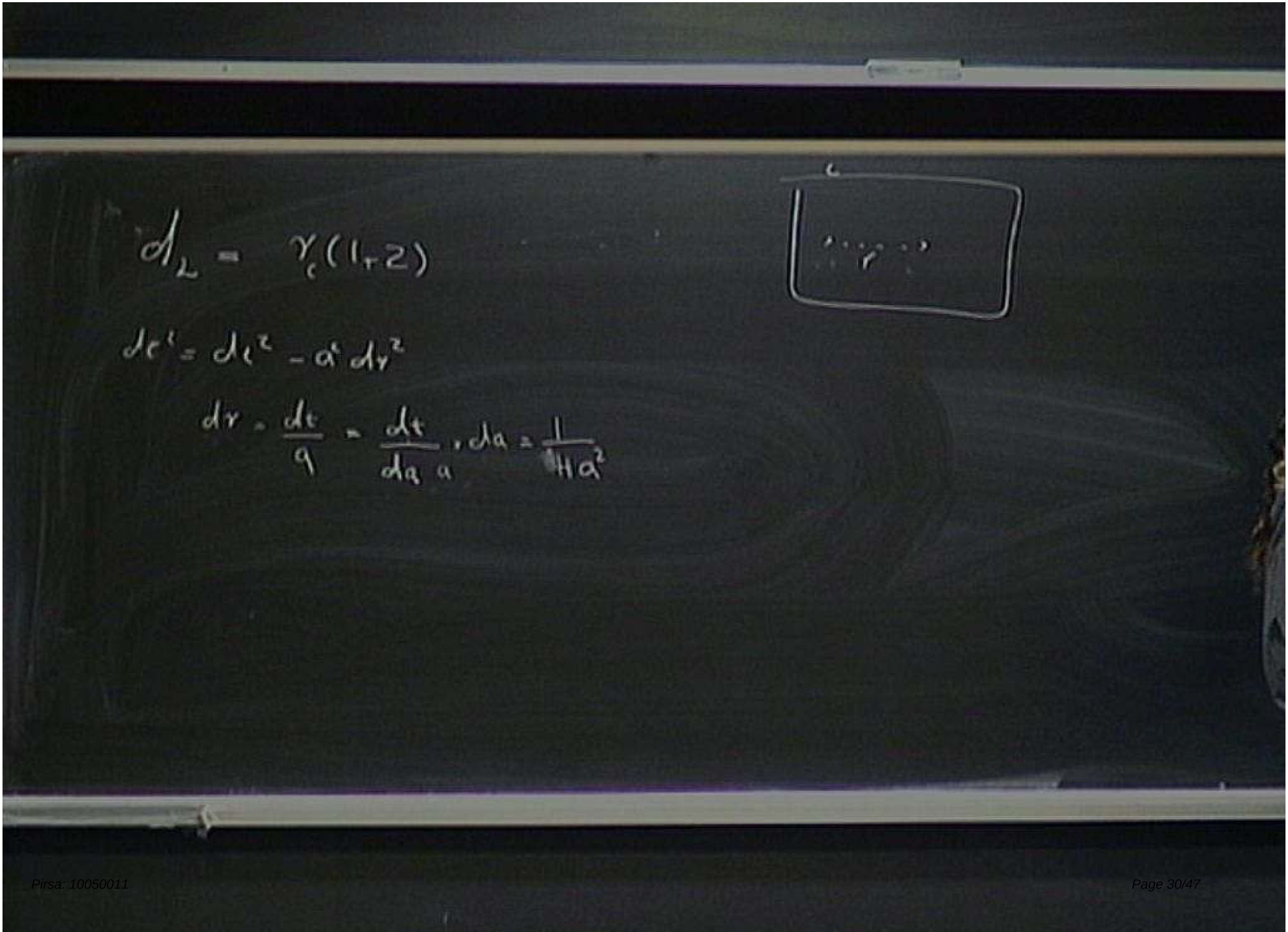
$$L \qquad \frac{\Delta E}{\Delta t}$$

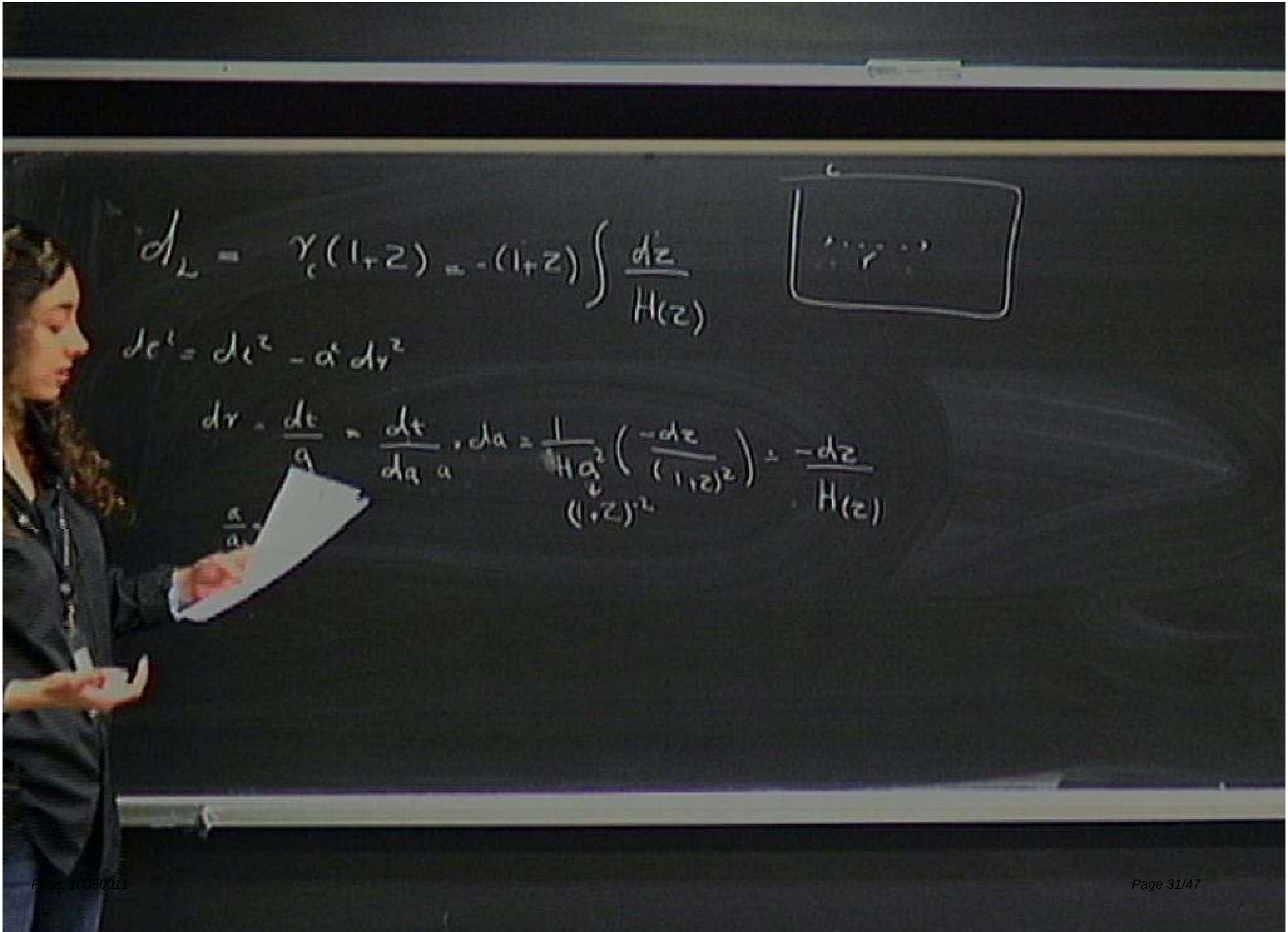
$$\ell = \frac{L}{4\pi r^2}$$

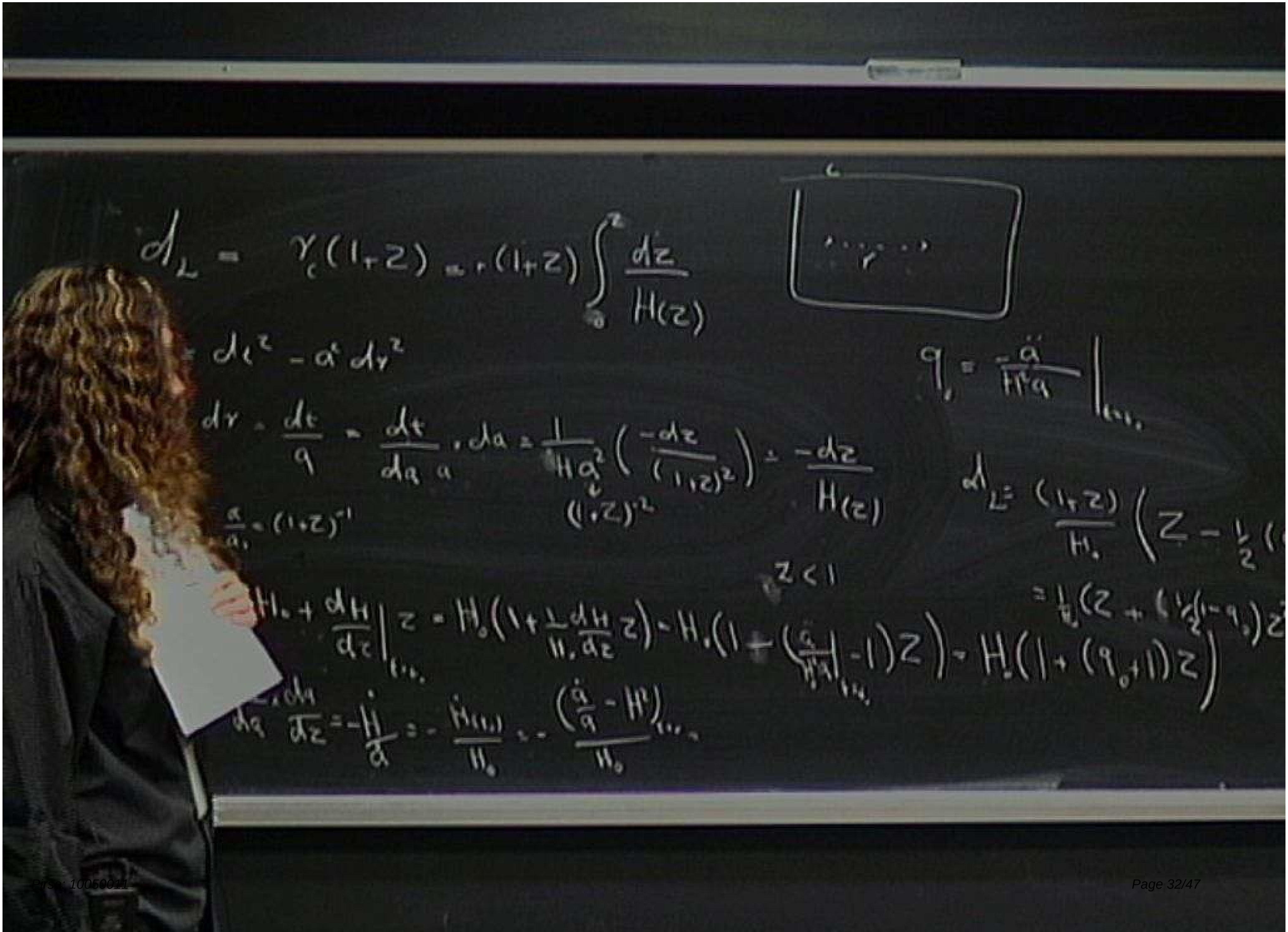
$$\tilde{\rho} = \frac{n\hbar\omega}{4\pi\, \Delta t\, a_0^2 r_1^2 (1+z)} = \frac{\Delta E}{4\pi\, \Delta t\, a^2 r^2 (1+z)^2} = \frac{L}{4\pi a_0^2 r_{(1)}^2 (1+z)^2}$$

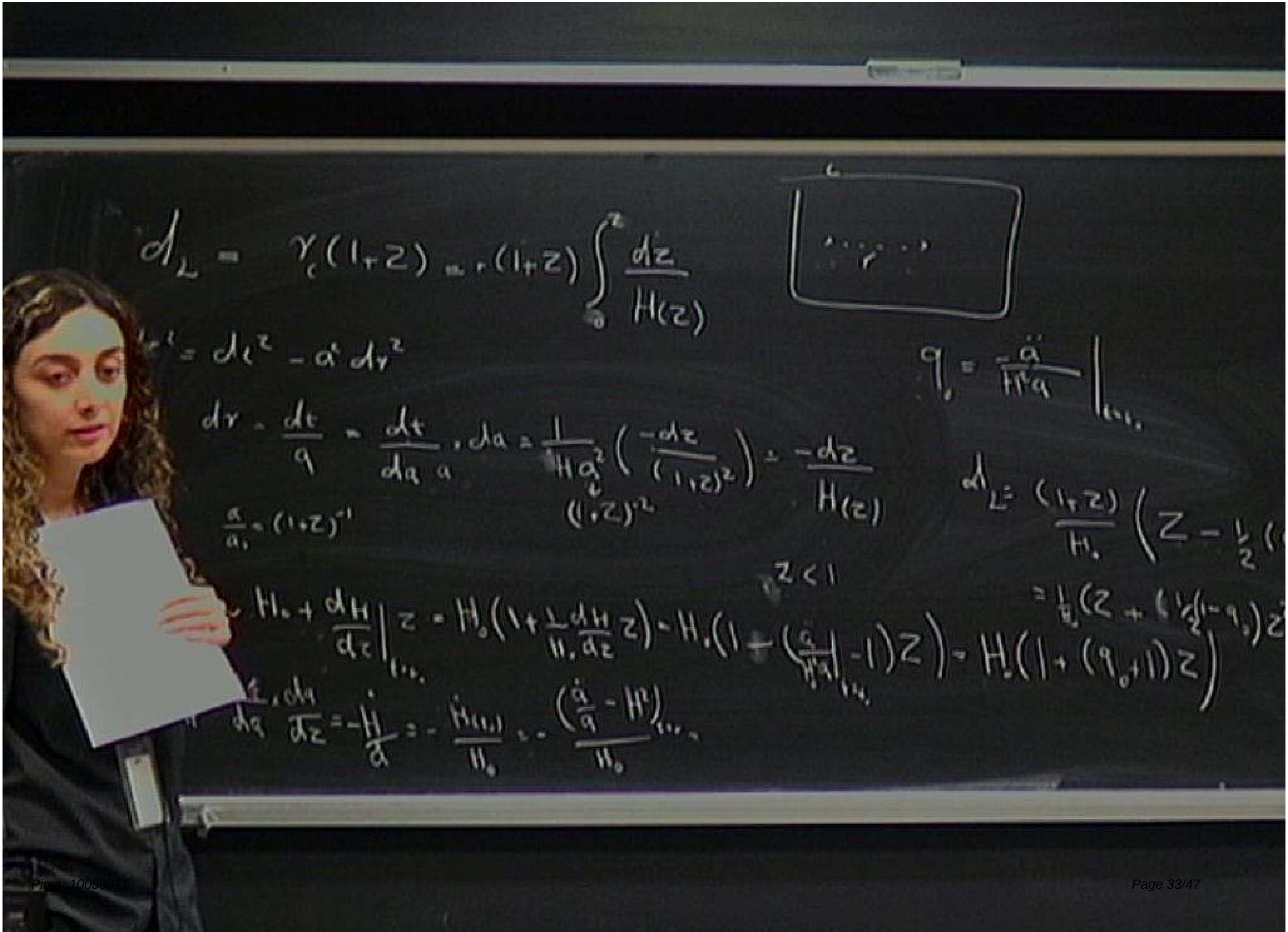
$$d_L$$

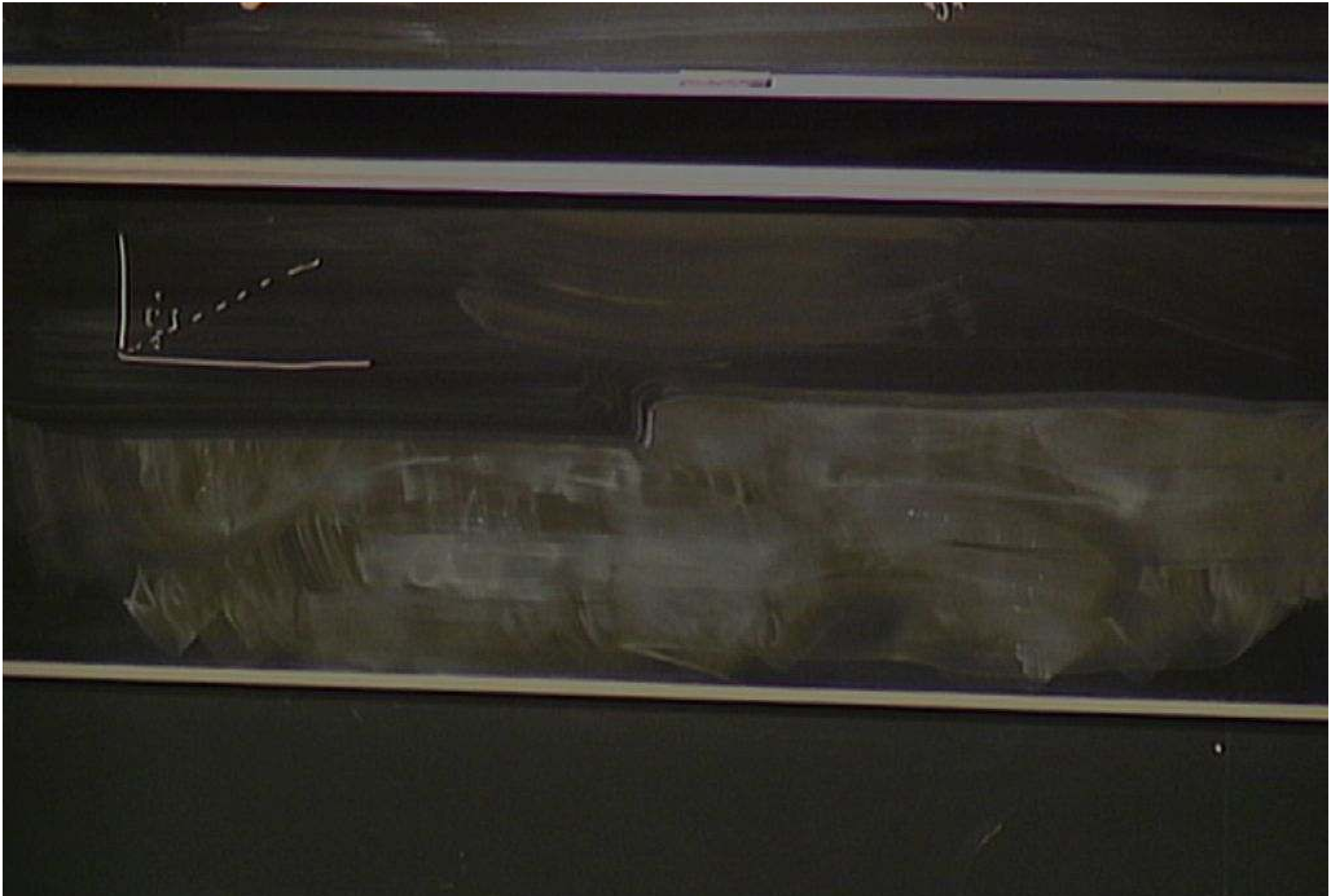

$d_L = r_c(1+z)$

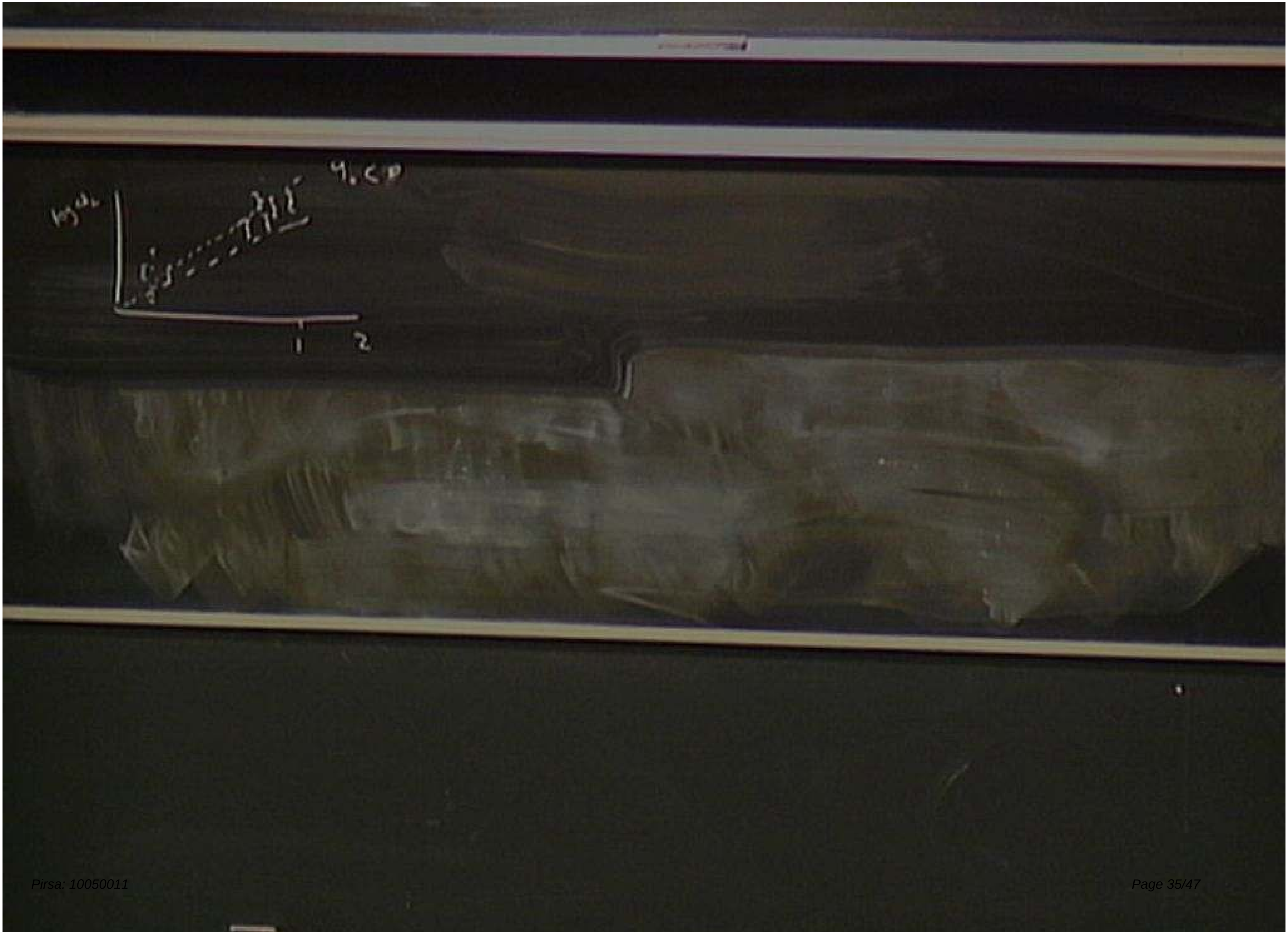

$d_L = r_c(1+z)$
$d\tau^2 = dt^2 - a^2 dr^2$
$dr = \frac{dt}{a} = \frac{dt}{da\, a} \cdot da = \frac{1}{Ha^2}$
r

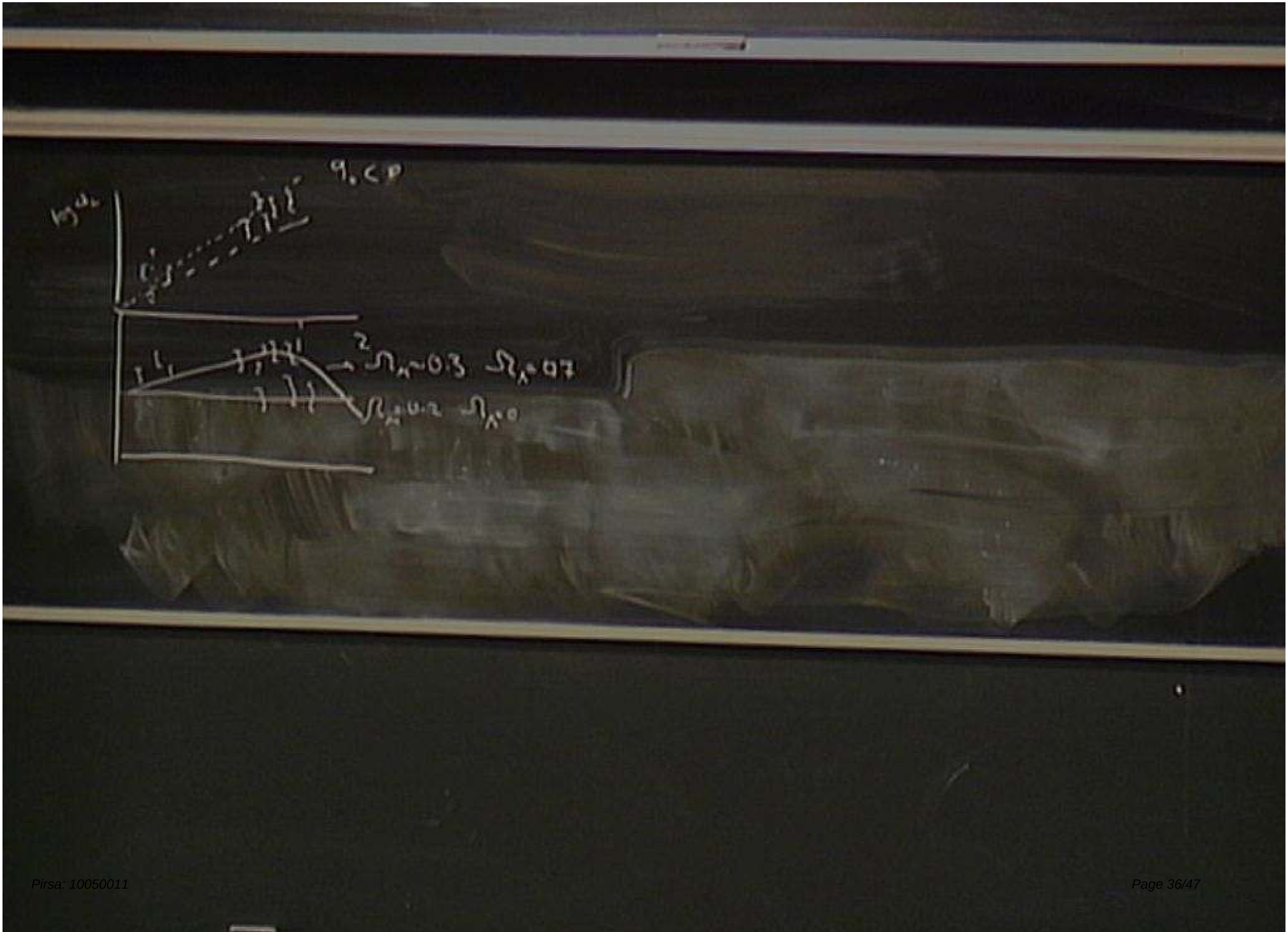

$d_L = r_c(1+z) = (1+z)\int \frac{dz}{H(z)}$
$d\tau^2 = dt^2 - a^2 dr^2$
$dr = \frac{dt}{a} = \frac{dt}{da}\frac{da}{a} = \frac{1}{Ha^2}\left(\frac{-dz}{(1+z)^2}\right) = \frac{-dz}{H(z)}$

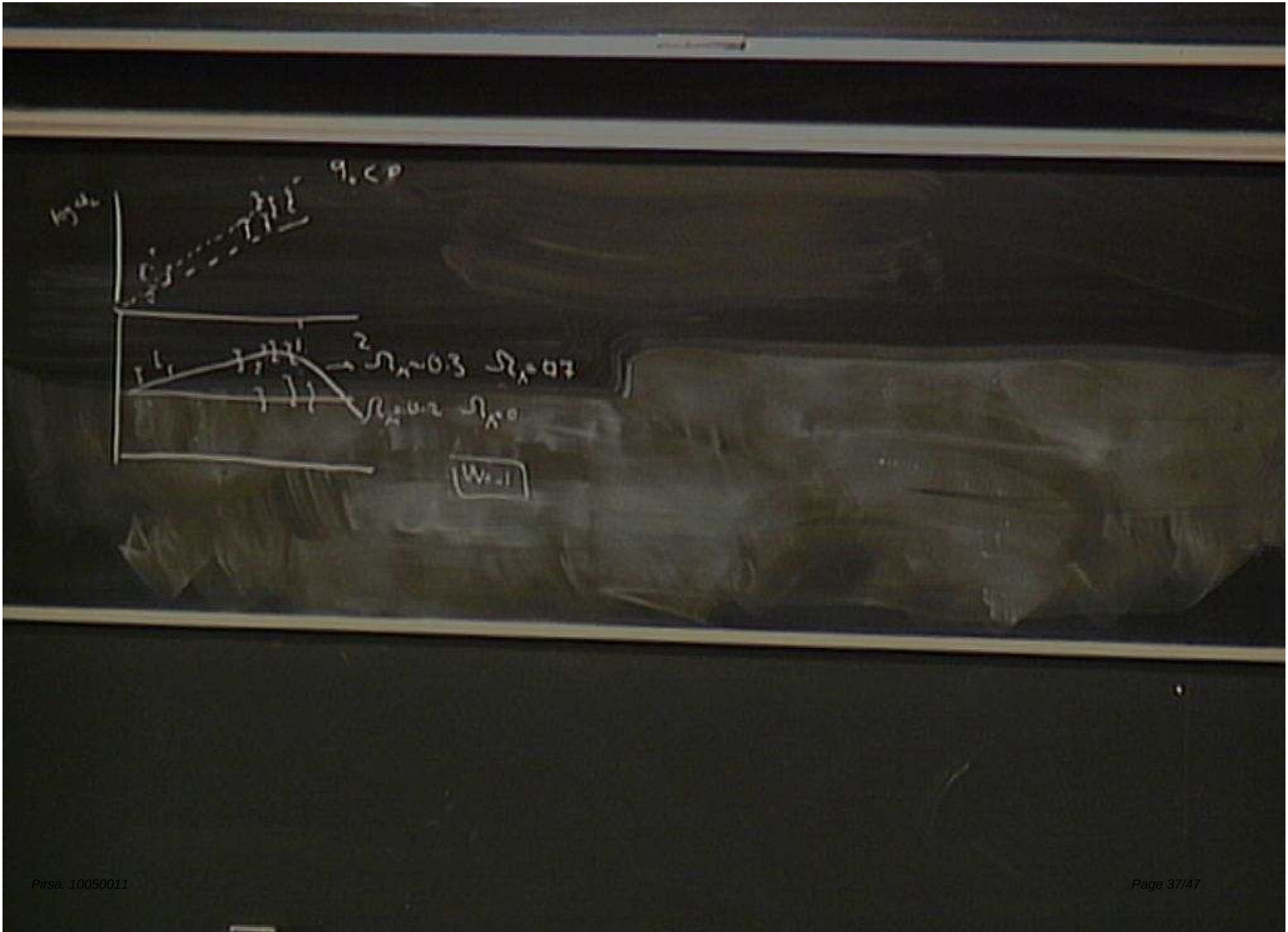

d_L = r_c(1+z) = r(1+z) ∫ dz / H(z)
dt² − a² dr²
dr = dt/a = dt/da · da/a = 1/(Ha²) (−dz/(1+z)²) = −dz/H(z)
a/a₀ = (1+z)⁻¹
z < 1

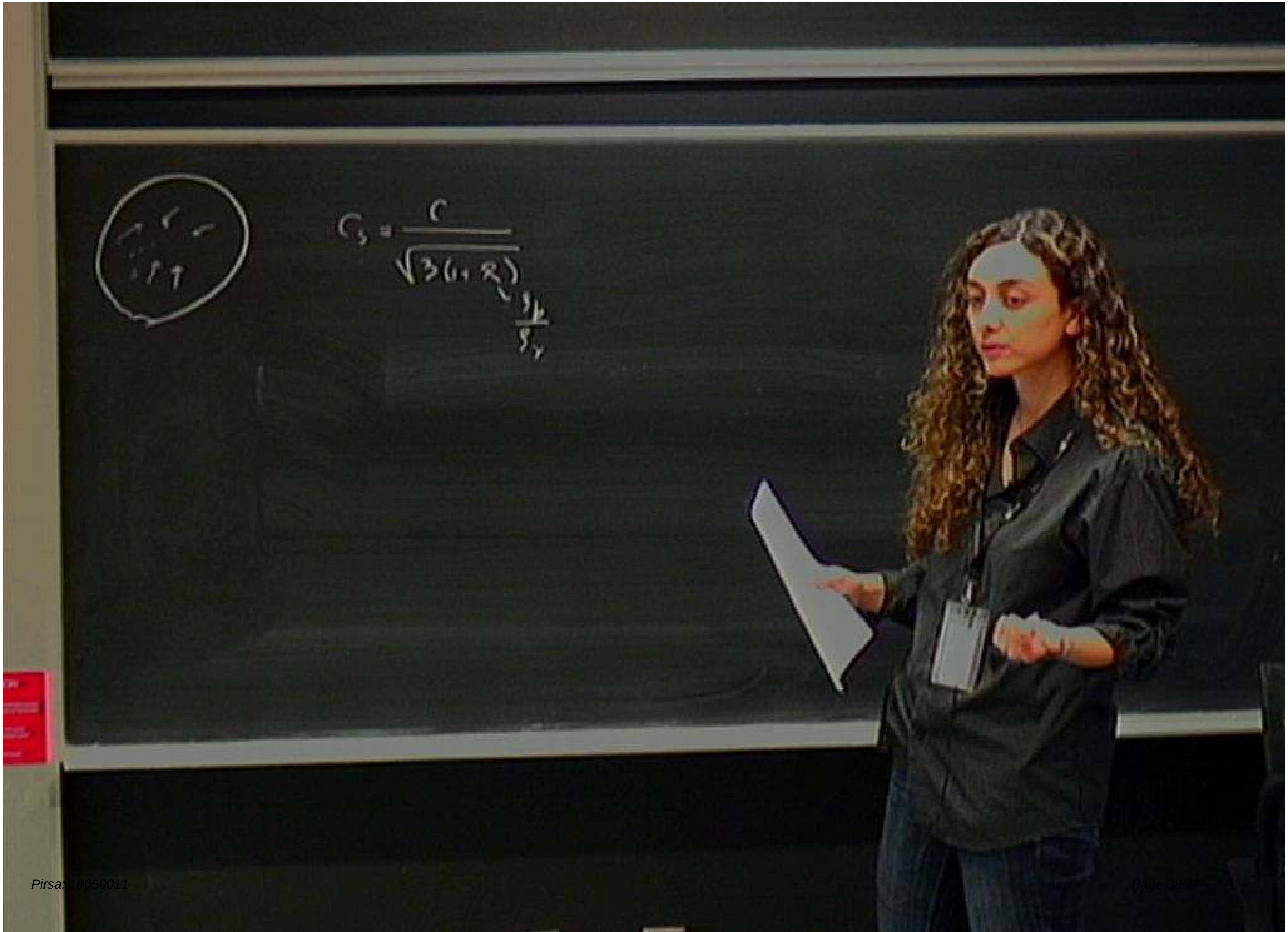

z < 1

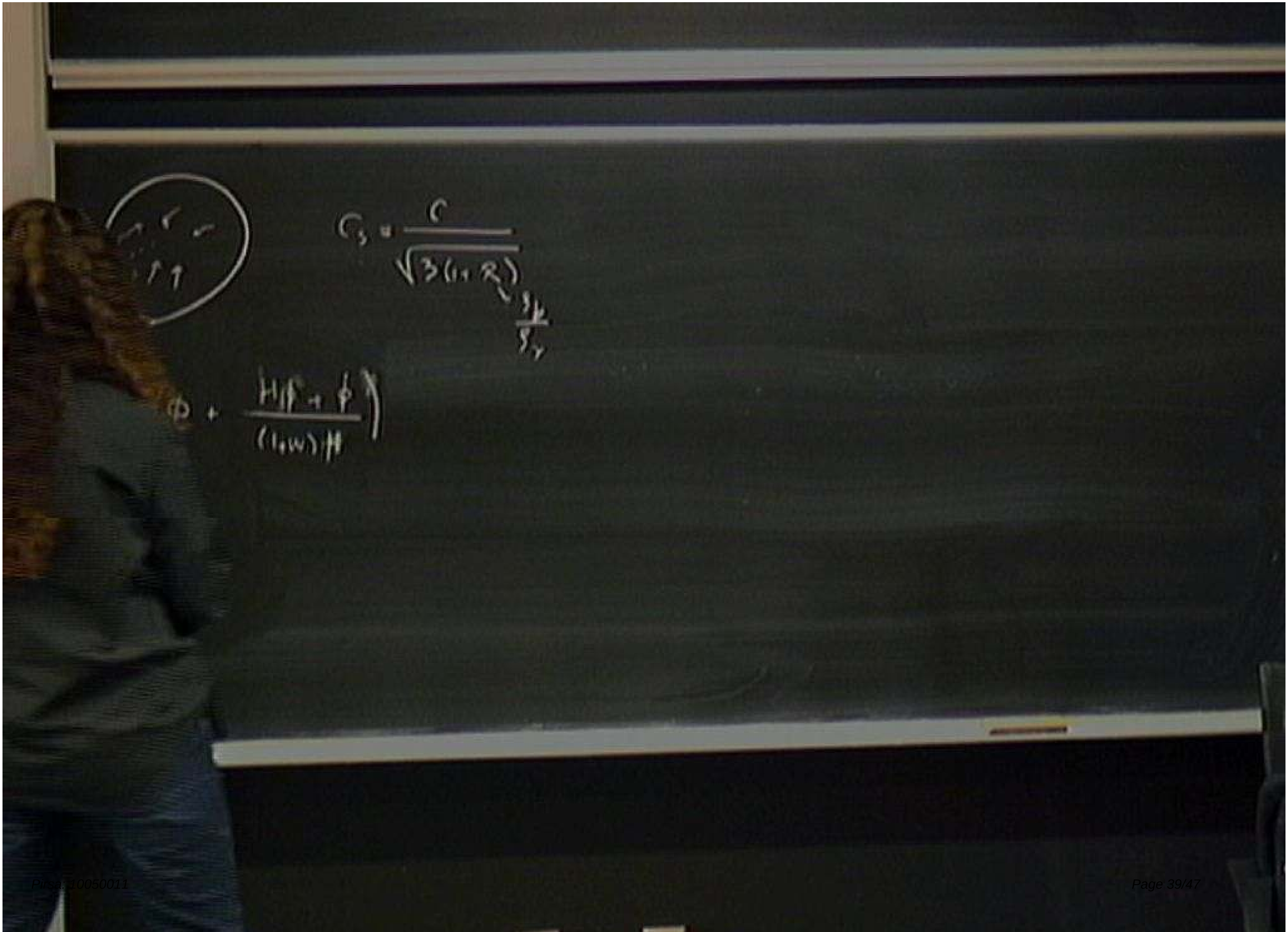




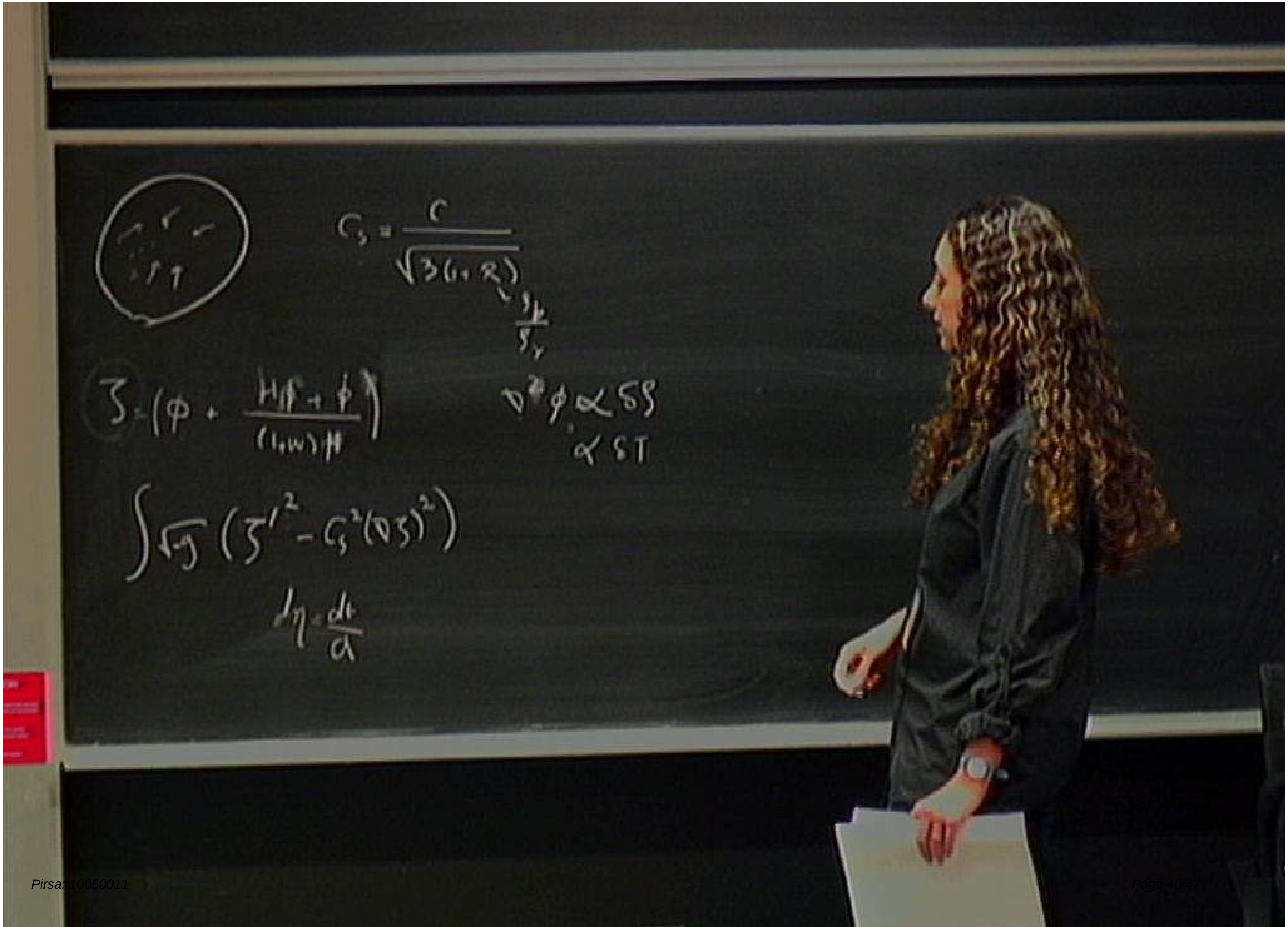

Ω_Λ~0.3 Ω_Λ=0.7
Ω_Λ=0.2 Ω_Λ=0


$q_0 < 0$
$\Omega_\Lambda \sim 0.3$
$\Omega_\Lambda = 0.7$
$\Omega_\Lambda = 0.2$
$\Omega_\Lambda = 0$

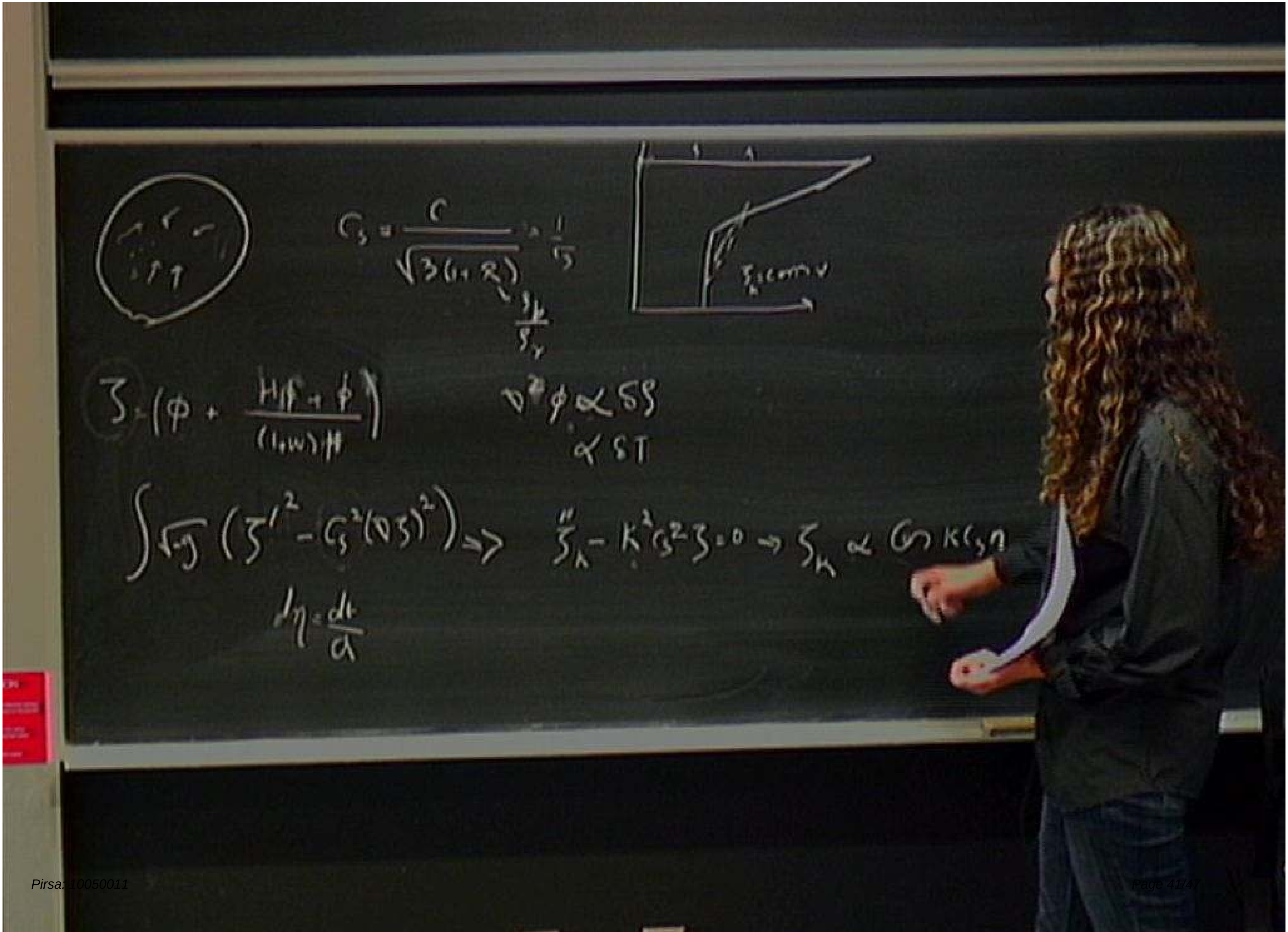

$C_s = \frac{c}{\sqrt{3(1+R)}}$

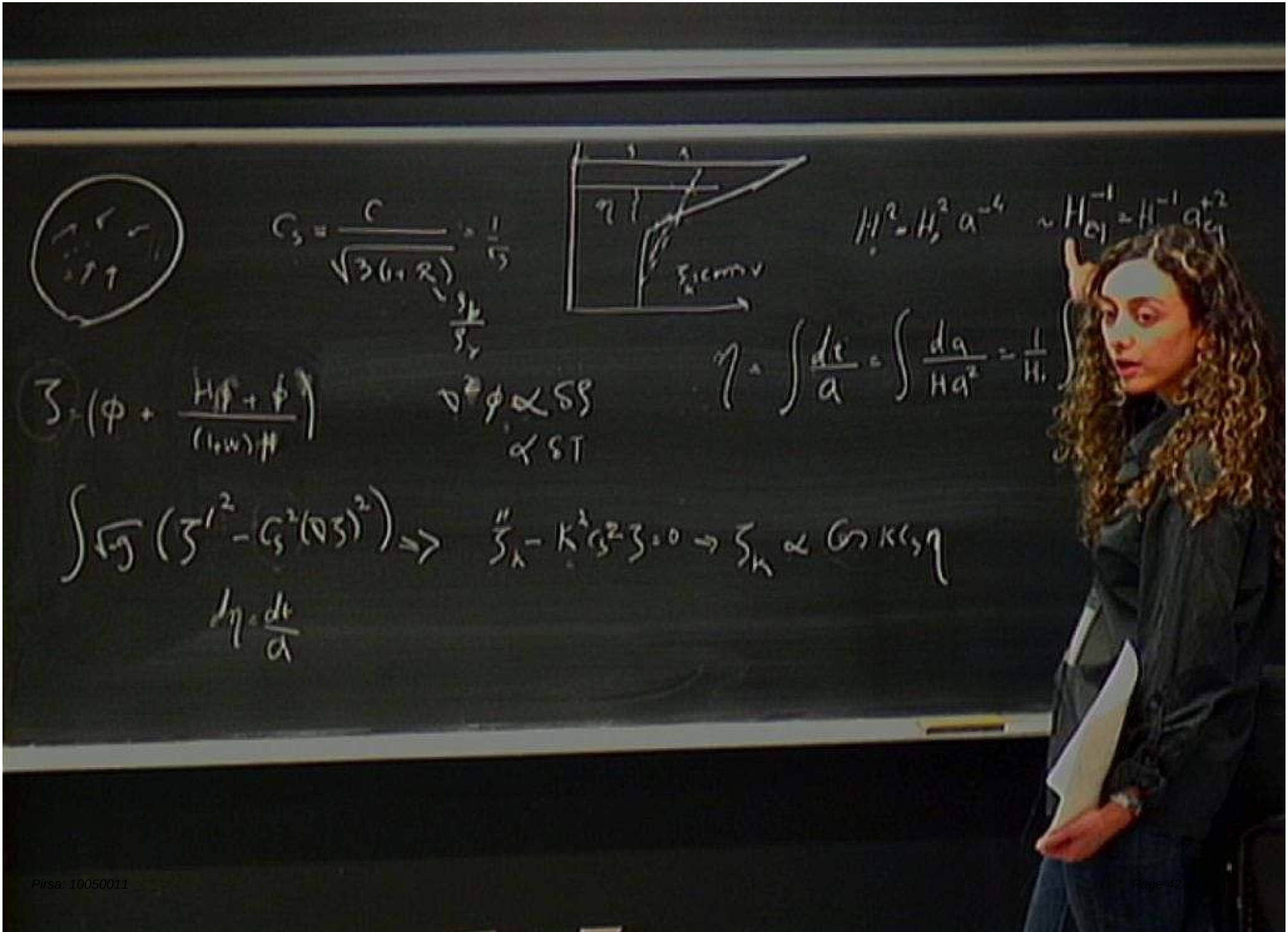


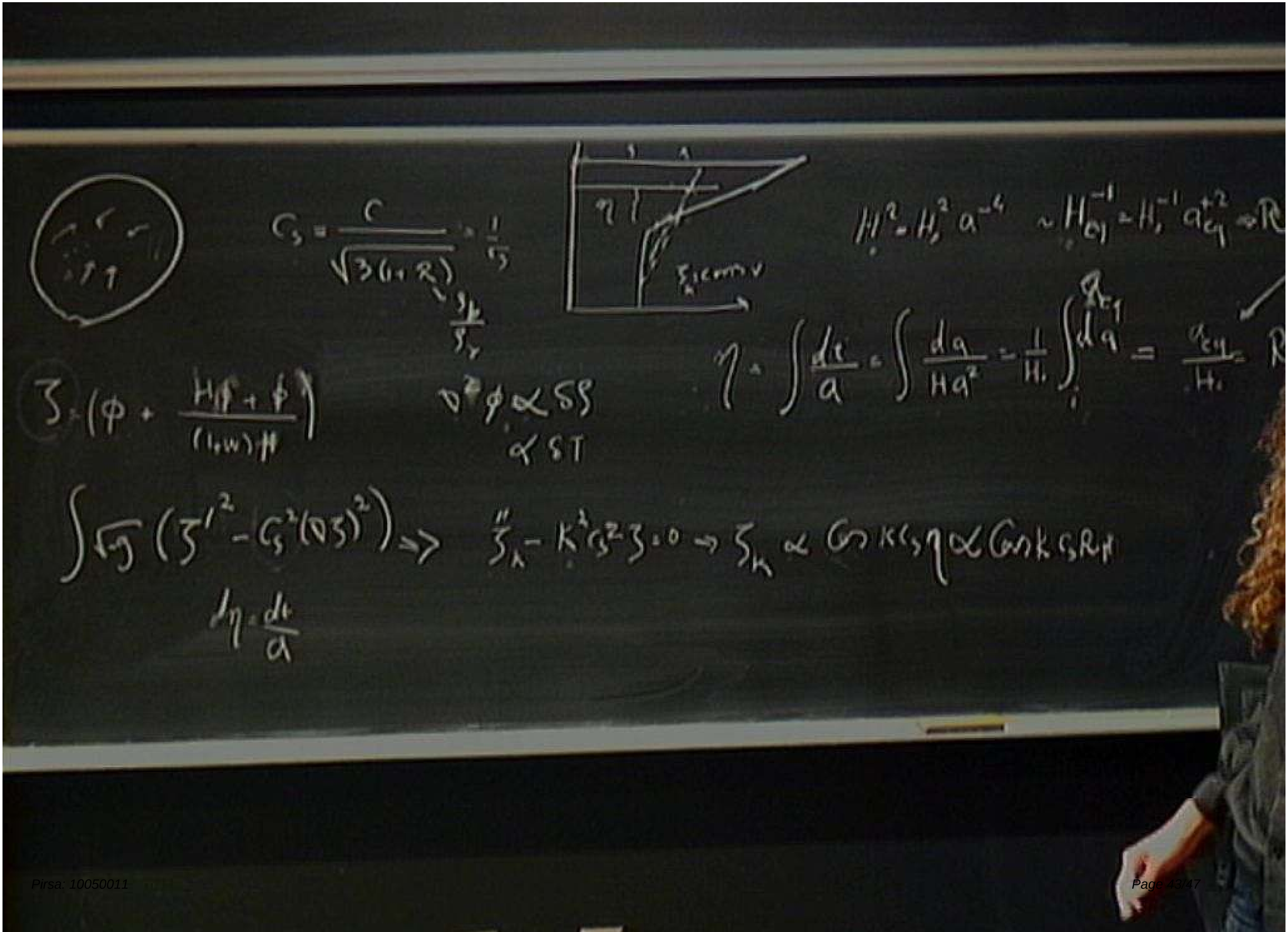
C_s = c / √3(1+R)



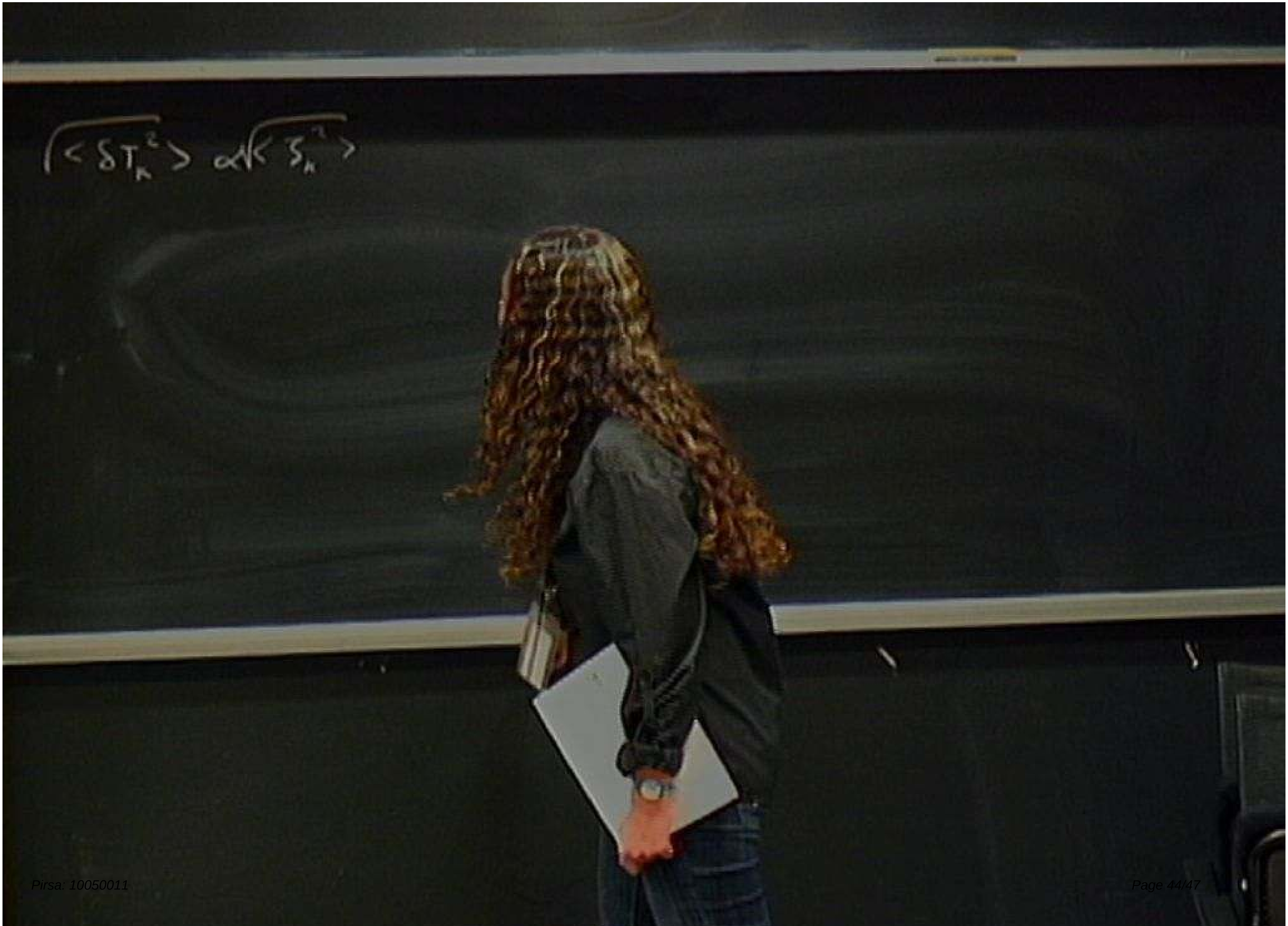
$c_s = \frac{c}{\sqrt{3(1+R)}}$
$\nabla^2 \phi \propto \delta\rho \propto \delta T$
$\int \sqrt{-g}\,(\zeta'^2 - c_s^2(\nabla\zeta)^2)$
$d\eta = \frac{dt}{a}$

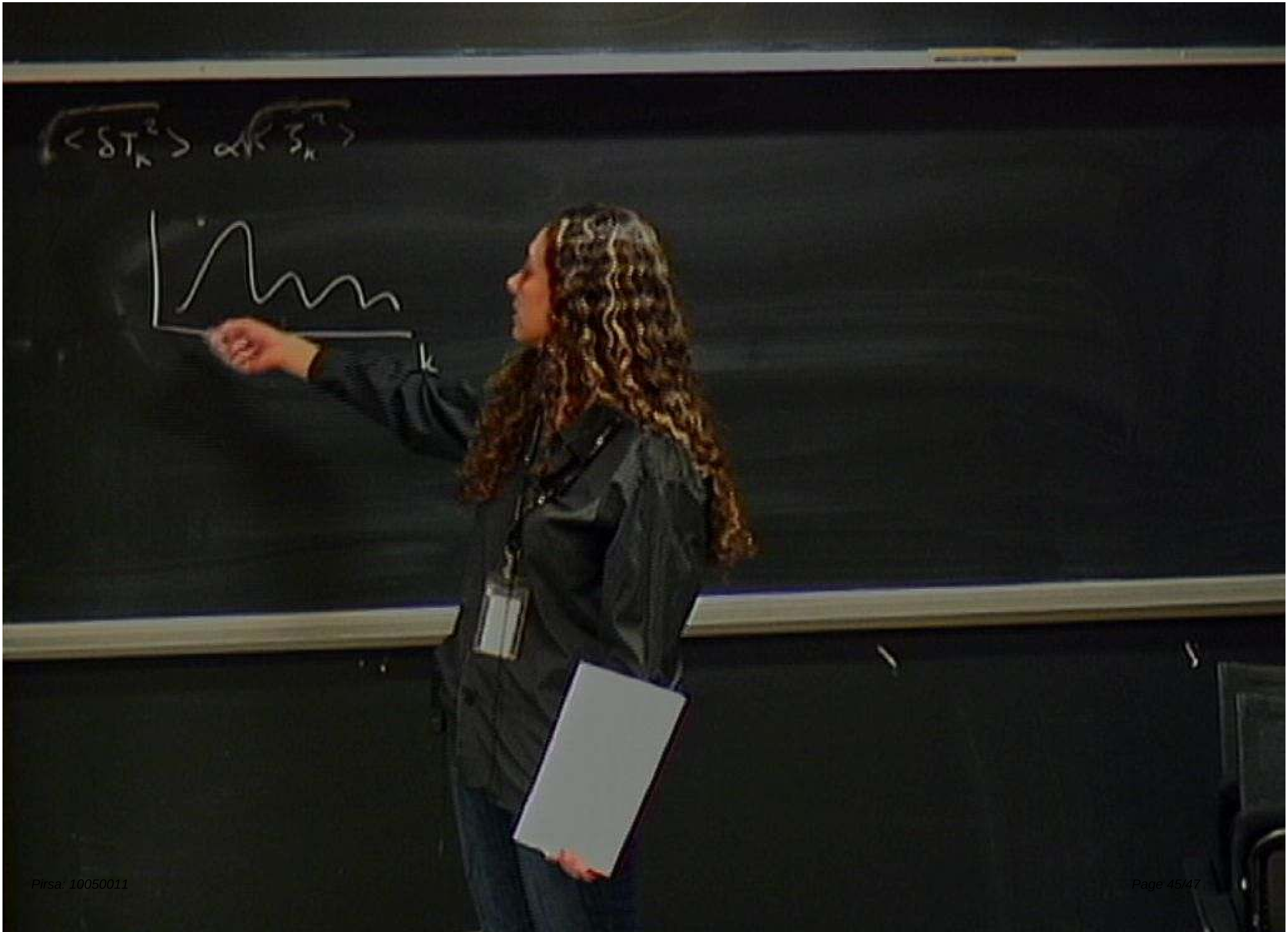

∇²φ ∝ δρ
∝ δT
dη = dt/a

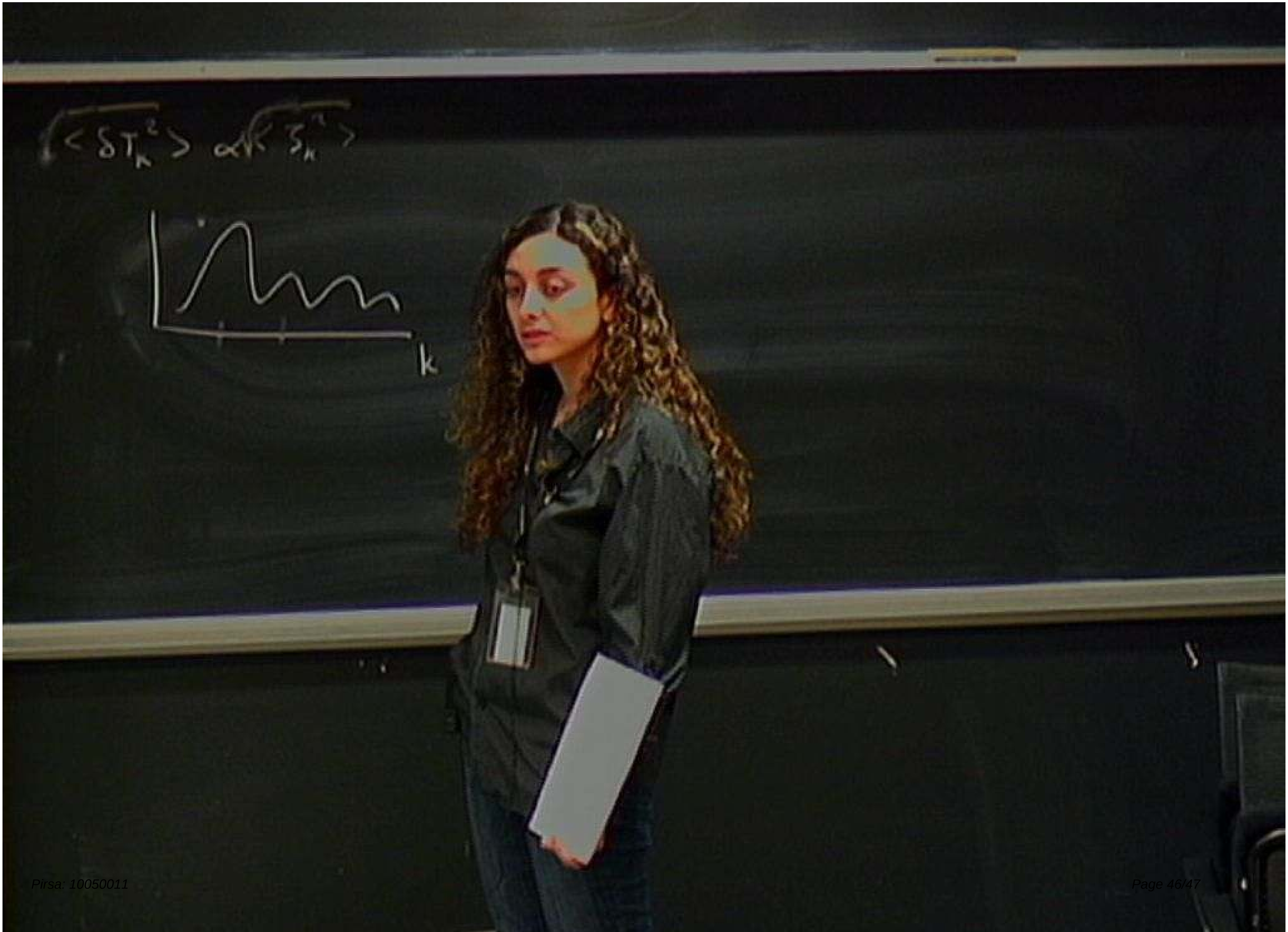




$c_s = \frac{c}{\sqrt{3(1+R)}}$
$\nabla^2\phi \propto \delta\rho$
$\propto \delta T$
$d\eta = \frac{dt}{a}$


$\sqrt{\langle \delta T_k^2 \rangle} \propto \sqrt{\langle \zeta_k^2 \rangle}$


k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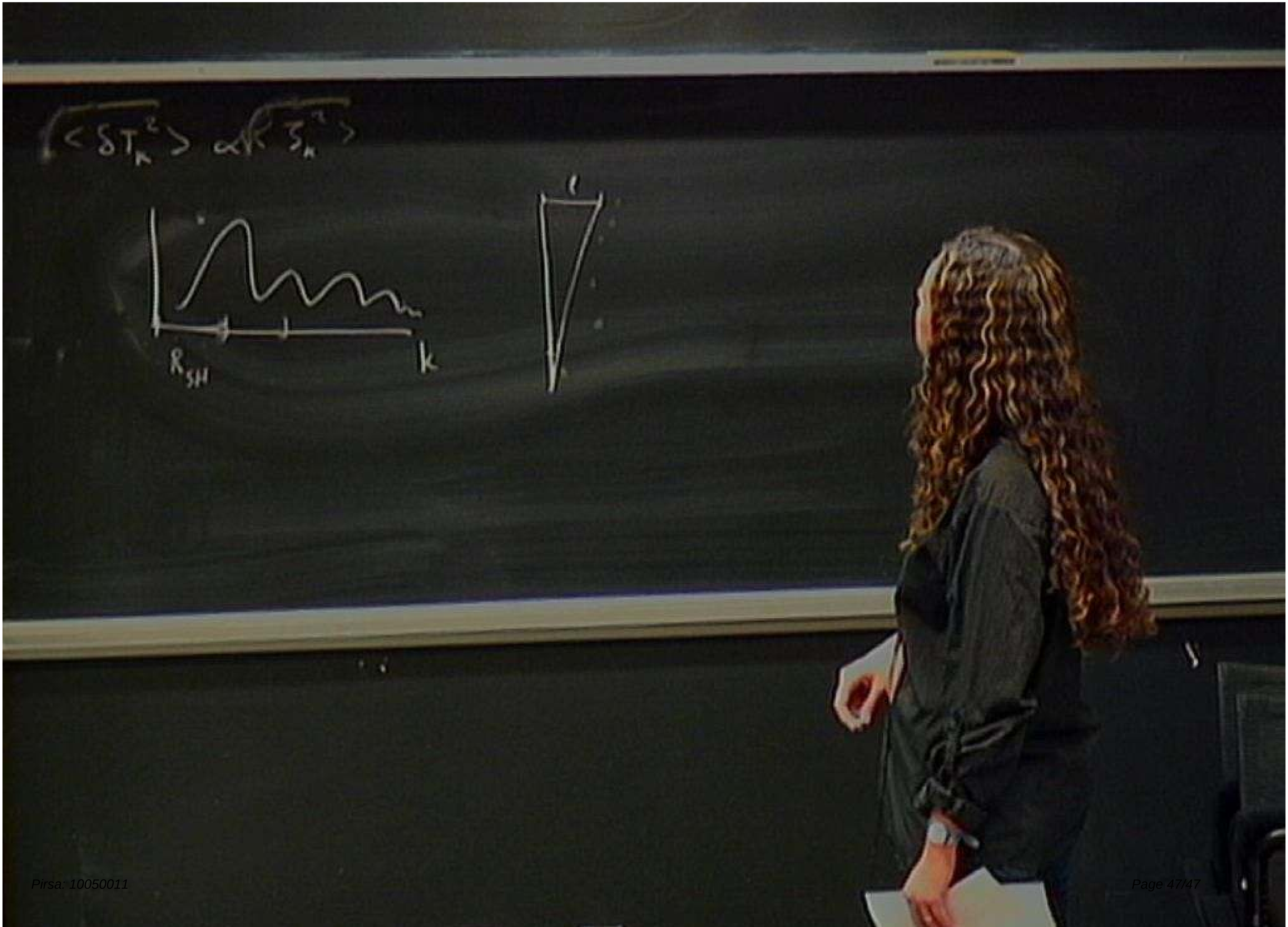
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