Title: PSI - Research Skills 1C

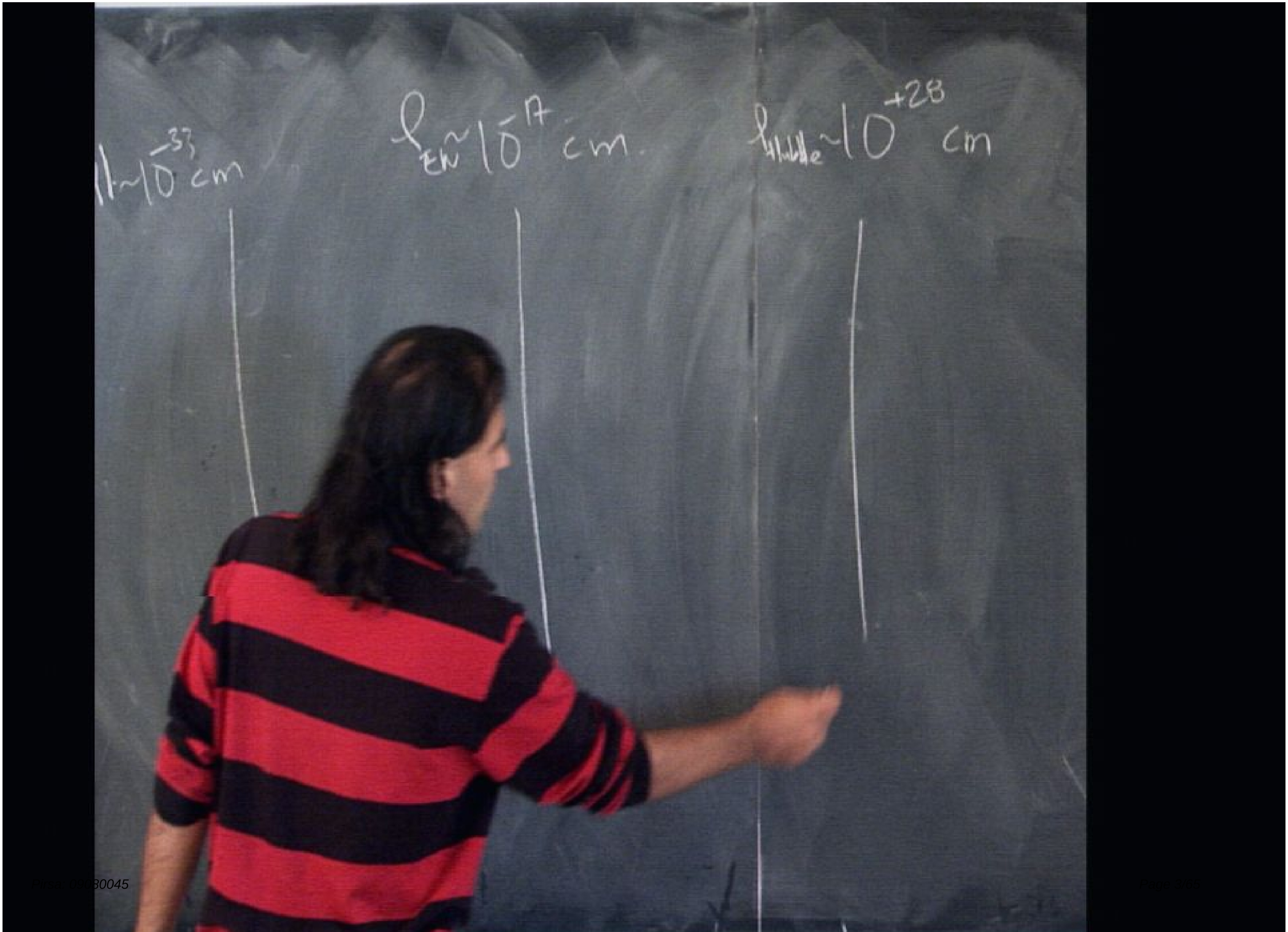
Date: Aug 24, 2009 01:00 PM

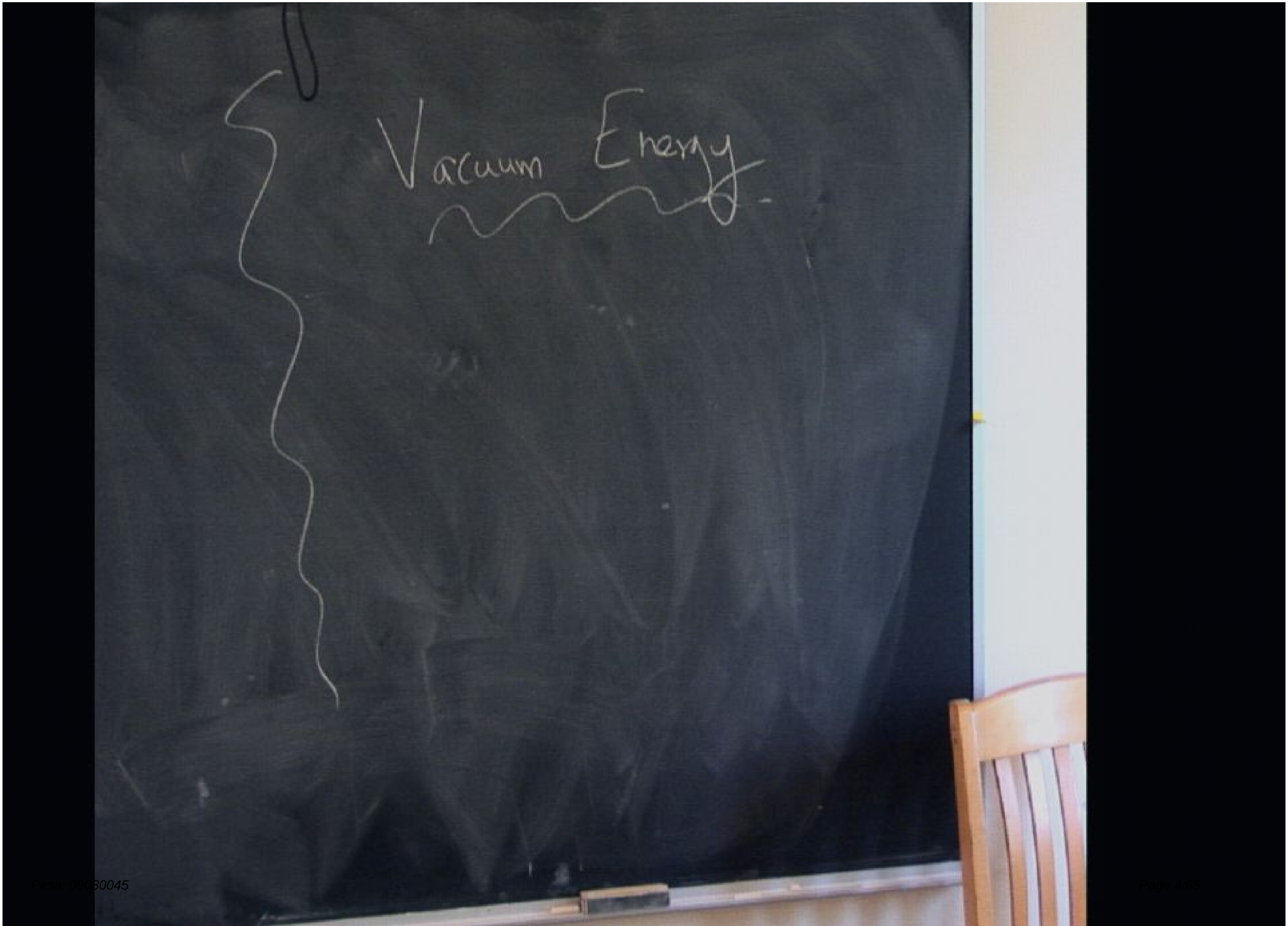
URL: http://pirsa.org/09080045

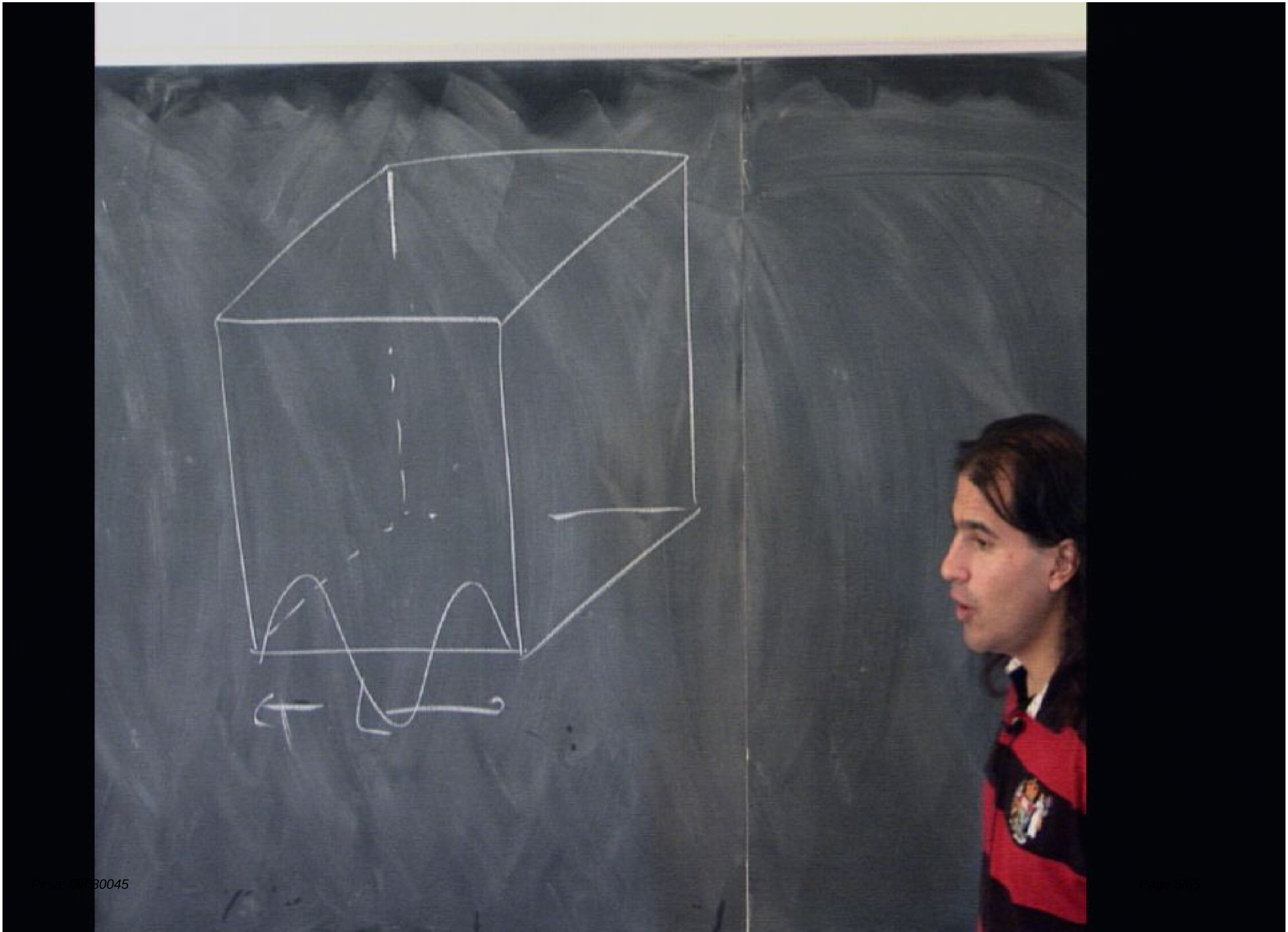
Abstract:

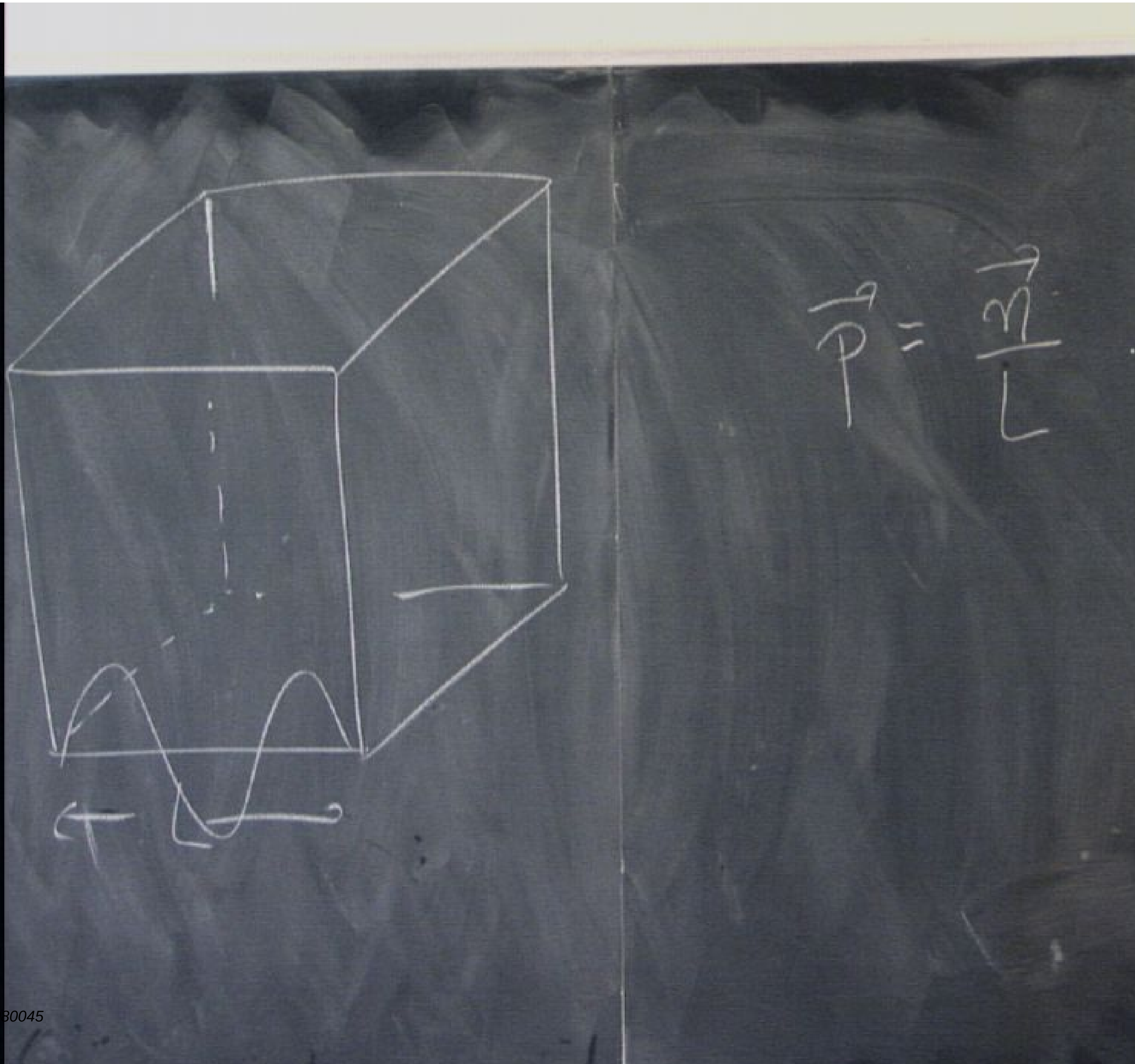
$$\frac{G m m}{r}\left(1 - \frac{1917}{\pi^3}\frac{\ell_{pl}^2}{r^2}\right) + \ldots$$

$$\delta^3(r)$$


$l \sim 10^{-33}$ cm
$l_{EW} \sim 10^{-17}$ cm.
$l_{Hubble} \sim 10^{+28}$ cm


Vacuum Energy





L
$\vec{p} = \frac{\vec{n}}{L}$

$$\vec{p} = \frac{\vec{n}}{L} = \frac{(n_1, n_2, n_3)}{L}$$

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$$\omega = \sqrt{p^2 + m^2}$$

$$\vec{p} = \frac{\vec{n}}{L} = \frac{(n_1, n_2, n_3)}{L}$$

$$\omega = \sqrt{p^2 + m^2} = \sqrt{\left(\frac{\vec{n}}{L}\right)^2 + m^2}$$

$$E^{vac} = \sum \frac{1}{2}\,\omega$$

$$= \sum_{\vec{n}} \sqrt{\frac{\vec{n}^{\,2}}{L^2} + m^2}$$

$$= \sum \frac{\quad}{2}$$

$$= \sum_{\vec{n}} \sqrt{\frac{\vec{n}^2}{L^2} + m^2}$$

$$= V \int d^3p \, \sqrt{p^2 + m^2}$$

$$\rho^{vac} = \frac{E^{vac}}{V}$$

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$$= \int d^3p \sqrt{p^2 + m^2}$$

$$= \frac{\quad}{V}$$

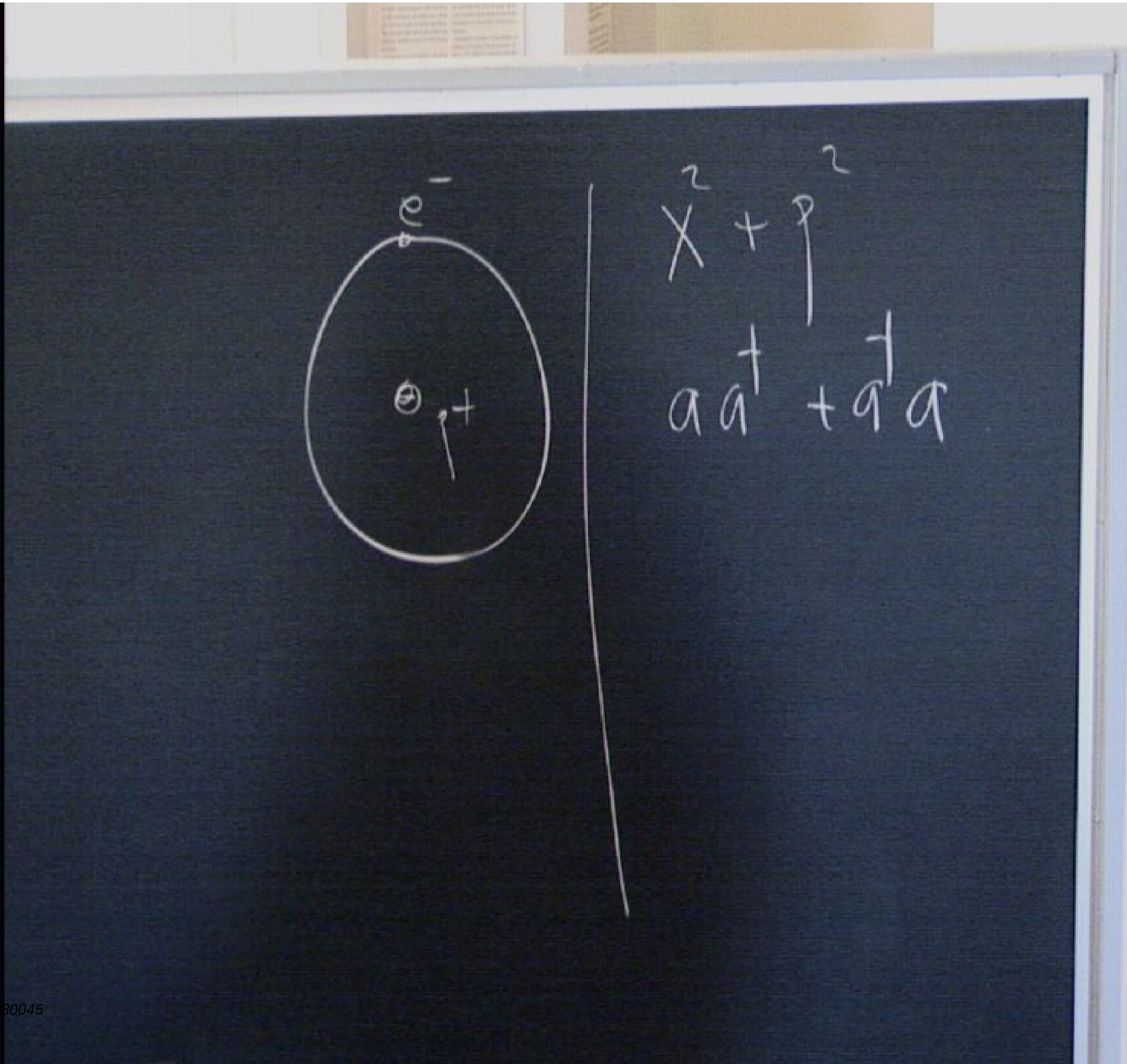
$$= \int d^3p \sqrt{p^2 + m^2}$$

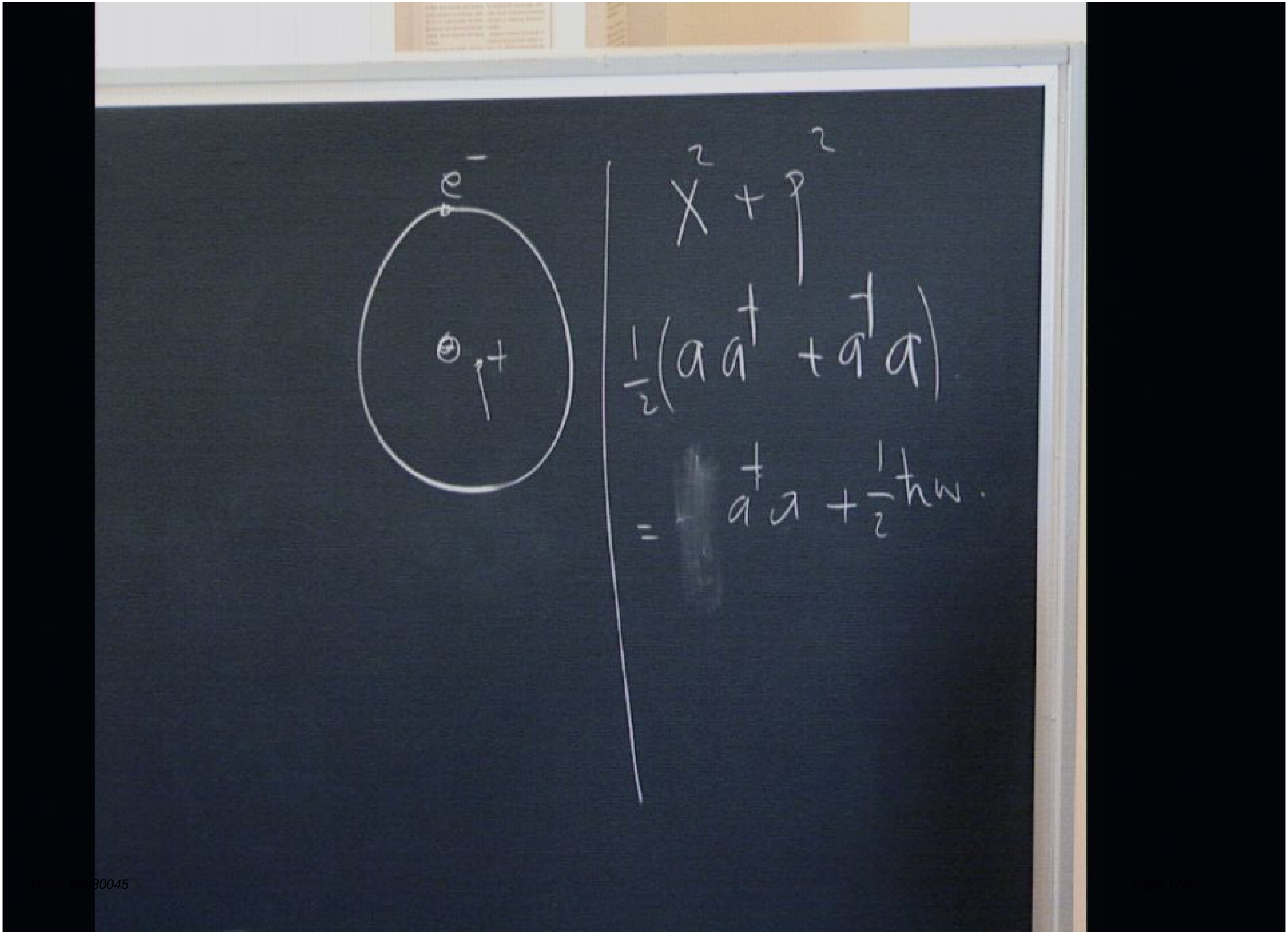
$$\rho^{vac} = \int d^3p \left(\sum_B \sqrt{p^2 + m^2} - \sum_F \sqrt{p \ldots} \right.$$

$$\rho^{vac} = \frac{E}{V}$$

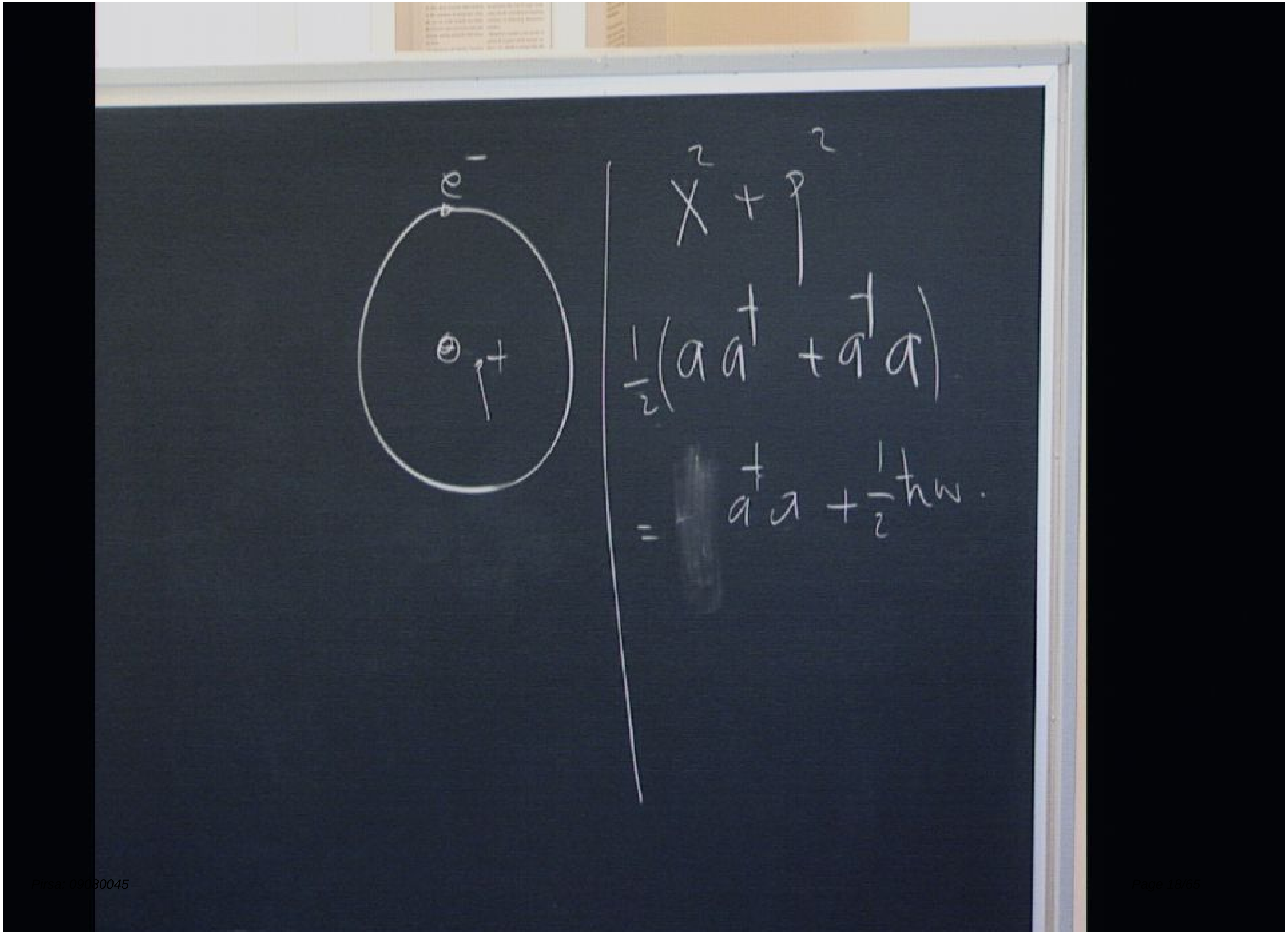
$$= \int d^3p \sqrt{p^2 + m^2}$$

$$\rho^{vac} = \int d^3p \left(\sum_B \sqrt{p^2 + m^2} - \sum_F \sqrt{p^2 + m^2} \right)$$


e^-
p^+
$x^2 + p^2$
$aa^\dagger + a^\dagger a$



e^-
p^+
$X^2 + P^2$
$\frac{1}{2}(aa^\dagger + a^\dagger a)$
$= a^\dagger a + \frac{1}{2}\hbar\omega.$


e^-
p^+
$X^2 + P^2$
$\frac{1}{2}(aa^\dagger + a^\dagger a)$
$= a^\dagger a + \frac{1}{2}\hbar w.$

$$\rho^{vac} = \int d^3p \sqrt{p^2+m^2}$$

$$\rho^{vac} = \int d^3p \sqrt{p^2+m^2}$$

$$\int_x^y \frac{dt}{t}$$

$$\rho^{vac} = \int d^3p \sqrt{p^2+m^2}$$

$$\int_x^y \frac{dt}{t} = \log y/x$$

$$\rho^{vac} = \int d^3p \sqrt{p^2+m^2}$$

$$\int^{y} dt\, t$$

$$\int_{x}^{y} \frac{dt}{t} = \log y/x$$

$$\rho^{vac} = \int d^3p \sqrt{p^2+m^2}$$

$$\int^{p_{max}} dp\, p^2 \sqrt{p^2+m^2}$$

$$\sim$$

$$\rho^{vac} = \int d^3p \sqrt{p^2+m^2}$$

$$\int^{P_{max}} dp\, p^2 \sqrt{p^2+m^2}$$

$$\sim P_{max}^4$$

$$\rho^{vac} = \int d^3p \sqrt{p^2+m^2}$$

$$\int^{p_{max}} dp\, p^2 \sqrt{p^2+m^2}$$

$$\sim p_{max}^4 + p_{max}^2 m^2$$

$$\rho^{vac} = \int d^3p \sqrt{p^2+m^2}$$

$$\int^{p_{max}} dp\, p^2 \sqrt{p^2+m^2}$$

$$\sim p_{max}^4 + p_{max}^2 m^2 + m^4$$

$$\rho^{vac} = \int d^3p \sqrt{p^2+m^2}$$

$$\int^{p_{max}} dp\, p^2 \sqrt{p^2+m^2}$$

$$\sim p_{max}^4 + p_{max}^2 m^2 + m^4 \log$$

$$\int dp\, p^3 \sqrt{1+\frac{m^2}{p^2}}$$

$$= \int dp\, p^3 \left[1+\frac{m^2}{p^2}+\frac{m^4}{p^4}+\cdots\right]$$

$$\int dp\, p^3 \sqrt{1+\frac{m^2}{p^2}}$$

$$= \int dp\, p^3 \left[1 + \frac{1}{2}\frac{m^2}{p^2} - \frac{1}{8}\frac{m^4}{p^4} + \cdots \right]$$

$$\int dp\, p^3 \sqrt{1 + \frac{m^2}{p^2}} \qquad \int \frac{dp}{p}$$

$$= \int^{p_{max}} dp\, p^3 \left[1 + \frac{1}{2}\frac{m^2}{p^2} - \frac{1}{8}\frac{m^4}{p^4} + \cdots \right]$$

$$\sim p_{max}^4 + p_{max}^2 m^2$$

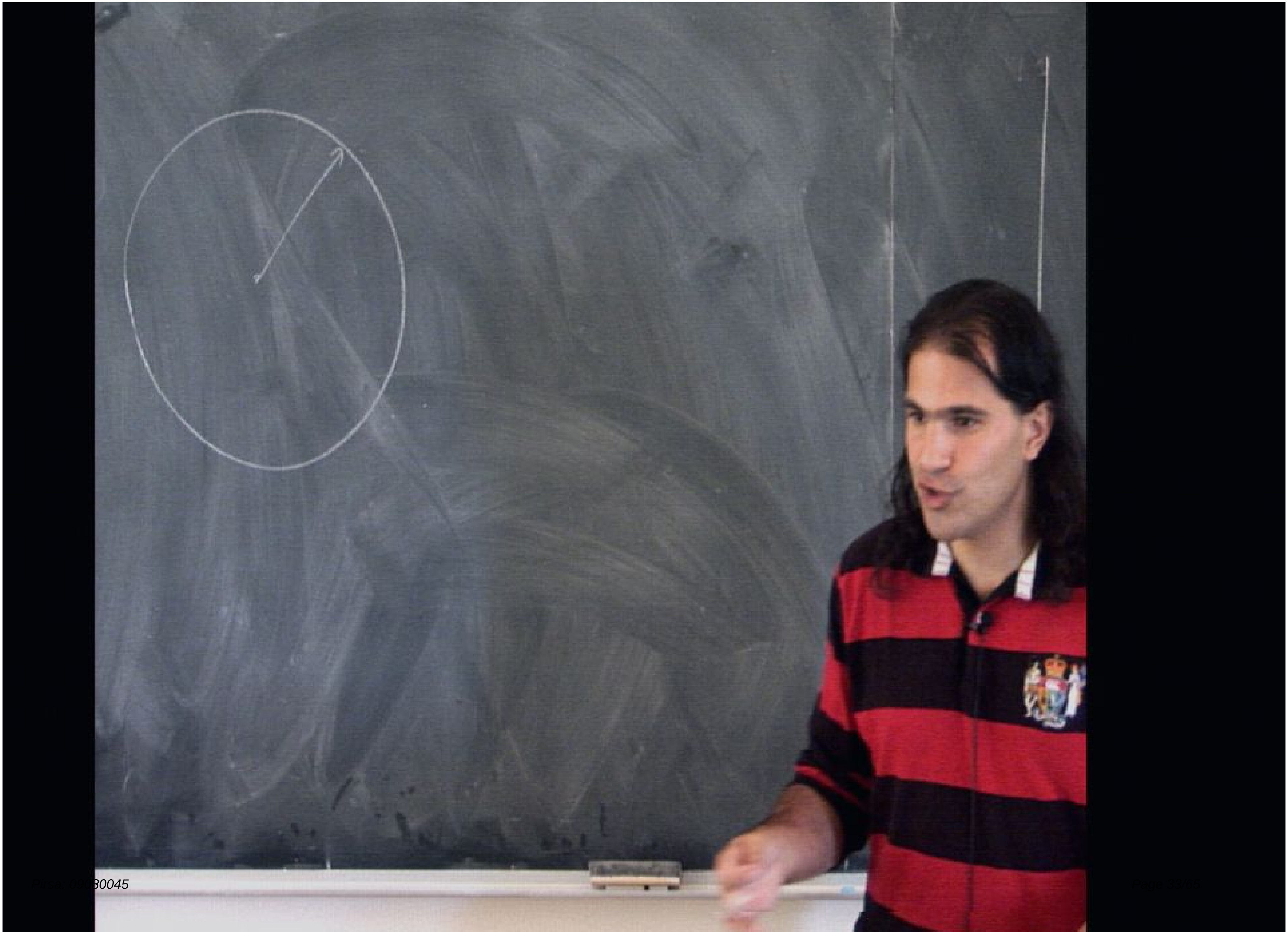
$$\int dp\, p^3 \sqrt{1 + \frac{m^2}{p^2}} \qquad \int \frac{dp}{p}$$

$$= \int^{p_{max}} dp\, p^3 \left[1 + \frac{1}{2}\frac{m^2}{p^2} - \frac{1}{8}\frac{m^4}{p^4} + \cdots \right]$$

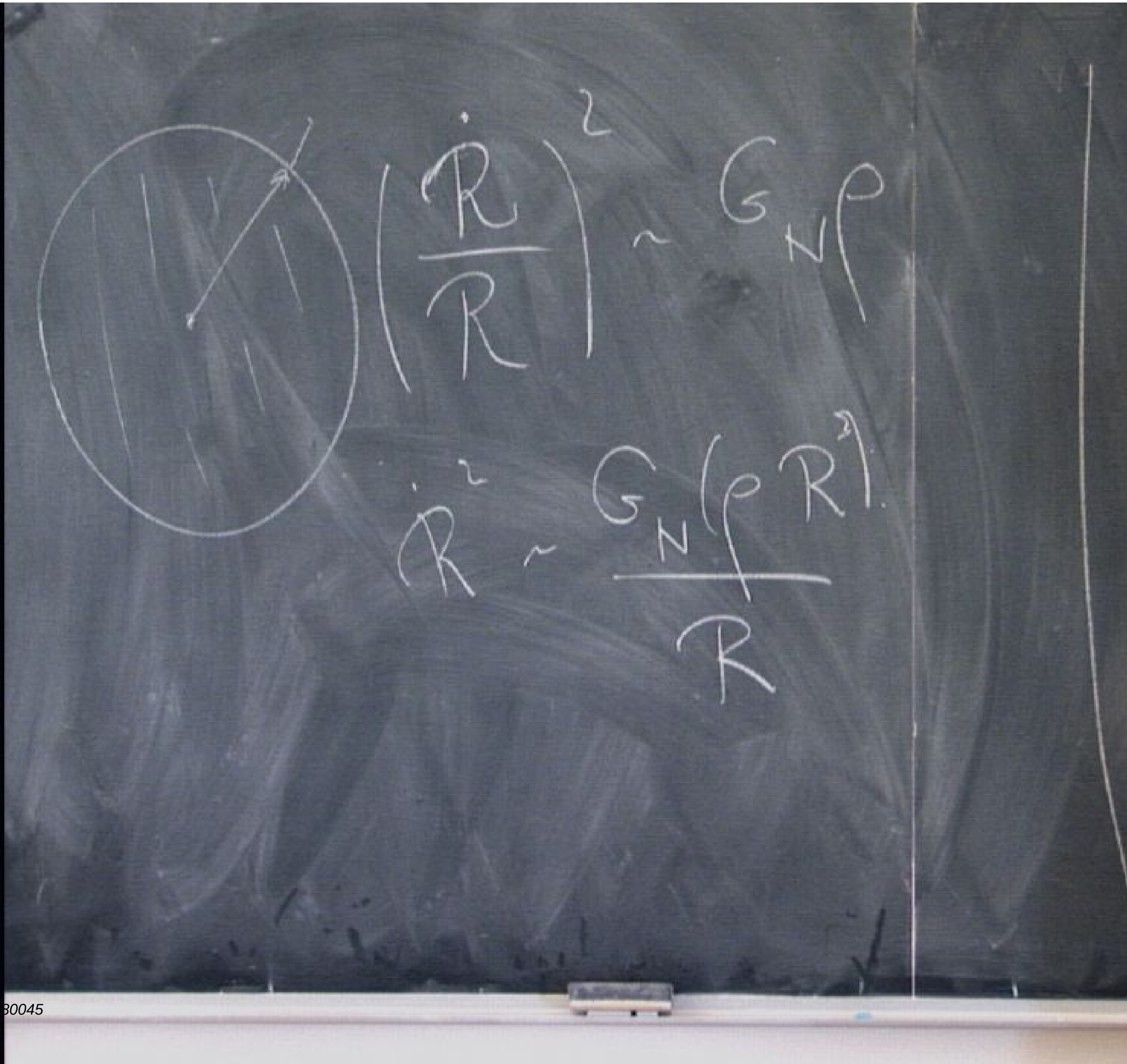
$$\sim p_{max}^4 + p_{max}^2 m^2 + m^4 \log \frac{p_{max}}{m}$$

$$\rho_{max} \sim M_{pl}$$

$$\rho^{vac} \sim M_{pl}^{4}$$

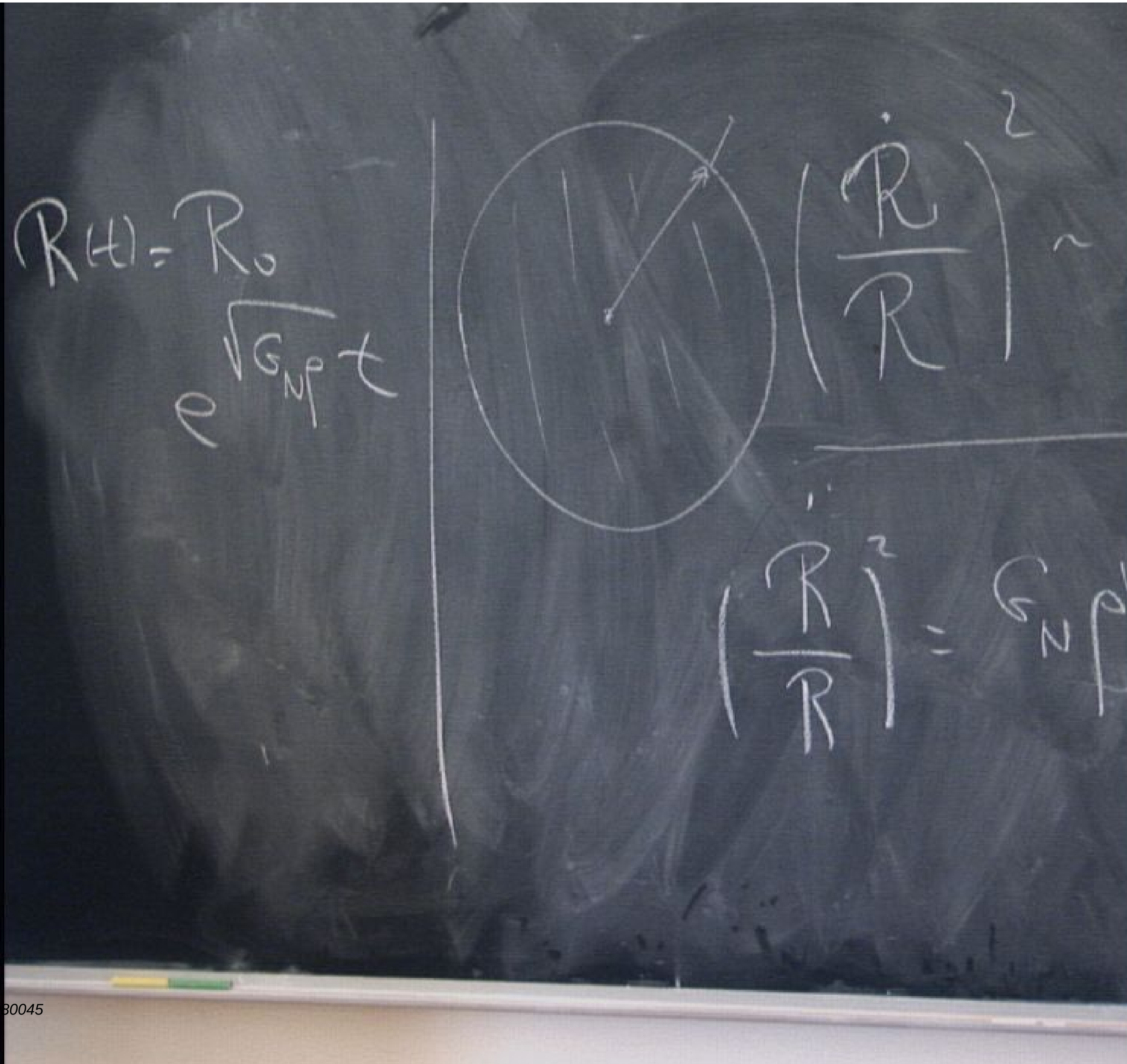



$\left(\frac{\dot{R}}{R}\right)^2 \sim G_N \rho$

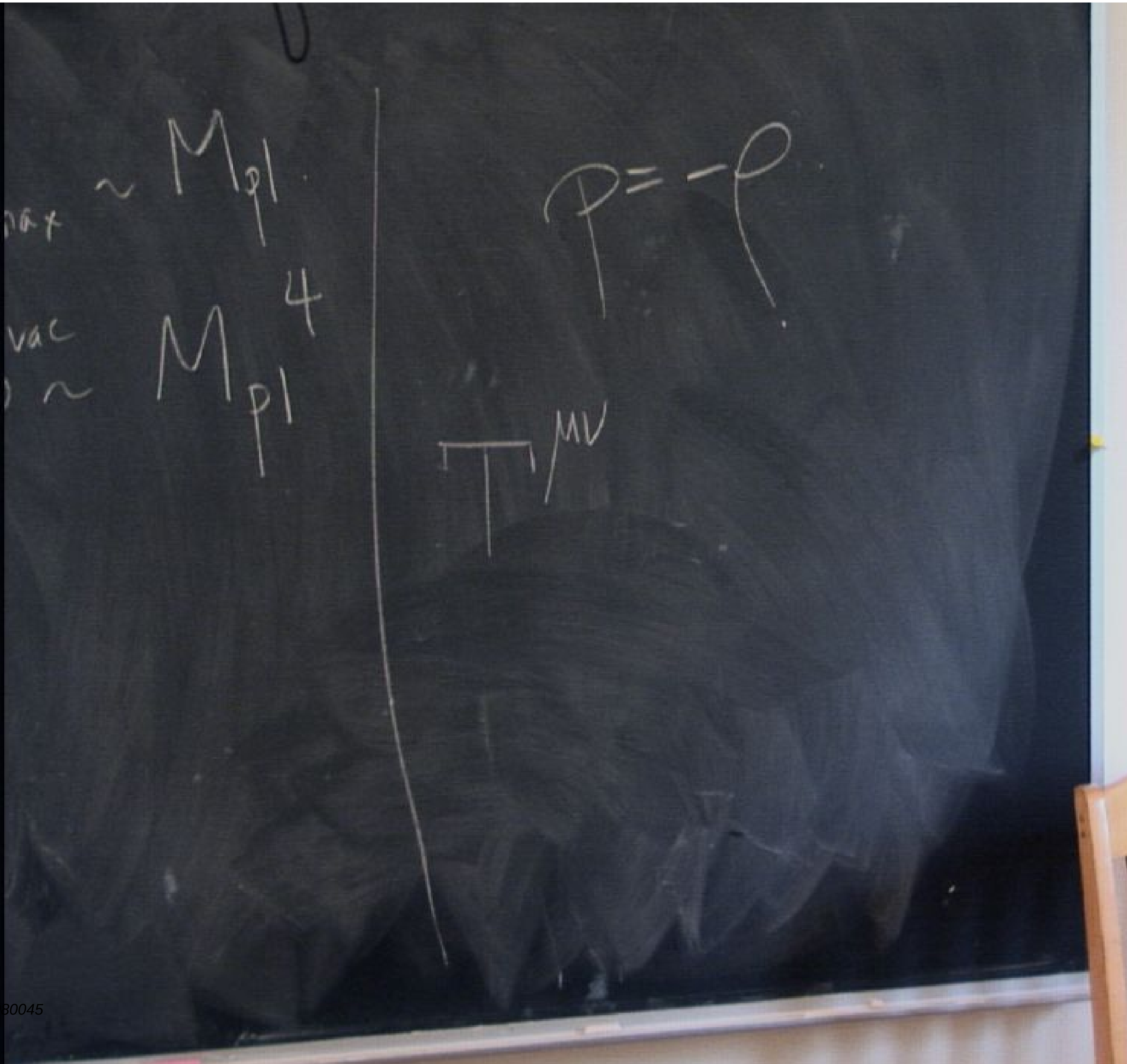

$\left(\frac{\dot{R}}{R}\right)^2 \sim G_N \rho$
$\dot{R}^2 \sim \frac{G_N (\rho R^3)}{R}$

$$\left(\frac{\dot{R}}{R}\right)^2 \sim G_N \rho$$

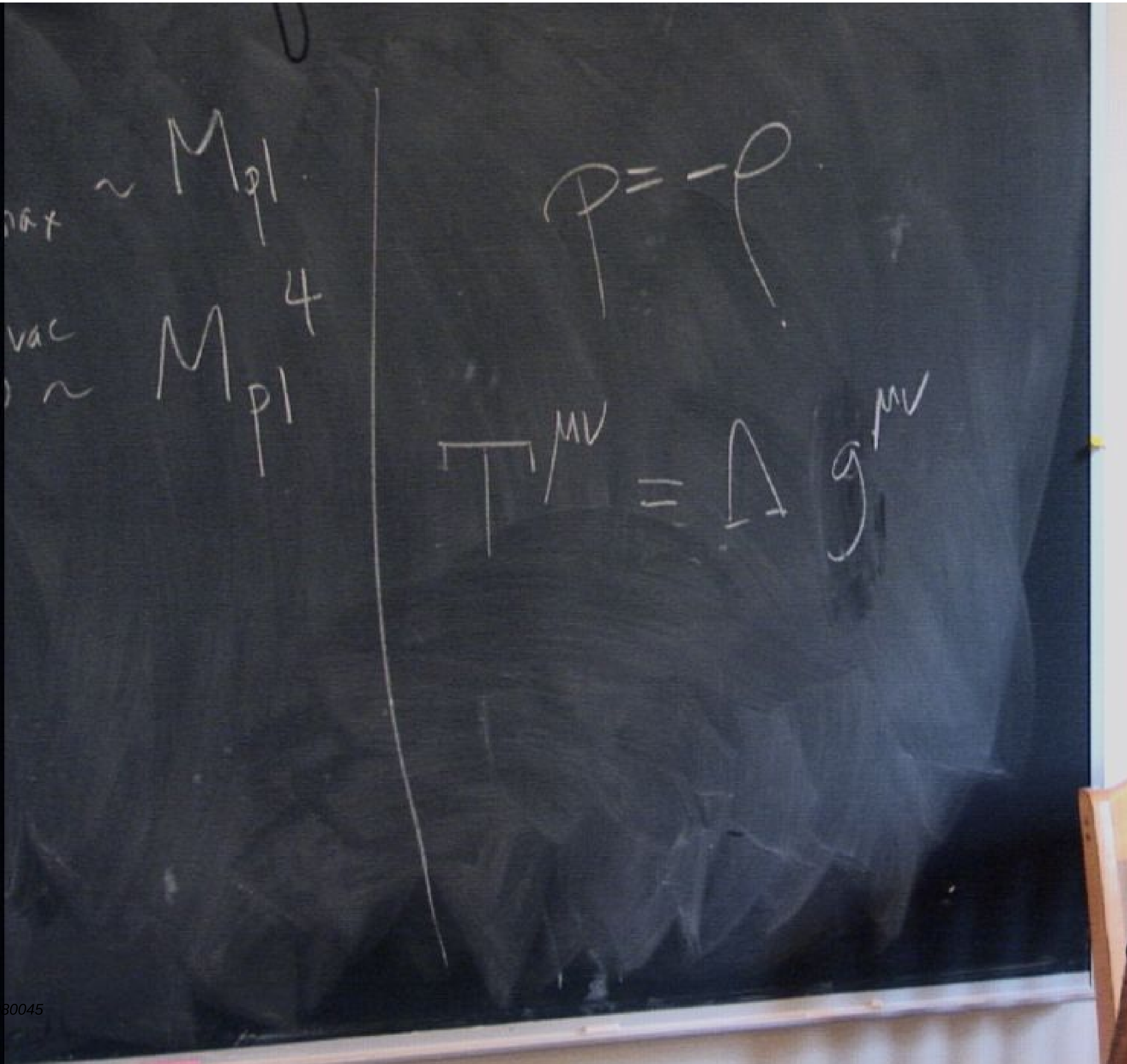
$$\left(\frac{\dot{R}}{R}\right)^2 = G_N \rho^{vac}$$

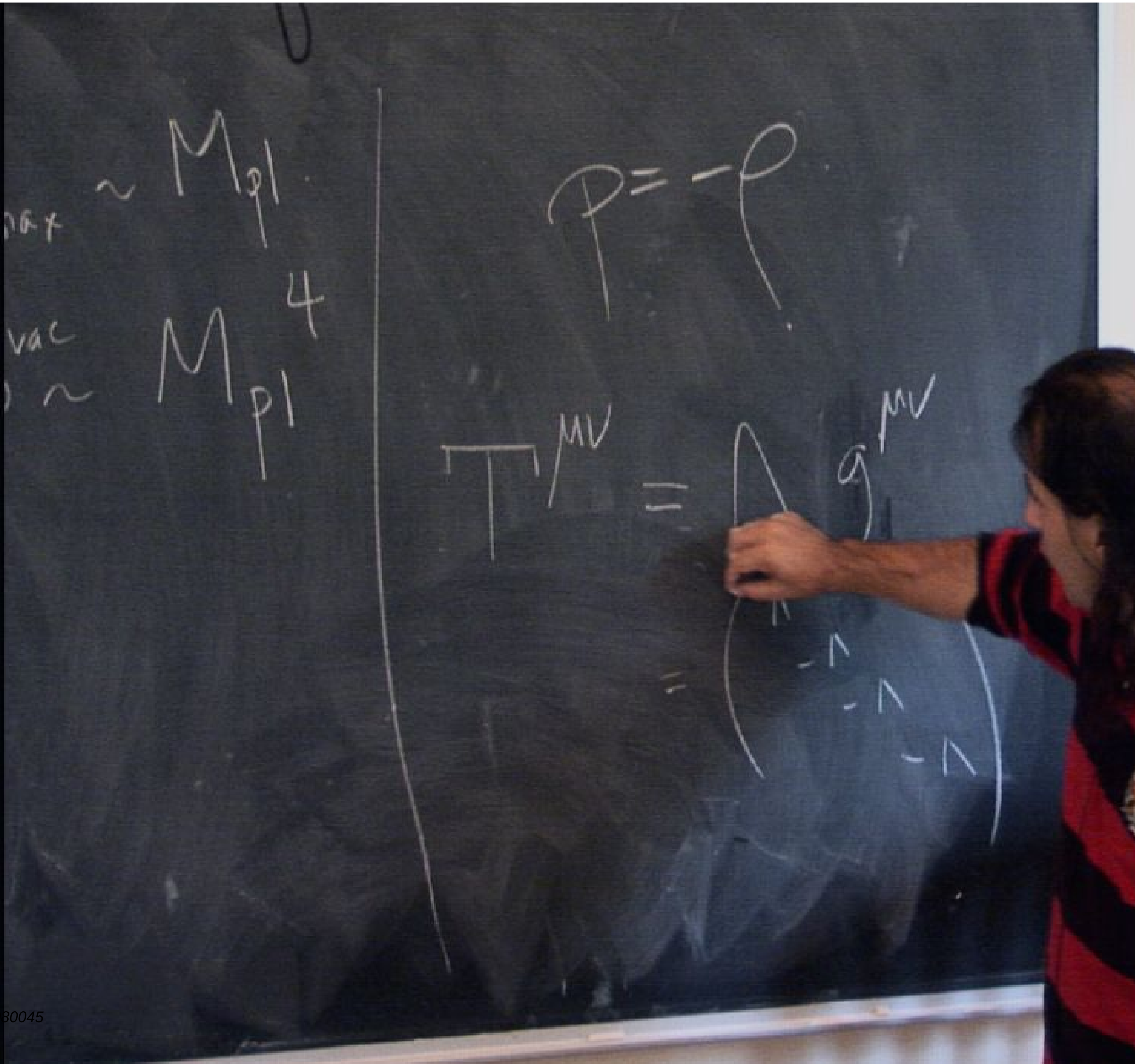


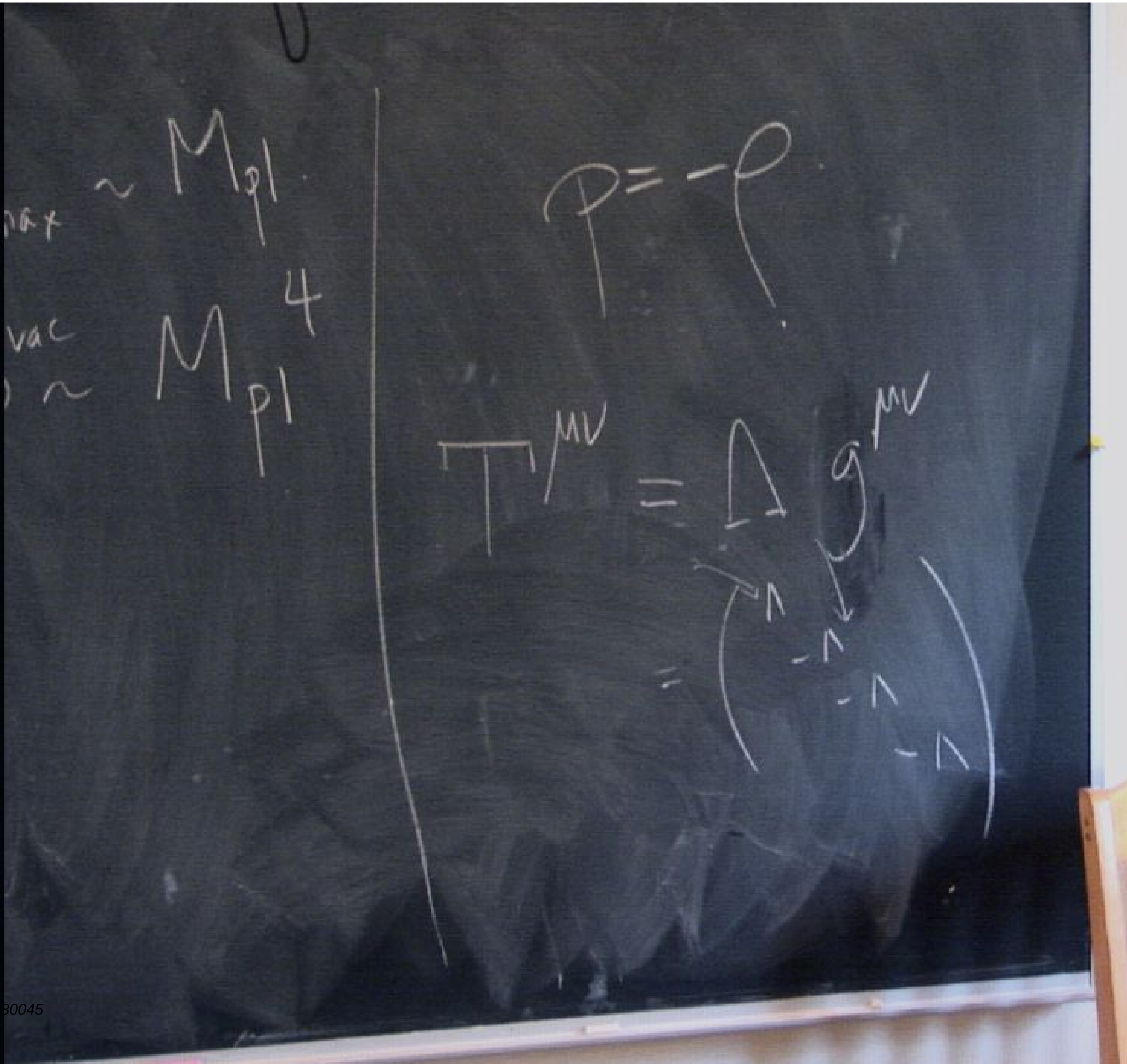
R(t) = R₀ e^√(G_N ρ) t
(Ṙ/R)² ~
(Ṙ/R)² = G_N ρ



~ M_{pl}
vac
~ M_{pl}^4
$p = -\rho$
$T^{\mu\nu}$


$_{max} \sim M_{pl}$
$_{vac} \sim M_{pl}^4$
$p = -\rho$
$T^{\mu\nu} = \Lambda g^{\mu\nu}$

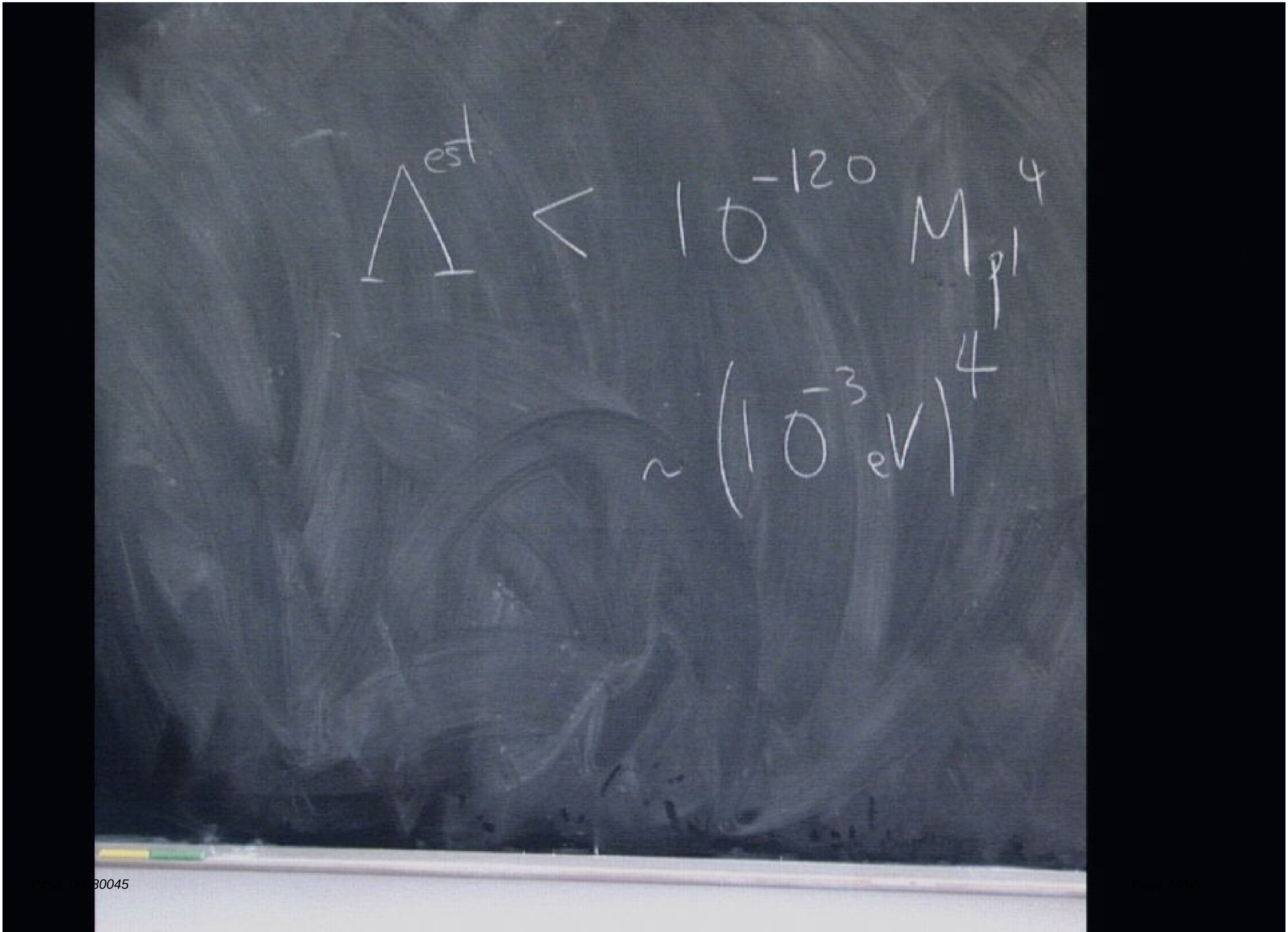

~ Mpl
vac
~ Mpl 4
p = -ρ
T μν = Λ g μν
-Λ
-Λ
-Λ



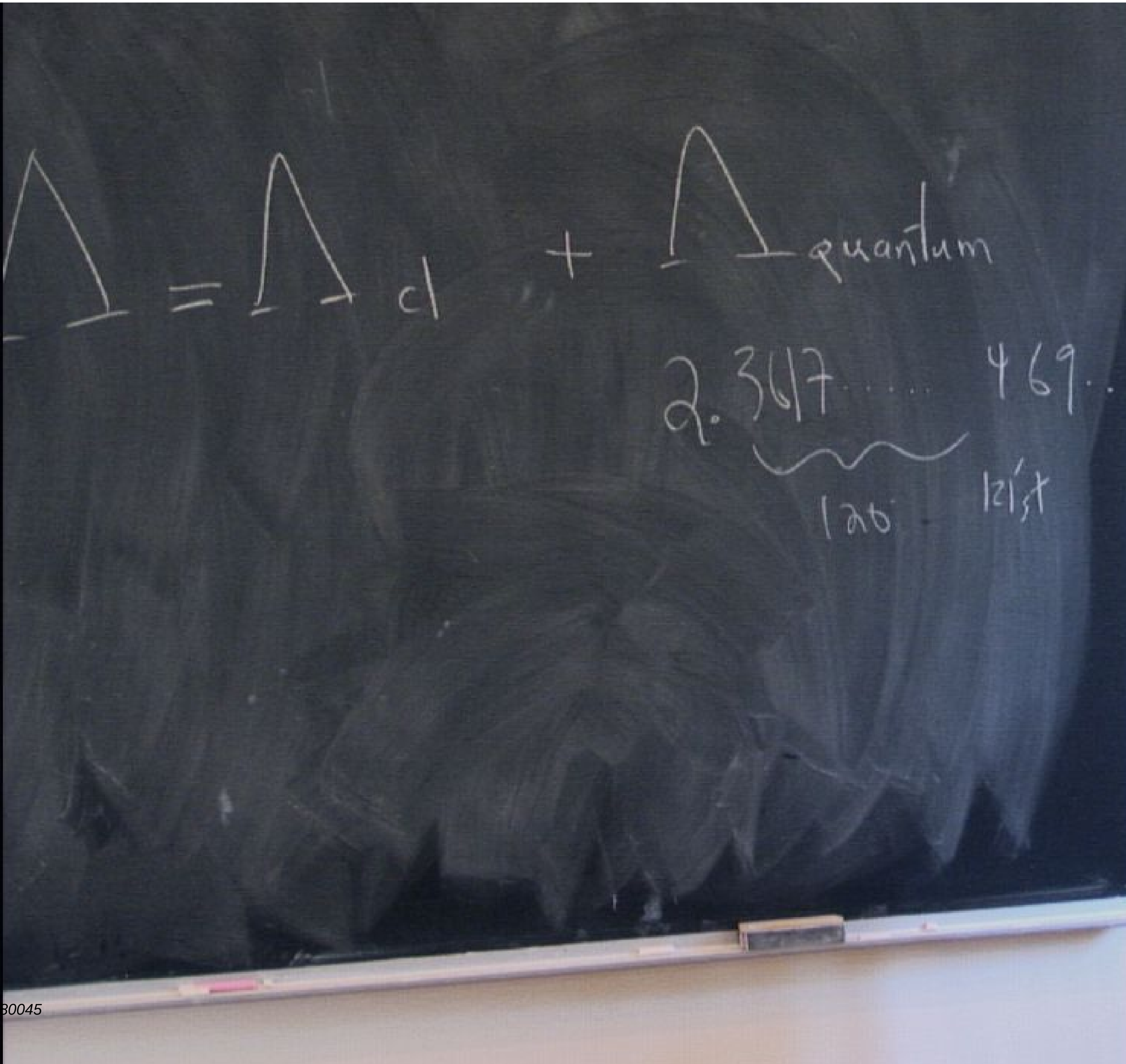
$\rho_{max} \sim M_{pl}$
$\rho_{vac} \sim M_{pl}^4$
$p = -\rho$
$T^{\mu\nu} = \Lambda g^{\mu\nu}$
$= (\Lambda, -\Lambda, -\Lambda, -\Lambda)$

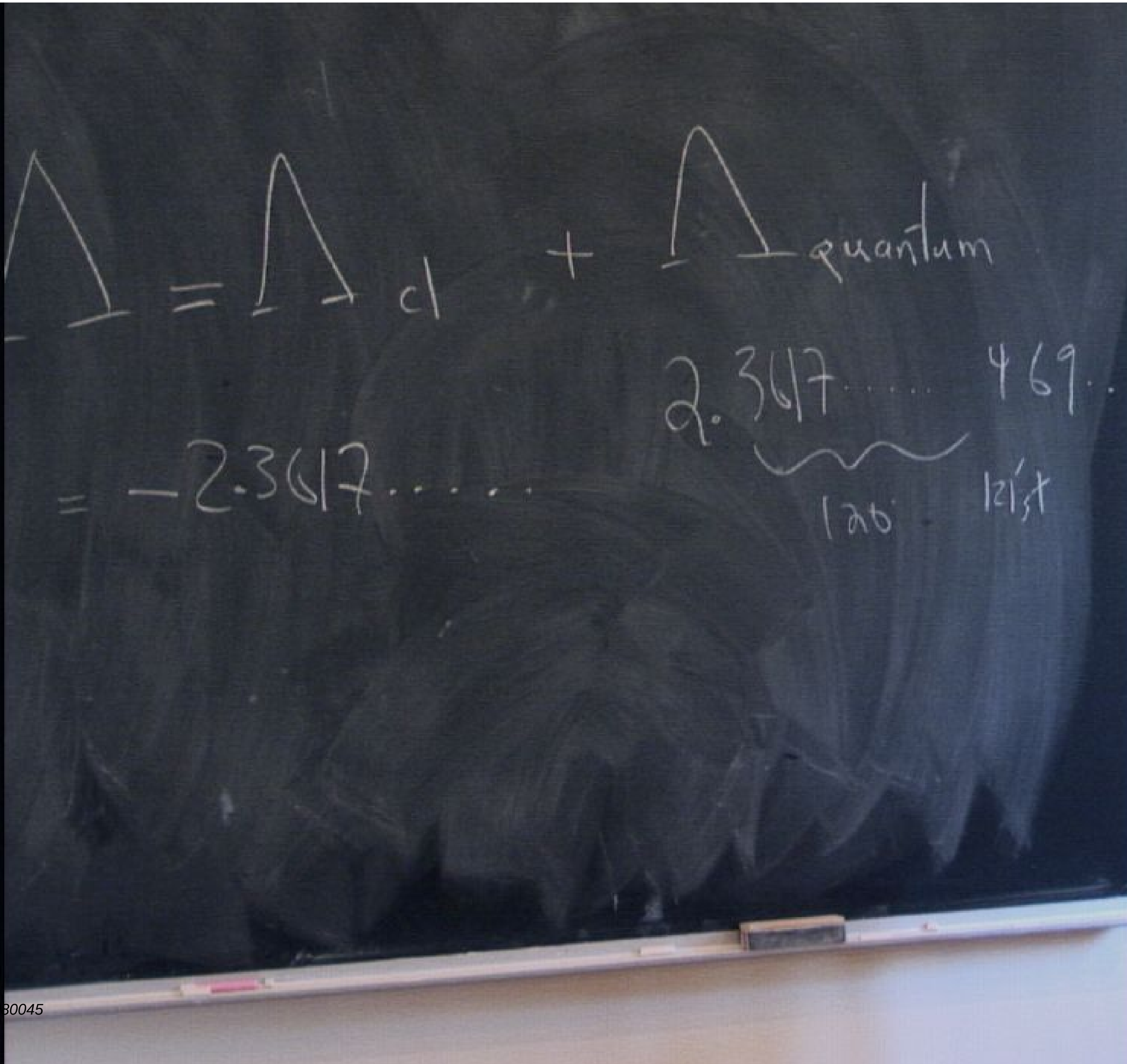
$$\Lambda < 10^{-120} M_{pl}^{4}$$

$$\sim \left(10^{-3} eV\right)^{4}$$


$\Lambda^{est} < 10^{-120} M_{pl}^4$
$\sim (10^{-3} eV)^4$


$\Lambda = \Lambda_{cl} + \Lambda_{quantum}$


$\Lambda = \Lambda_{cl} + \Lambda_{quantum}$
2.3617 ..... 469...
120
121st


Λ = Λ cl + Λ quantum
2.3617..... 469...
= −2.3617.....
120 121st

Cosmological Const. Problem:

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$$\Lambda \sim p_{max}^4 + p_{max}^2 m^2 + \cdots$$

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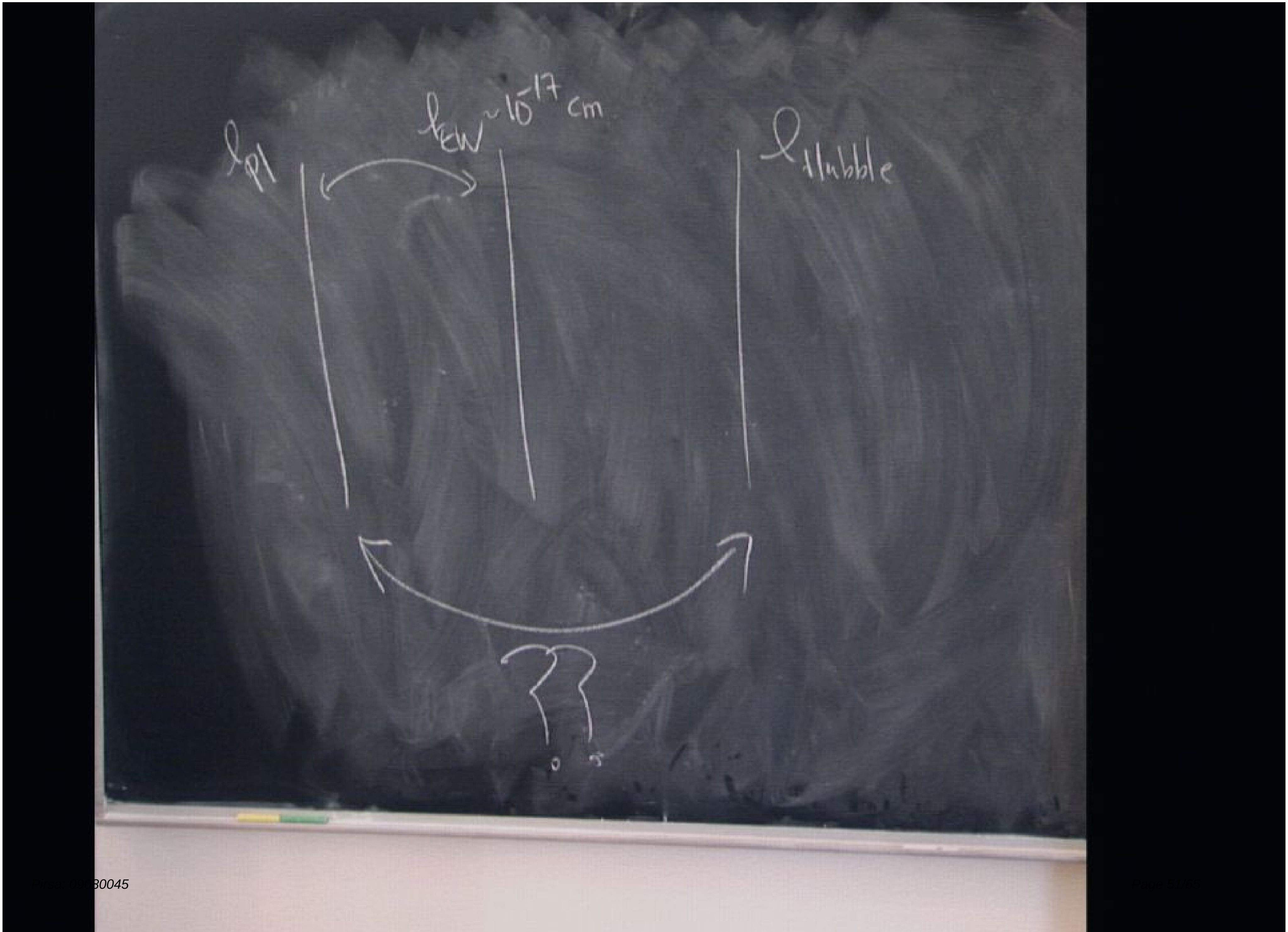
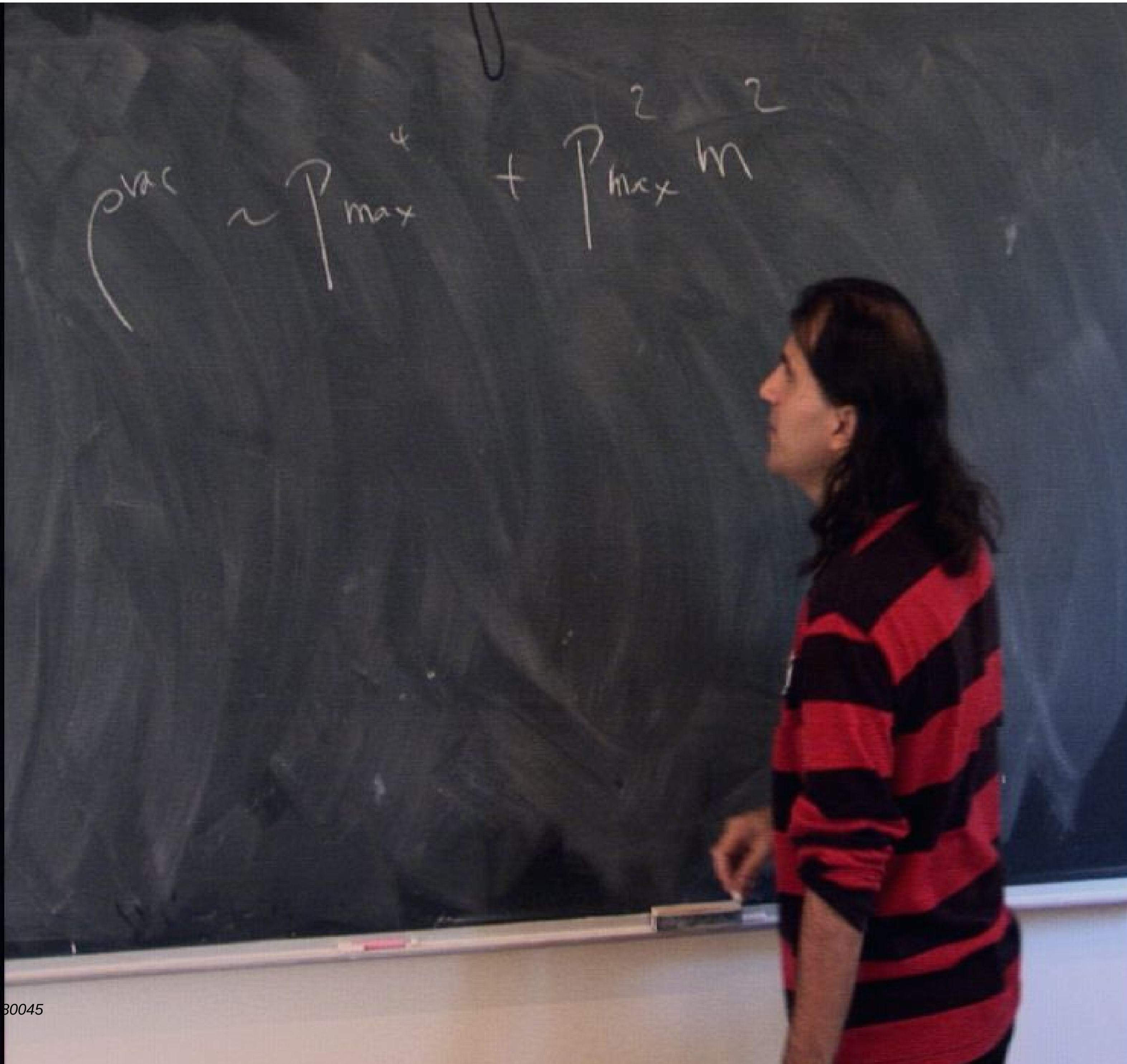
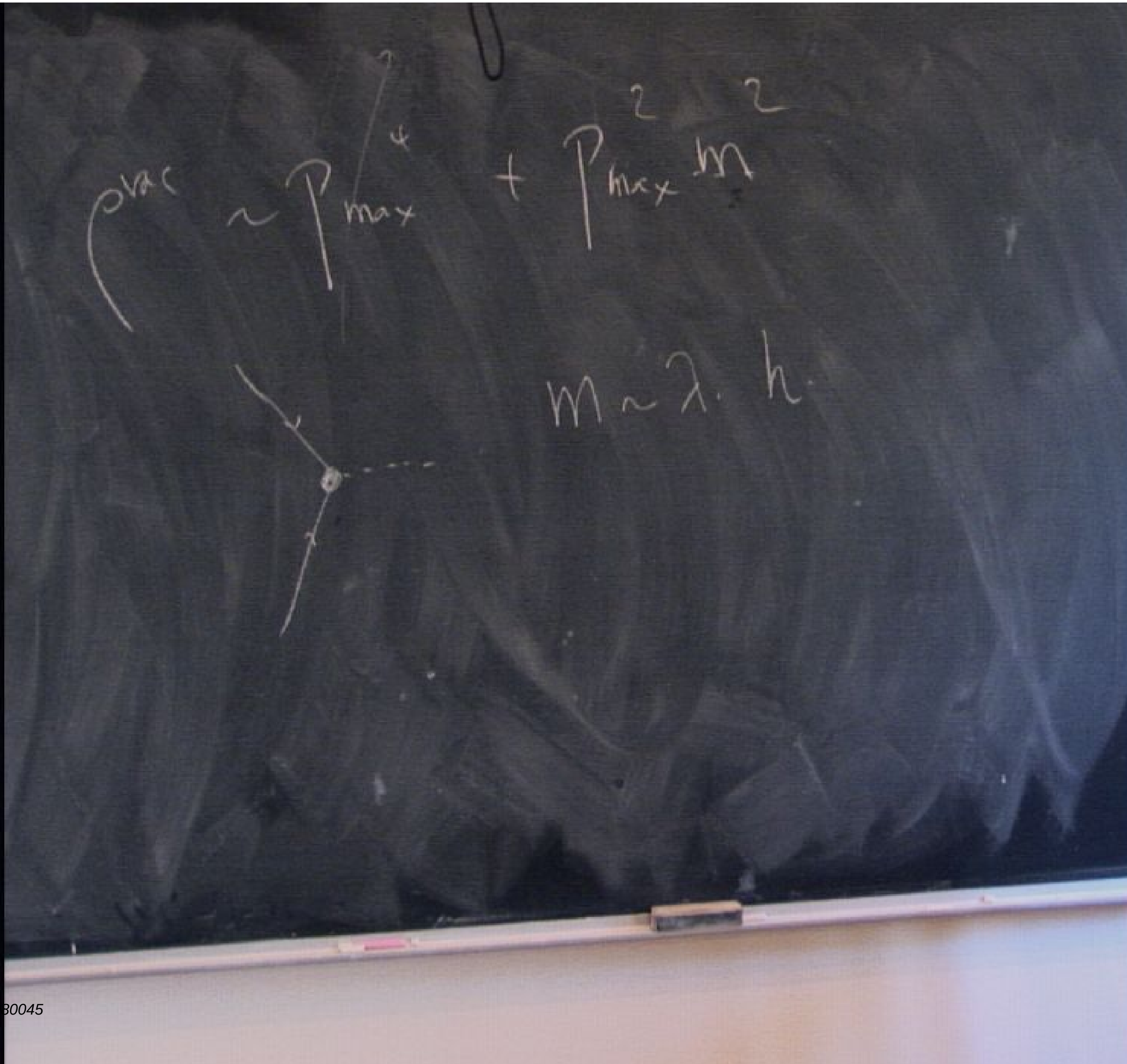
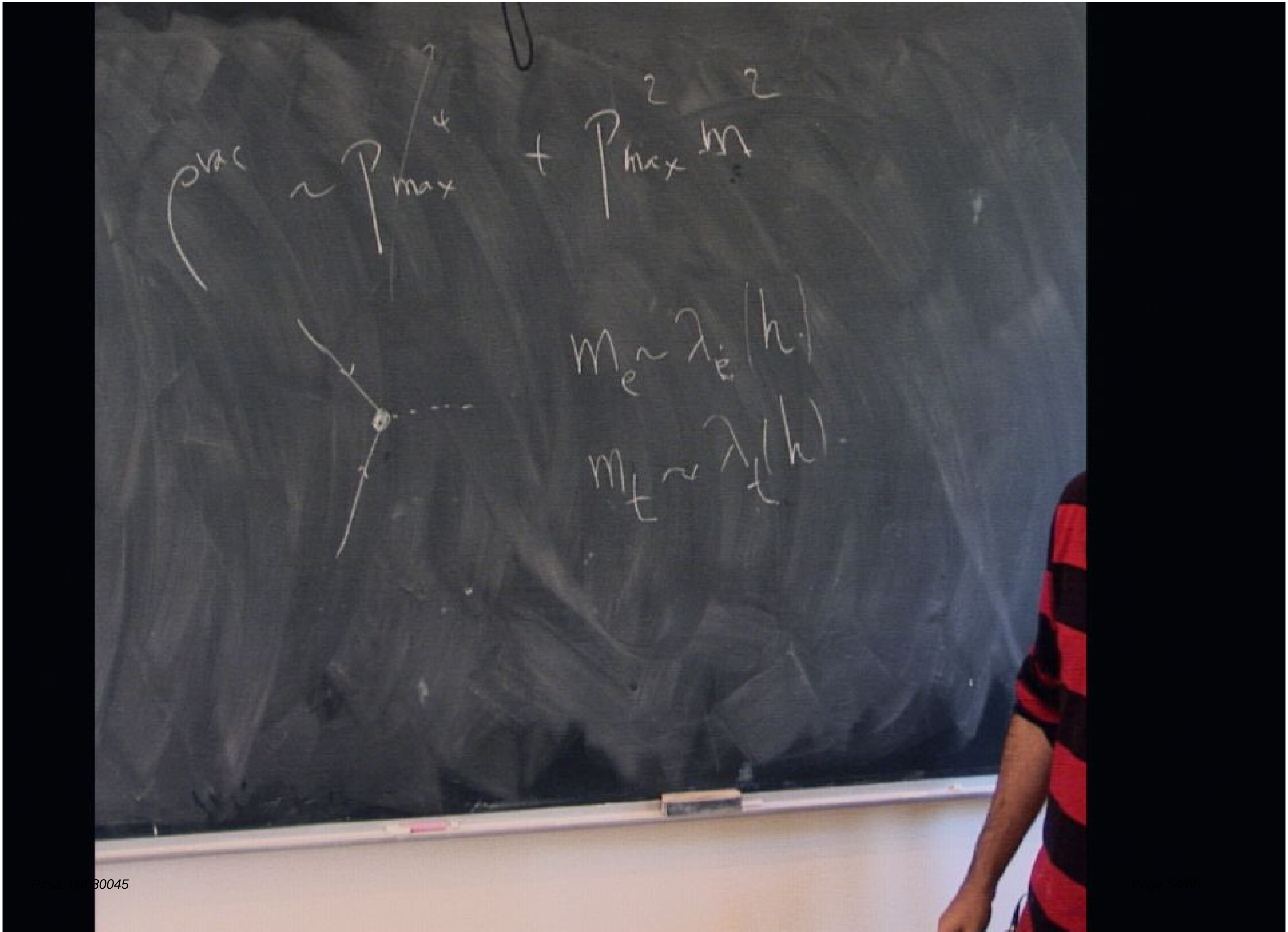
$$\Lambda \sim p_{max}^4 + p_{max}^2 m^2 + \ldots$$

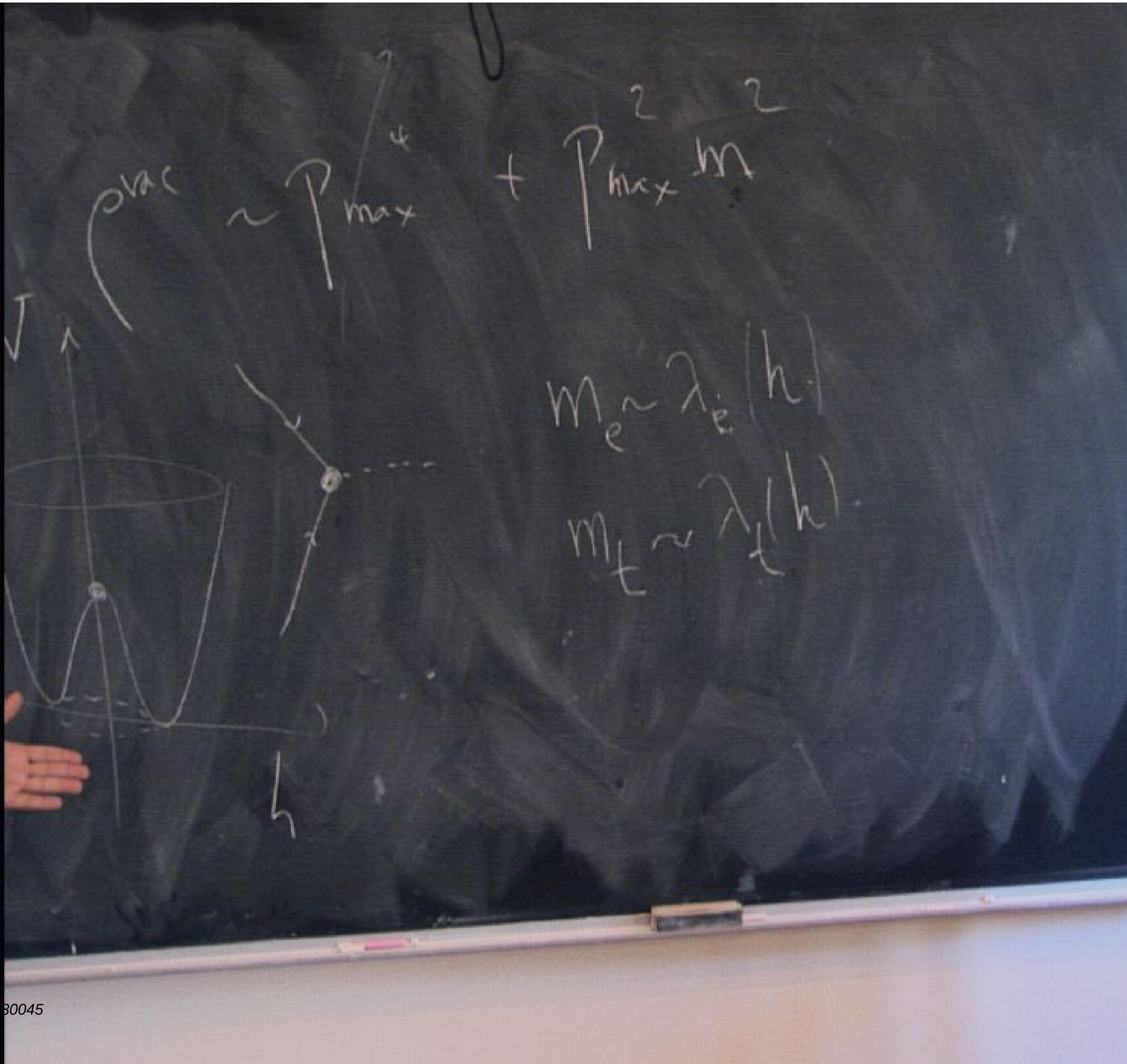
$$\rho^{vac} = \int d^3p \left(\sum_B \sqrt{p^2+m^2} - \sum_F \sqrt{p^2+m^2} \right)$$

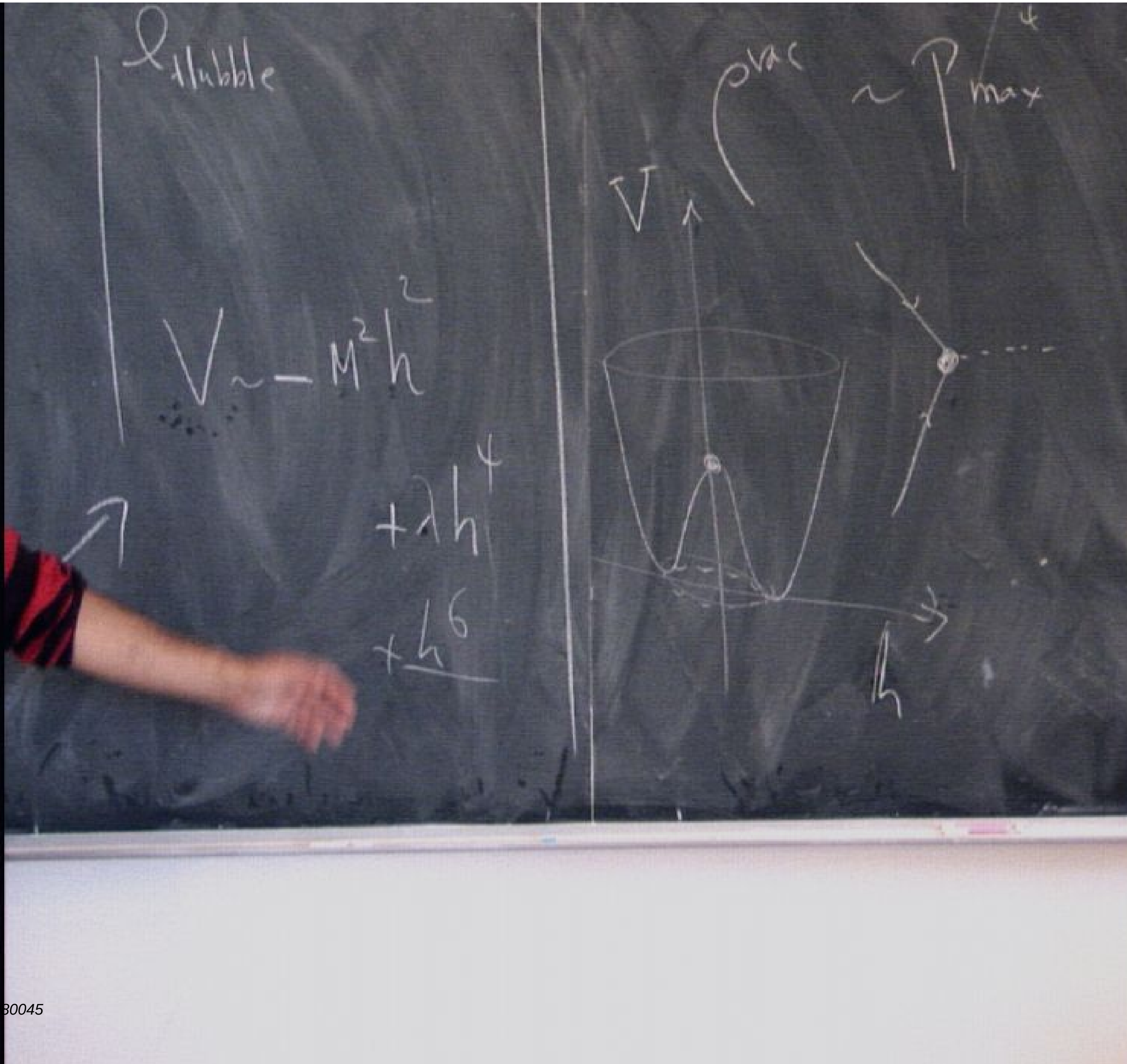

l_{Pl}
$l_{EW} \sim 10^{-17}$ cm
l_{Hubble}
??


$\rho^{vac} \sim P_{max}^4 + P_{max}^2 m^2$

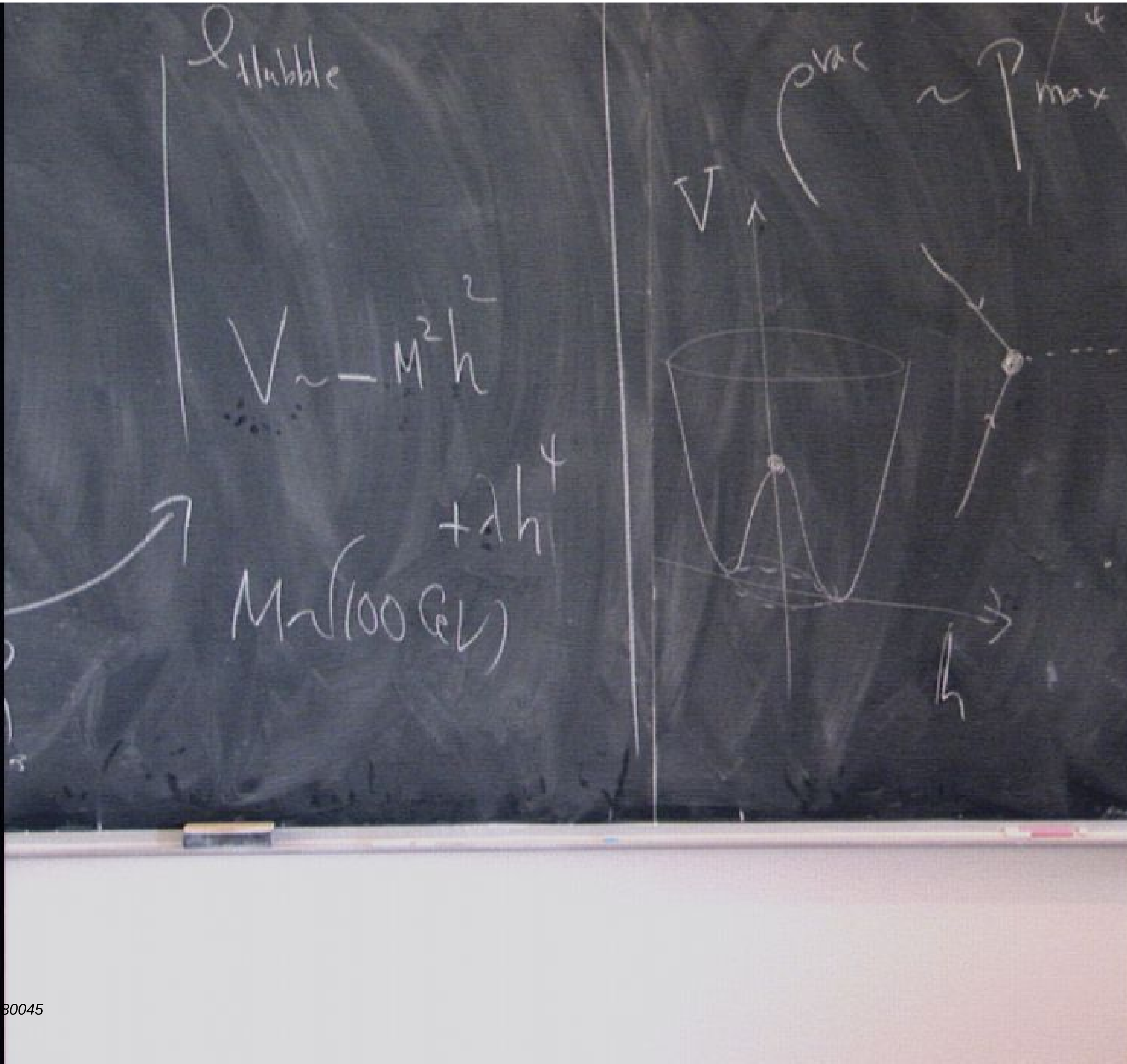

$\rho^{vac} \sim P_{max}^4 + P_{max}^2 m^2$
$m \sim \lambda \cdot h$

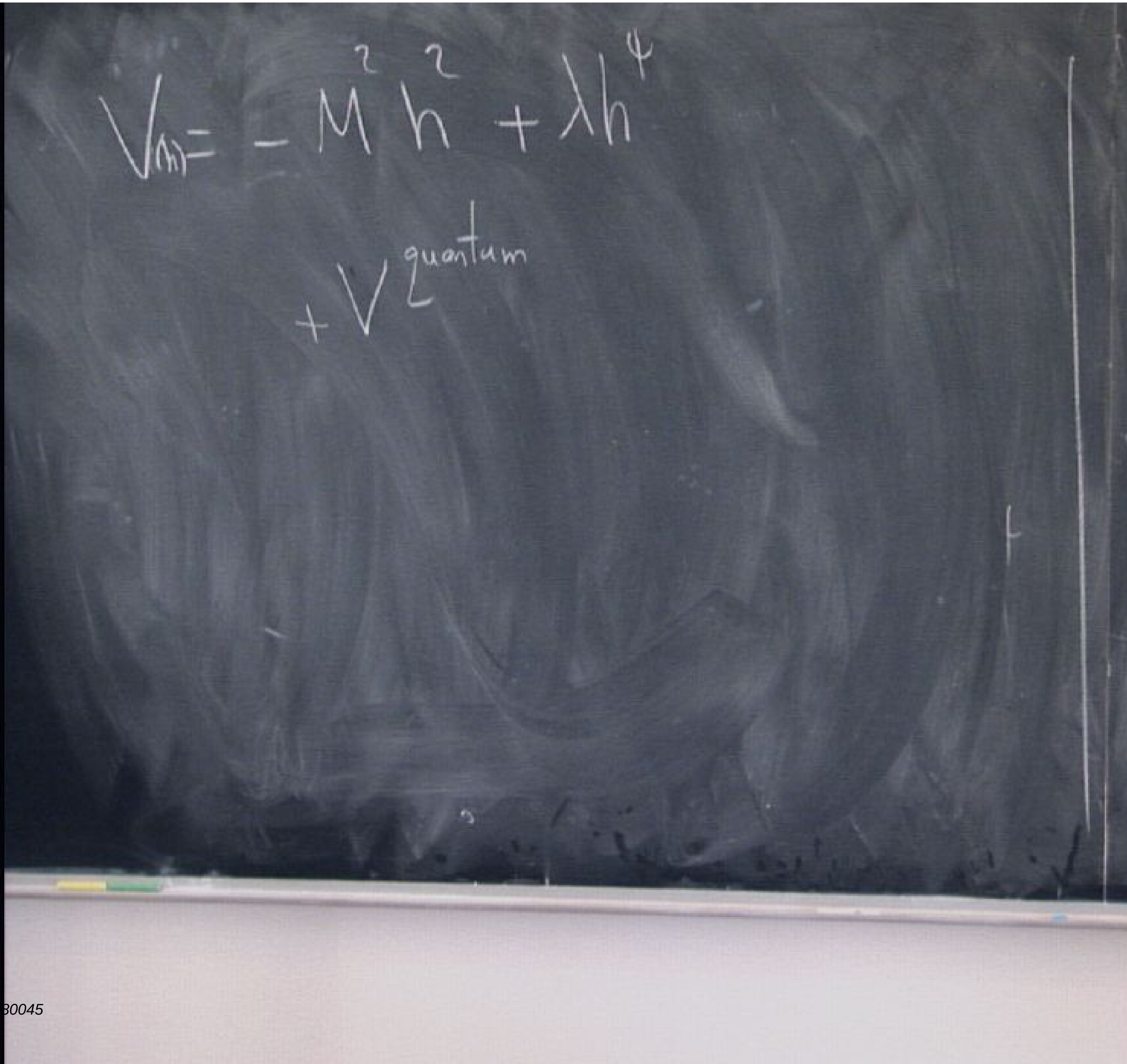

$\rho^{vac} \sim P_{max}^4 + P_{max}^2 m^2$
$m_e \sim \lambda_e \langle h \rangle$
$m_t \sim \lambda_t \langle h \rangle$


ρ^vac ~ P_max^4 + P_max^2 m^2
V
h
m_e ~ λ_e ⟨h⟩
m_t ~ λ_t ⟨h⟩



ℓ_{Hubble}
$V \sim -M^2 h^2$
$+\lambda h^4$
$+h^6$
$\rho^{vac} \sim P_{max}^4$
V
h

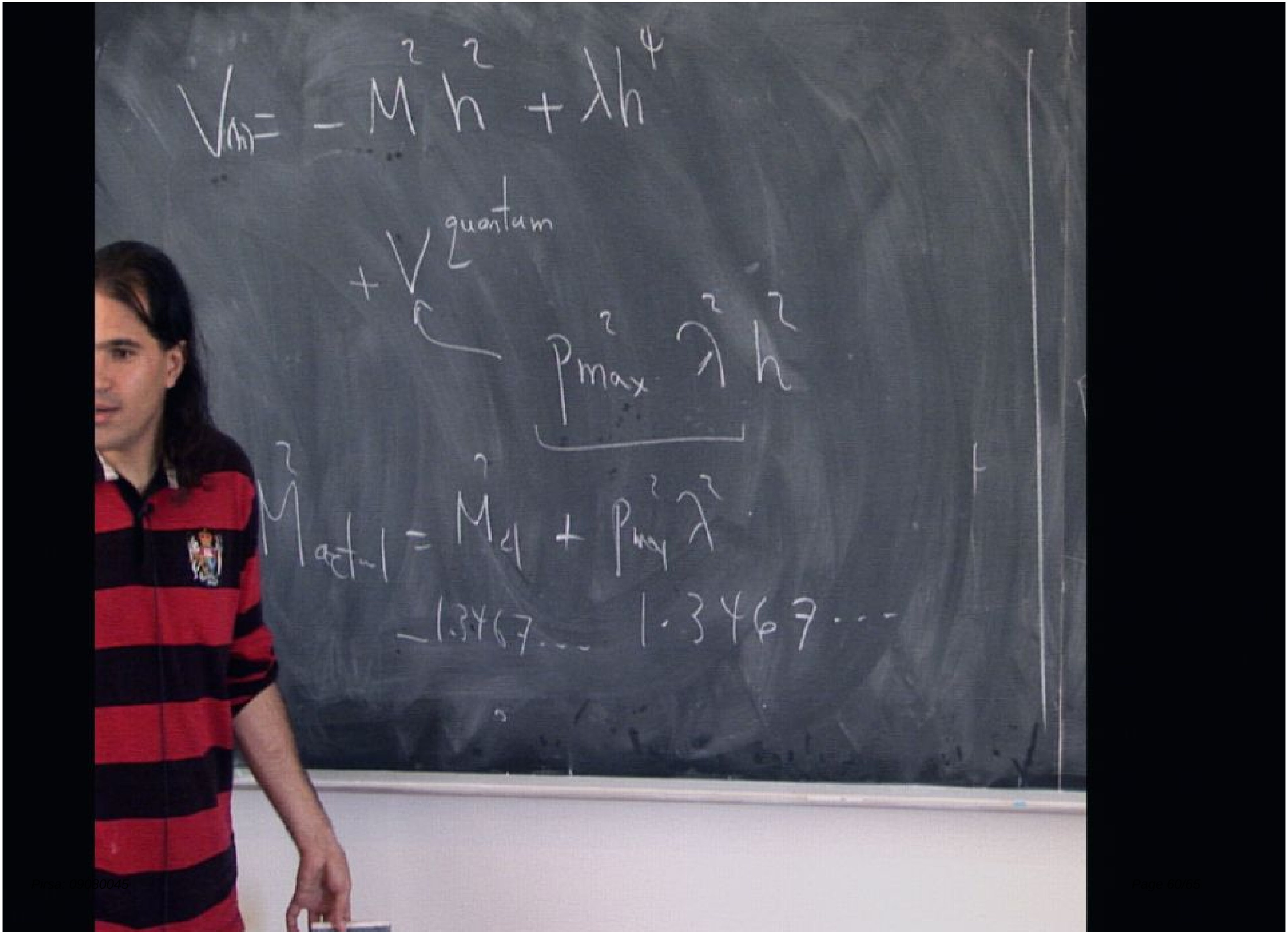

ℓ Hubble
V ~ −M²h²
+ λh⁴
M ~ (100 GeV)
ρ vac ~ P max ⁴
V
h


V(h) = − M² h² + λh⁴
+ V^quantum

$$V(h) = -M^2 h^2 + \lambda h^4$$

$$+ V^{\text{quantum}}$$

$$p_{max}^2 \, \lambda^2 h^2$$


$V(h) = -M^2 h^2 + \lambda h^4$
$+ V^{\text{quantum}}$
$p_{max}^2 \lambda^2 h^2$
$M_{actual}^2 = M_4^2 + p_{max}^2 \lambda^2$
$-1.3467\ldots \quad 1.3467\ldots$

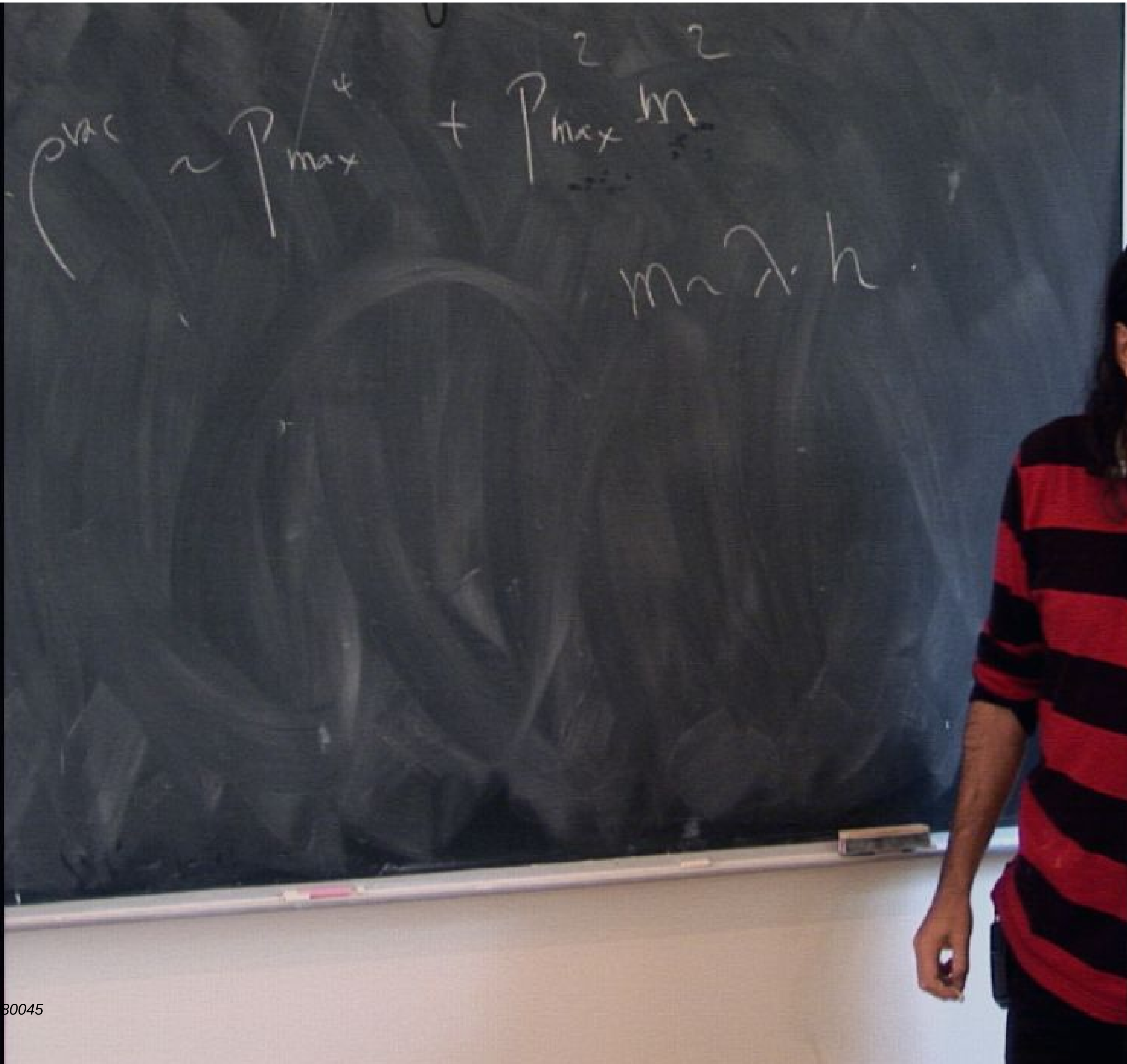
$$V(h) = -M^2 h^2 + \lambda h^4$$

$$+ V^{\text{quantum}}$$

$$p_{max}^2 \lambda^2 h^2$$

$$M^2_{actual} = M^2_4 + p^2_{max}\lambda^2$$

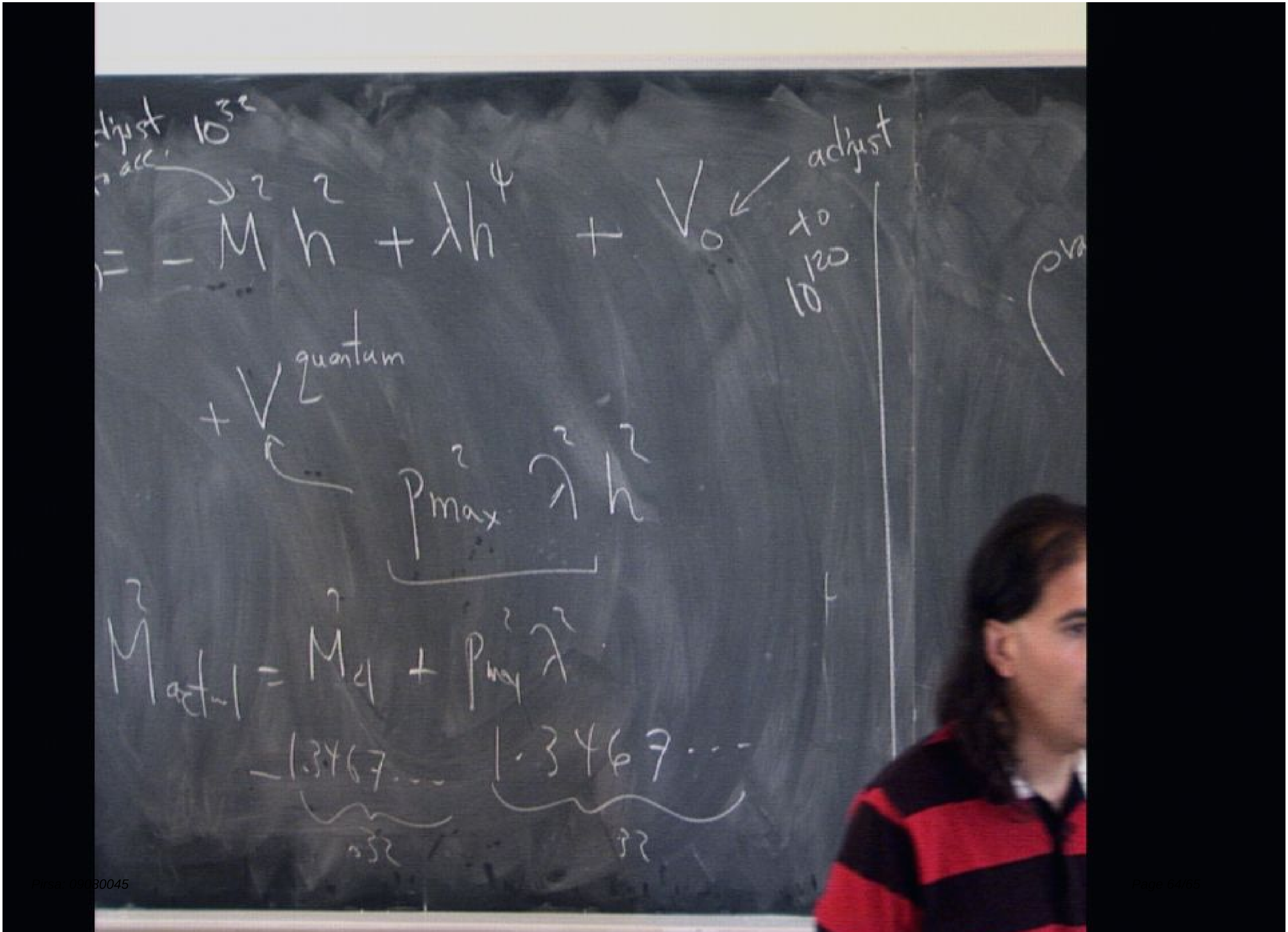
$$\underbrace{-1.3467\ldots}_{32} \quad \underbrace{1.3467\ldots}_{32}$$

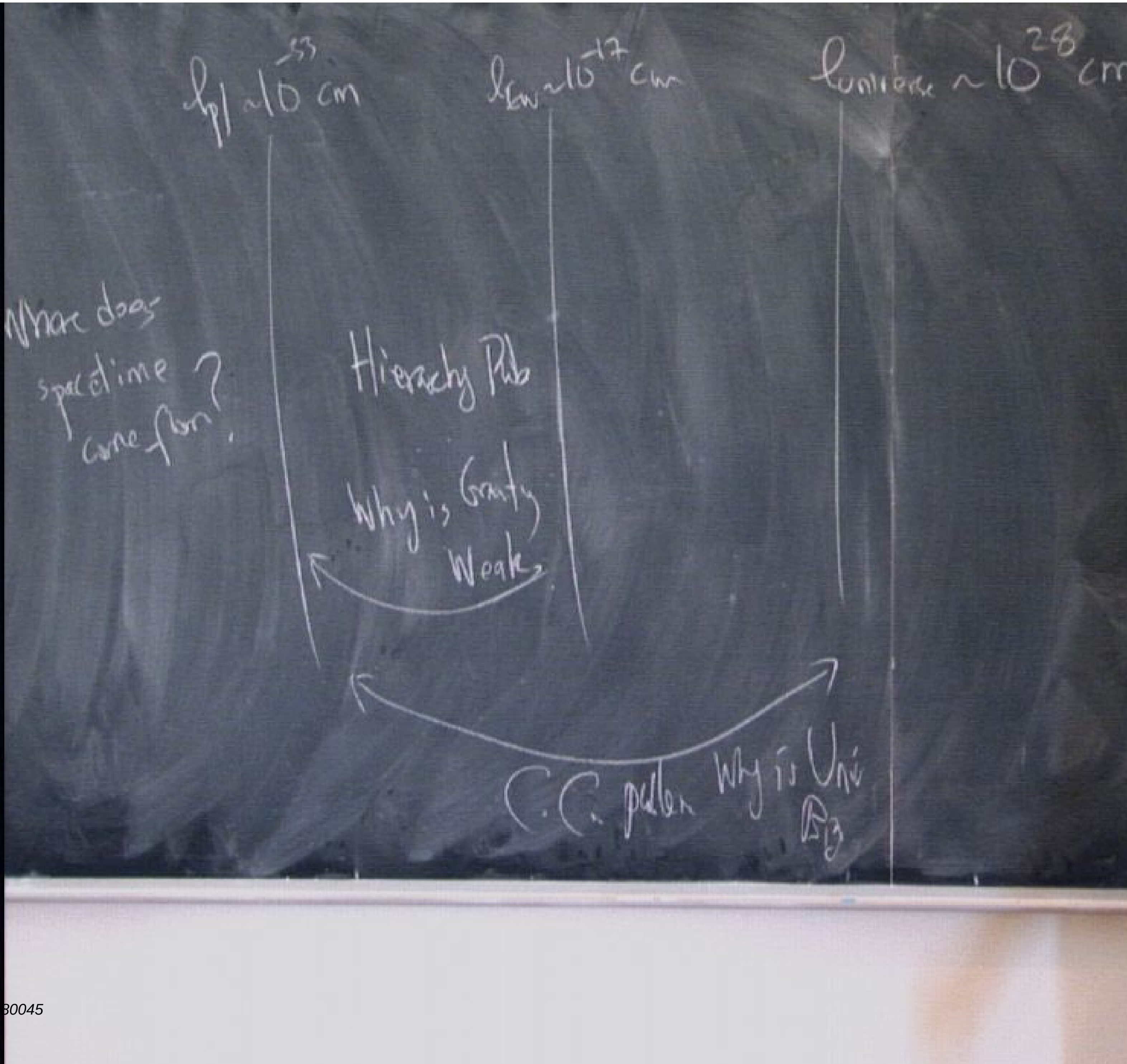

$\rho^{vac} \sim P_{max}^4 + P_{max}^2 m^2$
$m \sim \lambda \cdot h$

$$\rho^{vac} \sim P_{max}^4 + P_{max}^2 m^2$$

$$m \sim \lambda \cdot h$$

$$\sim P_{max}^4 + \lambda^2 P_{max}^2 h^2$$


adjust 10^32
adjust
V = - M^2 h^2 + λh^4 + V_0
to 10^120
+ V^quantum
p_max^2 λ^2 h^2
M_actual^2 = M_4^2 + p_max^2 λ^2
-1.3467...
1.3467...
32
32


$l_{pl} \sim 10^{-33}$ cm
$l_{EW} \sim 10^{-17}$ cm
$l_{universe} \sim 10^{28}$ cm
What does spacetime come from?
Hierarchy Prob
Why is Gravity Weak
C.C. problem
Why is Univ Big