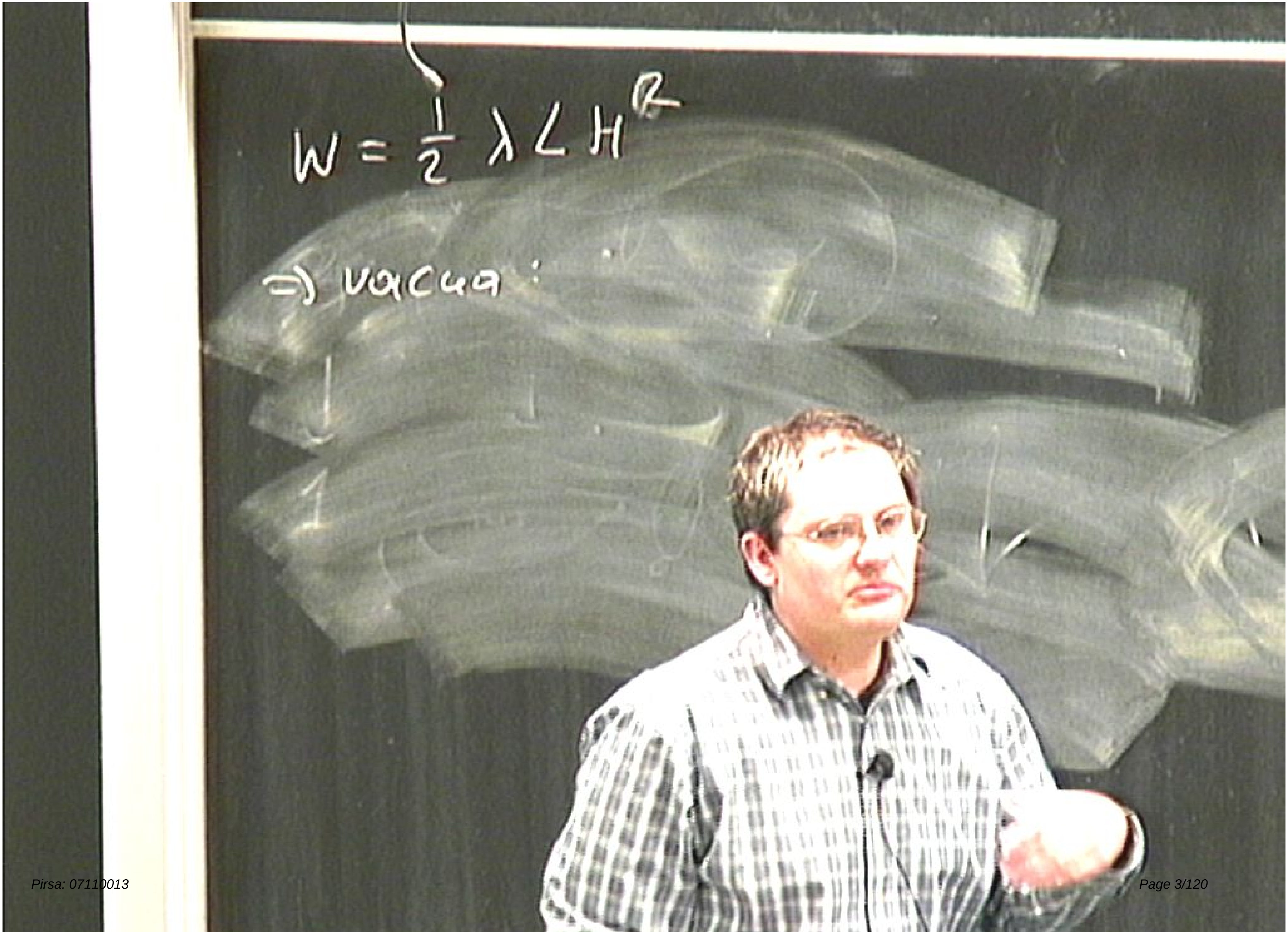
Title: Intro to Supersymmetry 17

Date: Nov 13, 2007 12:30 PM

URL: http://pirsa.org/07110013

Abstract:

$$W = \frac{1}{2} \lambda \angle H^{R}$$


W = 1/2 λ L H^R
⇒ vacua :

$$W = \frac{1}{2}\lambda L H^R$$

$\Rightarrow$ vacua : $H = 0$

$$W = \frac{1}{2} \lambda L H^{R}$$

$\Rightarrow$ vacua : $H = 0$ $\left(\langle H \rangle = 0 \right)$

L

$$W = \frac{1}{2} \lambda L H^R$$

$\Rightarrow$ vacua: $H = 0$ $\quad (\langle H \rangle = 0)$

L is anything

$$W = \frac{1}{2} \lambda L H^2$$

$\Rightarrow$ vacua: $H = 0$ $\left(\langle H \rangle = 0 \right)$

L is anything

$\Rightarrow$ small fluctuations on the moduli space

$$L = \langle L \rangle + X.$$

$W = \frac{1}{2} \lambda L H^2$

$\Rightarrow$ vacua : $H = 0$ $\left(\langle H \rangle = 0 \right)$

L is anything

$\Rightarrow$ small fluctuations on the moduli space

$L = \langle L \rangle + x$

$H = \langle H \rangle + y$

$\Rightarrow X$ is a massless xsf

$W_{\alpha}(x,y)$

$\Rightarrow$ X is a massless xsf (W_{eff} doesn't have a term $\propto X^{[illegible]}$

$W_{(0)}(x,y)$

$\Rightarrow$ X is a massless χSF (W_{eff} doesn't have a term $\propto X^2$

$W_{eff}(x, y)$

$\Rightarrow$ y

$\Rightarrow$ X is a massless xsf (W_{eff} does not have a term $\propto X^2$)

$W_{(2)}(X, Y)$

$\Rightarrow$ Y massive

$\Rightarrow$ X is a massless χSF (W_{eff} doesnt have a term $\propto X^2$)

$W_{(0)}(x, y)$

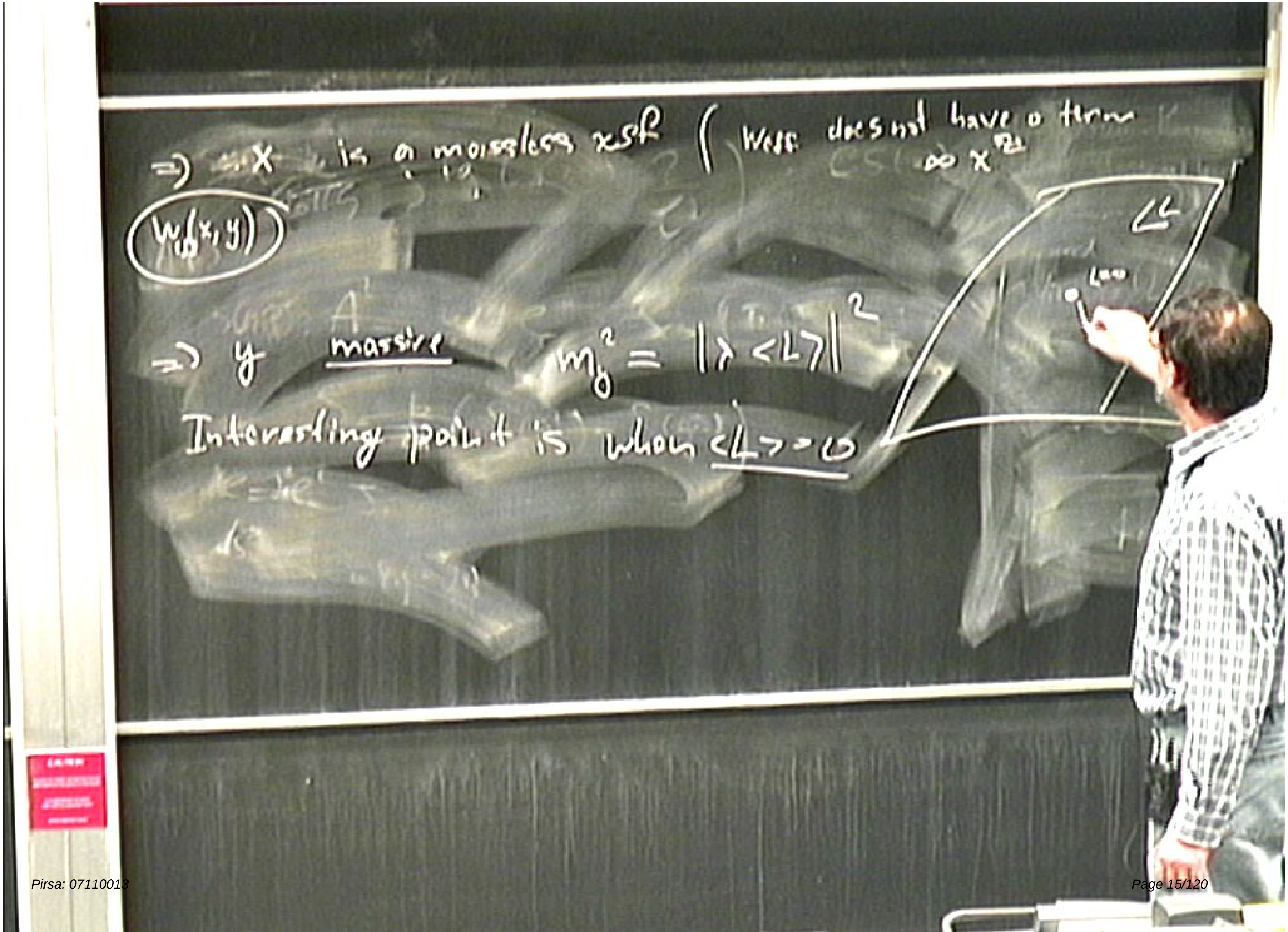
$\Rightarrow$ y massive $m_y^2 = |\lambda \langle L \rangle|^2$

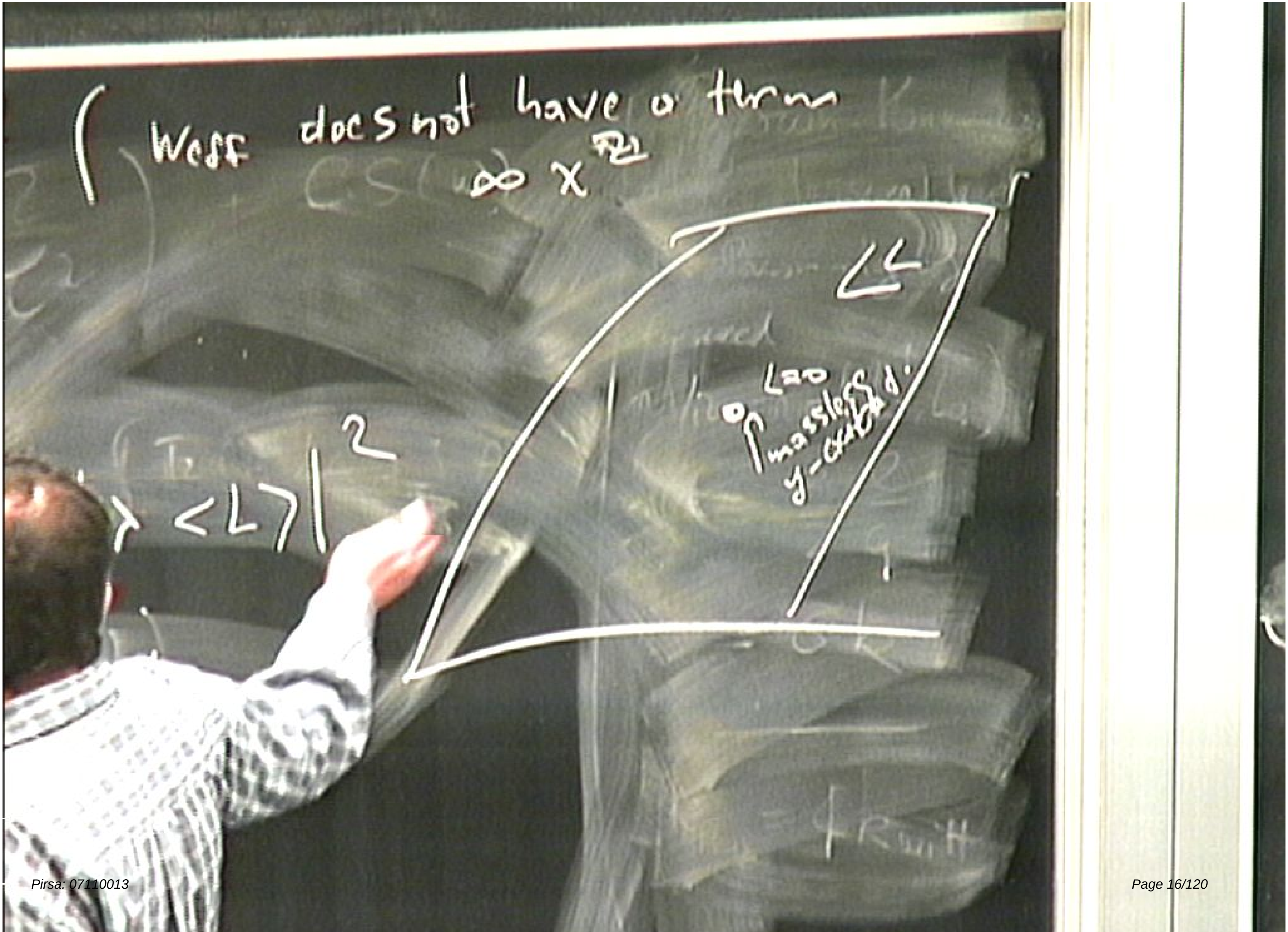
$\Rightarrow$ ~~ϕ~~ X is a massless x.s.f. (W_{eff} does not have a term $\propto X^{2}$)

$W_{(2)}(x,y)$

$\Rightarrow$ y massive $m_y^2 = |\lambda \langle L \rangle|^2$

Interesting point is when $\langle L \rangle = 0$


⇒ X is a massless xsf (W does not have a term ∝ X^2
W_0(x,y)
⇒ y massive m_y^2 = |λ⟨L⟩|^2
Interesting point is when ⟨L⟩ = 0
⟨L⟩
L=0


Weff does not have a term
L=0
massless

$\Rightarrow$ X is a massless xsf (W_{eff} does not have a term $\propto X^{2}$)

$W_{(0)}(x,y)$

$\Rightarrow$ y <u>massive</u> $m_y^2 = |\lambda \langle L \rangle|^2$

Interesting point is when $\underline{\langle L \rangle = 0}$

$\Rightarrow$ Geometry of a moduli space.

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Nakahara

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Modulis space is $\mathbb{C}^1$

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Nakahara

Modulii space is $\mathbb{C}^1$

$\Rightarrow$ Classically $\quad L, H$

K

⇒ <u>Geometry of a moduli space.</u>

<u>Nakahara</u>

Moduli space is $\mathbb{C}^1$

⇒ Classically

L, H ⇒ Configuration space is
2 complex d

K

⇒ Geometry of a moduli space.

Nakahara

Moduli space is $\mathbb{C}^1$

⇒ Classically L, H ⇒ Configuration space is 2 complex dim.

$K =$

$\Rightarrow$ Geometry of a modul space.

Nakahara

Moduli space is $\mathbb{C}^1$

$\Rightarrow$ Classically $\quad L, H \Rightarrow$ Configuration space is 2 complex dim.

$$K = L\bar{L} + H\bar{H}$$

⇒ Geometry of a moduli space.

Nakahara

Moduli space is $\mathbb{C}^1$

⇒ Classically L, H ⇒ Configuration space is 2 complex dim. $\{L, H\}$

$K = L\bar{L} + H\bar{H}$

⇒ If ~~every~~ complex manifold is Kähler

Geometry of a moduli space.

Nakahara

Moduli space is $\mathbb{C}^1$

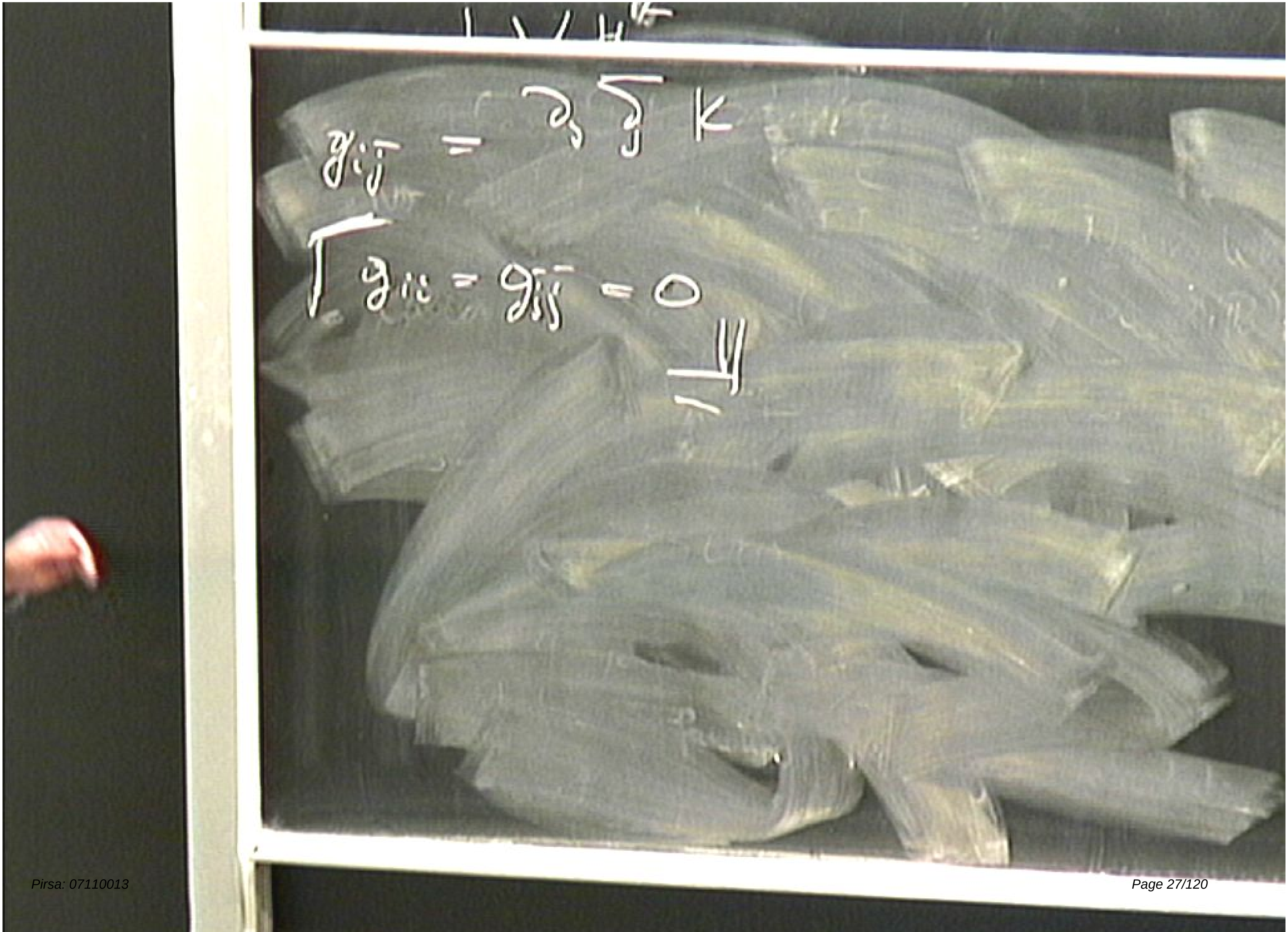
Classically $L, H \Rightarrow$ Configuration space is 2 complex dim.

$\{L, H\}$

$$K = L\bar{L} + H\bar{H}$$

$\Rightarrow$ If complex manifold is Kähler

$K(z_i, \bar{z}_i) \rightarrow$ a scalar function on a complex manifold


$g_{i\bar{j}} = \partial_i \partial_{\bar{j}} K$
$g_{ii} = g_{\bar{i}\bar{j}} = 0$

$$g_{i\bar{j}} = \partial_i \bar{\partial}_{\bar{j}} K$$

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$$g_{i\bar{j}} = \partial_i \partial_{\bar{j}} K$$

$$g_{ii} = g_{\bar{i}\bar{j}} = 0$$

$$K = L\bar{L} + H\bar{H}$$

$$g_{i\bar{j}} = \begin{array}{c|cc} & \frac{\partial}{\partial \bar{L}} & \frac{\partial}{\partial \bar{H}} \\ \hline \frac{\partial}{\partial L} & 1 & 0 \\ \frac{\partial}{\partial H} & 0 & 1 \end{array}$$

$\Rightarrow$ What is the metric on the moduli space?

$\mathbb{C}^{\Delta}$

$\rightarrow$ $K_{\text{moduli}} = K$

$\Rightarrow$ What is the metric on the moduli space?

$\mathbb{C}^{\Delta}$

$\rightarrow$ $K_{\text{moduli}} = K \Big|_{\text{moduli space}}$

→ What is the metric on the moduli space?

$\mathbb{C}^1$

→ $K_{\text{moduli}} = K \Big|_{\text{moduli space}}$

$H = 0, \bar{H} = 0.$

→ What is the metric on the moduli · space?

$\mathbb{C}^1$

→ $K_{moduli} = K \Big|_{moduli\ space} = L\bar{L}$

$H = 0,\ \bar{H} = 0.$

→ What is the metric on the moduli space?

$\mathbb{C}^{\Delta}$

→ $K_{\text{moduli}} = K\Big|_{\text{moduli space}} = LL$ → flat nonsingular metric on the moduli space

$H=0,\ \bar{H}=0.$

→ What is the metric on the moduli space?

$\mathbb{C}^{\Delta}$

→ $K_{\text{moduli}} = K \Big|_{\text{moduli space}} = L\bar{L}$ → flat nonsingular metric on the moduli space

$H=0, \bar{H}=0.$

classical

$$g_{i\bar j} = \partial_i \partial_{\bar j} K$$

$$g_{ij} = g_{\bar i \bar j} = 0$$

$$K = L\bar L + H\bar H$$

$$\begin{array}{ccc} & \frac{\partial}{\partial \bar L} & \frac{\partial}{\partial \bar H} \\ g_{i\bar j} = \frac{\partial}{\partial L} & 1 & 0 \\ \frac{\partial}{\partial H} & 0 & 1 \end{array}$$

$$ds^2 = g_{i\bar j}\, dz^i\, d\bar z^j = \frac{\partial^2 K}{\partial z_i \partial \bar z_j}\, dz_i\, d\bar z_j$$

$\Rightarrow$ Kahler potential will receive quantum corrections.

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$\ast$, $y \Leftrightarrow |m_y|^2 = |\lambda \langle\phi\rangle|^2$

$\Rightarrow$ Kahler potential will receive quantum corrections

$X\,,\quad y \Leftrightarrow |m_y|^2 = |\lambda L|^2$

due to cubic interactions

⇒ Kahler potential will receive quantum corrections

$X, \quad y \Leftarrow |m_y|^2 = |\lambda u|^2$

due to cubic interactions

⇒ there will be a wave-function renormalization

⇒ Kahler potential will receive quantum corrections

X, y ⟸ $|h_y|^2 = |\lambda_4|^2$

due to cubic interactions

⇒ there will be a wave-function renormalization

⇒ $K = L\bar{L} \longrightarrow K_{1\text{-loop}} =$

$\Rightarrow$ Kahler potential will receive quantum corrections.

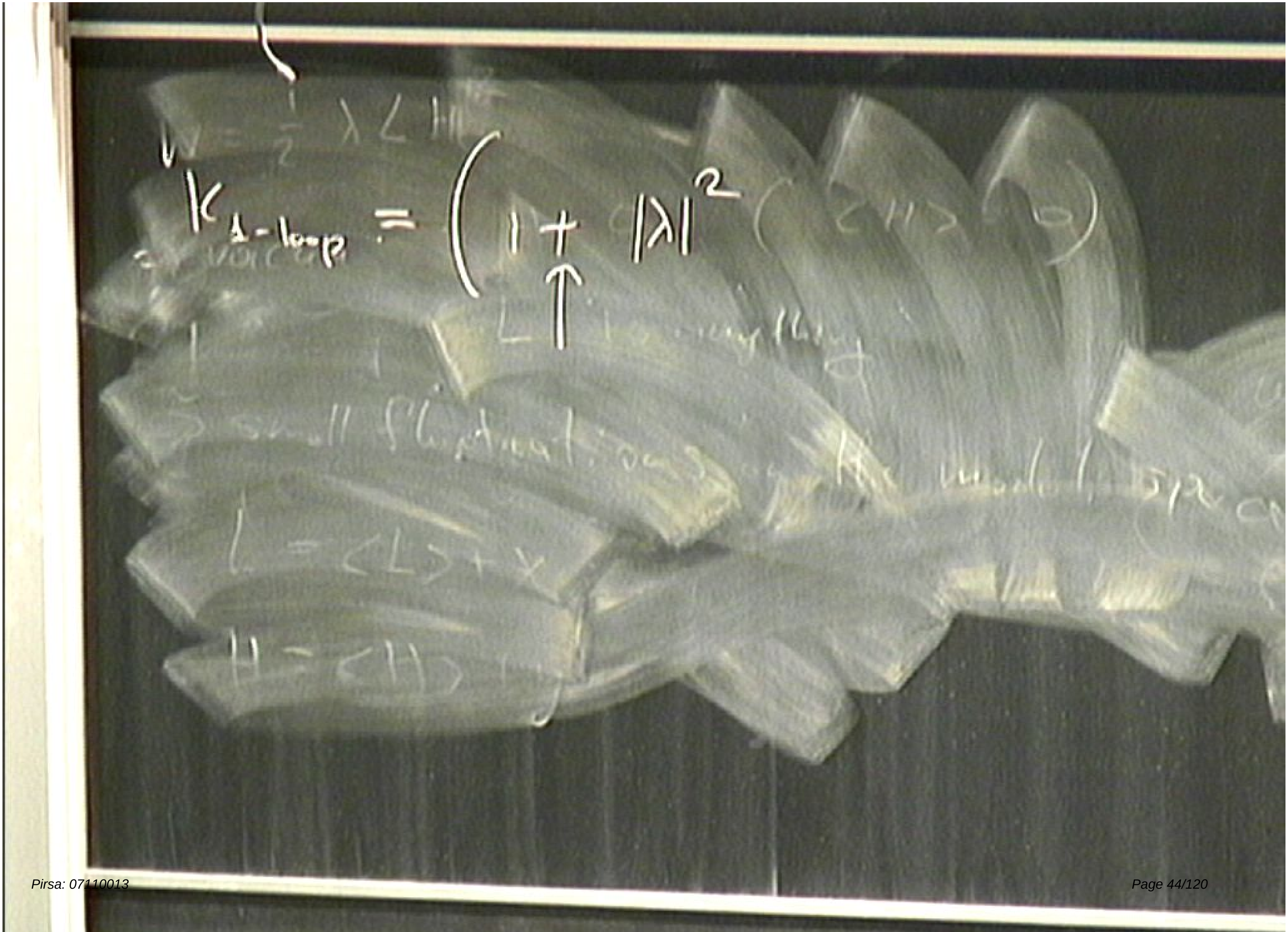
$X, \quad y \Leftarrow |h_y|^2 = |\lambda_4|^2$

due to cubic interactions

$\Rightarrow$ there will be a wave-function renormalization

$\Rightarrow \quad K = L\bar{L} \longrightarrow K_{1\text{-loop}} = Z_\psi L\bar{L}$

$$K_{1\text{-loop}} = \left(1 + \right.$$


$K_{1\text{-loop}} = (1 + |\lambda|^2$

$$K_{1\text{-loop}} = \left(1 + |\lambda|^2 \ln \frac{\Lambda}{|m_H|}\right) L \bar{L}$$

$$K_{\text{1-loop}} = \underbrace{\left(1 + |\lambda|^2 \ln \frac{\Lambda}{|m_H|} \right)}\, L\bar{L}$$

$$K_{1\text{-loop}} = \underbrace{\left(1 + |\lambda|^2 \ln \frac{\Lambda}{|m_H|}\right)}_{Z_y} L\bar{L}$$

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$$\Rightarrow \left(1 + \lambda\bar{\lambda} \ln \frac{\Lambda^2}{L\bar{L}}\right) L\bar{L}$$

$$K_{1\text{-loop}} = \underbrace{\left(1 + |\lambda|^2 \ln \frac{\Lambda}{|m_H|}\right)}_{Z_y} L\bar{L}$$

$$|m_H| \sim |L|$$

$$\Rightarrow \left(1 + \lambda\bar{\lambda} \ln \frac{\Lambda^2}{L\bar{L}}\right) L\bar{L}$$

$$K_{1\text{-loop}} = \underbrace{\left(1 + |\lambda|^2 \ln \frac{\Lambda}{|m_H|}\right)}_{Z_y} L\bar{L}$$

$|m_H| \to |L|$

$$\to \left(1 + \lambda\bar{\lambda} \ln \frac{\Lambda^2}{L\bar{L}}\right) L\bar{L}$$

$$\to -|\lambda|^2 \left(\ln L\bar{L}\right) L\bar{L}$$

$$K_{1\text{-loop}} = \underbrace{\left(1 + |\lambda|^2 \ln \frac{\Lambda}{|m_H|}\right)}_{Z_y} L\bar{L}$$

$$|m_H| \sim |L|$$

$$\sim \left(1 + \lambda\bar{\lambda} \ln \frac{\Lambda^2}{L\bar{L}}\right) L\bar{L}$$

$$\sim -|\lambda|^2 \left(\ln L\bar{L}\right) L\bar{L}$$

(dominant contribution for small $|L|$

$$g_{L\bar{L}} = \frac{\partial^2 K^{1\text{-loop}}}{\partial L \, \partial \bar{L}}$$

$$g_{L\bar{L}} = \frac{\partial^2 \mathcal{K}^{1\text{-loop}}}{\partial L \partial \bar{L}} = -|\lambda|^2 \ln \frac{L\bar{L}}{\Lambda^2} + \text{const}$$

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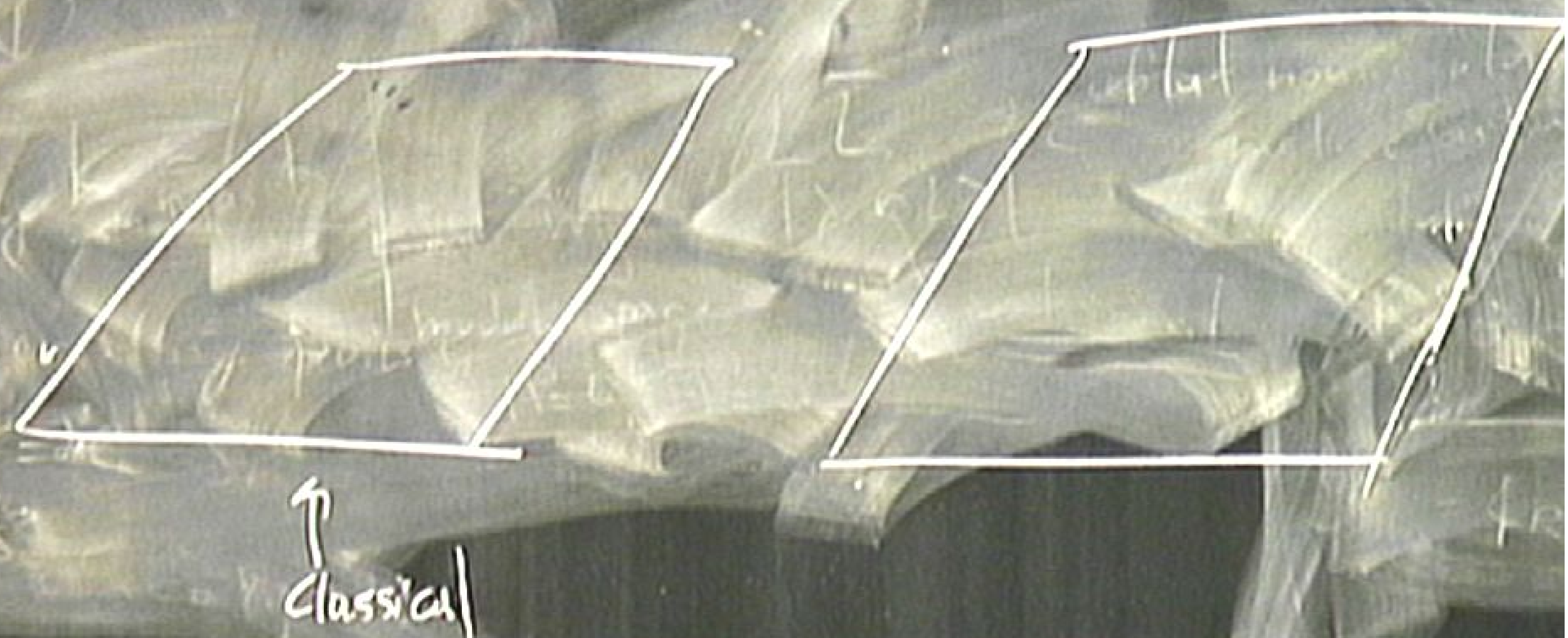
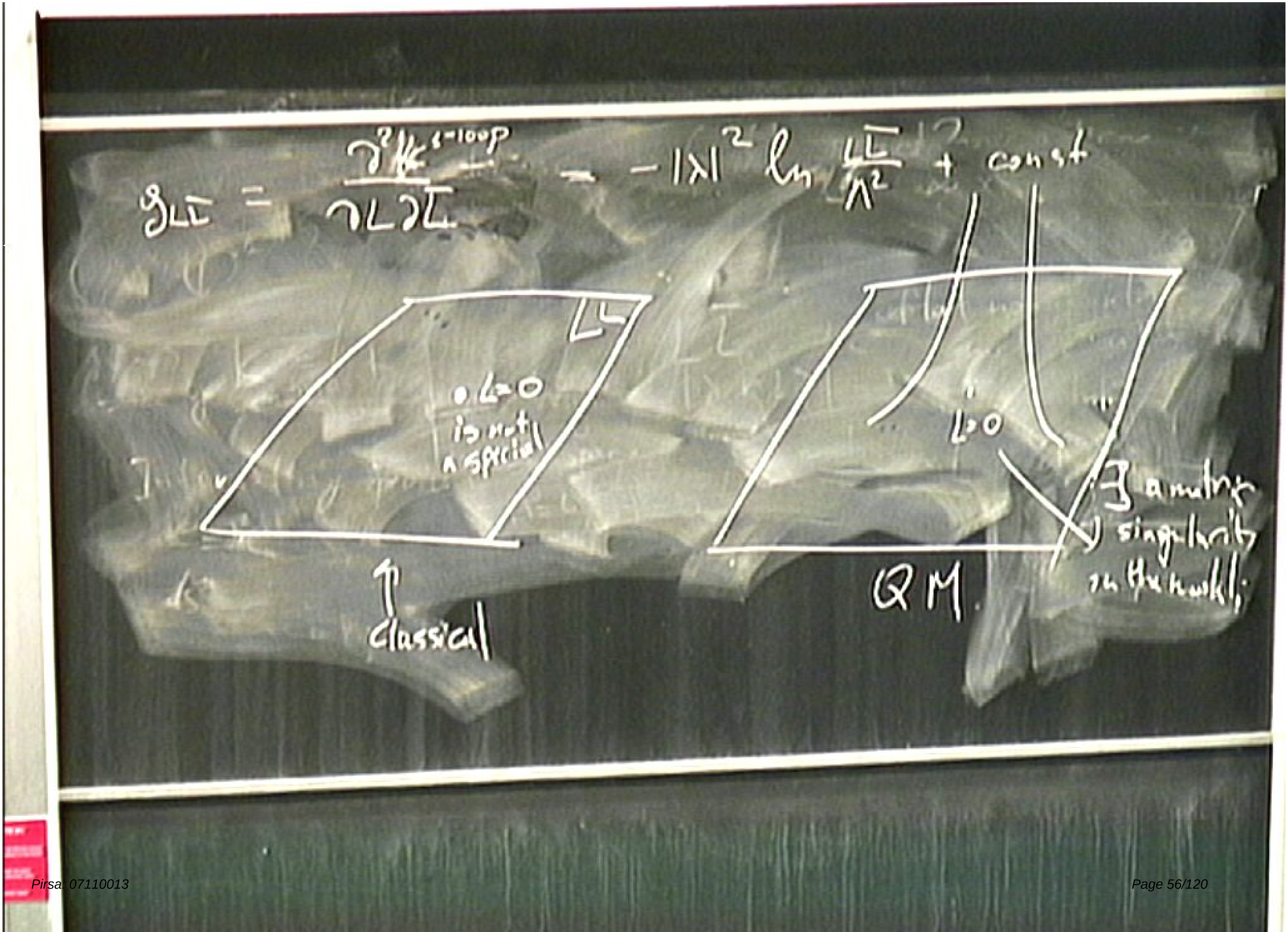
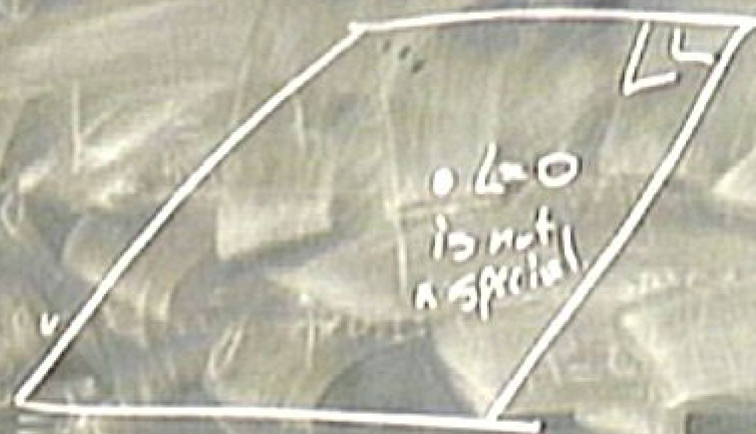


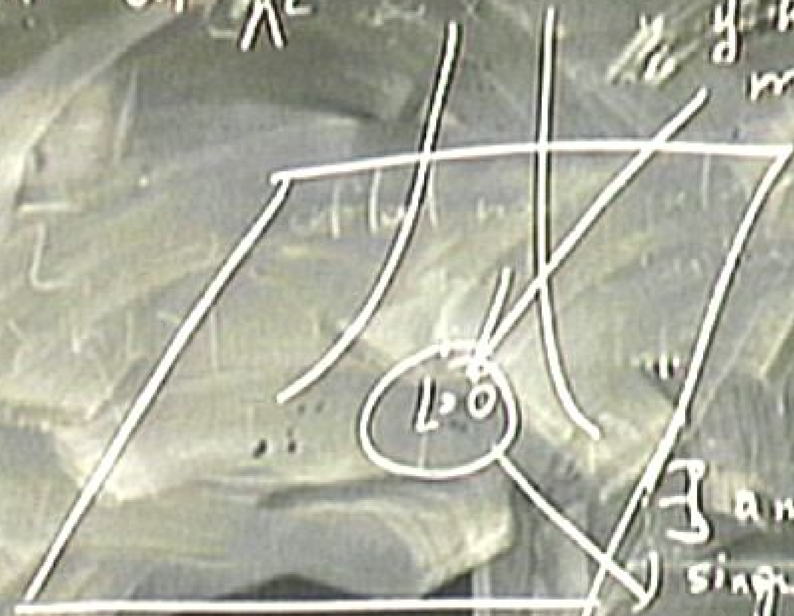

$g_{L\bar{L}} = \frac{\partial^2 K^{1\text{-loop}}}{\partial L \partial \bar{L}} \sim -|\lambda|^2 \ln \frac{L\bar{L}}{\Lambda^2} + \text{const}$
L=0 is not a special
L=0
Classical
QM

$$g_{L\bar{L}} = \frac{\partial^2 K^{1\text{-loop}}}{\partial L\,\partial \bar{L}} = -|\lambda|^2 \ln \frac{L\bar{L}}{\Lambda^2} + \text{const}$$

y's become massless

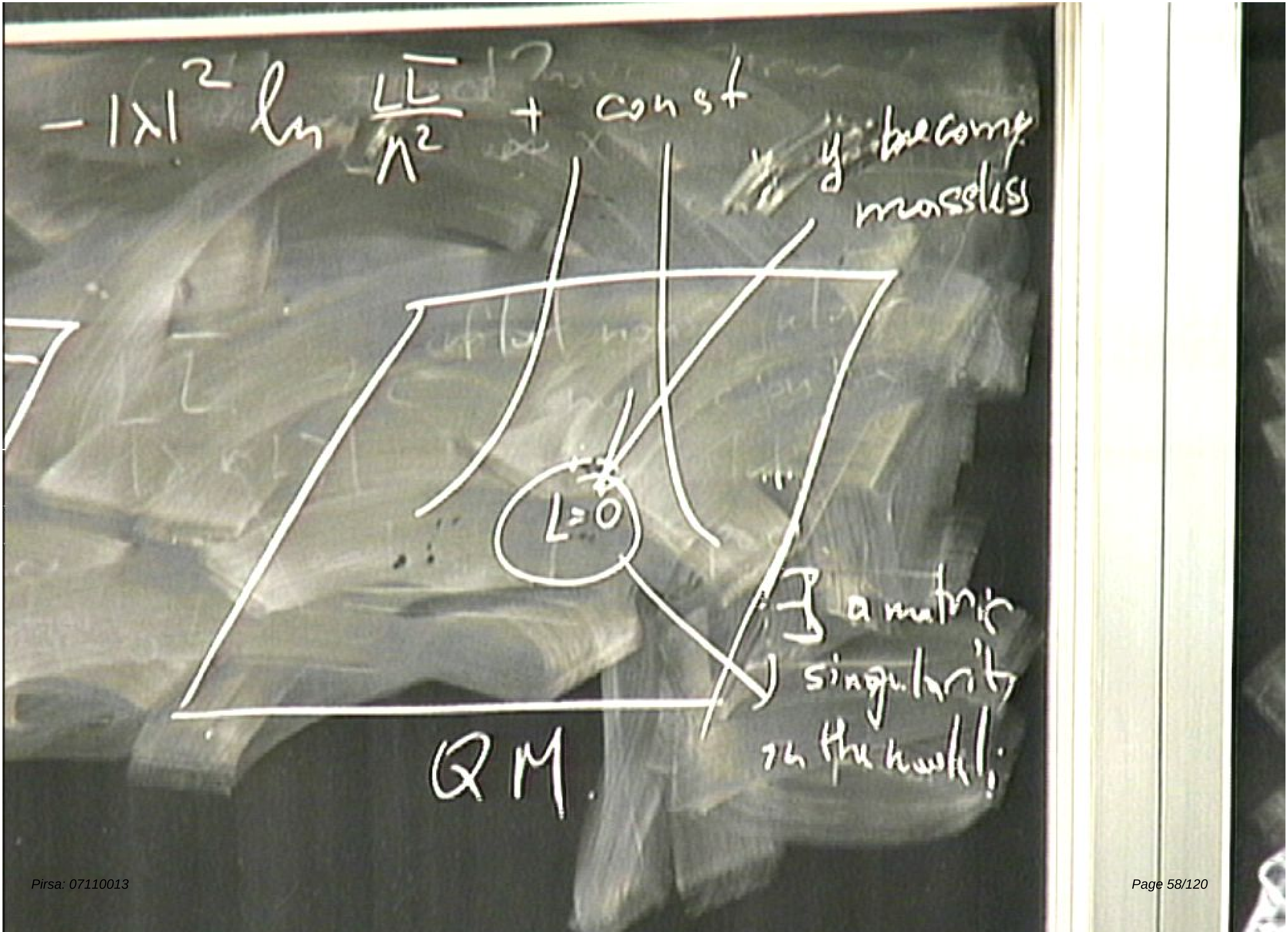


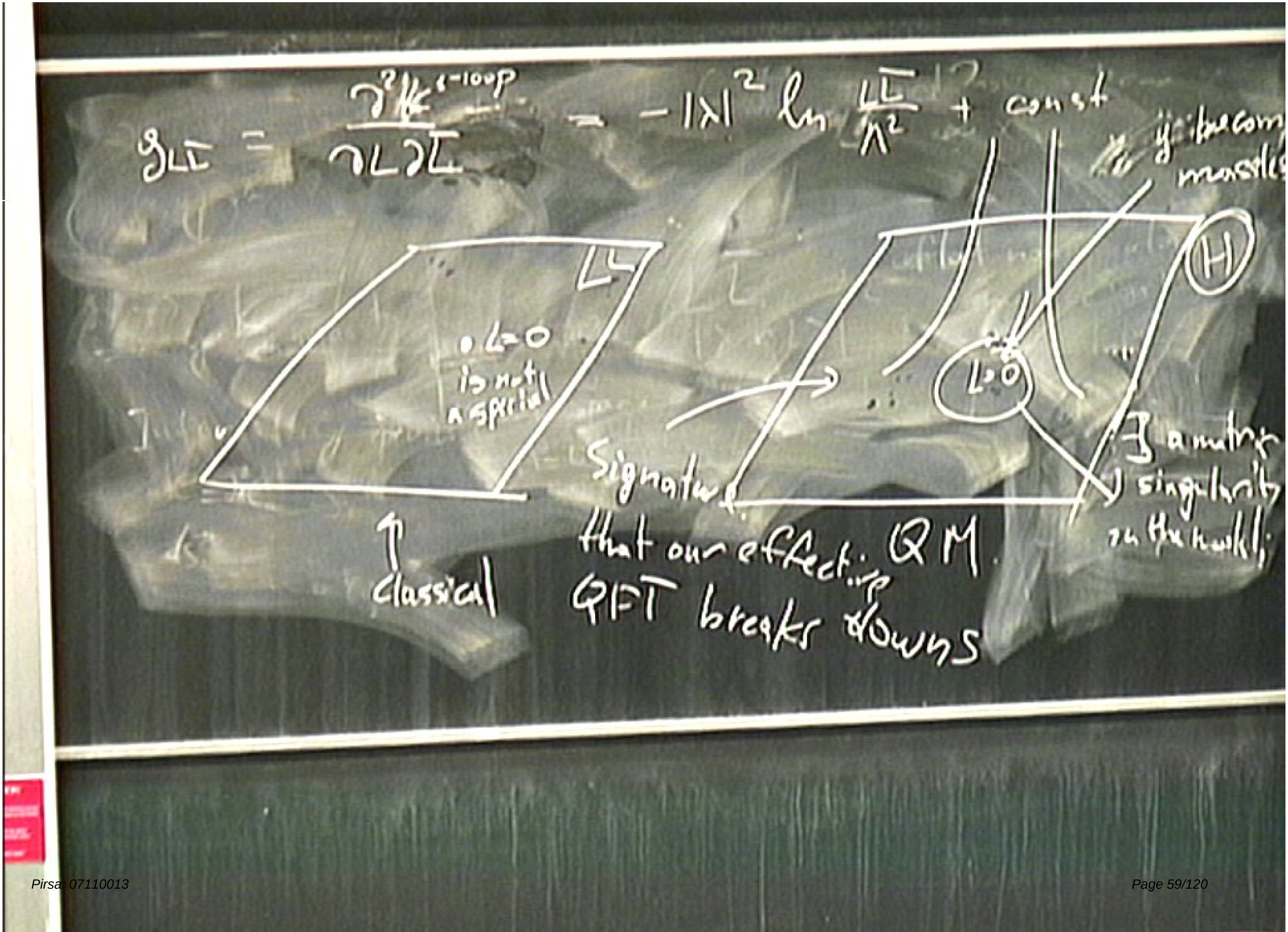
classical

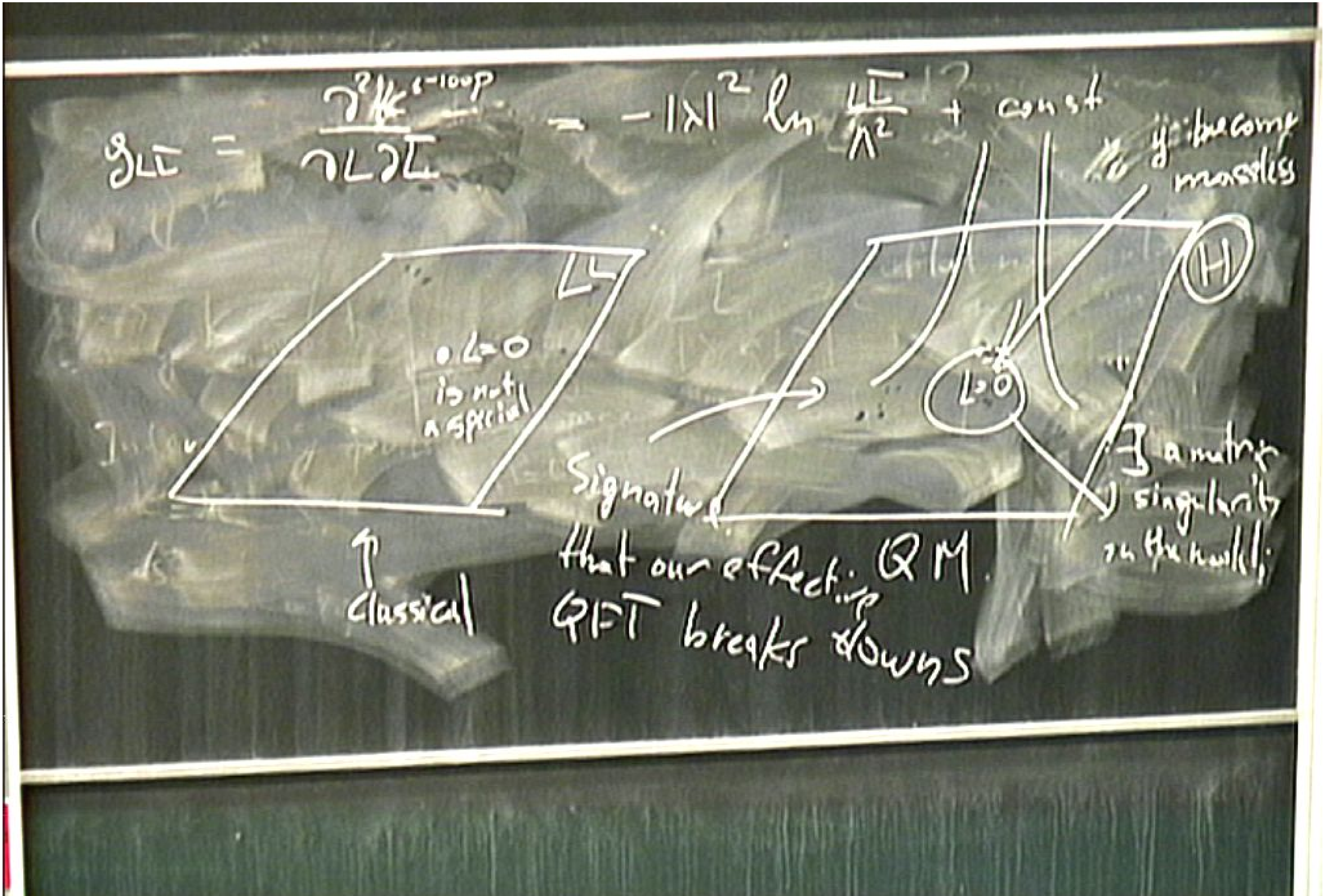


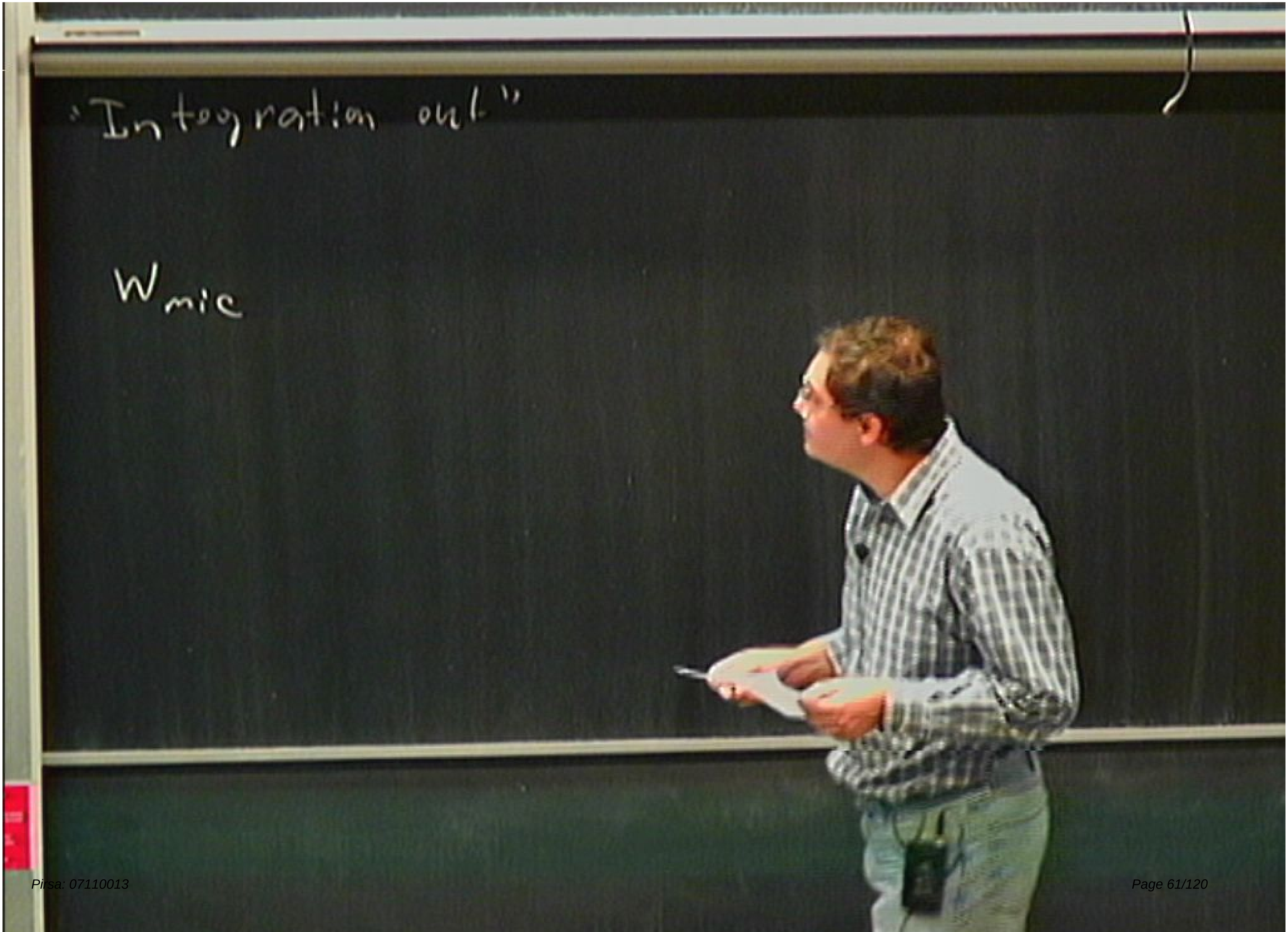
QM

∃ a metric singularity in the middle


$-|\lambda|^2 \ln \frac{L\bar{L}}{\Lambda^2} + \text{const}$
y_i become massless
$L=0$
∃ a metric singularity in the bulk
QM.


$g_{L\bar{L}} = \frac{\partial^2 K^{1-loop}}{\partial L \partial \bar{L}} = -|\lambda|^2 \ln \frac{L\bar{L}}{\Lambda^2} + const$
L=0 is not a special
L
L=0
H
Signature that our effective QM QFT breaks downs
classical
∃ another singularity in the bulk


$g_{L\bar{L}} = \frac{\partial^2 K^{1\text{-loop}}}{\partial L \partial \bar{L}} = -|\lambda|^2 \ln \frac{L\bar{L}}{\Lambda^2} + \text{const}$
becomes massless
L
L=0 is not a special
H
L=0
∃ a metric singularity in the moduli
Signature that our effective QM QFT breaks downs
Classical


"Integration out"
W_{mic}

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$$W_{mic} = \frac{1}{2} m H^2 + \lambda L^2 H$$

"Integration out"

$$W_{mic} = \frac{1}{2} m H^2 + \lambda L^2 H$$

H is massive.

L is massless.

"Integration out"

non renor

$$W_{mic} = \frac{1}{2} m H^2 + \lambda L^2 H \Rightarrow W_{eff} = \frac{1}{2} m H^2 + \lambda L^2 H$$

H is massive.

L is massless.

non the minimum

effective action

"Integration out"

$$W_{mic} = \frac{1}{2} m H^2 + \lambda L^2 H \xRightarrow{\text{nonrenor}} W_{eff} = \frac{1}{2} m H^2 + \lambda L^2 H$$

H is massive.

L is massless.

non the minimum

effective action

$E \ll |m|$

"Integration out"

$$W_{mic} = \frac{1}{2} m H^2 + \lambda L^2 H \Rightarrow W_{eff} = \frac{1}{2} m H^2 + \lambda L^2 H$$

nonrenorm

non the minimum effective action

H is massive.

L is massless.

$E \ll |m|$

→ effective action should not contain

$\Rightarrow \quad F_- \ll |h_m|$

$\Rightarrow$ we can integrate out H - field

$\Updownarrow$

solve EOM for H

$\Rightarrow$ $F_- \ll |m|$

$\Rightarrow$ we can integrate out H - field

$\Updownarrow$

solve EOM for H and substitute it into the superpotential

$\Rightarrow$ $F_{-} \ll |m|$

$\Rightarrow$ we can integrate out H_{-} field

$\Updownarrow$

solve EOM for H and substitute it into the superpotential

$m \rightarrow$

$\Rightarrow$ $F_- \ll |m|$

$\Rightarrow$ we can integrate out H - field

$\Updownarrow$

solve EOM for H and substitute it into the superpotential

$m \rightarrow \infty$

$\Rightarrow E_{-} \ll |m|$

$\Rightarrow$ we can integrate out H - field

$\Updownarrow$

solve EOM for H and substitute it into the superpotential

$m \to \infty$

$\left(E \ll |m| \right)$

$\Rightarrow E \ll |m|$

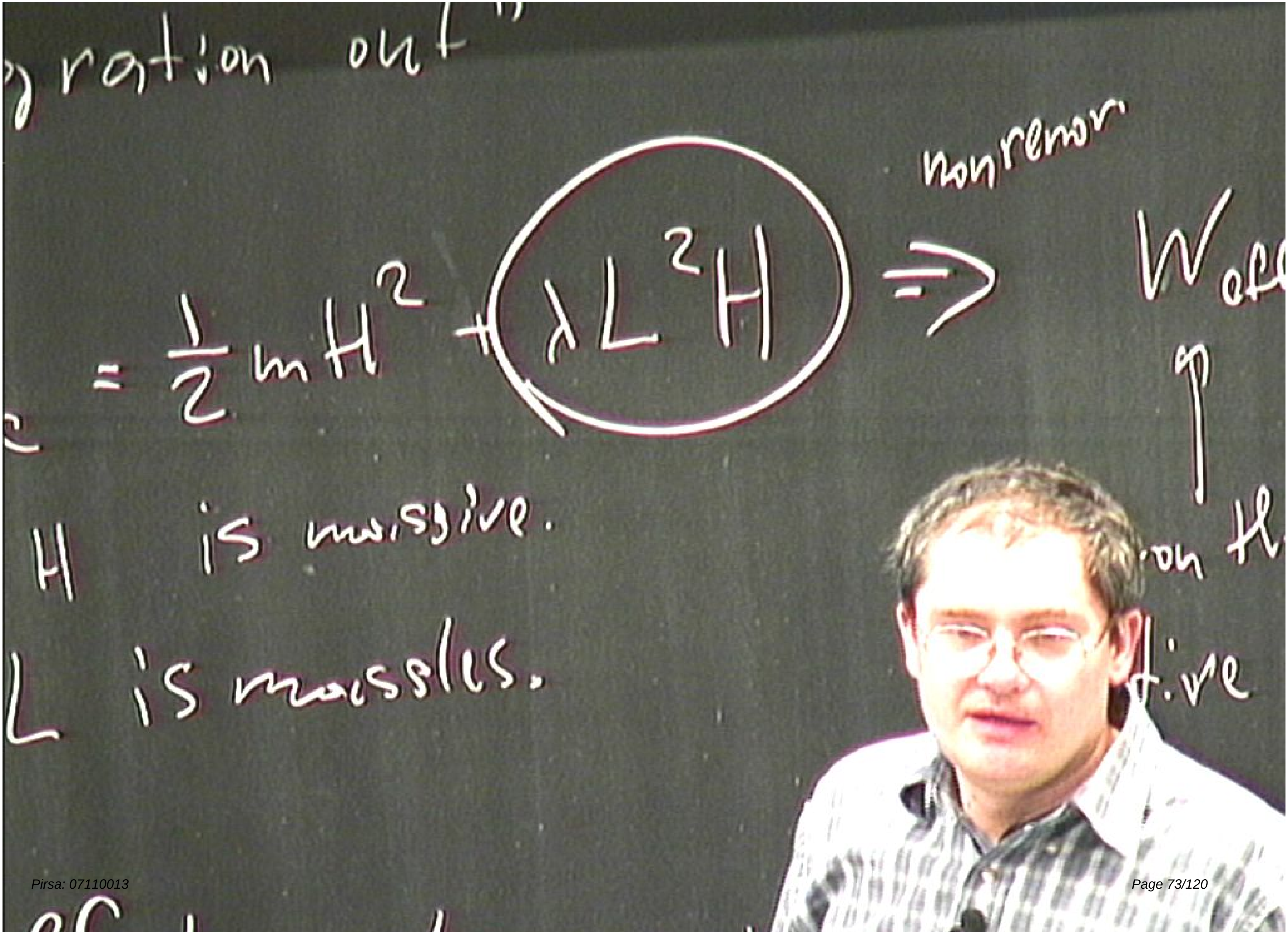
$\Rightarrow$ we can integrate out H - field

$\Updownarrow$

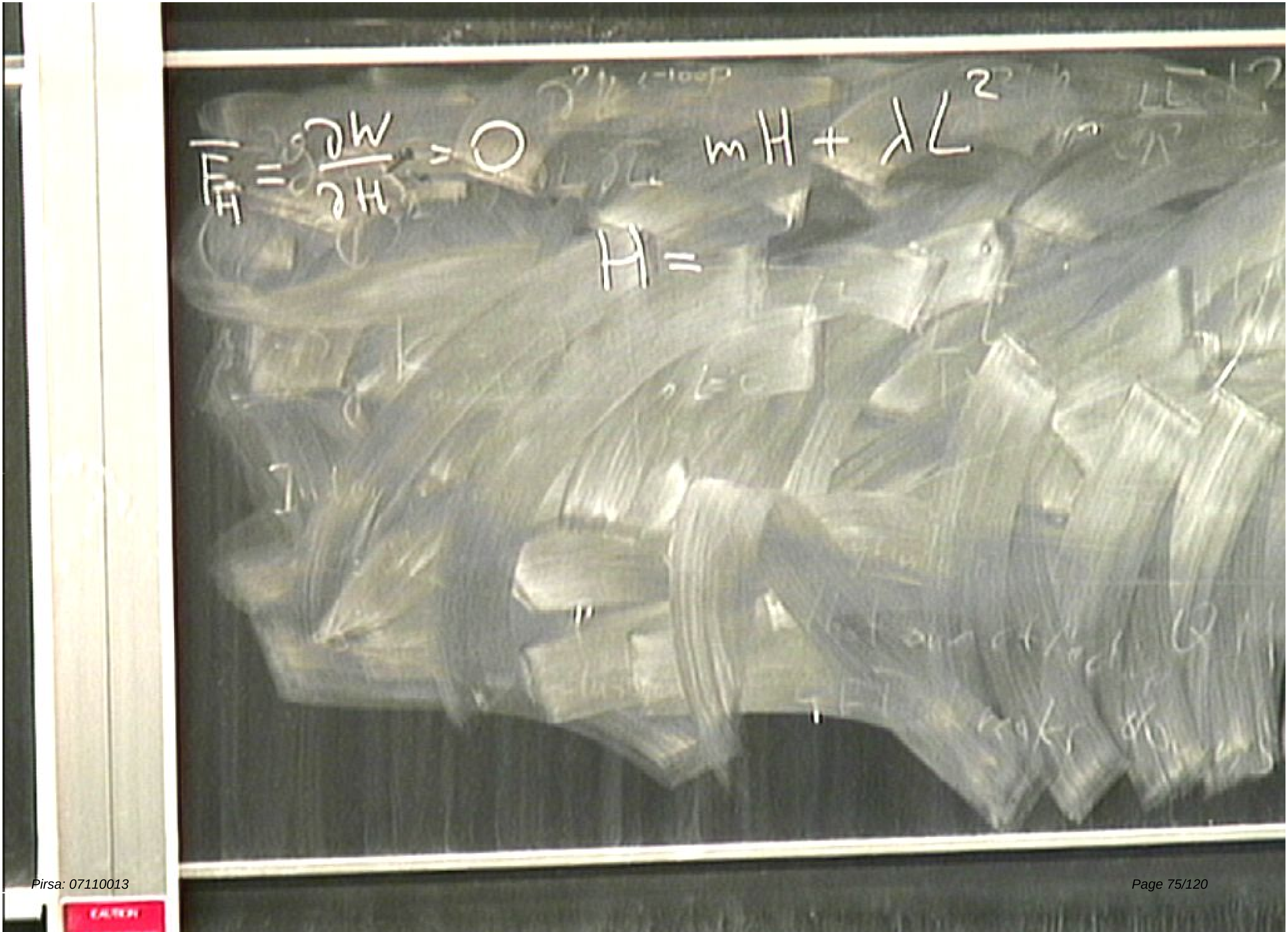
solve EOM for H and substitute it into the superpotential

$|m| \to \infty$

$\left(E \ll |m| \right)$


ration out
nonrenor.
$= \frac{1}{2} m H^2 + \lambda L^2 H \Rightarrow W_{eff}$
H is massive.
L is massless.
on th
tive

$$\bar{F}_H = \frac{\partial W}{\partial H} > 0 \qquad mH + \lambda L^2$$


$F_H = \frac{\partial W}{\partial H} = 0$
$mH + \lambda L^2$
$H =$

$$F_H = \frac{\partial W}{\partial H} = 0 \qquad mH + \lambda L^2$$

$$\langle H \rangle = -\frac{\lambda L^2}{m}$$

$$W_{eff}(L) =$$

$$F_H = \frac{\partial W}{\partial H} = 0 \qquad mH + \lambda L^2$$

$$\langle H \rangle = -\frac{\lambda L^2}{m}$$

$$W_{eff}(L) = -\frac{\lambda^2 L^4}{2m}$$

$$F_H = \frac{\partial W}{\partial H} = 0 \qquad mH + \lambda L^2$$

$$\langle H \rangle = -\frac{\lambda L^2}{m}$$

$$\underline{W_{eff}(L)} = -\frac{\lambda^2 L^4}{2m}$$

* L is a massless

* $E \ll m$

$\mathcal{L}_{eff}(L) = \frac{\lambda L^4}{2m}$

* L is a massless

* $E \ll m$

$\Rightarrow$ decide on light

$$\ldots_{eff}(L) = -\frac{\lambda L^4}{2m}$$

* L is a massless

* $E \ll m$

$\Rightarrow$ decide on Light

$\Rightarrow$ look at symmetries

$$\mathcal{L}_{eff}(L) = -\frac{\lambda L^4}{2m}$$

$* \; L$ is a massless

$* \; E \ll m$

$\Rightarrow$ decide on Light

$\Rightarrow$ look at symmetries

$\Rightarrow$ most general

$L) = -\frac{\lambda L^{9}}{2m}$

* L is a massless

* $E \ll m$

$\Rightarrow$ decide on Light

$\Rightarrow$ look at symmetries

$\Rightarrow$ most general W (holomorphic in couplings)

$$L) = -\frac{\lambda L^9}{2m}$$

$*$ L is a massless

$*$ $E \ll m$

$\Rightarrow$ decide on Light

$\Rightarrow$ look at symmetries

$\Rightarrow$ most general W (holomorphic in everything)

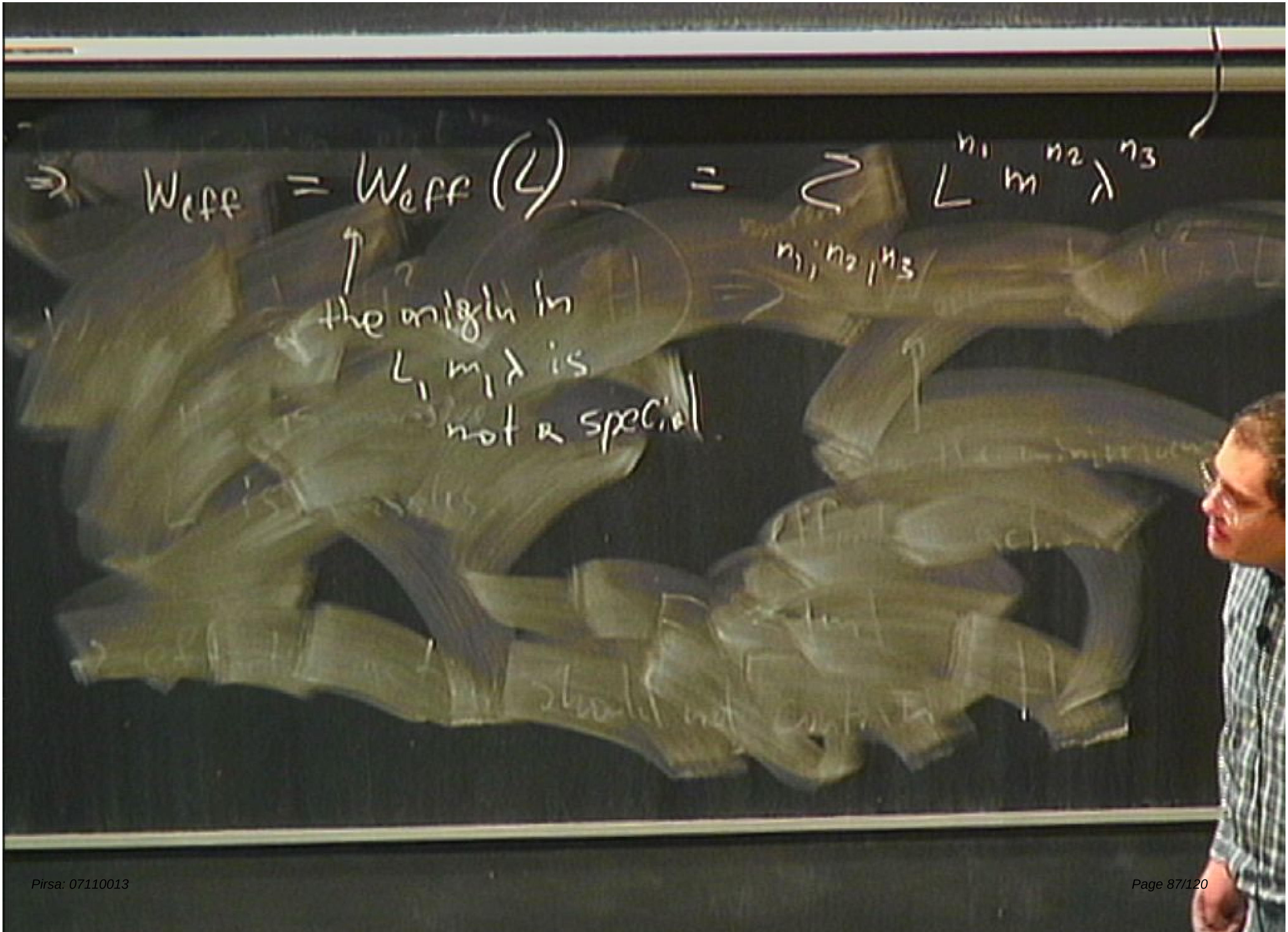
$\Rightarrow W_{eff} = W_{eff}(\zeta)$

$$\Rightarrow \quad W_{eff} = W_{eff}(L)$$

the origin in
L, m, λ is
not a special

$$\Rightarrow \quad W_{eff} = W_{eff}(L) = \sum_{n_1, n_2, n_3}$$

the origin in L, m, λ is not a special



$\Rightarrow W_{eff} = W_{eff}(L) = \sum_{n_1, n_2, n_3} L^{n_1} m^{n_2} \lambda^{n_3}$
the origin in
L, m, λ is
not a special

$$\Rightarrow \quad W_{eff} = W_{eff}(L) \quad = \sum_{n_1, n_2, n_3} L^{n_1} m^{n_2} \lambda^{n_3}$$

the origin in
L, m, λ is
not a special

$$W_{micr} = \frac{1}{2} m |H|^2 + \lambda L^2 H$$

$$\Rightarrow \quad W_{eff} = W_{eff}(L) = \sum_{n_1, n_2, n_3} L^{n_1} m^{n_2} \lambda^{n_3}$$

the origin in L, m, λ is not a special

$$W_{micro} = \frac{1}{2} m |H|^2 + \lambda L^3 H$$

$$\Rightarrow \quad W_{eff} = W_{eff}(L) = \sum_{n_1, n_2, n_3} L^{n_1} m^{n_2} \lambda^{n_3} c_{n_1 n_2 n_3}$$

the origin in L, m, λ is not special.

$$W_{micro} = \frac{1}{2} m H^2 + \lambda L^3 H$$

	$U(1)_H$	$U(1)_L$	$U(1)_R$
L	0	+1	
H	+1	0	
h			
λ			

	$U(1)_H$	$U(1)_L$	$U(1)_R$
L	0	$+1$	
H	$+1$	0	
$-h$	-2		
$+\lambda$			

$$H(W_{micro}) = 0 \quad L(W_{micro}) = 0 \quad R(W_{micro}) = 2$$

	$U(1)_H$	$U(1)_L$	$U(1)_R$
L	0	+1	+1
H	+1	0	
m	−2	0	
λ	−1	−2	

$$H(W_{micro}) = 0 \quad L(W_{micro}) = 0 \quad R(W_{micro}) = 2$$

	$U(1)_H$	$U(1)_L$	$U(1)_R$
L	0	$+1$	$+1$
H	$+1$	0	0
h	-2	0	$+2$
λ	-1	-2	0

$$H(W_{micro}) = 0 \qquad L(W_{micro}) = 0 \qquad R(W_{micro}) = 2$$

$\Rightarrow$ construct monomials.

$$U(1)_H: \quad -2n_2 - n_3 = 0$$

$$U(1)_L \quad n_1 - 2n_3 = 0$$

$\Rightarrow$ construct monomials.

$U(1)_H$: $-2n_2 - n_3 = 0$

$U(1)_L$ $n_1 - 2n_3 = 0$

$U(1)_R$ $2n_2 + n_1 = 2$

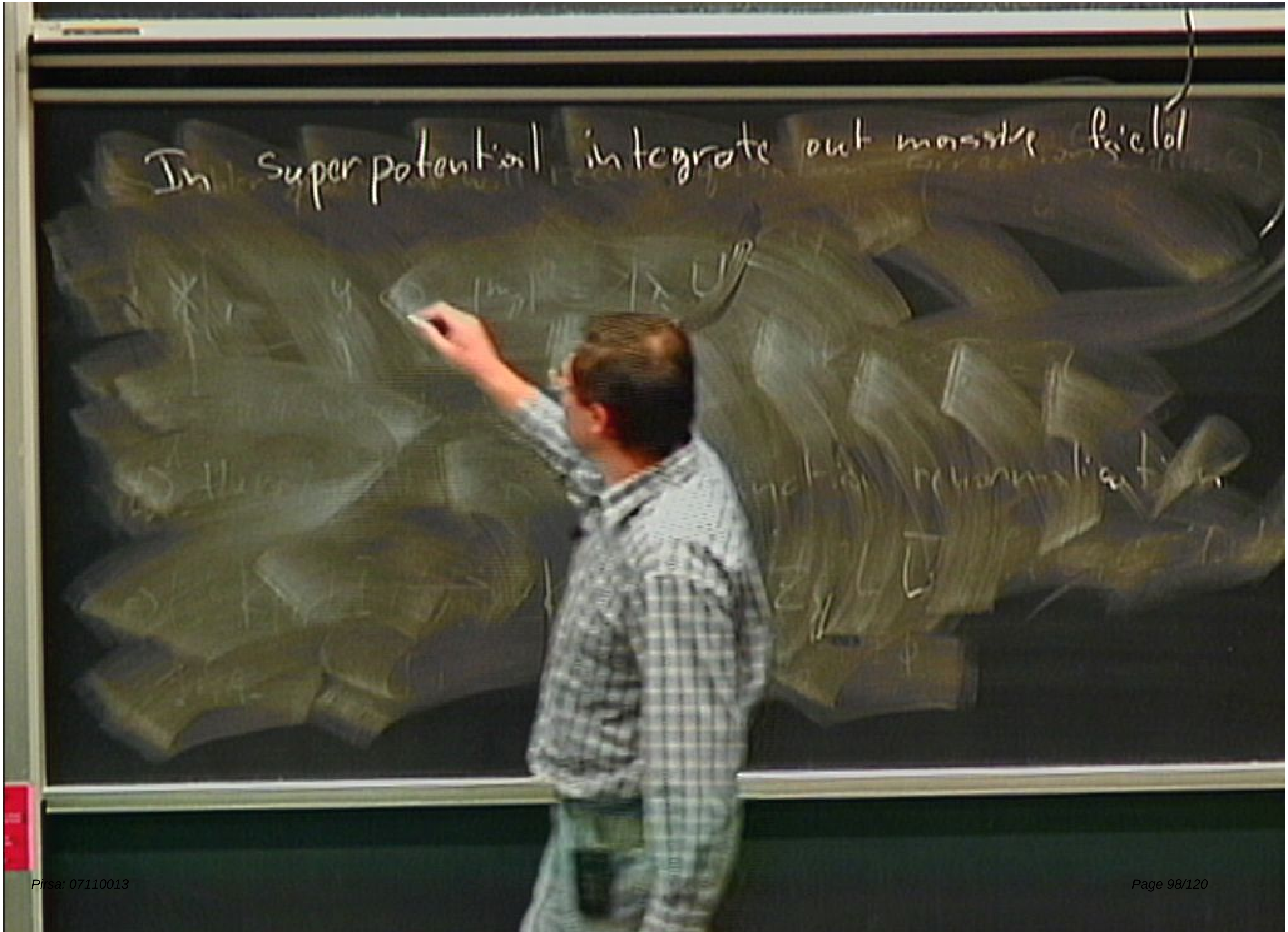
$\Rightarrow$ construct monomials.

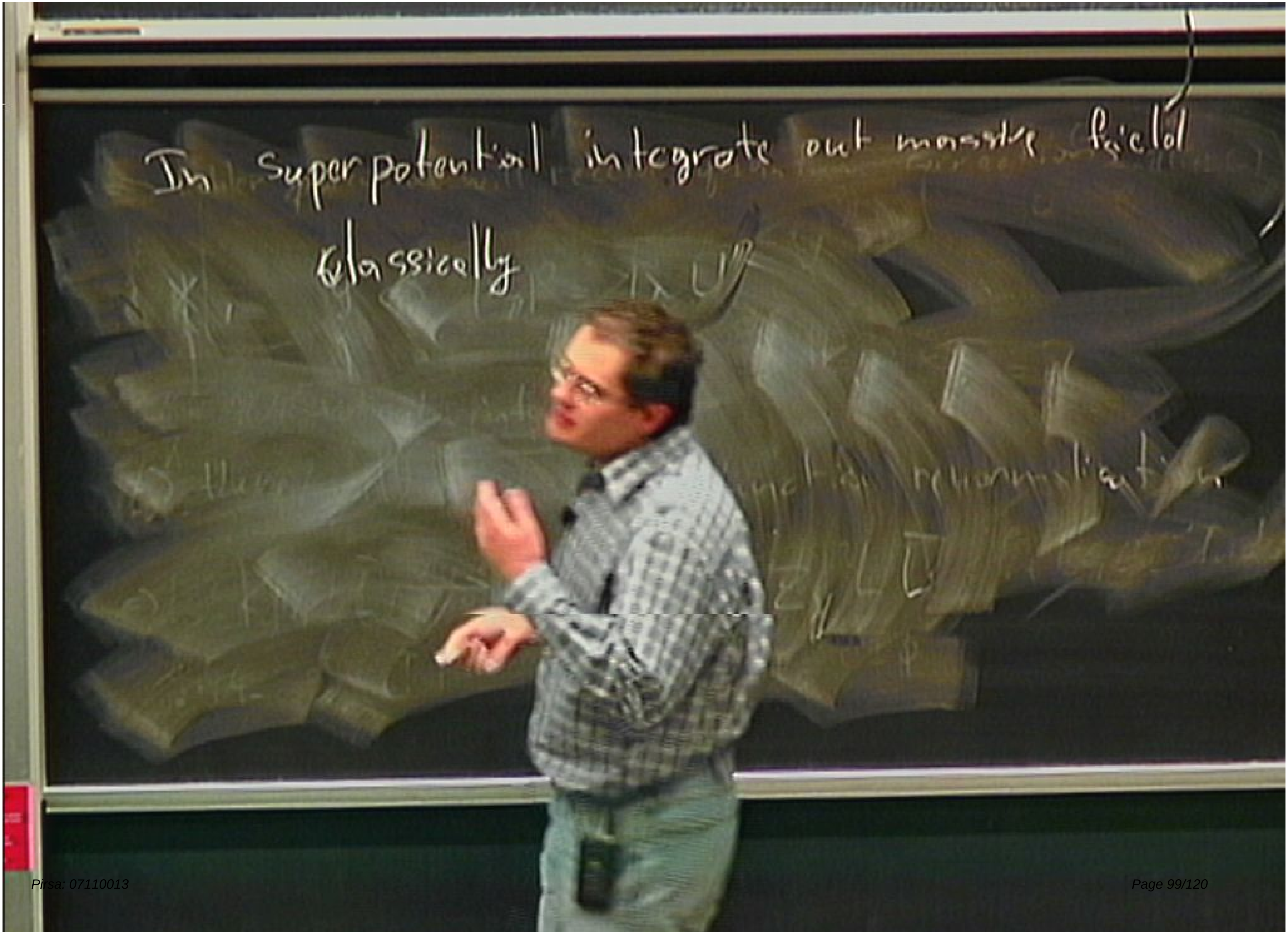
$U(1)_H$: $-2n_2 - n_3 = 0$

$W_{eff} \propto \frac{L^4 \lambda^2}{m^2}$

$U(1)_L$ $n_1 - 2n_3 = 0$

$U(1)_R$ $2n_2 + n_1 = 2$

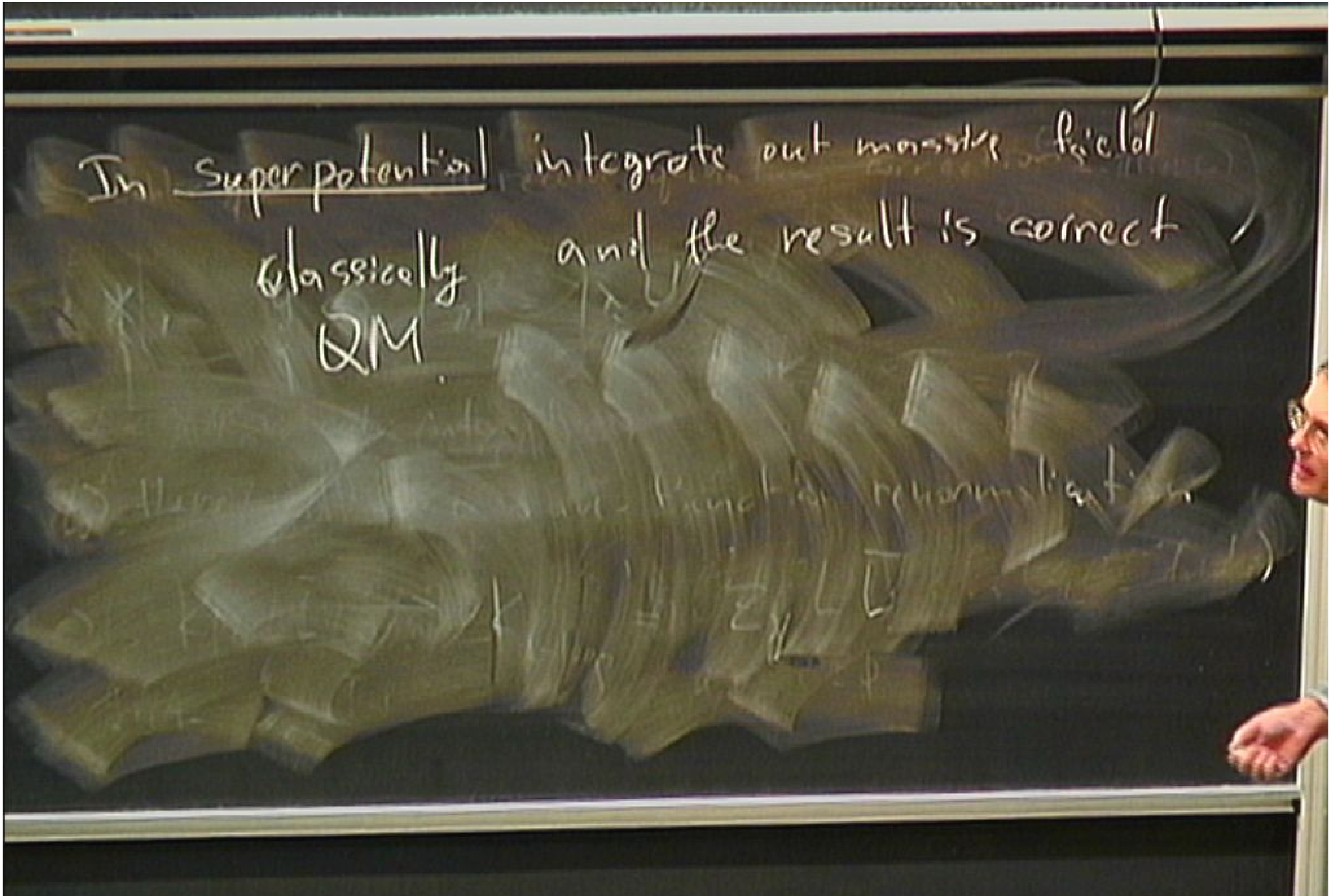

In superpotential integrate out massive field


In superpotential integrate out massive field
classically

In superpotential integrate out massive field

classically and the result is correct

QM.

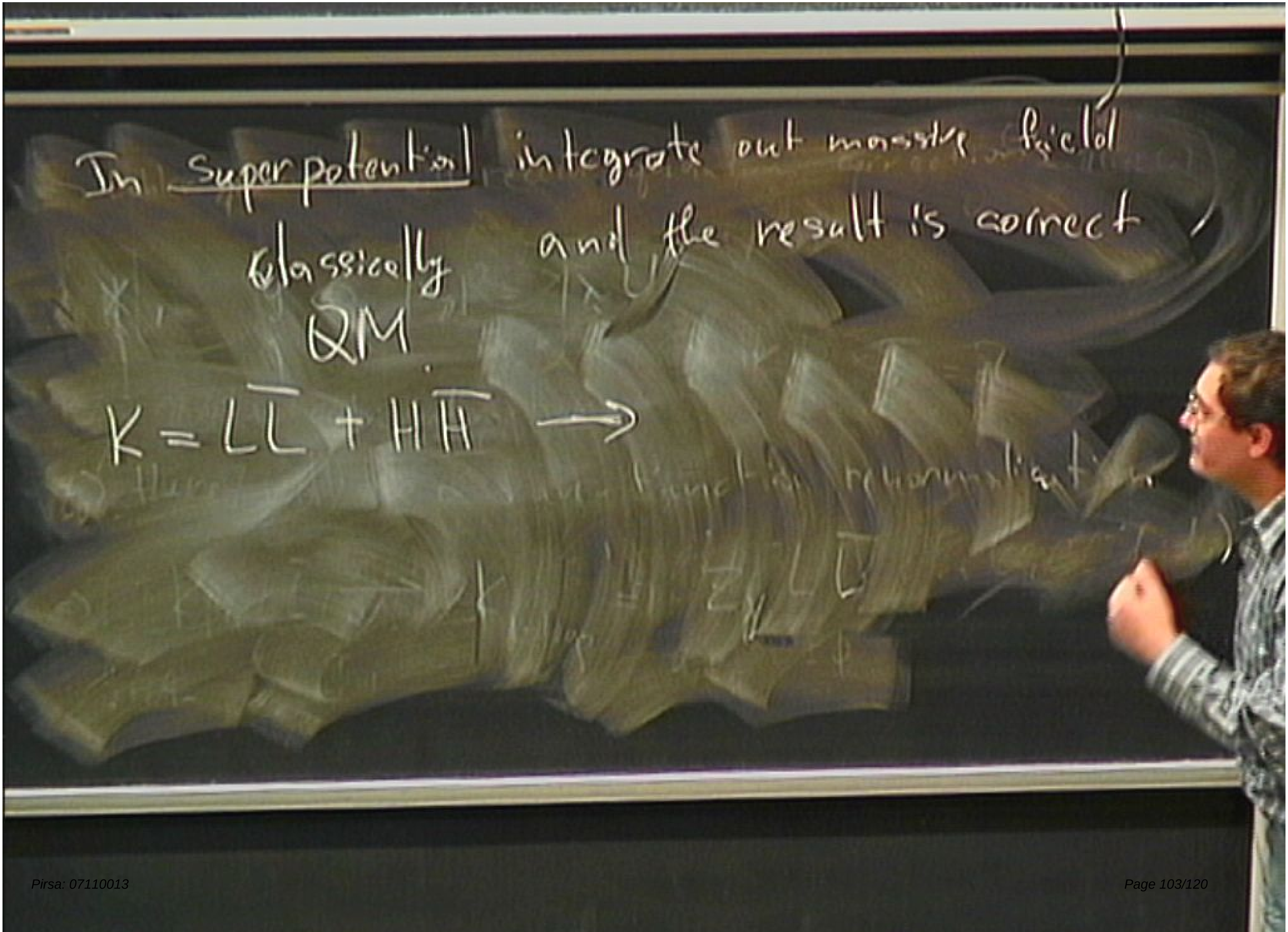

In Superpotential integrate out massive field
classically and the result is correct
QM

In Superpotential integrate out massive field

classically and the result is correct

QM

$K = L\bar{L} -$


In Superpotential integrate out massive field
classically and the result is correct
QM
K = LL̄ + HH̄ →

In Superpotential integrate out massive field

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QM

$$H = -\frac{\lambda L^2}{m}$$

$$K = L\bar{L} + H\bar{H} \longrightarrow K_{eff} = L\bar{L} + \left|\frac{\lambda}{m}\right|^2 (L\bar{L})^2$$

In <u>Superpotential</u> integrate out massive field and the result is correct classically

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<u>not exact</u>

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not exact

$$Z_L^{class} = 1 = Z_L (L\bar{L})$$

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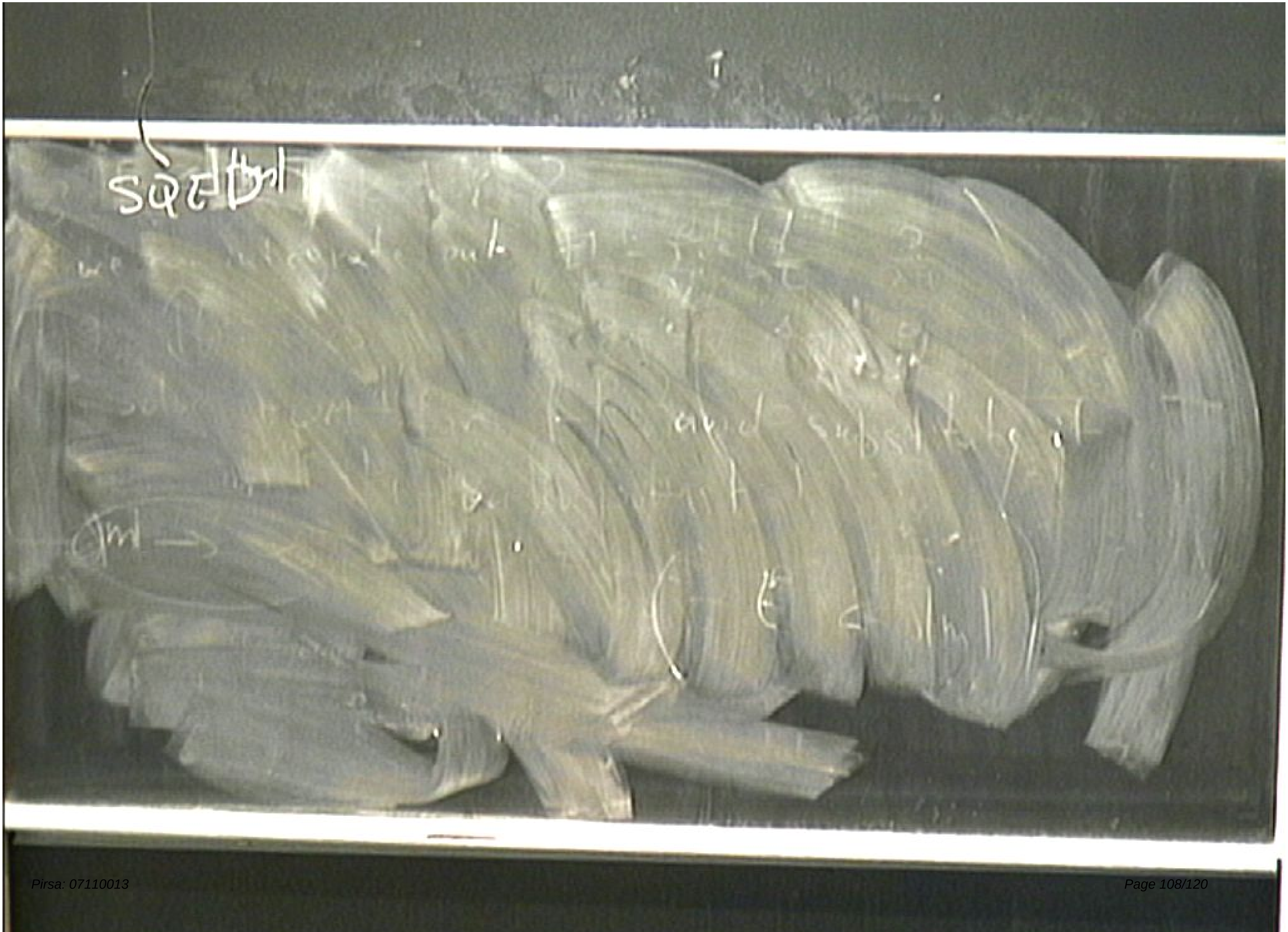
not exact

$$Z_L^{class} = 1 + \left|\frac{\lambda}{m}\right|^2 L\bar{L} = Z_L(L\bar{L})$$



SQCD

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu} F^{\mu\nu\,a} \qquad F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$$

SQED

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu} F^{\mu\nu} \qquad F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$$

$$A_\mu \to A_\mu + \partial_\mu \alpha$$

⇒ vector superfields

most general superfield

$$V = V^{\dagger}$$

⇒

$$V = C(x) + i\theta\chi(x) - i\bar{\theta}\bar{\chi}(x)$$

$\Rightarrow$ vector superfields

most general superfield

$\underline{V = V^+}$

$\Rightarrow$

$V = C(x) + i\theta\chi(x) - i\bar{\theta}\bar{\chi}(x) +$

real scalar

⇒ vector superfield

most general superfield

$V = V^\dagger$

⇒

$$V = C(x) + i\theta\chi(x) - i\bar\theta\bar\chi(x) + \frac{i}{2}\theta^2\left[M+iN\right] - \frac{i}{2}\bar\theta^2\left[M-iN\right]$$

real scalar

⇒ <u>vector superfield</u>

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$$V = C(x) + i\theta\chi(x) - i\bar\theta\bar\chi(x) + \frac{i}{2}\theta^2\left[M + iN\right] - \frac{i}{2}\bar\theta^2\left[M - iN\right]$$

real scalar

$$-\theta\sigma^\mu\bar\theta\, v_\mu + i\theta^2\bar\theta\left[\bar\lambda + \frac{i}{2}\bar\sigma^\mu\partial_\mu\chi\right]$$

$\Rightarrow$ vector superfields

most general superfield

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$$V = C(x) + i\theta\chi(x) - i\bar{\theta}\bar{\chi}(x) + \frac{i}{2}\theta^2\left[M + iN\right] - \frac{i}{2}\bar{\theta}^2\left[M - iN\right]$$

real scalar

$$- \theta\sigma^{\mu}\bar{\theta}\, v_{\mu} + i\theta^2\bar{\theta}\left[\bar{\lambda} + \frac{i}{2}\bar{\sigma}^{\mu}\partial_{\mu}\chi\right]$$

$$- i\bar{\theta}^2\theta\left[\lambda + \frac{i}{2}\sigma^{\mu}\partial_{\mu}\bar{\chi}\right]$$

$\Rightarrow$ look at symmetries

$\Rightarrow$ most general W (holomorphic in couplings)

$\Rightarrow$ vector superfields

most general superfield

$\underline{V = V^+}$

$\Rightarrow$

$V = C(x) + i\theta\chi(x) - i\bar\theta\bar\chi(x) + \frac{i}{2}\theta^2\left[M + iN\right] - \frac{i}{2}\bar\theta^2\left[M - iN\right]$

real scalar

$- \theta\sigma^\mu\bar\theta\, v_\mu + i\theta^2\bar\theta\left[\bar\lambda + \frac{i}{2}\bar\sigma^\mu\partial_\mu\chi\right]$

$- i\bar\theta^2\theta\left[\lambda + \frac{i}{2}\sigma^\mu\partial_\mu\bar\chi\right] + \frac{1}{2}\theta^2\bar\theta^2\left[\right.$

$\Rightarrow$ look at symmetries

$\Rightarrow$ most general W (holomorphic in couplings)

$$C,\ M, N,\ O_m,\ D$$

$$W_{eff} \propto \frac{L^4 \lambda^2}{m}$$

$$+ \frac{i}{2}\theta^2\left[M + iN\right] - \frac{i}{2}\bar{\theta}^2\left[M - iN\right]$$

$$C, M, N, O_m, D$$

spin-1

$$+\frac{i}{2}\theta^2\left[M+iN\right]-\frac{i}{2}\bar{\theta}^2\left[M-iN\right]$$

$C,\ M,\ N,\ v_m,\ D,\ \lambda,\ \chi,\ \bar{\delta},\ \bar{\psi}$

spin-1

$$+\frac{i}{2}\theta^2\left[M+iN\right]-\frac{i}{2}\bar{\theta}^2\left[M-iN\right]$$

$$\boxed{C,\ M,\ N,\ \underbrace{v_m}_{\text{spin-}1},\ D},\ \lambda,\ \chi,\ \bar{\zeta},\ \bar{\psi}$$

erfield

$$\ldots\ \bar{\theta}\bar{\chi}(x) + \frac{i}{2}\theta^2\left[M+iN\right] - \frac{i}{2}\bar{\theta}^2\left[M-iN\right]$$