Title: Intro to Supersymmetry 18

Date: Nov 15, 2007 12:30 PM

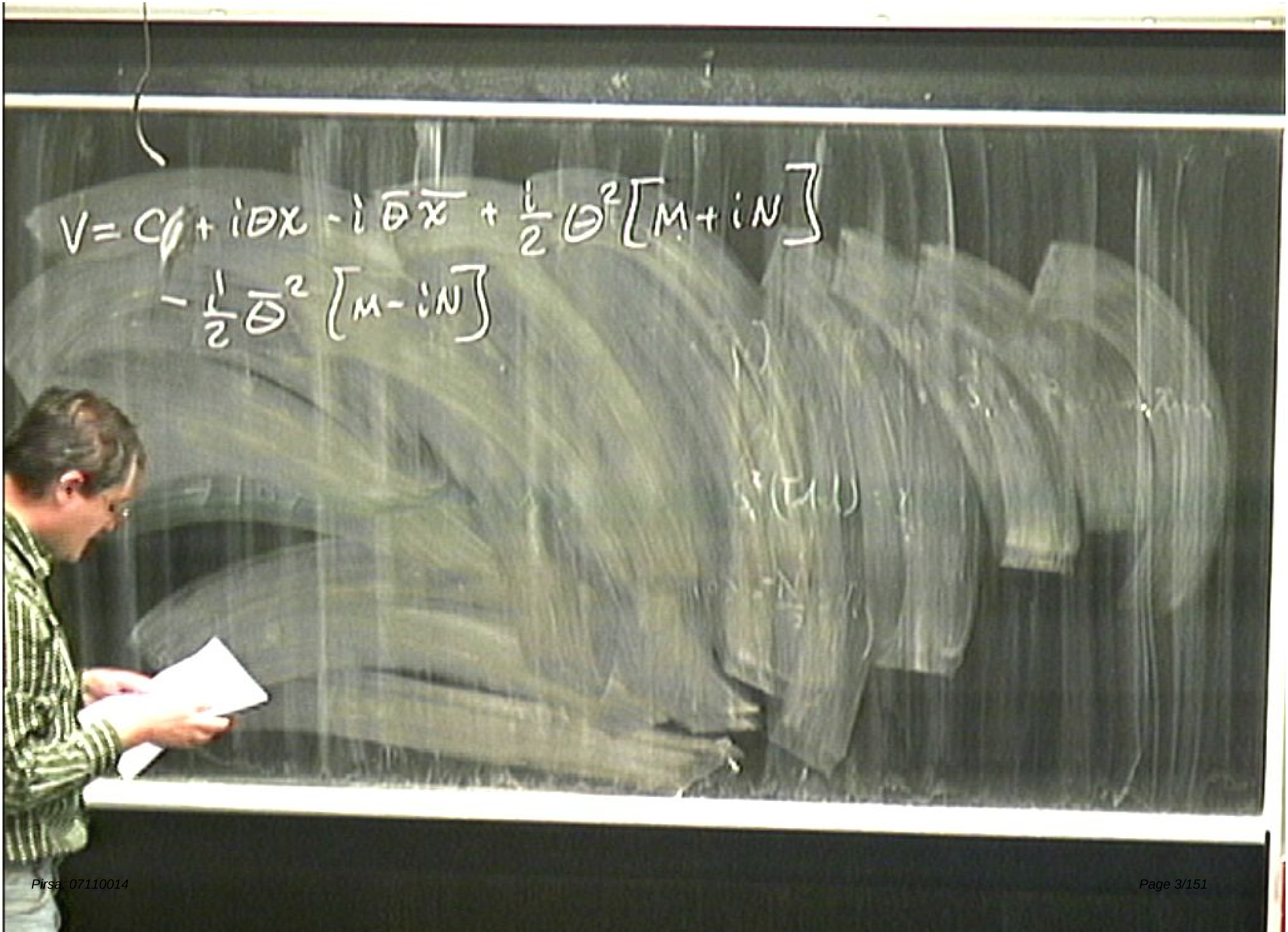
URL: http://pirsa.org/07110014

Abstract:

⇒ Last class ⟶ Thursday of week Dec 3

⇒ next week Homework #3

⇒ Supersymmetric gauge theories


$V = C\phi + i\theta\chi - i\bar{\theta}\bar{\chi} + \frac{1}{2}\theta^2[M + iN]$
$- \frac{1}{2}\bar{\theta}^2[M - iN]$

$$V = C + i\theta\chi - i\bar{\theta}\bar{\chi} + \frac{i}{2}\theta^2\left[M + iN\right]$$
$$- \frac{i}{2}\bar{\theta}^2\left[M - iN\right] - \theta\sigma^m\bar{\theta}A_m + i\theta^2\bar{\theta}\left[\bar{\lambda} + \frac{i}{2}\bar{\sigma}^m\partial_m\chi\right]$$

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

$$- \frac{i}{2}\bar{\theta}^2\left[M - iN\right] - \theta\sigma^m\bar{\theta}A_m + i\theta^2\bar{\theta}\left[\bar{\lambda} + \frac{i}{2}\bar{\sigma}^m\partial_m\chi\right]$$

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

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

$$- \frac{i}{2}\bar{\theta}^2\left[M - iN\right] - \theta\sigma^m\bar{\theta}A_m + i\theta^2\bar{\theta}\left[\bar{\lambda} + \frac{i}{2}\bar{\sigma}^m\partial_m\chi\right]$$

$$- i\bar{\theta}^2\theta\left[\lambda + \frac{i}{2}\underbrace{\sigma^m\partial_m\bar{\chi}}_{\sigma^m_{\alpha\dot{\alpha}}\partial_m\bar{\chi}^{\dot{\alpha}}}\right]$$

$$
\begin{aligned}
V = C &+ i\theta\chi - i\bar{\theta}\bar{\chi} + \frac{i}{2}\theta^2\left[M + iN\right] \\
&- \frac{i}{2}\bar{\theta}^2\left[M - iN\right] - \theta\sigma^m\bar{\theta}A_m + i\theta^2\bar{\theta}\left[\bar{\lambda} + \frac{i}{2}\bar{\sigma}^m\partial_m\chi\right] \\
&- i\bar{\theta}^2\theta^\alpha\left[\lambda_\alpha + \frac{i}{2}\underbrace{\sigma^m\partial_m\bar{\chi}}_{\sigma^m_{\alpha\dot{\alpha}}\partial_m\bar{\chi}^{\dot{\alpha}}}\right]
\end{aligned}
$$

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

$$-\frac{i}{2}\bar{\theta}^2\left[M - iN\right] - \theta\sigma^m\bar{\theta}A_m + i\theta^2\bar{\theta}\left[\bar{\lambda} + \frac{i}{2}\bar{\sigma}^m\partial_m\chi\right]$$

$$-i\bar{\theta}^2\theta^2\left[\lambda_\alpha + \frac{i}{2}\underbrace{\sigma^m\partial_m\bar{\chi}}_{\sigma^m_{\alpha\dot{\alpha}}\partial_m\bar{\chi}^{\dot{\alpha}}}\right]$$

$$+\frac{1}{2}\theta^2\bar{\theta}^2\left[D + \frac{1}{2}\Box C\right]$$

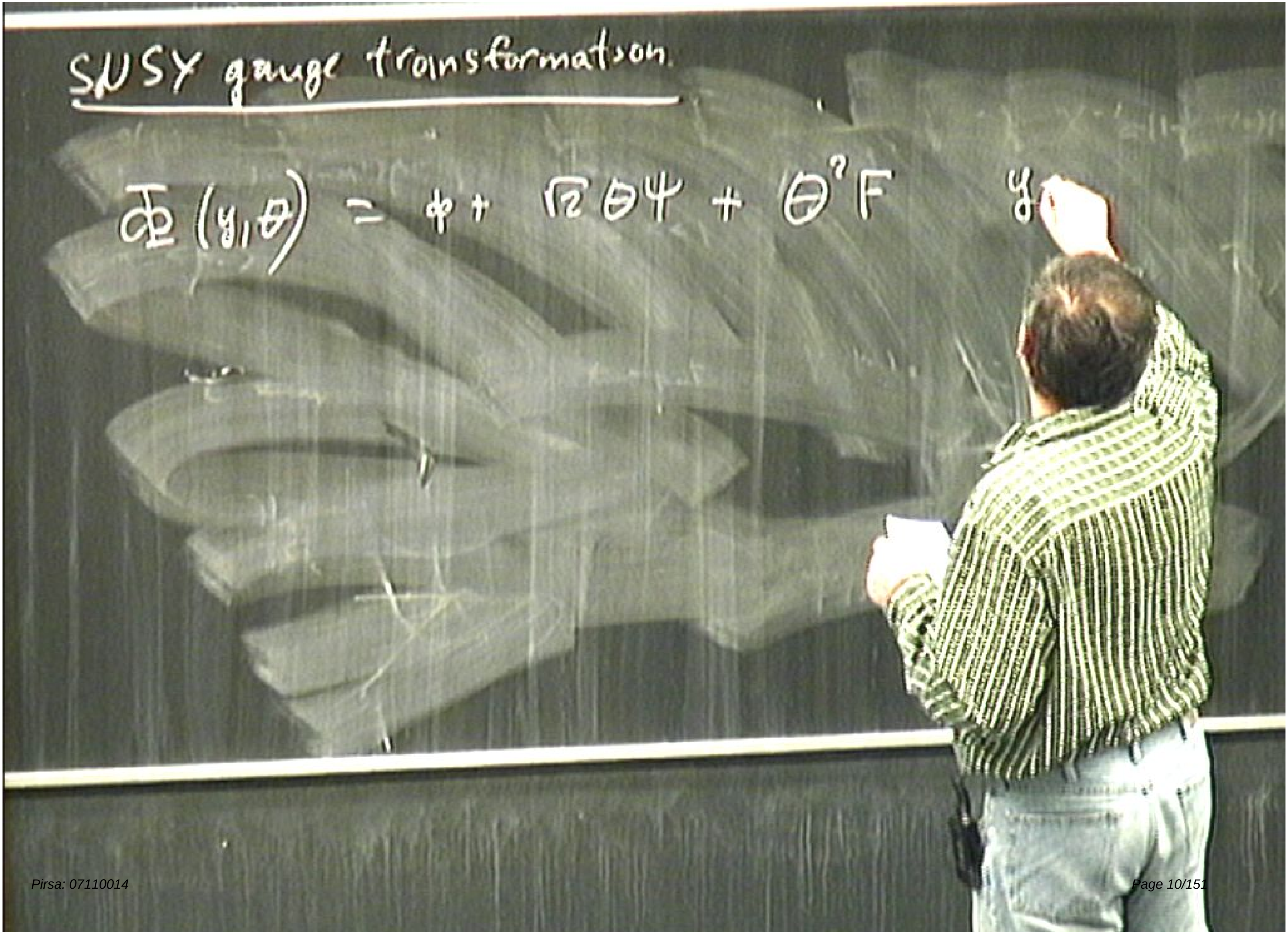
Homework #3

gauge theories

A_μ - spin-1

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

gauge transformation


SUSY gauge transformation
$\Phi(y,\theta) = \phi + \sqrt{2}\,\theta\psi + \theta^2 F$ y

SUSY gauge transformation

$$\Phi(y,\theta) = \phi + \sqrt{2}\,\theta\psi + \theta^2 F \qquad y = x + \theta\sigma\bar{\theta}$$

SUSY gauge transformation

$$\Phi(y,\theta) = \phi + \sqrt{2}\,\theta\psi + \theta^2 F \qquad y = x + i\theta\sigma\bar{\theta}$$

$$\bar{\Phi}(\bar{y},\bar{\theta}) \;.\;.\; - \;-$$

SUSY gauge transformation

$$\Phi(y,\theta) = \phi + \sqrt{2}\,\theta\psi + \theta^2 F \qquad y = x + i\theta\sigma\bar{\theta}$$

$$\bar{\Phi}(\bar{y},\bar{\theta}) \quad \cdot \quad \cdot \quad - \quad -$$

$$\Phi + \bar{\Phi}$$

$$V \longrightarrow V + \Phi + \bar{\Phi}$$

SUSY gauge transformation

$$\Phi(y,\theta) = \phi + \sqrt{2}\,\theta\psi + \theta^2 F \qquad y = x + i\theta\sigma\bar\theta$$

$$\bar\Phi(\bar y,\bar\theta) \; . \; . \; - \; -$$

$$\Phi + \bar\Phi$$

$$\begin{array}{cc} x s f & x s f \\ \uparrow & \uparrow \end{array}$$

$$V \longrightarrow V + \Phi + \bar\Phi$$

In components:

$$C \longrightarrow C + \varphi(x) + \bar{\varphi}(x)$$

In components:

$$C \to C + \phi(x) + \bar{\phi}(x)$$

$$\chi \to \chi - i\sqrt{2}\,\psi$$

$$\bar{\chi} \to \bar{\chi} + i\sqrt{2}\,\bar{\psi}$$

<u>In components:</u>

$$C \longrightarrow C + \phi(x) + \bar{\phi}(x)$$

$$x \longrightarrow x - i\sqrt{2}\,\psi$$

$$\bar{x} \longrightarrow \bar{x} + i\sqrt{2}\,\bar{\psi}$$

$$M + iN \longrightarrow$$

In components:

$$C \longrightarrow C + \phi(x) + \bar{\phi}(x)$$

$$\chi \longrightarrow \chi - i\sqrt{2}\,\psi$$

$$\bar{\chi} \longrightarrow \bar{\chi} + i\sqrt{2}\,\bar{\psi}$$

$$M + iN \longrightarrow M + iN$$

In components:

$$C \to C + \varphi(x) + \bar{\varphi}(x)$$

$$\chi \to \chi - i\sqrt{2}\,\psi$$

$$\bar{\chi} \to \bar{\chi} + i\sqrt{2}\,\bar{\psi}$$

$$M + iN \to M + iN - 2iF$$

$$A_\mu \to A_\mu - i\,\partial_\mu\left[\varphi - \bar{\varphi}\right]$$

In components:

$$C \to C + \varphi(x) + \bar{\varphi}(x)$$

$$\chi \to \chi - i\sqrt{2}\,\psi$$

$$\bar{\chi} \to \bar{\chi} + i\sqrt{2}\,\bar{\psi}$$

$$M + iN \to M + iN - 2iF$$

$$A_\mu \to A_\mu - i\,\partial_\mu\left[\varphi - \bar{\varphi}\right]$$

gauge transformation

$$\lambda \to$$

In components:

$$C \rightarrow C + \varphi(x) + \bar{\varphi}(x)$$

$$\chi \rightarrow \chi - i\sqrt{2}\,\psi$$

$$\bar{\chi} \rightarrow \bar{\chi} + i\sqrt{2}\,\bar{\psi}$$

$$M + iN \rightarrow M + iN - 2iF$$

$$A_m \rightarrow \underbrace{A_m - i\partial_m\left[\varphi - \bar{\varphi}\right]}_{\text{gauge transformation}}$$

$$\left.\begin{aligned} \lambda &\rightarrow \lambda \\ D &\rightarrow D \end{aligned}\right\} \begin{array}{l}\text{SUSY} \\ \text{gauge invariant}\end{array}$$

In components:

$$C \to C + \phi(x) + \bar{\phi}(x)$$

$$\chi \to \chi - i\sqrt{2}\,\psi$$

$$\bar{\chi} \to \bar{\chi} + i\sqrt{2}\,\bar{\psi}$$

$$M + iN \to M + iN - 2iF$$

$\Rightarrow$ SUSY gauge transform is a symmetry

$$\underset{\substack{\uparrow \\ \text{gauge transformation}}}{A_\mu \to A_\mu} - i\partial_\mu[\phi - \bar{\phi}]$$

$$\left.\begin{array}{l} \lambda \to \lambda \\ D \to D \end{array}\right\} \text{SUSY gauge invariant}$$

In components:

$$C \rightarrow C + \phi(x) + \bar{\phi}(x)$$

$$\chi \rightarrow \chi - i\sqrt{2}\,\psi$$

$$\bar{\chi} \rightarrow \bar{\chi} + i\sqrt{2}\,\bar{\psi}$$

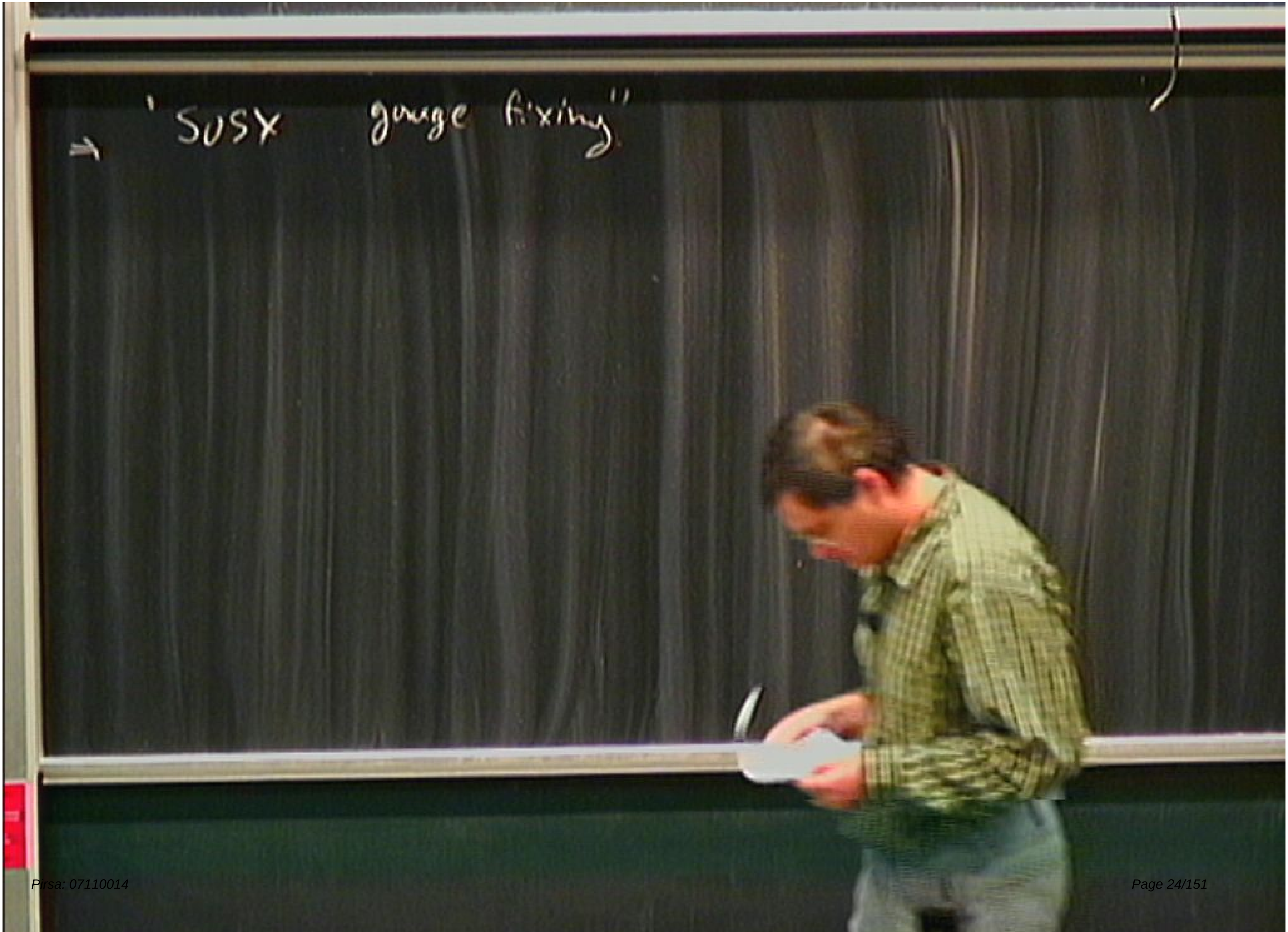
$$M + iN \rightarrow M + iN - 2iF$$

$\Rightarrow$ SUSY gauge transform is a symmetry of SUSY action

$$A_\mu \rightarrow A_\mu - i\partial_\mu[\phi - \bar{\phi}]$$

$\Uparrow$ gauge transformation

$$\left.\begin{aligned}\lambda &\rightarrow \lambda \\ D &\rightarrow D\end{aligned}\right\}\ \text{SUSY gauge invariant}$$


→ 'SUSY gauge fixing'

$\Rightarrow$ "SUSY gauge fixing"

$\rightarrow$ WZ gauge.

$\hookrightarrow$ $C = 0$ $\rightarrow$ fixed $\mathrm{Re}(\varphi)$

$\Rightarrow$ "SUSY gauge fixing"

$\longrightarrow$ WZ gauge.

$\hookrightarrow$ $C = 0$ $\rightarrow$ fixed by $Re(\varphi)$

$\chi = 0$ $\longrightarrow$ fixed by ψ

$\Rightarrow$ "SUSY gauge fixing"

$\rightarrow$ WZ gauge.

$\hookrightarrow$ $C = 0$ $\rightarrow$ fixed by $Re(\varphi)$

$\chi = 0$ $\rightarrow$ fixed by ψ

$M + iN = 0$

$\Rightarrow$ "SUSY gauge fixing"

$\rightarrow$ WZ gauge.

$\hookrightarrow$ $C = 0$ $\rightarrow$ fixed by $Re(\varphi)$

$\chi = 0$ $\rightarrow$ fixed by ψ

$M + iN = 0$ $\rightarrow$ fixed by $Re(F)$, $Im(F)$

$\hookrightarrow \quad C = 0 \quad \longrightarrow$ fixed by $\mathrm{Re}(\varphi)$

$x = 0 \quad \longrightarrow$ fixed by ψ

$M + iN = 0 \quad \longrightarrow$ fixed by $\mathrm{Re}(F)$, $\mathrm{Im}(F)$

$\Rightarrow \mathrm{Im}(\varphi)$ <u>is not fixed</u>

In WZ gauge

A_m, λ, D (arbitrary)

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$\mathrm{Im}(\varphi)$ is not fixed $\Rightarrow$

In WZ gauge:

A_m, λ, D (arbitrary)

$\mathrm{Im}(\varphi)$ is not fixed $\Rightarrow$

$$A_m \to A_m - \partial\, \mathrm{Im}(\varphi)$$

In WZ gauge:

$A_m, \quad \lambda, \quad D \quad$ (arbitrary)

$\mathrm{Im}(\varphi)$ is not fixed $\Rightarrow$

$$A_m \to A_m + \partial\, \mathrm{Im}(\varphi)$$

In WZ gauge

A_m, λ, D (arbitrary)

$\mathrm{Im}(\varphi)$ is not fixed $\Rightarrow$

$$A_m \to A_m + \partial_m [2\,\mathrm{Im}(\varphi)]$$

must be massless $\Rightarrow$ 2 DOF (bosonic)

In WZ gauge

A_m, λ, D (arbitrary)

$\mathrm{Im}(\varphi)$ is not fixed $\Rightarrow$

$$A_m \to A_m + \partial_m [2\,\mathrm{Im}(\varphi)]$$

must be massless $\Rightarrow$ 2 DOF (bosonic)

λ (photino)

(

In WZ gauge:

A_m, λ, D (arbitrary)

$\mathrm{Im}(\varphi)$ is not fixed $\Rightarrow$

$$A_m \to A_m + \partial_m [2\,\mathrm{Im}(\varphi)]$$

$\to$ must be massless $\Rightarrow$ 2 DOF (bosonic)

λ (photino) (gaugino) 2 DOF (fermionic)

In WZ gauge

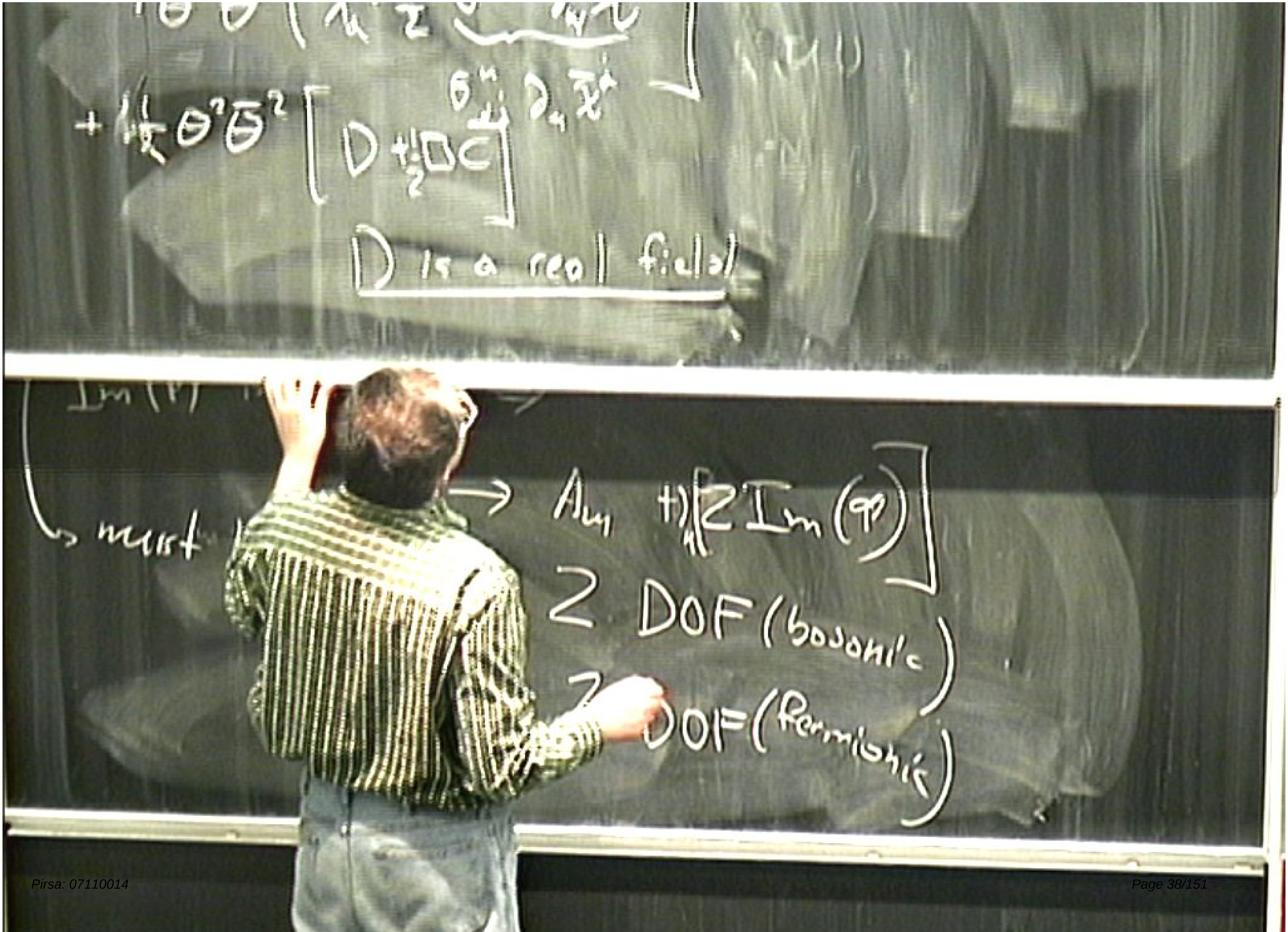
A_m, λ, D (arbitrary)

Im (φ) is not fixed $\Rightarrow$

$$A_m \to A_m + \partial_m [2\,\mathrm{Im}(\varphi)]$$

must be massless $\Rightarrow$ 2 DOF (bosonic)

λ (photino) (gaugino) 2 DOF (fermionic)


D is a real field
must
2 DOF (bosonic)
DOF (fermionic)

In WZ gauge

A_m, λ, $D \to$ non propagating

(arbitrary)

$\mathrm{Im}(\varphi)$ is not fixed $\Rightarrow$

$$A_m \to A_m + \partial_m \left[2\,\mathrm{Im}(\varphi) \right]$$

must be massless $\Rightarrow$ 2 DOF (bosonic)

λ (photino) (gaugino) 2 DOF (fermionic)

$$V = -\theta\sigma^m\bar{\theta}A_m + i\theta^2\bar{\theta}\bar{\lambda} - i\bar{\theta}^2\theta\lambda + \frac{1}{2}\theta^2\bar{\theta}^2 D$$

$\boxed{\text{WZ gauge}}$

$$V = -\theta\sigma^m\bar{\theta}A_m + i\theta^2\bar{\theta}\bar{\lambda} - i\bar{\theta}^2\theta\lambda + \frac{1}{2}\theta^2\bar{\theta}^2 D$$

$\boxed{\text{WZ gauge}}$

$$V = -\theta\sigma^m\bar\theta A_m + i\theta^2\bar\theta\bar\lambda - i\bar\theta^2\theta\lambda + \frac{1}{2}\theta^2\bar\theta^2 D$$

$$V^2 =$$

$$V^3 = 0$$

$\boxed{\text{WZ gauge}}$

$$V = -\theta\sigma^m\bar{\theta}A_m + i\theta^2\bar{\theta}\bar{\lambda} - i\bar{\theta}^2\theta\lambda + \frac{1}{2}\theta^2\bar{\theta}^2 D$$

$$V^2 = (\theta\sigma^m\bar{\theta}A_m)(\theta\sigma^n\bar{\theta}A_n)$$

$$V^3 = 0$$

$\boxed{\text{WZ gauge}}$

$$V = -\theta\sigma^m\bar\theta A_m + i\theta^2\bar\theta\bar\lambda - i\bar\theta^2\theta\lambda + \frac{1}{2}\theta^2\bar\theta^2 D$$

$$V^2 = (\theta\sigma^m\bar\theta A_m)(\theta\sigma^n\bar\theta A_n) \underset{\substack{\text{homework}\\ 1.}}{=} -\frac{1}{2}\theta^2\bar\theta^2 A_n A^n$$

$$V^3 = 0$$

SUSY gauge transformation

⇒ SUSY field strength

In ordinary QFT: $F_{\mu\nu} \xrightarrow{\text{gauge}} F_{\mu\nu}$

in SQFT: $xxx \xrightarrow{\text{SUSY gauge}} xxx$

⇒ SUSY field strength

In orginary QFT: $F_{\mu\nu} \xrightarrow{\text{gauge}} F_{\mu\nu}$

in SQFT: $xxx \xrightarrow{\text{SUSY gauge}} xxx$

$\Rightarrow$ SUSY field strength

In ordinary QFT: $F_{\mu\nu} \xrightarrow{\text{gauge}} F_{\mu\nu}$

in SQFT: $\times\times\times \xrightarrow{\text{SUSY gauge}} \times\times\times$

$\Rightarrow$ W_α

left-handed spinor index

⇒ SUSY field strength

In ordinary QFT: $F_{\mu\nu} \xrightarrow{\text{gauge}} F_{\mu\nu}$

in SQFT: $xxx \xrightarrow{\text{SUSY gauge}} xxx$

$$\Rightarrow \quad W_\alpha \overset{\text{def}}{=} -\frac{1}{4}\bar{D}^2 D_\alpha V \quad ; \quad \bar{W}_{\dot\alpha}$$

left-handed spinor index

⇒ SUSY field strength

In ordinary QFT: $F_{\mu\nu} \xrightarrow{\text{gauge}} F_{\mu\nu}$

in SQFT: $xxx \xrightarrow{\text{SUSY gauge}} xxx$

$$\Rightarrow W_\alpha \stackrel{\text{def}}{=} -\frac{1}{4}\bar{D}^2 D_\alpha V \; ; \; \overline{W}_{\dot\alpha} = -\frac{1}{2} D^2 \bar{D}_{\dot\alpha} V$$

W_α: left-handed spinor index

⇒ SUSY field strength

In ordinary QFT: $F_{\mu\nu} \xrightarrow{\text{gauge}} F_{\mu\nu}$

in SQFT: $xxx \xrightarrow{\text{susy gauge}} xxx$

$$\Rightarrow W_\alpha \overset{\text{def}}{=} -\frac{1}{4}\bar{D}^2 D_\alpha V \; ; \; \overline{W_{\dot\alpha}} = -\frac{1}{4} D^2 \bar{D}_{\dot\alpha} V$$

left-handed spinor index

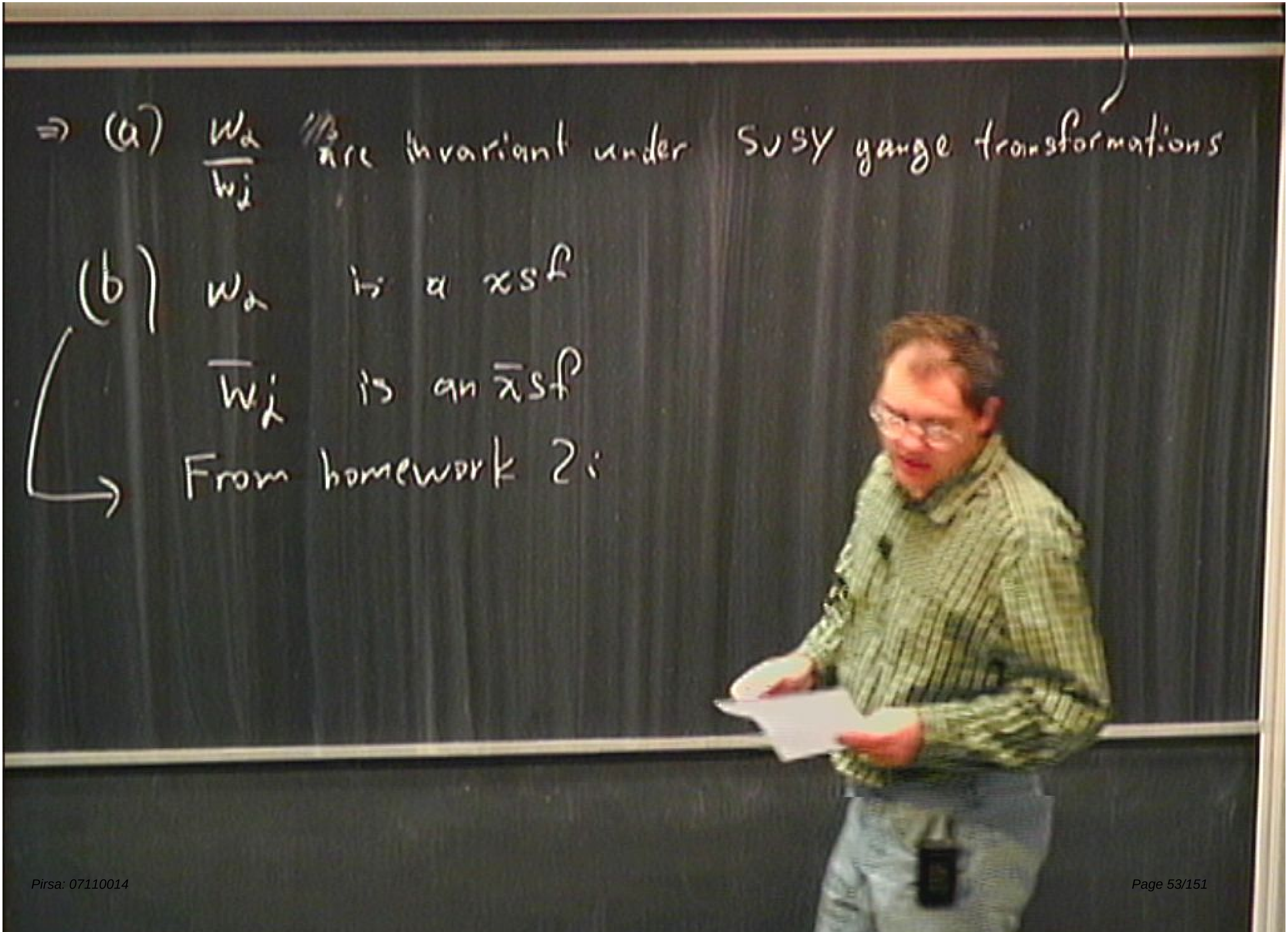
$\Rightarrow$ (a) $\dfrac{W_\alpha}{W_\dot{\alpha}}$ are invariant under SUSY gauge transformations

(b) W_α

$\Rightarrow$ (a) W_α, $\overline{W}_{\dot\alpha}$ are invariant under SUSY gauge transformations

(b) W_α is a χsf

$\overline{W}_{\dot\alpha}$ is an $\bar{\chi}$sf


⇒ (a) W_α, $\overline{W}_{\dot\alpha}$ are invariant under SUSY gauge transformations
(b) W_α is a $x$sf
$\overline{W}_{\dot\alpha}$ is an $\bar{x}$sf
From homework 2:

$\Rightarrow$ (a) $\dfrac{W_\alpha}{\overline{W}_{\dot\alpha}}$ are invariant under SUSY gauge transformations

(b) W_α is a χsf

$\overline{W}_{\dot\alpha}$ is an $\bar{\chi}$sf

From homework 2: $\exists$ $\mathcal{V}$

$\Rightarrow$ (a) $\dfrac{W_\alpha}{\overline{W}_{\dot\alpha}}$ are invariant under SUSY gauge transformations

(b) W_α is a χsf

$\overline{W}_{\dot\alpha}$ is an $\bar\chi$sf

From homework 2: $\exists\ U$ then

$\overline{D}^2 U$ is a χsf

$\Rightarrow$ (a) W_α, $\overline{W}_{\dot\alpha}$ are invariant under SUSY gauge transformations

(b) W_α is a χsf

$\overline{W}_{\dot\alpha}$ is an $\bar{\chi}$sf

From homework 2: $\exists\, U$ then

$\overline{D}^2 U$ is a χsf

$\Rightarrow$ (a) $\frac{W_\alpha}{\bar{W}_{\dot\alpha}}$ are invariant under SUSY gauge transformations

(b) W_α is a χsf

$\bar{W}_{\dot\alpha}$ is an $\bar{\chi}$sf

From homework 2: $\exists$ V then $\bar{D}^2 V$ is χsf

$\bar{D}_{\dot\alpha}[\bar{D}^2 V] = 0$ is a χsf

$\Rightarrow$ (a) $\dfrac{W_\alpha}{\overline{W}_{\dot\alpha}}$ are invariant under SUSY gauge transformations

(b) W_α is a χsf

$\overline{W}_{\dot\alpha}$ is an $\bar\chi$sf

From homework 2: $\exists$ U then $\overline{D}^2 V$ is χsf

$\overline{D}_{\dot\alpha}[\overline{D}^2 U] = 0$ is a χsf $\qquad D^2 V$ is $\bar\chi$sf

$D_\alpha[D^2 U] = 0$

$\Rightarrow$ (a) $\dfrac{W_\alpha}{\overline{W}_{\dot\alpha}}$ are invariant under SUSY gauge transformations (and thus invariant under ordinary gauge trans)

(b) W_α is a χsf

$\overline{W}_{\dot\alpha}$ is an $\bar{\chi}$sf

From homework 2: $\exists$ V then $\overline{D}V$ is χ[...]

$D^2 V$ is $\bar{\chi}$s[...]

$\overline{D}_{\dot\alpha}[\overline{D}^2 V] = 0$ is a χsf

$D_\alpha[D^2 V] = 0$

$$W_\alpha \to W_\alpha - \frac{1}{4}\bar{D}^2 D_\alpha (\bar{\Phi} + \bar{\Sigma})$$

$$W_\alpha \longrightarrow W_\alpha - \frac{1}{4}\underbrace{\bar{D}^2 D_\alpha (\bar{\Phi} + \bar{\Xi})}_{=0}$$

$$W_\alpha \rightarrow W_\alpha - \frac{1}{4}\bar{D}^2 D_\alpha\left(\underbrace{\Phi + \bar{\Phi}}\right)$$

$$\boxed{0}$$

$$D_\alpha \bar{\Phi} = 0$$

$$\bar{x}, \theta$$

$$\bar{D}^2 D_\alpha \bar{\Phi}$$

$$W_\alpha \to W_\alpha - \frac{1}{4}\bar{D}^2 D_\alpha(\Phi + \bar{\Phi})$$

$$\bar{D}^2 D_\alpha \bar{\Phi} = $$

$$\{D_\alpha, \bar{D}_{\dot\alpha}\} =$$

$$D_\alpha \bar{\Phi} = 0$$

$$\bar{y}, \bar{x}, \theta$$

$$W_\alpha \rightarrow W_\alpha - \frac{1}{4}\bar{D}^2 D_\alpha\left(\Phi + \bar{\Phi}\right)$$

$$D_\alpha \bar{\Phi} = 0$$

$\uparrow \bar{x}, \theta$

$$\bar{D}^2 D_\alpha \bar{\Phi} = $$

$$\{D_\alpha, \bar{D}_{\dot{\alpha}}\} = 2P_{\alpha\dot{\alpha}}$$

$$\ominus \quad \bar{D}_{\dot\alpha} \bar{D}^{\dot\alpha} D_\alpha \Phi = -\bar{D}^{\dot\alpha} \bar{D}_{\dot\alpha} D_\alpha \Phi$$

$$\Rightarrow \bar{D}_{\dot\alpha}\bar{D}^{\dot\alpha} D_\alpha \Phi = -\bar{D}^{\dot\alpha}\bar{D}_{\dot\alpha} D_\alpha \phi$$

$$= -\bar{D}^{\dot\alpha}\left[2P_{\alpha\dot\alpha} - D_\alpha \bar{D}_{\dot\alpha}\right]\phi$$

$$= \bar{D}_{\dot\alpha}\bar{D}^{\dot\alpha} D_\alpha \Phi = -\bar{D}^{\dot\alpha}\bar{D}_{\dot\alpha} D_\alpha \phi$$

$$= -\bar{D}^{\dot\alpha}\left[2P_{\alpha\dot\alpha} - D_\alpha \bar{D}_{\dot\alpha}\right]\phi = 0$$

use WZ gauge.

$W_\alpha(x, \theta, \bar\theta)$

use WZ gauge.

$$W_\alpha(x,\theta,\bar\theta) = W_\alpha(y,\theta)$$

use WZ gauge.

$$W_\alpha(x,\theta,\bar\theta) = W_\alpha(y,\theta)$$

$$W_\alpha = -\frac{1}{4}\bar{D}^2 D_\alpha V$$

$$V(x,\theta,\bar\theta)$$

use WZ gauge.

$$W_\alpha(x, \theta, \bar\theta) = W_\alpha(y, \theta)$$

$$W_\alpha = -\frac{1}{4}\bar{D}^2 D_\alpha V$$

$$V(x, \theta, \bar\theta)$$

In term of y coordinate

use WZ gauge.

$$W_\alpha(x,\theta,\bar\theta) \equiv W_\alpha(y,\theta)$$

$$W_\alpha = -\frac{1}{4}\bar{D}^2 D_\alpha V$$

$$\downarrow V(x,\theta,\bar\theta)$$

$\hookrightarrow$ In term of y coordinate

$$\hat\partial_\mu \stackrel{\text{def}}{=} \frac{\partial}{\partial y^\mu} \qquad \partial_\mu = \frac{\partial}{\partial x^\mu}$$

$$V(x,\theta,\bar\theta) = V(y,\theta,\bar\theta)$$

$$V = -\theta\sigma^m\bar\theta A_m + i\theta^2\bar\theta\bar\lambda - i\bar\theta^2\theta\lambda + \frac{1}{2}\theta^2\bar\theta^2 D$$

$$V(x,\theta,\bar\theta) = V(y,\theta,\bar\theta)$$

$$V = -\theta\sigma^m\bar\theta A_m + i\theta^2\bar\theta\bar\lambda - i\bar\theta^2\theta\lambda + \frac{1}{2}\theta^2\bar\theta^2 D$$

depend on x

$$V(x,\theta,\bar\theta) = V(y,\theta,\bar\theta)$$

$$V = -\theta\sigma^m\bar\theta A_m + i\theta^2\bar\theta\bar\lambda - i\bar\theta^2\theta\lambda + \frac{1}{2}\theta^2\bar\theta^2 D$$

depend on x

$$A_m(y) = A_m(x + i\theta\sigma\bar\theta) = A_m + \partial A_m \, i\theta\sigma^p\bar\theta$$

$$V(x,\theta,\bar\theta) = V(y,\theta,\bar\theta)$$

$$V = -\theta\sigma^m\bar\theta A_m + i\theta^2\bar\theta\bar\lambda - i\bar\theta^2\theta\lambda + \frac{1}{2}\theta^2\bar\theta^2 D$$

depend on x

$$A_m(y) = A_m(x + i\theta\sigma\bar\theta) = A_m + \partial A_m\, i\theta\sigma^p\bar\theta$$

$$V(y,\theta,\bar\theta) = -\theta\sigma^m\bar\theta\left[A_m(y) - \right.$$

$$V(x,\theta,\bar\theta) = V(y,\theta,\bar\theta)$$

$$V = -\theta\sigma^m\bar\theta A_m + i\theta^2\bar\theta\bar\lambda - i\bar\theta^2\theta\lambda + \tfrac{1}{2}\theta^2\bar\theta^2 D$$

depend on x

$$A_m(y) = A_m(x + i\theta\sigma\bar\theta) = A_m + \partial_\nu A_m \, i\theta\sigma^\nu\bar\theta$$

$$V(y,\theta,\bar\theta) = -\theta\sigma^m\bar\theta\left[A_m(y) - \hat\partial_\nu A_m(y)\, i\theta\sigma^\nu\bar\theta\right]$$

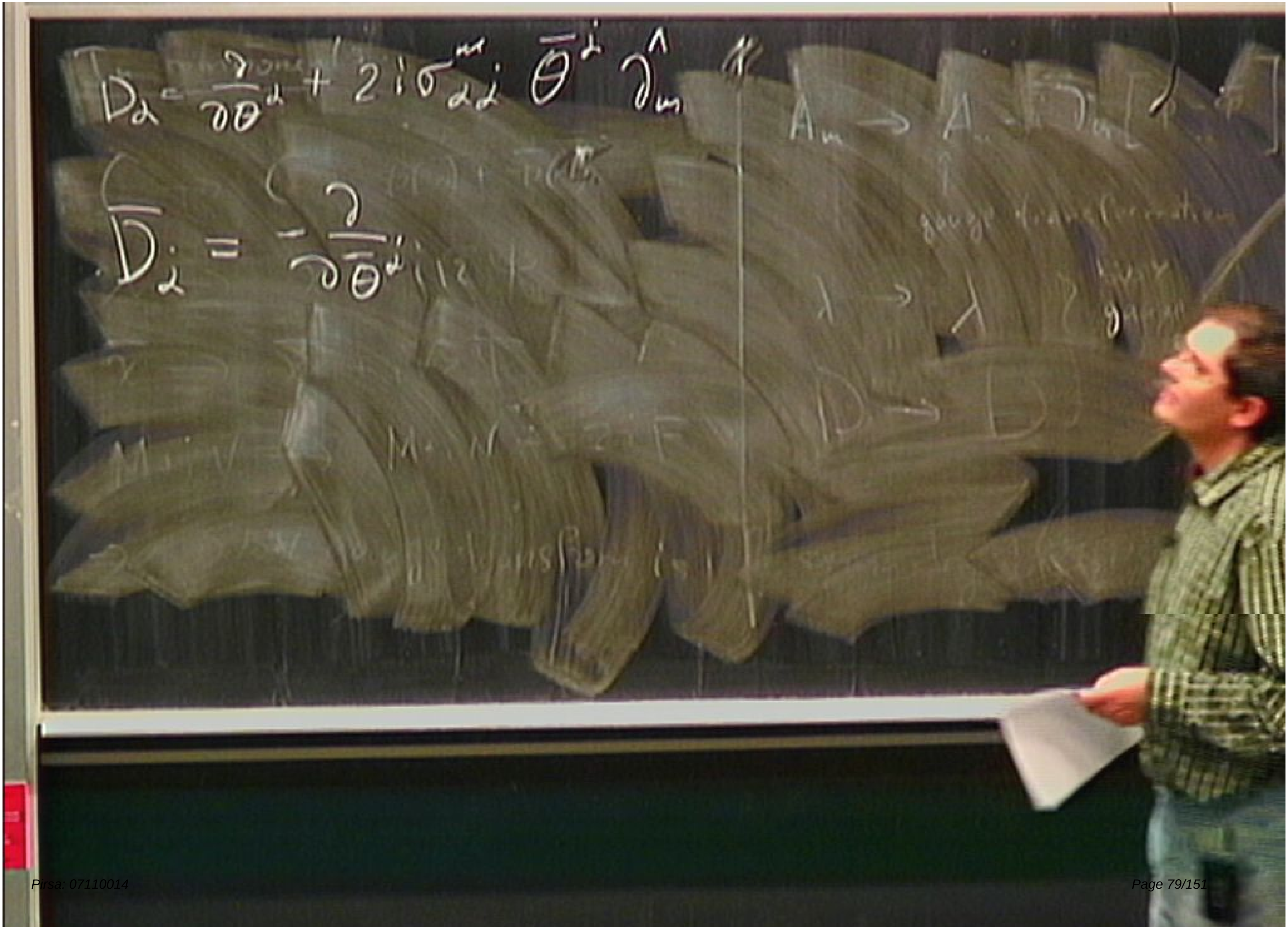
$$V(x,\theta,\bar\theta) = V(y,\theta,\bar\theta)$$

$$V = -\theta\sigma^m\bar\theta A_m + i\theta^2\bar\theta\bar\lambda - i\bar\theta^2\theta\lambda + \frac{1}{2}\theta^2\bar\theta^2 D$$

depend on x

$$A_m(y) = A_m(x + i\theta\sigma\bar\theta) = A_m + \partial_\nu A_m \, i\theta\sigma^\nu\bar\theta$$

$$V(y,\theta,\bar\theta) = -\theta\sigma^m\bar\theta\left[A_m(y) - \hat\partial_\nu A_m(y)\, i\theta\sigma^\nu\bar\theta\right]$$
$$-i\bar\theta^2\theta\lambda(y) + i\theta^2\bar\theta\bar\lambda(y) + \frac{1}{2}\theta^2\bar\theta^2 D(y)$$



$D_\alpha = \frac{\partial}{\partial\theta^\alpha} + 2i\sigma^m_{\alpha\dot\alpha}\bar\theta^{\dot\alpha}\partial_m$
$\bar D_{\dot\alpha} = -\frac{\partial}{\partial\bar\theta^{\dot\alpha}}$

$$D_\alpha = \frac{\partial}{\partial\theta^\alpha} + 2i\sigma^m_{\alpha\dot\alpha}\bar\theta^{\dot\alpha}\hat\partial_m$$

$$\bar D_{\dot\alpha} = -\frac{\partial}{\partial\bar\theta^{\dot\alpha}}$$

$\bar D_{\dot\alpha}\,\phi(y,\theta)$

$A_m \to A_m$

gauge transformation

$\lambda \to \lambda$

$D \to D$

$$D_\alpha = \frac{\partial}{\partial\theta^\alpha} + 2i\sigma^m_{\alpha\dot\alpha}\bar\theta^{\dot\alpha}\partial_m$$

$$\bar D_{\dot\alpha} = -\frac{\partial}{\partial\bar\theta^{\dot\alpha}} \cdots$$

$$\bar D_{\dot\alpha}\,\Phi(y,\theta) = 0$$

$$A_m \to A_m - \partial_m[\lambda \ldots]$$

$$\lambda \to \lambda$$

$$D \to D$$

$$\underbrace{\varepsilon^{\dot\alpha\dot\beta}\frac{\partial}{\partial\bar\theta^{\dot\alpha}}\frac{\partial}{\partial\bar\theta^{\dot\beta}}}_{\bar D_{\dot\alpha}\bar D^{\dot\alpha}}$$

$$D_\alpha = \frac{\partial}{\partial\theta^\alpha} + 2i\sigma^m_{\alpha\dot\alpha}\,\bar\theta^{\dot\alpha}\,\hat\partial_m$$

$$\bar D_{\dot\alpha} = -\frac{\partial}{\partial\bar\theta^{\dot\alpha}}$$

$$\bar D_{\dot\alpha}\,\phi(y,\theta) = 0$$

$$\underbrace{\varepsilon^{\dot\alpha\dot\beta}\frac{\partial}{\partial\bar\theta^{\dot\alpha}}\frac{\partial}{\partial\bar\theta^{\dot\beta}}}_{\bar D_{\dot\alpha}\bar D^{\dot\alpha}}$$

$$\bar\theta^2 = -4$$

$$\bar D^2 X(y,\theta,\bar\theta) =$$

$$D_\alpha = \frac{\partial}{\partial \theta^\alpha} + 2i\sigma^m_{\alpha\dot\alpha}\,\bar\theta^{\dot\alpha}\,\hat\partial_m$$

$A_m \to A_m$

$$\bar D_{\dot\alpha} = -\frac{\partial}{\partial \bar\theta^{\dot\alpha}}$$

$\bar D_{\dot\alpha}\,\phi(y,\theta) = 0$

$$\underbrace{\varepsilon^{\dot\alpha\dot\beta}\frac{\partial}{\partial\bar\theta^{\dot\alpha}}\frac{\partial}{\partial\bar\theta^{\dot\beta}}}_{\bar D_{\dot\alpha}\bar D^{\dot\alpha}} \quad \bar\theta^2 = -4$$

$$\bar D^2\, X(y,\theta,\bar\theta) =$$

$\bar\theta^0,\ \bar\theta^1,\ \bar\theta^2$

$$D_\alpha = \frac{\partial}{\partial\theta^\alpha} + 2i\sigma^m_{\alpha\dot\alpha}\,\bar\theta^{\dot\alpha}\,\partial_m$$

$$\bar D_{\dot\alpha} = -\frac{\partial}{\partial\bar\theta^{\dot\alpha}}$$

$$\underbrace{\varepsilon^{\dot\alpha\dot\beta}\,\frac{\partial}{\partial\bar\theta^{\dot\alpha}}\,\frac{\partial}{\partial\bar\theta^{\dot\beta}}}_{\bar D_{\dot\alpha}\bar D^{\dot\alpha}}$$

$$\bar D_{\dot\alpha}\,\Phi(y,\theta) = 0$$

$$\bar\theta^2 = -4$$

$$\bar D^2 X(y,\theta,\bar\theta) = -4X\Big|_{\bar\theta^2}$$

$$\cancel{\bar\theta^0},\ \cancel{\bar\theta^1},\ \bar\theta^2$$

$$W_\alpha = -i\lambda_\alpha$$

$$W_\alpha^{(y,0)} = -i\lambda_\alpha + [\delta_\alpha^\beta D$$

$$W_\alpha^{(y,\theta)} = -i\lambda_\alpha + \Big[\delta_\alpha^\beta D - i(\sigma^\nu\bar{\sigma}^\mu)_\alpha{}^\beta \partial_\nu A_\mu$$

$$- i\,\partial_\mu A^\mu \delta_\alpha^\beta$$

$$W_\alpha^{(y,0)} = -i\lambda_\alpha + \Big[\delta_\alpha^\beta D - i(\sigma^0\bar\sigma^\mu)_\alpha{}^\beta \partial_\nu A_\mu$$

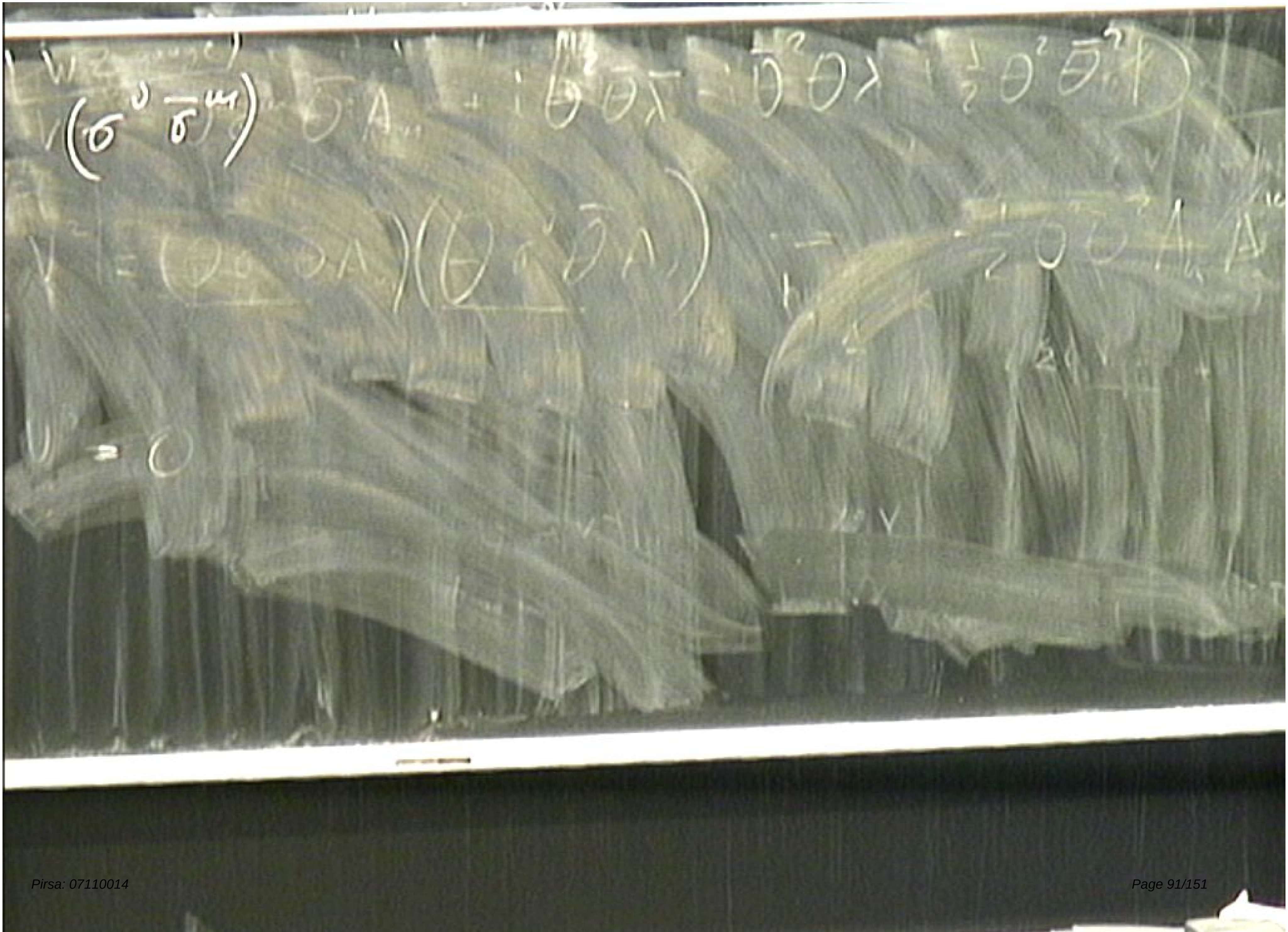
$$-i\,\partial_\mu A^\mu \delta_\alpha{}^\beta\Big]\theta_\beta$$

$$W_\alpha^{(y,0)} = -i\lambda_\alpha + \Big[\delta_\alpha^\beta D - i(\sigma^0\bar{\sigma}^\mu)_\alpha{}^\beta \partial_\nu A_\mu$$

$$- i\, \partial_\mu A^\mu \delta_\alpha{}^\beta\Big]\theta_\beta +$$

$$+ \theta^2 \sigma^\mu_{\alpha\dot{\alpha}} \partial_\mu \bar{\lambda}^{\dot{\alpha}}$$

$$W_\alpha^{(y,\theta)} = -i\lambda_\alpha + \left[\delta_\alpha^\beta D - i(\sigma^\nu \bar\sigma^\mu)_\alpha{}^\beta \partial_\nu A_\mu - i\,\partial_\mu A^\mu \delta_\alpha^\beta\right]\theta_\beta + \theta^2 \sigma^\mu_{\alpha\dot\alpha}\,\partial_\mu \bar\lambda^{\dot\alpha}$$


$(\sigma^\nu \bar{\sigma}^\mu)$

$$\left(\sigma^{\nu}\bar{\sigma}^{\mu}\right) = \frac{1}{2}\left(\sigma^{\nu}\bar{\sigma}^{\mu} + \sigma^{\mu}\bar{\sigma}^{\nu}\right)$$

$$\left(\sigma^{\nu}\bar{\sigma}^{\mu}\right) = \frac{1}{2}\left(\sigma^{\nu}\bar{\sigma}^{\mu} + \sigma^{\mu}\bar{\sigma}^{\nu}\right)$$

$$+\frac{1}{2}\left(\sigma^{\nu}\bar{\sigma}^{\mu} - \sigma^{\mu}\bar{\sigma}^{\nu}\right)$$

$= 0$

$$(\sigma^\nu \bar\sigma^\mu)_\alpha{}^\beta = \frac{1}{2}\left(\sigma^\nu\bar\sigma^\mu + \sigma^\mu\bar\sigma^\nu\right)_\alpha{}^\beta + \frac{1}{2}\left(\sigma^\nu\bar\sigma^\mu - \sigma^\mu\bar\sigma^\nu\right)_\alpha{}^\beta$$

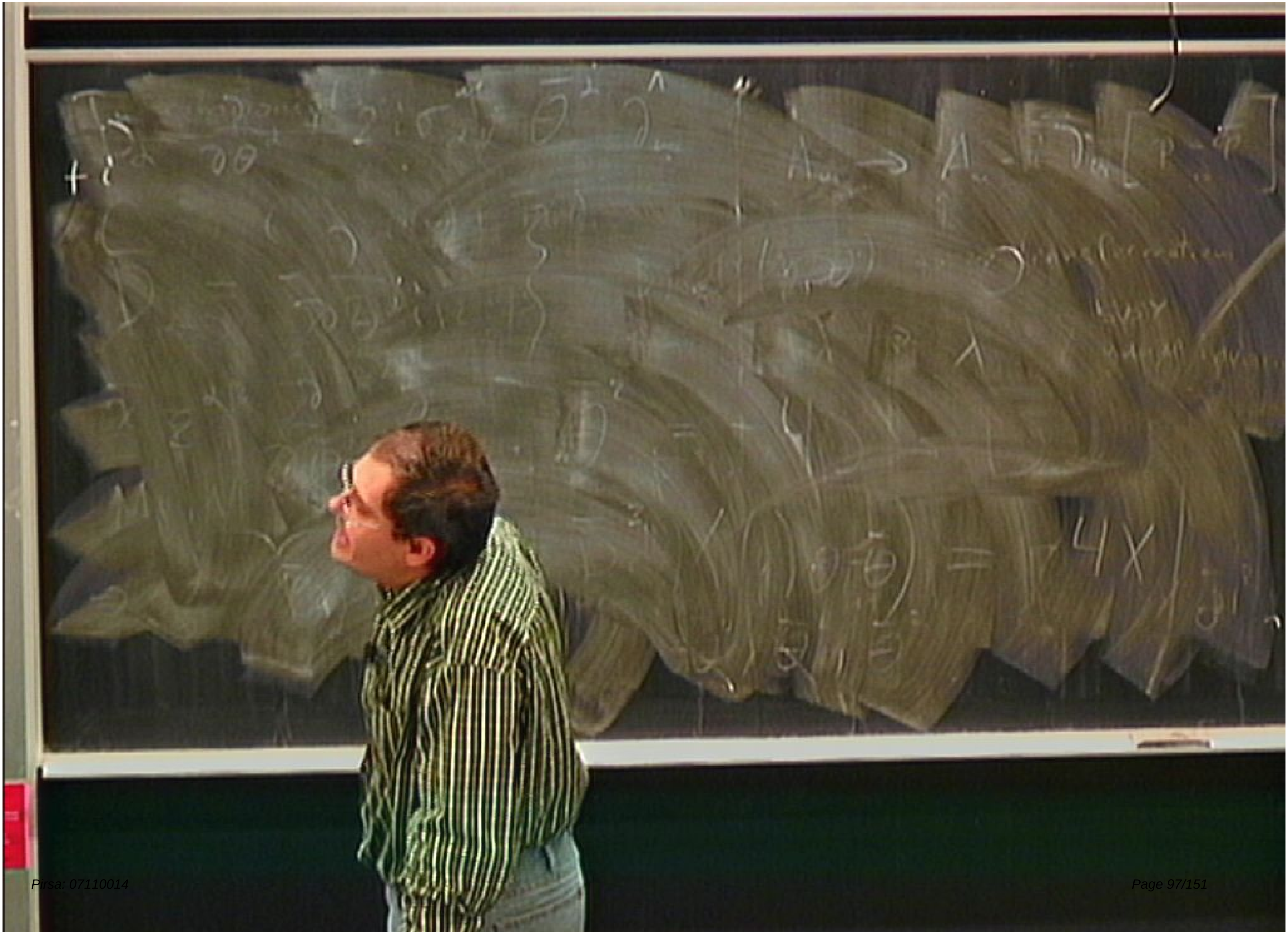
$$= \frac{1}{2}\cdot\left[-2\eta^{\mu\nu}\delta\right.$$

$$(\sigma^{\nu}\bar{\sigma}^{\mu})_{\alpha}{}^{\beta} = \frac{1}{2}\left(\sigma^{\nu}\bar{\sigma}^{\mu} + \sigma^{\mu}\bar{\sigma}^{\nu}\right)_{\alpha}{}^{\beta} + \frac{1}{2}\left(\sigma^{\nu}\bar{\sigma}^{\mu} - \sigma^{\mu}\bar{\sigma}^{\nu}\right)_{\alpha}{}^{\beta}$$

$$= \frac{1}{2}\cdot\left[-2\eta^{\mu\nu}\delta_{\alpha}{}^{\beta}\right] + \frac{1}{2}\left(\sigma^{\nu}\bar{\sigma}^{\mu} - \sigma^{\mu}\bar{\sigma}^{\nu}\right)_{\alpha}{}^{\beta}$$

$$(\sigma^\nu \bar{\sigma}^\mu)_\alpha^{\ \beta} = \frac{1}{2}\left(\sigma^\nu \bar{\sigma}^\mu + \sigma^\mu \bar{\sigma}^\nu\right)_\alpha^{\ \beta} + \frac{1}{2}\left(\sigma^\nu \bar{\sigma}^\mu - \sigma^\mu \bar{\sigma}^\nu\right)_\alpha^{\ \beta}$$

$$= \underbrace{\frac{1}{2}\cdot\left[-2\eta^{\mu\nu}\delta_\alpha^{\ \beta}\right]}_{-\eta^{\mu\nu}\delta_\alpha^{\ \beta}} + \frac{1}{2}\left(\sigma^\nu \bar{\sigma}^\mu - \sigma^\mu \bar{\sigma}^\nu\right)_\alpha^{\ \beta}$$



$$+ i\, \partial_m A^m \delta_\alpha^{\ \beta} - \frac{i}{2}\left(\sigma^\nu \bar{\sigma}^m - \sigma^m \bar{\sigma}^\nu\right) \partial$$

$$+ i\, \partial_\mu A^\mu \, \delta_\alpha{}^\beta - \frac{i}{2}\left(\sigma^\nu \bar{\sigma}^\mu - \sigma^\mu \bar{\sigma}^\nu\right)_\alpha{}^\beta \partial_\nu A_\mu$$

$$+i\,\partial_\mu A^\mu \delta_\alpha{}^\beta - \frac{i}{2}\left(\sigma^\nu\bar{\sigma}^\mu - \sigma^\mu\bar{\sigma}^\nu\right)_\alpha{}^\beta \partial_\nu A_\mu \quad -i\,\partial_\mu A^\mu \delta_\alpha{}^\beta$$

$4X$

$$+i\,\cancel{\gamma_m} A^{m}\,\delta_\alpha{}^{\beta} - \frac{i}{2}\Big(\underbrace{\sigma^{\nu}\bar\sigma^{m} - \sigma^{m}\bar\sigma^{\nu}}\Big)_\alpha{}^{\beta}\,\partial_\nu A_m - i\,\cancel{\partial_m A^{m}}\,\delta_\alpha{}^{\beta}$$

$$(\nu,m) \to -(m,\nu)$$

$$+i\,\cancel{\partial_m} A^m \delta_\alpha{}^\beta - \frac{i}{2}\big(\underbrace{\sigma^\nu\bar\sigma^m - \sigma^m\bar\sigma^\nu}_{(\nu,m)\to-(m,\nu)}\big)_\alpha{}^\beta \partial_\nu A_m - i\,\cancel{\partial_m A^m \delta_\alpha{}^\beta}$$

$$\to -\frac{i}{2}\left(\sigma^\nu\bar\sigma^m\right)_\alpha{}^\beta\left[\partial_\nu A_m - \partial_m A_\nu\right]$$

$$+i\cancel{\chi_m A^m \delta_\alpha{}^\beta} - \frac{i}{2}\Big(\underbrace{\sigma^\nu\bar\sigma^m - \sigma^m\bar\sigma^\nu}_{(\nu,m)\to-(m,\nu)}\Big)_\alpha{}^\beta \partial_\nu A_m - i\,\cancel{\partial_m A^m \delta_\alpha{}^\beta}$$

$$= -\frac{i}{2}\left(\sigma^\nu\bar\sigma^m\right)_\alpha{}^\beta\left[\partial_\nu A_m - \partial_m A_\nu\right]$$

$$= -\frac{i}{2}\left(\sigma^\nu\bar\sigma^m\right)_\alpha{}^\beta F_{\nu m}$$

$\overline{W}_{\dot{\alpha}} =$

$\overline{W}_{\dot{\alpha}} = \ldots$

Super

$\overline{W}_{\dot{\alpha}}$: $\equiv$ ...

$\overline{\Pi}$ Super Bianchi identity

$\bar{W}_{\dot{\alpha}} := \ldots$

III Super Bianchi identity

$$D^{\alpha} W_{\alpha}$$

$\overline{W}_{\dot\alpha} = \ldots$

$\overline{\Gamma}$ Super Bianchi identity

$$D^\alpha W_\alpha = \overline{D}_{\dot\alpha} \overline{W}^{\dot\alpha}$$

$\bar{W}_{\dot{\alpha}} = \ldots$

Super Bianchi identity

$$D^{\alpha} W_{\alpha} = \bar{D}_{\dot{\alpha}} \bar{W}^{\dot{\alpha}}$$

$dF =$

$\overline{W}_{\dot{\alpha}} = \ldots$

II Super Bianchi identity

$$D^{\alpha} W_{\alpha} = \bar{D}_{\dot{\alpha}} \overline{W}^{\dot{\alpha}}$$

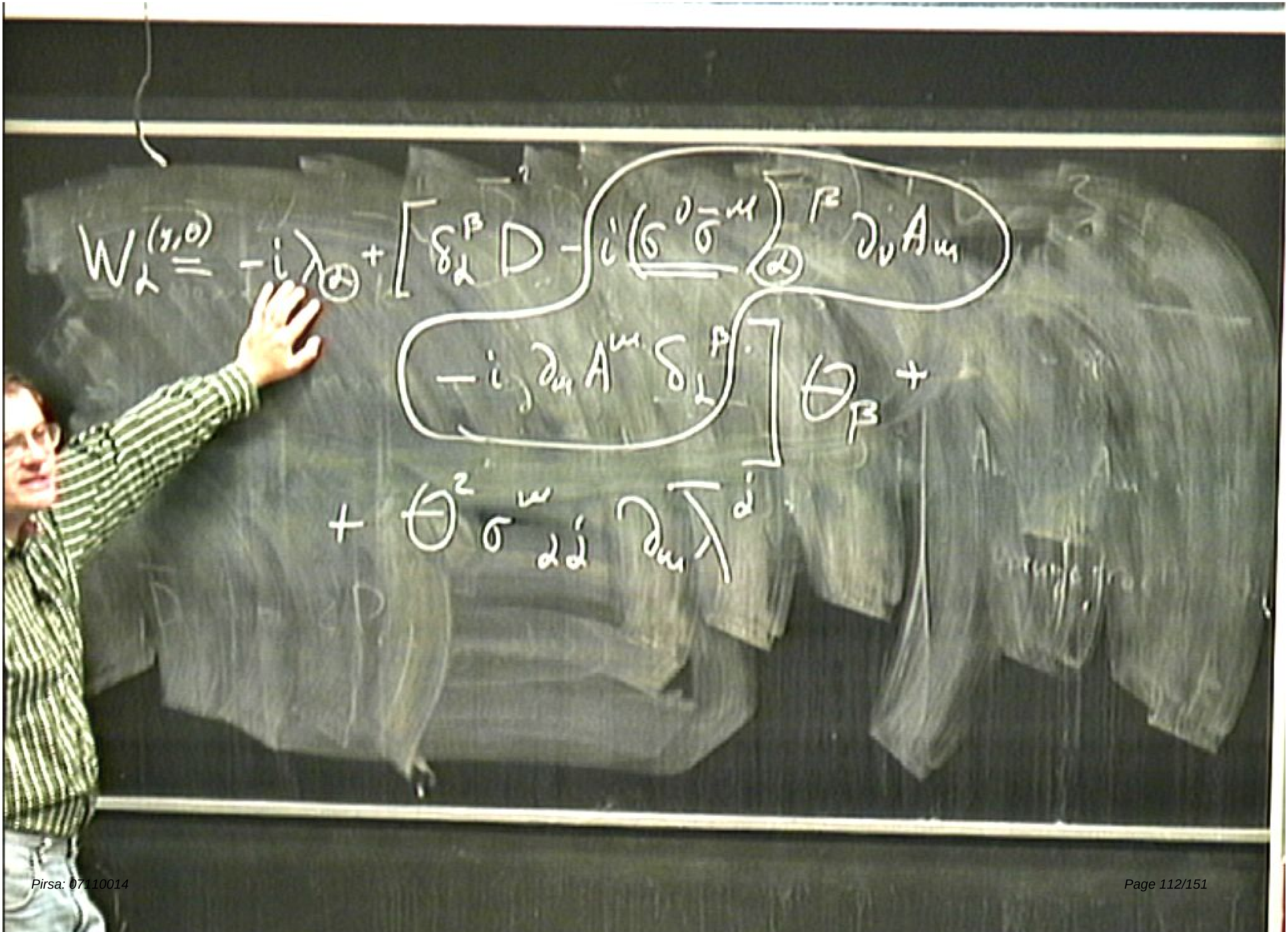
$\boxed{dF = 0}$ — ordinary Bianchi identity

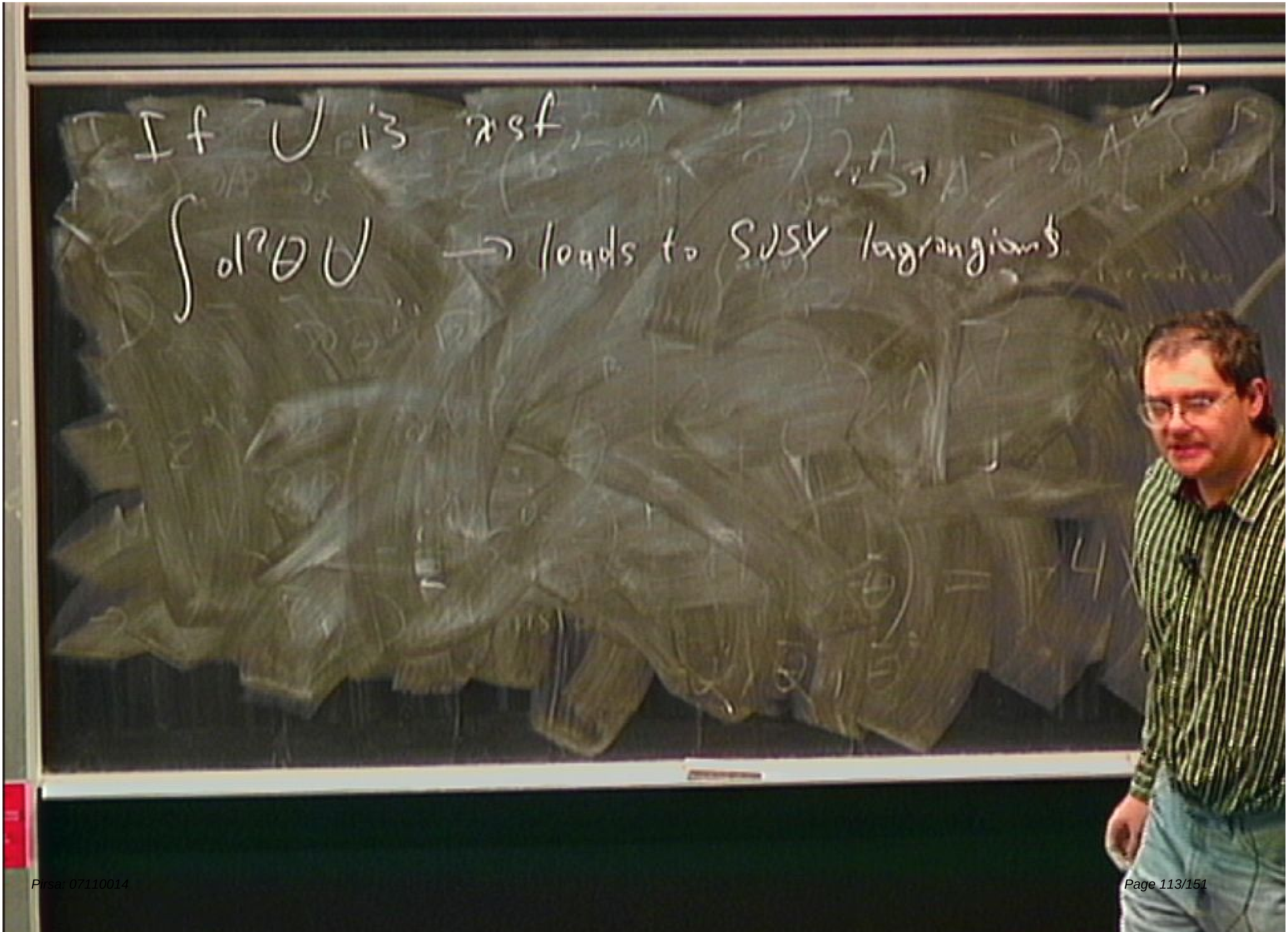
$\overline{W}_{\dot\alpha} = \dots$

II Super Bianchi identity

$$D^\alpha W_\alpha = \overline{D}_{\dot\alpha} \overline{W}^{\dot\alpha}$$

$\boxed{dF = 0}$ — ordinary Bianchi identity


$W_\alpha^{(y,\theta)} = -i\lambda_\alpha + \left[\delta_\alpha^\beta D - i(\sigma^\nu\bar{\sigma}^\mu)_\alpha{}^\beta \partial_\nu A_\mu - i\,\partial_\mu A^\mu \delta_\alpha^\beta\right]\theta_\beta +$
$+\ \theta^2 \sigma^\mu_{\alpha\dot{\alpha}} \partial_\mu \bar{\lambda}^{\dot{\alpha}}$


If U is a sf,
∫ d²θ U → leads to SUSY lagrangians

If U is rsf,

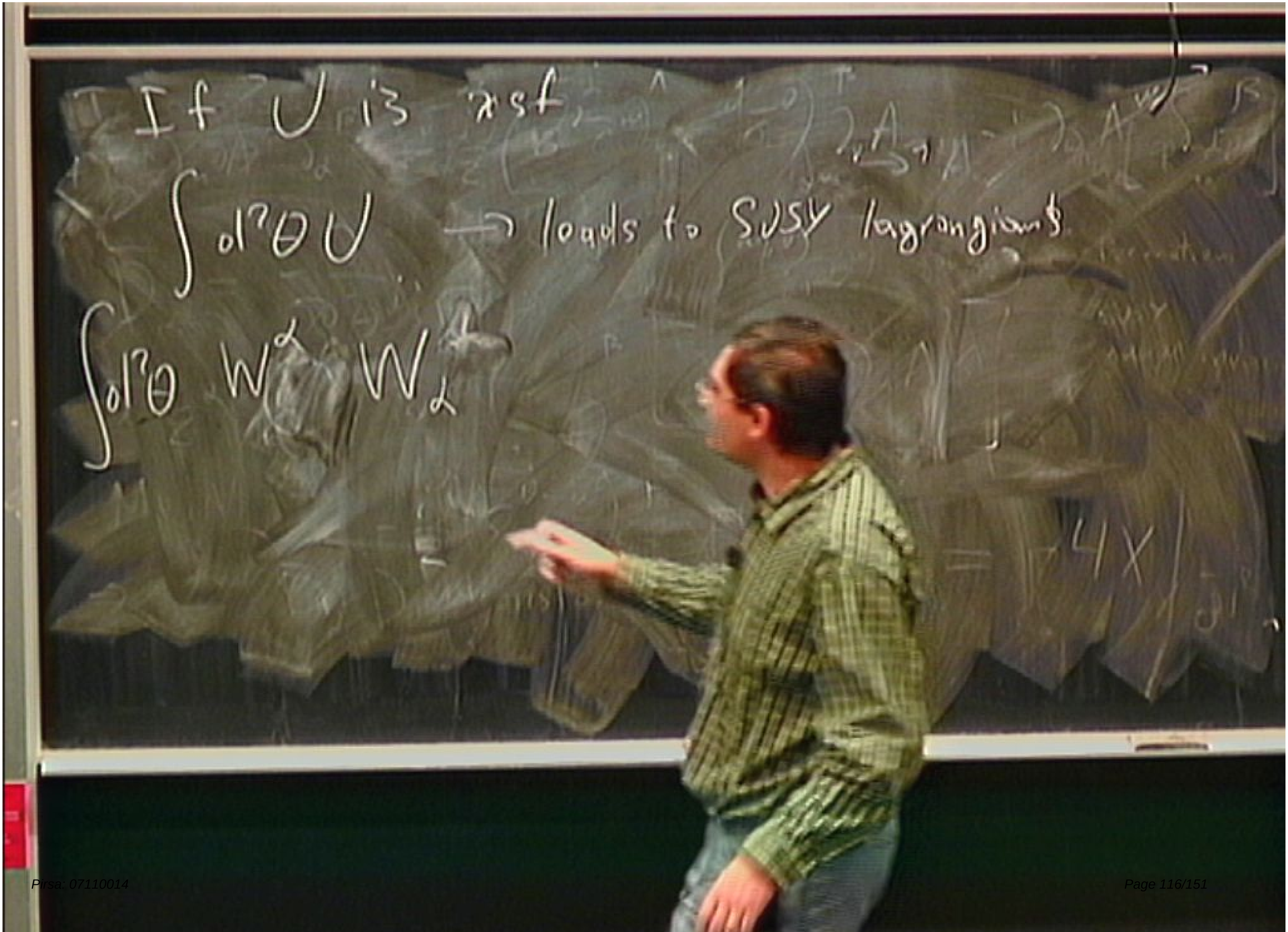
$$\int d^2\theta\, U \rightarrow \text{leads to SUSY lagrangians}$$

$$\int d^2\theta\, W_\alpha$$

If U is $\mathcal{S}$sf,

$\int d^2\theta\, U \rightarrow$ leads to SUSY lagrangians

$\int d^2\theta\, W_\alpha$


If U is rsf,
∫d²θ U → leads to SUSY lagrangians
∫d²θ W^α W_α
4X

If U is χsf,

$\int d^2\theta\, U$ → leads to SUSY lagrangians

$\int d^2\theta\, W^\alpha W_\alpha$

$\bar{D} U_1 = 0$

$\bar{D} U_2 = 0$

If U is rsf

$$\int d^2\theta\, U \rightarrow \text{leads to SUSY lagrangians}$$

$$\int d^2\theta\, W^\alpha W_\alpha$$

$$\bar{D}\, U_1 = 0$$

$$\bar{D}\, U_2 = 0$$

$$\bar{D}\,[U_1 U_2] = 0$$

$$= (\bar{D}\cancel{U_1})\, U_2$$

$$+ U_1\, \bar{D} U_2$$

If U is $\bar{x}$sf,

$$\int d^2\theta\, U \longrightarrow \text{leads to SUSY lagrangians}$$

$$\int d^2\theta\, W^\alpha W_\alpha \left(-\frac{i\tau}{16\pi}\right)$$

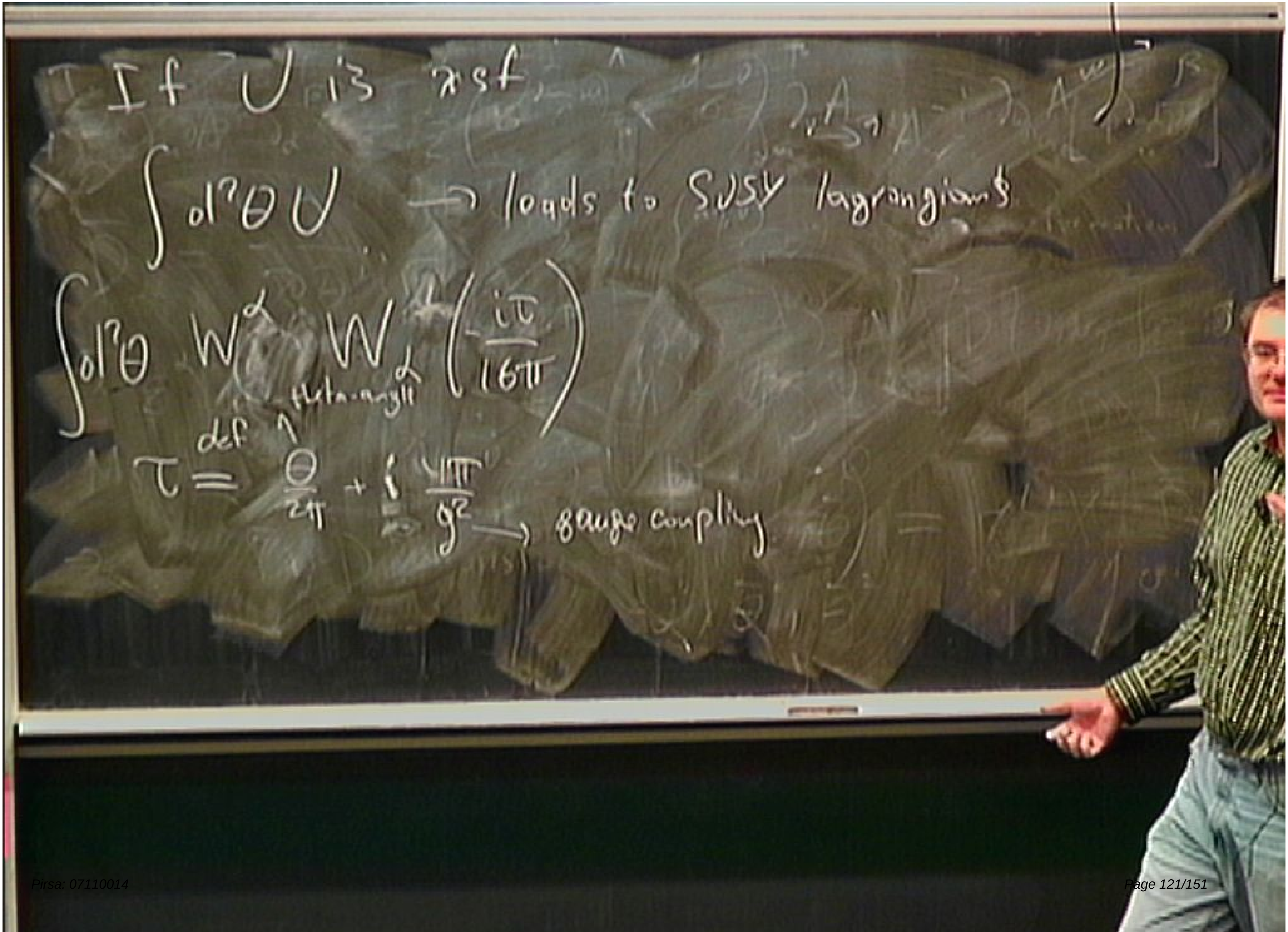
$$\tau \stackrel{\text{def}}{=} \frac{\theta}{2\pi} + i\,\frac{4\pi}{g^2}$$

If $\mathcal{U}$ is "sf"

$$\int d^2\theta\, \mathcal{U} \longrightarrow \text{leads to SUSY lagrangians}$$

$$\int d^2\theta\, W^\alpha W_\alpha \left(-\frac{i\tau}{16\pi}\right)$$

$$\tau \overset{def}{=} \frac{\theta}{2\pi} + i\,\frac{4\pi}{g^2}$$


If U is
$\int d^2\theta\, U$ → leads to SUSY lagrangians
$\int d^2\theta\, W^\alpha W_\alpha \left(-\frac{i\tau}{16\pi}\right)$
theta-angle
$\tau \overset{def}{=} \frac{\theta}{2\pi} + i\frac{4\pi}{g^2}$
gauge coupling

$\int d^2\theta\, U \rightarrow$ leads to SUSY Lagrangians

$$\int d^2\theta\, W^\alpha W_\alpha \left(\frac{i\tau}{16\pi} \right)$$

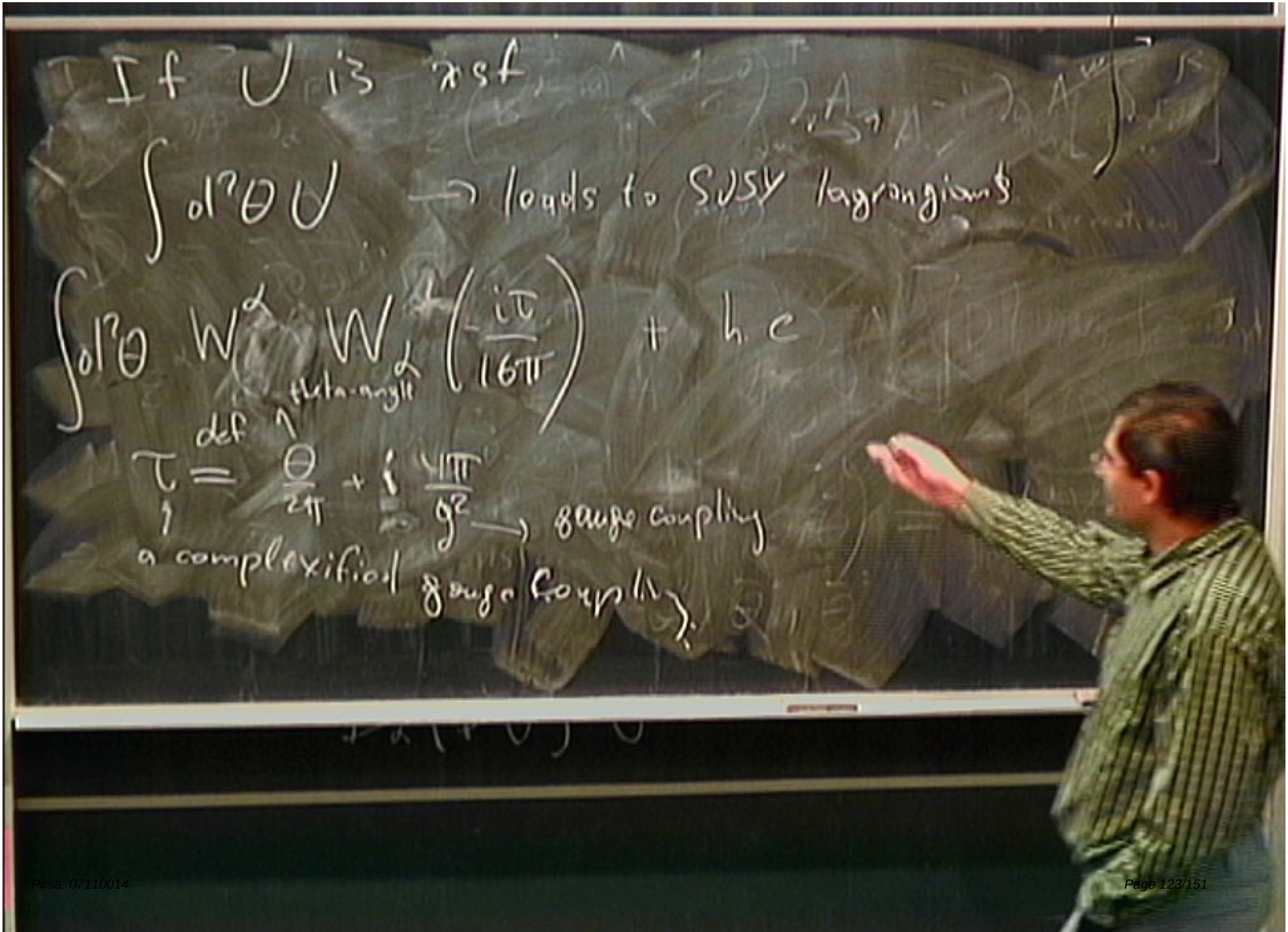
theta-angle

def

$$\tau = \frac{\theta}{2\pi} + i\frac{4\pi}{g^2} \rightarrow \text{gauge coupling}$$

a complexified gauge coupling.

$$D_\alpha \left[D^2 U \right] = 0$$


If V is rst,
∫ d²θ V → leads to SUSY lagrangians
∫ d²θ W^α W_α (−iτ/16π) + h.c
theta-angle
def
τ = θ/2π + i 4π/g² → gauge coupling
a complexified gauge coupling.

If $\mathcal{U}$ is rsf

$\int d^2\theta\, \mathcal{U} \rightarrow$ leads to SUSY lagrangians

$$\int d^2\theta\, W^\alpha W_\alpha \left(\frac{-i\tau}{16\pi}\right) + h.c = \mathcal{L}$$

theta angle

def

$$\tau = \frac{\theta}{2\pi} + i\frac{4\pi}{g^2}$$

$g^2 \rightarrow$ gauge coupling

a complexified gauge coupling

(i) SUSY invariant

(ii)

If $\mho$ is a sf,

$$\int d^2\theta\, \mho \longrightarrow \text{leads to SUSY lagrangians}$$

superpotential

$$\int d^2\theta\, W^\alpha W_\alpha \left(\frac{-i\tau}{16\pi}\right) + h.c = \mathcal{L}$$

theta-angle

$$\tau \overset{def}{=} \frac{\theta}{2\pi} + i\frac{4\pi}{g^2} \longrightarrow \text{gauge coupling}$$

a complexified gauge coupling

(i) SUSY invariant

(ii)

If U is ? st,

$\int d^2\theta\, U \longrightarrow$ leads to SUSY lagrangians

$$\int d^2\theta\, \underset{\text{superpotential}}{W^\alpha W_\alpha} \left(\frac{i\tau}{16\pi}\right) + h.c = \mathcal{L}$$

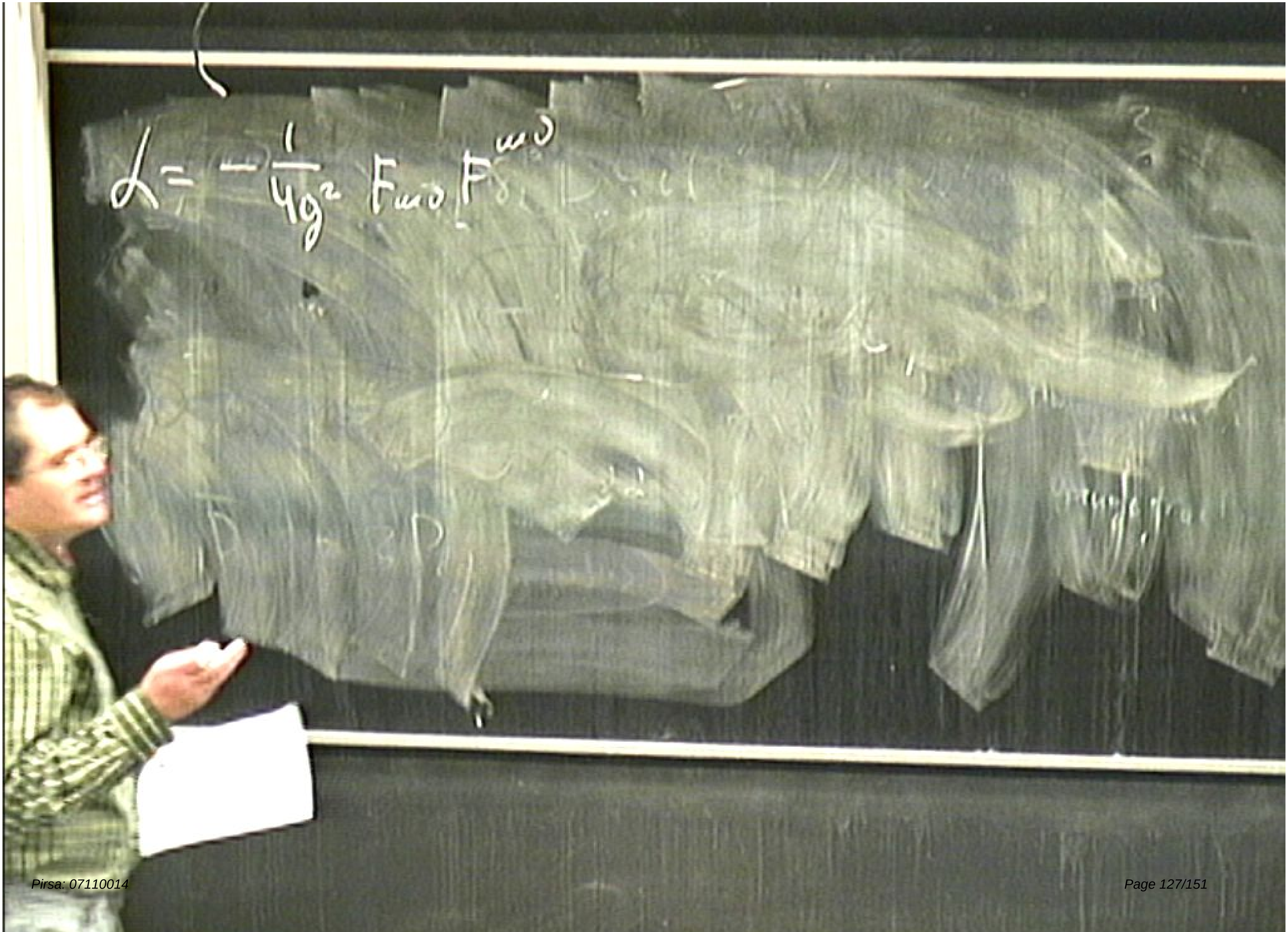
theta-angle

$\tau \overset{def}{=} \frac{\theta}{2\pi} + i\frac{4\pi}{g^2} \longrightarrow$ gauge coupling

a complexified gauge coupling

(i) SUSY invariant

(ii) does not receive quantum corrections


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

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

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu} F^{\mu\nu} + \ldots$$

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu} F^{\mu\nu} + \frac{1}{2g^2} D^2$$

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu} F^{\mu\nu} + \frac{1}{2g^2} D^2$$

$-i\lambda$

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu} F^{\mu\nu} + \frac{1}{2g^2} D^2$$

$$-\frac{i\lambda\sigma^\mu \partial_\mu \bar{\lambda}}{g^2} + $$

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu} F^{\mu\nu} + \frac{1}{2g^2} D^2$$

$$-\frac{i\lambda\sigma^\mu \partial_\mu \bar{\lambda}}{g^2} + \frac{\theta}{32\pi^2} F_{\mu\nu} \tilde{F}^{\mu\nu}$$

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu}F^{\mu\nu} + \frac{1}{2g^2} D^2$$

$$-\frac{i\lambda\sigma^\mu\partial_\mu\bar{\lambda}}{g^2} + \frac{\theta}{32\pi^2} F_{\mu\nu}\tilde{F}^{\mu\nu}$$

$$\tilde{F} = \frac{1}{2}\varepsilon^{\mu\nu\rho\lambda} F_{\rho\lambda}$$

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu} F^{\mu\nu} + \frac{1}{2g^2} D^2$$

$$-\frac{i\lambda \sigma^\mu \partial_\mu \bar{\lambda}}{g^2} + \frac{\theta}{32\pi^2} F_{\mu\nu} \tilde{F}^{\mu\nu}$$

$$\tilde{F}^{\mu\nu} = \frac{1}{2} \varepsilon^{\mu\nu\rho\lambda} F_{\rho\lambda} \qquad \varepsilon_{0123} = -1$$

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu}F^{\mu\nu} + \frac{1}{2g^2} D^2$$

$$-\frac{i\lambda\sigma^{\mu}\partial_{\mu}\bar{\lambda}}{g^2} + \frac{\theta}{32\pi^2} F_{\mu\nu}\tilde{F}^{\mu\nu}$$

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$$\tilde{F}^{\mu\nu} = \frac{1}{2}\epsilon^{\mu\nu\rho\lambda} F_{\rho\lambda} \qquad \epsilon_{0123} = -1$$

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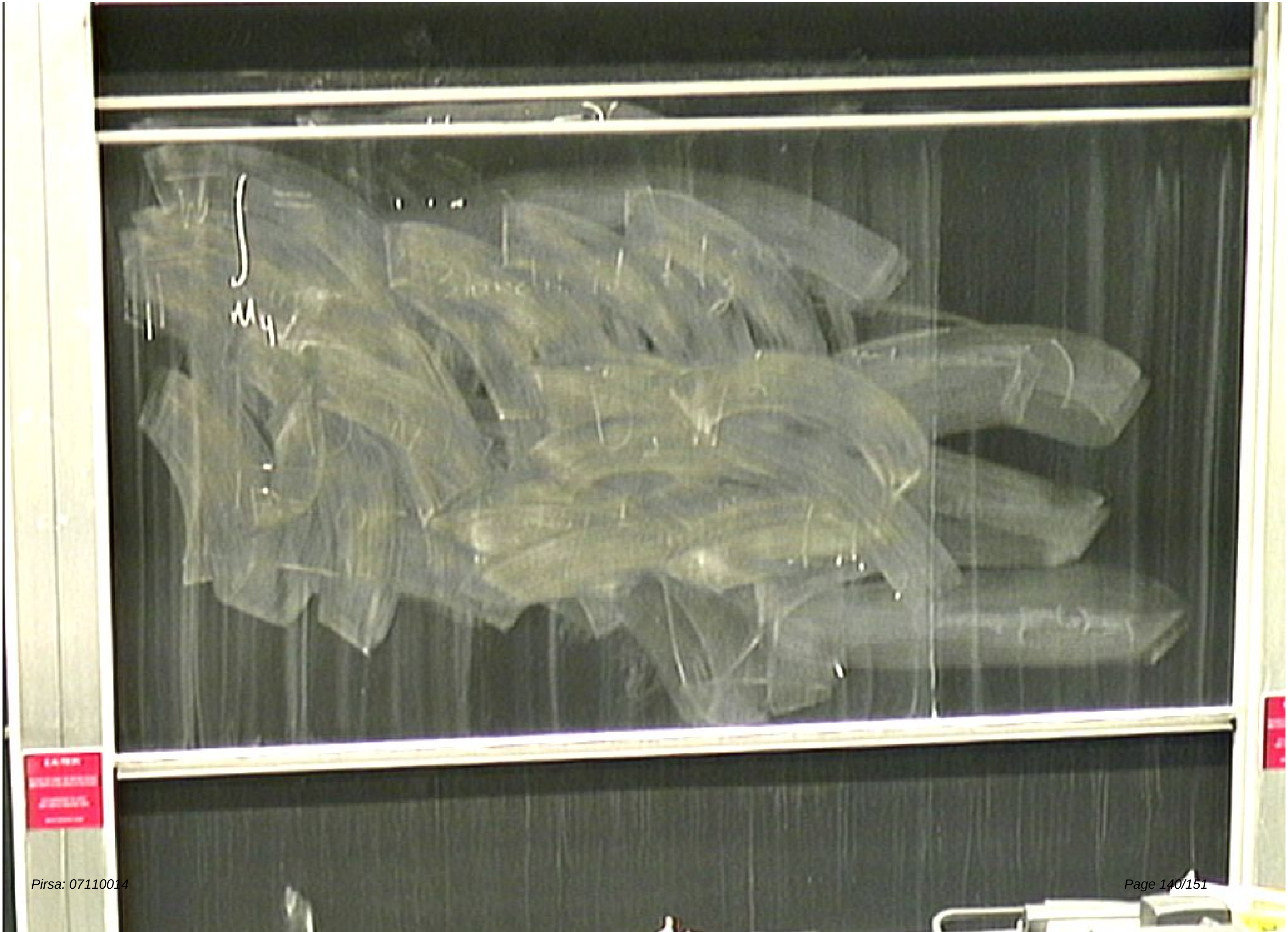
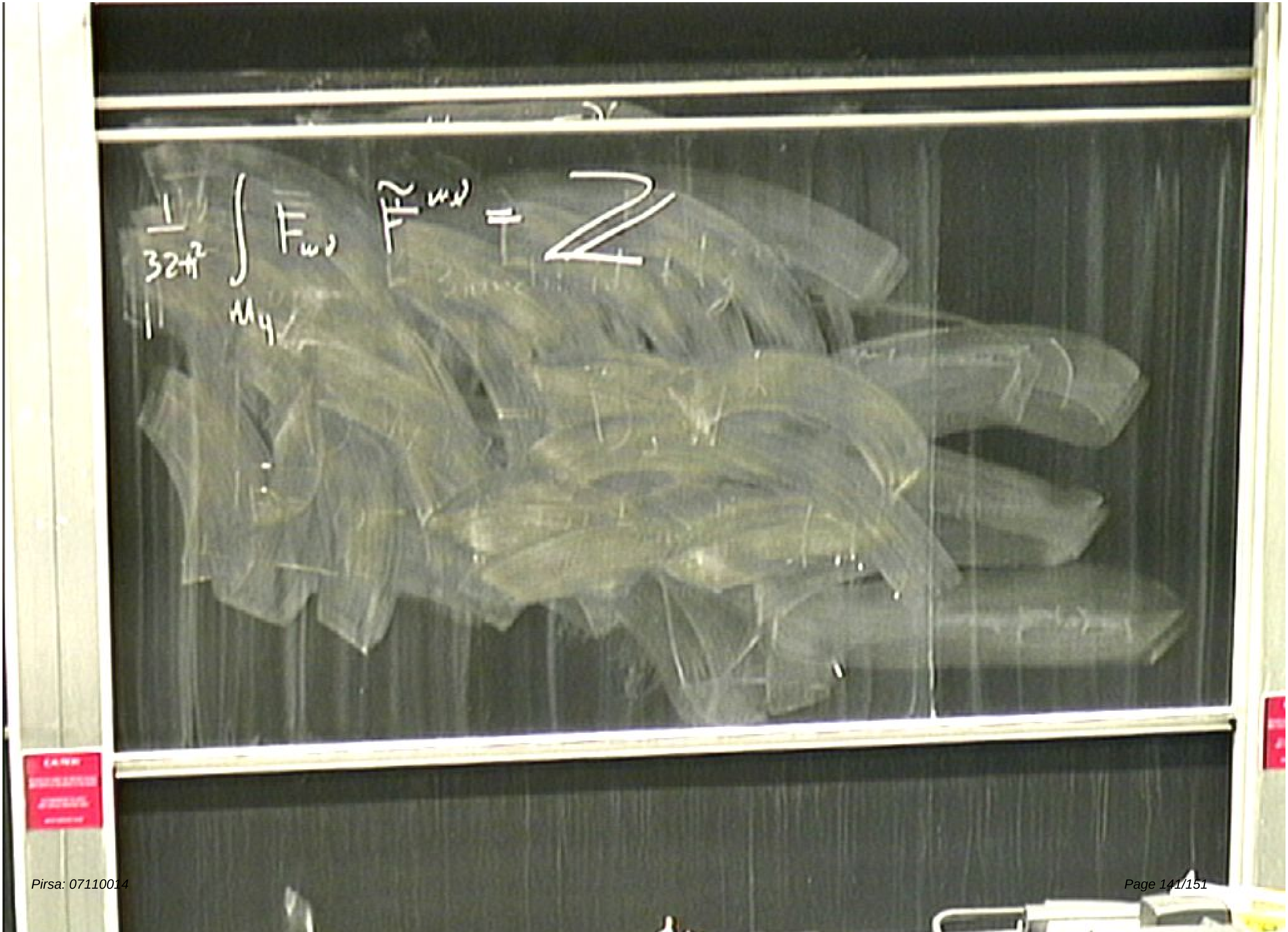
$$\tilde{F}^{\mu\nu} = \frac{1}{2} \varepsilon^{\mu\nu\rho\lambda} F_{\rho\lambda} \qquad \varepsilon_{0123} = -1$$

$$\mathcal{L} = -\frac{1}{4g^2} F_{\mu\nu} F^{\mu\nu} + \frac{1}{2g^2} D^2$$

$$-\frac{i\lambda\sigma^\mu \partial_\mu \bar{\lambda}}{g^2} + \boxed{\frac{\theta}{32\pi^2} F_{\mu\nu} \tilde{F}^{\mu\nu}}$$

$$\tilde{F}^{\mu\nu} = \frac{1}{2}\varepsilon^{\mu\nu\rho\lambda} F_{\rho\lambda} \qquad \varepsilon_{0123} = -1$$




$\frac{1}{32\pi^2}\int_{M_4} F_{\mu\nu}\tilde{F}^{\mu\nu} = \mathbb{Z}$

$$\frac{1}{32\pi^2}\int_{M_4} F_{\mu\nu}\,\tilde{F}^{\mu\nu} \in \mathbb{Z}$$

SUSY $U(1) \rightarrow$ SQED

$\vdots$

$$\frac{1}{32\pi^2}\int_{M_4} F_{\mu\nu}\tilde{F}^{\mu\nu} = \mathbb{Z}$$

SUSY $U(1) \to$ SQED

$\hookrightarrow$ + charged fields

$$\frac{1}{32\pi^2}\int_{M_4} F_{\mu\nu}\tilde{F}^{\mu\nu} \in \mathbb{Z}$$

SUSY $U(1) \rightarrow$ SQED

K: L + charged fields Φ $\times 5\beta$

W

$\mathcal{L}_{KE} + \mathcal{L}_{PF}$

$$\frac{1}{32\pi^2}\int_{M_4} F_{\mu\nu}\tilde{F}^{\mu\nu} = \mathbb{Z}$$

SUSY $U(1) \to$ SQED $\times 5\beta$

K $L \to +$ charged field ϕ

$\alpha_{KP} + \alpha_{PF}$ W...

$W_\alpha W^\alpha$

(and thus nontrivial under ... gauge trans)

From ...

$$\left(W_\alpha W^\alpha\right)^2 \rightarrow \text{higher deriv}$$

$$\left(W_\alpha W^\alpha\right)^2 \to \text{higher deriv}$$

$$\Rightarrow \int \quad V$$

$$(W_\alpha W^\alpha)^2 \rightarrow \text{higher deriv}$$

$$\Rightarrow \int d^4\theta \, {}_{2k}V$$

$$\left(W_\alpha W^\alpha\right)^2 \rightarrow \text{higher deriv}$$

$$\Rightarrow \int d^4\theta \, 2k V = \underset{\sim}{k} D$$

$$(W_\alpha W^\alpha)^2 \to \text{higher deriv}$$

$$\Rightarrow \int d^4\theta\, 2kV = \underbrace{k\,D}$$

$$V \to V + \varphi + \varphi^\dagger$$

$$K \to K + f(\varphi) + \bar{g}(\bar{\varphi})$$