Title: Superstring Cosmology Mini-Course: Part 3

Date: Feb 01, 2006 11:00 PM

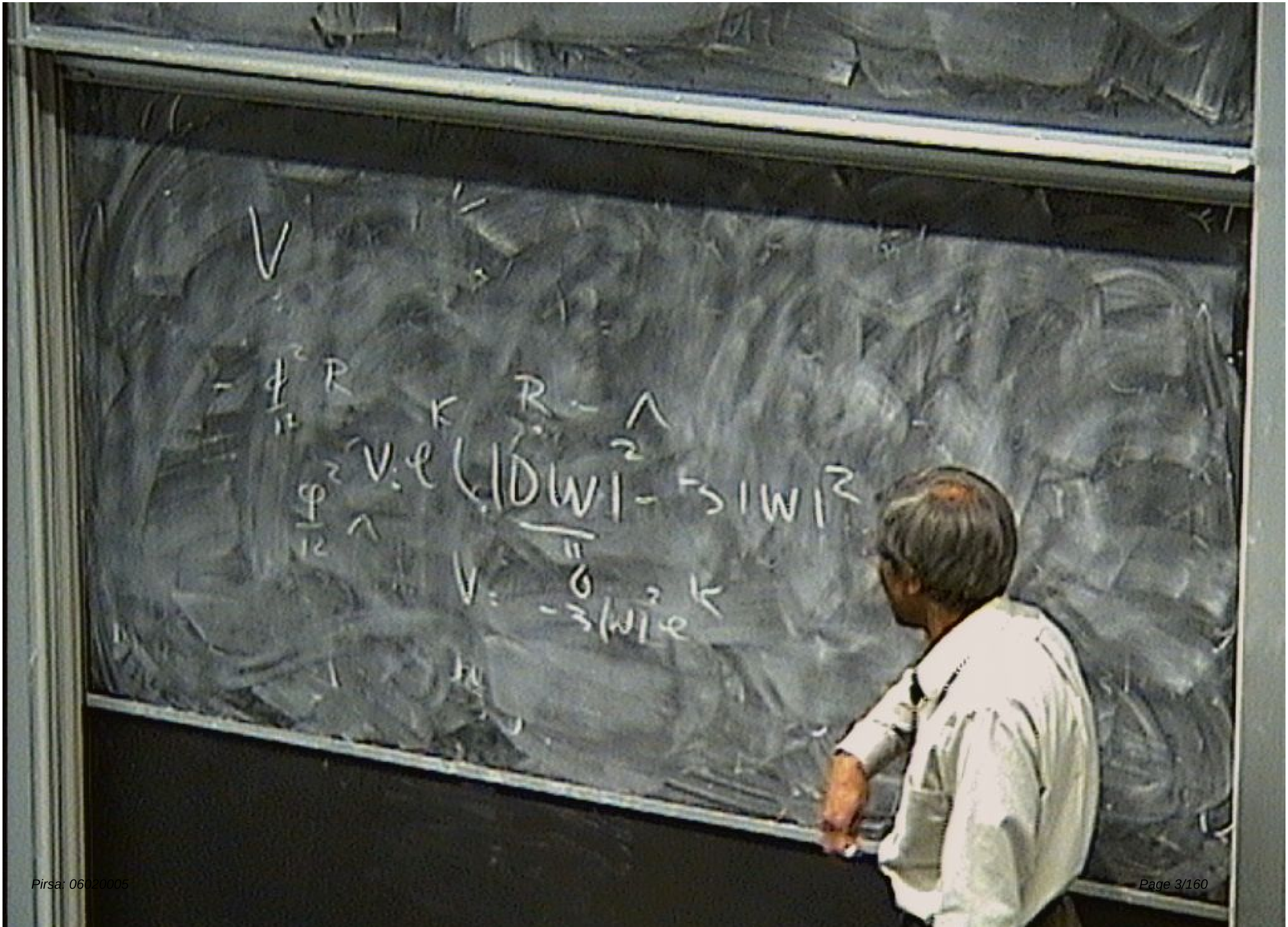
URL: http://pirsa.org/06020005

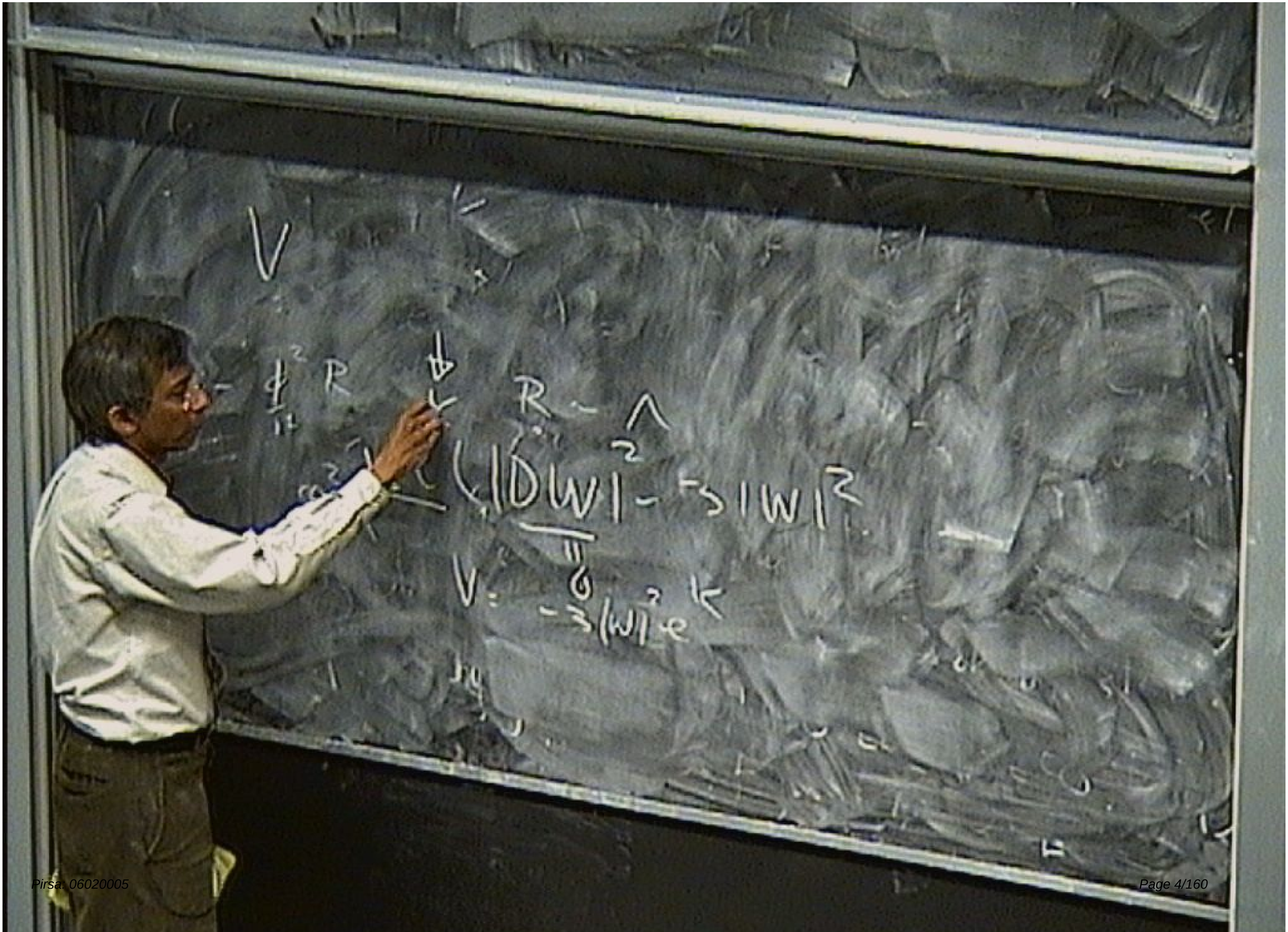
Abstract: From Monday, January 30th to Thursday, February 2nd, Senarath (Shanta) de Alwis will give a four lecture mini-course on `Potentials for light moduli in N=1 supergravity and string theory'. In these lectures, Shanta will be describing some of the technical ingredients used in recent constructions of inflation in string theory. The lectures will be given at a level appropriate for advanced graduate students and will be held in the Bob Room at 11:00am each day.

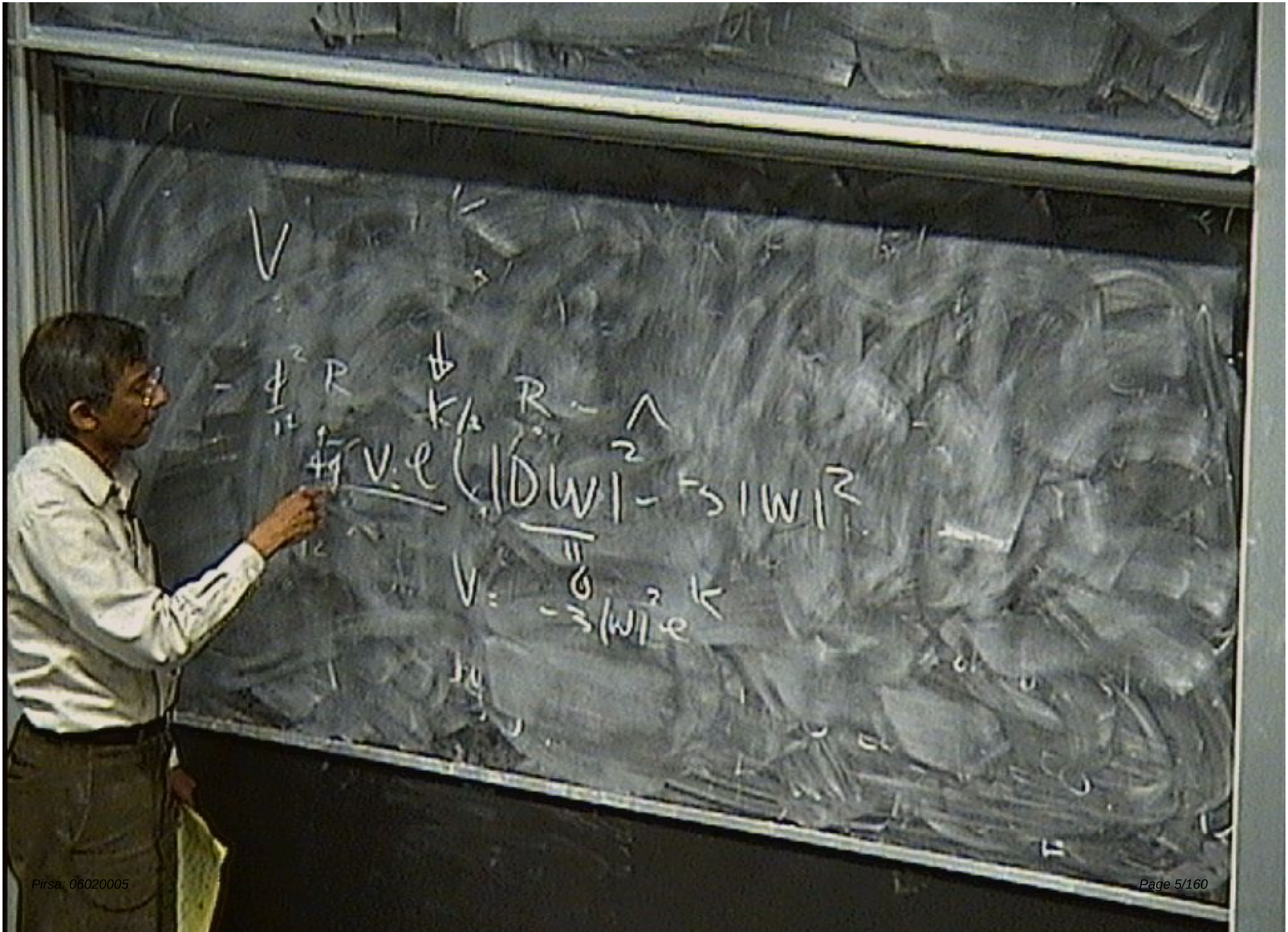
The topics to be covered include:
Derivation of the potential for chiral scalars in N=1 supergravity;
Weyl anomalies and the generation of non-perturbative terms in the superpotential;
Derivation of moduli potentials from fluxes in type IIB and heterotic string theory;
Derivation of potentials for light moduli by integrating out heavy moduli.

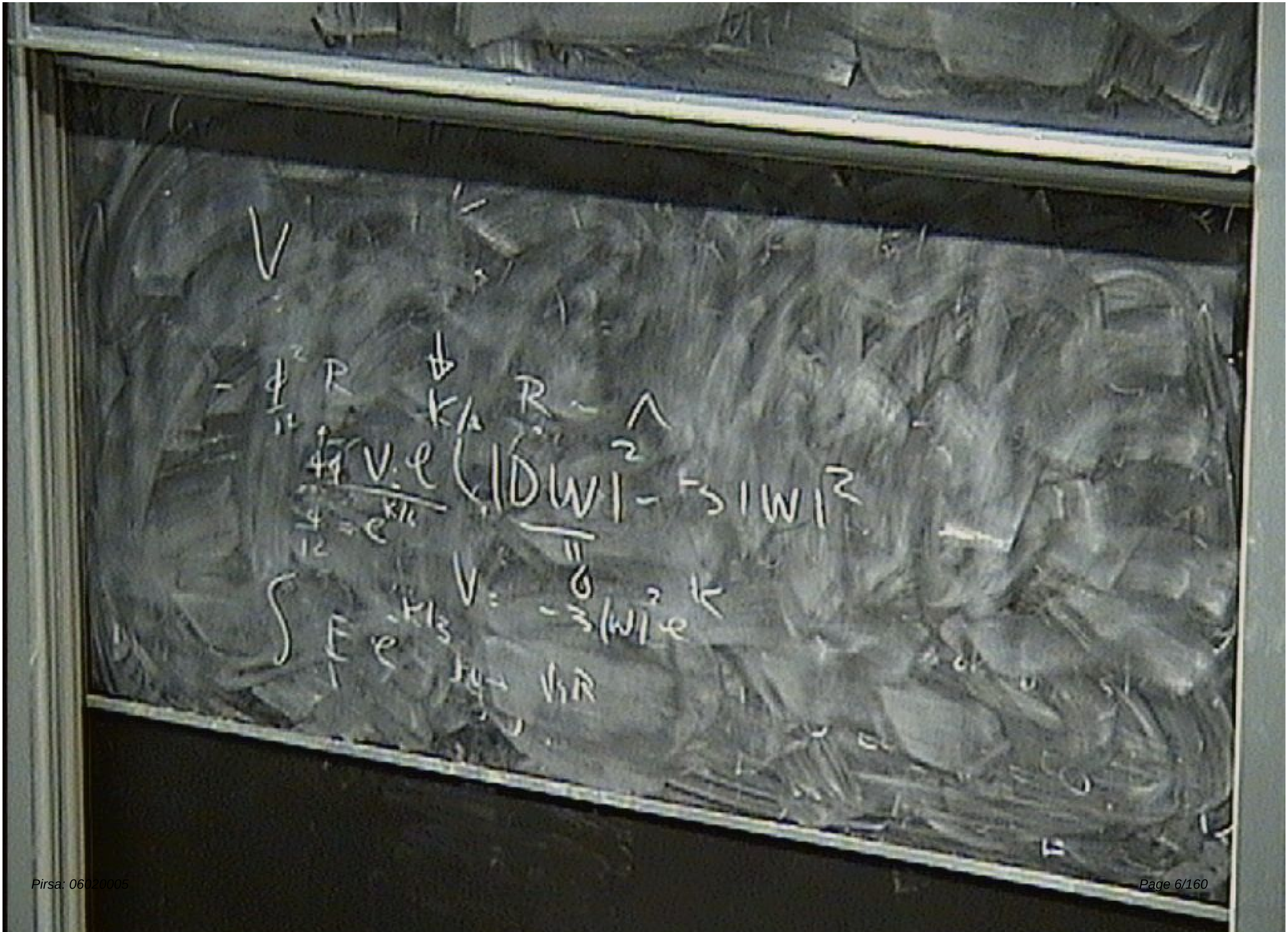
Shanta is a faculty member in the Physics Department at the University of Colorado, Boulder who is spending his sabbatical year here at Perimeter.

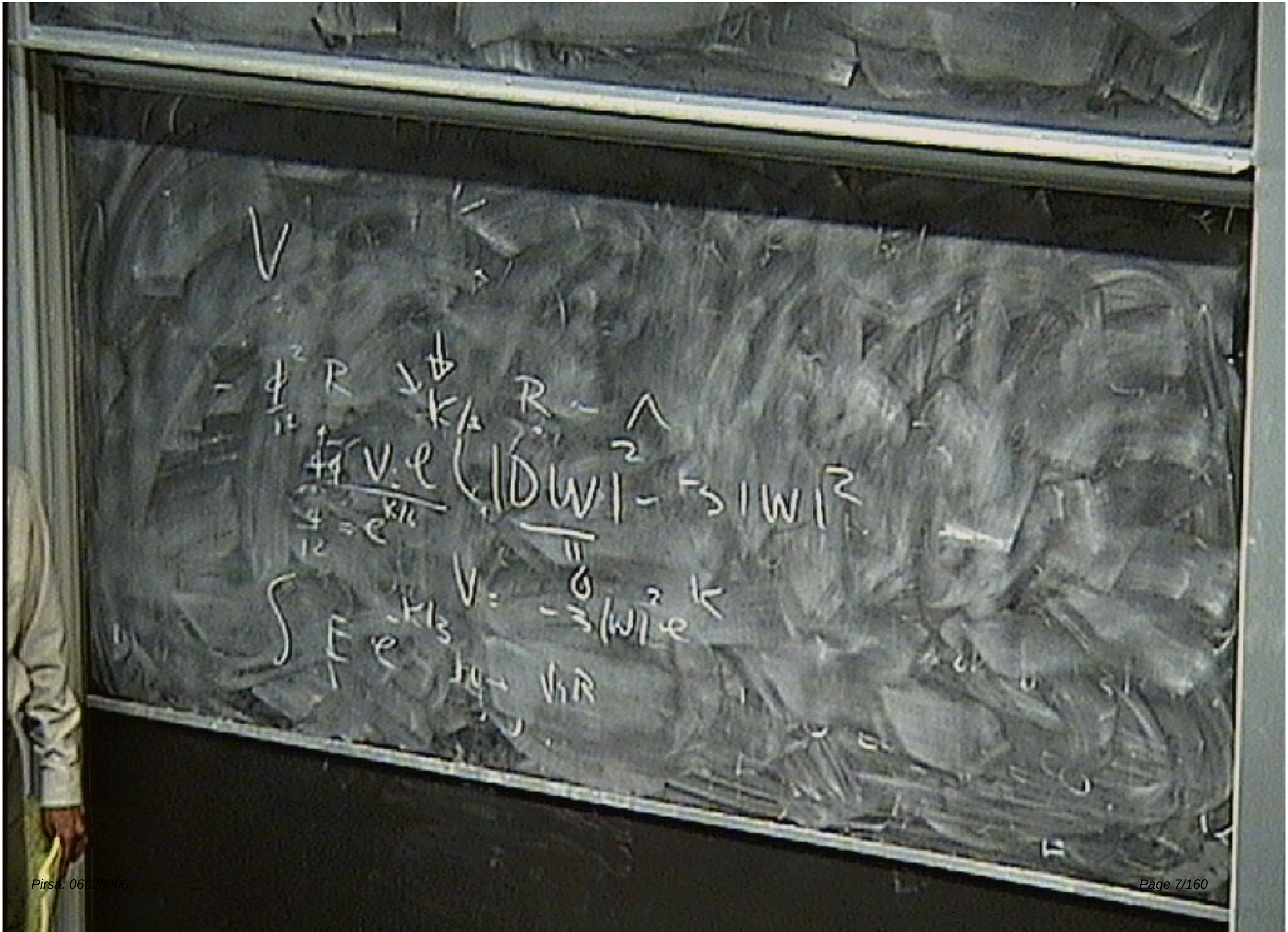

V
$-\frac{\varphi^2}{12} R$
$R - \Lambda$
$\frac{\varphi^2}{12} \Lambda$








V
R
R ~ Λ
V e (|DW|² - 3|W|²)
V = -3|W|² e^K
∫ E e



$$V \quad \sqrt{g}R$$

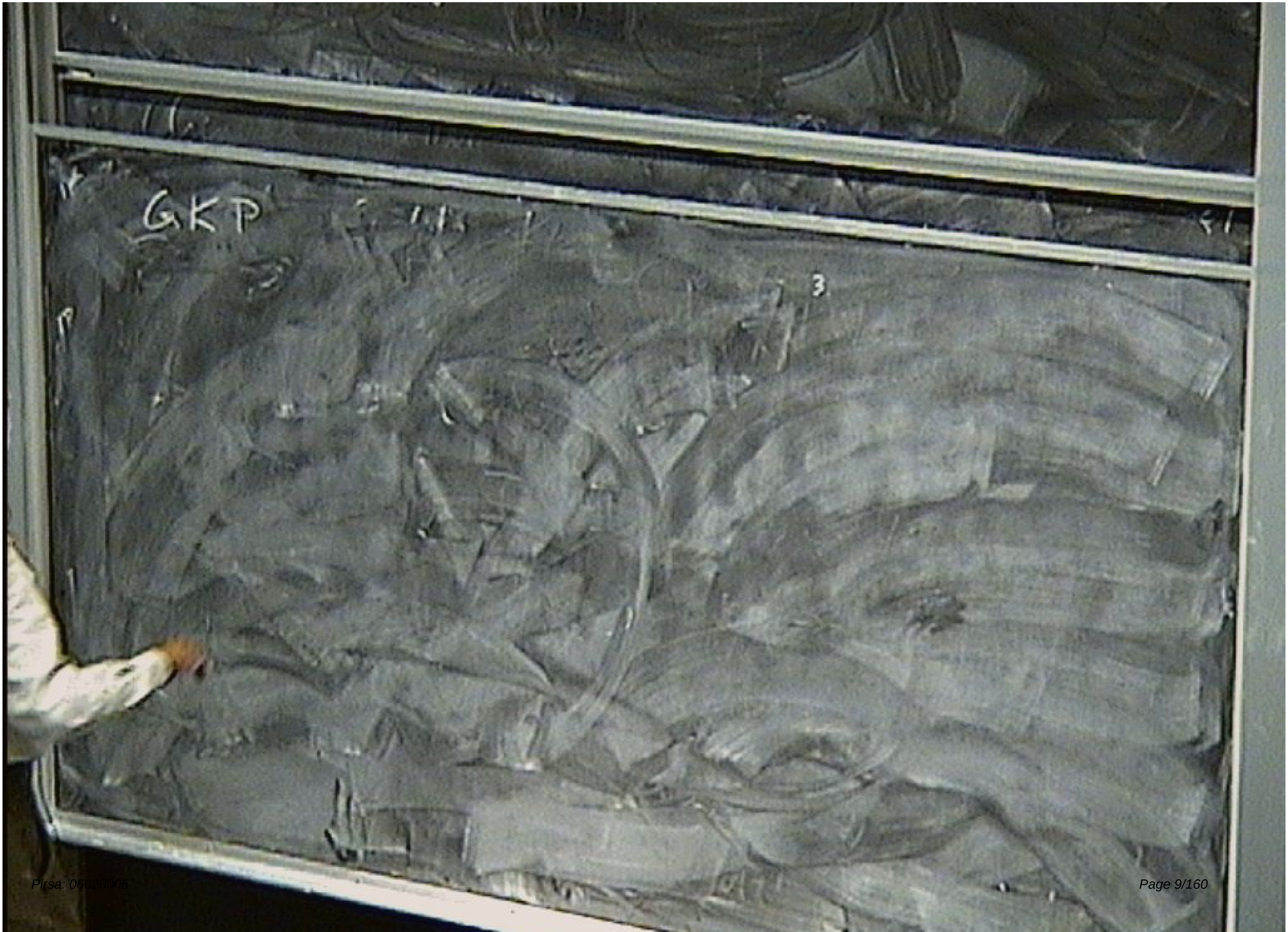
$$-\frac{\phi^2}{12} R \quad \Downarrow \quad e^{-K/3} R - \Lambda$$

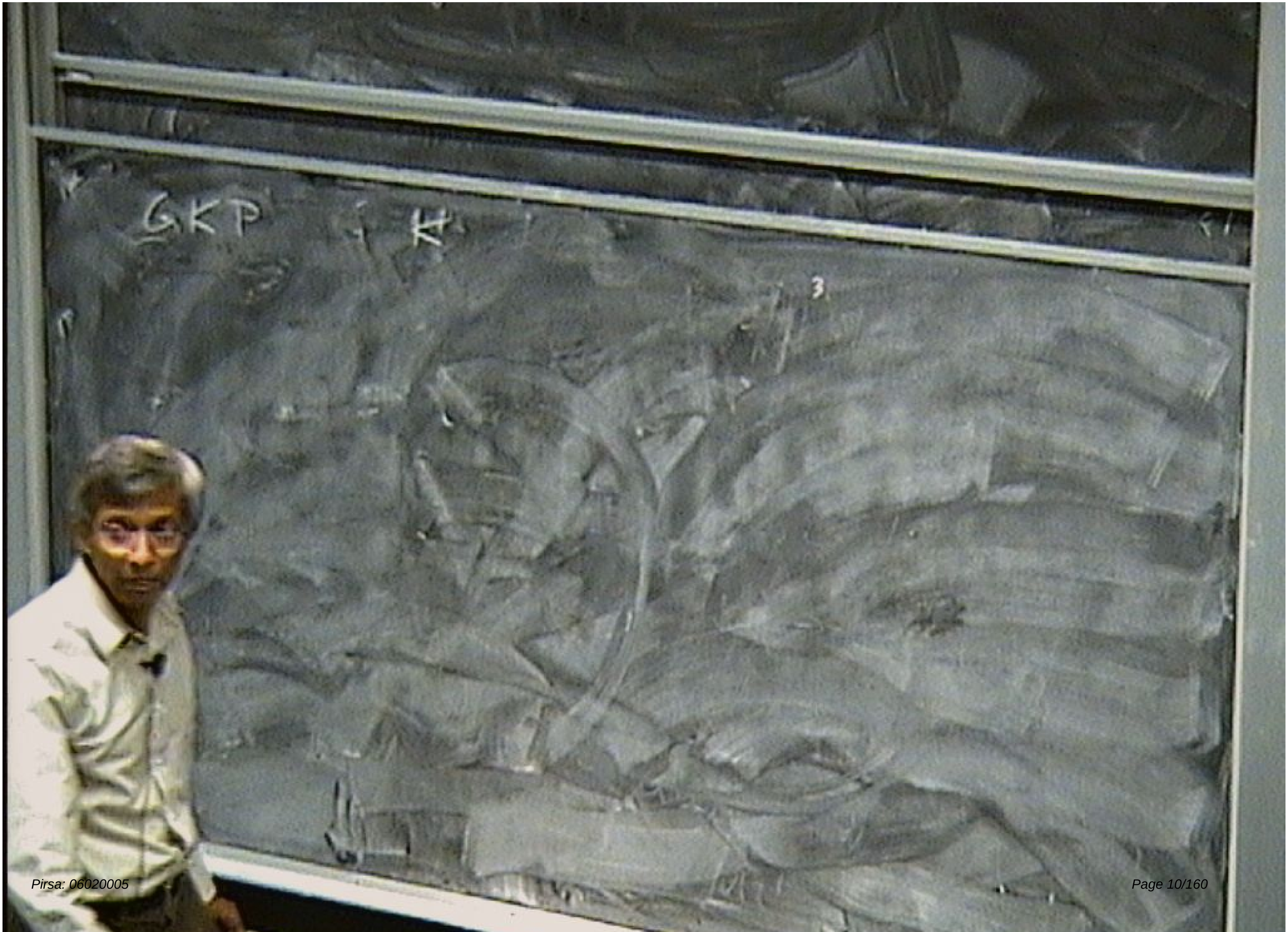
$$\frac{\phi^4}{?} V \cdot e^{K/3}\left(|DW|^2 - 3|W|^2\right)$$

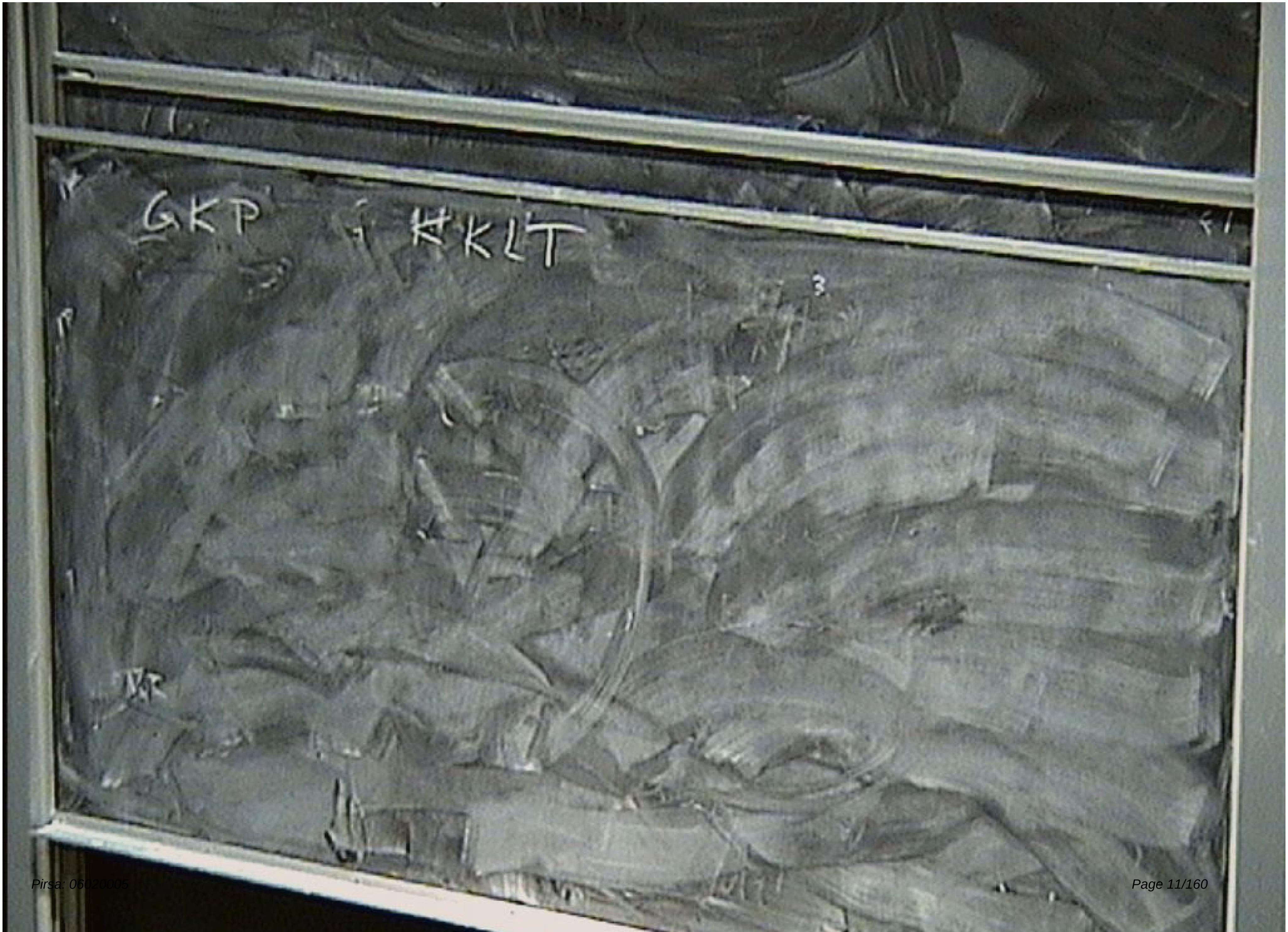
$$\frac{\phi^2}{12} = e^{-K/3}$$

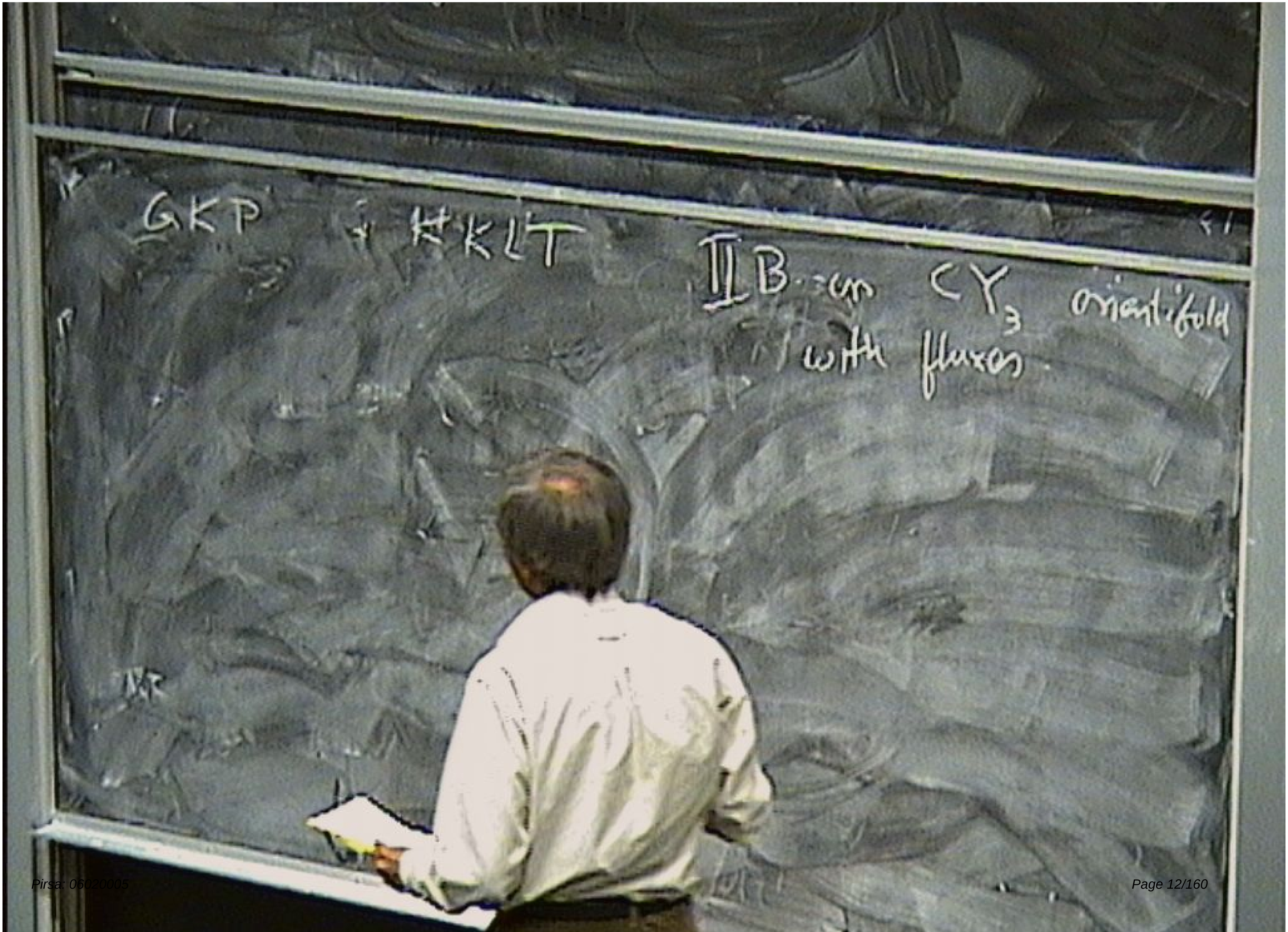
$$V = 0 \quad -3|W|^2 e^{K}$$

$$\int F e^{-K/3} \sqrt{g} \to \sqrt{g}R$$


GKP
3


GKP

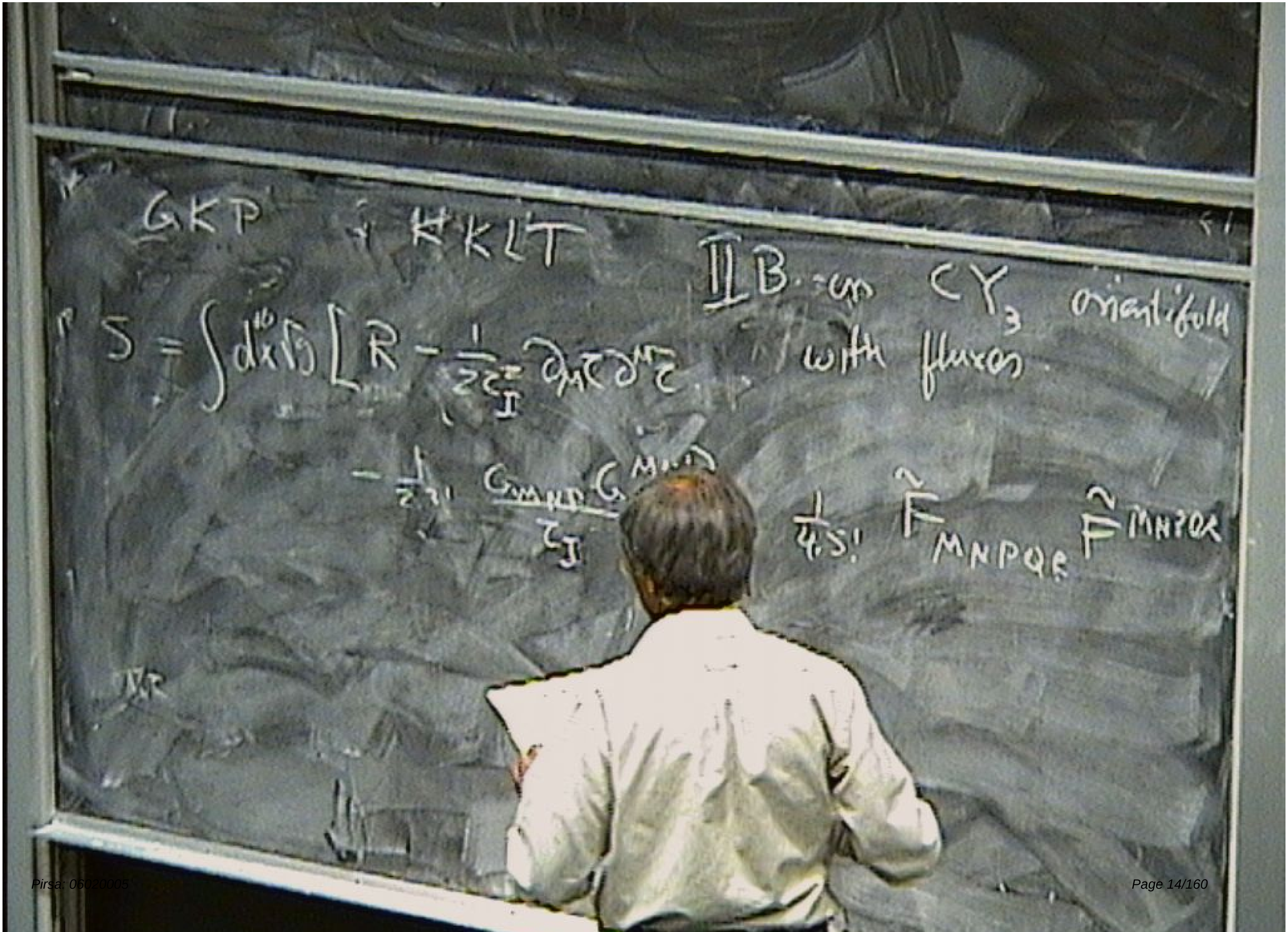

GKP
HKLT


GKP & KKLT
IIB on CY3 orientifold
with fluxes

GKP & KKLT

IIB on CY_3 orientifold
with fluxes

$S =$

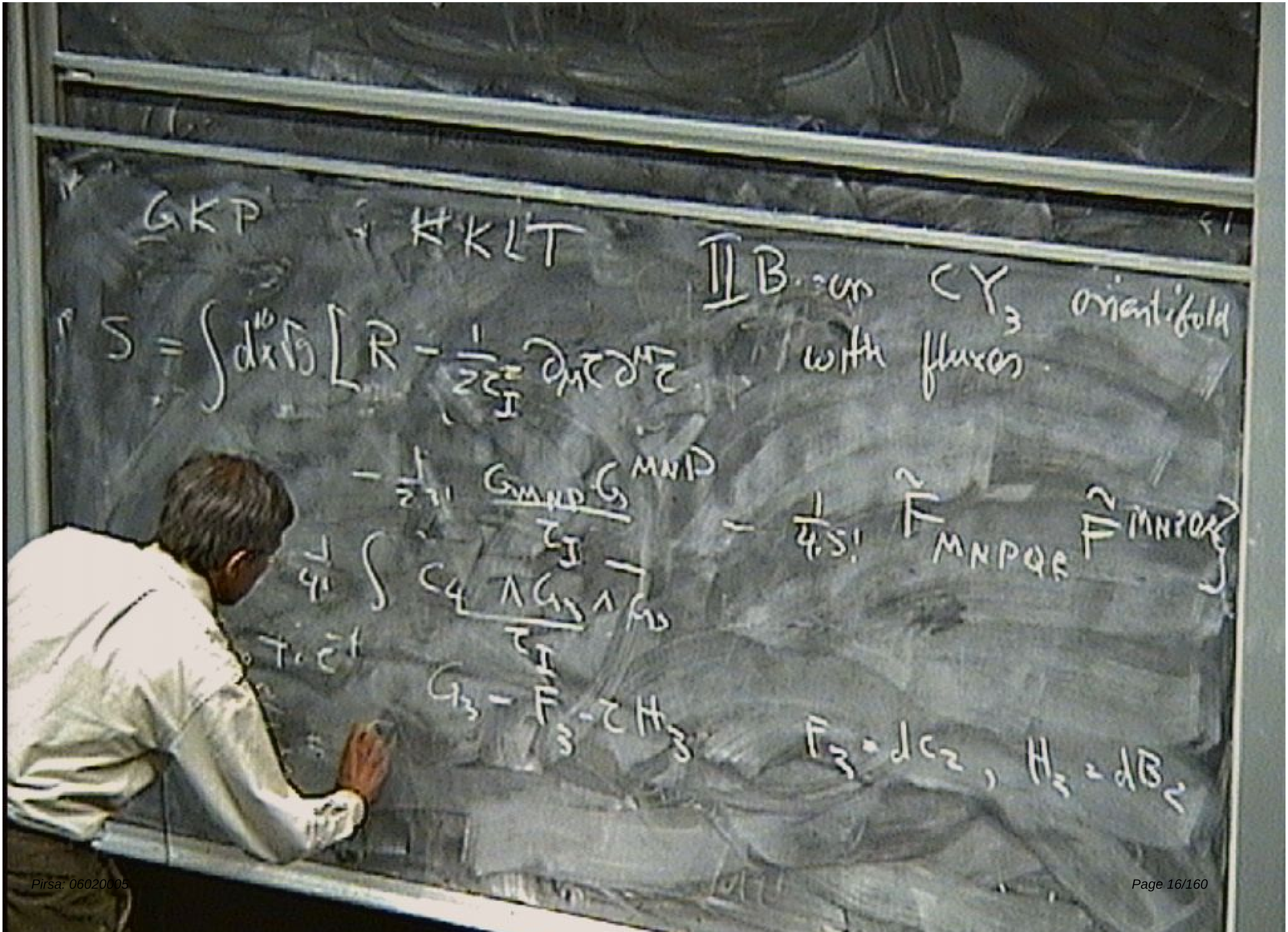

GKP & KKLT
IIB on CY3 orientifold
with fluxes
S = ∫d^10x √g [R − 1/(2τ_I²) ∂_M τ ∂^M τ̄
− 1/(2·3!) G_MNP G^MNP / τ_I
1/(4·5!) F̃_MNPQR F̃^MNPQR

GKP & KKLT

IIB on CY_3 orientifold with fluxes

$$S = \int d^{10}x\sqrt{g}\Big[R - \frac{1}{2\tau_I^2}\partial_M\tau\,\partial^M\bar\tau - \frac{1}{2\cdot 3!}\frac{G_{MNP}\,\bar G^{MNP}}{\tau_I} - \frac{1}{4\cdot 5!}\tilde F_{MNPQR}\tilde F^{MNPQR}\Big\}$$

$$+ \frac{1}{4i}\int \frac{C_4\wedge G_3\wedge \bar G_3}{\tau_I}$$


GKP & KKLT
IIB on CY3 orientifold
with fluxes
$S = \int d^{10}x \sqrt{g} \left[R - \frac{1}{2\tau_I^2} \partial_M \tau \partial^M \bar{\tau} \right.$
$- \frac{1}{2 \cdot 3!} \frac{G_{MNP} \bar{G}^{MNP}}{\tau_I} - \frac{1}{4 \cdot 5!} \tilde{F}_{MNPQR} \tilde{F}^{MNPQR} \Big\}$
$\frac{1}{4i} \int \frac{C_4 \wedge G_3 \wedge \bar{G}_3}{\tau_I}$
$G_3 = F_3 - \tau H_3$
$F_3 = dC_2 , \; H_3 = dB_2$

GKP & KKLT

IIB on CY_3 orientifold with fluxes

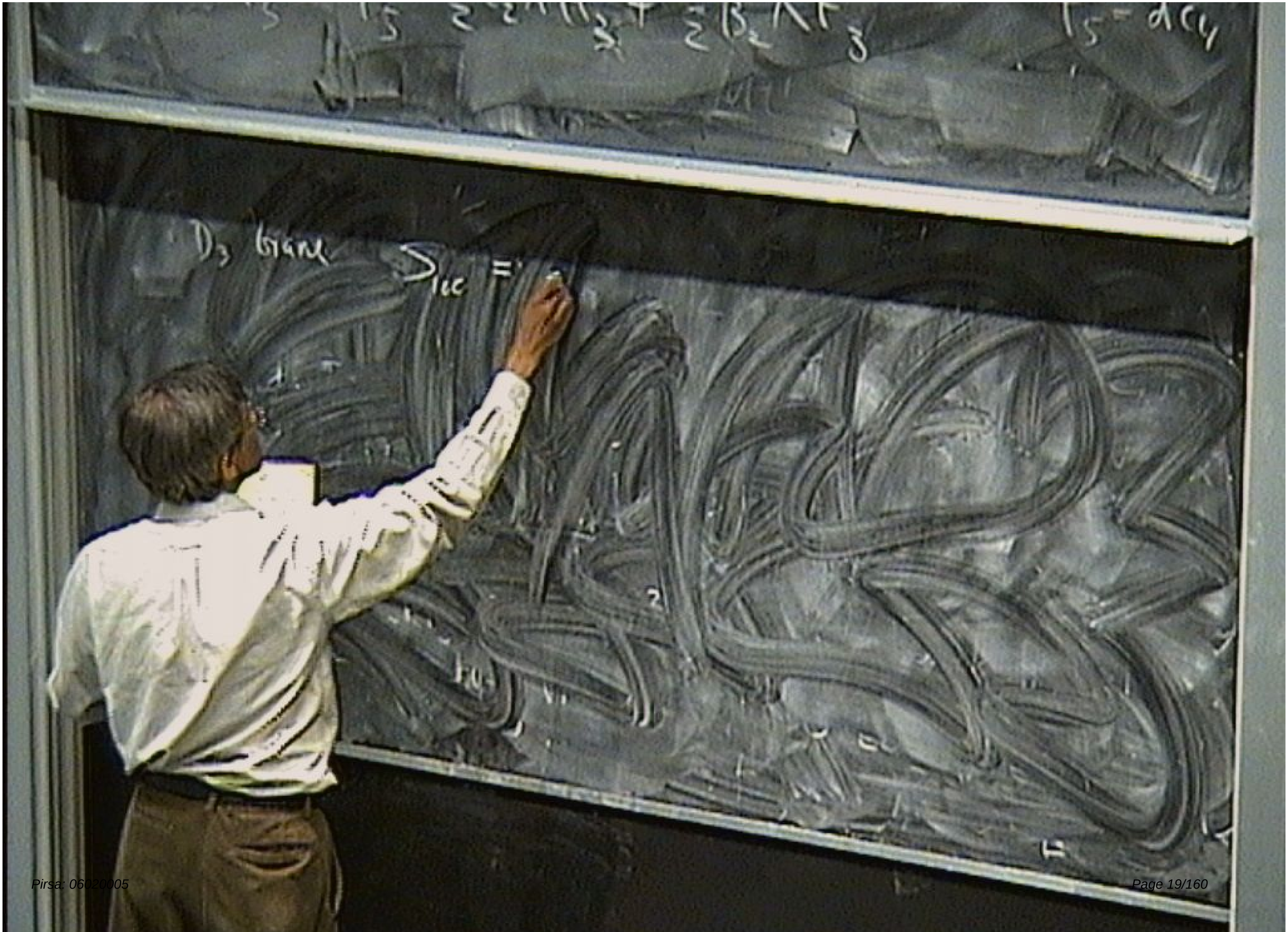
$$S = \int d^{10}x \sqrt{g} \Big[R - \frac{1}{2\tau_I^2} \partial_M \tau \partial^M \bar{\tau} - \frac{1}{2\cdot 3!} \frac{G_{MNP} \bar{G}^{MNP}}{\tau_I} - \frac{1}{4\cdot 5!} \tilde{F}_{MNPQR} \tilde{F}^{MNPQR} \Big] + \frac{1}{4i} \int \frac{C_4 \wedge G_3 \wedge \bar{G}_3}{\tau_I}$$

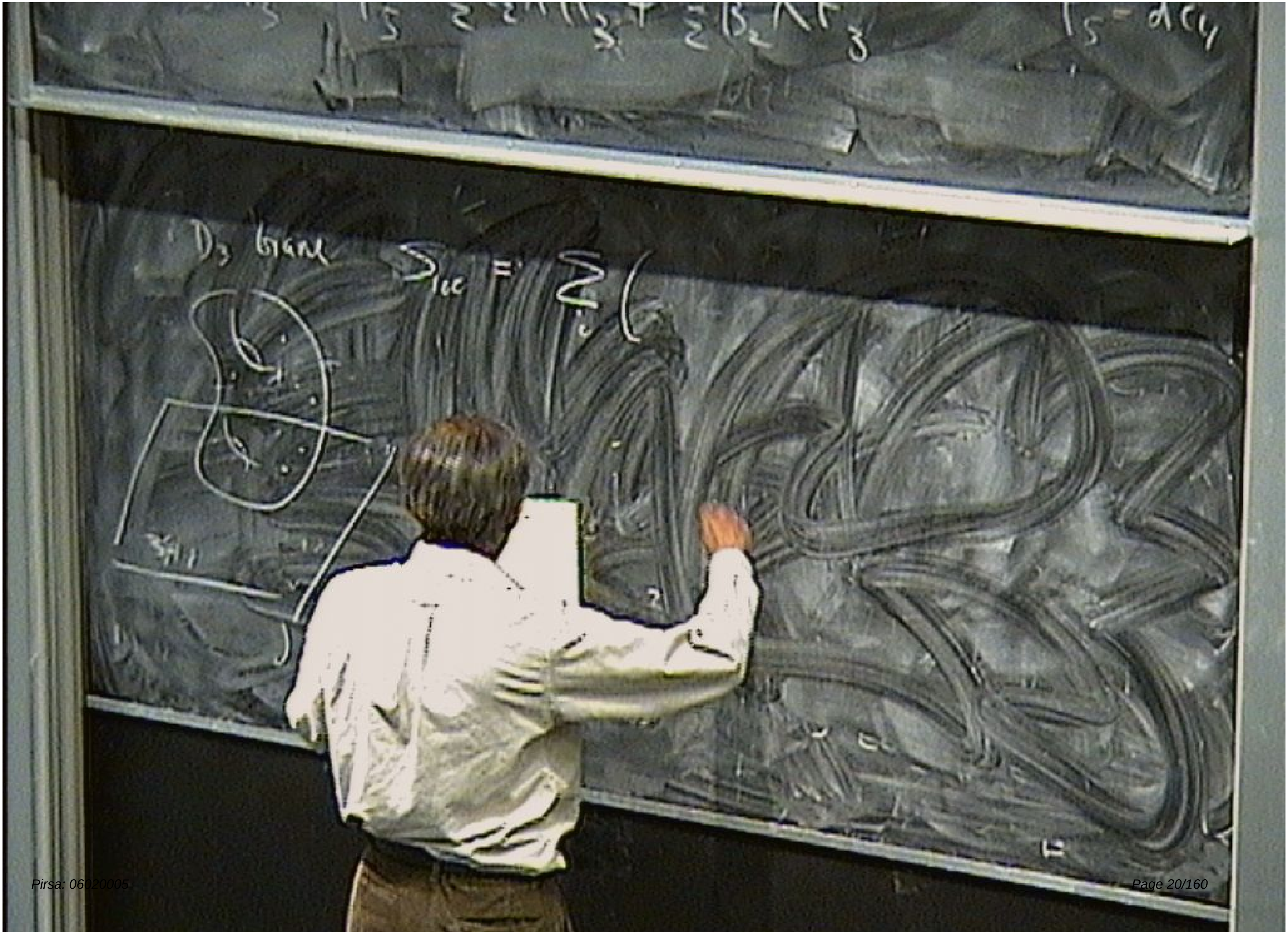
$\tau = C_0 + i e^{-\phi}$

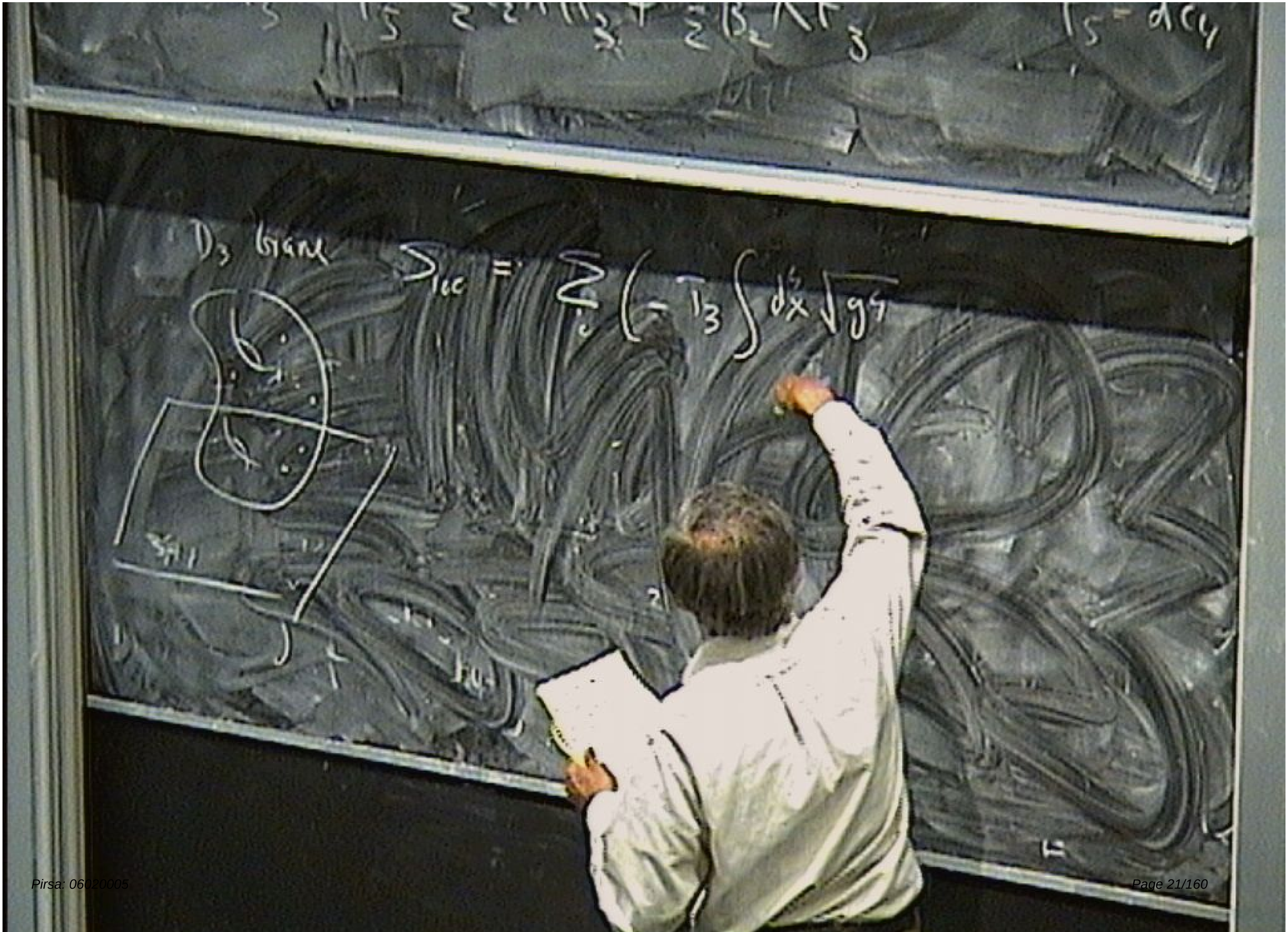
$G_3 = F_3 - \tau H_3 \qquad F_3 = dC_2, \quad H_3 = dB_2$

$\tilde{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$


D3 brane

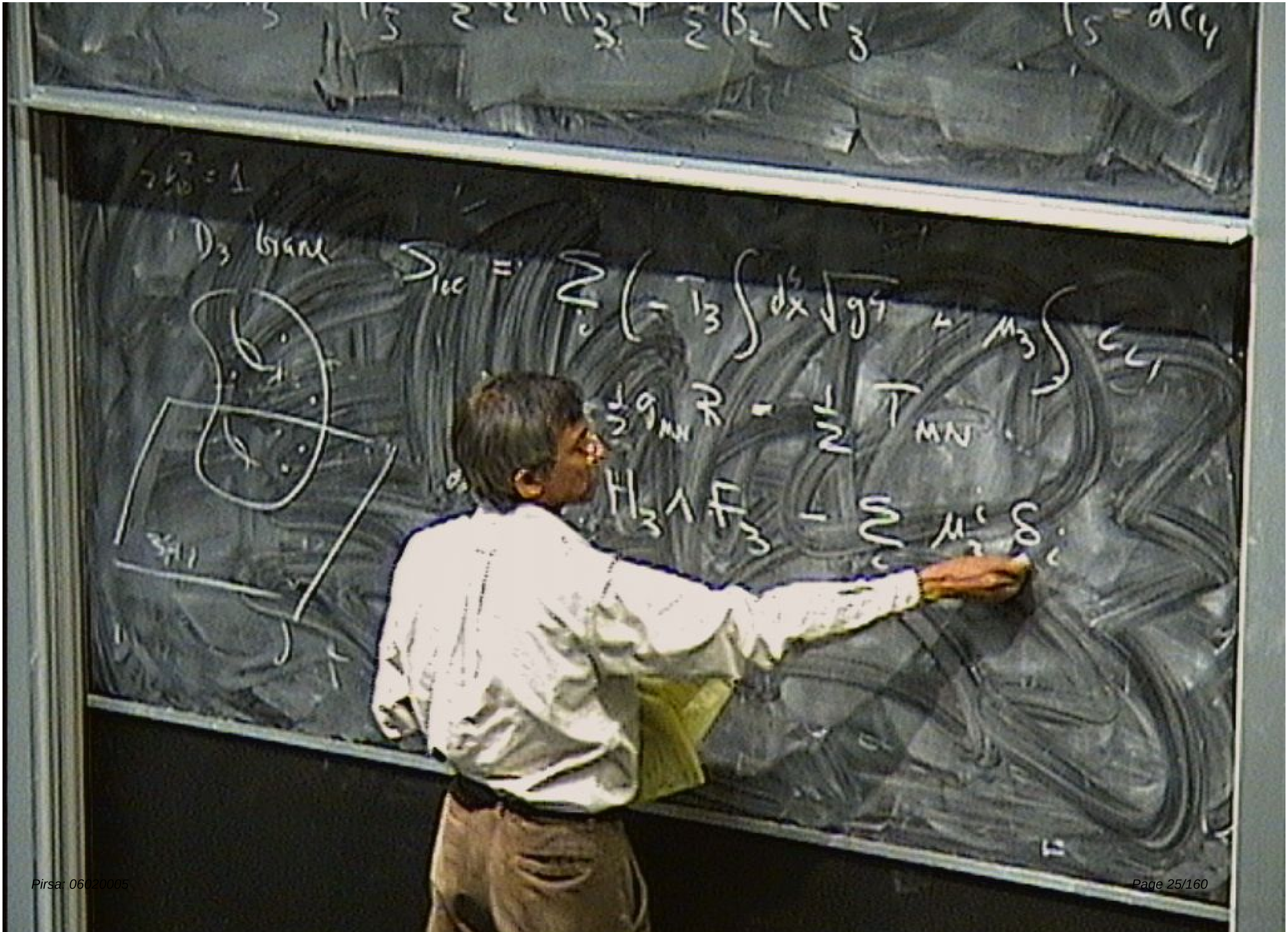


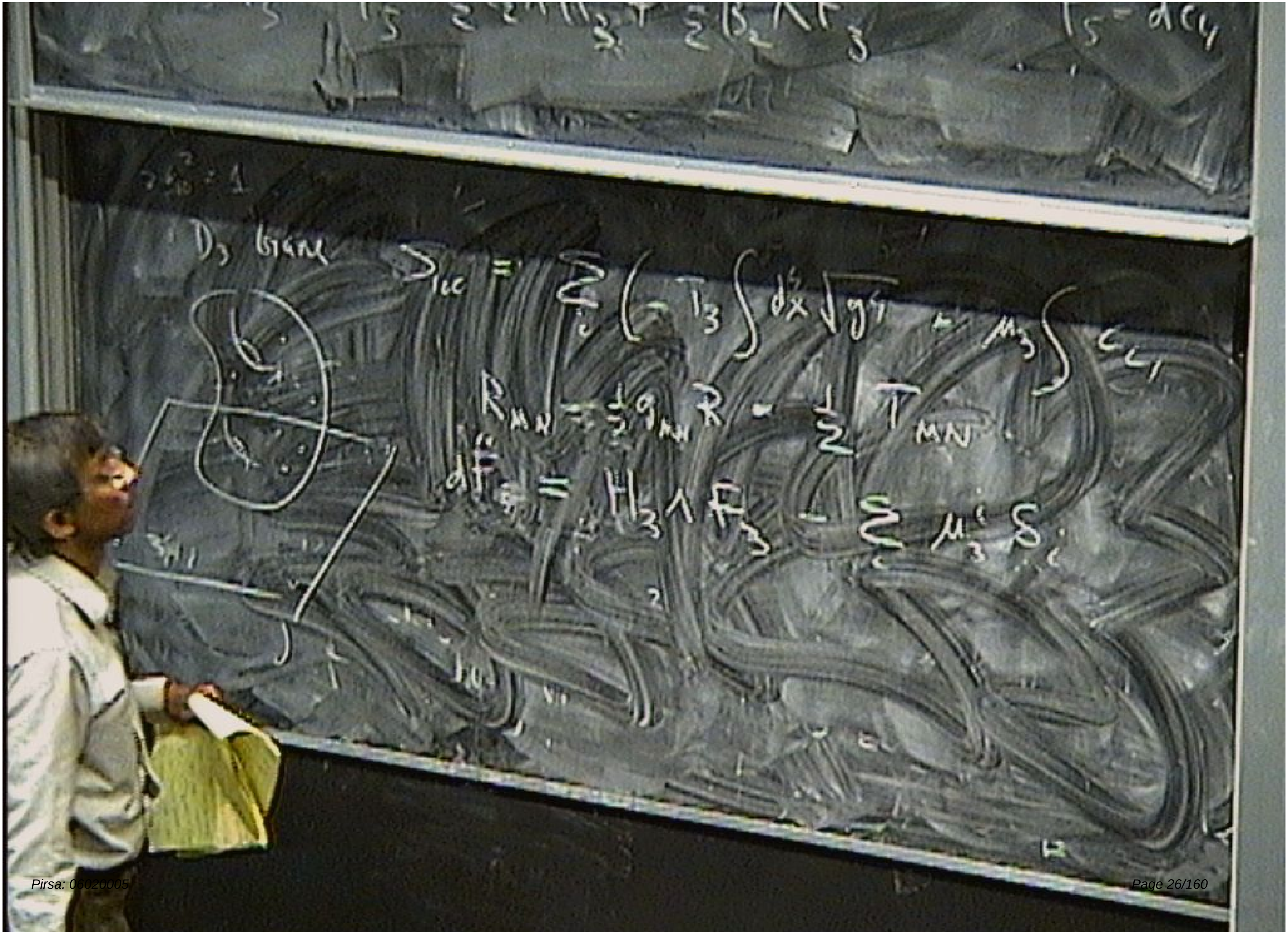

D3 brane


D3 brane


D3 brane


D3 brane

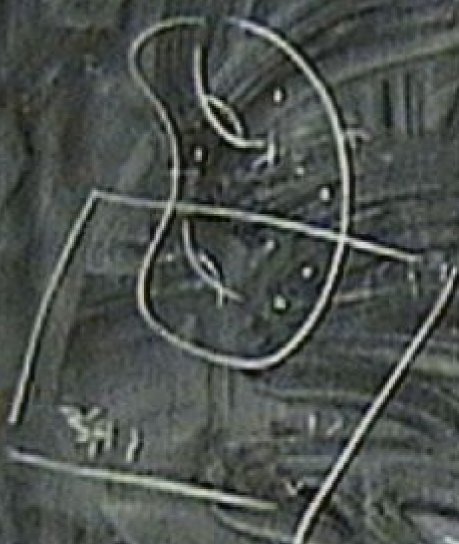

D3 brane


D3 brane
$S_{loc} = \sum_i \left(- T_3 \int d^4x \sqrt{g} + \mu_3 \int C_4 \right.$
$R_{MN} - \frac{1}{2} g_{MN} R = \frac{1}{2} T_{MN}$
$dF_5 = H_3 \wedge F_3 - \sum_i \mu_3^i \delta_i$
$F_5 = dC_4$

$F_5 = dC_4$

$g_s = 1$

D_3 brane

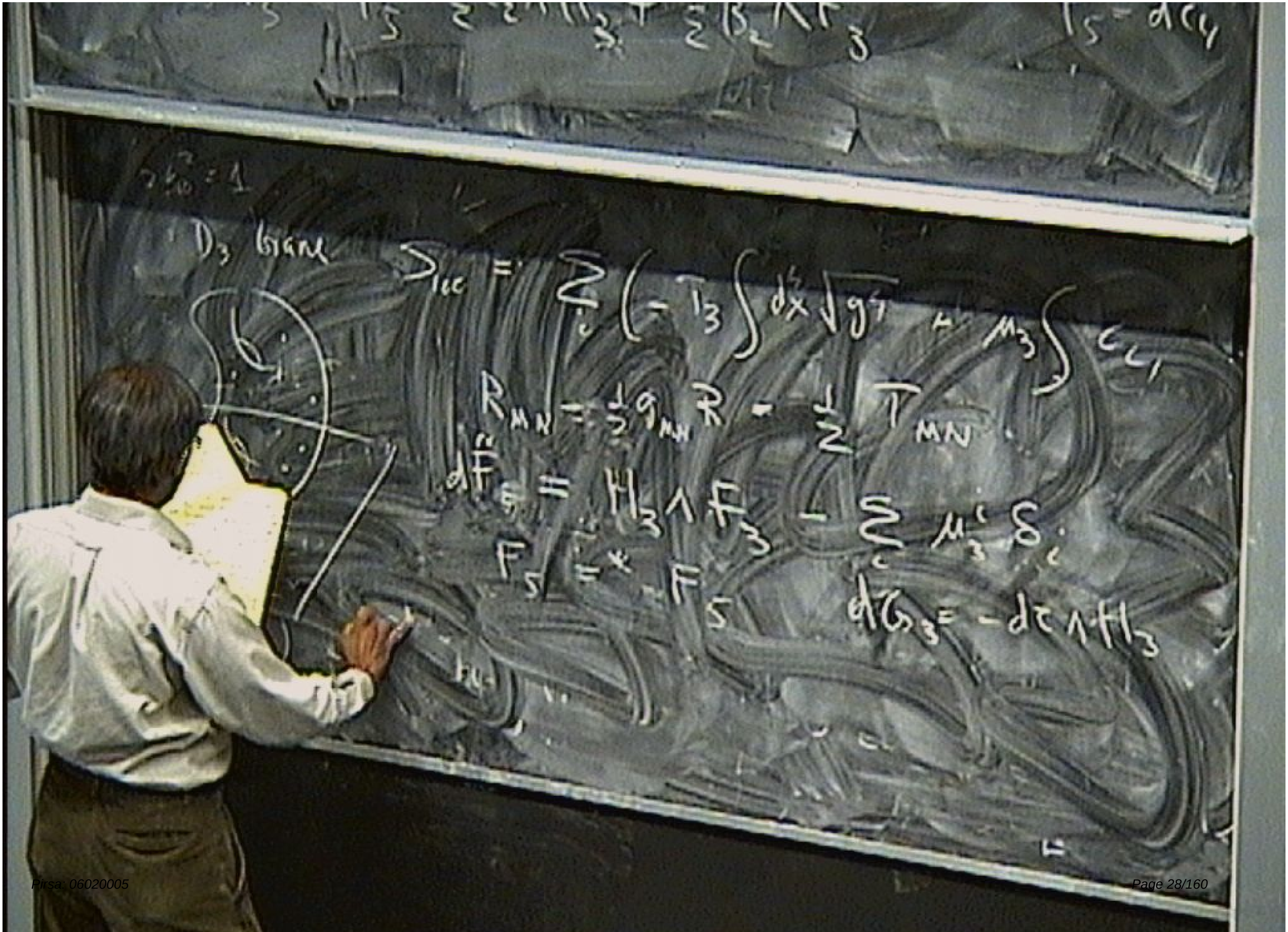


$$S_{loc} = \sum_i \left(-T_3 \int d^4x \sqrt{g_4} + \mu_3 \int C_4 \right)$$

$$R_{MN} - \frac{1}{2} g_{MN} R = \frac{1}{2} T_{MN}$$

$$d\tilde{F}_5 = H_3 \wedge F_3 + \sum_i \mu_3^i \delta_i$$

$$\tilde{F}_5 = * \tilde{F}_5$$


D3 brane
S_loc = Σ_i (− T_3 ∫ d^4x √g + μ_3 ∫ C_4)
R_MN − 1/2 g_MN R = 1/2 T_MN
dF̃_5 = H_3 ∧ F_3 − Σ_i μ_3^i δ_i
F̃_5 = * F̃_5
dG_3 = − dτ ∧ H_3

$\tilde{F}_5 = \ldots \frac{1}{2} \ldots \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$

$2\kappa_{10}^2 = 1$

D3 brane

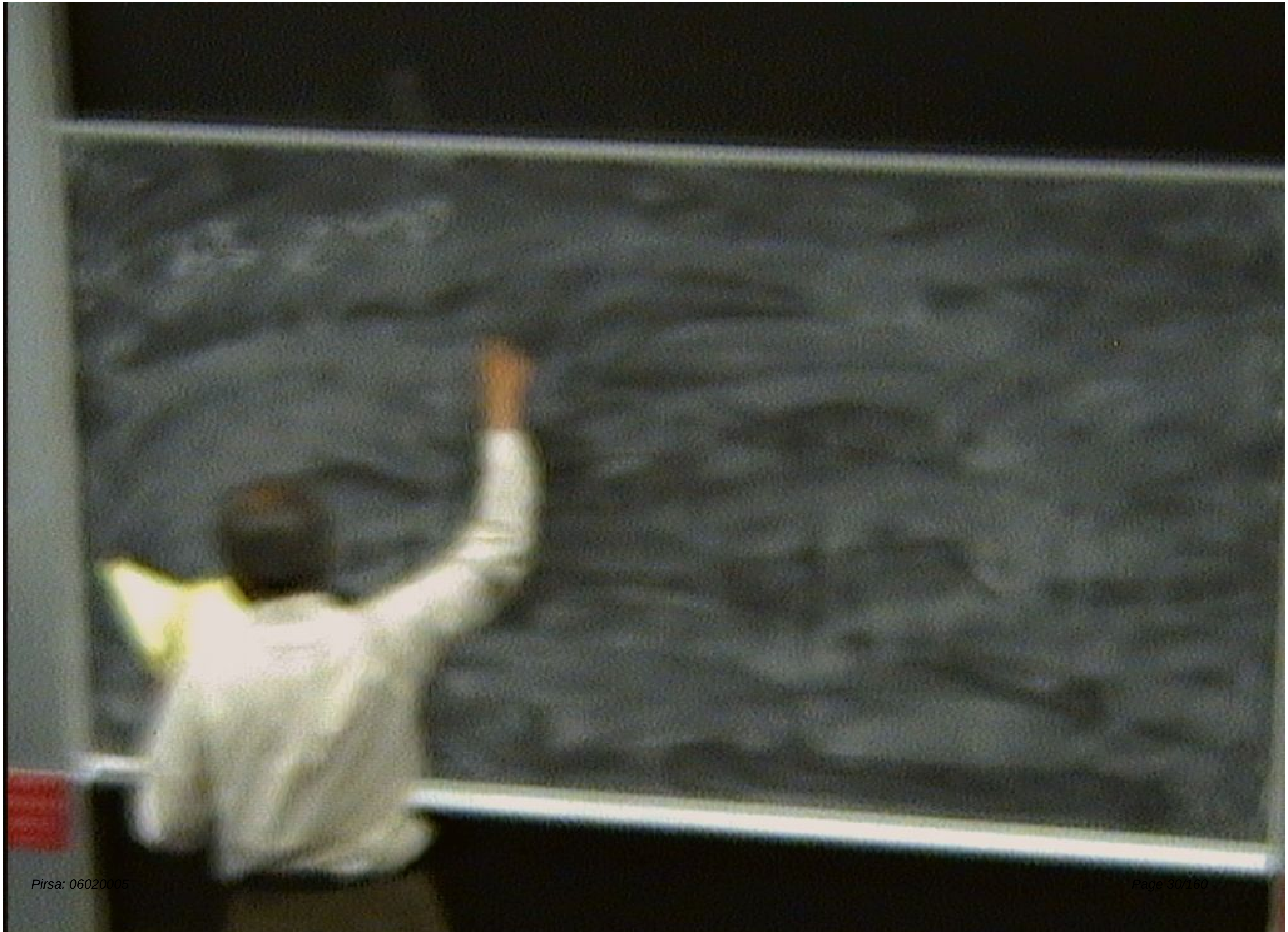
$$S_{loc} = \sum_i \left(-T_3 \int d^4x \sqrt{g_4} + \mu_3 \int C_4 \right)$$

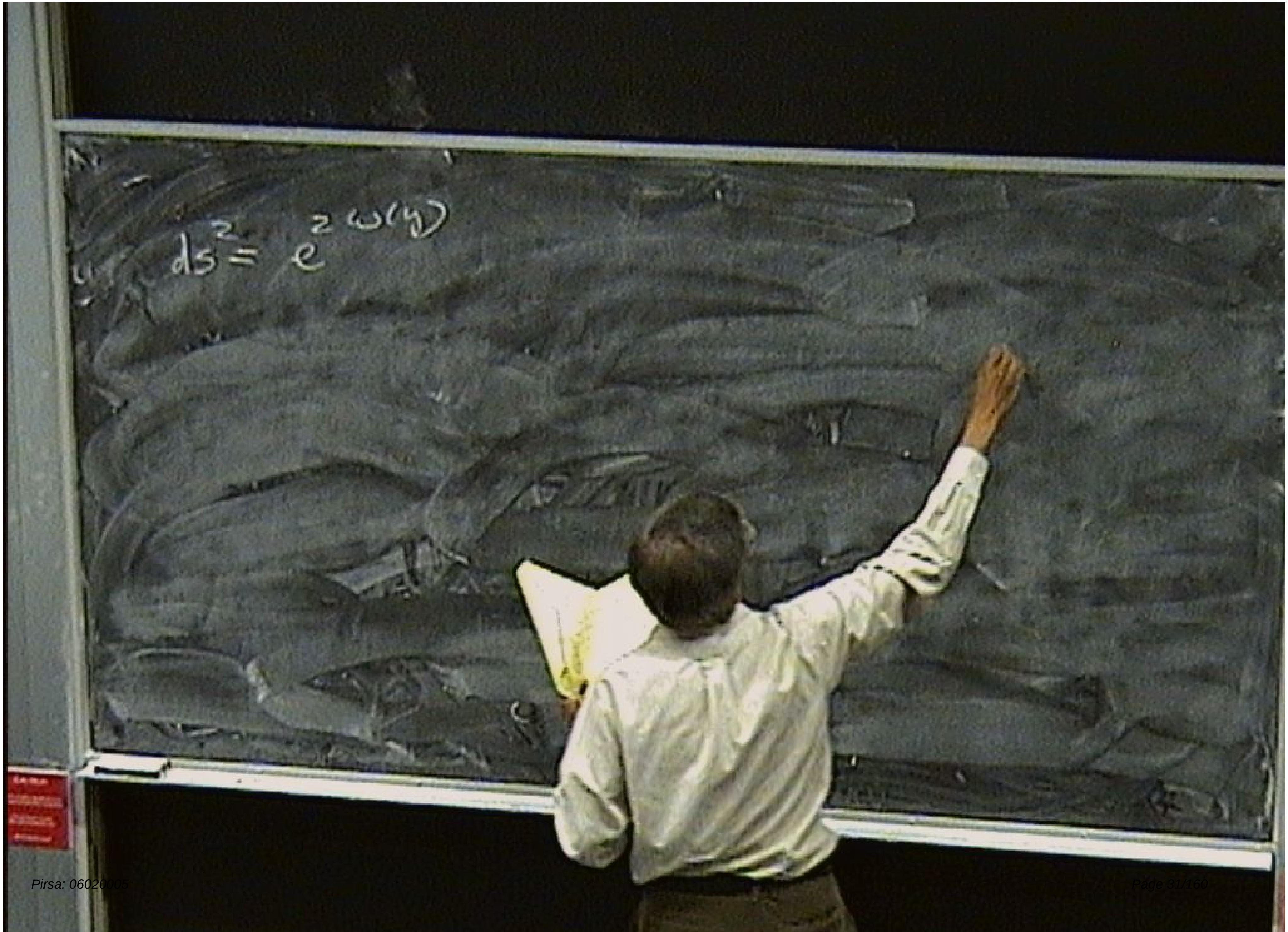
$$R_{MN} - \frac{1}{2} g_{MN} R = \frac{1}{2} T_{MN}$$

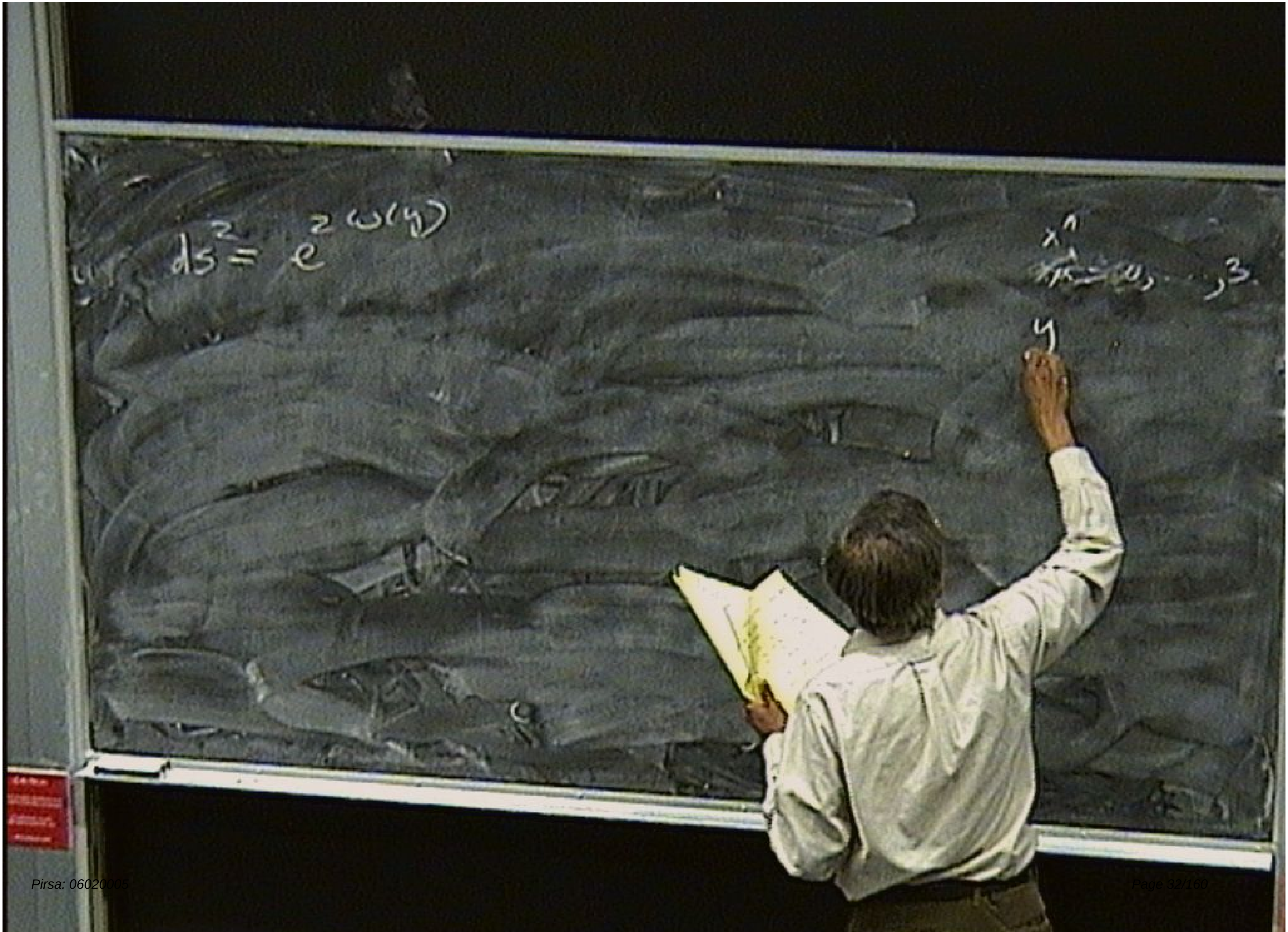
$$d\tilde{F}_5 = H_3 \wedge F_3 + \sum_i \mu_3^i \delta_i$$

$$\tilde{F}_5 = {}^* \tilde{F}_5$$

$$dG_3 = -d\tau \wedge H_3$$




$ds^2 = e^{2\omega(y)}$

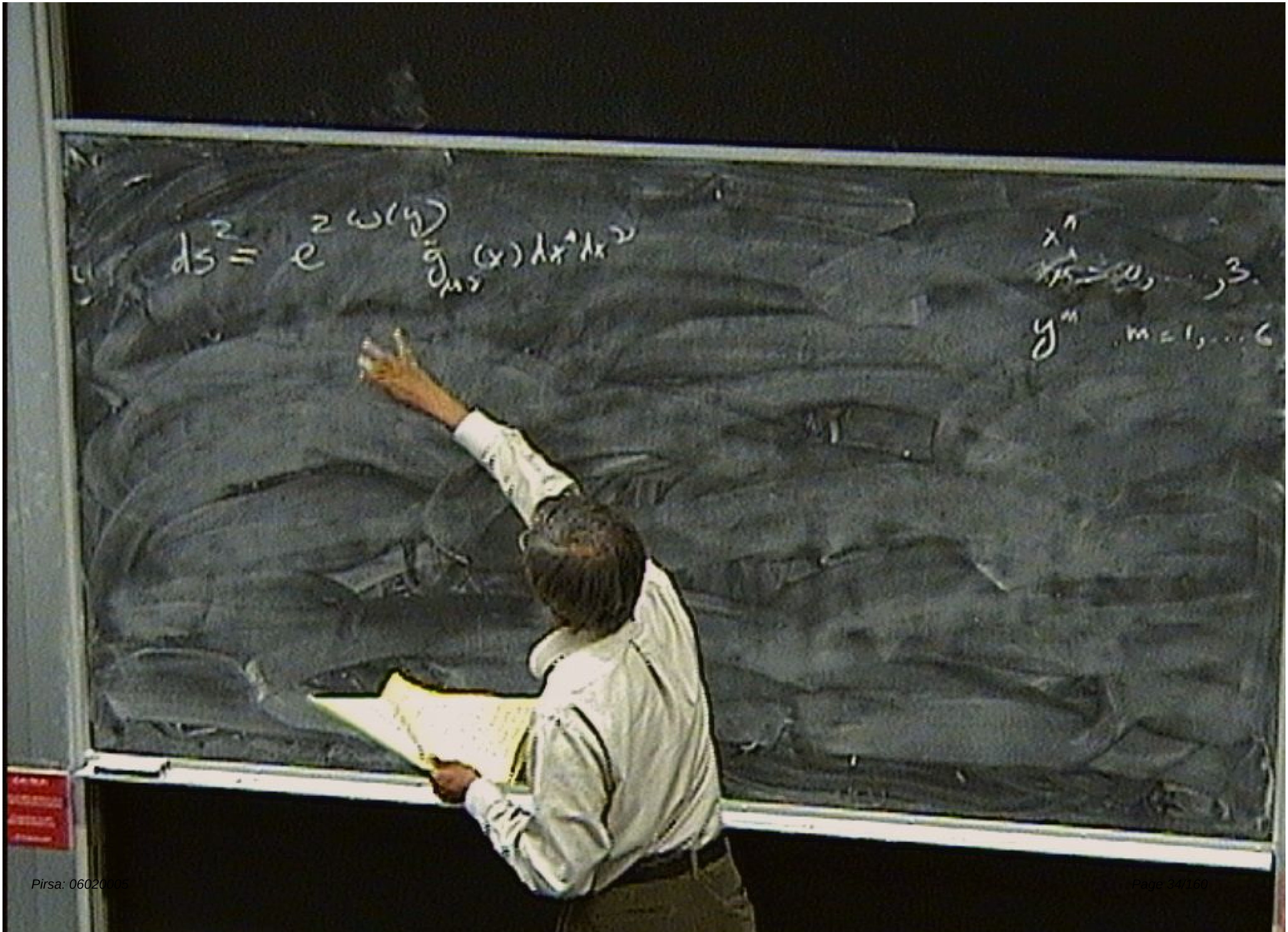

$ds^2 = e^{2\omega(y)}$

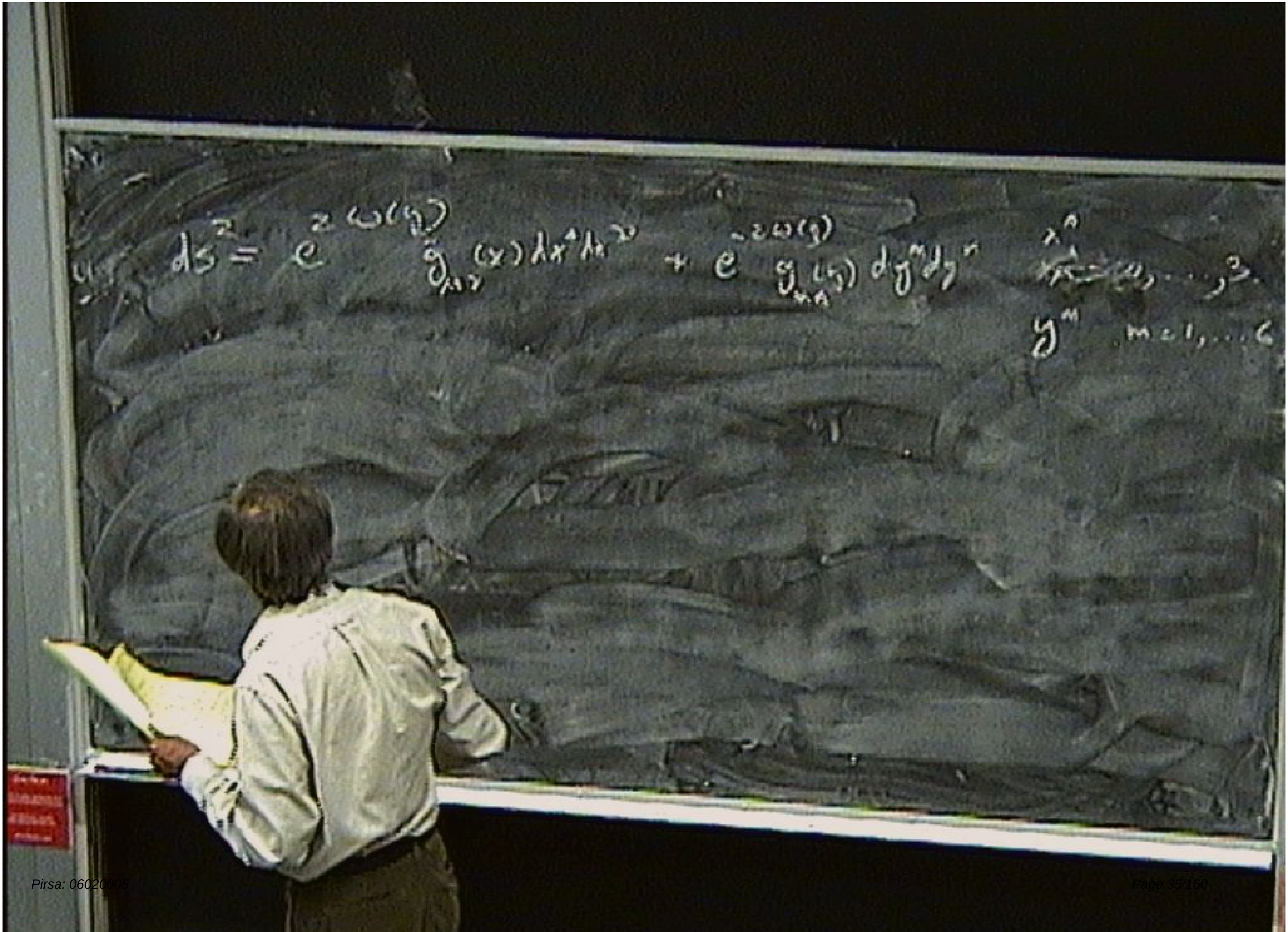
$$ds^2 = e^{2\omega(y)}$$

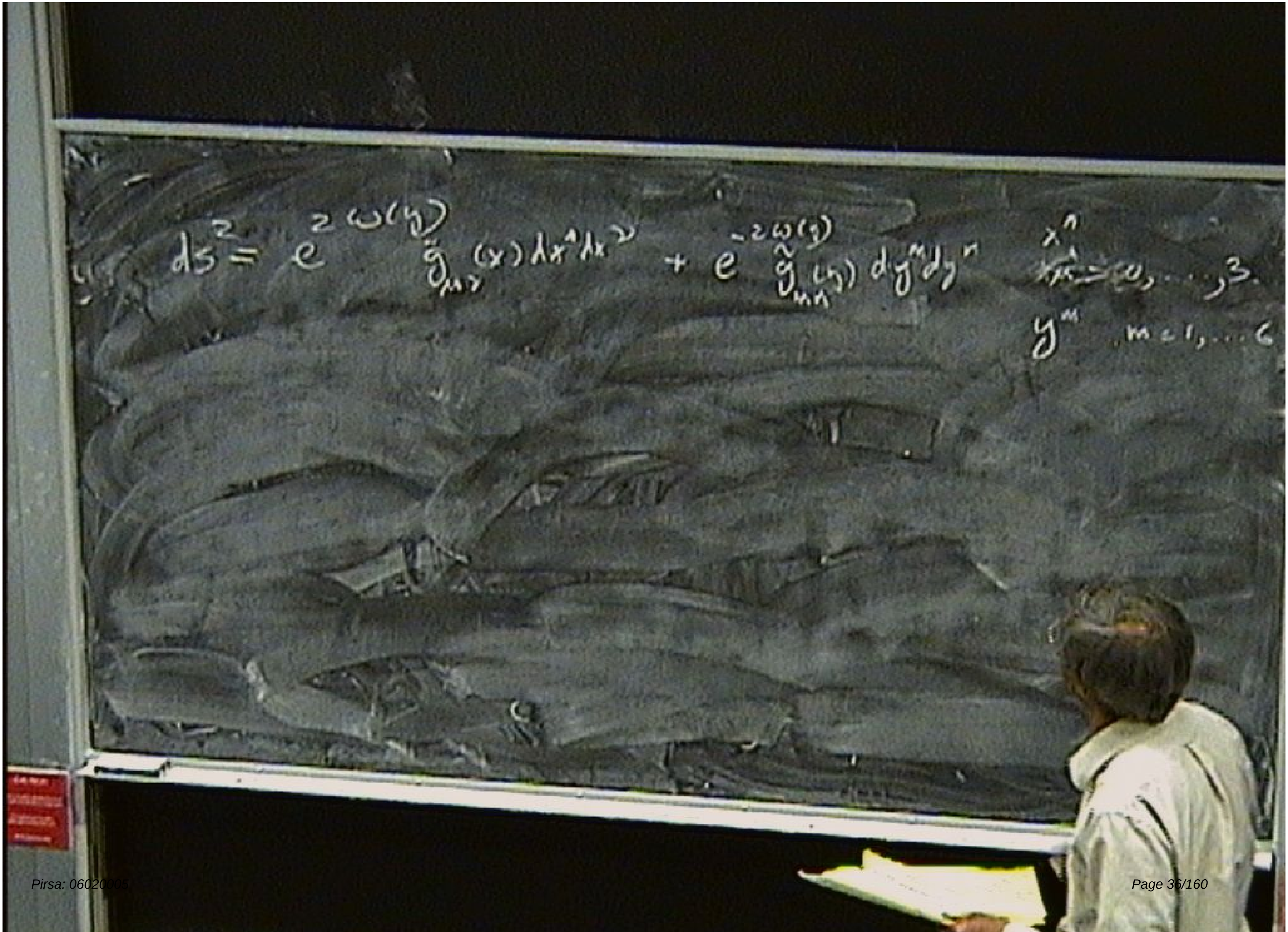
x^μ

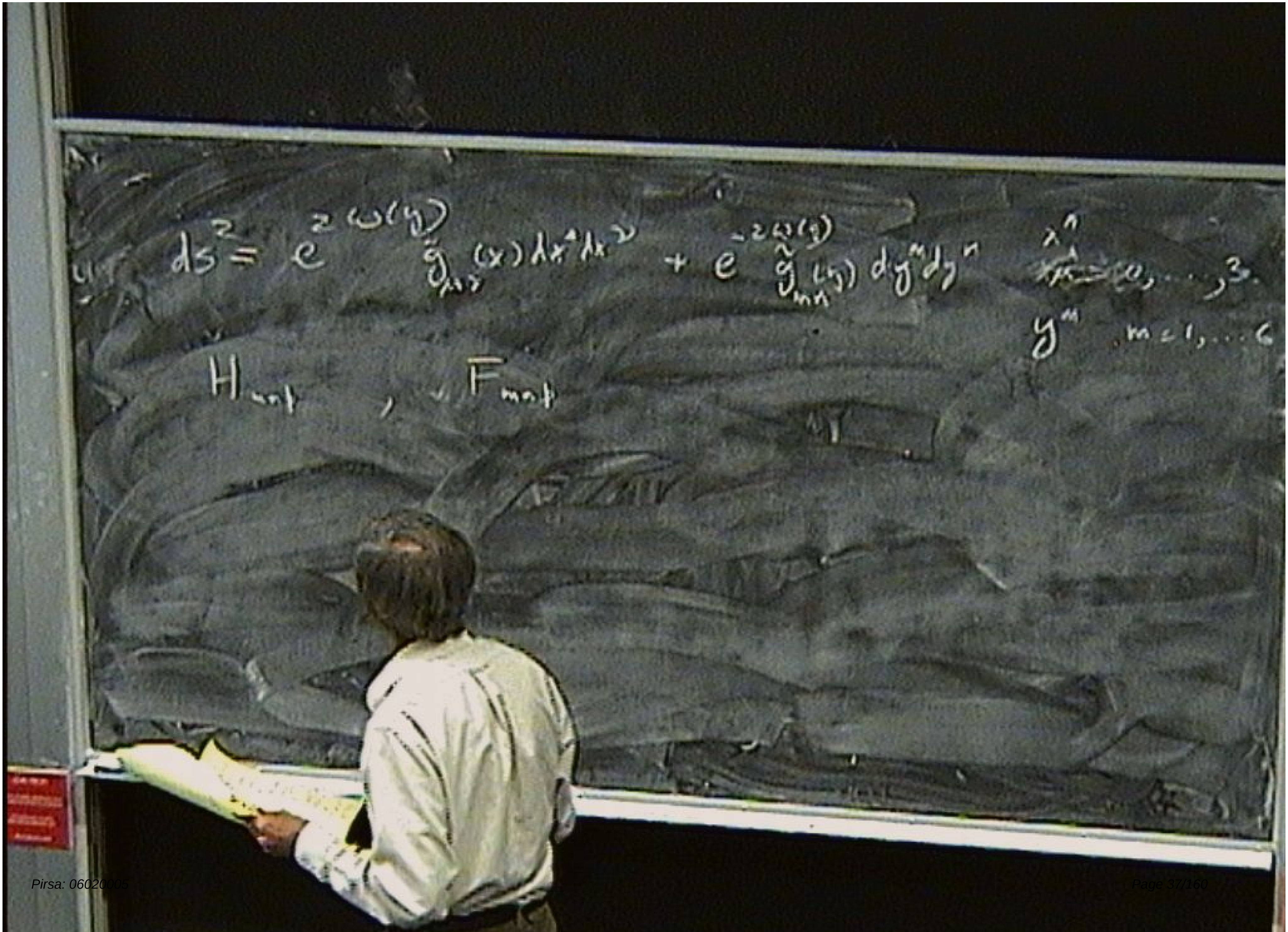
$\mu = 0, \ldots, 3.$

$y^m \quad m = 1, \ldots, 6$

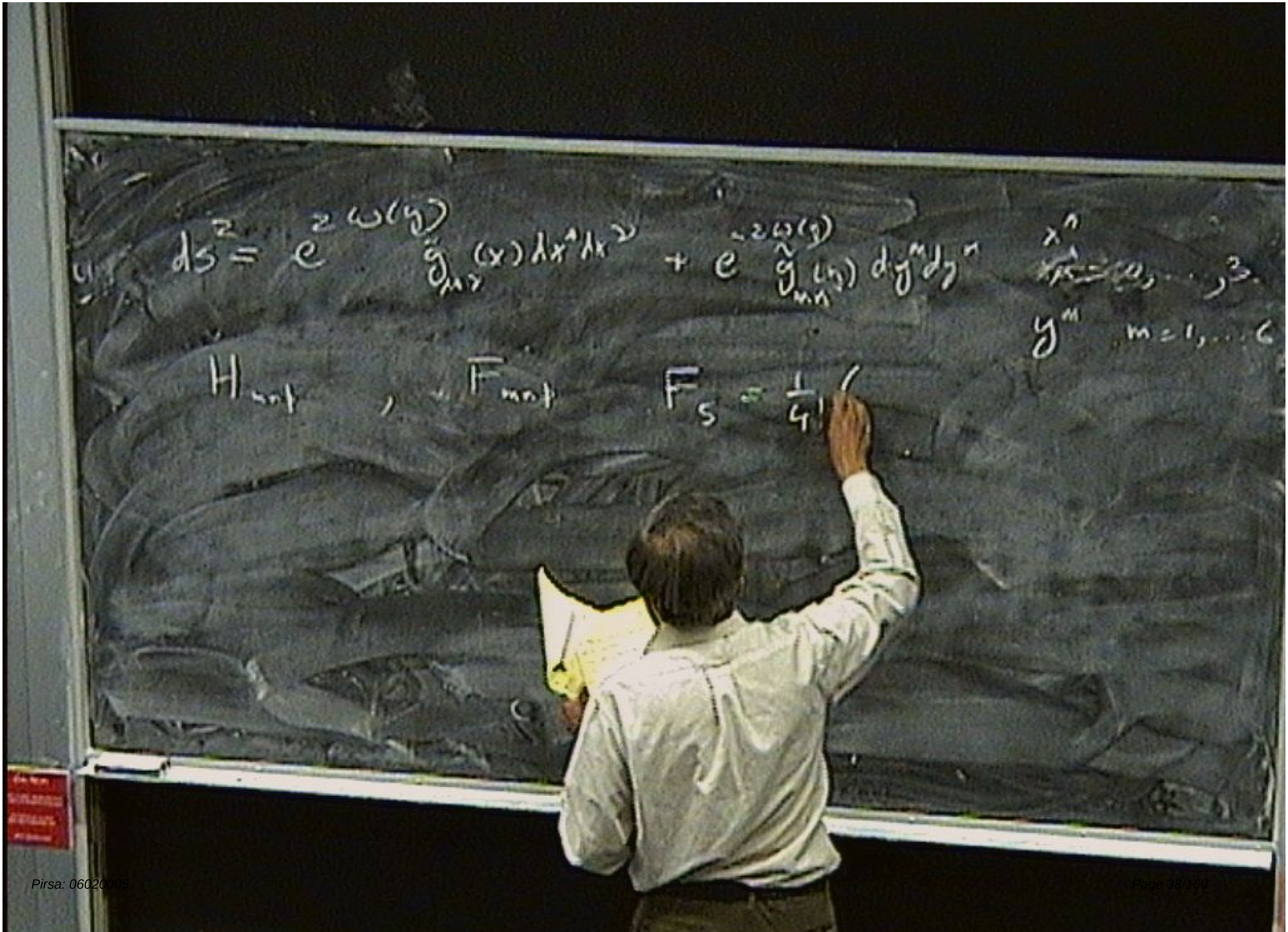

ds² = e^{2ω(y)} g_μν(x) dx^μ dx^ν
x^μ
y^m , m = 1, … 6


$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x) dx^\mu dx^\nu + e^{-2\omega(y)} g_{mn}(y) dy^m dy^n$
x^μ $\mu = 0, \ldots, 3$
y^m $m = 1, \ldots, 6$


$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n$
$x^\mu \quad \mu = 0, \ldots, 3$
$y^m \quad m = 1, \ldots, 6$



$ds^2 = e^{2\omega(y)} \tilde{g}_{\mu\nu}(x) dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y) dy^m dy^n$
x^μ $\mu = 0, \dots, 3$
y^m $m = 1, \dots 6$
H_{mnp} , F_{mnp}


$ds^2 = e^{2\omega(y)} \tilde{g}_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n$
x^μ $\mu = 0, \ldots, 3$
y^m $m = 1, \ldots, 6$
H_{mnp} , F_{mnp} $F_5 = \frac{1}{4!}($

$$ds^2 = e^{2\omega(y)} \tilde{g}_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n$$

x^μ $\mu = 0, \ldots, 3.$

y^m $m = 1, \ldots 6$

H_{mnp}, F_{mnp}

$$F_5 = \frac{1}{4!}(1 + *)\sqrt{\tilde{g}_4}(x)\, dx^0 \wedge dx^1 \ldots \wedge dx^3$$

with fluxes

$$S = \int d^{10}x\sqrt{g}\Big[R - \frac{1}{2\tau_I^2}\partial_M\tau\,\partial^M\bar\tau - \frac{1}{2\cdot 3!}\frac{G_{MNP}\bar G^{MNP}}{\tau_I} - \frac{1}{4\cdot 5!}\tilde F_{MNPQR}\tilde F^{MNPQR}\Big]$$

$$+ \frac{1}{4i}\int \frac{C_4\wedge G_3\wedge \bar G_3}{\tau_I}$$

$\tau = C_0 + i e^{-\phi}$ $\qquad G_3 = F_3 - \tau H_3$ $\qquad F_3 = dC_2,\ H_3 = dB_2$

$\tilde F_5 = F_5 - \frac{1}{2}C_2\wedge H_3 + \frac{1}{2}B_2\wedge F_3$ $\qquad F_5 = dC_4$

$2\kappa^2 = 1$

D_3 here

$$S_{loc} = \sum_i\Big(-T_3\int d^4x\sqrt{g} + \mu_3\int C_4\Big)$$

$$R_{MN} - \frac{1}{2}g_{MN}R = \frac{1}{2}T_{MN}$$

$$d\tilde F_5 = H_3\wedge F_3 - \sum_i \mu_3^i\,\delta_i$$

$$\tilde F_5 = *\tilde F_5 \qquad dG_3 = -d\tau\wedge H_3$$

$$ds^2 = e^{2\omega(y)}\,\tilde{g}_{\mu\nu}(x)\,dx^\mu dx^\nu + e^{-2\omega(y)}\,\tilde{g}_{mn}(y)\,dy^m dy^n \qquad x^\mu \quad \mu = 0,\dots,3.$$

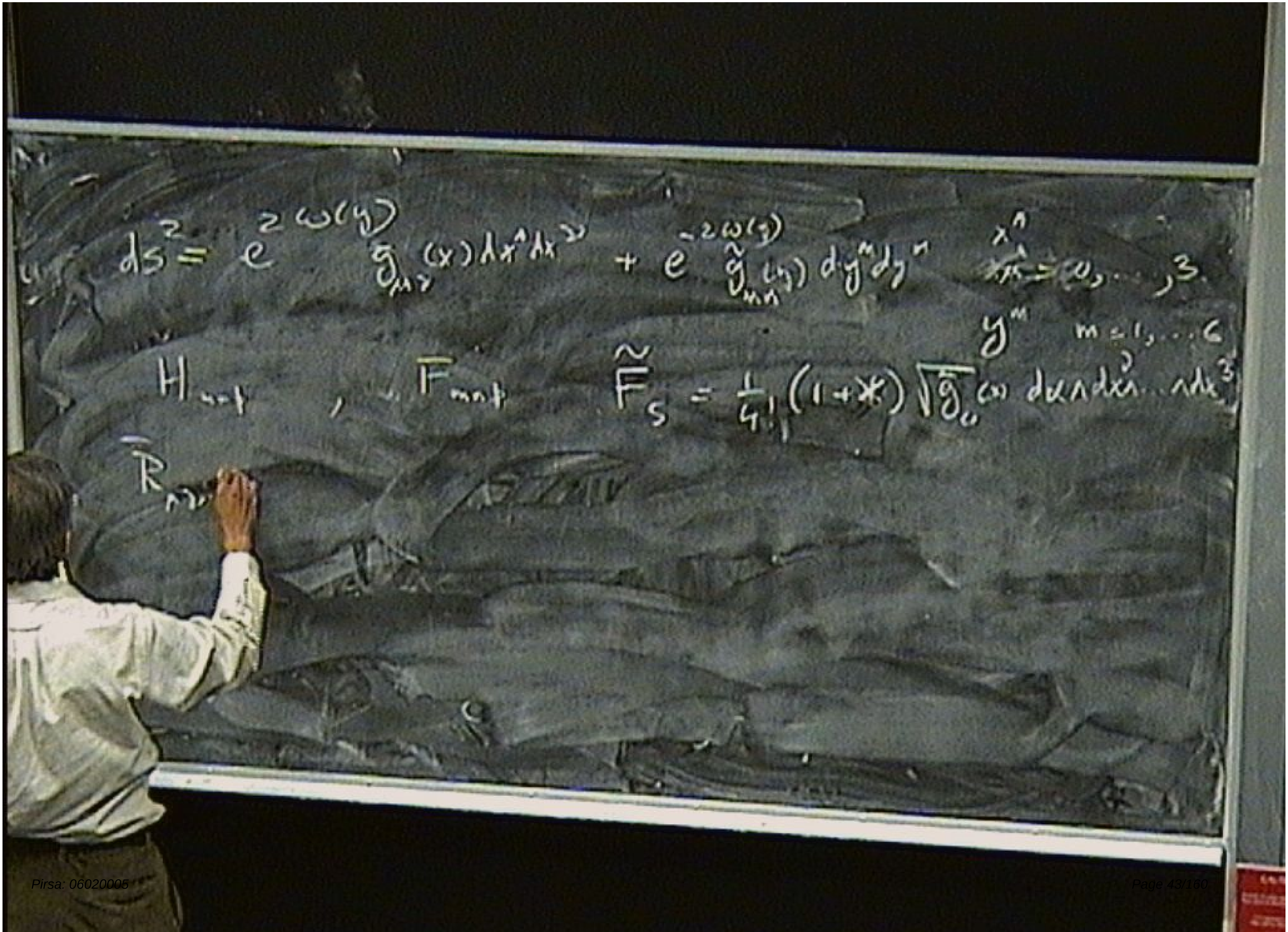
$$y^m \qquad m = 1,\dots,6$$

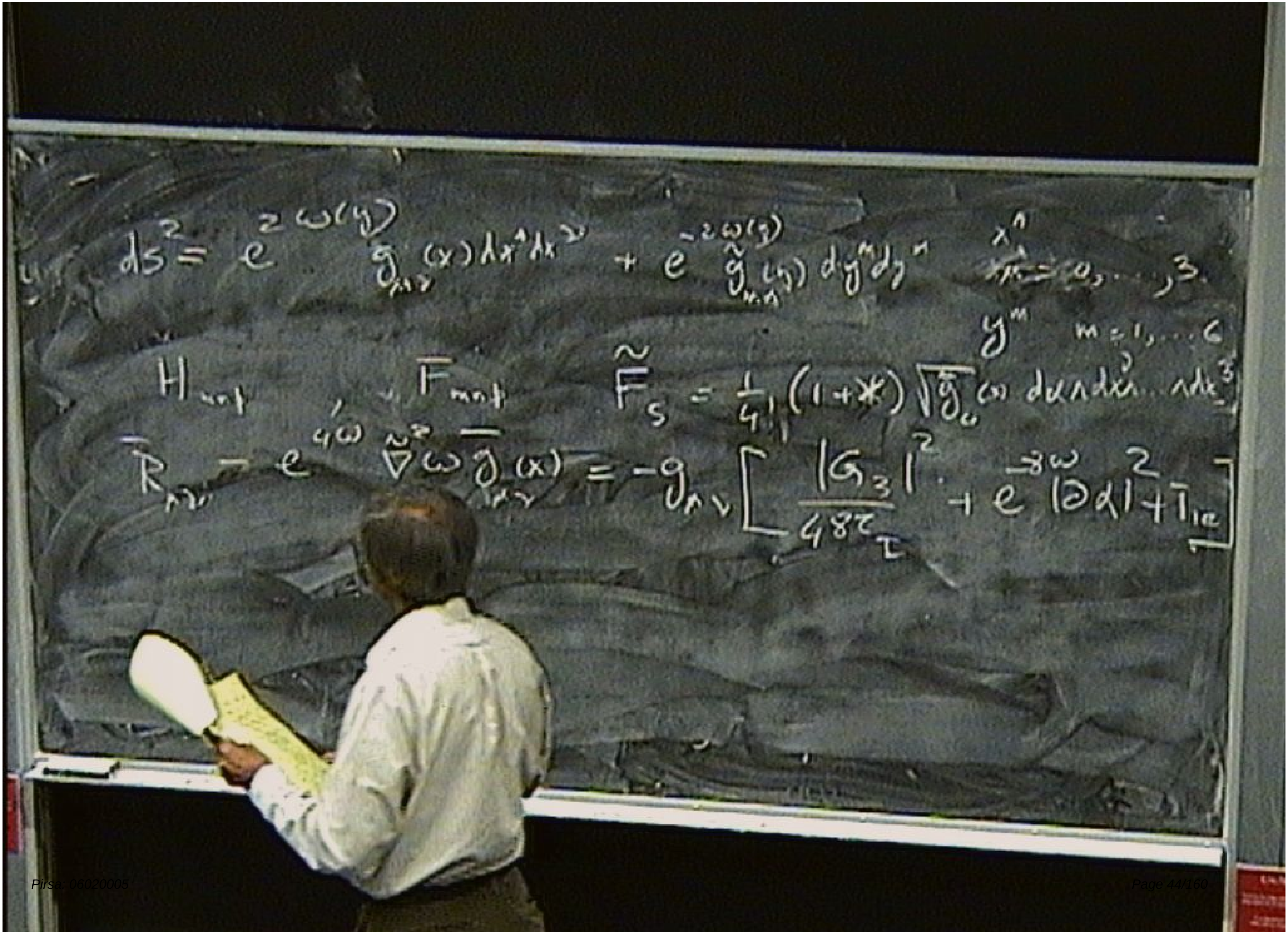
$$H_{mnp}\,, \qquad F_{mnp} \qquad F_5 = \frac{1}{4!}(1+*)\sqrt{\tilde{g}_4(x)}\; dx^0\wedge dx^1 \cdots \wedge dx^3$$

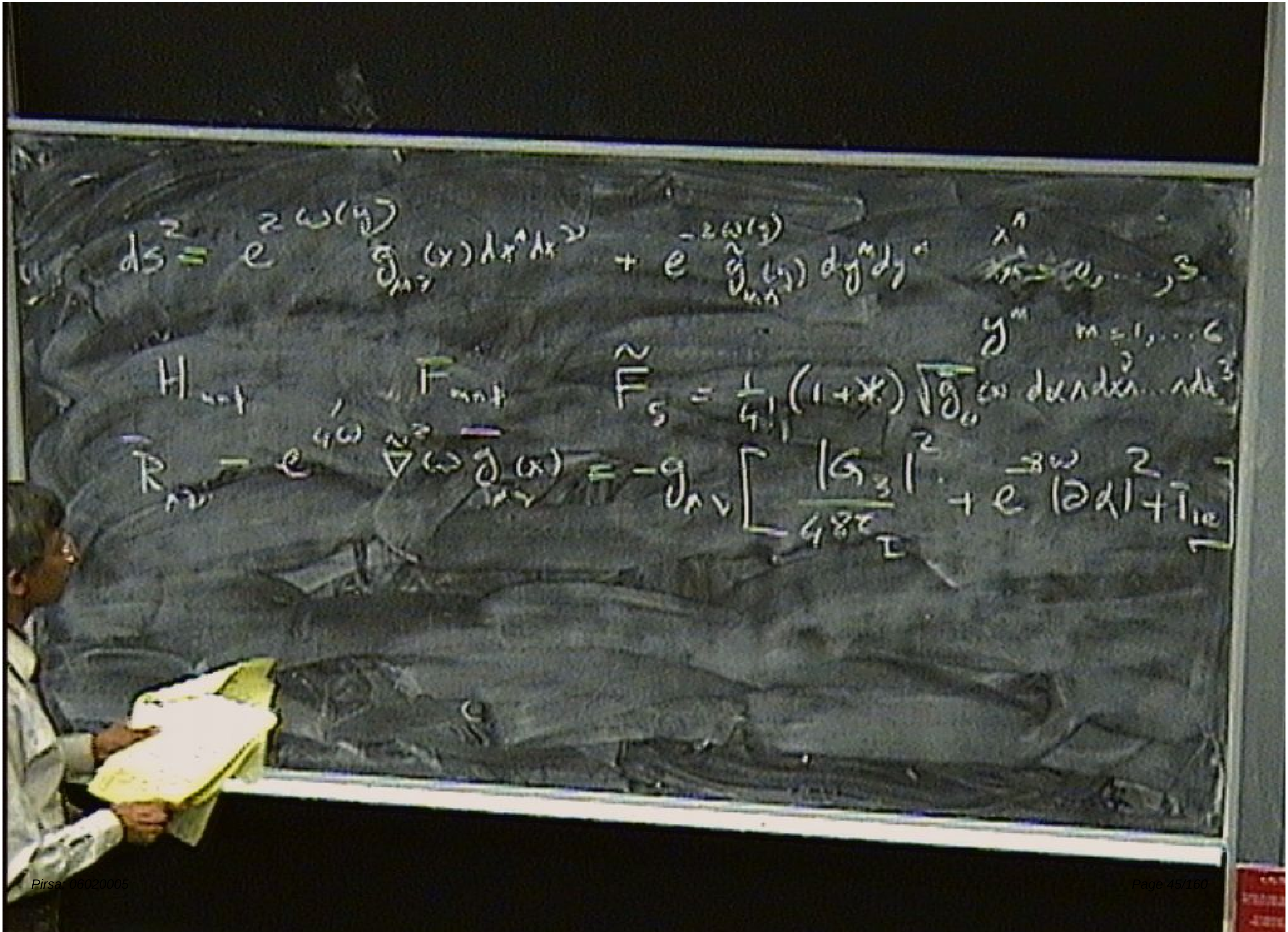
$$ds^2 = e^{2\omega(y)} \tilde{g}_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n \qquad x^\mu \quad \mu = 0, \dots, 3$$

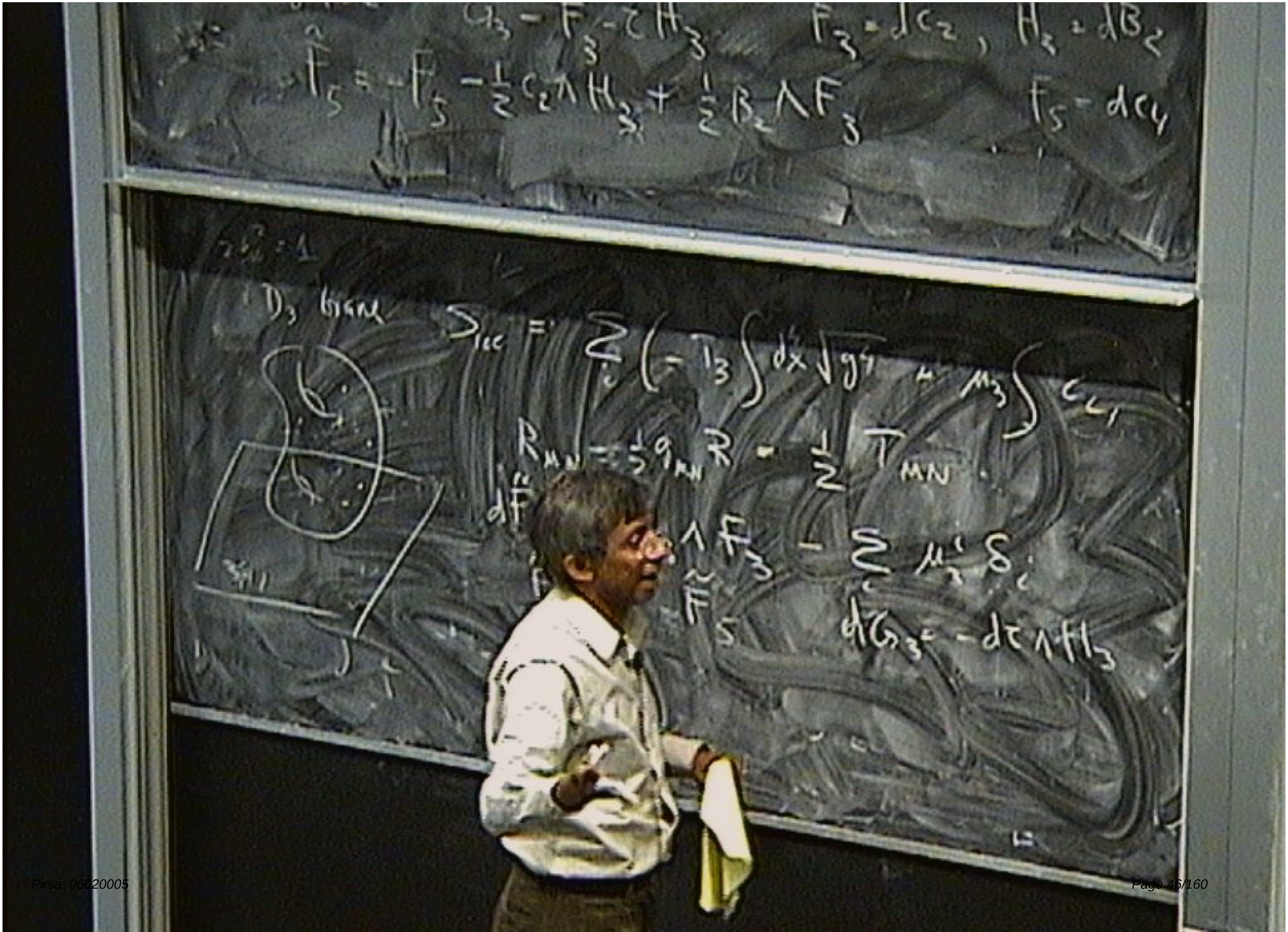
$$y^m \qquad m = 1, \dots, 6$$

$$H_{mnp} \quad , \quad F_{mnp} \qquad \tilde{F}_5 = \frac{1}{4!}(1 + *)\sqrt{g_0}(x)\, dx^0 \wedge dx^1 \dots \wedge dx^3$$


$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n$
$x^\mu \quad \mu = 0, \dots, 3$
$y^m \quad m = 1, \dots, 6$
$H_{mnp}, \quad F_{mnp}$
$\tilde{F}_5 = \frac{1}{4!}(1+*)\sqrt{g_0(x)}\, dx^0 \wedge dx^1 \dots \wedge dx^3$
$\bar{R}_{\mu\nu}$


$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x) dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y) dy^m dy^n$
$x^\mu \quad \mu = 0, \ldots, 3.$
$y^m \quad m = 1, \ldots, 6$
$H_{mnp}, \quad F_{mnp}$
$\tilde{F}_5 = \frac{1}{4!}(1 + *)\sqrt{\tilde{g}_4}(x)\, d\alpha \wedge dx^0 \ldots \wedge dx^3$
$\bar{R}_{\mu\nu} - e^{4\omega} \tilde{\nabla}^2 \omega \bar{g}_{\mu\nu}(x) = -g_{\mu\nu}\left[\frac{|G_3|^2}{48\tau_2} + e^{-8\omega}|\partial\alpha|^2 + T_{loc}\right]$


(1) $ds^2 = e^{2\omega(y)} g_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n$ x^μ $\mu = 0,\dots,3$
y^m $m = 1,\dots,6$
H_{mnp} F_{mnp} $\tilde{F}_5 = \frac{1}{4!}(1+*)\sqrt{g_4}(x)\, dx^0\wedge dx^1 \dots \wedge dx^3$
$\bar{R}_{\mu\nu} - e^{4\omega}\tilde{\nabla}^2\omega\, \bar{g}_{\mu\nu}(x) = -g_{\mu\nu}\left[\frac{|G_3|^2}{48\tau_I} + e^{-8\omega}|\partial\alpha|^2 + T_{10}\right]$


F3 = dC2 , H3 = dB2
F̃5 = F5 − ½ C2∧H3 + ½ B2∧F3
F5 = dC4
D3 brane
RMN − ½ gMN R = ½ TMN

$$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n \qquad x^\mu \quad \mu = 0, \dots, 3$$

$$y^m \quad m = 1, \dots, 6$$

$$H_{mnp}, \quad F_{mnp} \qquad \tilde{F}_5 = \frac{1}{4!}(1 + *) \sqrt{g_4}(x)\, d\alpha \wedge dx^1 \wedge dx^2 \dots \wedge dx^3$$

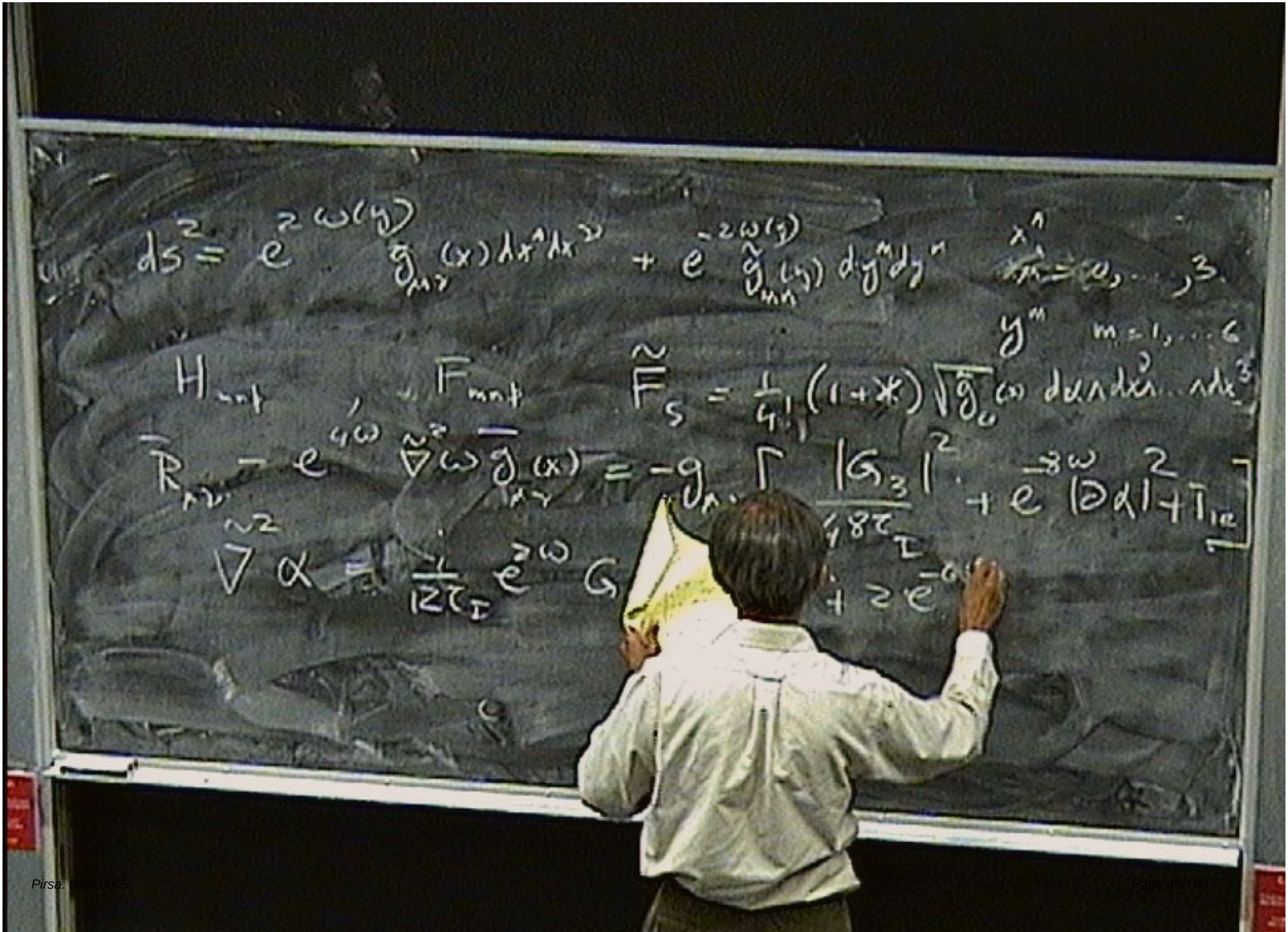
$$\bar{R}_{\mu\nu} - e^{4\omega} \tilde{\nabla}^2 \omega\, \bar{g}_{\mu\nu}(x) = -g_{\mu\nu}\left[\frac{|G_3|^2}{48\tau_2} + e^{-8\omega} |\partial\alpha|^2 + \dots \right.$$

$$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n \qquad x^\mu \quad \mu = 0, \dots, 3$$

$$y^m \quad m = 1, \dots, 6$$

$$H_{mnp} \qquad F_{mnp} \qquad \tilde{F}_5 = \frac{1}{4!}(1 + *)\sqrt{g_0(x)}\, d\alpha \wedge dx^0 \wedge \dots \wedge dx^3$$

$$\bar{R}_{\mu\nu} - e^{4\omega}\tilde{\nabla}^2\omega\, \bar{g}_{\mu\nu}(x) = -g_{\mu\nu}\left[\frac{|G_3|^2}{48\tau_I} + e^{-8\omega}|\partial\alpha|^2 + T_{loc}\right]$$



$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n$
$y^m \quad m = 1, \dots, 6$
$H_{mnp} \quad F_{mnp} \quad \tilde{F}_5 = \frac{1}{4!}(1+*)\sqrt{g_4(x)}\, dx^0 \wedge dx^1 \dots \wedge dx^3$
$\bar{R}_{\mu\nu} - e^{4\omega}\, \tilde{\nabla}^2\omega\, \bar{g}_{\mu\nu}(x) = -g_{\mu\nu}\left[\frac{|G_3|^2}{48\tau_I} + e^{-8\omega}|\partial\alpha|^2 + T_{loc}\right]$
$\tilde{\nabla}^2 \alpha = \frac{i}{12\tau_I} e^{2\omega} G$
$+ 2e^{-}$

$$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n \qquad x^\mu \quad \mu = 0, \dots, 3$$

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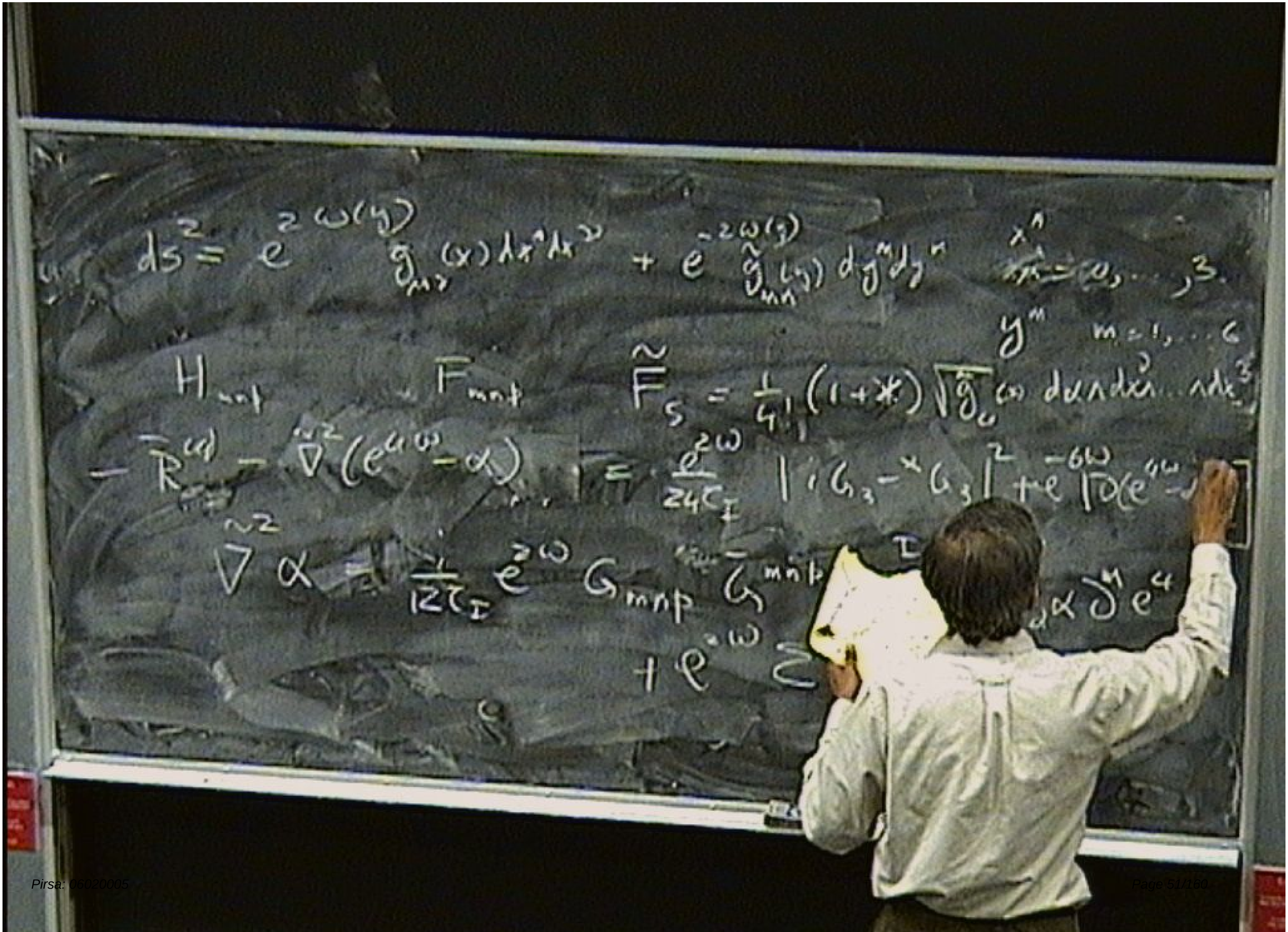
$$H_{mnp}, \quad F_{mnp} \qquad \tilde{F}_5 = \frac{1}{4!}(1 + *) \sqrt{\tilde{g}_4}(x)\, d\alpha \wedge dx^0 \wedge \dots \wedge dx^3$$

$$\bar{R}_{\mu\nu} - e^{4\omega} \tilde{\nabla}^2 \omega\, \bar{g}_{\mu\nu}(x) = -g_{\mu\nu} \left[\frac{|G_3|^2}{48 \tau_I} + e^{-8\omega} |\partial\alpha|^2 + T_{loc} \right]$$

$$\tilde{\nabla}^2 \alpha = \frac{i}{12 \tau_I} e^{2\omega} G_{mnp} \bar{G}^{mnp} + 2 e^{-6\omega} \partial_m \alpha\, \partial^m e^{4\omega}$$

$$+ e^{2\omega} \sum \mu_3 \delta_i$$


ds^2 = e^{2ω(y)} g_{μν}(x) dx^μ dx^ν + e^{-2ω(y)} g̃_{mn}(y) dy^m dy^n
x^μ
y^m   m = 1, ..., 6
H_{mnp}
F_{mnp}
F̃_5 = 1/4! (1 + *) √g̃_4(x) dx^0 ∧ dx^1 ... ∧ dx^3
− R̃^{(4)} − ∇̃^2 (e^{4ω} − α)
= e^{2ω}/(24 Im τ) | iG_3 − *G_3 |^2 + e^{−6ω} |∂(e^{4ω} − α)|^2
∇̃^2 α = i/(12 Im τ) e^{2ω} G_{mnp} Ḡ^{mnp}
+ e^{2ω}

$$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n \qquad x^\mu \quad \mu = 0, \dots, 3$$

$$y^m \qquad m = 1, \dots, 6$$

$$H_{mnp} \qquad F_{mnp} \qquad \tilde{F}_5 = \frac{1}{4!}(1 + *)\sqrt{g_4(x)}\, d\alpha \wedge dx^0 \dots \wedge dx^3$$

$$-\bar{R}^{(4)} - \tilde{\nabla}^2 (e^{4\omega} - \alpha) = \frac{e^{2\omega}}{24\,\tau_I} \left| i G_3 - {*G_3} \right|^2 + e^{-6\omega} \left| \partial (e^{4\omega} - \alpha) \right|^2$$

$$\tilde{\nabla}^2 \alpha = \frac{i}{12\,\tau_I} e^{2\omega} G_{mnp} \bar{G}^{mnp} + 2 e^{-6\omega} \partial_m \alpha\, \partial^m e^{4\omega} + e^{2\omega} \sum \mu_3 \delta_i$$

$$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde g_{mn}(y)\, dy^m dy^n \qquad x^\mu \quad \mu = 0,\dots,3$$

$$y^m \quad m = 1,\dots,6$$

$$H_{mnp} \qquad F_{mnp} \qquad \tilde F_5 = \frac{1}{4!}(1+*)\sqrt{\bar g_4}(x)\, d\alpha \wedge dx^0 \wedge \dots \wedge dx^3$$

$$-\bar R^{(4)} - \tilde\nabla^2\left(e^{4\omega} - \alpha\right) = \frac{e^{2\omega}}{24\,\mathrm{Im}\,\tau}\left|iG_3 - *G_3\right|^2 + e^{-6\omega}\left|\partial\left(e^{4\omega} - \alpha\right)\right|^2$$

$$\tilde\nabla^2 \alpha = \frac{i}{12\,\mathrm{Im}\,\tau} e^{2\omega} G_{mnp} (*\bar G_3)^{mnp} + 2 e^{-6\omega}\partial_m \alpha\, \partial^m e^{4\omega}$$

$$-\bar R^{(4)} \leq 0 \qquad + e^{2\omega} \sum \mu_3 \delta_i$$

$$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)} \tilde{g}_{mn}(y)\, dy^m dy^n$$

x^μ $\mu = 0, \dots, 3$

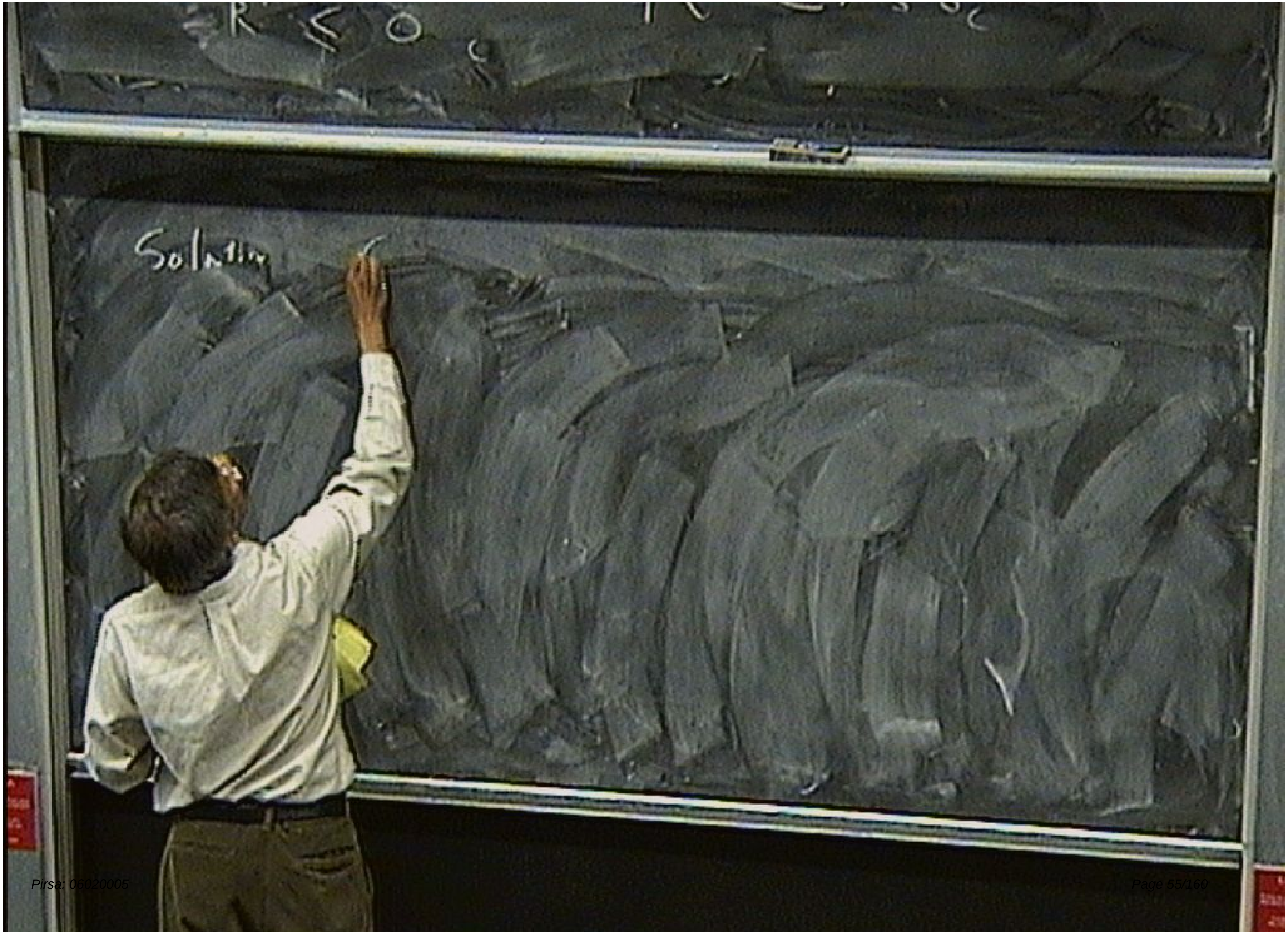
y^m $m = 1, \dots, 6$

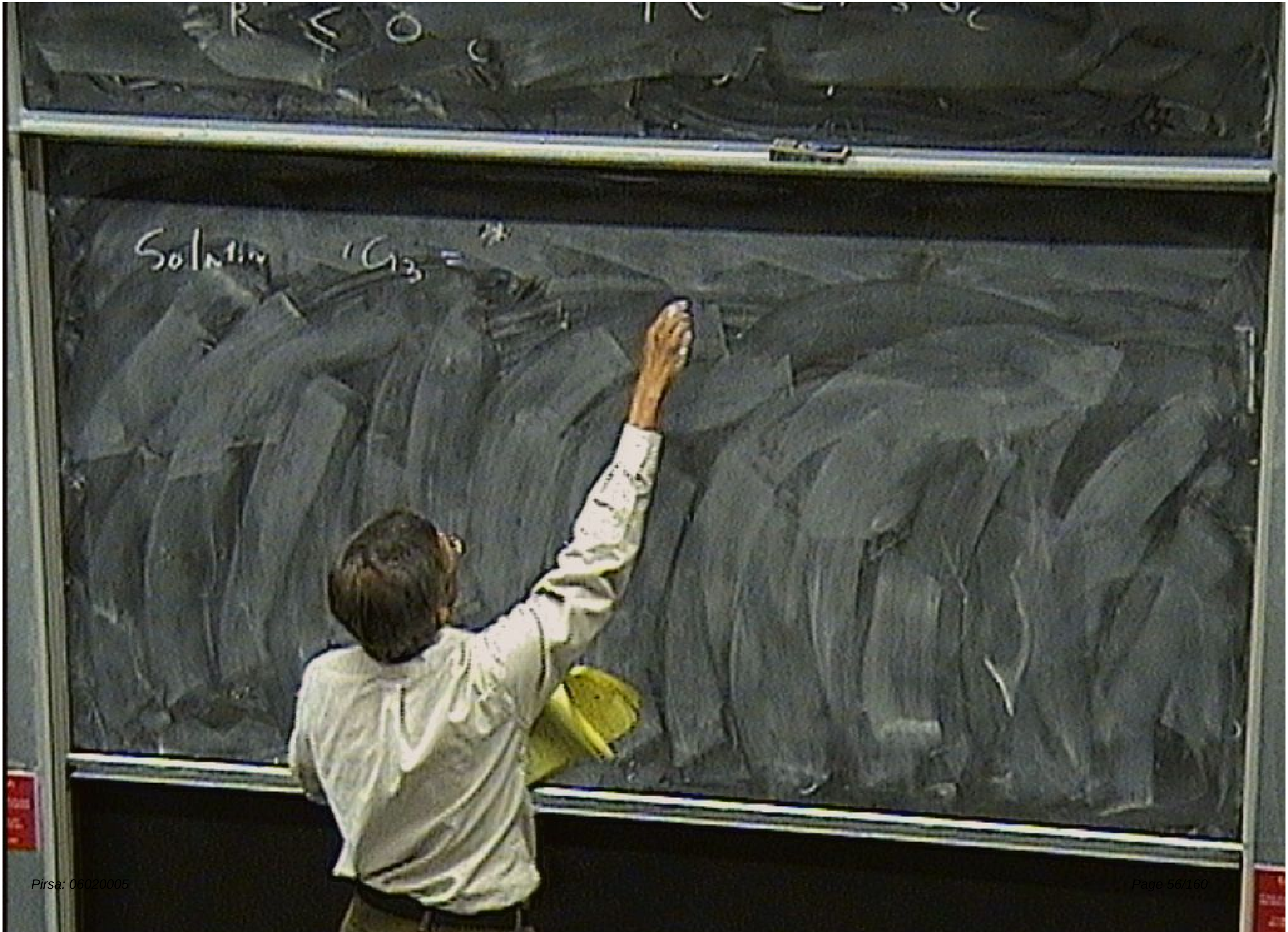
H_{mnp} , F_{mnp} $\quad \tilde{F}_5 = \frac{1}{4!}(1 + *)\sqrt{g_4}\,\alpha\, dx^0 \wedge dx^1 \dots \wedge dx^3$

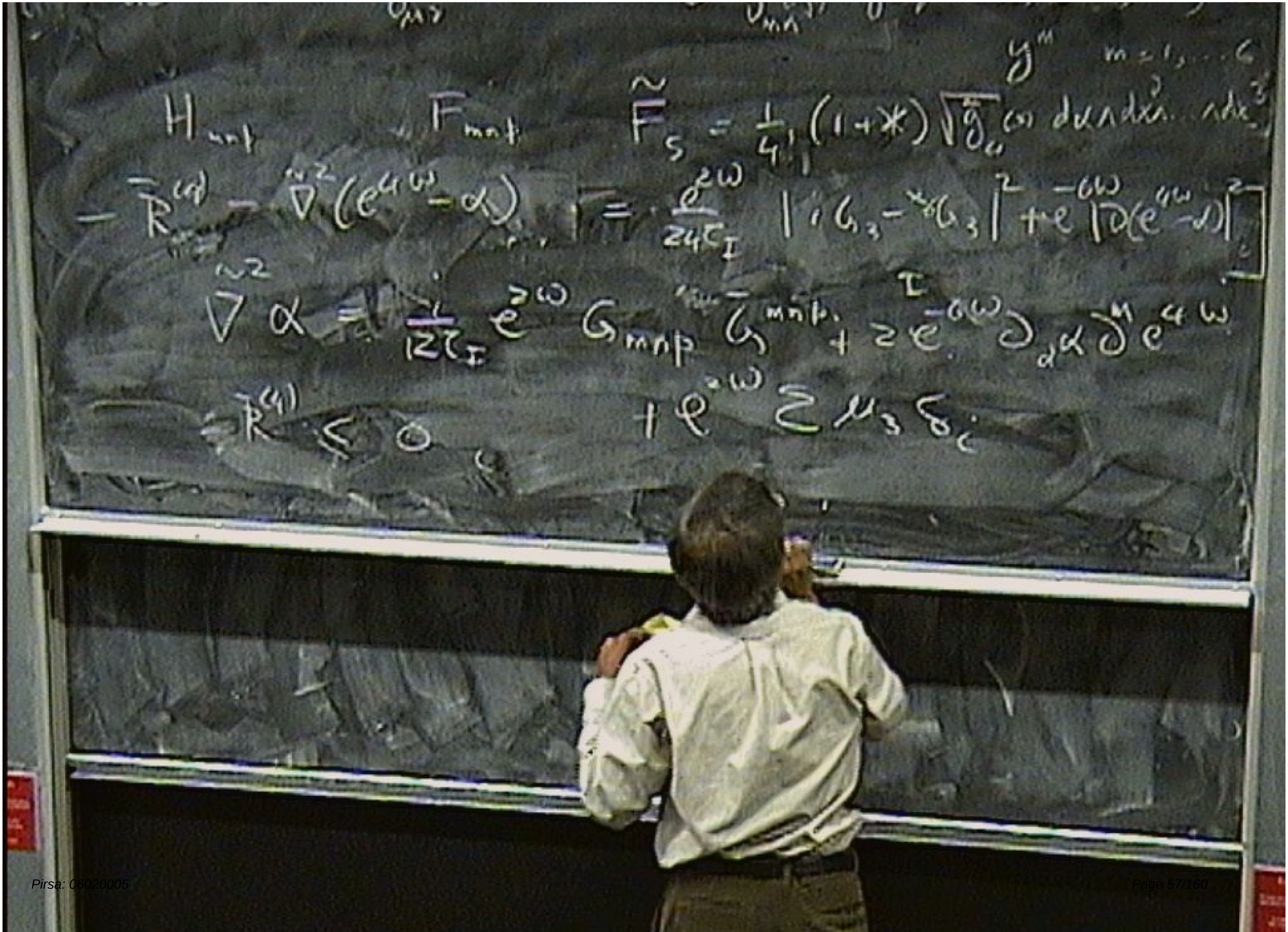
$$-\bar{R}^{(4)} - \tilde{\nabla}^2 (e^{4\omega} - \alpha) = \frac{e^{2\omega}}{24\kappa_I} \left| iG_3 - *G_3 \right|^2 + e^{-6\omega} \left| \partial (e^{4\omega} - \alpha) \right|^2$$

$$\tilde{\nabla}^2 \alpha = \frac{i}{12\kappa_I} e^{2\omega} G_{mnp} (*\bar{G})^{mnp} + 2 e^{-6\omega} \partial_m \alpha\, \partial^m e^{4\omega}$$

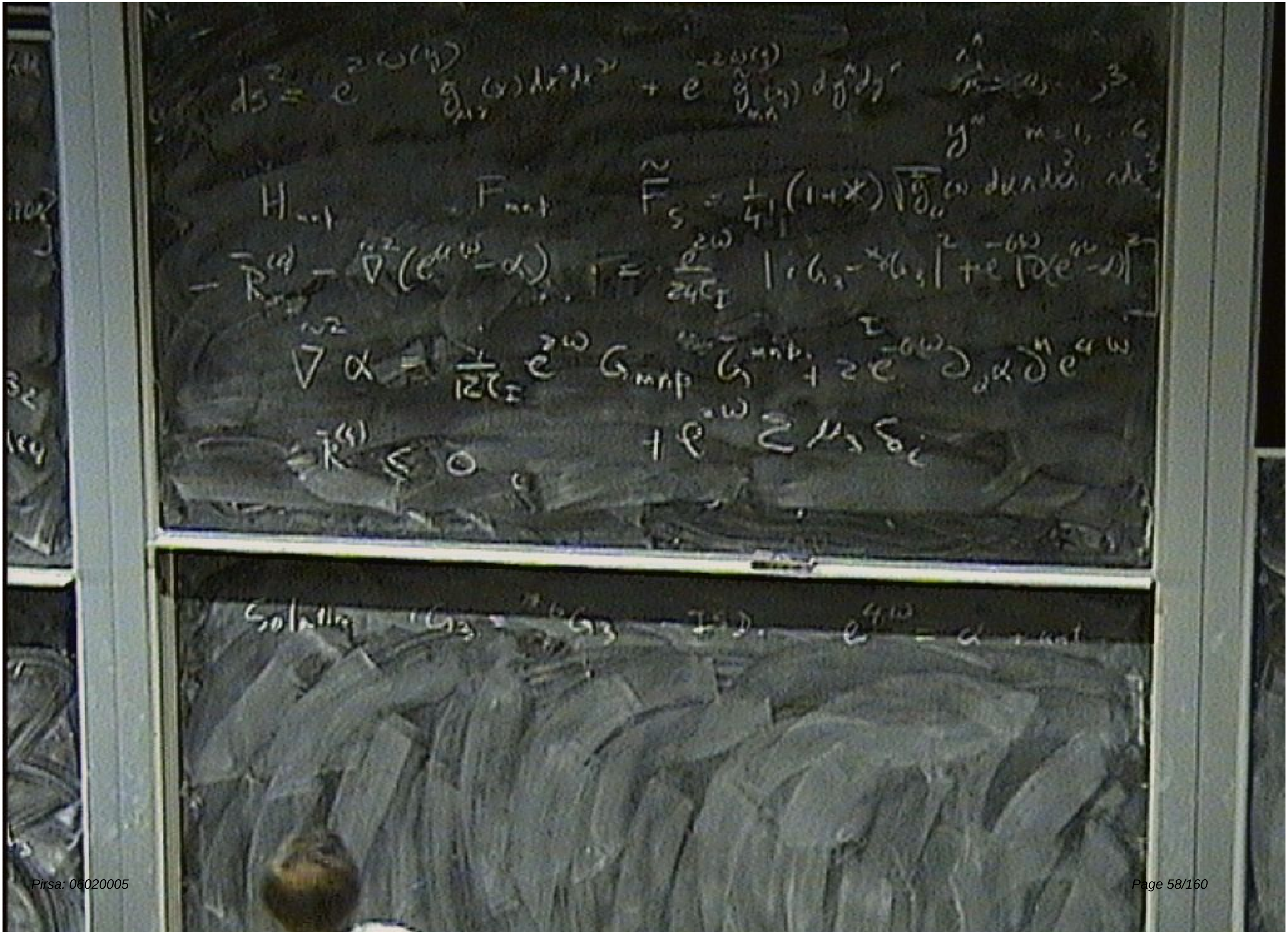
$\bar{R}^{(4)} < 0$ $\quad + e^{2\omega} \sum \mu_3 \delta_i$




Solution



$y^m \quad m=1,\dots,6$
$H_{mnp} \quad F_{mnp} \quad \tilde{F}_5 = \frac{1}{4!}(1+*)\sqrt{\tilde{g}_4}\,\alpha\, dx^0\wedge dx^1 \wedge dx^2 \wedge dx^3$
$-\tilde{R}^{(4)} - \tilde{\nabla}^2(e^{4\omega}-\alpha) = \frac{e^{2\omega}}{24\tau_I}\,|iG_3 - *_6G_3|^2 + e^{-6\omega}|\partial(e^{4\omega}-\alpha)|^2$
$\tilde{\nabla}^2\alpha = \frac{i}{12\tau_I}e^{2\omega}G_{mnp}\bar{G}^{mnp} + 2e^{-6\omega}\partial_m\alpha\,\partial^m e^{4\omega}$
$+\, e^{2\omega}\sum \mu_3\delta_i$
$\tilde{R}^{(4)} \le 0$



$ds^2 = e^{2\omega(y)} g_{\mu\nu}(x) dx^\mu dx^\nu + e^{-2\omega(y)} \tilde g_{mn}(y) dy^m dy^n$
$y^m \quad m=1,\dots,6$
$H_{mnp} \quad F_{mnp} \quad \tilde F_5 = \frac{1}{4!}(1+*)\sqrt{g_4}\, d\alpha\, dx^0 \dots dx^3$
$-\tilde R^{(4)}_{mn} - \tilde\nabla^2(e^{4\omega} - \alpha) = \frac{e^{2\omega}}{24\tau_I} |iG_3 - *_6 G_3|^2 + e^{-6\omega} |\partial(e^{4\omega} - \alpha)|^2$
$\tilde\nabla^2 \alpha = \frac{i}{12\tau_I} e^{2\omega} G_{mnp} *\bar G^{mnp} + 2 e^{-6\omega} \partial_m \alpha\, \partial^m e^{4\omega}$
$-\tilde R^{(4)} \leq 0 \quad + e^{2\omega} \sum \mu_3 \delta_i$
Solutions $*_6 G_3 = i G_3$ $e^{4\omega} = \alpha$

$$ds^2 = e^{2\omega(y)}\, \hat{g}_{\mu\nu}(x)\, dx^\mu dx^\nu + e^{-2\omega(y)}\, \tilde{g}_{mn}(y)\, dy^m dy^n \qquad x^\mu \;\; \mu = 0, \dots, 3$$

$$y^m \quad m = 1, \dots, 6$$

$$H_{mnl} \qquad F_{mnl} \qquad \tilde{F}_5 = \frac{1}{g_s}(1 + *)\sqrt{g_4}\,(\alpha)\, dx^0 \wedge dx^1 \wedge \dots \wedge dx^3$$

$$-\tilde{R}^{(4)} - \tilde{\nabla}^2 (e^{4\omega} - \alpha) = \Gamma = \frac{e^{2\omega}}{24 c_I} \left| i G_3 - *_6 G_3 \right|^2 + e^{-6\omega} \left| \partial (e^{4\omega} - \alpha) \right|^2$$

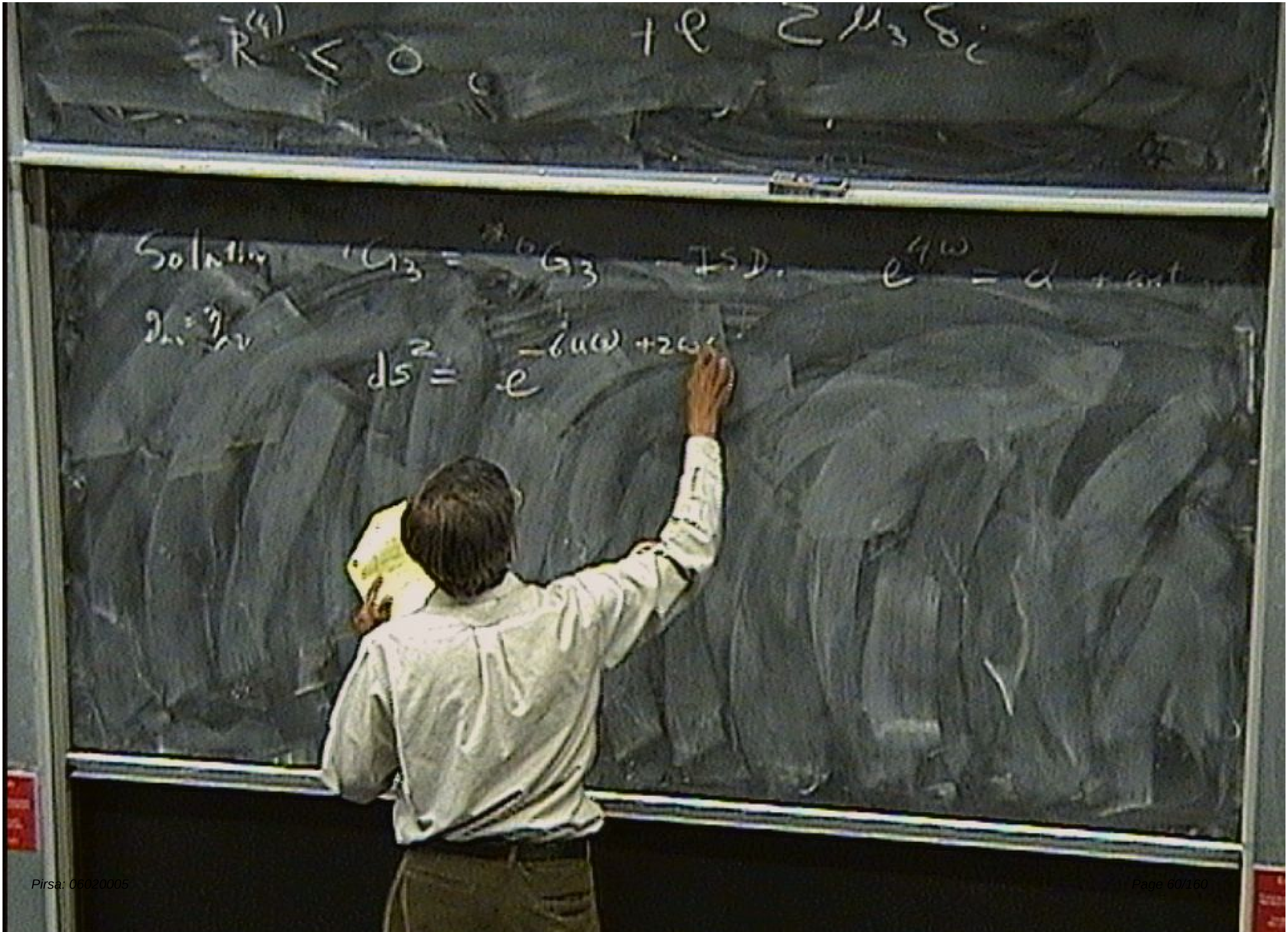
$$\tilde{\nabla}^2 \alpha = \frac{i}{12 c_I} e^{2\omega} G_{mnp} \, {*_6}\bar{G}^{mnp} + 2 e^{-6\omega} \partial_a \alpha \, \partial^a e^{4\omega}$$

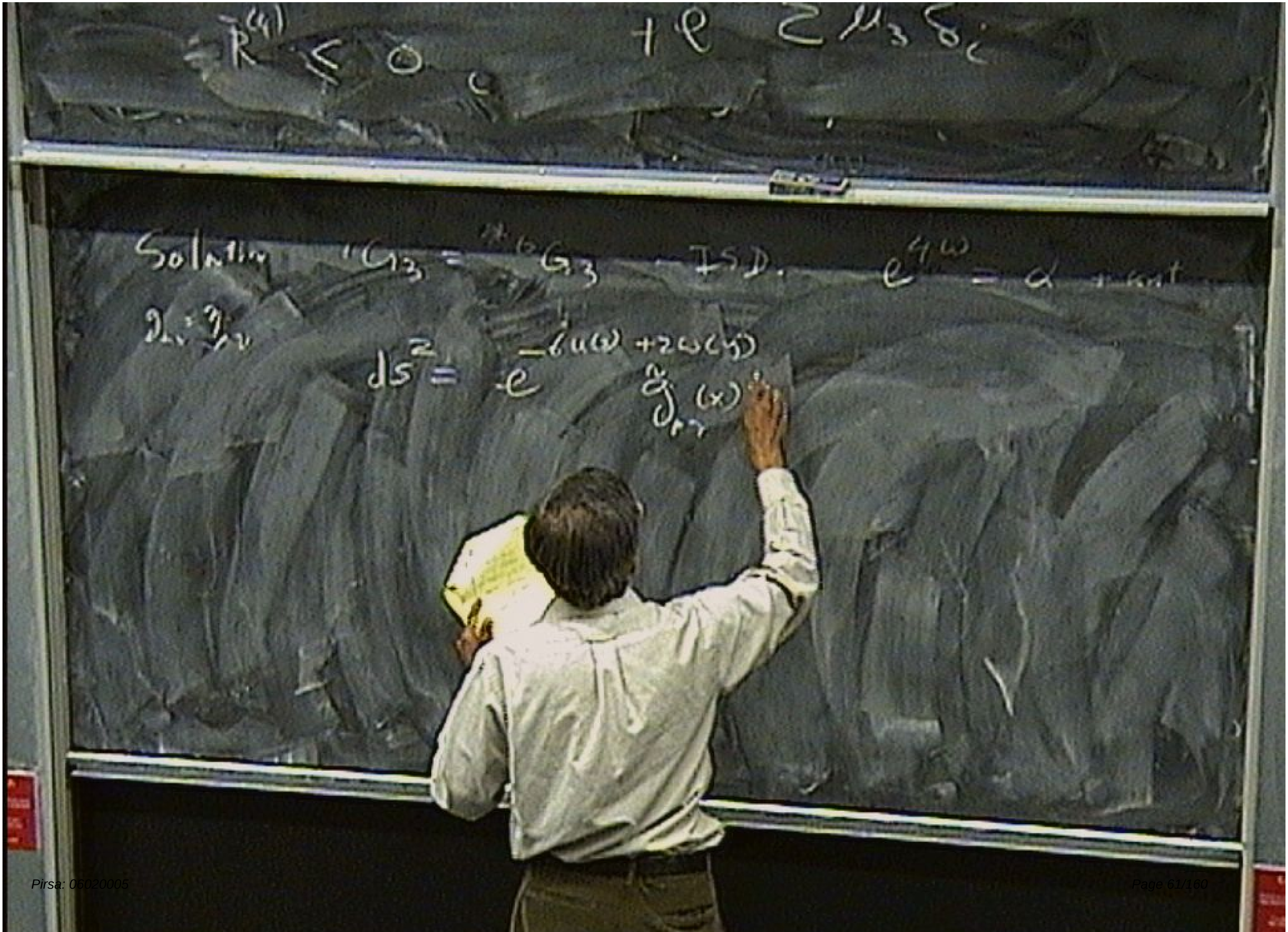
$$+ e^{2\omega} \sum \mu_3 \delta_i$$

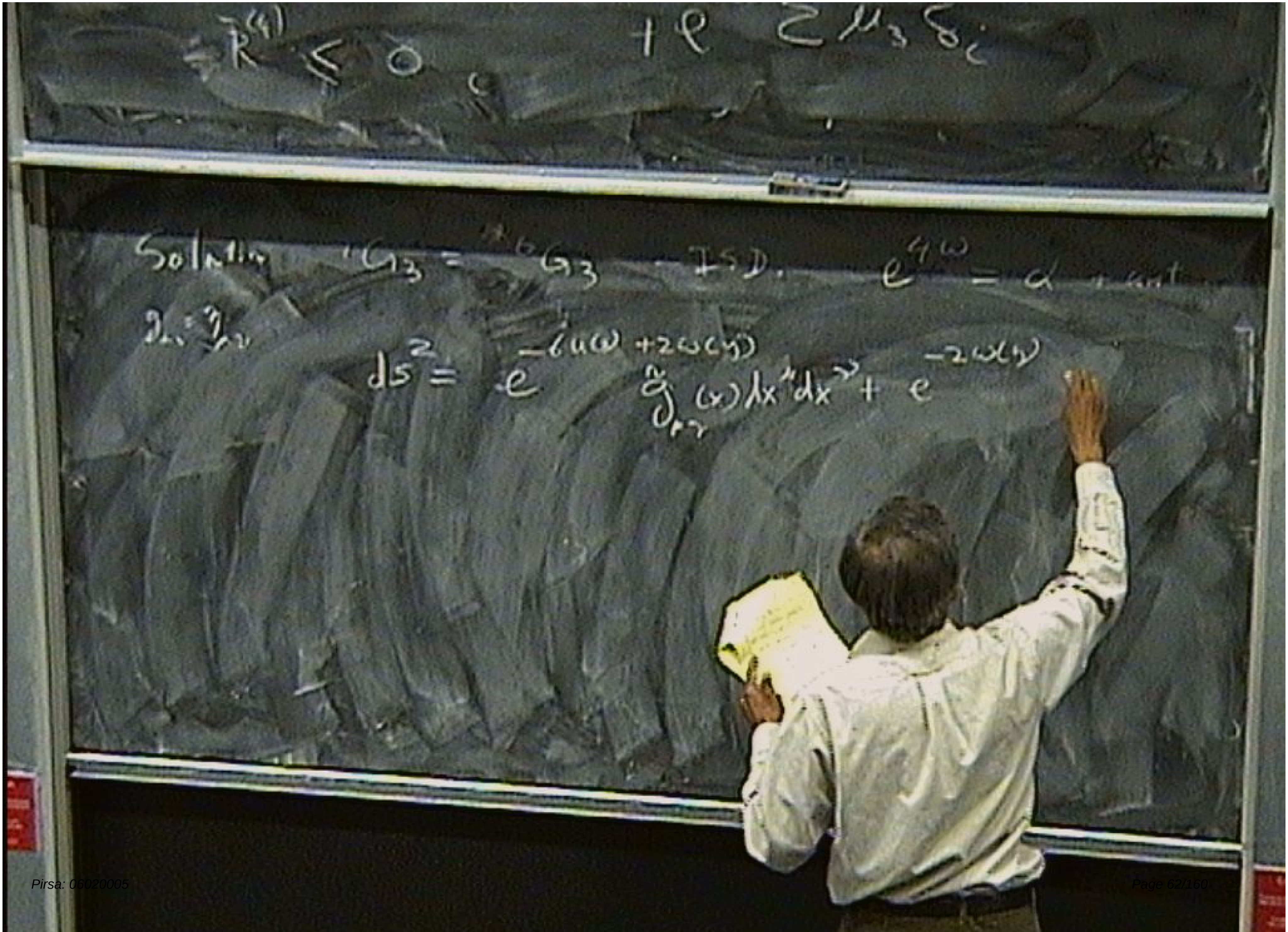
$$\tilde{R}^{(4)} \leq 0$$

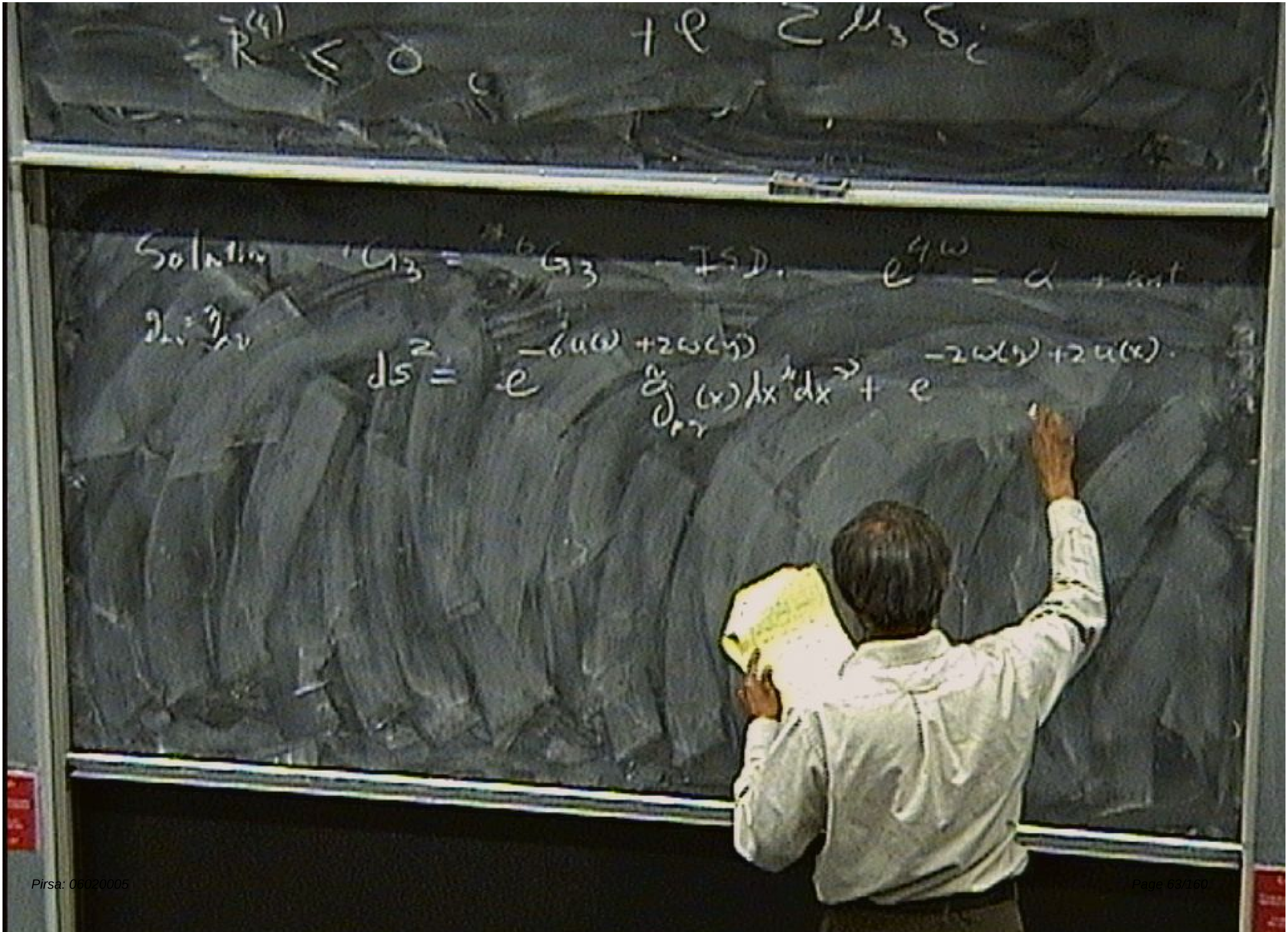
Solution $*_6 G_3 = i G_3$ ISD. $e^{4\omega} - \alpha = \text{const}$

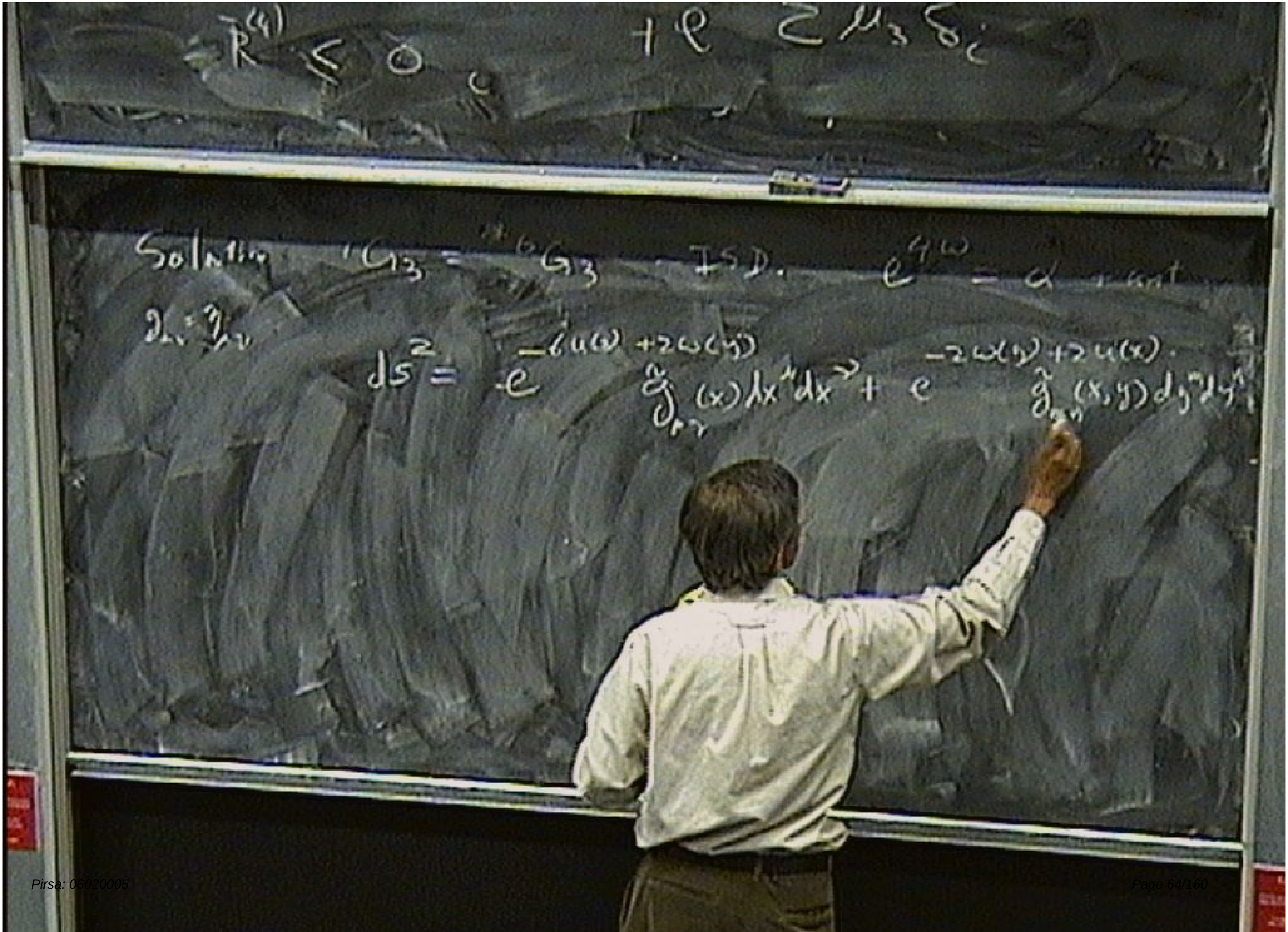
$\tilde{g}_{mn}$

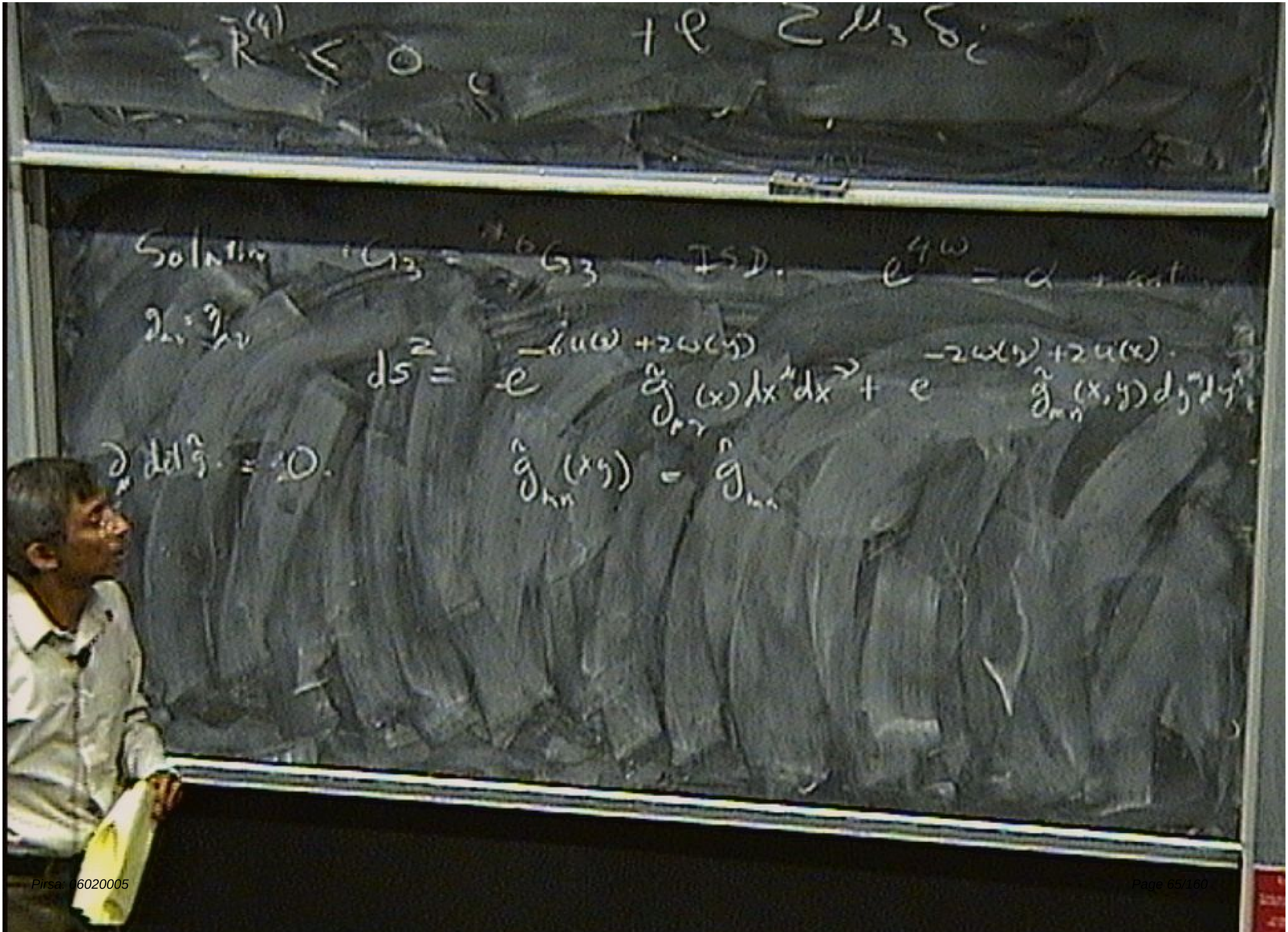

Solving

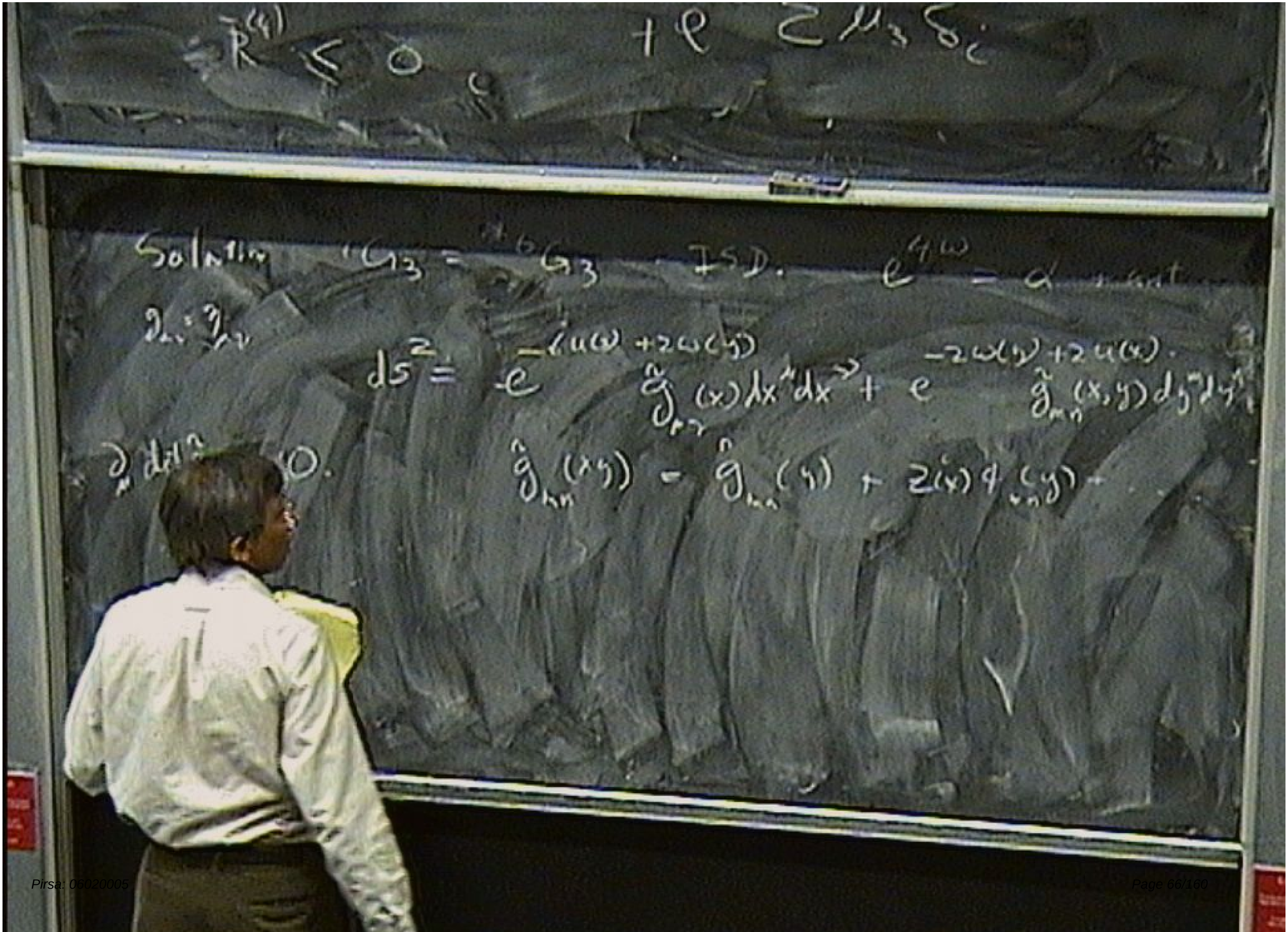

Solution
ISD.


Solution
ISD.




Solving
ISD.


Solution
ISD.
ds² =
ĝ_mn (x,y) = ĝ_mn


$\tilde{R}^{(4)} \leq 0$
Solution
$ds^2 = e^{-(u(x)+2\omega(y))} \hat{g}_{\mu\nu}(x) dx^\mu dx^\nu + e^{-2\omega(y)+2u(x)} \hat{g}_{mn}(x,y) dy^m dy^n$
$\hat{g}_{mn}(x,y) = \hat{g}_{mn}(y) + z(x) \phi_{mn}(y)$

$\bar{R}^{(4)} \leq 0$ $+ \varrho \sum \mu_s \delta_i$

Solution ${}^{i}G_3 = {}^{4,6}G_3$ ISD. $e^{4\omega} = \alpha$ + kat

$g_{\mu\nu} : \hat{g}_{\mu\nu}$

$$ds^2 = e^{-2u(x)+2\omega(y)} \hat{g}_{\mu\nu}(x) dx^\mu dx^\nu + e^{-2\omega(y)+2u(x)} \hat{g}_{mn}(x,y) dy^m dy^n$$

$\partial_\mu \det \hat{g} = 0.$

$$\hat{g}_{mn}(x,y) = \hat{g}_{mn}(y) + 2 \dot{u}(x)\, \dot{\phi}_{mn}(x,y) +$$

$\hat{R}^{(4)} \leq \tilde{O}$ $+ e \; \Sigma \mu_3 \delta_{0i}$

Solution $G_3 = {}^{*_6} G_3$ ISD. $e^{4\omega}$ α = const

$g_{\mu\nu} = \hat{g}_{\mu\nu}$

$$ds^2 = e^{-6u(x) + 2\omega(y)} \hat{g}_{\mu\nu}(x) dx^\mu dx^\nu + e^{-2\omega(y) + 2u(x)} \hat{g}_{mn}(x,y) dy^m dy^n$$

$\partial_\mu \det \hat{g} = 0.$ $\hat{g}_{mn}(x,y) = \hat{g}_{mn}(y) + z^i(x)\, \phi^i_{mn}(y) +$

$R_{cy} = \langle e^{u} \rangle$

$\tilde{R}^{(4)} \leq 0$ $\qquad + \rho \quad \sum \mu_3 \delta_i$

Solution $\quad G_3 = {}^{*}{}_6 G_3 \quad$ ISD. $\quad e^{4\omega} = \alpha$ const

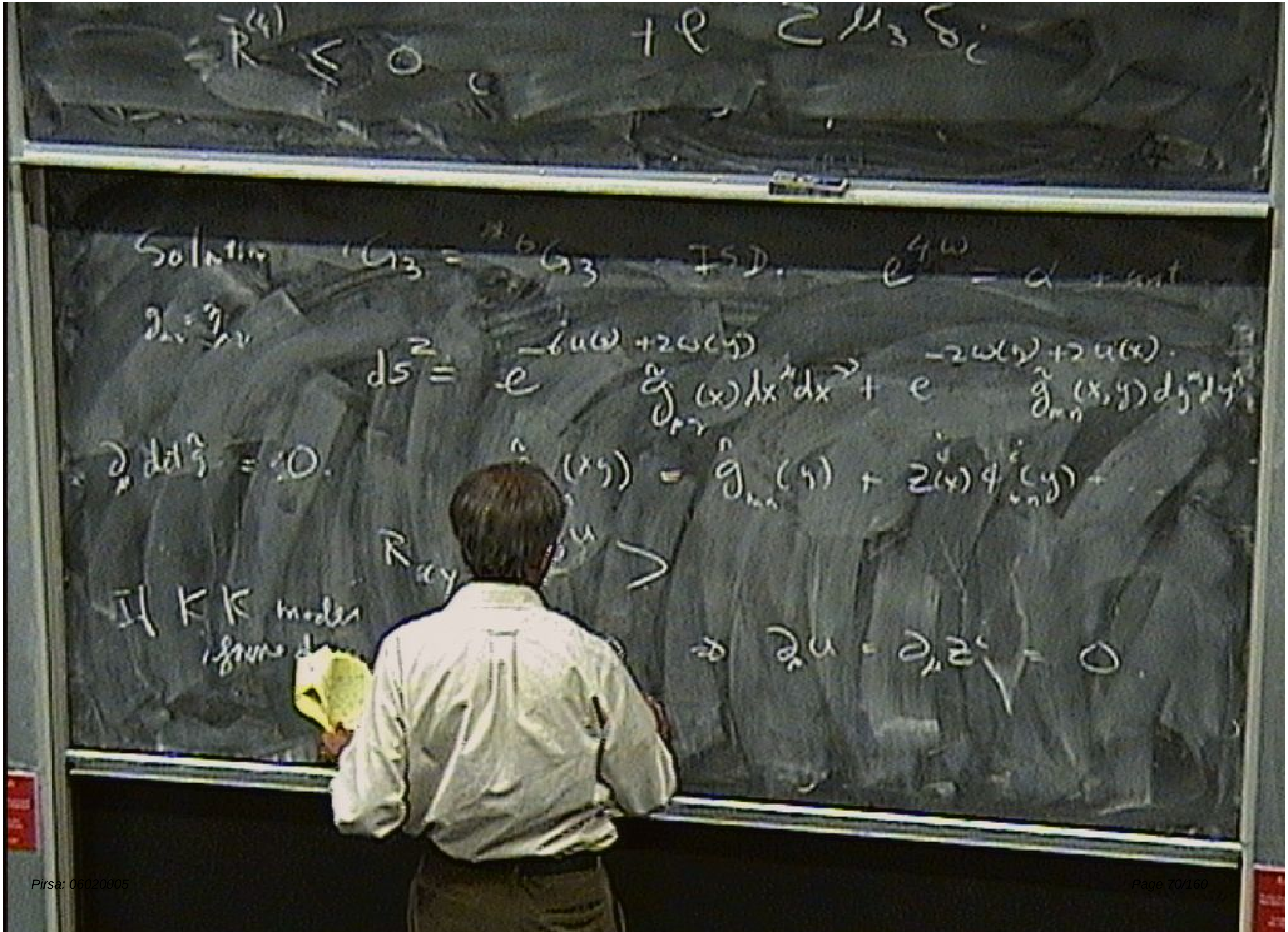
$g_{\mu\nu} = \hat{g}_{\mu\nu}$

$$ds^2 = e^{-2u(x)+2\omega(y)} \hat{g}_{\mu\nu}(x) dx^\mu dx^\nu + e^{-2\omega(y)+2u(x)} \hat{g}_{mn}(x,y) dy^m dy^n$$

$\partial_\mu \det \hat{g} = 0.$ $\qquad \hat{g}_{mn}(x,y) = \hat{g}_{mn}(y) + z^i(x)\, \phi^i_{mn}(y)$

$R_{(4)} \sim \langle e^{4u} \rangle$

If KK modes ignored $\qquad \partial_\mu \omega \neq 0 \Rightarrow \partial_\mu u = \partial_\mu z^i \neq 0$


Solution
ISD.
If KK modes
ignored
ds² =
∂_μ det g̃ = 0.

$\tilde{R}^{(4)} \lesssim 0 \qquad + \ell \ \sum \mu_3 \delta_i$

Solution $G_3 = {}^{*}_{6}G_3$ ISD. $e^{4\omega} = \alpha$ const.

$g_{\mu\nu} = \tilde{g}_{\mu\nu}$

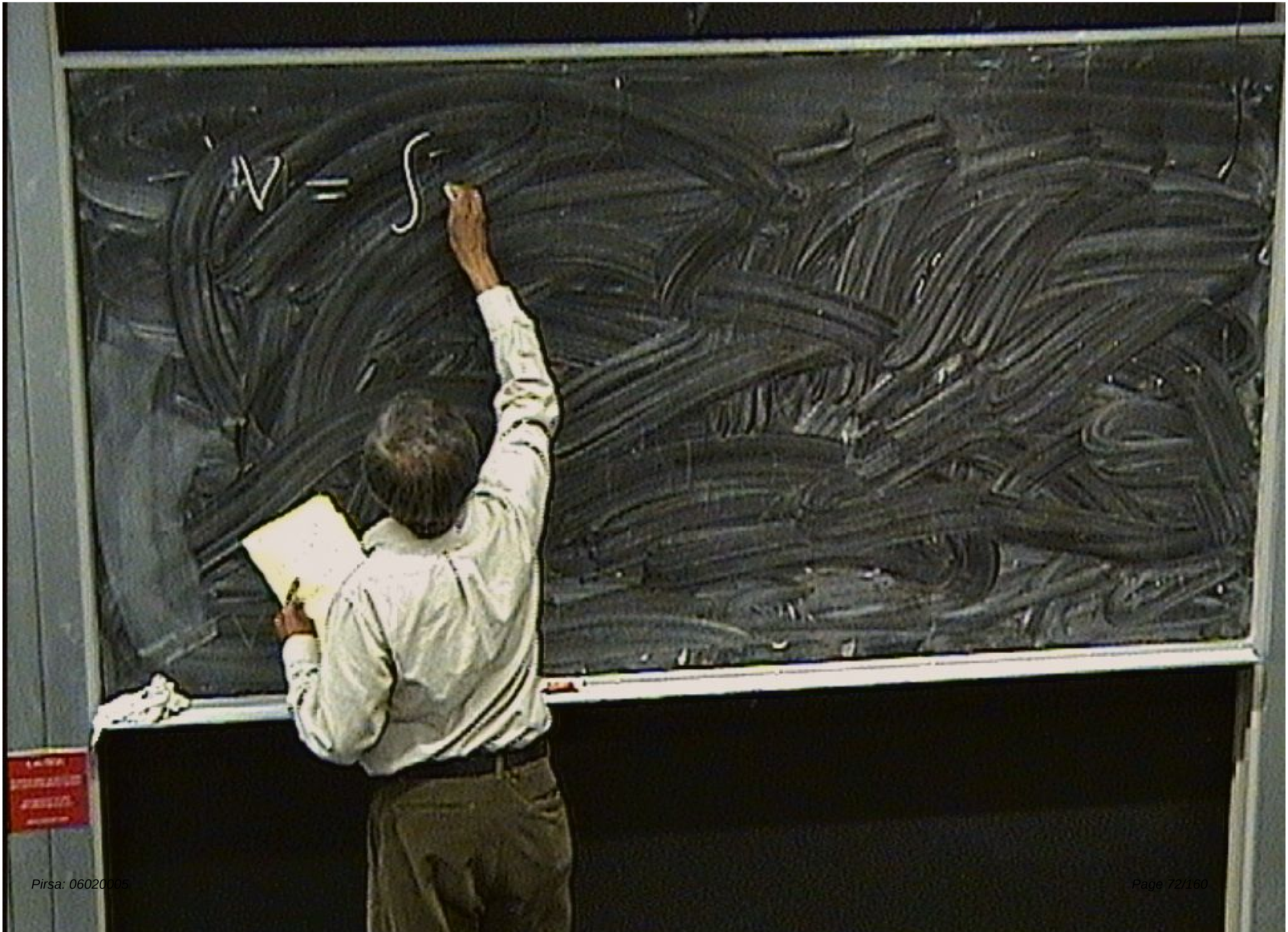
$$ds^2 = e^{-6u(x)+2\omega(y)} \tilde{g}_{\mu\nu}(x)\,dx^\mu dx^\nu + e^{-2\omega(y)+2u(x)}\, \tilde{g}_{mn}(x,y)\,dy^m dy^n$$

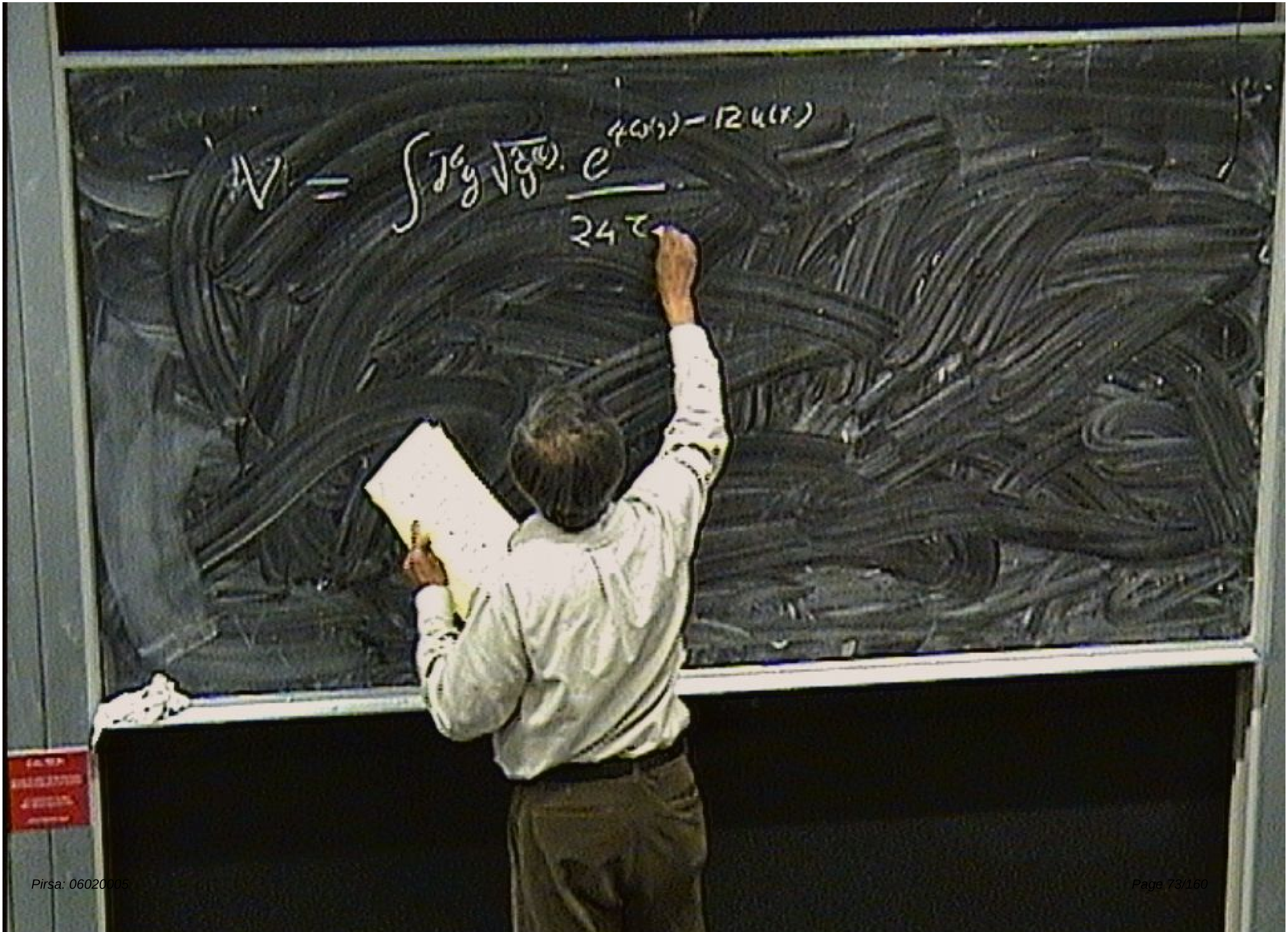
$\partial_\mu \det \tilde{g} = 0.$ $\quad \tilde{g}_{mn}(x,y) = \hat{g}_{mn}(y) + z^i(x)\,\phi^i_{mn}(y) + \ldots$

$R_{cy} = \langle e^u \rangle$

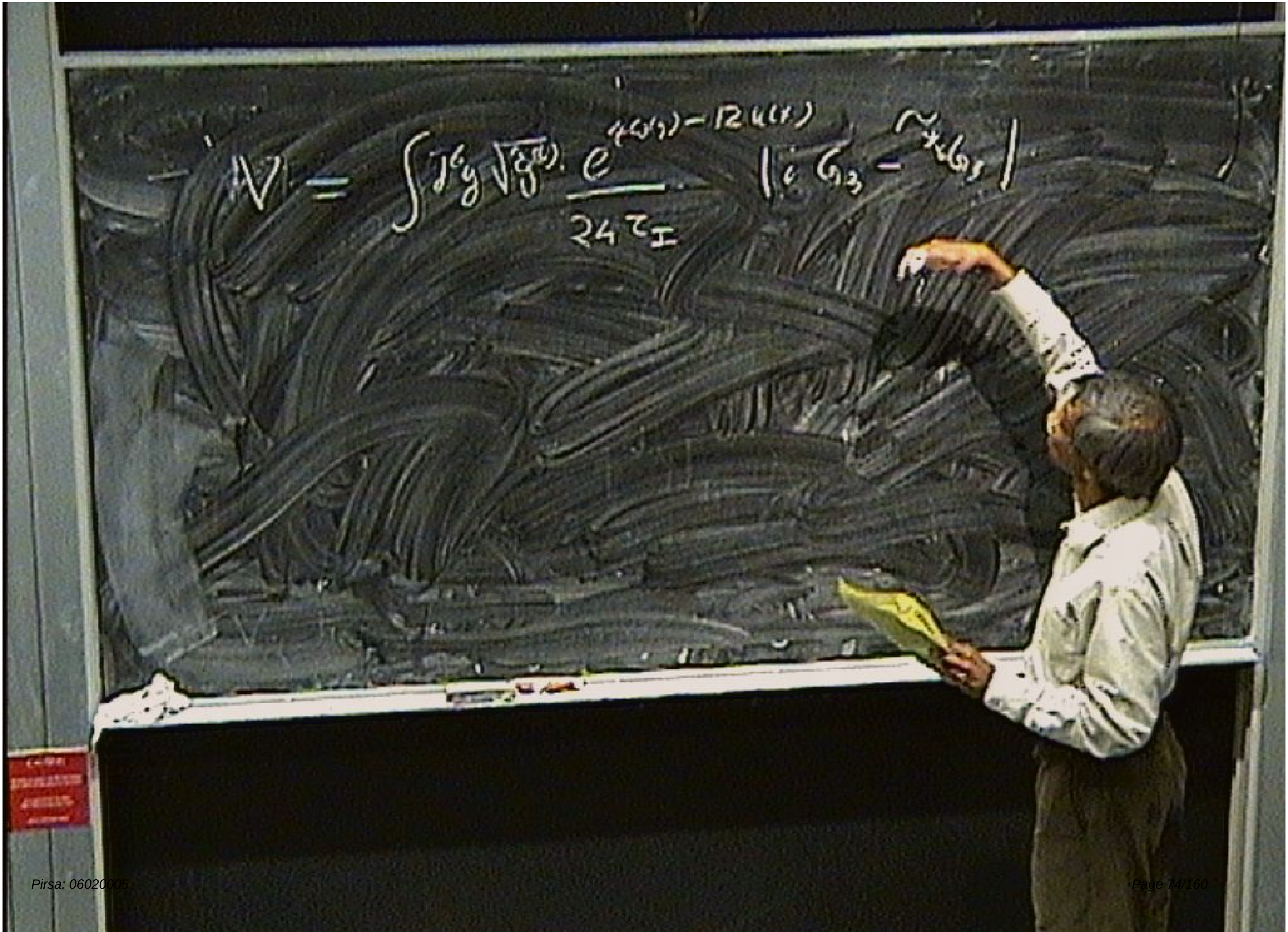
If KK modes ignored $\quad \partial_\mu \omega \neq 0 \Rightarrow \partial_\mu u = \partial_\mu z^i = 0$

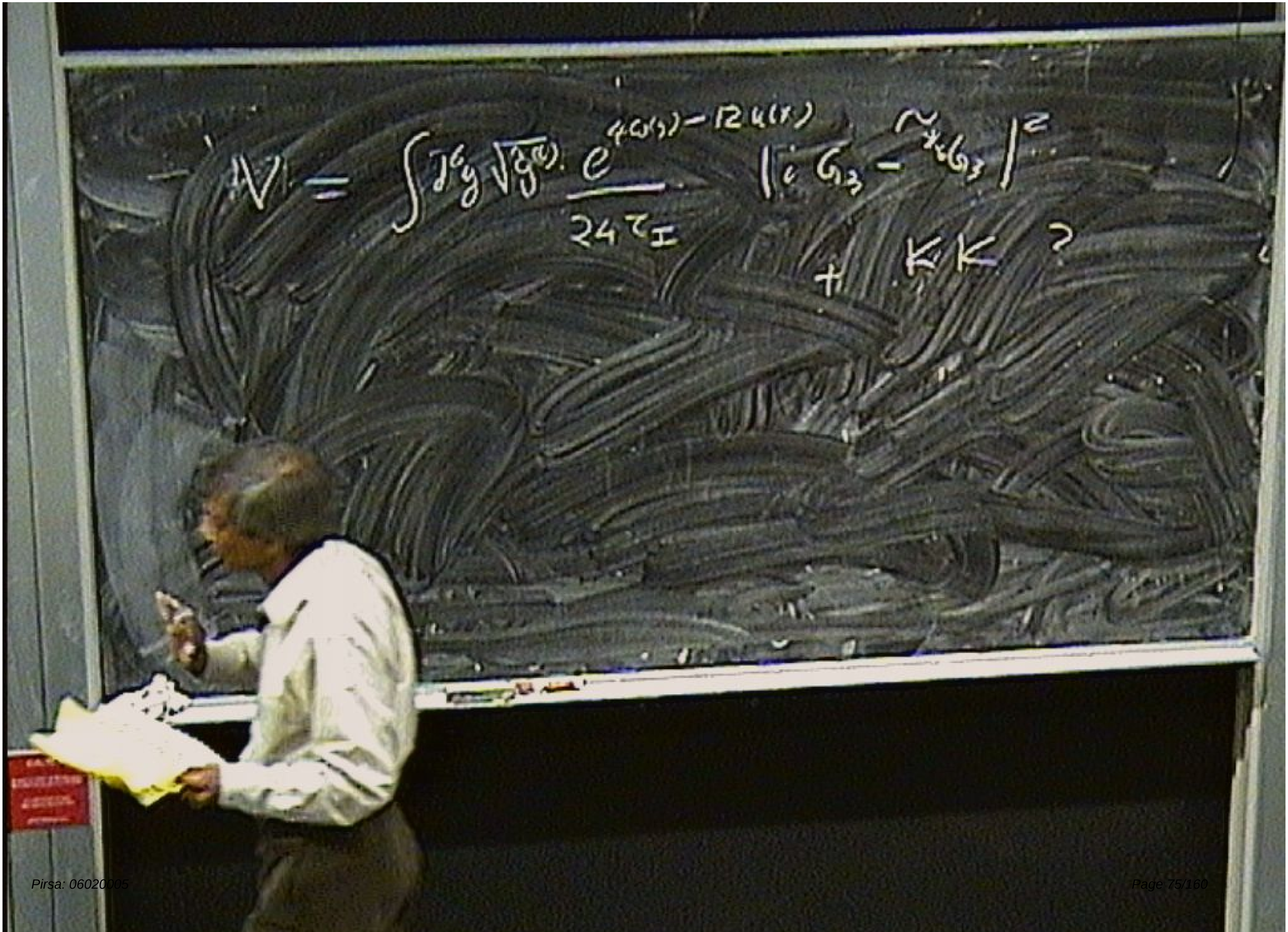
All KK mode

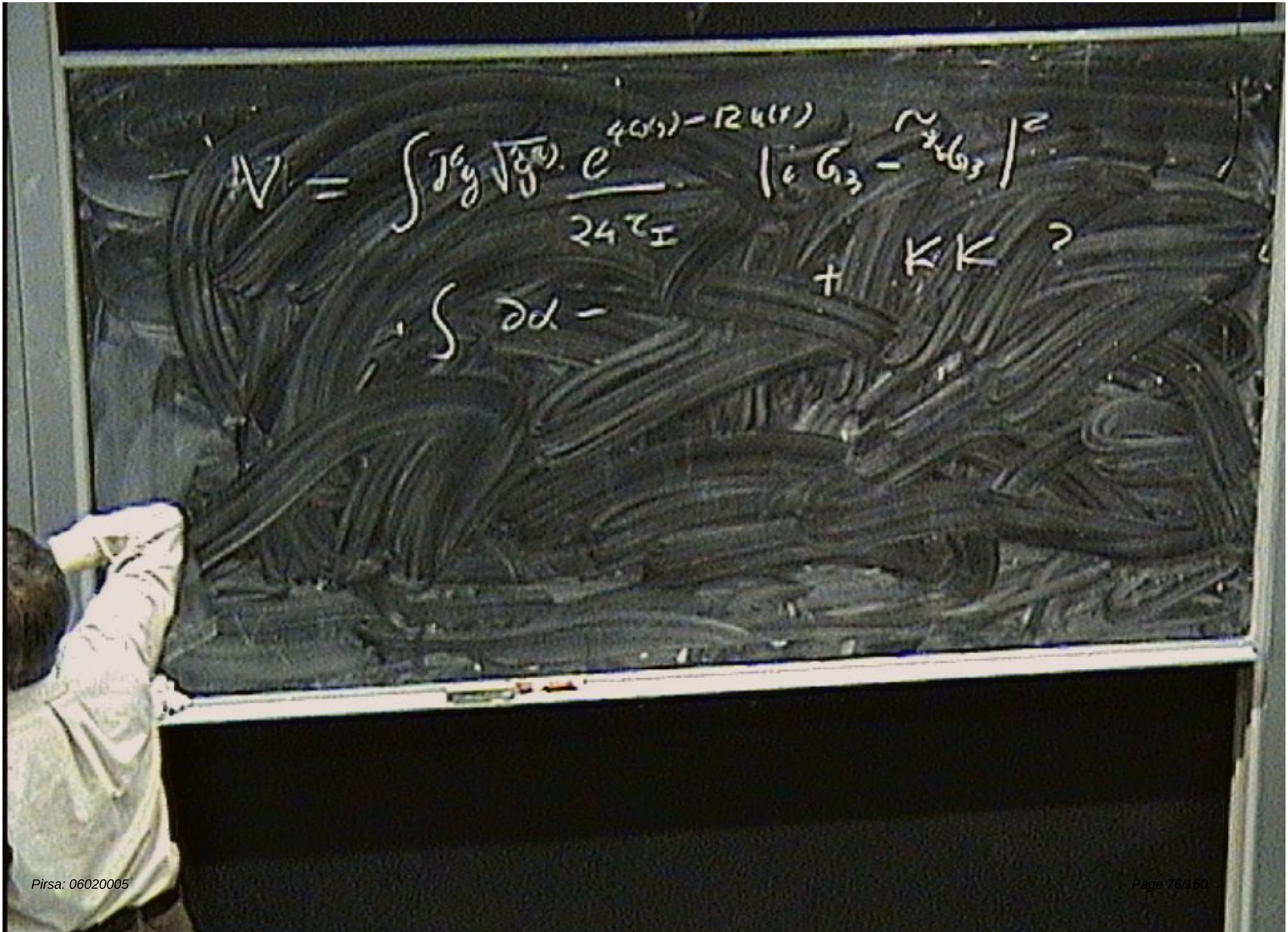


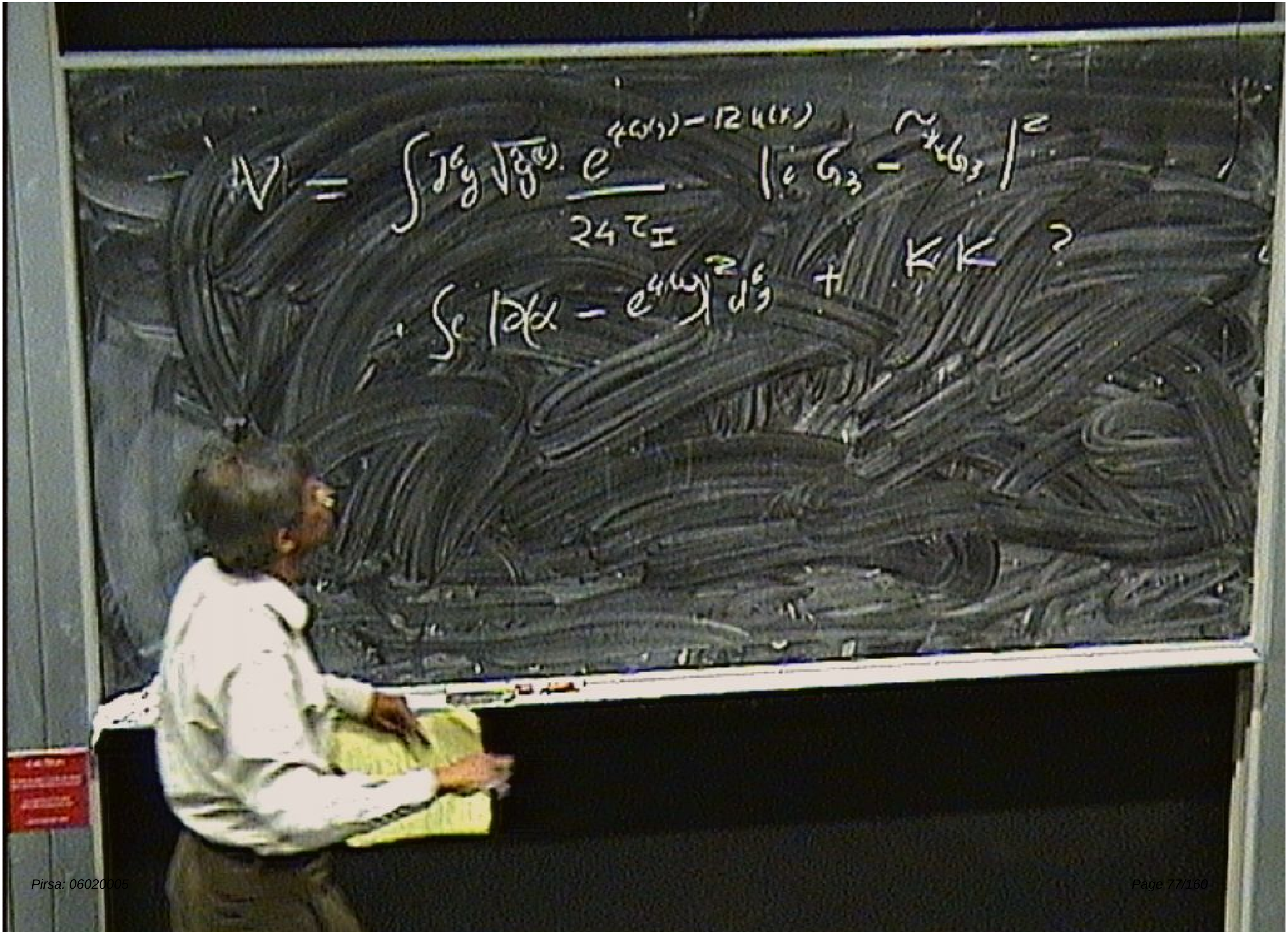


$V = \int d^6y \sqrt{g(y)}\, \frac{e^{\varphi(y) - 12u(x)}}{24\tau}$

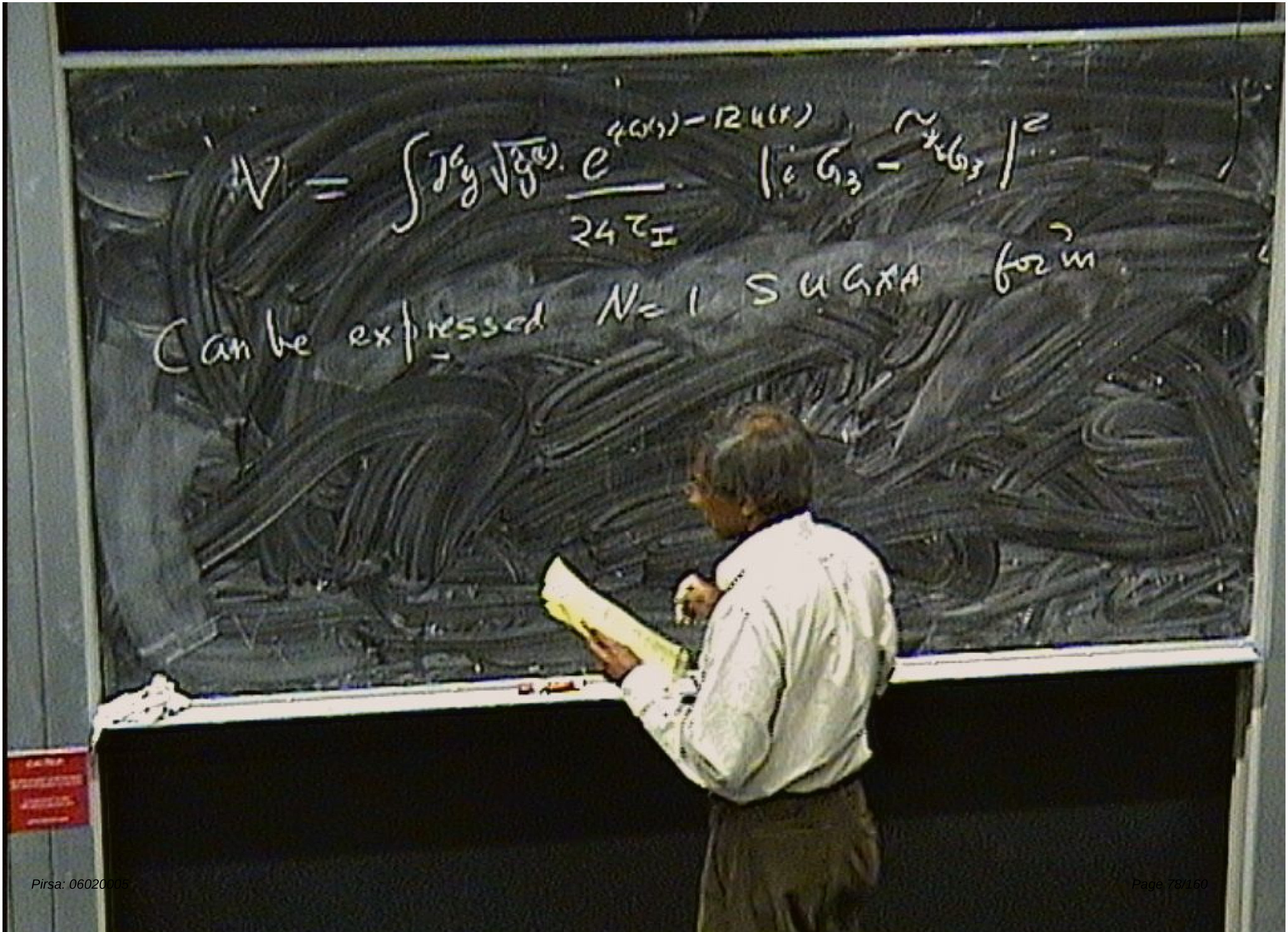

$V = \int d^6y \sqrt{g(y)}\, \frac{e^{4A(y) - 12u(x)}}{24\tau_I} \left| iG_3 - *_6 G_3 \right|$

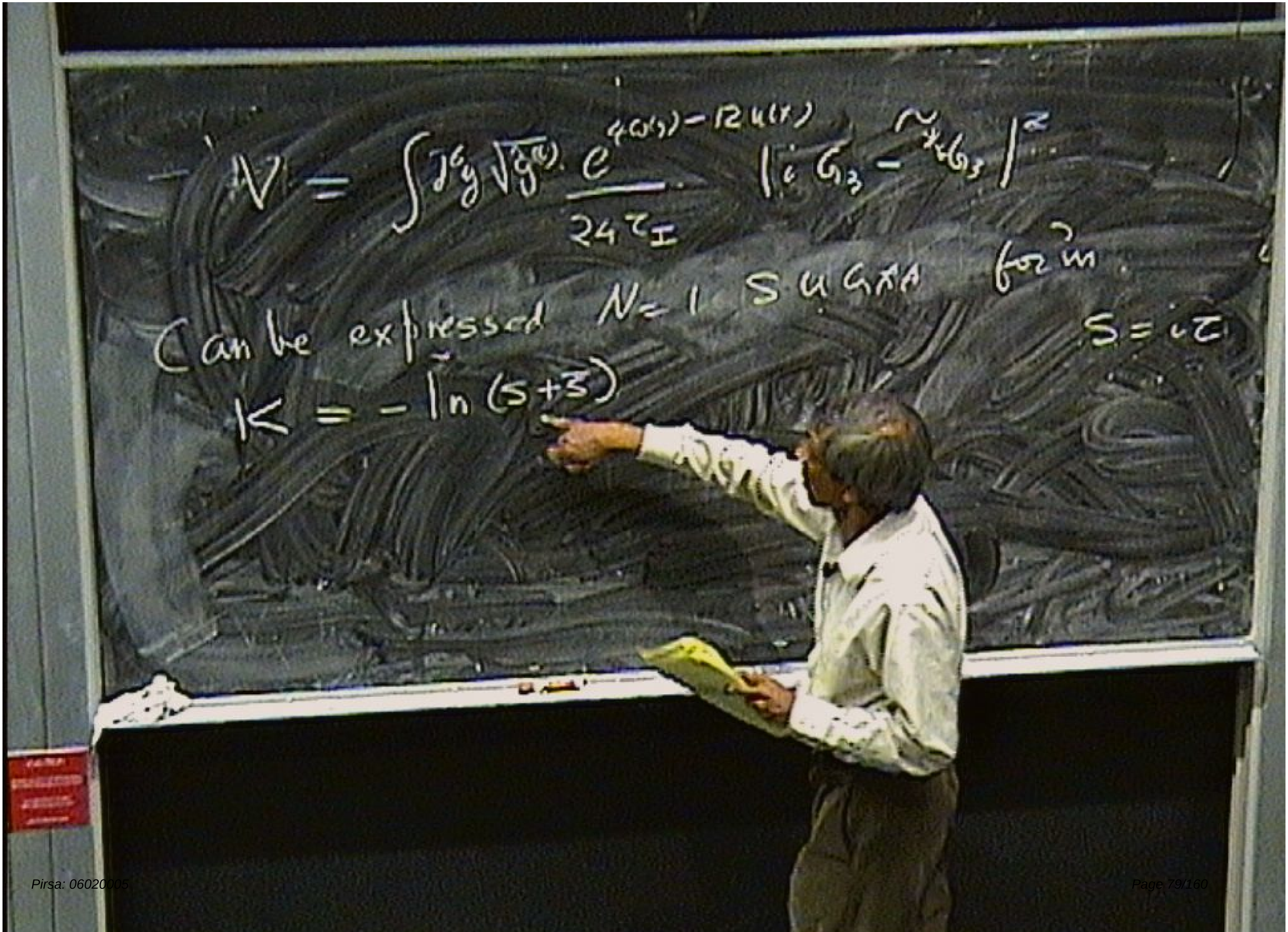

V = ∫ d⁶y √g(6) e^{4ω(y) − 12u(x)} / 24τ_I |i G₃ − *₆G₃|²
+ KK ?


$V = \int d^6y \sqrt{g^{(6)}} \frac{e^{4\omega(y) - 12u(x)}}{24\tau_I} \left| i G_3 - *_6 G_3 \right|^2$
$+ KK$?
$\int \partial\alpha -$



KK ?


Can be expressed N=1 SUGRA form


Can be expressed N=1 SUGRA form
S = iτ
K = − ln (S+S̄)

$$V = \int d^6y \sqrt{g^{(6)}}\, \frac{e^{4A(y) - 12u(x)}}{24\tau_I} \left| i G_3 - \tilde{*} G_3 \right|^2$$

Can be expressed $N=1$ SUGRA form

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T})$$

$S = i\tau$

$\mathrm{Re}\, T = e^{4u}$

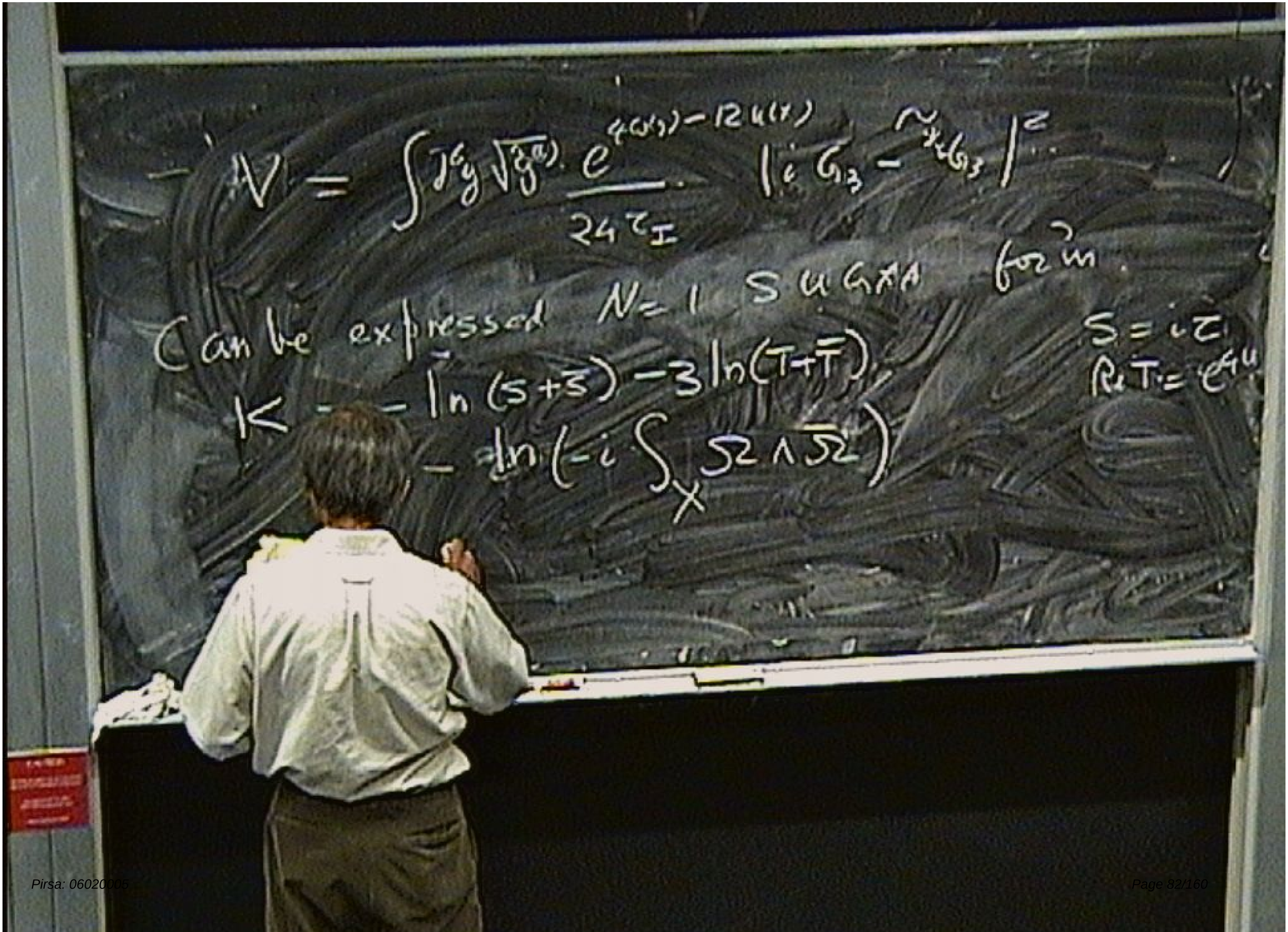
$$V = \int d^6y \sqrt{g^{(6)}}\, \frac{e^{4A(y) - 12u(x)}}{24\,\tau_I} \left| i\, G_3 - *_6 G_3 \right|^2$$

Can be expressed $N=1$ SUGRA form

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T}) - \ln\left(-i \int_X \Omega \wedge \bar{\Omega}\right)$$

$S = i\tau$

$\mathrm{Re}\, T = e^{4u}$



$V = \int d^6y \sqrt{g^{(6)}} \frac{e^{4\omega(y) - 12u(x)}}{24\tau_I} |i G_3 - *_6 G_3|^2$
Can be expressed N=1 SUGRA form
$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T})$
$- \ln(-i \int_X \Omega \wedge \bar{\Omega})$
$S = i\tau$
$\mathrm{Re}\, T = e^{4u}$

$$V = \int d^6y \sqrt{g(y)} \, \frac{e^{4\omega(y) - 12u(x)}}{24 \tau_I} \left| i G_3 - *_6 G_3 \right|^2$$

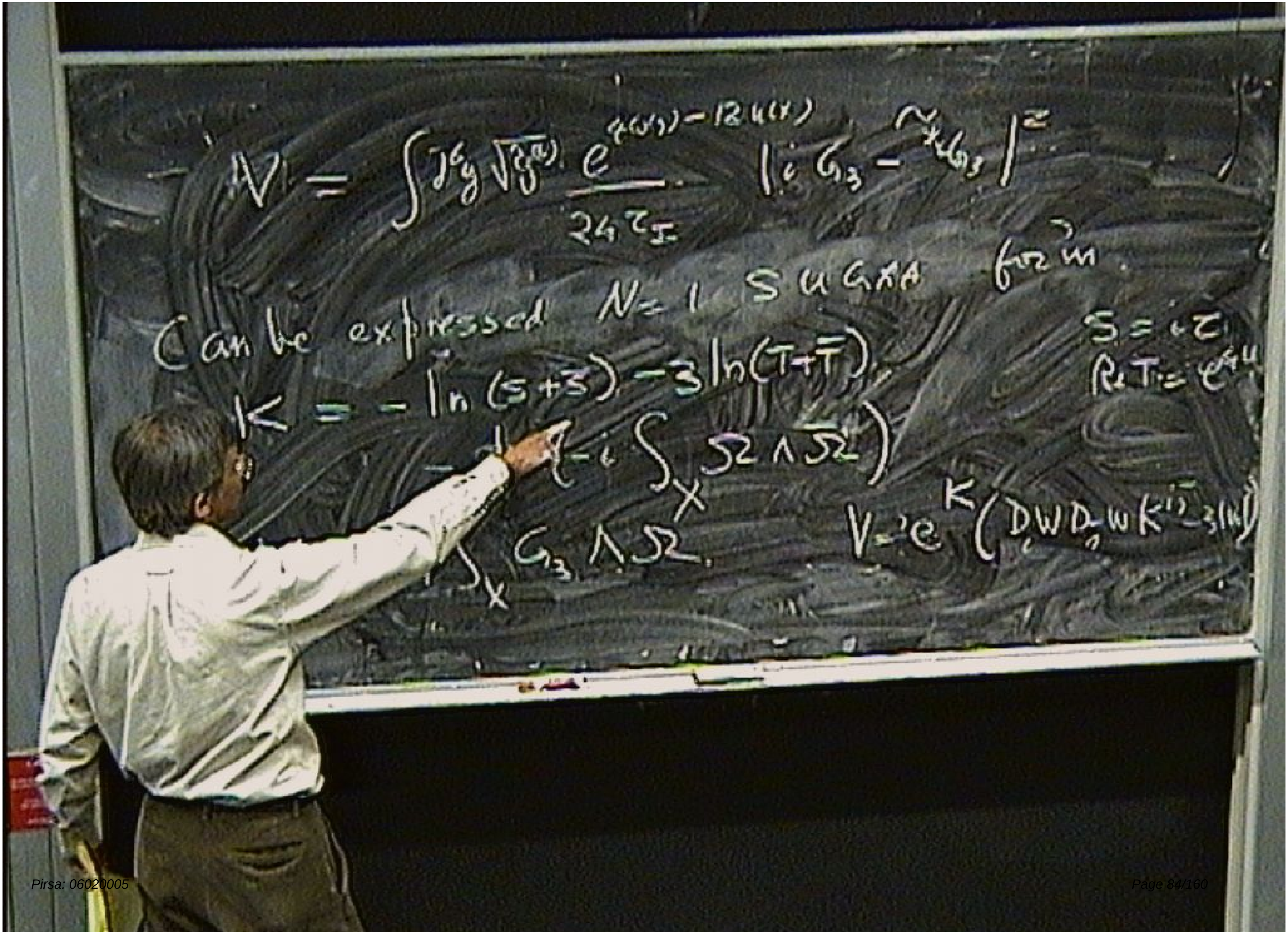
Can be expressed $N=1$ SUGRA form

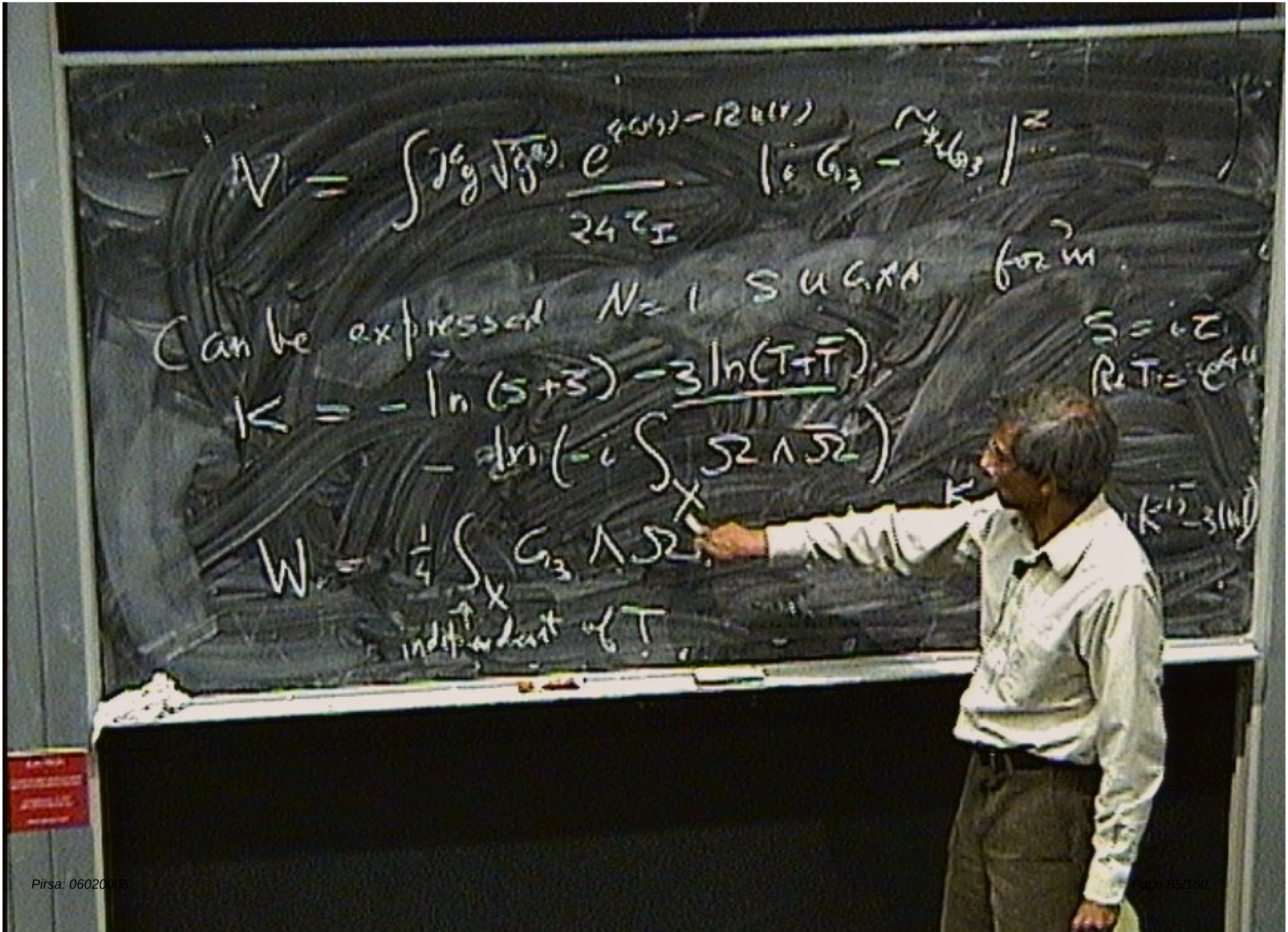
$S = i\tau$

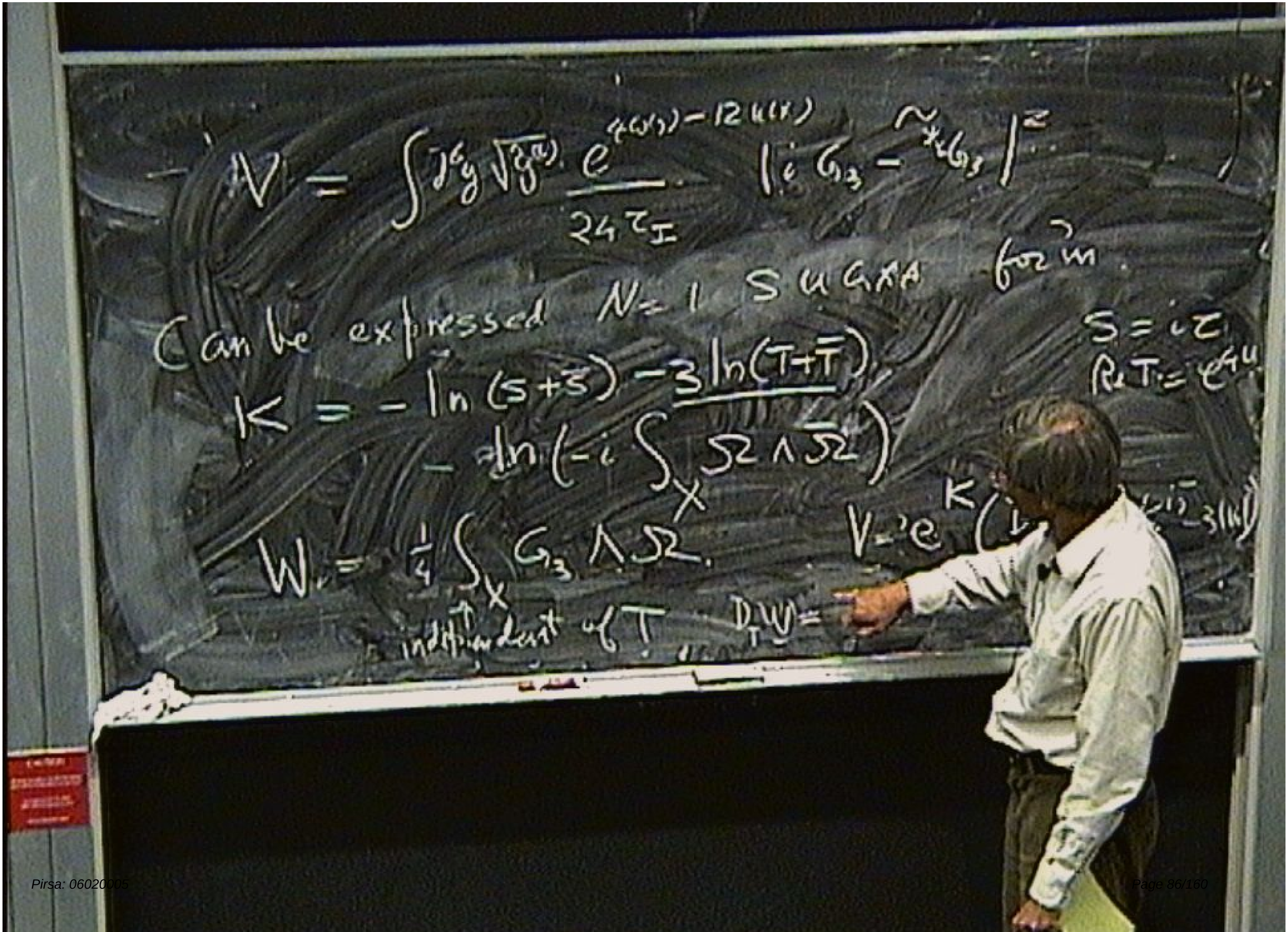
$\mathrm{Re}\, T = e^{4u}$

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T}) - \ln\left(-i \int_X \Omega \wedge \bar{\Omega}\right)$$

$$W = \frac{1}{4} \int_X G_3 \wedge \Omega$$


$V = \int d^6y \sqrt{g^{(0)}} \frac{e^{4A(y)-12u(x)}}{24\tau_I} |iG_3 - *_6 G_3|^2$
Can be expressed $N=1$ SUGRA form.
$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T})$
$- \ln\left(-i\int_X \Omega \wedge \bar{\Omega}\right)$
$W = \int_X G_3 \wedge \Omega$
$V = e^K(D_i W D_{\bar{j}} \bar{W} K^{i\bar{j}} - 3|W|^2)$
$S = i\tau$
$\mathrm{Re}\, T = e^{4u}$


V = ∫ d^6y √g^(6) e^(…) / 24 τ_I |i G_3 − …|^2
for m
Can be expressed N=1 SUGRA
S = iτ
K = − ln(S+S̄) − 3 ln(T+T̄)
− ln(−i ∫_X Ω ∧ Ω̄)
W = 1/4 ∫_X G_3 ∧ Ω
independent of T


V = ∫ d⁶y √g(y) e^{4ω(y) − 12u(x)} / 24τ_I |i G₃ − *₆G₃|²
Can be expressed N=1 SUGRA form
S = iτ
Re T = e^{4u}
K = − ln(S+S̄) − 3 ln(T+T̄) − ln(−i ∫_X Ω∧Ω̄)
W = 1/4 ∫_X G₃∧Ω
V = e^K
independent of T
D_T W =

$$V = \int d^6y \sqrt{g^{(0)}}\, \frac{e^{4A(y) - 12u(x)}}{24\,\tau_I} \left| i G_3 - *_6 G_3 \right|^2$$

Can be expressed $N=1$ SUGRA form

$S = i\tau$

$\mathrm{Re}\, T = e^{4u}$

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T}) - \ln\left(-i\int_X \Omega \wedge \bar{\Omega}\right)$$

$$V = e^K \left(D_i W D_{\bar{j}} \bar{W} K^{i\bar{j}} - 3|W|^2\right)$$

$$W = \frac{1}{4}\int_X G_3 \wedge \Omega$$

independent of T, $D_T W = -\frac{3}{(T+\bar{T})} W$

$$V = \int d^6y \sqrt{g^{(6)}} \frac{e^{4\omega(y) - 12u(x)}}{24\tau_I} \left| i G_3 - *_6 G_3 \right|^2$$

Can be expressed $N=1$ SUGRA form

$S = i\tau$

$\mathrm{Re}\, T = e^{4u}$

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T}) - \ln\left(-i\int_X \Omega \wedge \bar{\Omega}\right)$$

$$V = e^K \left(D_i W D_{\bar{j}} \bar{W} K^{i\bar{j}} - 3|W|^2 \right)$$

$$W = \frac{1}{4}\int_X G_3 \wedge \Omega$$

independent of T $\quad D_T W = -\frac{3}{(T+\bar{T})} W$ $\quad = e^K \left[|D_i W|^2 + |D_S W|^2 \right]$

independent of T, $D_T W = \frac{3}{(T+\bar{T})} W$

$S =$

$$\tilde{G}_3 = F_3 - \tau H_3 \qquad F_3 = dC_2\,, \quad H_3 = dB_2$$

$$\tilde{F}_5 = F_5 - \tfrac{1}{2} C_2 \wedge H_3 + \tfrac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$$

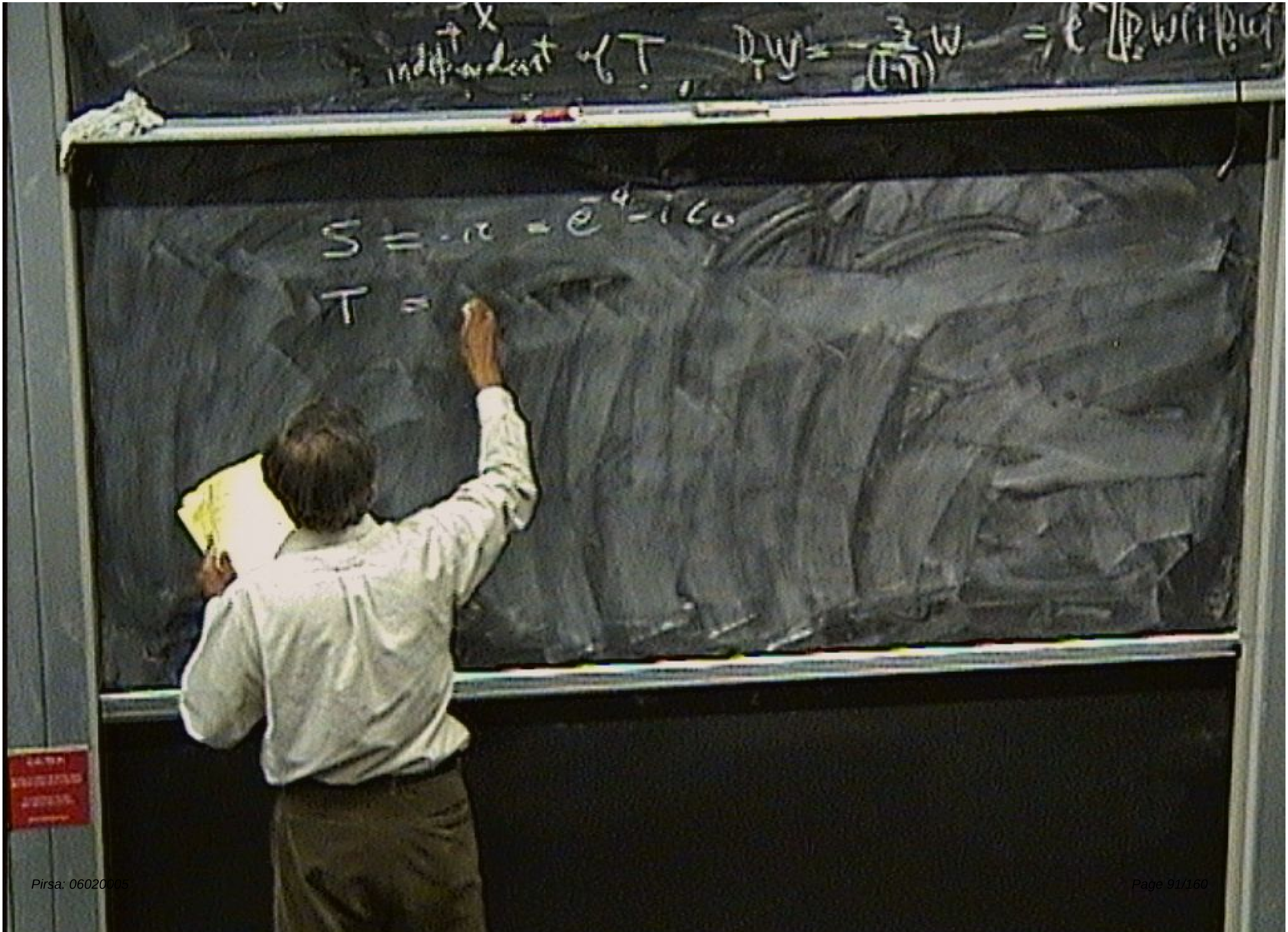
$2\ell_s^2 = 1$

D_3 brane $\quad S_{loc} = \sum_i \left(-T_3 \int d^4x \sqrt{-g} \pm \mu_3 \int C_4 \right)$

$$R_{MN} - \tfrac{1}{2} g_{MN} R = \tfrac{1}{2} T_{MN}$$

$$d\tilde{F}_5 = H_3 \wedge F_3 - \sum_i \mu_3^i \delta_i$$

$$\tilde{F}_5 = * \tilde{F}_5 \qquad dG_3 = -d\tau \wedge H_3$$

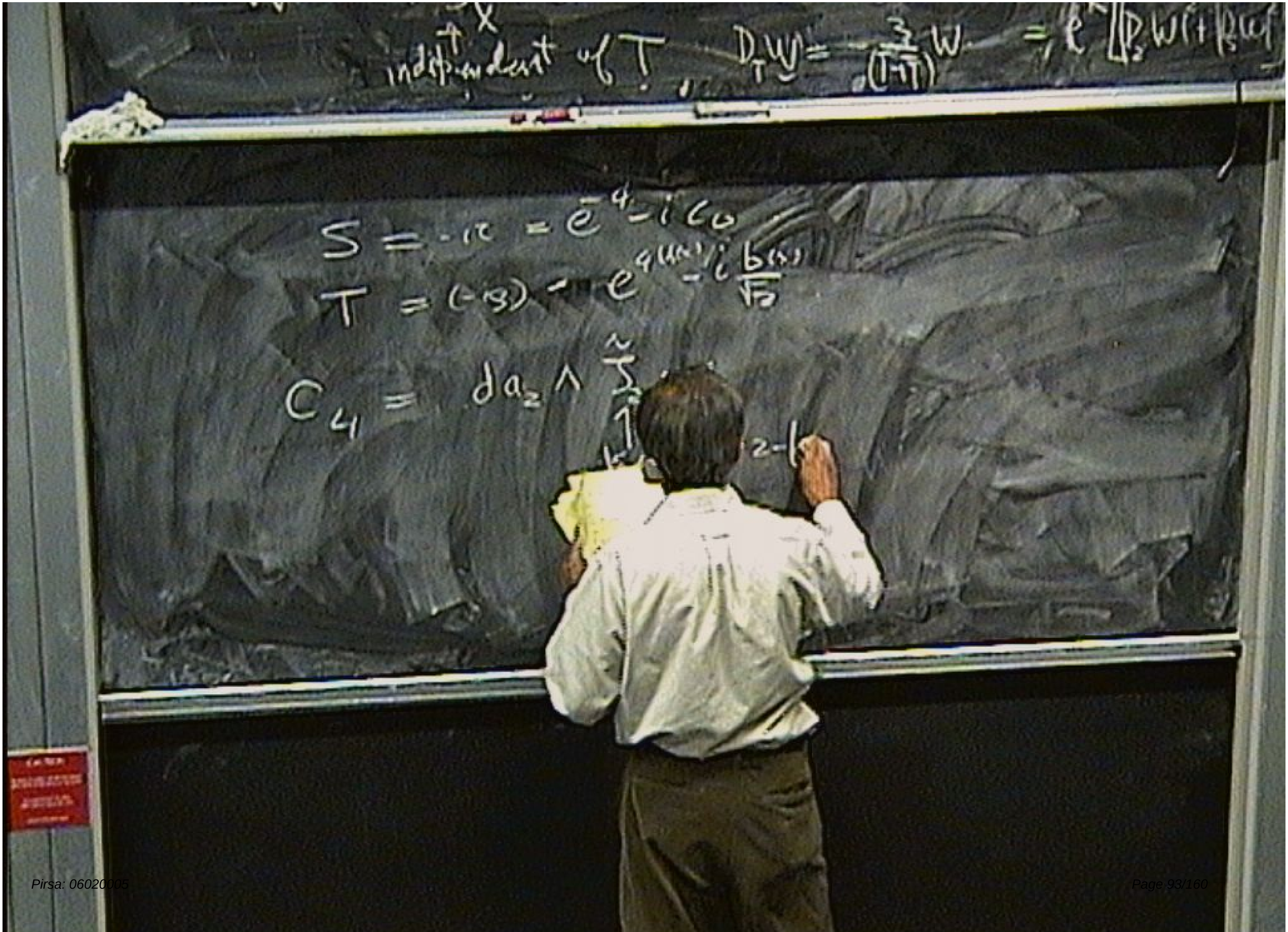

independent of T
T =

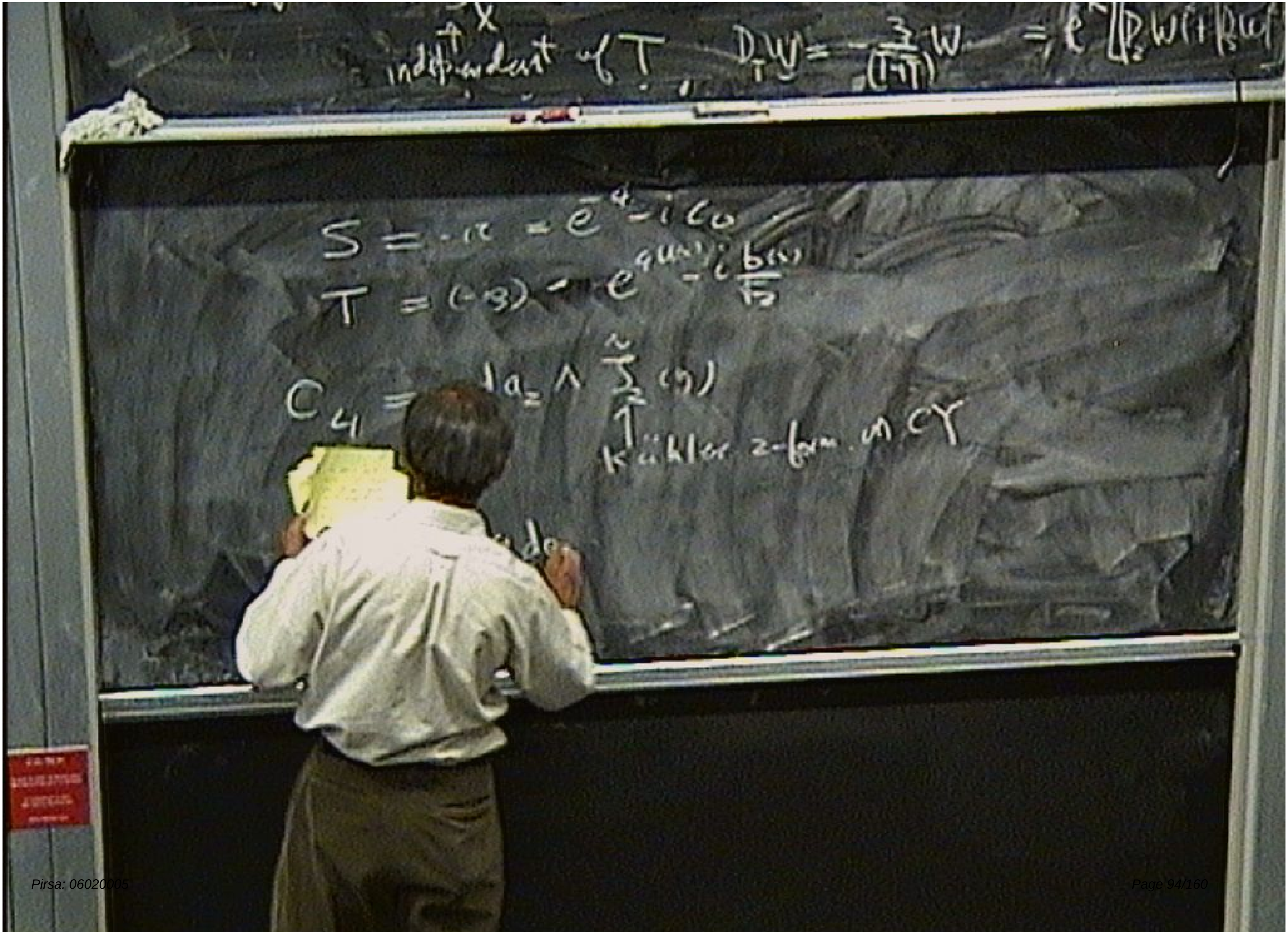
independent of T, $D_T W = \frac{3}{(T+\bar{T})} W = e^{K}[\partial_S W (+ \partial_S K) \ldots$

$S = -ic = e^{-4 - i c_0}$

$T = (-iB) = e^{4u(x) - i \frac{b(x)}{\sqrt{2}}}$

$C_4 =$


independent of T
S = -ic = e^-φ - i c0
C4 = da2 ∧


independent of T
S =
T =
C4 =
kähler 2-form in CY

independent of T, $D_T W = -\frac{3}{(T+\bar{T})} W$ $= e^{K}[\partial_T W + \partial_T K W]$

$$S = -i\tau = e^{-\phi} - i c_0$$

$$T = (-\rho) = e^{4u(x)} - i \frac{b(x)}{\sqrt{2}}$$

$$C_4 = da_2 \wedge \tilde{\omega}_2(y)$$

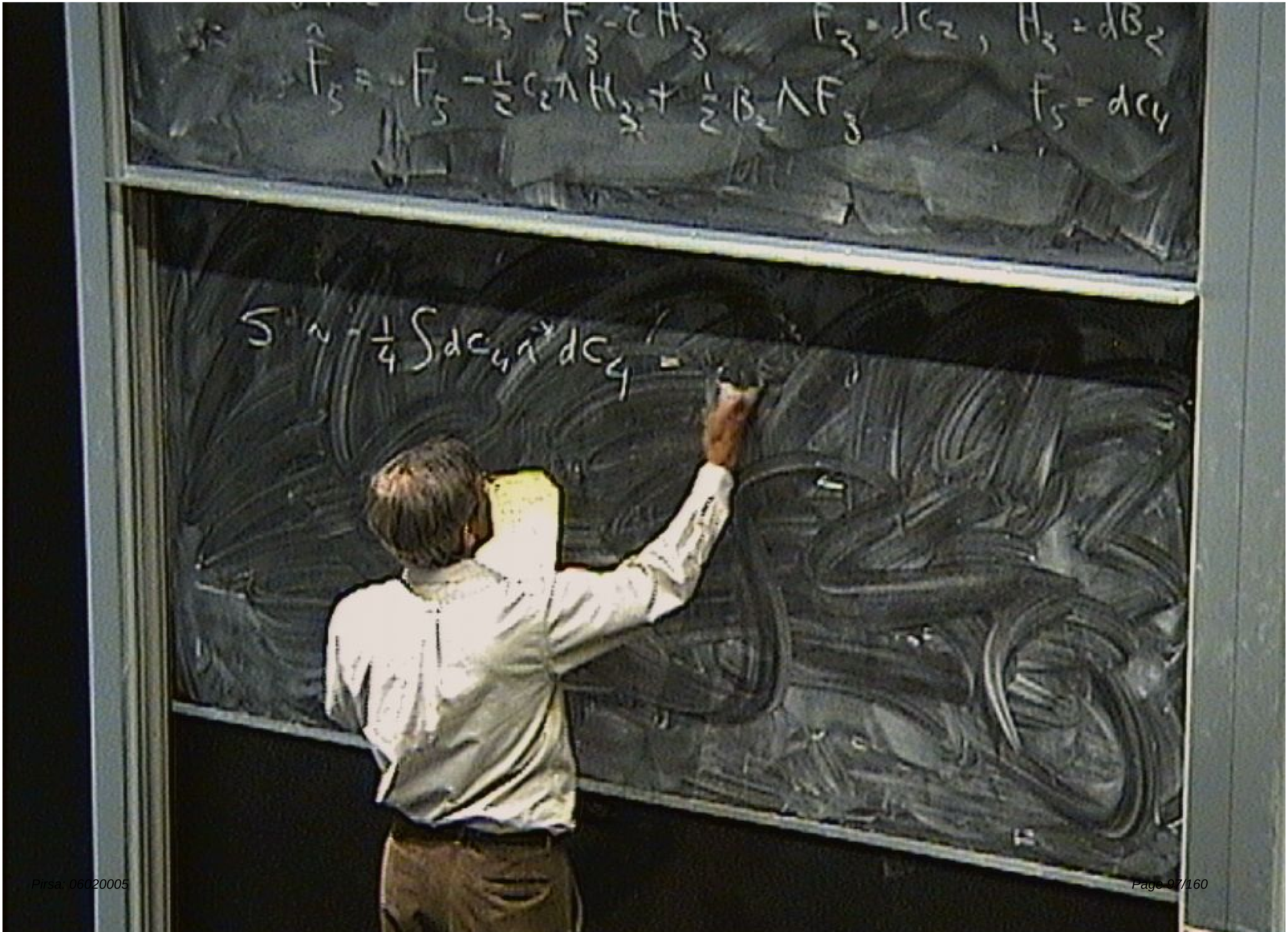
Kähler 2-form on CY

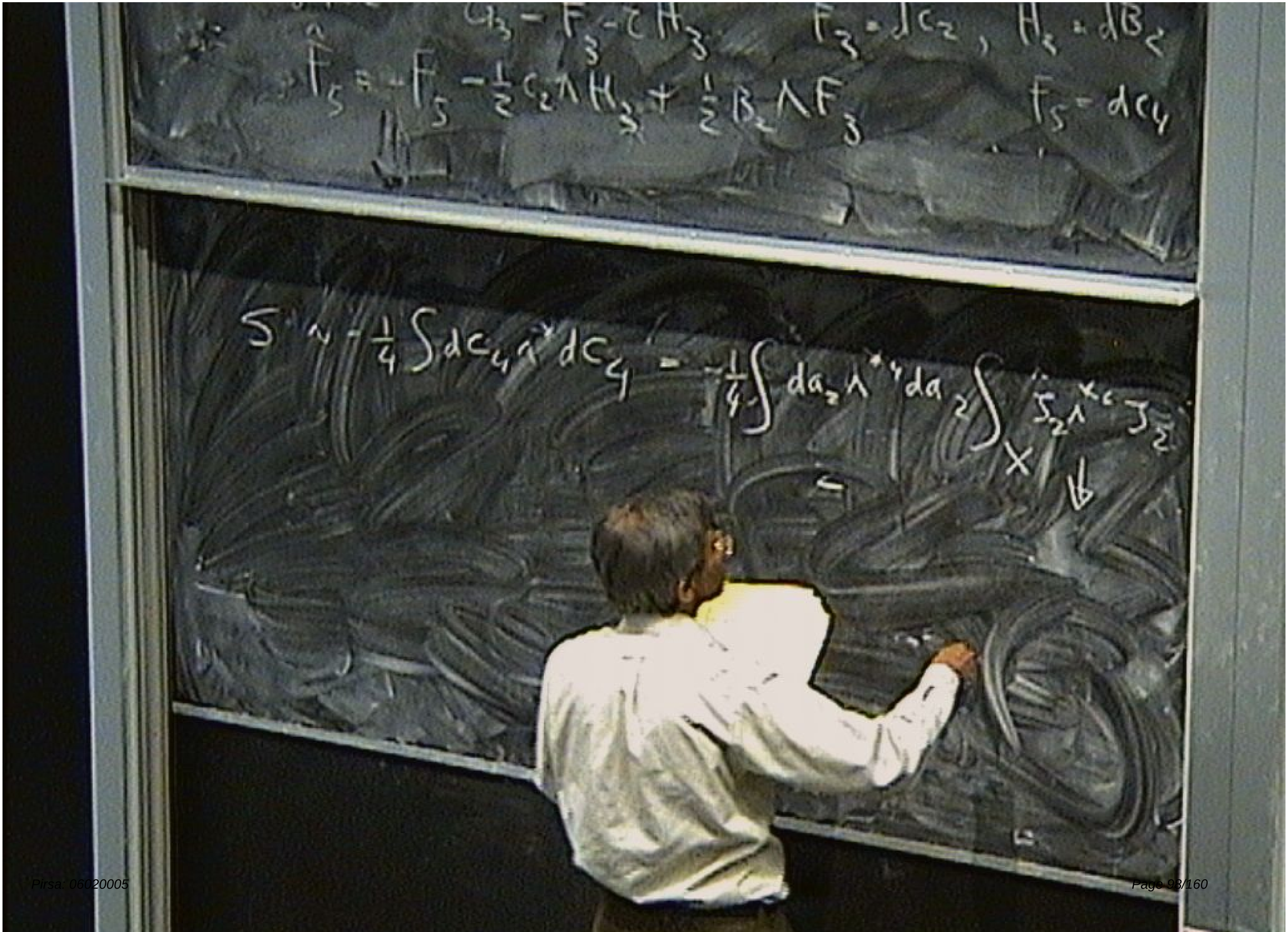
$$db = e^{2u} *_4 da_2$$

$$G_3 = F_3 - \tau H_3 \qquad F_3 = dC_2 \,,\quad H_3 = dB_2$$

$$\tilde{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$$

$$S \sim -\frac{1}{4} \int dC_4 \wedge {*dC_4}$$


G3 = F3 − τH3   F3 = dC2 , H3 = dB2
F̂5 = F5 − ½ C2∧H3 + ½ B2∧F3   F5 = dC4
S ~ −¼ ∫ dC4 ∧ * dC4 =


F3 = dC2 , H3 = dB2
F̂5 = F5 − ½ C2 ∧ H3 + ½ B2 ∧ F3
F5 = dC4

Can be expressed

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T})$$

$$-\ln\left(-i\int_X \Omega\wedge\bar{\Omega}\right)$$

$S = i\tau$

$\mathrm{Re}\,T = e^{4u}$

$$W = \frac{1}{4}\int_X G_3\wedge\Omega$$

indep. of T

$$V = e^K\left(D_i W D_{\bar{j}} \bar{W} K^{i\bar{j}} - 3|W|^2\right)$$

$$D_T W = -\frac{3}{(T+\bar{T})}W$$

$$= e^K\left(D_i W \ldots\right)$$

$$S = i\tau = e^{-\phi} - i C_0$$

$$T = (\ldots) = e^{4u(x)} - i\frac{b(x)}{\ldots}$$

$$C_4 = da_2\wedge\tilde{\omega}_2(y)$$

Kähler 2-form in CY

$$db = e^{8u+\ldots} * da_2$$

ignore warp factor

$$G_3 = F_3 - \tau H_3 \qquad F_3 = dC_2\,,\ H_3 = dB_2$$

$$\hat{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$$

$$S \sim -\frac{1}{4}\int dC_4 \wedge {}^* dC_4 = -\frac{1}{4}\int da_2 \wedge {}^{*_4} da_2 \int_X \Sigma_2 \wedge {}^{*_6} \Sigma_2$$

$$\sim -\frac{3}{4}\hat{V}_6\, e \qquad\qquad -3\int\sqrt{g}$$

$\tilde{R}^{(4)} \leq 0$ $\quad + \rho \quad \Sigma \mu_3 \delta_i$

Solving $G_3 = {}^{*}{}_6 G_3$ ISD. $e^{4\omega} = \alpha$ ...

$g_{\mu\nu} = \tilde{g}_{\mu\nu}$ $\quad e^{-6u(x)}$

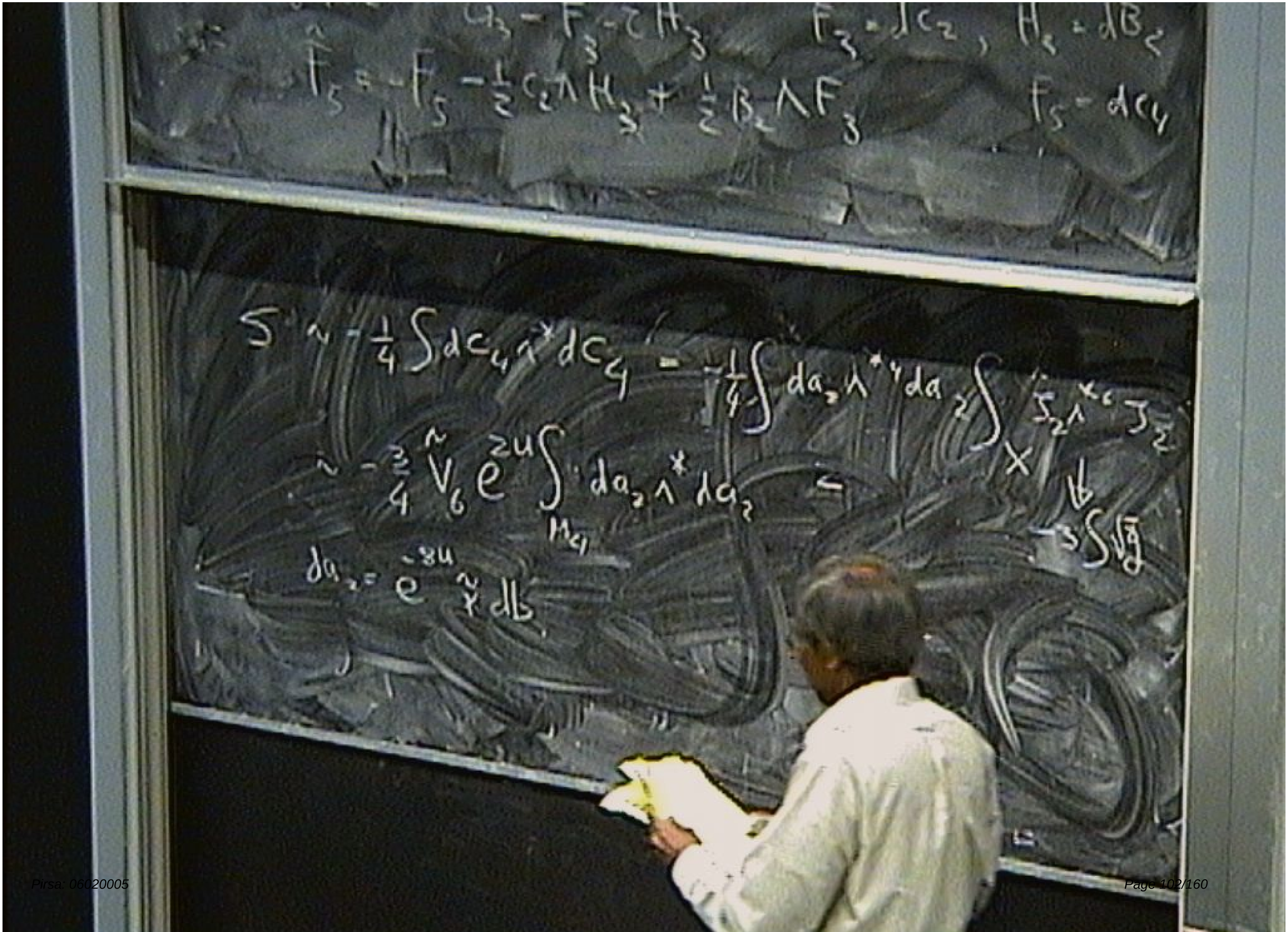
$$ds^2 = e^{-6u(x)} \tilde{g}_{\mu\nu}(x) dx^\mu dx^\nu + e^{2u(x)} \tilde{g}_{mn}(x,y) dy^m dy^n$$

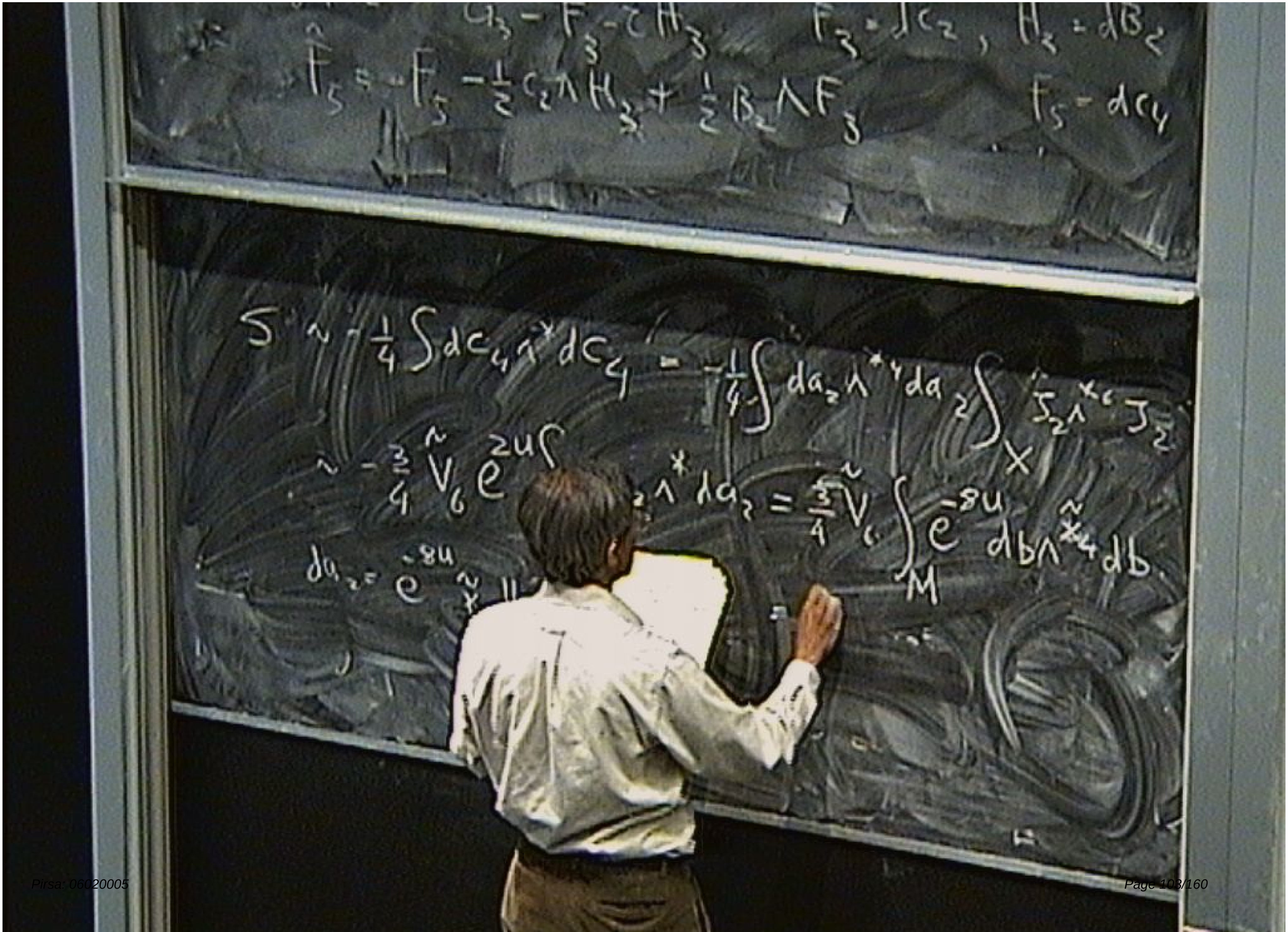
$\partial_\mu \det \tilde{g} = 0.$ $\quad \hat{g}_{mn}(x,y) = \hat{g}_{mn}(y) + z^i(x)\, \phi^i_{mn}(y) + \ldots$

$R_{\alpha y} = \langle e^{4u} \rangle$

If KK modes ignored $\quad \partial_\mu \omega \neq 0 \Rightarrow \partial_\mu u = \partial_\mu z^i = 0$

$\quad$ all KK modes


F3 = dC2 , H3 = dB2
F̂5 = F5 − ½ C2 ∧ H3 + ½ B2 ∧ F3
F5 = dC4


$F_3 = dC_2 \, , \quad H_3 = dB_2$
$\hat{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$
$S \sim -\frac{1}{4}\int dC_4 \wedge {}^* dC_4 = -\frac{1}{4}\int da_2 \wedge {}^{*_4} da_2 \int_X J_2 \wedge {}^{*_6} J_2$
$\sim -\frac{3}{4}\tilde{V}_6 e^{2u}$
$\wedge {}^* da_2 = \frac{3}{4}\tilde{V}_6 \int_M e^{-8u} db \wedge \tilde{*}_4 db$
$da_2 = e^{-8u} \tilde{*}$

$$G_3 = F_3 - \tau H_3 \qquad F_3 = dC_2\,,\quad H_3 = dB_2$$

$$\tilde{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$$

$$S \sim -\frac{1}{4}\int dC_4 \wedge {}^* dC_4 = -\frac{1}{4}\int da_2 \wedge {}^{*_4} da_2 \int_X J_2 \wedge {}^{*_6} J_2$$

$$\sim -\frac{3}{4}\tilde{V}_6 e^{2u} \int_{M_4} da_2 \wedge {}^* da_2 = \frac{3}{4}\tilde{V}_6 \int_M e^{-8u}\, db \wedge \tilde{*}_4\, db$$

$$da_2 = e^{-8u}\, \tilde{*}\, db$$

$$= \frac{3}{4}\hat{V}_6 \int \sqrt{\tilde{g}_4}\, e^{-8u} (\tilde{\partial}_\mu b)^2$$

$$\hat{F}_3 = F_3 - \tau H_3 \qquad F_3 = dC_2 , \quad H_3 = dB_2$$

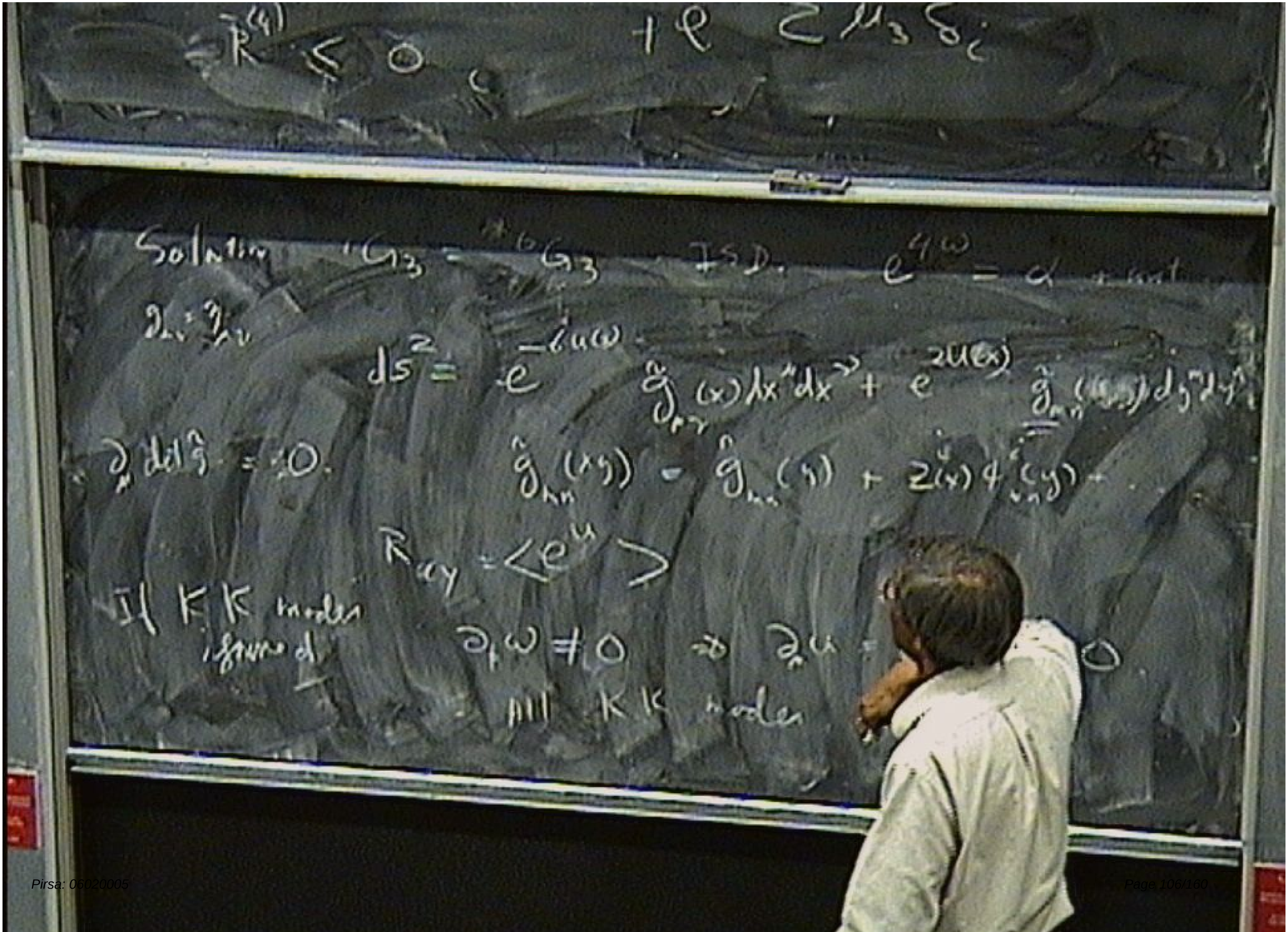
$$\tilde{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$$

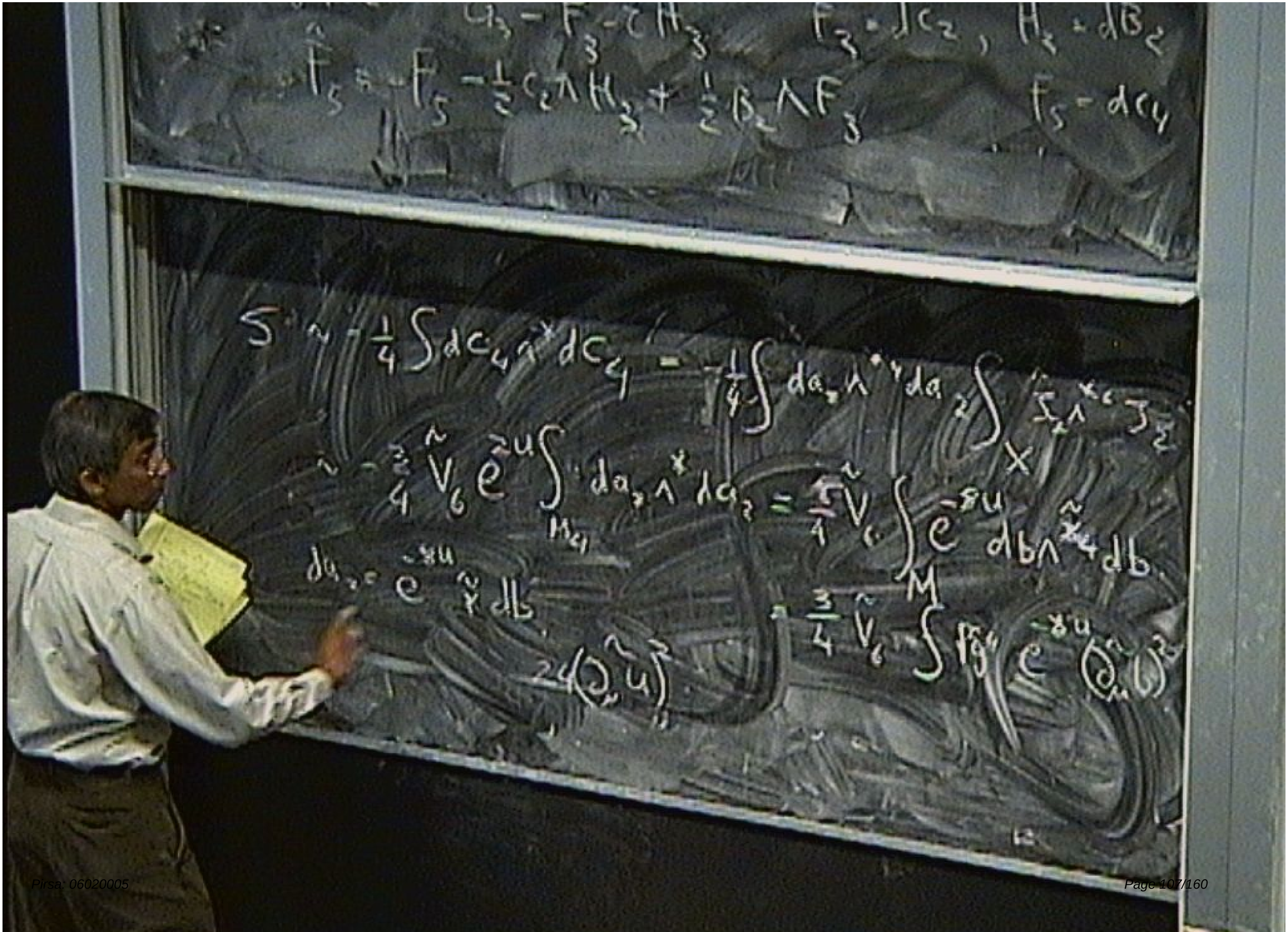
$$S \sim -\frac{1}{4} \int dC_4 \wedge {}^{*} dC_4 = -\frac{1}{4} \int da_2 \wedge {}^{*_4} da_2 \int_X J_2 \wedge {}^{*_6} J_2$$

$$\sim -\frac{3}{4} \tilde{V}_6 e^{2u} \int_{M_4} da_2 \wedge {}^{*} da_2 = \frac{3}{4} \tilde{V}_6 \int_M e^{-8u} \, db \wedge \tilde{*}_4 \, db$$

$$da_2 = e^{-8u} \tilde{*} \, db$$

$$= \frac{3}{4} \hat{V}_6 \int \sqrt{\tilde{g}_4} \, e^{-8u} (\tilde{\partial}_\mu b)^2$$


Solution
ISD.
$ds^2 = e^{-2u(x)} \tilde{g}_{\mu\nu}(x) dx^\mu dx^\nu + e^{2u(x)} \tilde{g}_{mn}(x,y) dy^m dy^n$
$\partial_\mu \det \tilde{g} = 0.$
$R_{(4)} \propto \langle e^{4u} \rangle$
If KK modes ignored
$\partial_t \omega \neq 0 \Rightarrow \partial_t u$
all KK modes


F_3 = dC_2 , H_3 = dB_2
F̂_5 = F_5 − ½ C_2 ∧ H_3 + ½ B_2 ∧ F_3
F_5 = dC_4

$$G_3 = F_3 - \tau H_3 \qquad F_3 = dC_2\,, \quad H_3 = dB_2$$

$$\tilde{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$$

$$S \sim -\frac{1}{4}\int dC_4 \wedge {}^* dC_4 = -\frac{1}{4}\int da_2 \wedge {}^{*_4} da_2 \int_X J_2 \wedge {}^{*_6} J_2$$

$$\sim -\frac{3}{4}\tilde{V}_6 e^{2u} \int_{M_4} da_2 \wedge {}^* da_2 = \frac{3}{4}\tilde{V}_6 \int_M e^{-8u}\, db \wedge \tilde{*}_4\, db$$

$$da_2 = e^{-8u}\, \tilde{*}\, db$$

$$= \frac{3}{4}\hat{V}_6 \int \sqrt{\tilde{g}}\, e^{-8u} (\tilde{\partial}_\mu b)^2$$

$$\frac{3}{4} e^{-8u} (\tilde{\partial}_\mu b)^2 + 24 (\tilde{\partial}_\mu u)^2 = 6 \frac{|\partial_\mu T|^2}{(T + \bar{T})^2}$$

$$\hat{G}_3 = F_3 - \tau H_3 \qquad F_3 = dC_2\,, \quad H_3 = dB_2$$

$$\hat{F}_5 = F_5 - \tfrac{1}{2} C_2 \wedge H_3 + \tfrac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$$

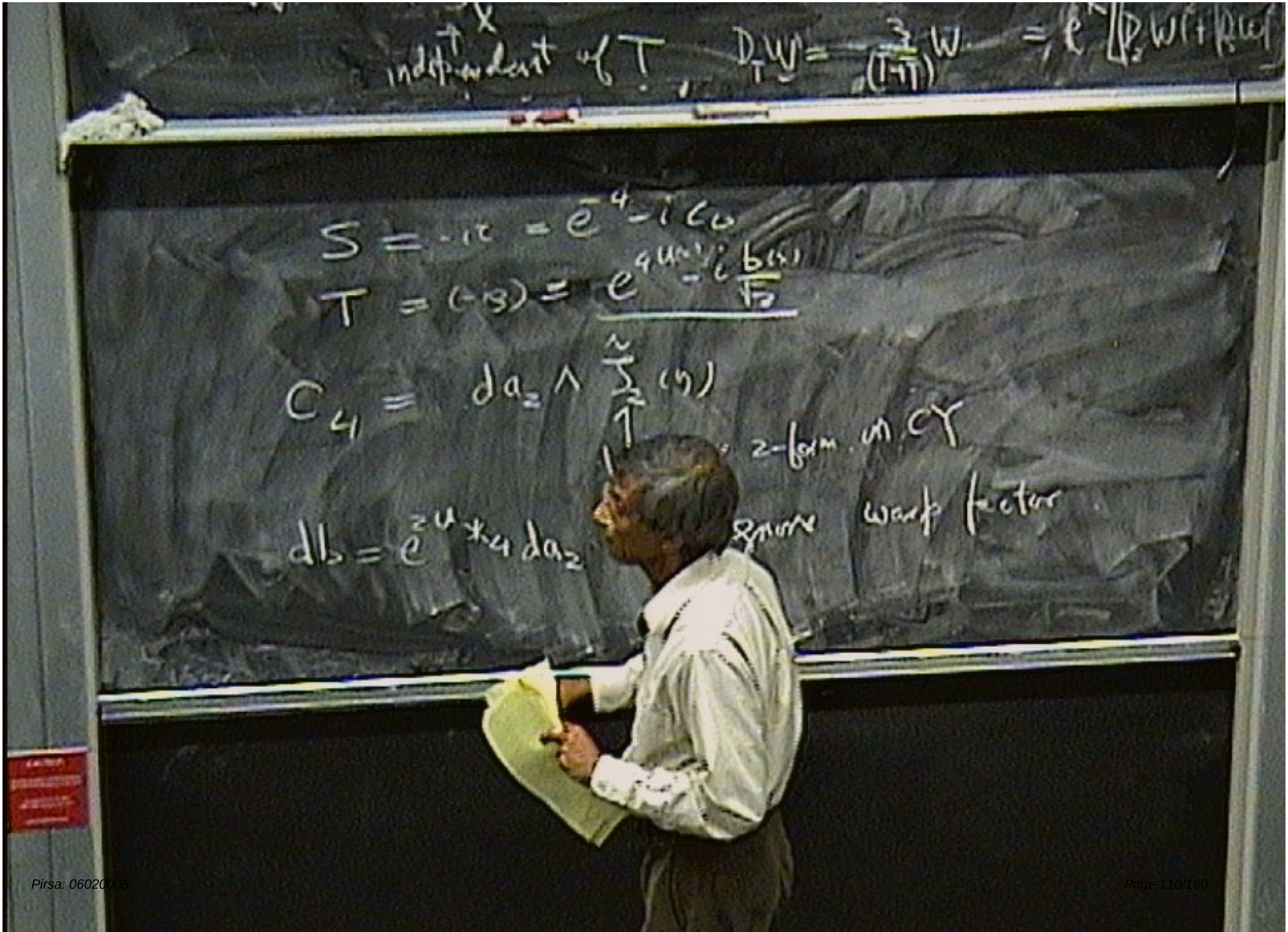
$$S \sim -\frac{1}{4}\int dC_4 \wedge {}^{*} dC_4 = -\frac{1}{4}\int da_2 \wedge {}^{*_4} da_2 \; 2\int_X \Sigma_2 \wedge {}^{*_6} \Sigma_2$$

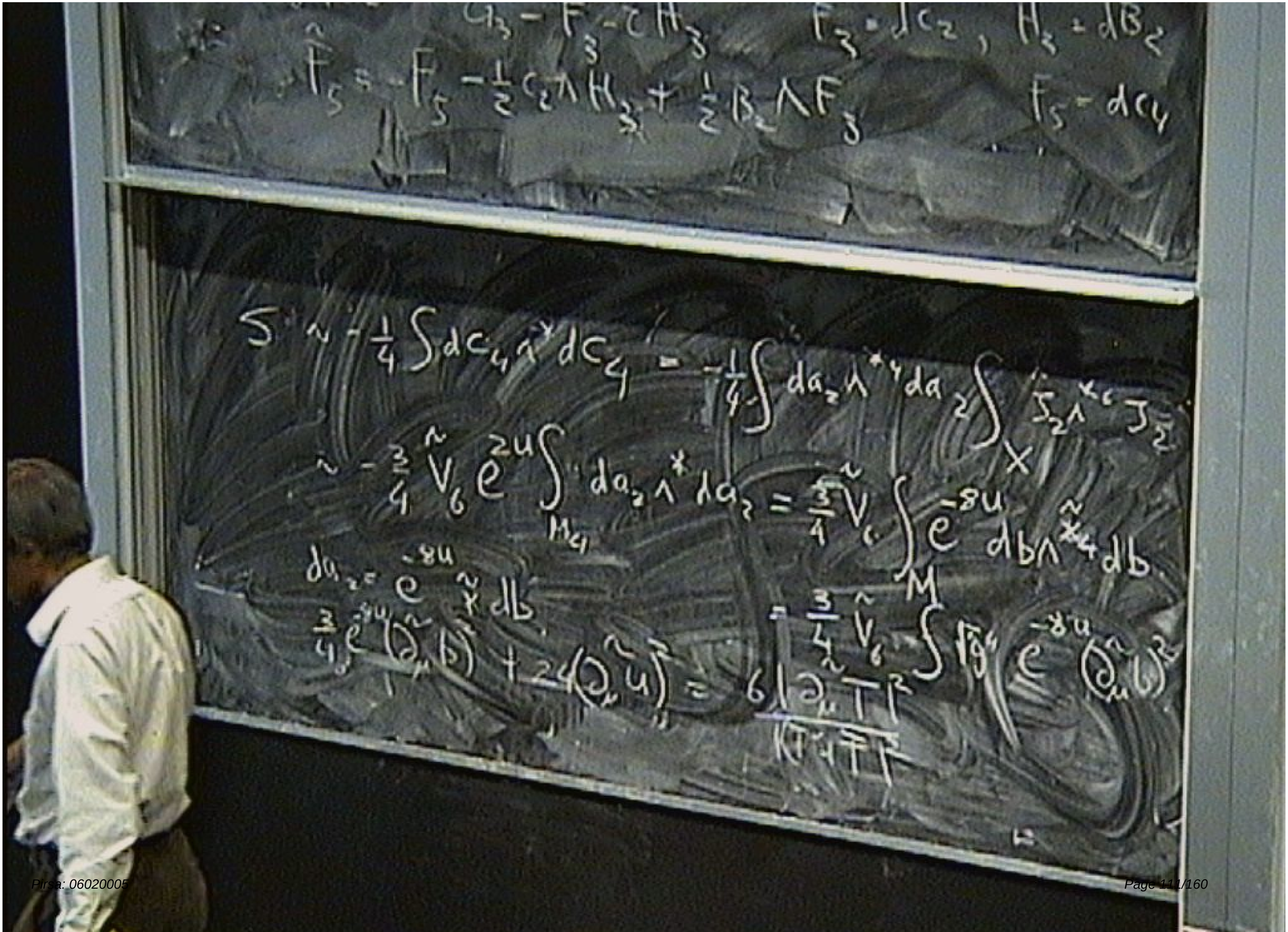
$$\sim -\frac{3}{4}\tilde{V}_6\, e^{-2u} \int_{M_4} da_2 \wedge {}^{*} da_2 = -\frac{3}{4}\tilde{V}_6 \int_M e^{-8u}\, db \wedge \tilde{*}_4\, db$$

$$da_2 = e^{-8u}\, \tilde{*}\, db$$

$$= -\frac{3}{4}\tilde{V}_6 \int \sqrt{g_4}\, e^{-8u} (\partial_\mu b)^2$$

$$\frac{3}{4} e^{-8u} (\partial_\mu b)^2 + 24 (\partial_\mu \tilde{u})^2 = 6\,\frac{|\partial_\mu T|^2}{(T+\bar{T})^2}$$


independent of T
$D_T W = -\frac{3}{(T+\bar{T})} W$
$S = -ic = e^{-\phi} - i C_0$
$T = (-\rho) = e^{4u} - i \frac{b(x)}{\sqrt{2}}$
$C_4 = da_2 \wedge \tilde{\omega}_2(y)$
2-form in CY
$db = e^{2u} *_4 da_2$
ignore warp factor


$\hat{G}_3 = F_3 - \tau H_3$ $F_3 = dC_2$, $H_3 = dB_2$
$\tilde{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3$ $F_5 = dC_4$
$S \sim -\frac{1}{4} \int dC_4 \wedge {}^* dC_4 = -\frac{1}{4} \int da_2 \wedge {}^{*_4} da_2 \int_X J_2 \wedge {}^{*_6} J_2$
$\sim -\frac{3}{4} \hat{V}_6 e^{2u} \int_{M_4} da_2 \wedge {}^* da_2 = \frac{3}{4} \tilde{V}_6 \int_M e^{-8u} db \wedge \tilde{*}_4 db$
$da_2 = e^{-8u} \tilde{*} db$
$= \frac{3}{4} \hat{V}_6 \int \sqrt{\tilde{g}} \, e^{-8u} (\partial_\mu b)^2$
$\frac{3}{4} e^{-8u} (\partial_\mu b)^2 + 24 (\partial_\mu u)^2 = 6 \frac{|\partial_\mu T|^2}{|T - \bar{T}|^2}$

$$G_3 = F_3 - \tau H_3, \qquad F_3 = dC_2, \qquad H_3 = dB_2$$

$$\hat{F}_5 = F_5 - \tfrac{1}{2} C_2 \wedge H_3 + \tfrac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$$

$$S \sim -\frac{1}{4} \int dC_4 \wedge * dC_4 = -\frac{1}{4} \int da_2 \wedge *_4 da_2 \int_X J_2 \wedge *_6 J_2$$

$$\sim -\frac{3}{4} \hat{V}_6 e^{2u} \int_{M_4} da_2 \wedge * da_2 = \frac{3}{4} \tilde{V}_6 \int_M e^{-8u} db \wedge \tilde{*}_4 db$$

$$da_2 = e^{-8u} \tilde{*} db$$

$$= \frac{3}{4} \hat{V}_6 \int \sqrt{\tilde{g}_4}\, e^{-8u} (\partial_\mu b)^2$$

$$\frac{3}{4} e^{-8u} (\partial_\mu b)^2 + 2 (\partial_\mu \tilde{u})^2 = 6 \frac{|\partial_\mu T|^2}{|T - \bar{T}|^2} = K_{T\bar{T}} |\partial_\mu T|^2$$

$$S = \int d^{10}x \sqrt{g} \Big[R - \frac{1}{2\tau_I^2} \partial_M \tau \partial^M \bar{\tau} - \frac{1}{2\cdot 3!} \frac{G_{MNP} \bar{G}^{MNP}}{\tau_I} - \frac{1}{4\cdot 5!} \tilde{F}_{MNPQR} \tilde{F}^{MNPQR} \Big]$$

$$+ \frac{1}{4i} \int \frac{C_4 \wedge G_3 \wedge \bar{G}_3}{\tau_I}$$

$$\tau = C_0 + i e^{-\phi} \qquad G_3 = F_3 - \tau H_3 \qquad F_3 = dC_2 , \quad H_3 = dB_2$$

$$\tilde{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$$

$$S \sim -\frac{1}{4} \int dC_4 \wedge {*dC_4} - \frac{1}{4} \int da_2 \wedge {*da_2} \int_X \Sigma_2 \wedge {*_6 \Sigma_2}$$

$$\sim -\frac{3}{4} \tilde{V}_6 e^{2u} \int_{M_4} da_2 \wedge {*da_2} = \frac{3}{4} \tilde{V}_6 \int e^{-8u} \, d\tilde{b} \wedge {*_4 d\tilde{b}}$$

$$\hat{G}_3 = F_3 - \tau H_3 \qquad F_3 = dC_2 \,,\quad H_3 = dB_2$$

$$\hat{F}_5 = F_5 - \tfrac{1}{2} C_2 \wedge H_3 + \tfrac{1}{2} B_2 \wedge F_3 \qquad f_5 = dC_4$$

$$S \sim -\frac{1}{4}\int dC_4 \wedge {}^*dC_4 = -\frac{1}{4}\int da_2 \wedge {}^* da_2 \int_X \Sigma_2 \wedge {}^{*_6} J_2$$

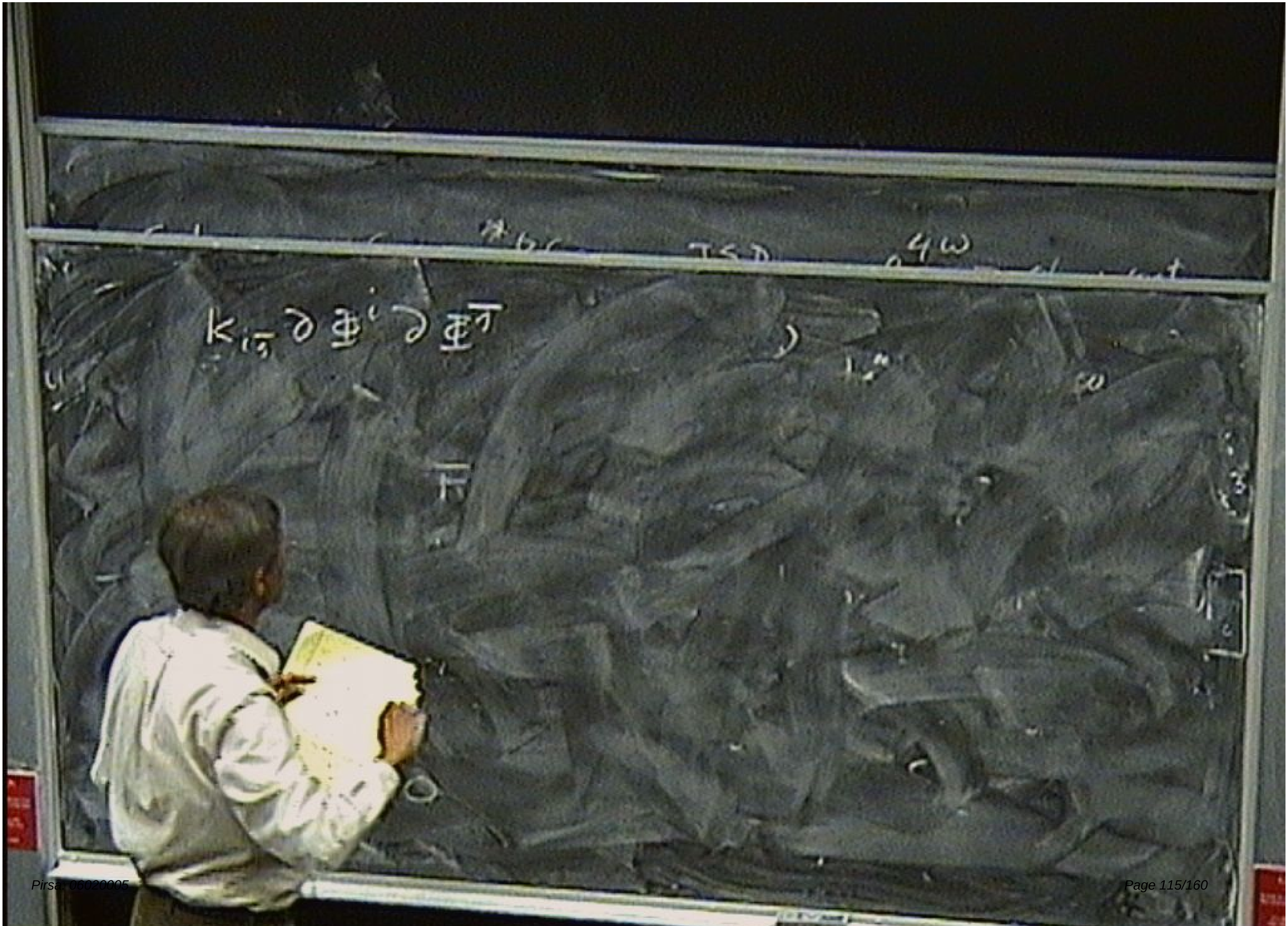
$$\sim -\frac{3}{4}\tilde{V}_6 e^{2u} \int_{M_4} da_2 \wedge {}^* da_2 = \frac{3}{4}\tilde{V}_6 \int_M e^{-8u}\, db \wedge \tilde{*}_4 db$$

$$da_2 = e^{-8u}\, \tilde{*}\, db$$

$$= \frac{3}{4}\hat{V}_6 \int \sqrt{\tilde{g}_4}\, e^{-8u} (\partial_\mu b)^2$$

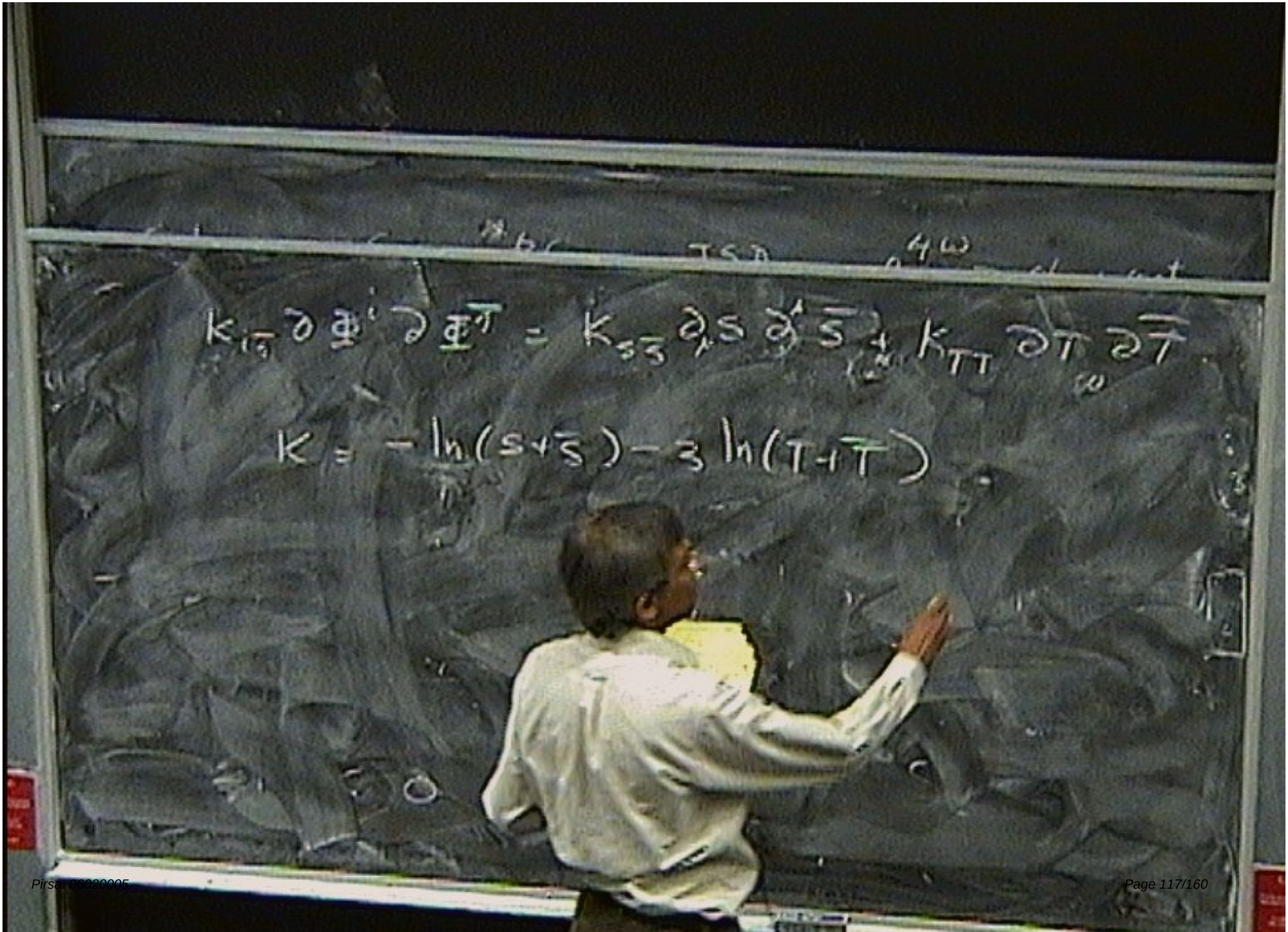
$$\frac{3}{4} e^{-8u} (\tilde{\partial}_\mu b)^2 + 24 (\partial_\mu \tilde{u})^2 = 6 \frac{|\partial_\mu T|^2}{(T+\bar{T})^2} = K_{T\bar{T}}\, \partial_\mu T\, \partial^\mu \bar{T}$$

$$=$$

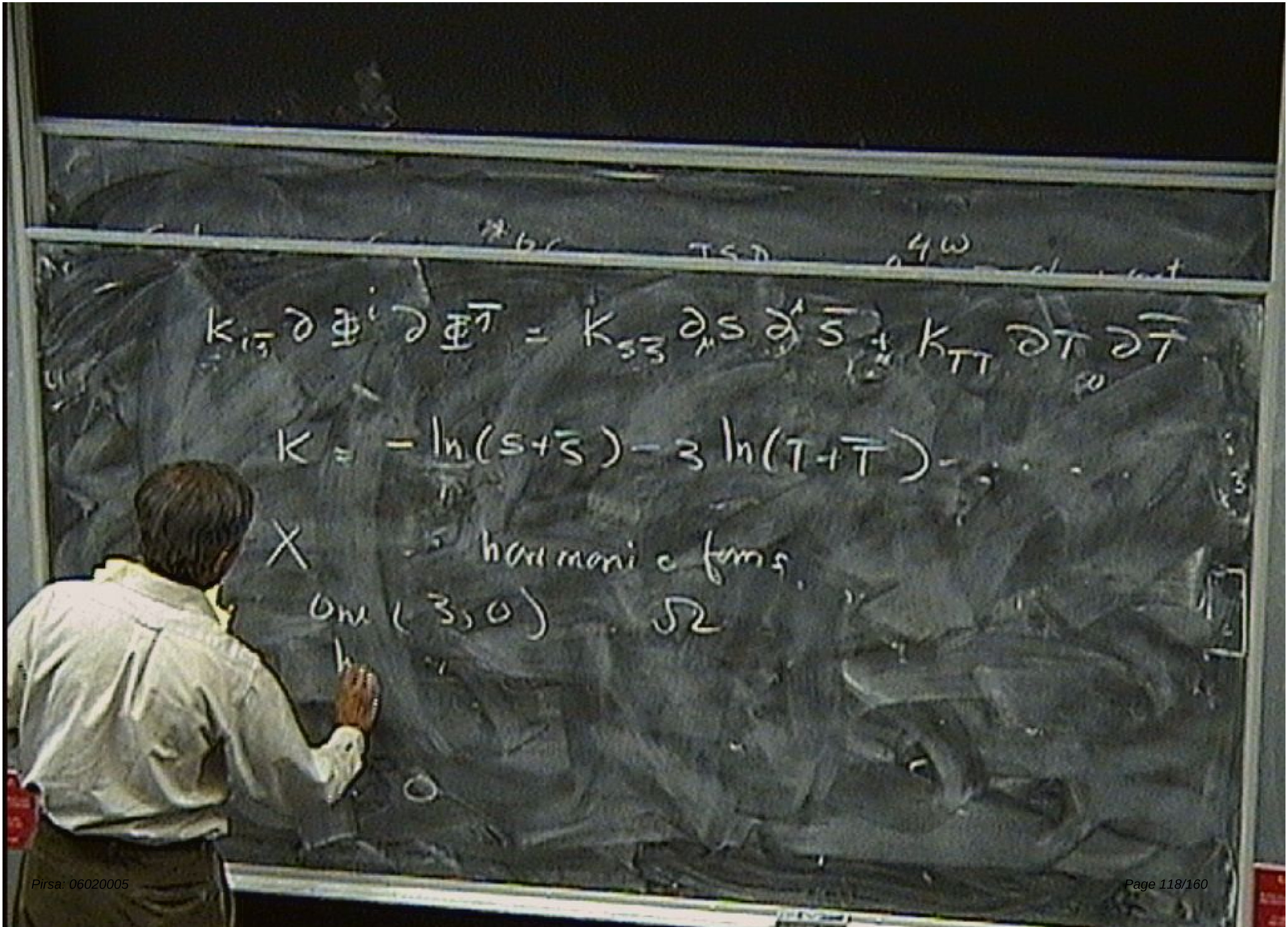

$K_{i\bar{j}}\,\partial\Phi^i\,\partial\bar{\Phi}^{\bar{j}}$

$$K_{i\bar{j}}\,\partial\Phi^i\,\partial\bar{\Phi}^{\bar{j}} = K_{s\bar{s}}\,\partial_\mu s\,\partial^\mu \bar{s}$$

$$K = -\ln(s+\bar{s})$$



$K_{i\bar{j}}\,\partial\Phi^i\,\partial\bar{\Phi}^{\bar{j}} = K_{S\bar{S}}\,\partial S\,\partial\bar{S} + K_{T\bar{T}}\,\partial T\,\partial\bar{T}$
$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T})$


K_{i\bar j} ∂Φ^i ∂Φ^{\bar j} = K_{S\bar S} ∂_μ S ∂^μ \bar S + K_{T\bar T} ∂T ∂\bar T
K = − ln(S + \bar S) − 3 ln(T + \bar T) − . . .
X harmonic forms
on (3,0) Ω

$$K_{i\bar{j}}\,\partial\Phi^i\,\partial\bar{\Phi}^{\bar{j}} = K_{S\bar{S}}\,\partial_\mu S\,\partial^\mu\bar{S} + K_{T\bar{T}}\,\partial T\,\partial\bar{T}$$

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T}) - \dots$$

On X harmonic forms

1. One (3,0) Ω
2. $h_{2,1}$ primitive (2,1)

$$K_{i\bar{j}}\,\partial\Phi^i\,\partial\bar{\Phi}^{\bar{j}} = K_{S\bar{S}}\,\partial_\mu S\,\partial^\mu \bar{S} + K_{T\bar{T}}\,\partial T\,\partial\bar{T}$$

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T}) - \ldots$$

on X ... ha... forms

1. on (3,0) Ω

2. h_{21} ...) χ_α $(\bar{g}^{i\bar{j}}\,\lambda_{\alpha,k\bar{j}} = 0)$

3. h_{12} ...

$$K_{i\bar{j}}\,\partial\Phi^i\,\partial\bar{\Phi}^{\bar{j}} = K_{S\bar{S}}\,\partial_\mu S\,\partial^\mu \bar{S} + K_{T\bar{T}}\,\partial T\,\partial\bar{T}$$

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T}) - \dots$$

On X harmonic forms

1. One $(3,0)$ Ω
2. $h_{2,1}$ primitive $(2,1)$ χ_α
3. $h_{12} = h_{21}$ $(1,2)$ $\bar{\chi}$
4. $(0,3)$ $\bar{\Omega}$

$$K_{i\bar{j}}\,\partial\Phi^i\,\partial\bar{\Phi}^{\bar{j}} = K_{S\bar{S}}\,\partial_\mu S\,\partial^\mu\bar{S} + K_{T\bar{T}}\,\partial T\,\partial\bar{T}$$

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T}) - \cdots$$

on X — harmonic forms

1 one $(3,0)$ Ω

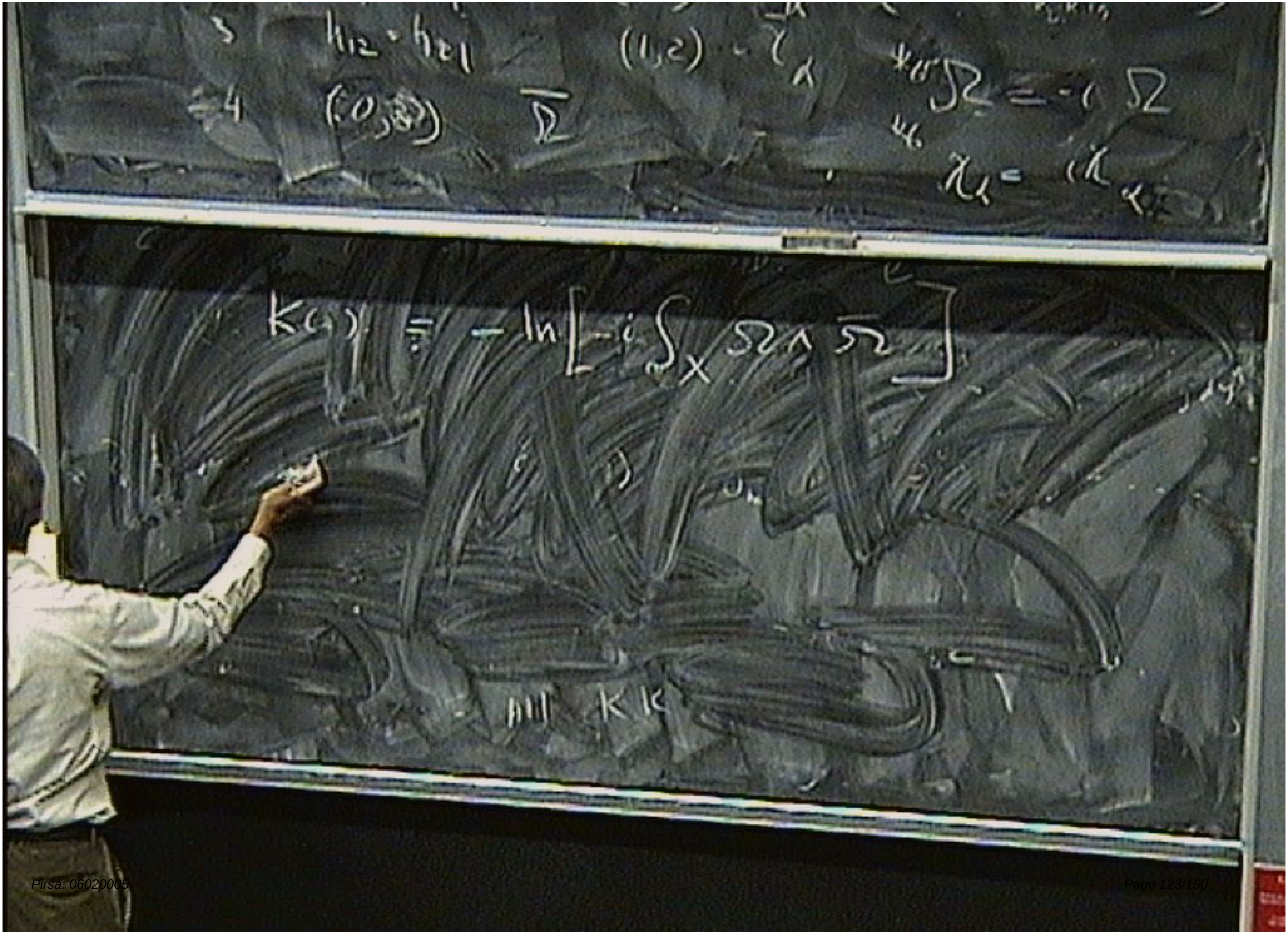
2 $h_{2,1}$ primitive $(2,1)$ χ_α $\left(g^{i\bar{j}}\chi_{\alpha, k i\bar{j}} = 0\right)$

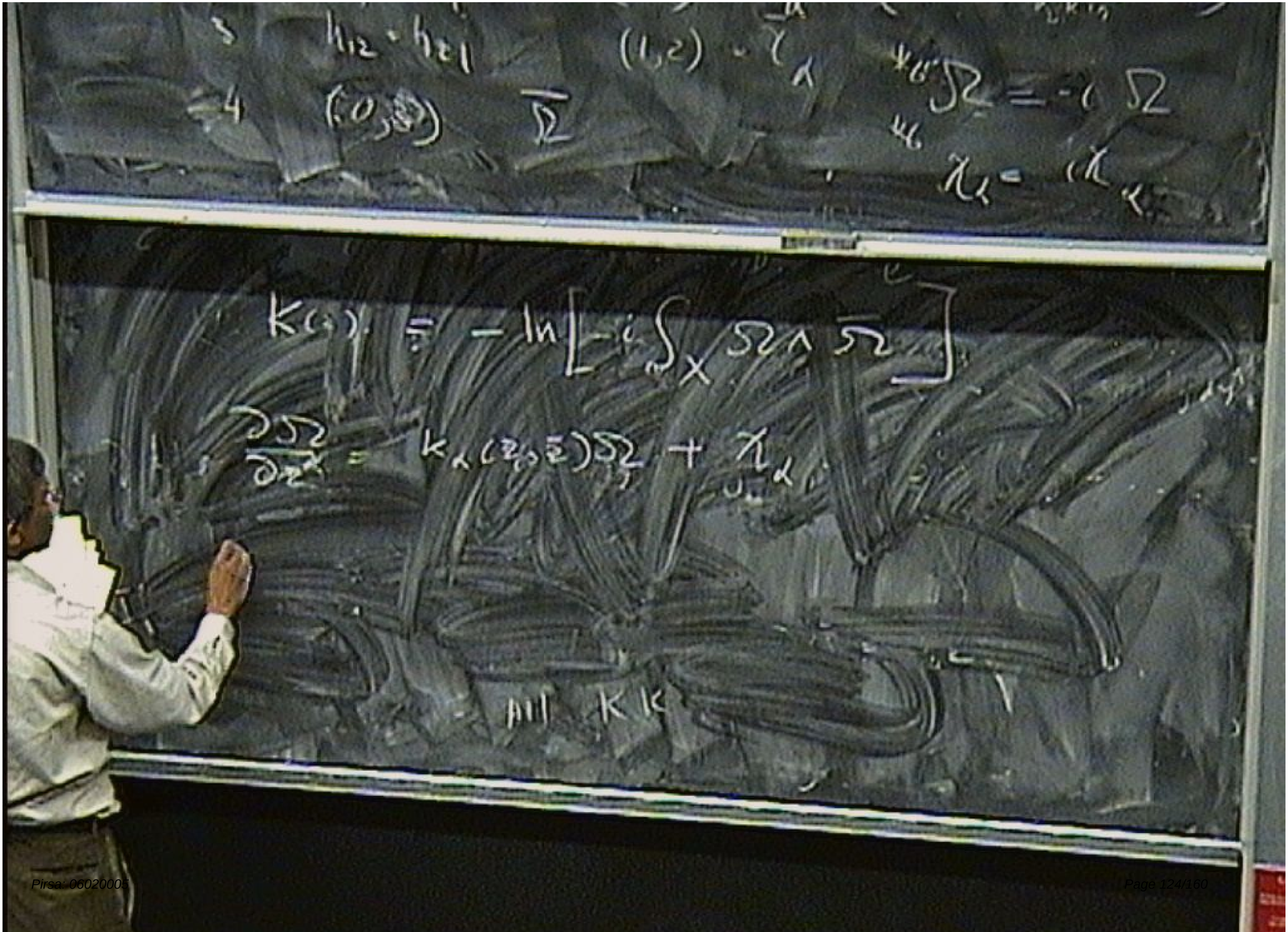
3 $h_{12} = h_{21}$ $(1,2)$ $\bar{\chi}_\alpha$

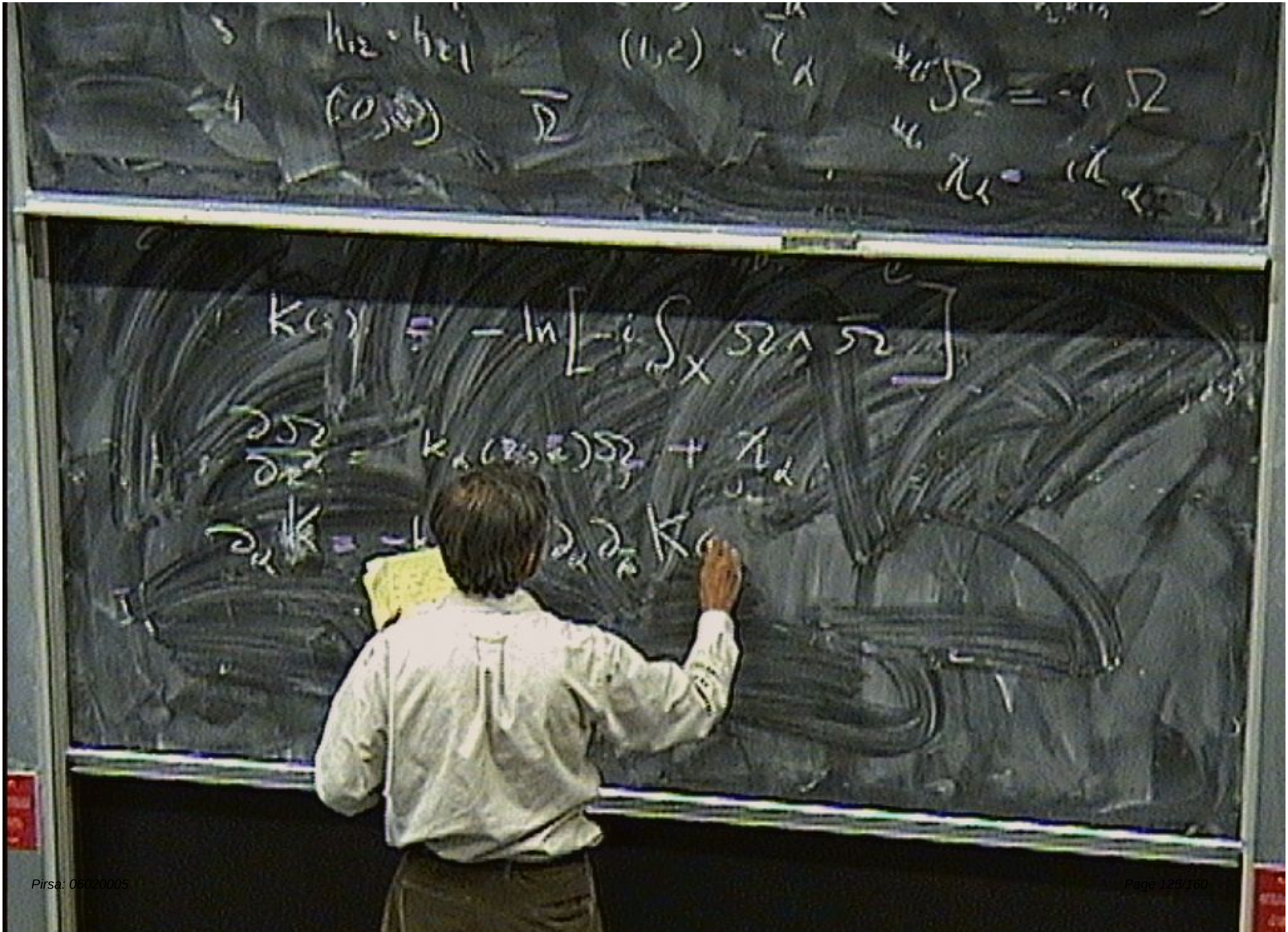
4 $(0,3)$ $\bar{\Omega}$ $*_6\,\Omega = -i\,\Omega$

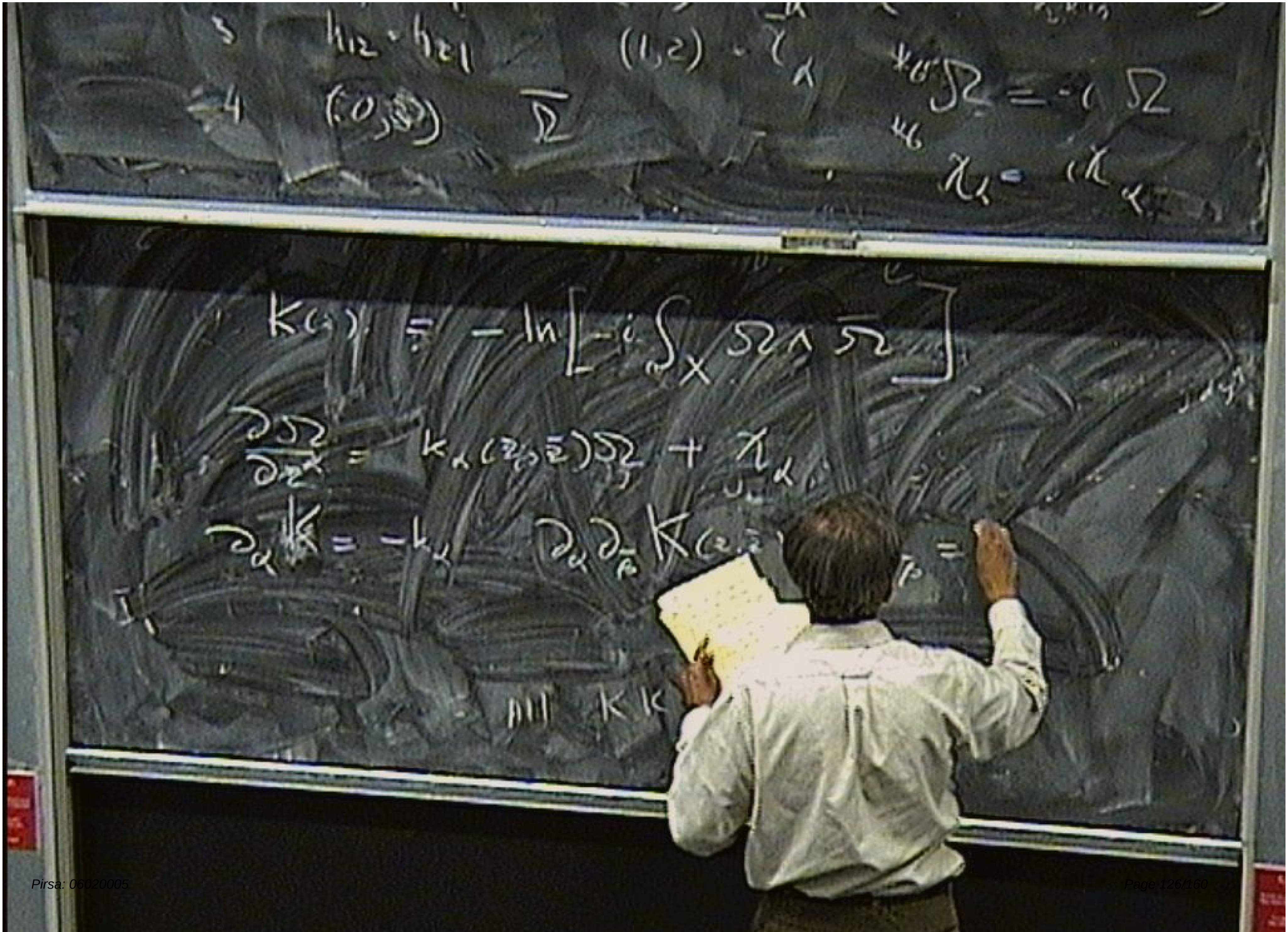
$*_6$

$\chi_\alpha = \; i\,\chi_\alpha$


h12 = h21
(1,2)
(0,3)
*Ω = -i Ω
K(t) = -ln[i ∫X Ω ∧ Ω̄]


h12 = h21
(1,2)
(0,3)
$K(z) = -\ln\left[i \int_X \Omega \wedge \bar{\Omega} \right]$
$\frac{\partial \Omega}{\partial z^\alpha} = k_\alpha(z, \bar{z})\Omega + \chi_\alpha$


$K = -\ln\left[i \int_X \Omega \wedge \bar{\Omega} \right]$


h12 + h21
(1,2)
(0,3)
K(z) = -ln [i ∫X Ω ∧ Ω̄]

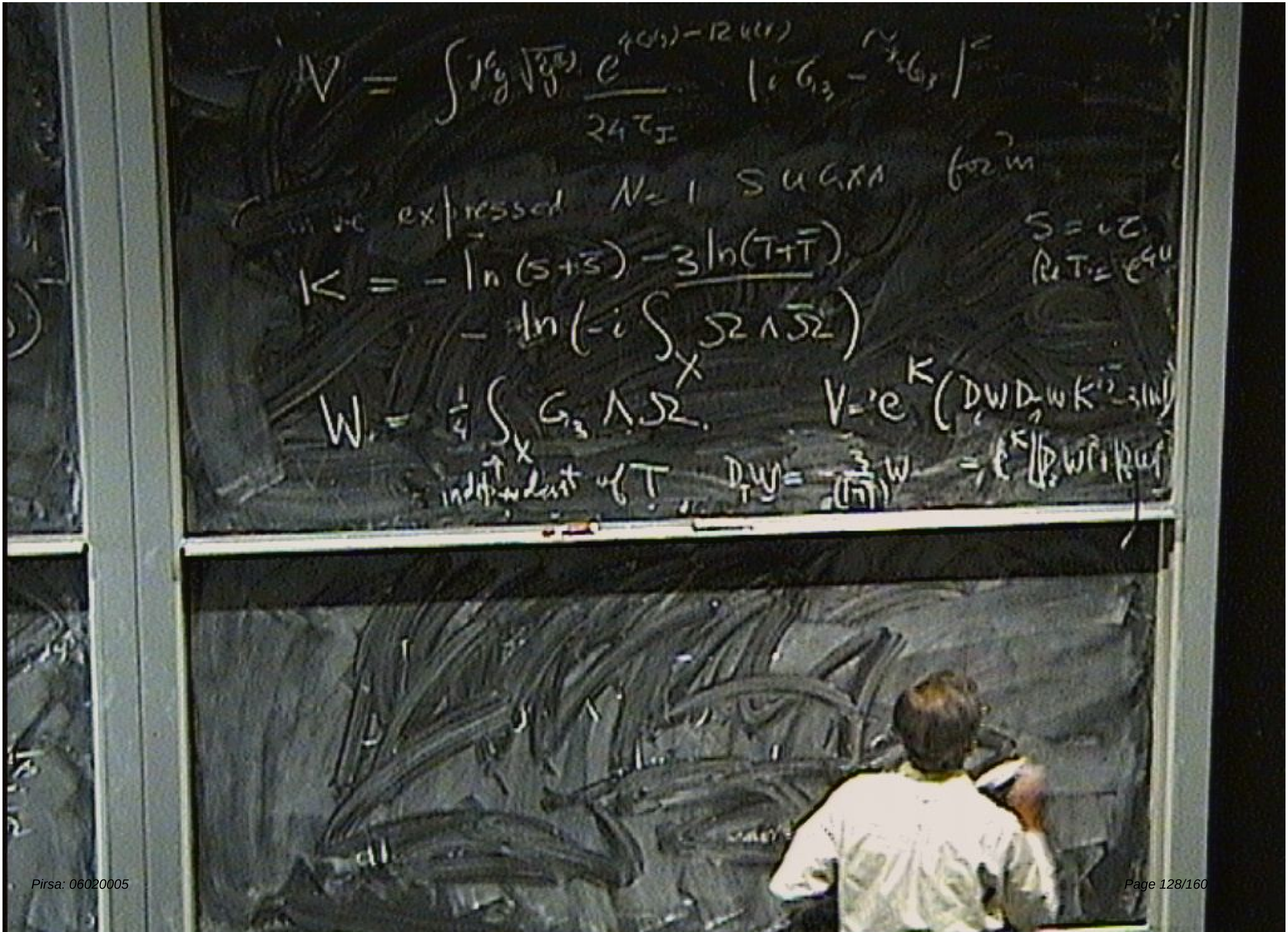
$3 \quad h_{12} + h_{21} \quad (1,2) \quad \chi_\alpha \quad *d\Omega = -i\,\Omega$

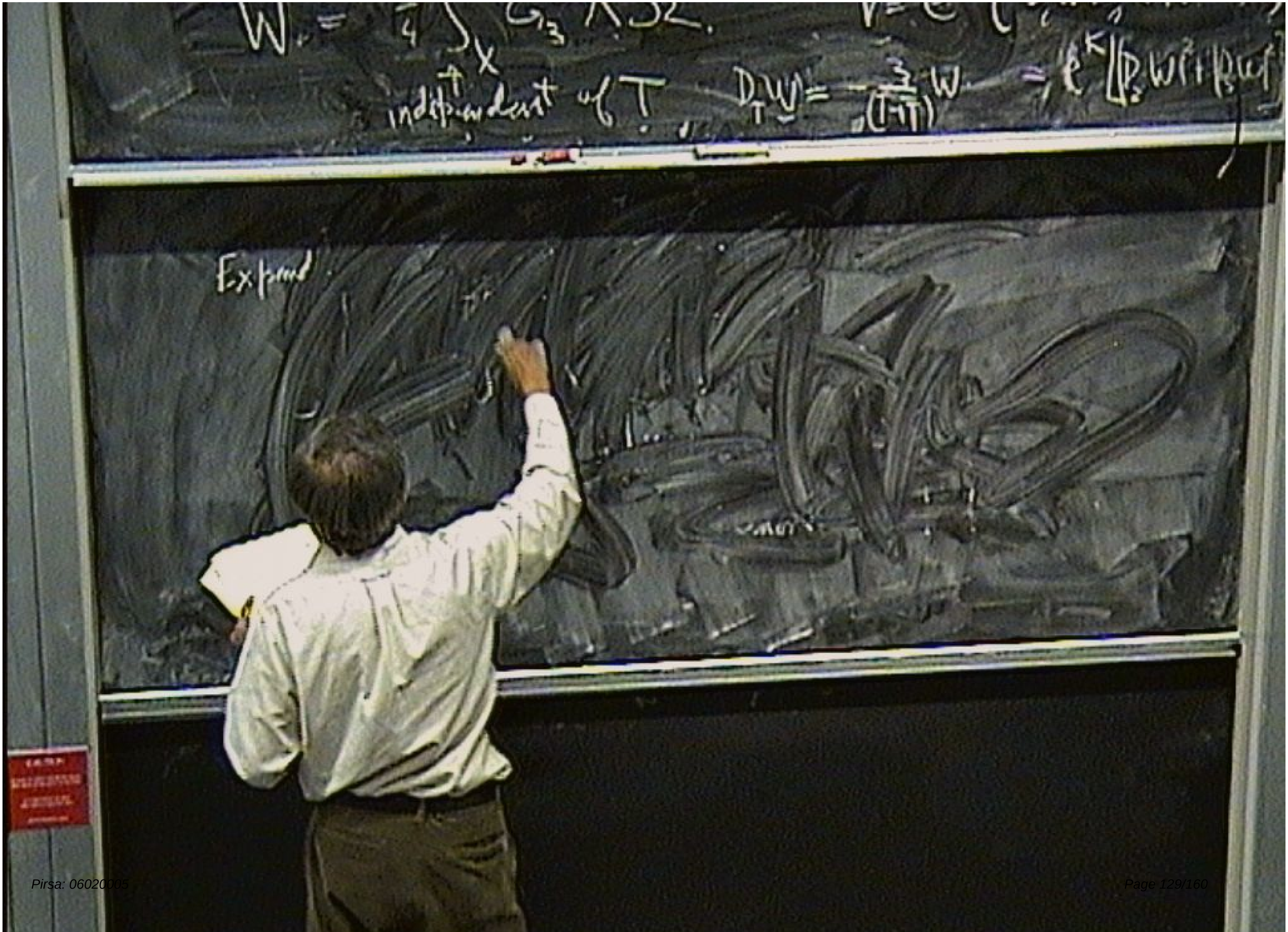
$4 \quad (0,3) \quad \bar{\Omega} \quad \chi_\alpha = i\chi_\alpha$

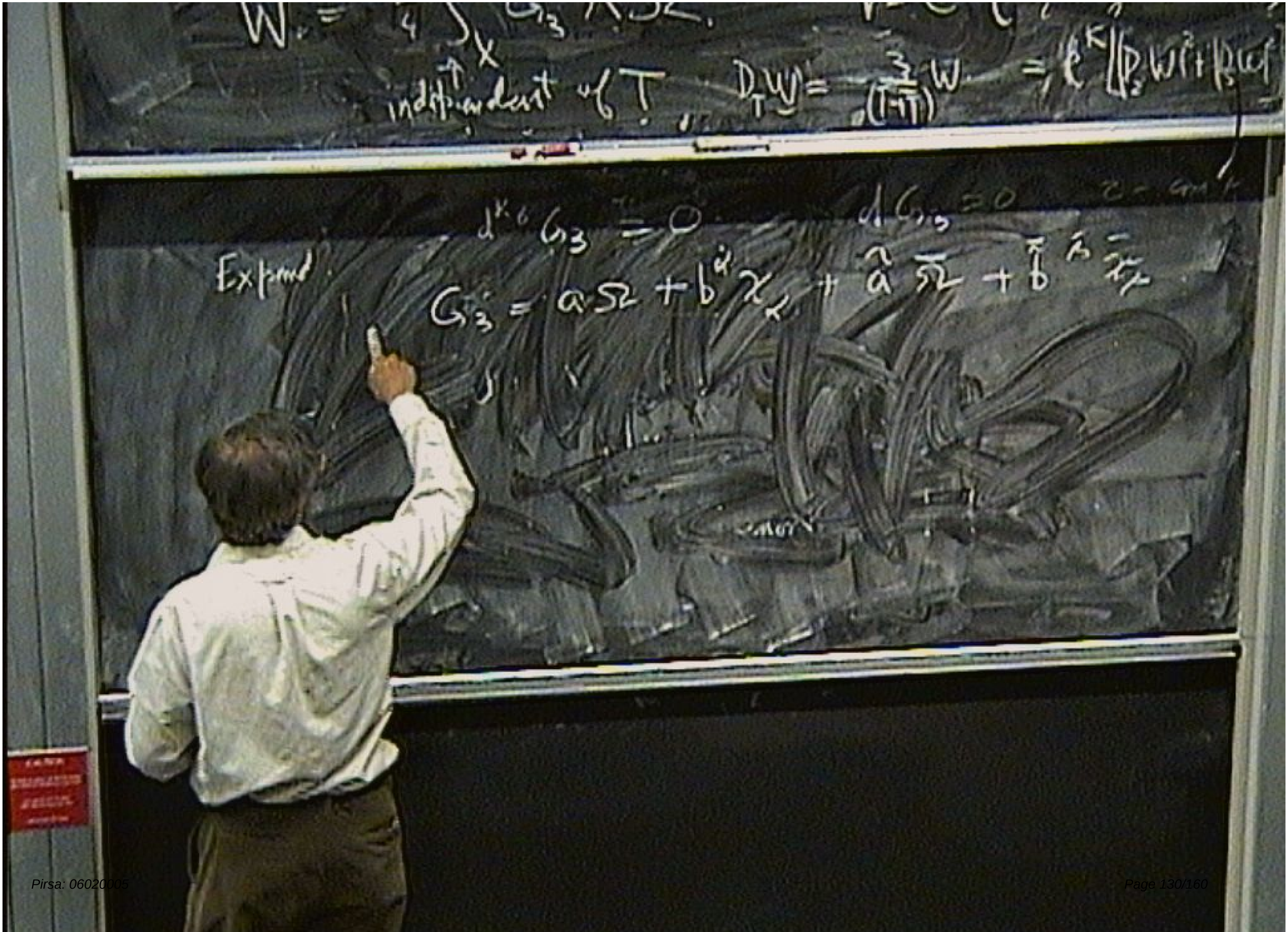
$$K(z,\bar z) = -\ln\left[i \int_X \Omega \wedge \bar{\Omega} \right]$$

$$\frac{\partial \Omega}{\partial z^\alpha} = k_\alpha(z,\bar z)\,\Omega + \chi_\alpha$$

$$\partial_\alpha K = -k_\alpha \qquad \partial_\alpha \partial_{\bar\beta} K(z,\bar z) = G_{\alpha\bar\beta} = -\frac{\int \chi_\alpha \wedge \bar\chi_{\bar\beta}}{\int \Omega \wedge \bar\Omega}$$


can be expressed N=1 SUGRA form
K = − ln (S + S̄) − 3 ln (T + T̄)
− ln (− i ∫X Ω ∧ Ω̄)
W = 1/4 ∫X G3 ∧ Ω
S = iτ
independent of T


independent of T
Expand


independent of T
Expand

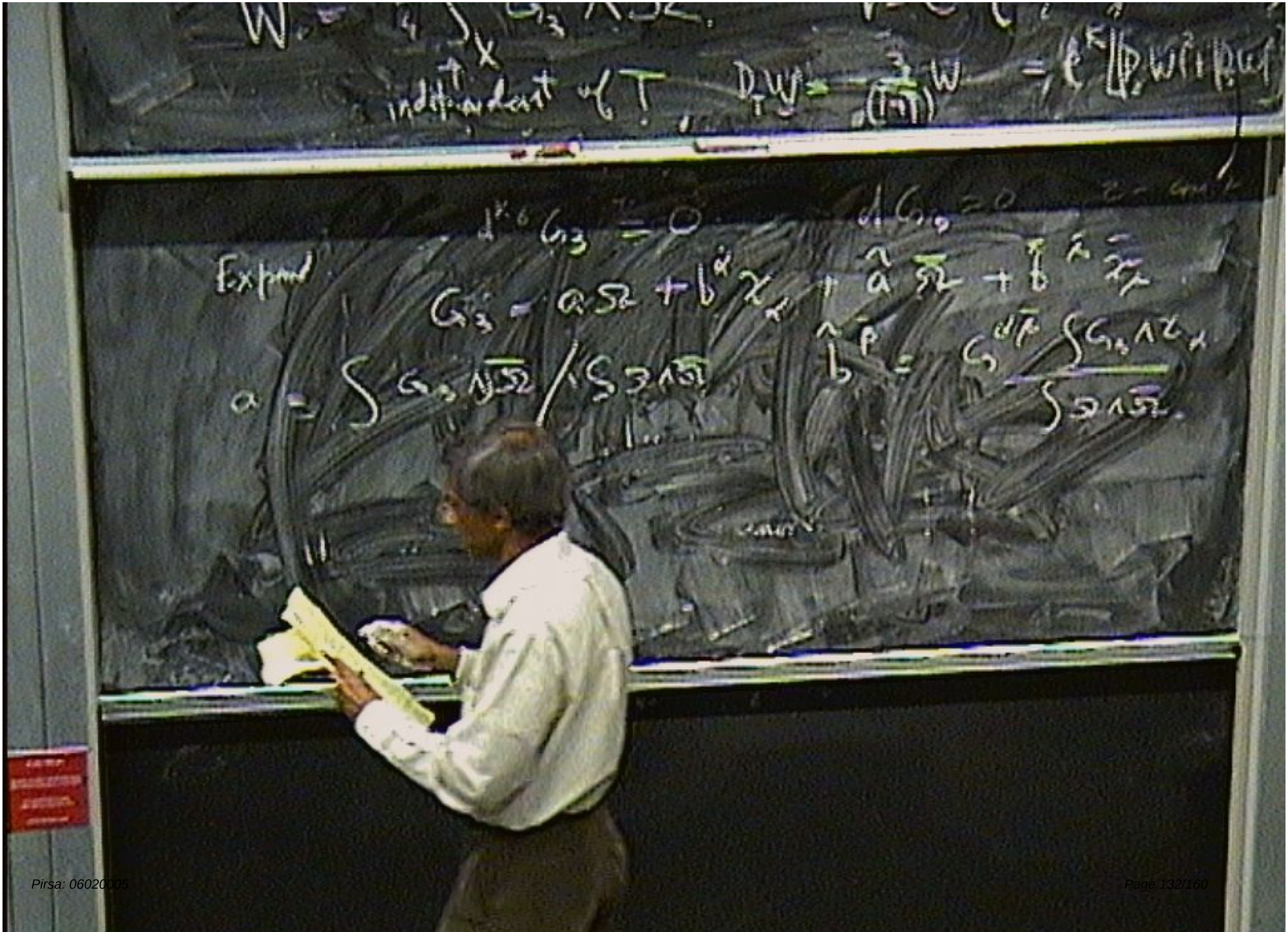
$W = \frac{1}{4}\int_X G_3 \wedge \Omega$

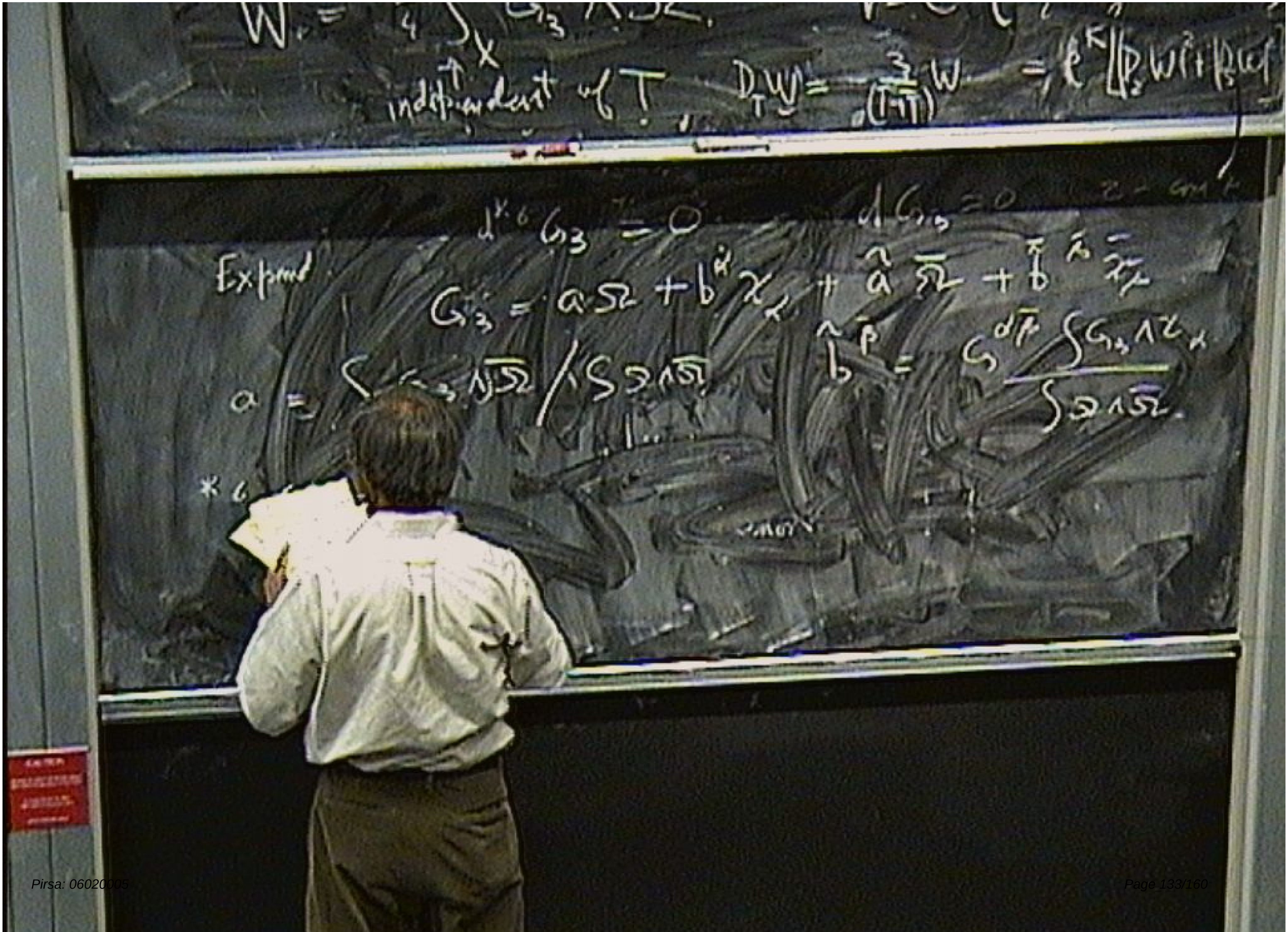
independent of T $\quad D_T W = \frac{3}{(T+\bar{T})} W = e^K \left[|D_T W|^2 + |D_\sigma W|^2 \ldots \right]$

$d^{\star_6} G_3 = 0 \qquad d\, G_3 = 0$

Expand

$$G_3 = a\Omega + b^\alpha \chi_\alpha + \hat{a}\,\bar{\Omega} + \bar{b}^{\hat{\alpha}}\,\bar{\chi}_\alpha$$


independent of T
Expand


independent of T
Expand

$24\tau_I$

Can be expressed $N=1$ sugra form

$S = i\tau$

$\mathrm{Re}\,T = e^{4u}$

$$K = -\ln(S+\bar S) - 3\ln(T+\bar T) - \ln\left(-i\int_X \Omega\wedge\bar\Omega\right)$$

$$W = \frac{1}{4}\int_X G_3\wedge\Omega \qquad V = e^K\left(D_i W D_{\bar j}\bar W K^{i\bar j} - 3|W|^2\right)$$

independent of T, $D_T W = \frac{-3}{(T+\bar T)} W$ $\quad = e^K(D_\alpha W \ldots)$

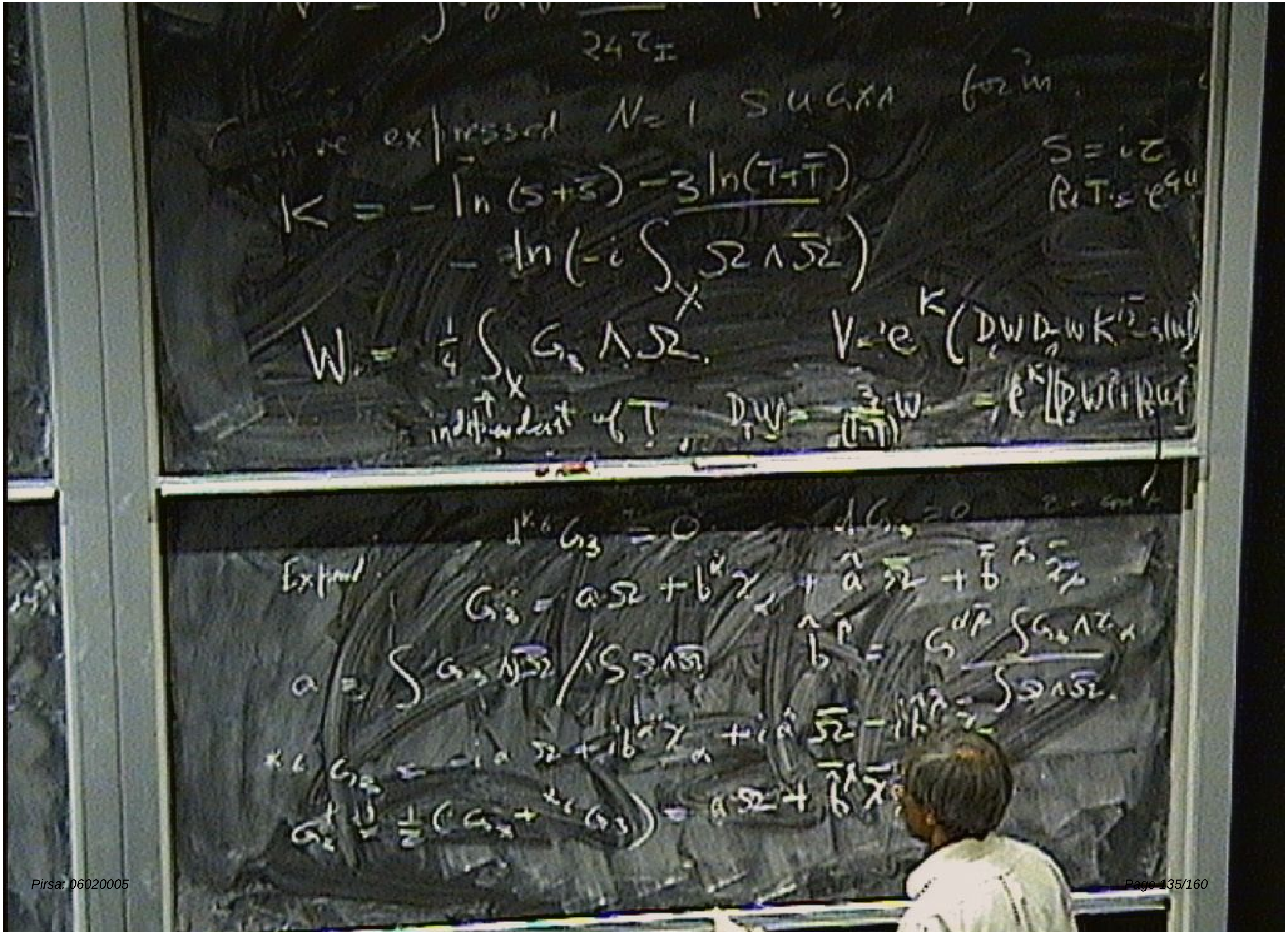
$d^{*}G_3 = 0 \qquad dG_3 = 0$

Expand

$$G_3 = a\Omega + b^\alpha\chi_\alpha + \hat a\,\bar\Omega + \hat b^{\bar\alpha}\bar\chi_{\bar\alpha}$$

$$a = \int G_3\wedge\bar\Omega \Big/ \int\Omega\wedge\bar\Omega \qquad \hat b^{\bar\beta} = \frac{G^{\alpha\bar\beta}\int G_3\wedge\chi_\alpha}{\int\Omega\wedge\bar\Omega}$$

$$*_6 G_3 = -ia\Omega + ib^\alpha\chi_\alpha + i\hat a\,\bar\Omega - i\hat b^{\bar\alpha}\bar\chi_{\bar\alpha}$$


24 τ_I
for in
Can be expressed N=1 SUGRA
K = - ln(S+S̄) - 3 ln(T+T̄)
- ln(-i ∫_X Ω ∧ Ω̄)
S = iτ
Re T = e^{4u}
W = 1/4 ∫_X G_3 ∧ Ω
V = e^K (D_i W D_j̄ W̄ K^{ij̄} - 3|W|^2)
independent of T
Expand
a = ∫ G_3 ∧ Ω̄ / ∫ Ω ∧ Ω̄

$24\tau_I$

Can be expressed $N=1$ SUGRA form

$S = i\tau$

$\mathrm{Re}\,T = e^{4u}$

$$K = -\ln(S+\bar S) - 3\ln(T+\bar T) - \ln\left(-i\int_X \Omega\wedge\bar\Omega\right)$$

$$W = \frac{1}{4}\int_X G_3\wedge\Omega$$

$$V = e^K\left(D_i W D_{\bar j}\bar W K^{i\bar j} - 3|W|^2\right)$$

independent of T, $D_T W = \frac{3}{(T+\bar T)} W$ $= e^K [D_S W \ldots]$

$d^{*6} G_3 = 0$ $\qquad dG_3 = 0$

Expand

$$G_3 = a\Omega + b^\alpha \chi_\alpha + \hat a\bar\Omega + \hat b^\alpha \bar\chi_\alpha$$

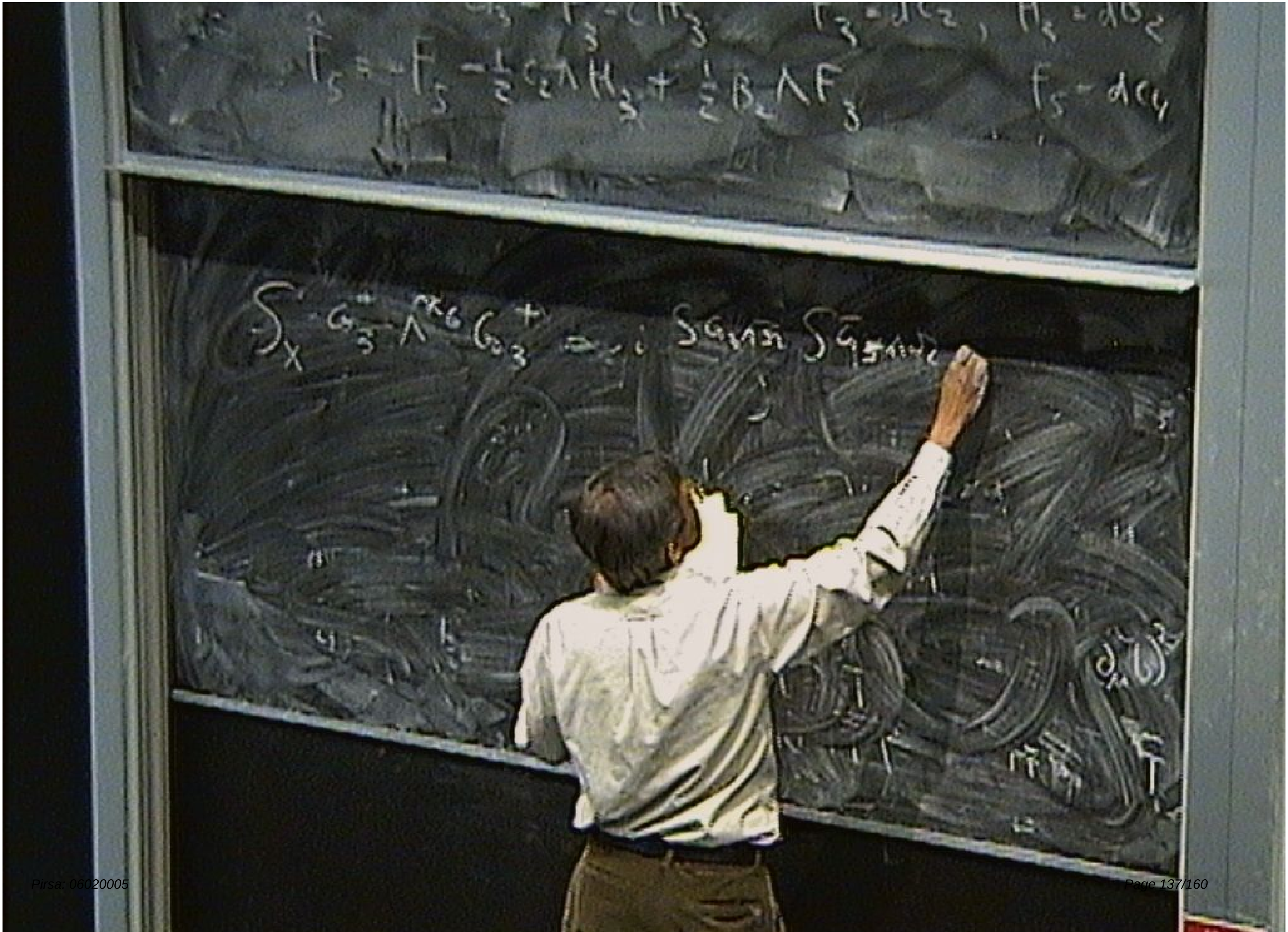
$$a = \int G_3\wedge\bar\Omega \Big/ \int \Omega\wedge\bar\Omega \qquad \hat b^\alpha = \frac{G_3^{\alpha\bar\beta}\int G_3\wedge\chi_\alpha}{\int \Omega\wedge\bar\Omega}$$

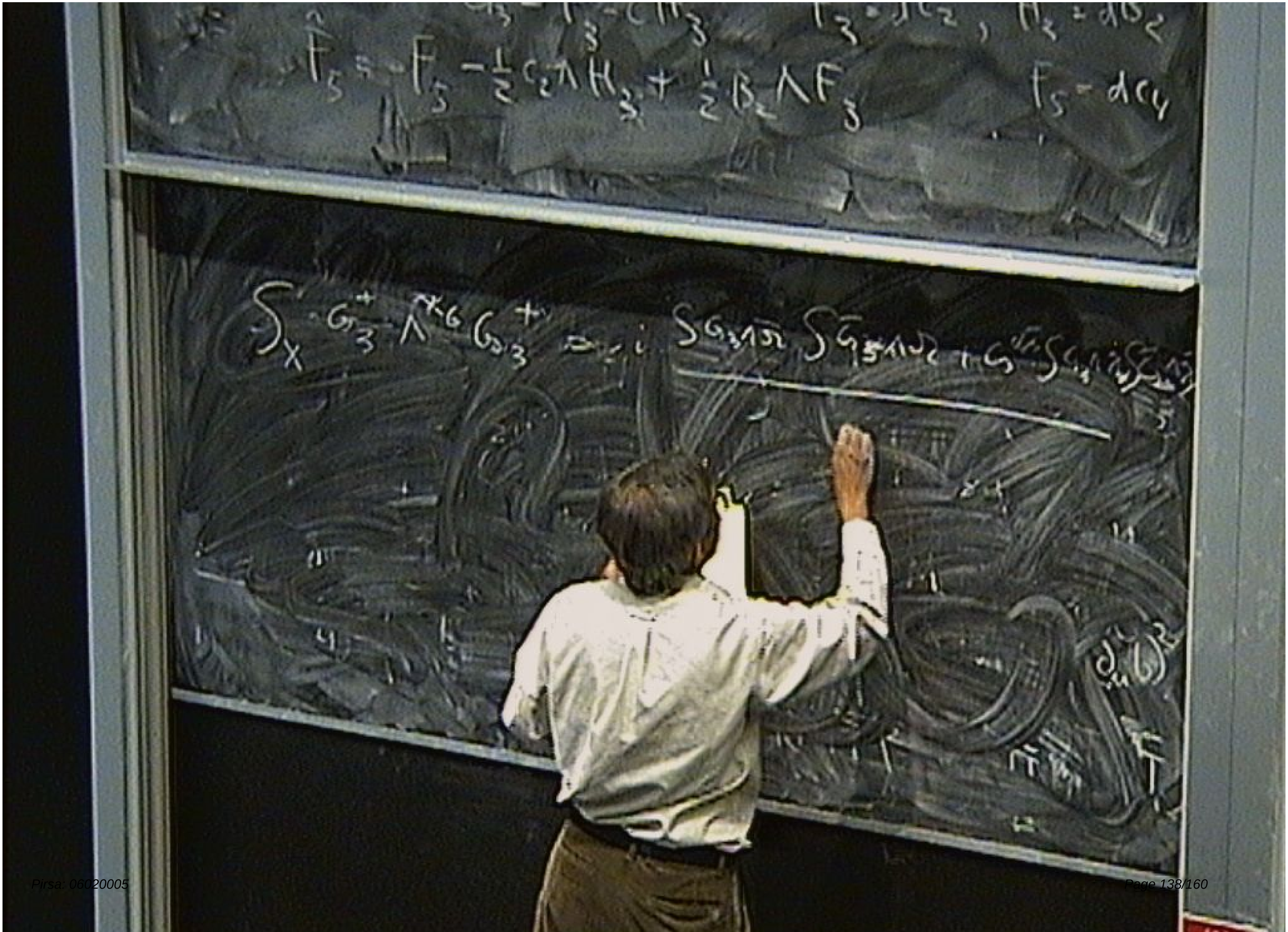
$$*_6 G_3 = -ia\Omega + ib^\alpha\chi_\alpha + i\hat a\bar\Omega - i\hat b^\alpha\bar\chi_\alpha$$

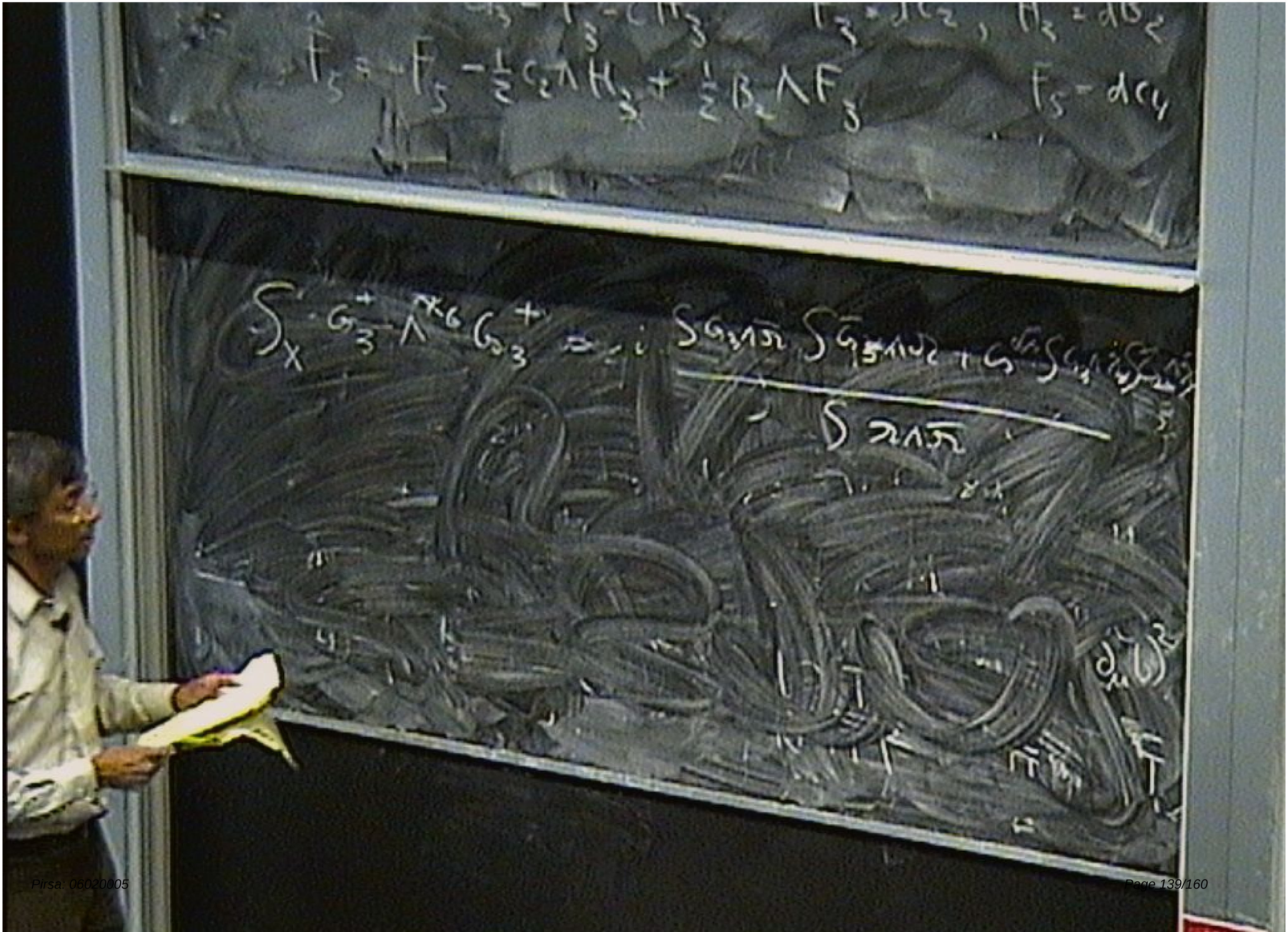
$$G_3^{\pm} = \frac{1}{2}\left(G_3 \pm i *_6 G_3\right) = a\Omega + b^\alpha\chi_\alpha$$

$$\hat a\bar\Omega + \hat b^\alpha\bar\chi_\alpha$$

$\bar G_3$


F̃5 = F5 − ½ C2 ∧ H3 + ½ B2 ∧ F3
F5 = dC4


$\hat{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3$
$F_5 = dC_4$


$\tilde F_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3$
$F_5 = dC_4$
$H_3 = dB_2$

$W = \frac{1}{4}\int_X G_3 \wedge \Omega$

independent of T, $D_T W = \frac{3}{(T+\bar T)} W = e^K [\partial_T W + \partial_T K W]$

$d^{\dagger 6} G_3 = 0 \qquad d G_3 = 0$

Expand

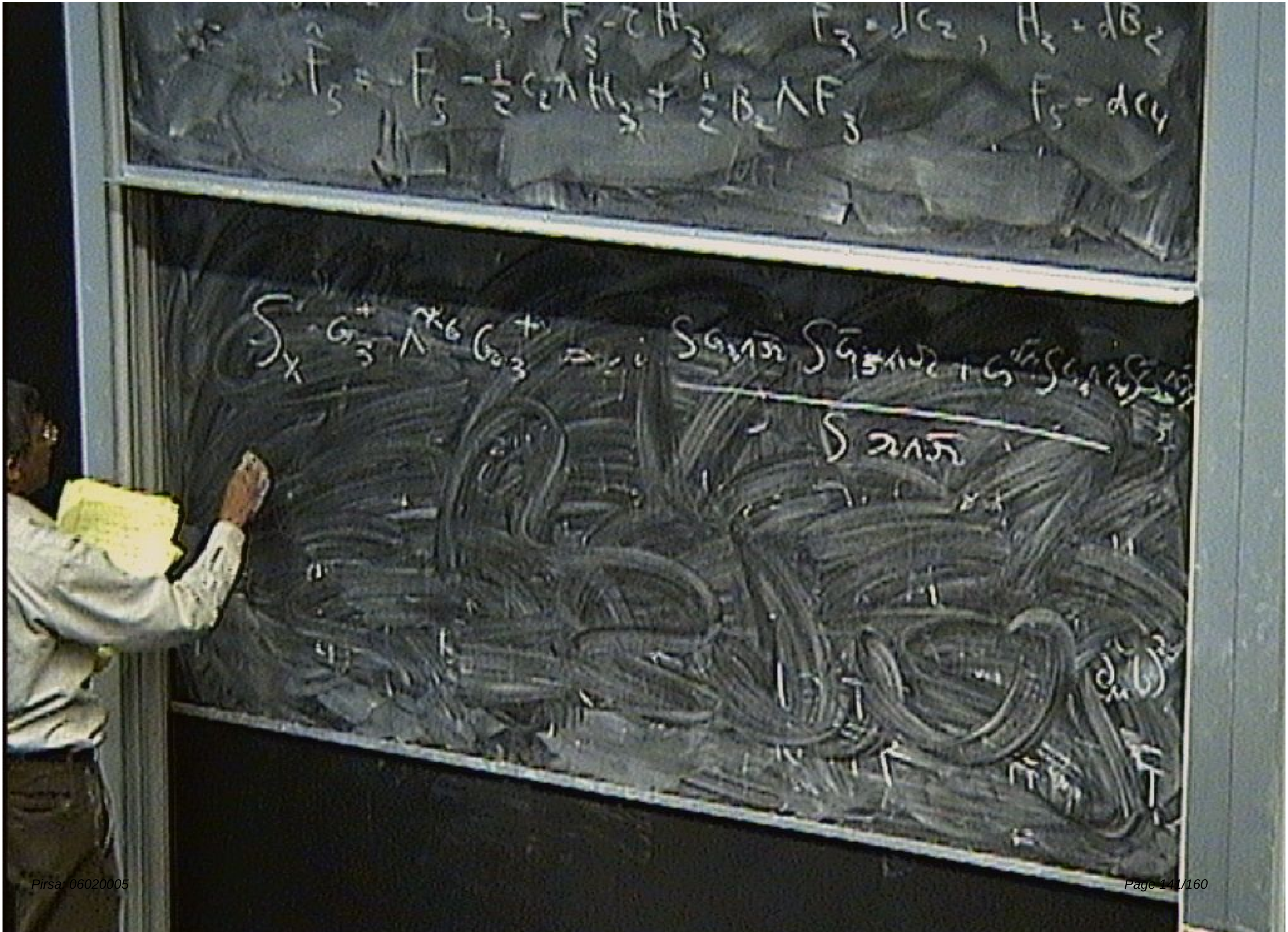
$$G_3 = a\Omega + b^\alpha \chi_\alpha + \hat a \bar\Omega + \hat b^{\bar\beta} \bar\chi_{\bar\beta}$$

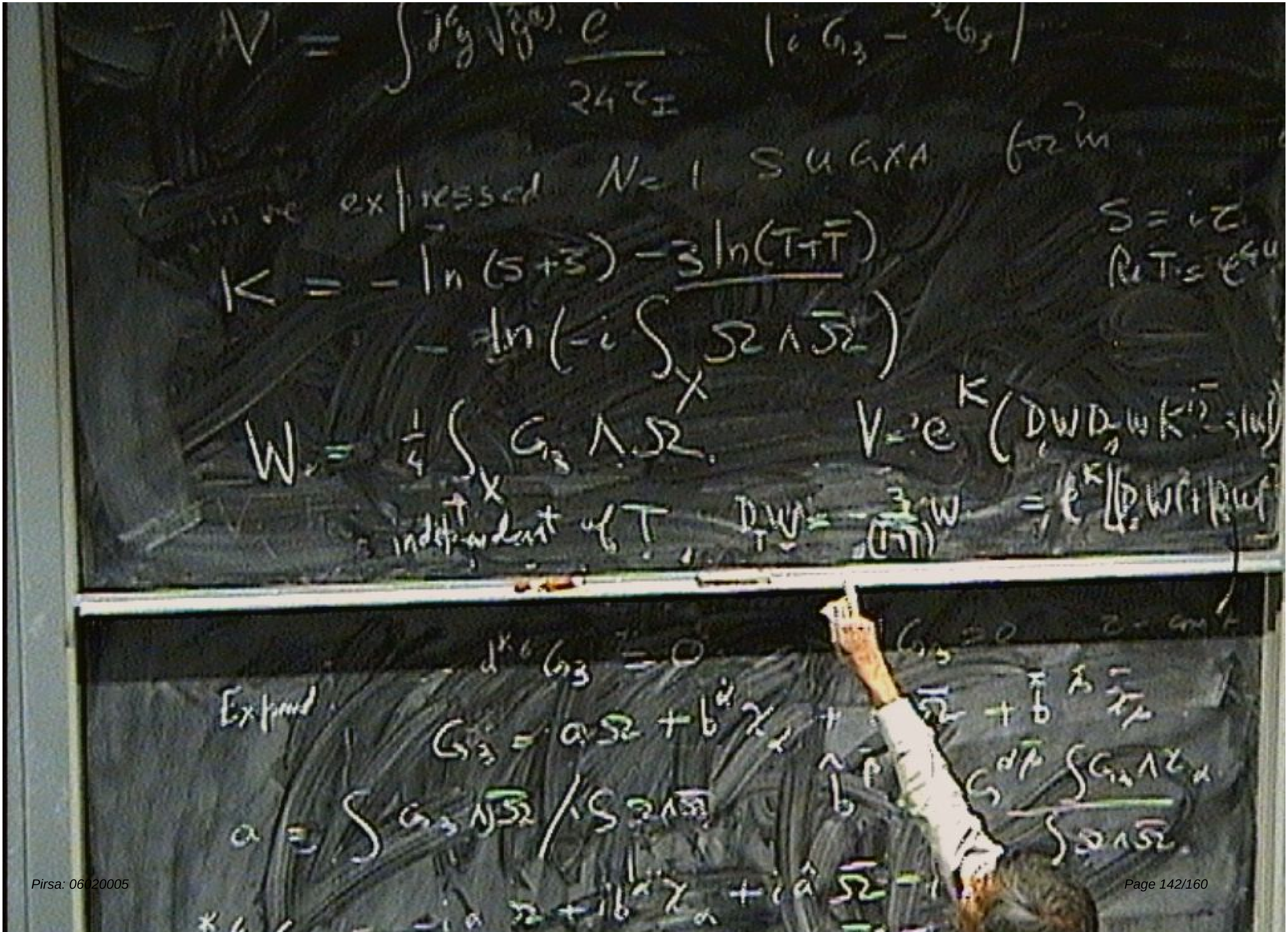
$$a = \int G_3 \wedge \bar\Omega \Big/ \int \Omega \wedge \bar\Omega \qquad \hat b^{\bar\beta} = G^{\alpha\bar\beta} \frac{\int G_3 \wedge \chi_\alpha}{\int \Omega \wedge \bar\Omega}$$

$$*_6 G_3 = -ia\Omega + ib^\alpha \chi_\alpha + i\hat a \bar\Omega - i\hat b^{\bar\beta} \bar\chi_{\bar\beta}$$

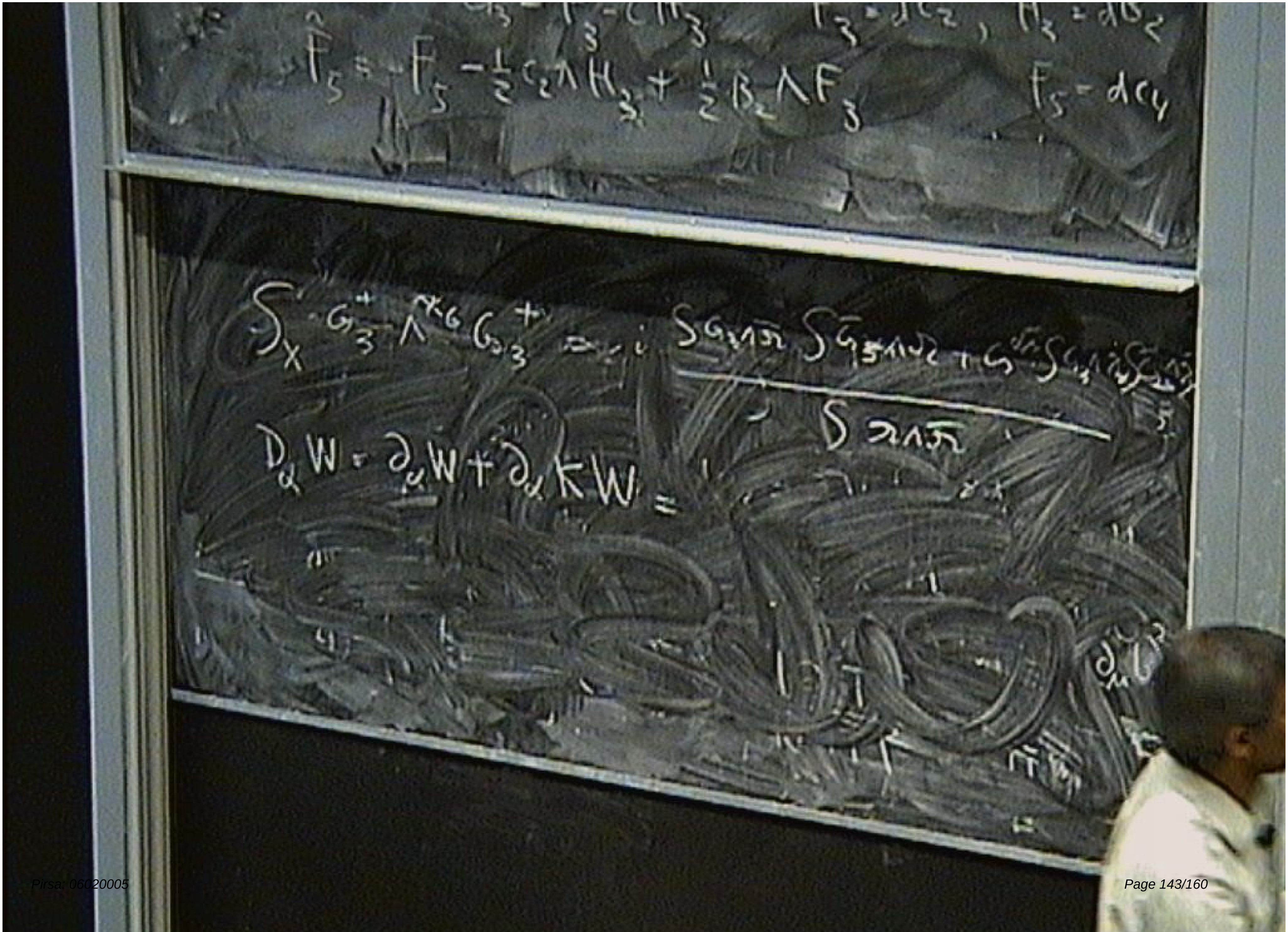
$$G_3^+ = \frac{1}{2}(G_3 + *_6 G_3) = a\Omega + \hat b^{\bar\beta} \bar\chi_{\bar\beta}$$

$$\bar G_3^+ = \bar a \bar\Omega + \bar{\hat b}^{\alpha} \chi_\alpha$$

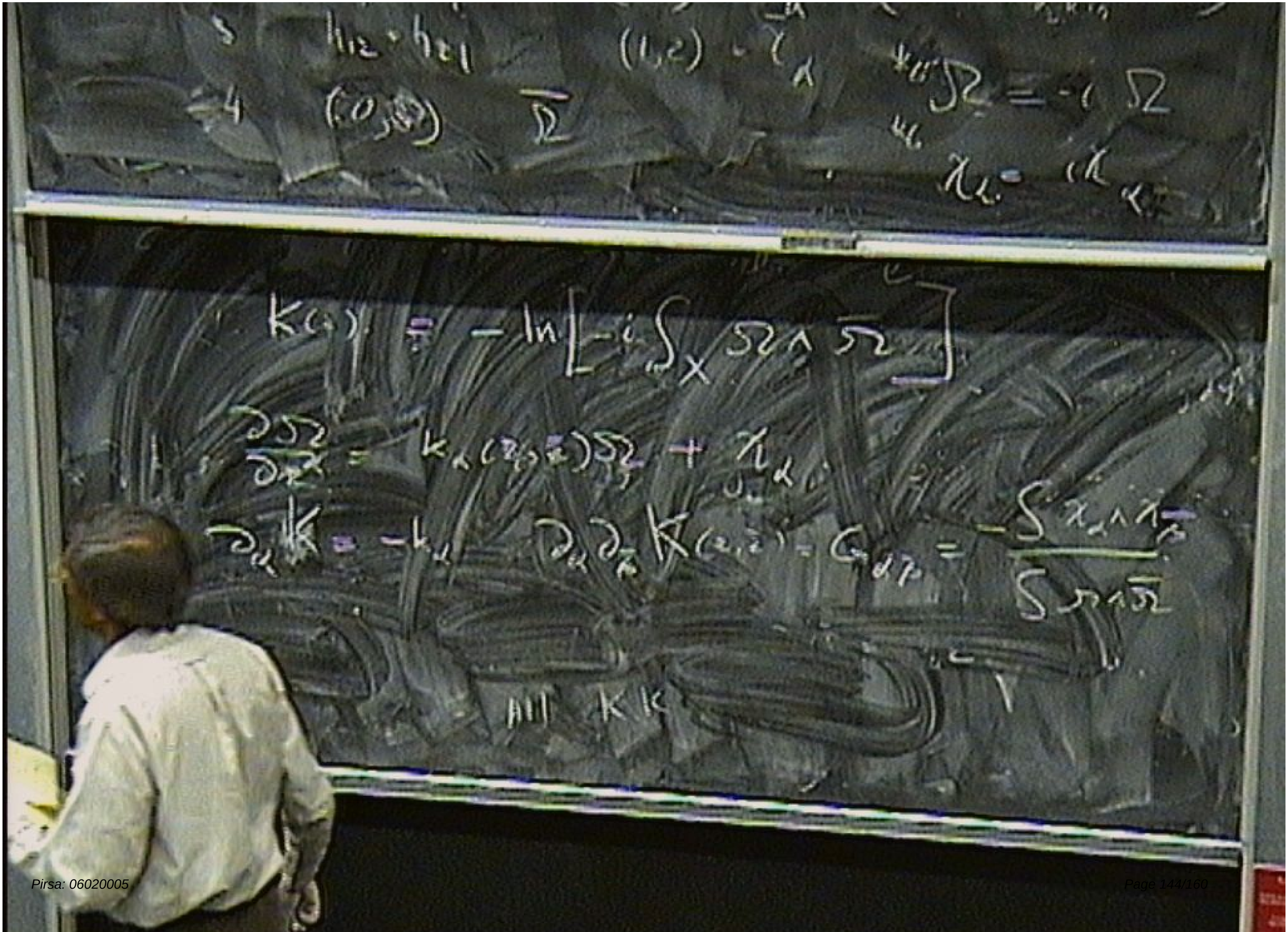

F3 = dC2 , H3 = dB2
F̂5 = F5 − ½ C2 ∧ H3 + ½ B2 ∧ F3
F5 = dC4



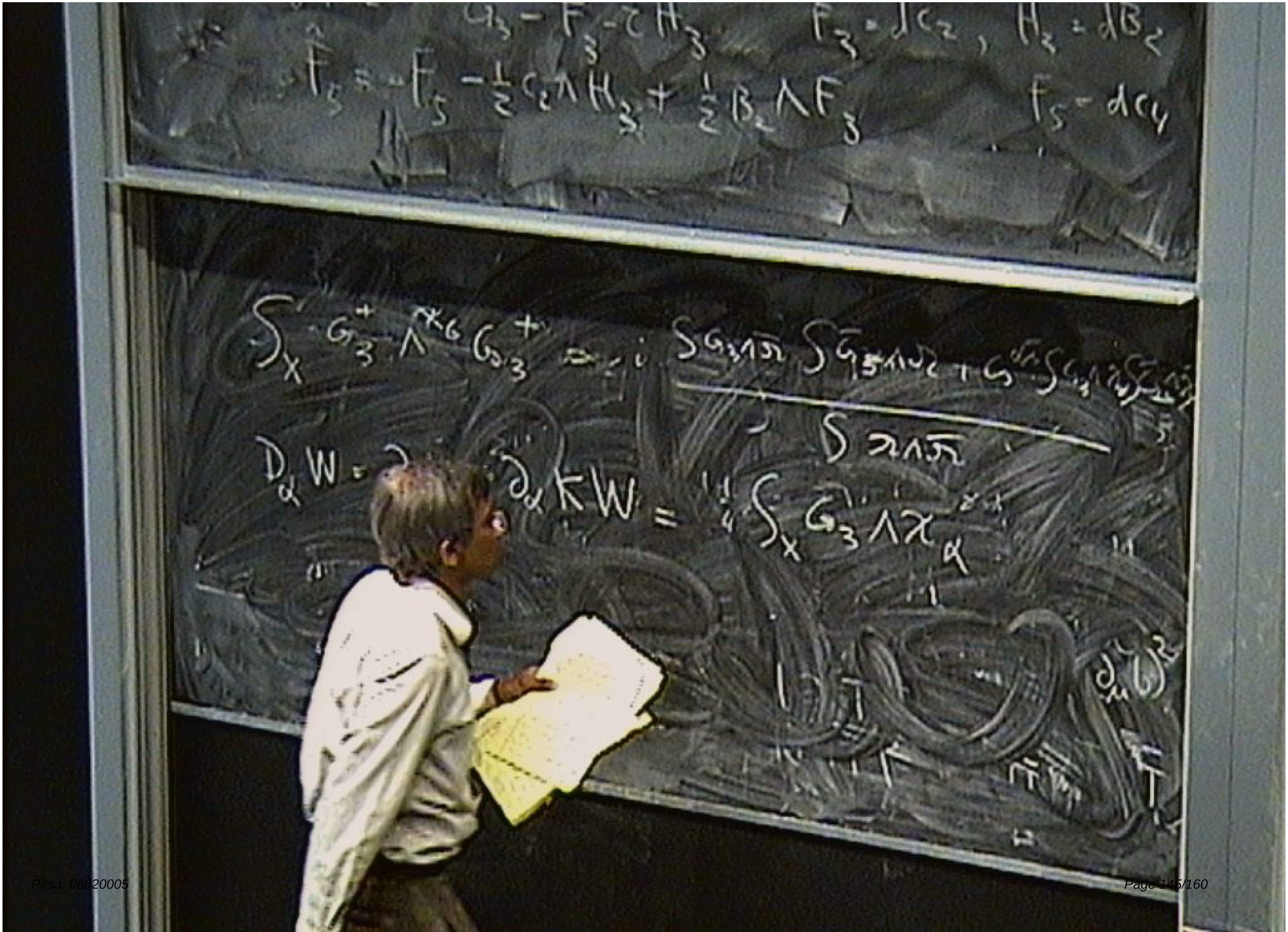
expressed N=1 SUGRA form
K = - ln(S+S̄) - 3 ln(T+T̄)
- ln(-i ∫_X Ω∧Ω̄)
W = 1/4 ∫_X G_3 ∧ Ω
independent of T
Expand
G_3 = aΩ + b^α χ_α +

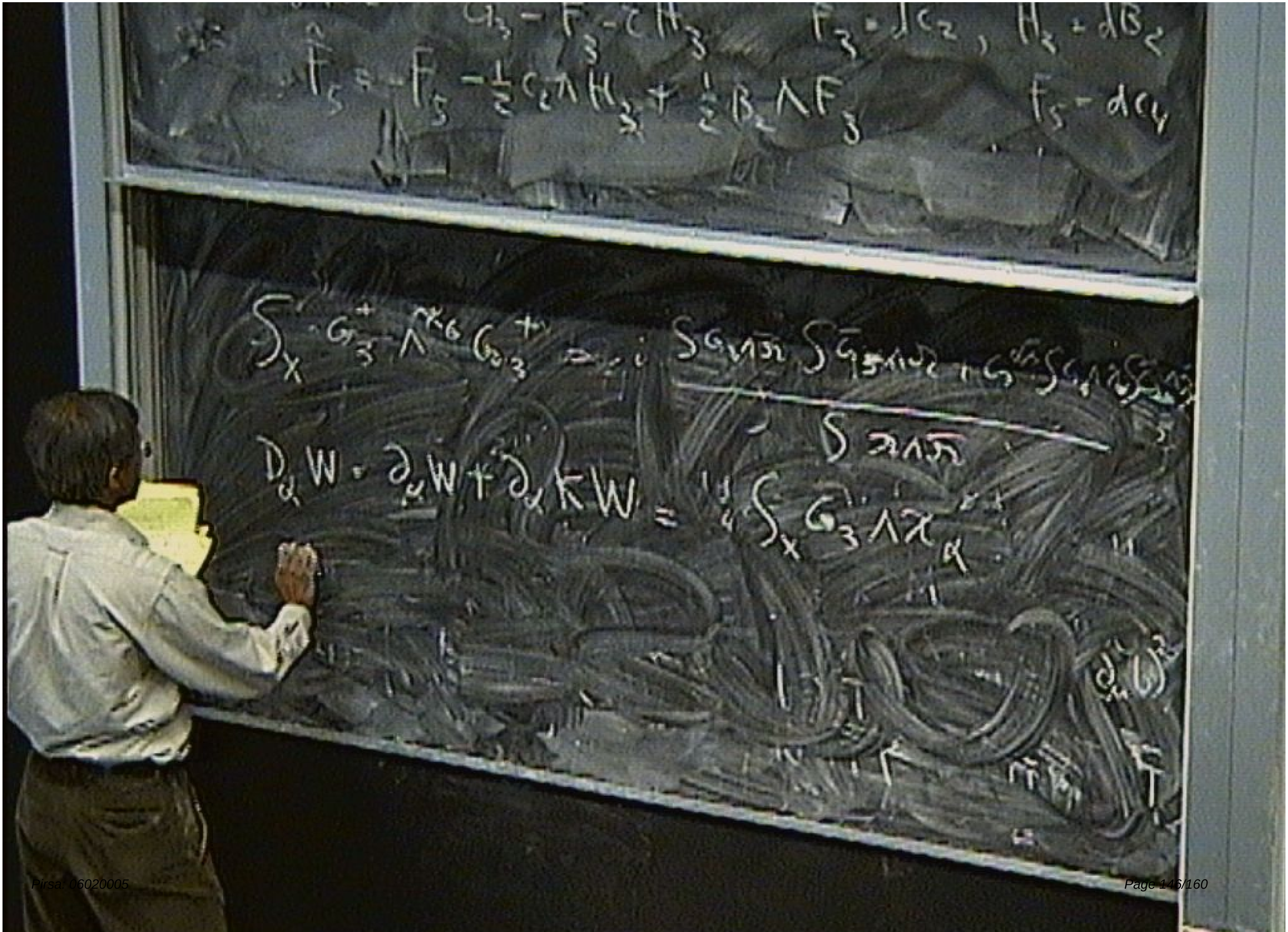


F_5 = dC_4
D_a W = ∂_a W + ∂_a K W =



$K(z) = -\ln\left[i \int_X \Omega \wedge \bar{\Omega} \right]$
$\frac{\partial \Omega}{\partial z^\alpha} = k_\alpha(z, \bar{z})\Omega + \chi_\alpha$
$\partial_\alpha K = -k_\alpha$
$\partial_\alpha \partial_{\bar\beta} K(z, \bar{z}) = G_{\alpha\bar\beta} = \frac{-\int \chi_\alpha \wedge \bar\chi_{\bar\beta}}{\int \Omega \wedge \bar\Omega}$




F3 = dC2 , H3 = dB2
F5 = dC4

$G_3 = F_3 - \tau H_3 \qquad F_3 = dC_2\,, \quad H_3 = dB_2$

$\tilde{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$

$$\int_X G_3^{+} \wedge *_6 G_3^{+} = i\, \frac{\int G_3 \wedge \bar{\Omega} \int \bar{G}_3 \wedge \Omega + \ldots}{\int \Omega \wedge \bar{\Omega}}$$

$$D_\alpha W = \partial_\alpha W + \partial_\alpha K\, W = \frac{1}{4} \int_X G_3 \wedge \chi_\alpha$$

$$D_\tau W = \partial_\tau W + \partial_\tau K\, W = \frac{1}{4}\, \frac{1}{\bar{\tau} - \tau} \int \bar{G}_3 \wedge \Omega$$

$$V = \int d^6y \sqrt{g^{(6)}} \, \frac{e^{4A(y) - 12u(x)}}{24\tau_I} \left| i G_3 - \tilde{*}_6 G_3 \right|^2$$

$\simeq$ expressed $N=1$ SUGRA form

$$K = -\ln(S+\bar{S}) - \underline{3\ln(T+\bar{T})} - \ln\left(-i \int_X \Omega \wedge \bar{\Omega}\right)$$

$S = i\tau$

$\mathrm{Re}\, T = e^{4u}$

$$W = \frac{1}{4} \int_X G_3 \wedge \Omega$$

independent of T, $D_T W = -\frac{3}{(T+\bar{T})} W$

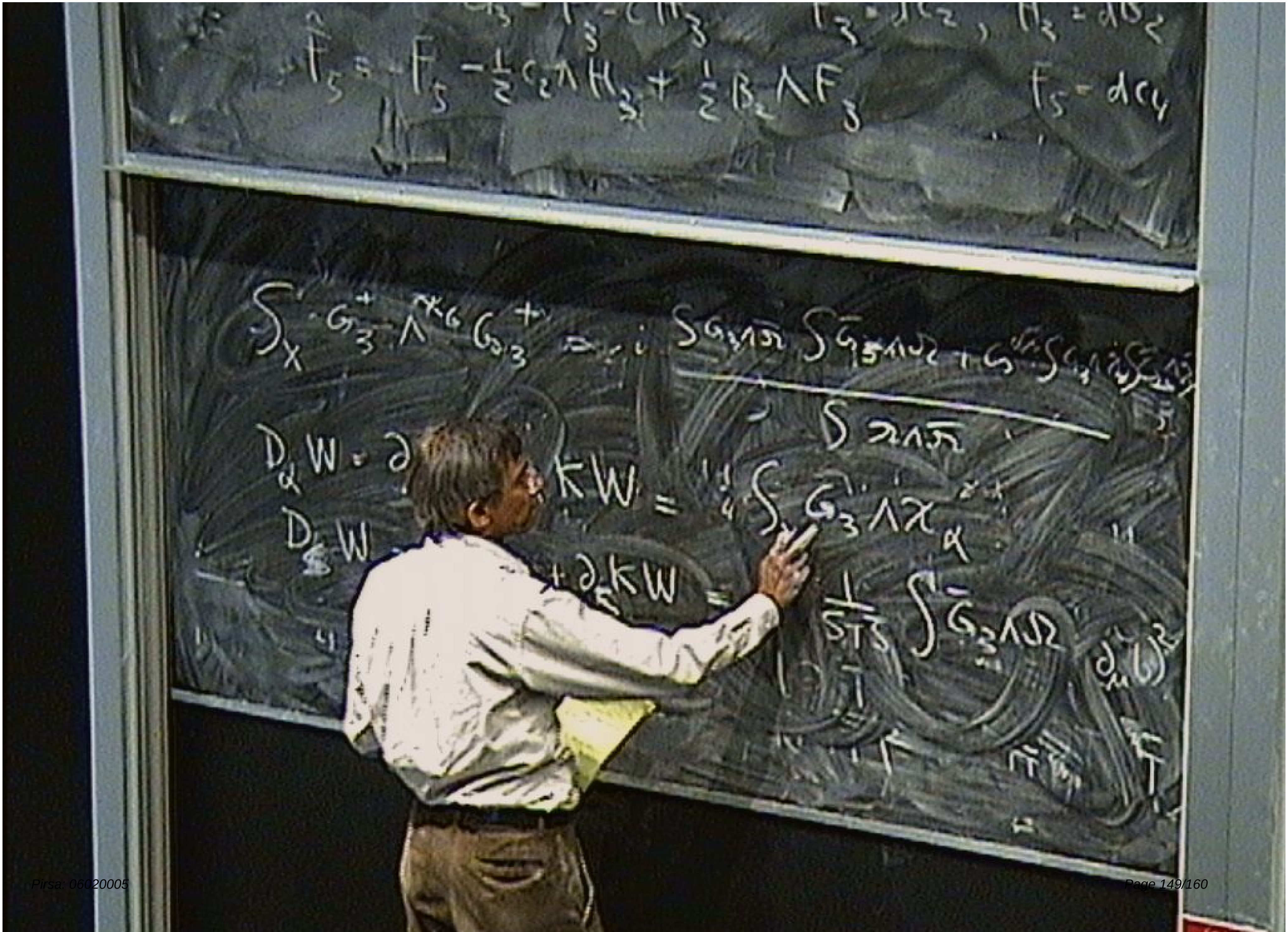
$$V = e^K \left(D_i W D_{\bar{j}} \bar{W} K^{i\bar{j}} - 3|W|^2 \right) = e^K \left[|D_\tau W|^2 + |D_\rho W|^2 \right]$$

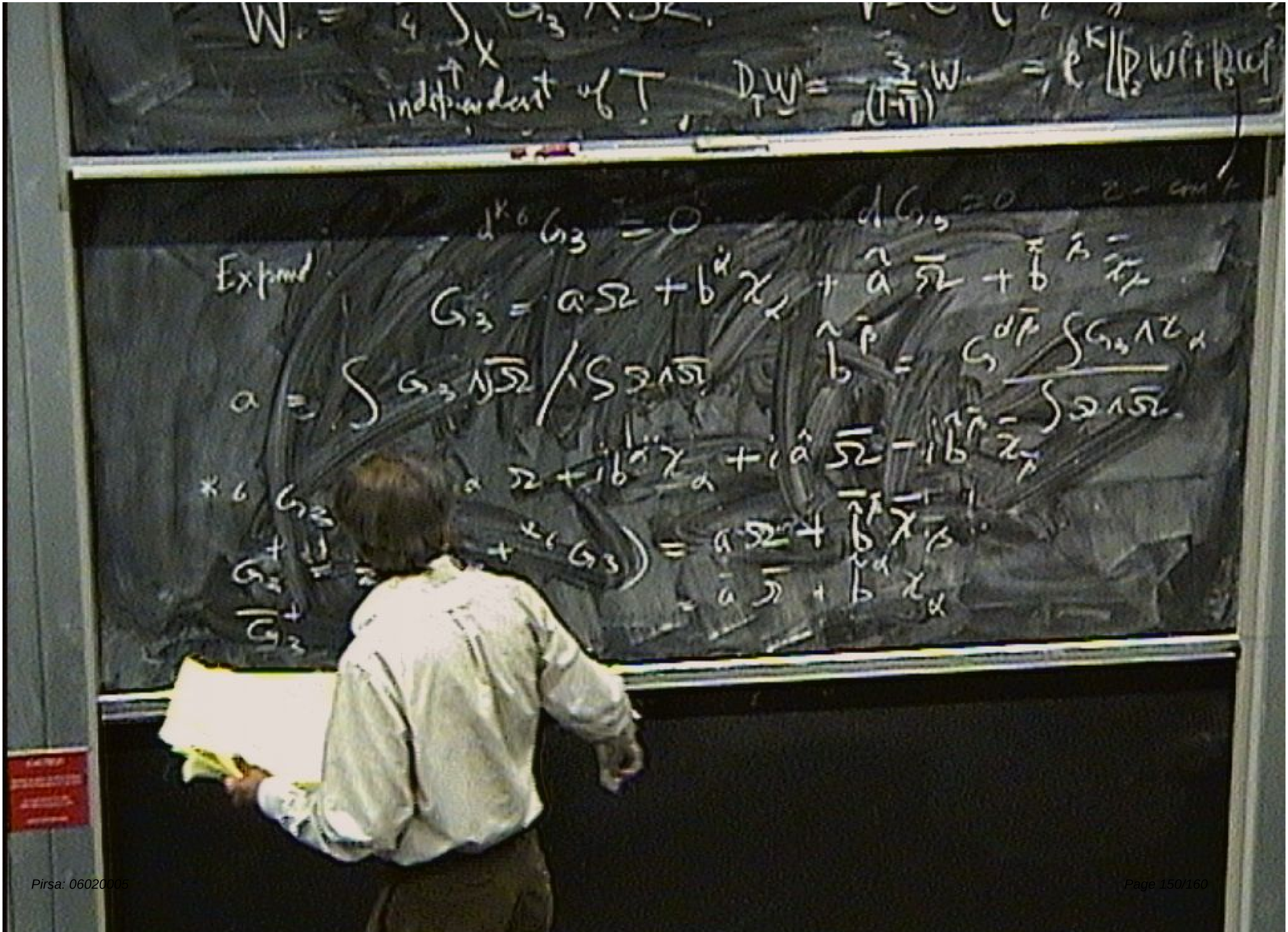
$d^{\,*6} G_3 = 0 \qquad dG_3 = 0$

Expand

$$G_3 = a\Omega + b^\alpha \chi_\alpha + \hat{a}\bar{\Omega} + \hat{b}^{\bar{\alpha}} \bar{\chi}_{\bar{\alpha}}$$

$$a = \int G_3 \wedge \bar{\Omega} \Big/ \int \Omega \wedge \bar{\Omega} \qquad \hat{b}^{\bar{\beta}} = G^{\alpha\bar{\beta}} \frac{\int G_3 \wedge \chi_\alpha}{\int \Omega \wedge \bar{\Omega}}$$




independent of T
Expand

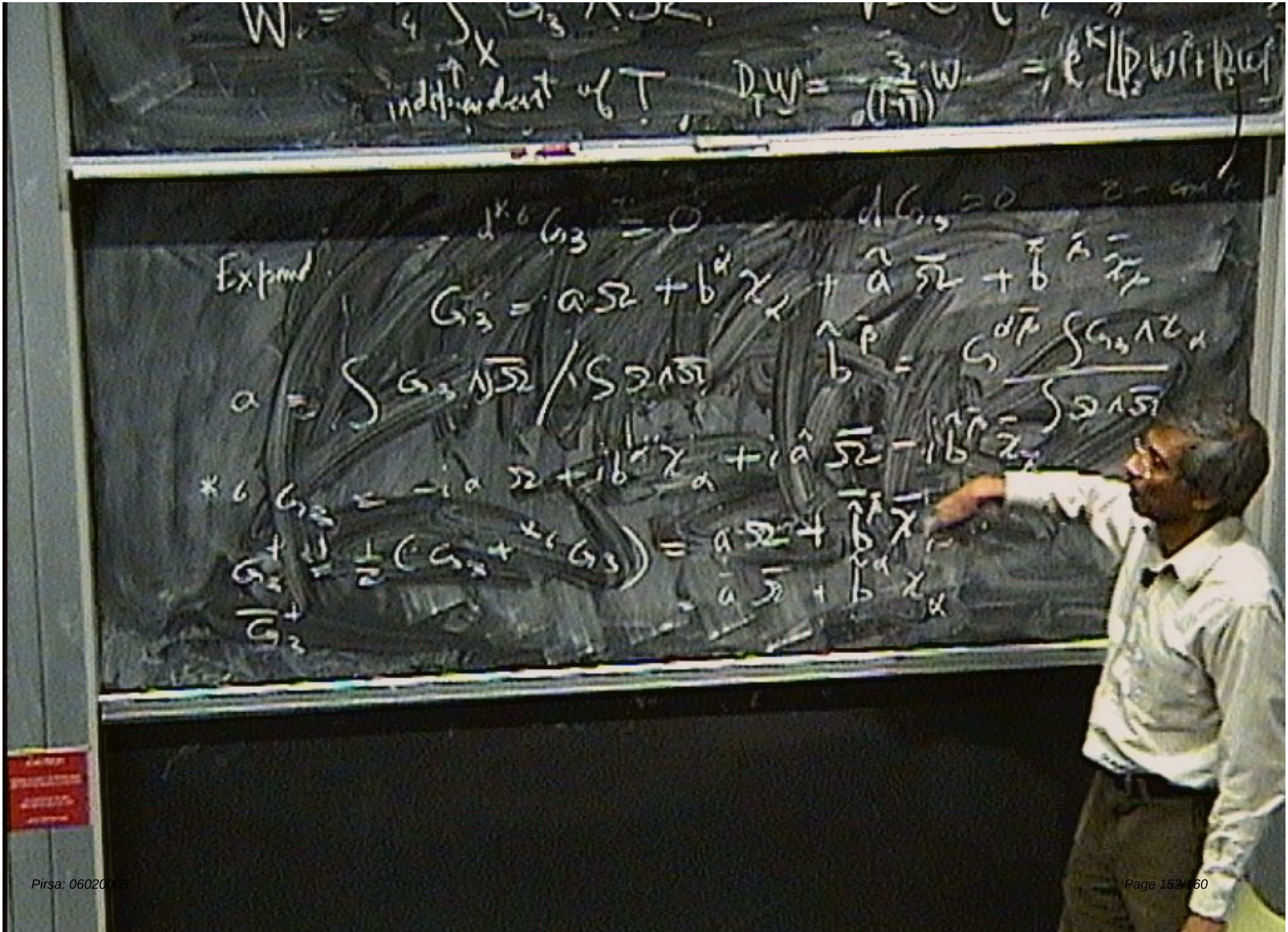
$G_3 = F_3 - \tau H_3 \qquad F_3 = dC_2\,, \quad H_3 = dB_2$

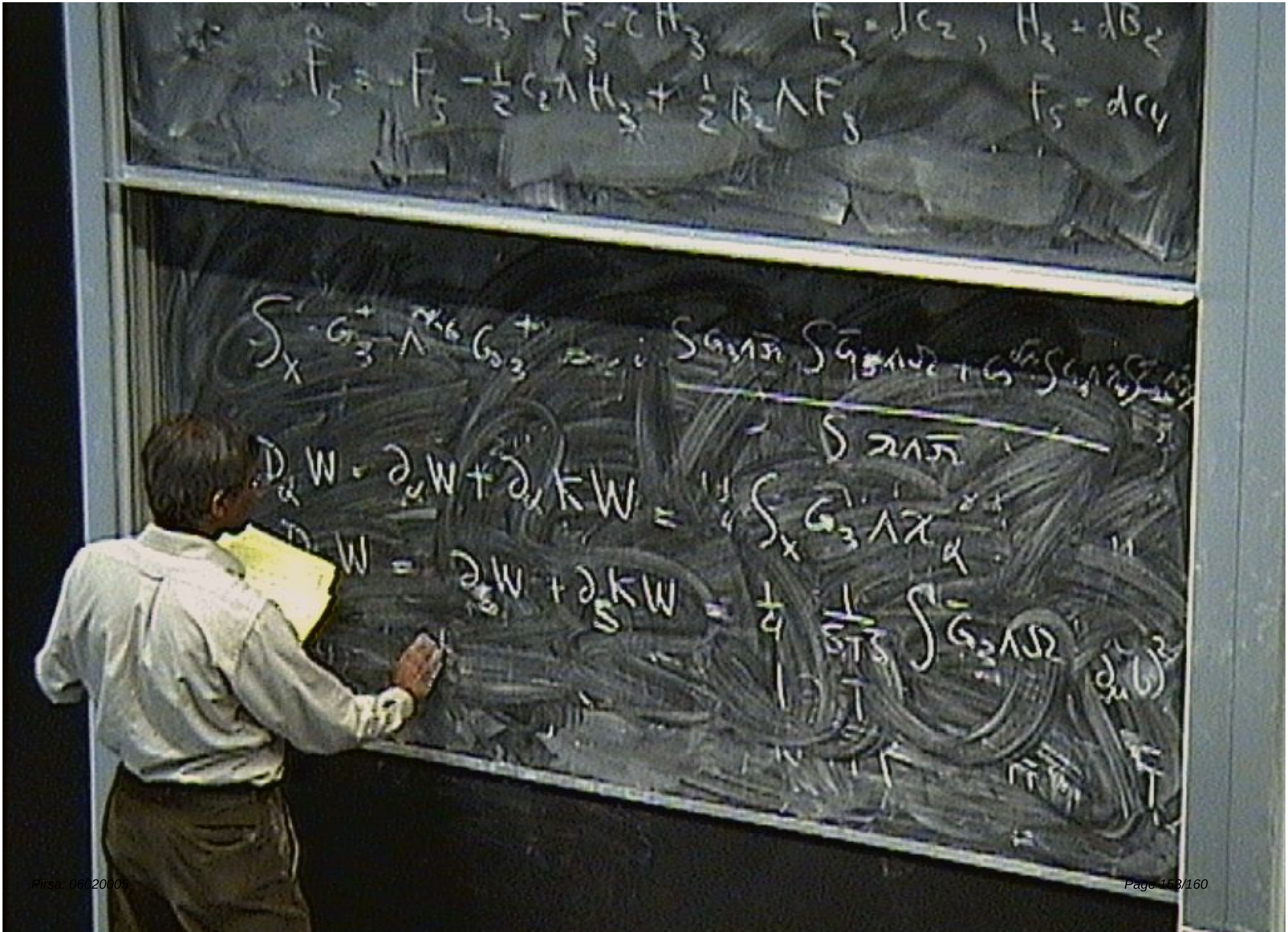
$\tilde{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$

$$\int_X G_3^+ \wedge {}^{*6} G_3^+ = \ldots \frac{\int G_3 \wedge \bar{\Omega} \int \bar{G}_3 \wedge \Omega + G^{\alpha\bar{\beta}} \int G_3 \wedge \chi_\alpha \int \bar{G}_3 \wedge \bar{\chi}_{\bar{\beta}}}{\int \Omega \wedge \bar{\Omega}}$$

$$D_\alpha W = \partial_\alpha W + \partial_\alpha K W = \frac{1}{4} \int_X G_3 \wedge \chi_\alpha$$

$$D_S W = \partial_S W + \partial_S K W = \frac{1}{4} \frac{1}{S - \bar{S}} \int \bar{G}_3 \wedge \Omega$$


independent of T
Expand
$G_3 = a\Omega + b^\alpha \chi_\alpha + \hat{a}\bar{\Omega} + \bar{b}^{\hat\alpha}\bar{\chi}_{\bar\alpha}$
$a = \int G_3 \wedge \bar\Omega / \int \Omega \wedge \bar\Omega$
$G_3^+ = \frac{1}{2}(G_3 + *_6 G_3) = a\Omega + \bar{b}^{\bar\alpha}\bar\chi_{\bar\alpha}$



$G_3 = F_3 - \tau H_3 \qquad F_3 = dC_2 \,,\quad H_3 = dB_2$

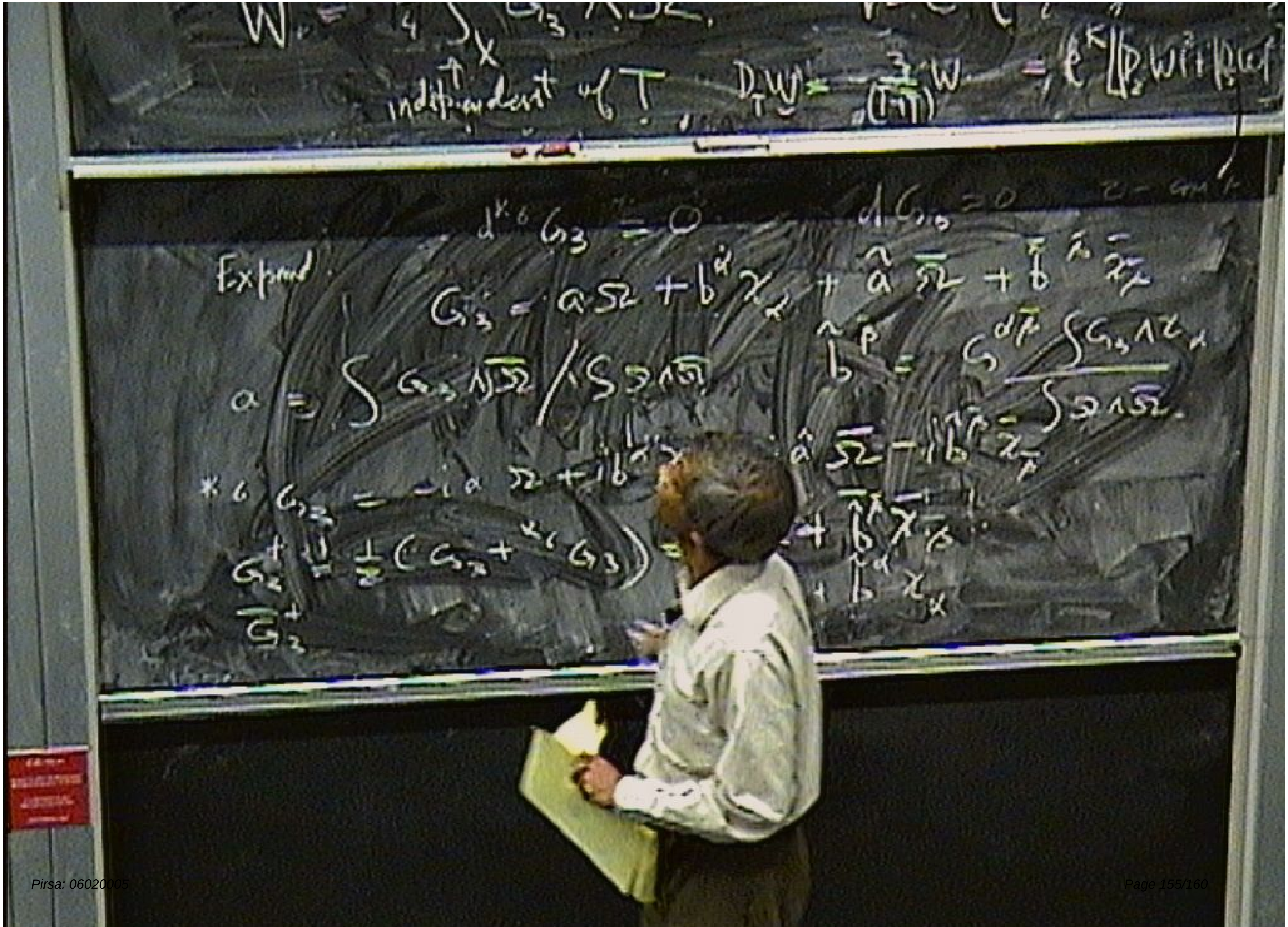
$\tilde{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3 \qquad F_5 = dC_4$

$\int_X G_3^+ \wedge *_6 G_3^+ = -i \dfrac{\int G_3 \wedge \bar\Omega \int \bar G_3 \wedge \Omega + \ldots}{\int \Omega \wedge \bar\Omega}$

$D_\alpha W = \partial_\alpha W + \partial_\alpha K W = \frac{1}{4} \int_X G_3 \wedge \chi_\alpha$

$D_S W = \partial_S W + \partial_S K W = \frac{1}{4} \frac{1}{S - \bar S} \int \bar G_3 \wedge \Omega$

$D_\alpha W = D_S W = 0 \qquad b = 0 = a$


independent of T
Expand

$$V = \int d^6y \sqrt{g^{(6)}}\, \frac{e^{4\omega(y) - 12u(x)}}{24\tau_I} \left| iG_3 - *_6 G_3 \right|^2$$

can be expressed $N=1$ SUGRA form

$S = i\tau$

$\mathrm{Re}\,T = e^{4u}$

$$K = -\ln(S+\bar{S}) - 3\ln(T+\bar{T}) - \ln\left(-i\int_X \Omega \wedge \bar{\Omega}\right)$$

$$W = \frac{1}{4}\int_X G_3 \wedge \Omega$$

independent of T

$V = e^K \left(D_i W D_{\bar{j}} \bar{W} K^{i\bar{j}} - 3|W|^2\right)$

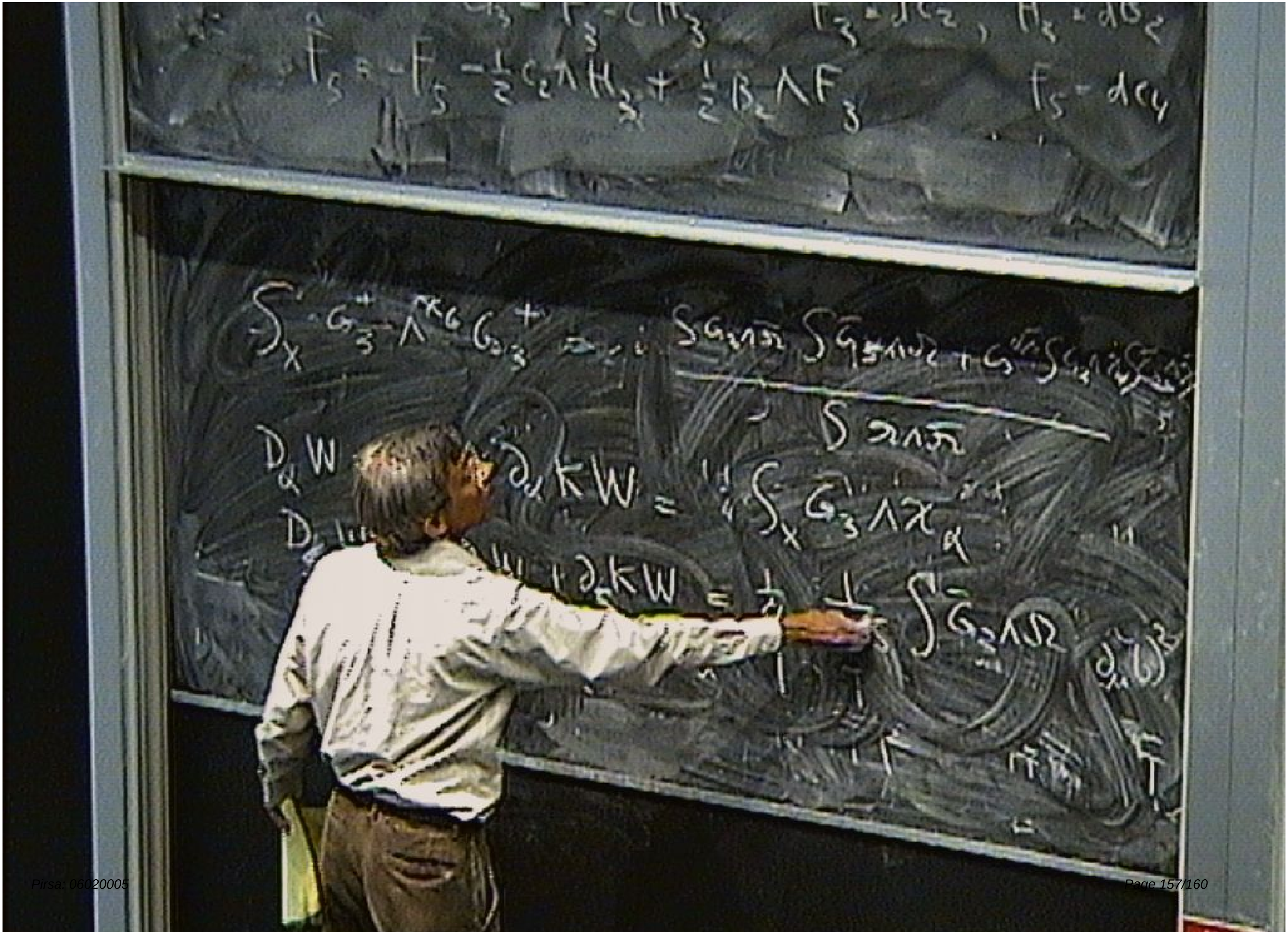
$D_T W = -\frac{3}{(T+\bar{T})} W$

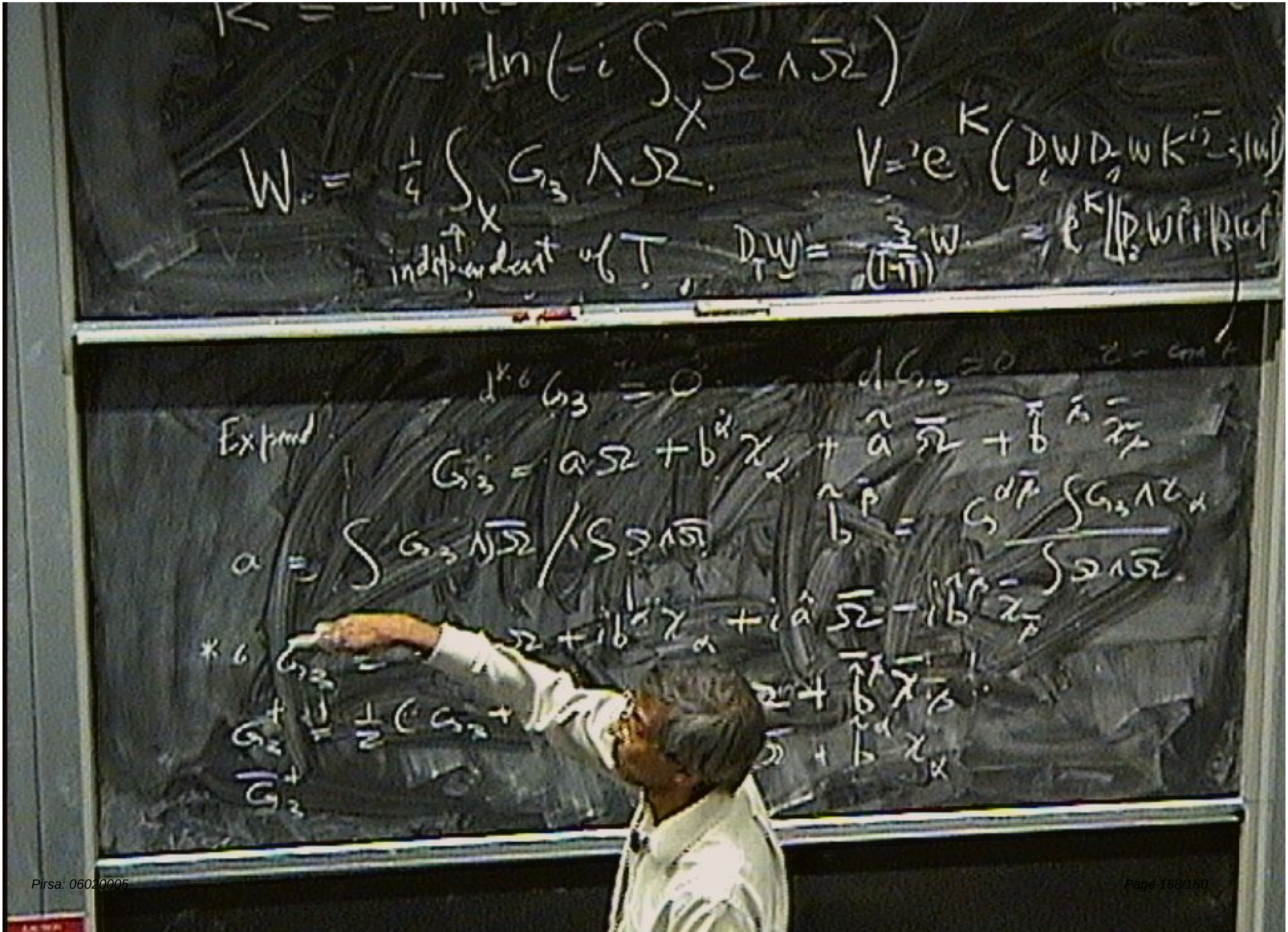
$= e^K \left[|D_\tau W|^2 + |D_S W|^2 \right]$

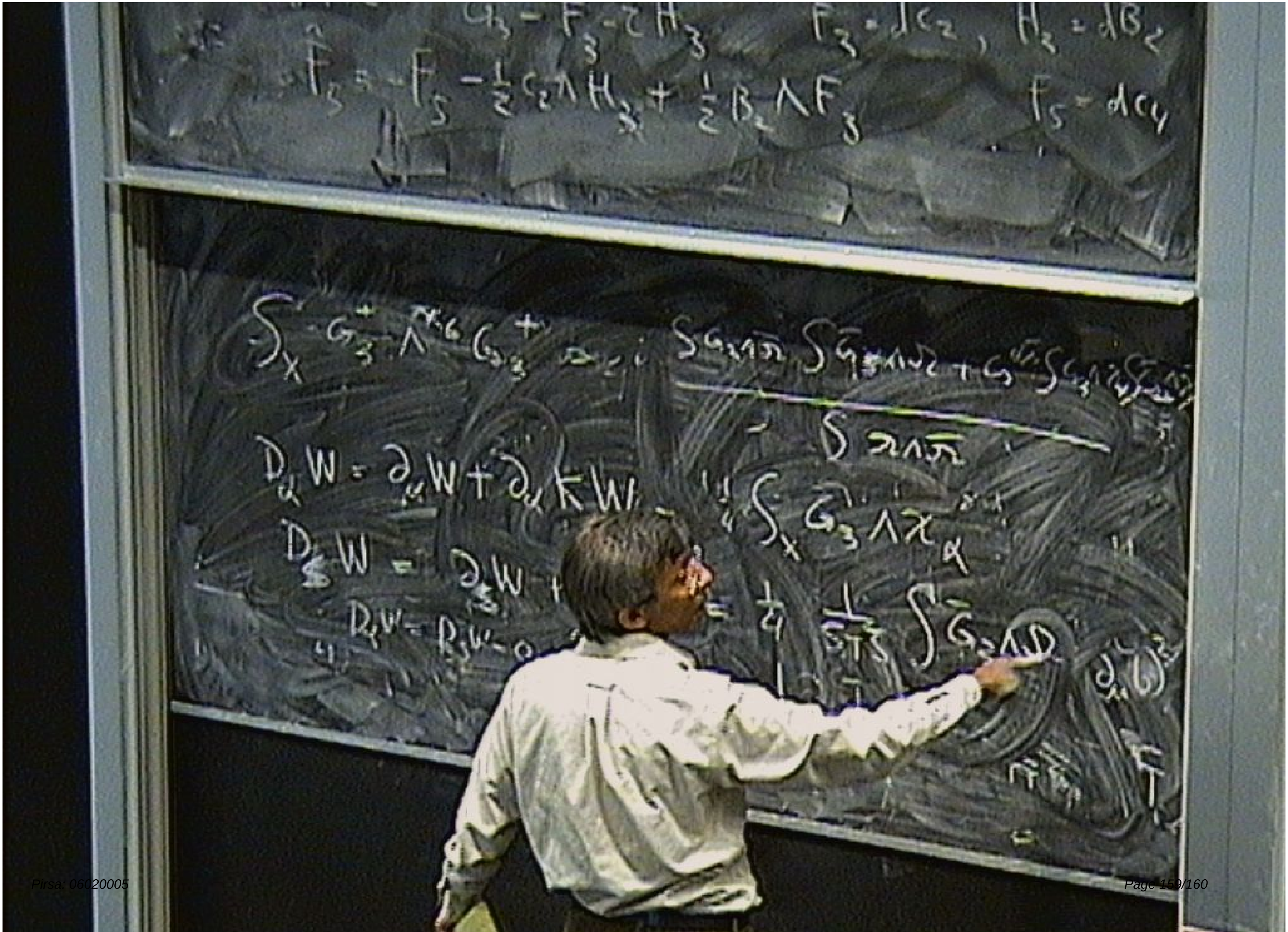
$d *_6 G_3 = 0 \qquad dG_3 = 0$

Expand

$G_3 = a\,\Omega + b^\alpha \chi_\alpha + \hat{a}\,\bar{\Omega} + \hat{b}^{\bar{\alpha}} \bar{\chi}_{\bar{\alpha}}$




$-\ln(-i\int_X \Omega\wedge\bar{\Omega})$
$W = \frac{1}{4}\int_X G_3\wedge\Omega$
independent of T
Expand
$G_3 = a\Omega + b^\alpha \chi_\alpha + \hat{a}\bar{\Omega} + \bar{b}^{\hat{\alpha}}\bar{\chi}_\alpha$
$a = \int G_3\wedge\bar{\Omega} / \int \Omega\wedge\bar{\Omega}$


$G_3 = F_3 - \tau H_3$
$F_3 = dC_2 \;,\; H_3 = dB_2$
$\hat{F}_5 = F_5 - \frac{1}{2} C_2 \wedge H_3 + \frac{1}{2} B_2 \wedge F_3$
$F_5 = dC_4$
$D_\alpha W = \partial_\alpha W + \partial_\alpha K W$

$h_{12} \cdot h_{21}$ $(1,2) \cdot \chi_\alpha$ $*_6 \Omega = -i\,\Omega$

4 $(0,0)$ $\overline{\Omega}$ $*_6$

$\chi_\alpha = i\,\chi_\alpha$

$$K(z) = -\ln\left[-i\int_X \Omega \wedge \overline{\Omega}\right]$$

$$\frac{\partial \Omega}{\partial z^\alpha} = k_\alpha(z,\bar{z})\,\Omega + \chi_\alpha$$

$$\partial_\alpha K = -k_\alpha \qquad \partial_\alpha \partial_{\bar\beta} K(z,\bar z) = G_{\alpha\bar\beta} = \frac{-\int \chi_\alpha \wedge \overline{\chi}_{\bar\beta}}{\int \Omega \wedge \overline{\Omega}}$$