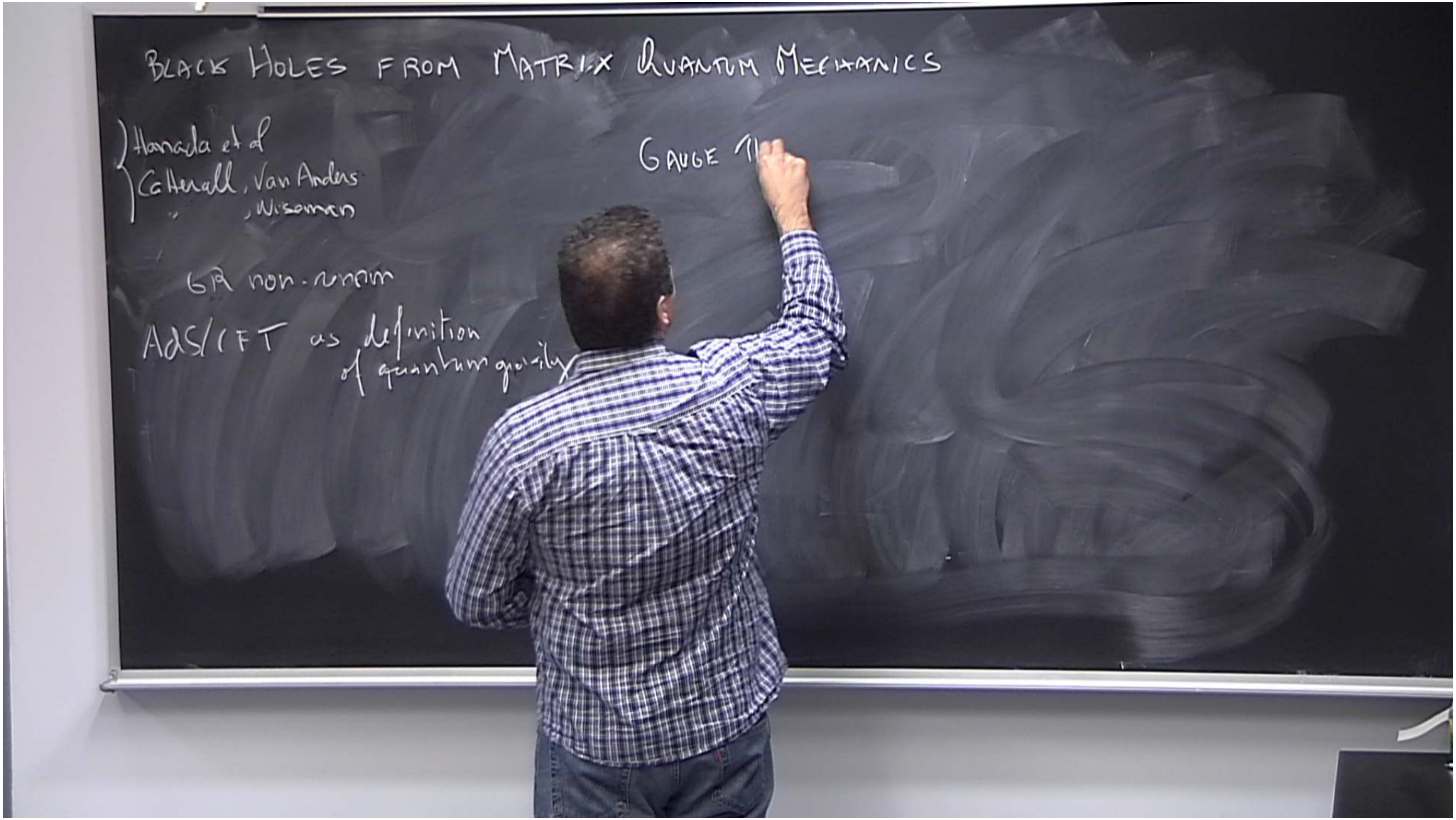
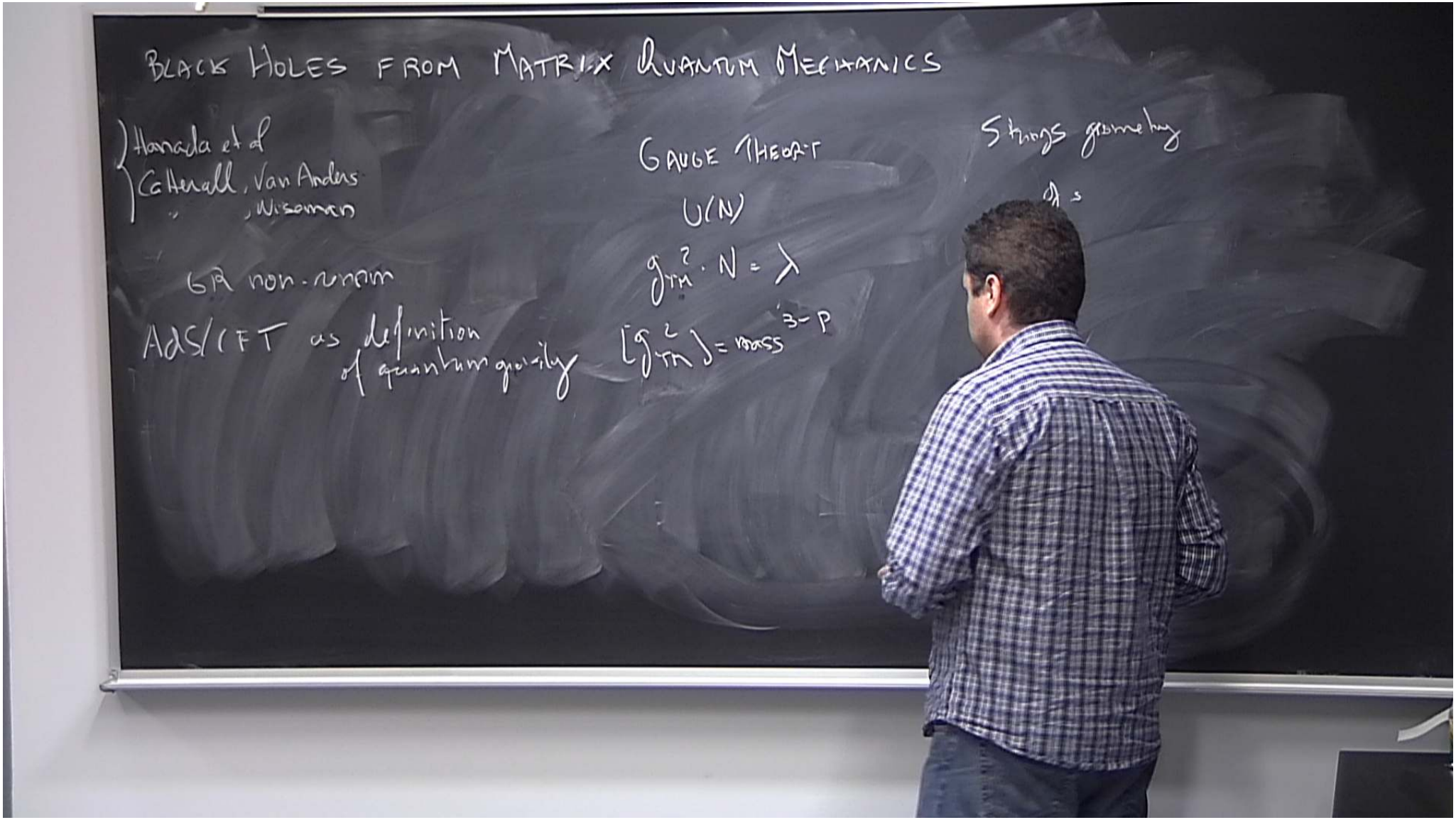
Title: TBA

Date: Jun 07, 2012  03:30 PM

URL: http://pirsa.org/12060026

Abstract: TBA


BLACK HOLES FROM MATRIX QUANTUM MECHANICS
Hanada et al
Catterall, Van Anders
Wiseman
GAUGE
GR non-comm
AdS/CFT as definition
of quantum gravity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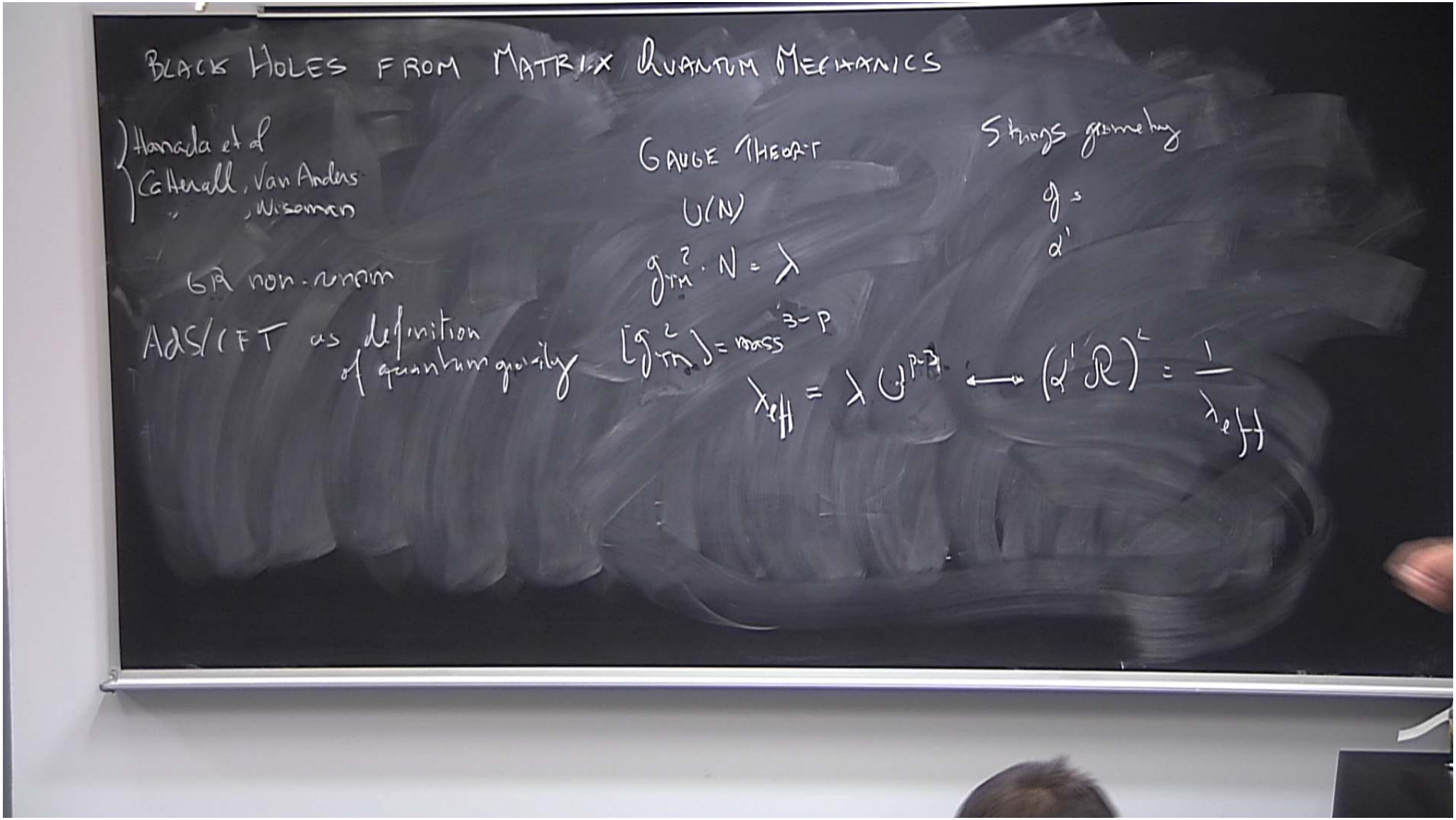
GAUGE THEORY
U(N)
$g_{YM}^2 \cdot N = \lambda$
$[g_{YM}^2] = \text{mass}^{3-p}$
Strings gravity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$\lambda_{eff} = \lambda U^{p-3}$
Strings gravity
$g_s$
$\alpha'$
$(\alpha' R)^2 = \frac{1}{\lambda_{eff}}$

# BLACK HOLES FROM MATRIX QUANTUM MECHANICS

Hanada et al
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GR non-renorm

AdS/CFT as definition of quantum gravity

GAUGE THEORY

$U(N)$

$g_{YM}^2 \cdot N = \lambda$

$[g_{YM}^2] = \text{mass}^{3-p}$

$\lambda_{eff} = \lambda U^{p-3} \longleftrightarrow (\alpha' R)^2 = \frac{1}{\lambda_{eff}}$

$\frac{1}{N^2} \equiv g_s$

Strings gravity

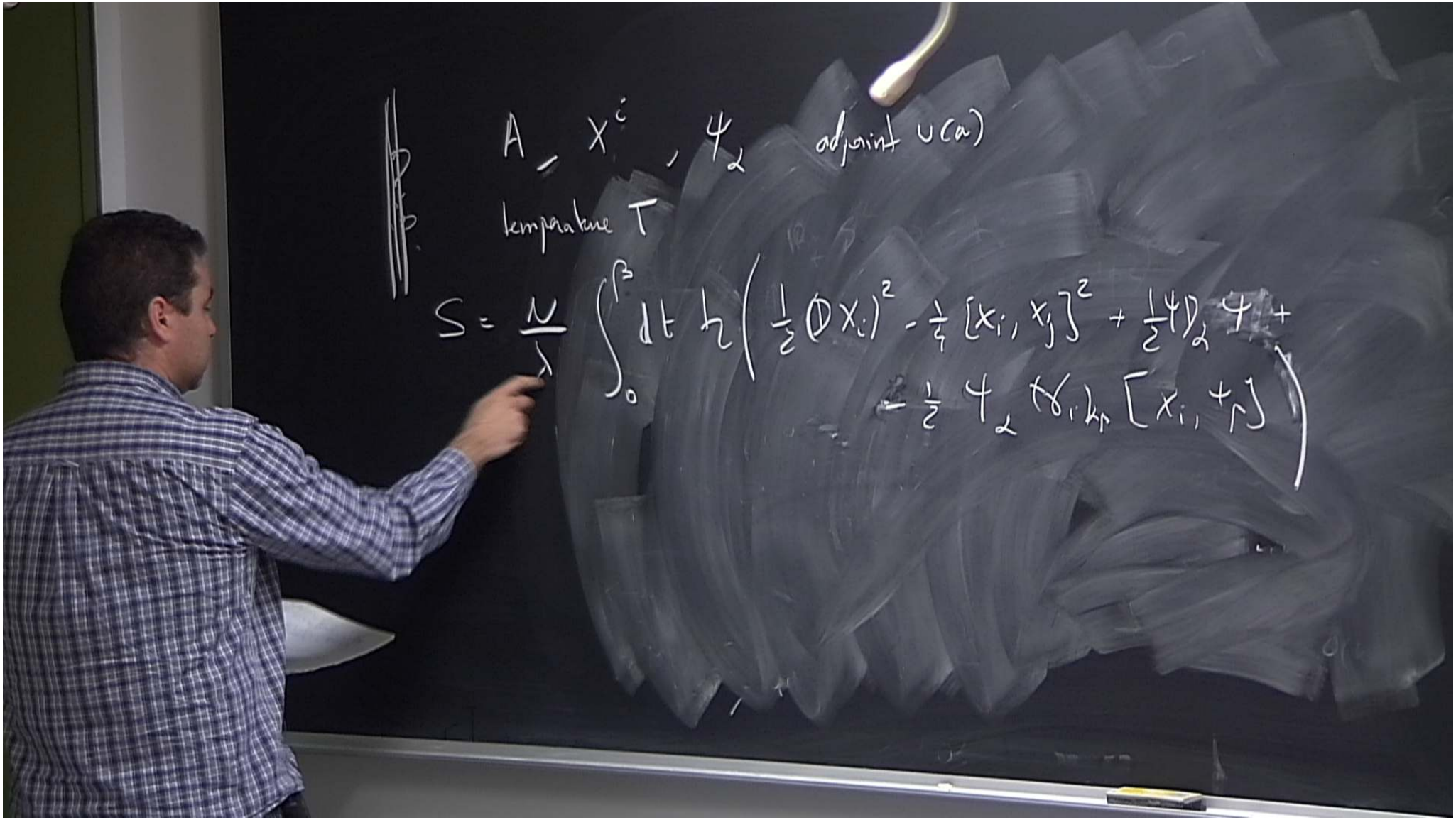
$g_s$

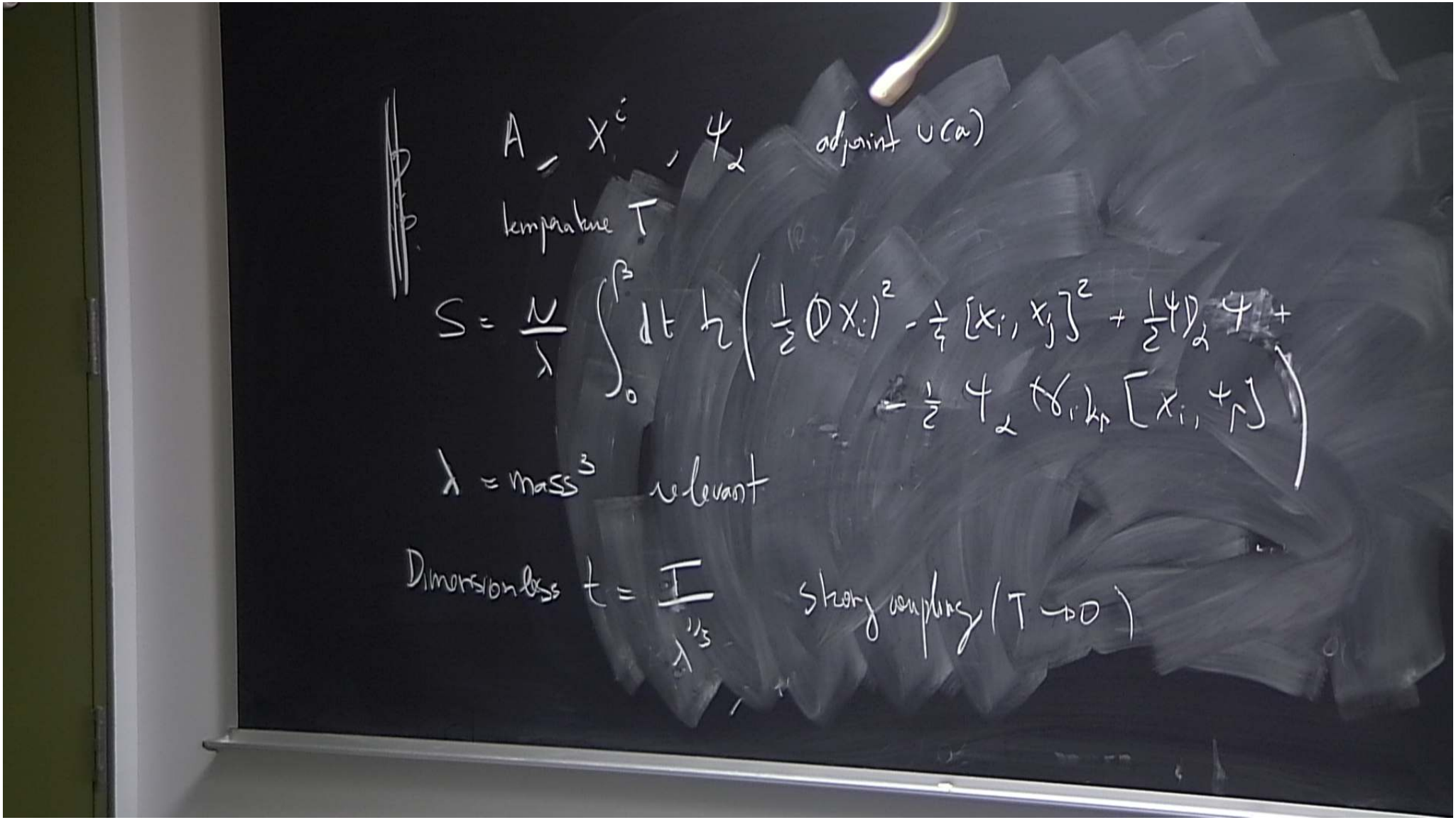
$\alpha'$

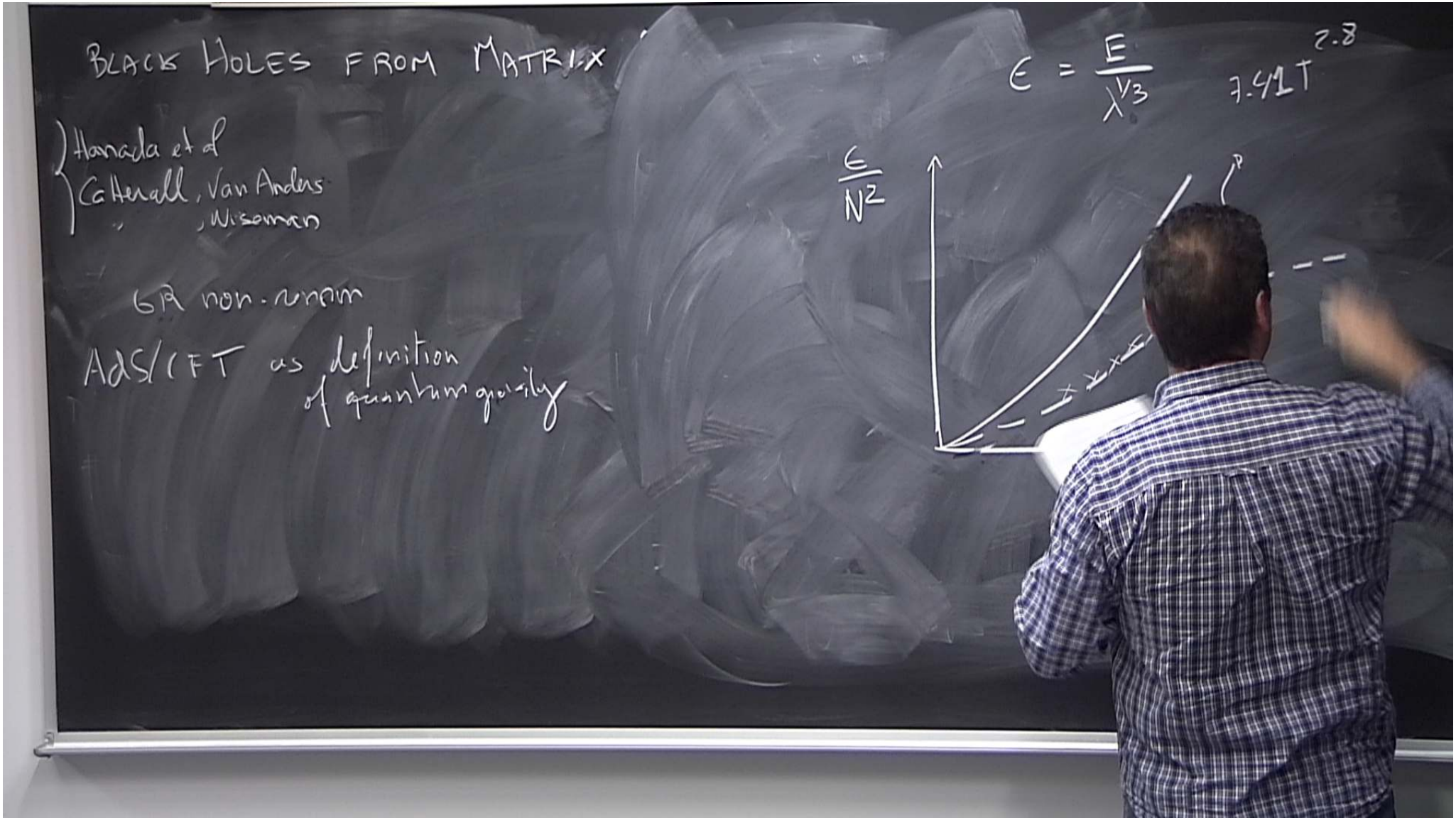
Gravity $\leftrightarrow$ strong coupling

$N \to \infty$ classical gravity

$\frac{1}{N}$


A _ X^i _ ψ_α adjoint U(a)
temperature T
S = N/λ ∫_0^β dt tr( ½ (D X_i)^2 - ¼ [X_i, X_j]^2 + ½ ψ D_α ψ +
- ½ ψ_α (γ_i)_αβ [X_i, ψ_β] )


A _ $X^i$ _ $\psi_\alpha$ adjoint U(a)
temperature T
$S = \frac{N}{\lambda} \int_0^\beta dt\, tr\left( \frac{1}{2}(DX_i)^2 - \frac{1}{4}[X_i, X_j]^2 + \frac{1}{2}\psi_\alpha \psi_\alpha + \right.$
$\left. - \frac{1}{2}\psi_\alpha (\gamma_i)_{\alpha\beta} [X_i, \psi_\beta] \right)$
$\lambda$ = mass$^3$ relevant
Dimensionless $t = \frac{T}{\lambda^{1/3}}$ strong coupling ($T \to 0$)


BLACK HOLES FROM MATRIX
Hanada et al
Catterall, Van Anders
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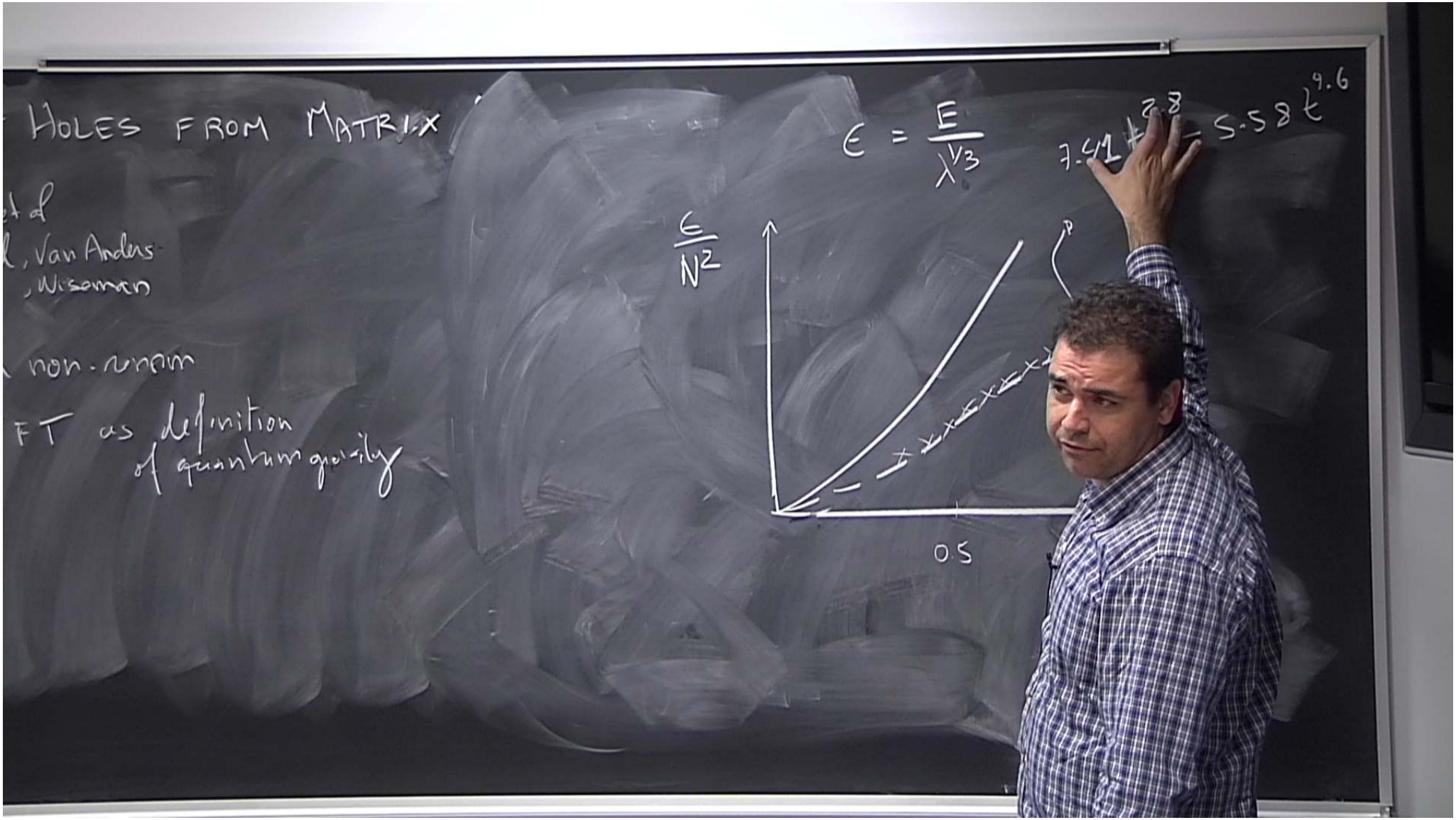
GR non-zero
AdS/CFT as definition
of quantum gravity
$\epsilon = \frac{E}{\lambda^{1/3}}$
7.41 T
2.8
$\frac{\epsilon}{N^2}$


HOLES FROM MATRIX
et al
l, Van Anders
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non-uniform
FT as definition
of quantum gravity
$\epsilon = \frac{E}{\lambda^{1/3}}$
$\frac{\epsilon}{N^2}$
0.5

HOLES FROM MATRIX

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non-uniform

FT as definition
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$\epsilon = \frac{E}{\lambda^{1/3}}$

$7.41 t^{2.8} - 5.58 t^{9.6}$

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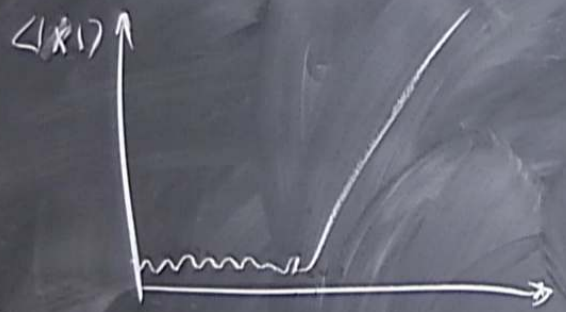
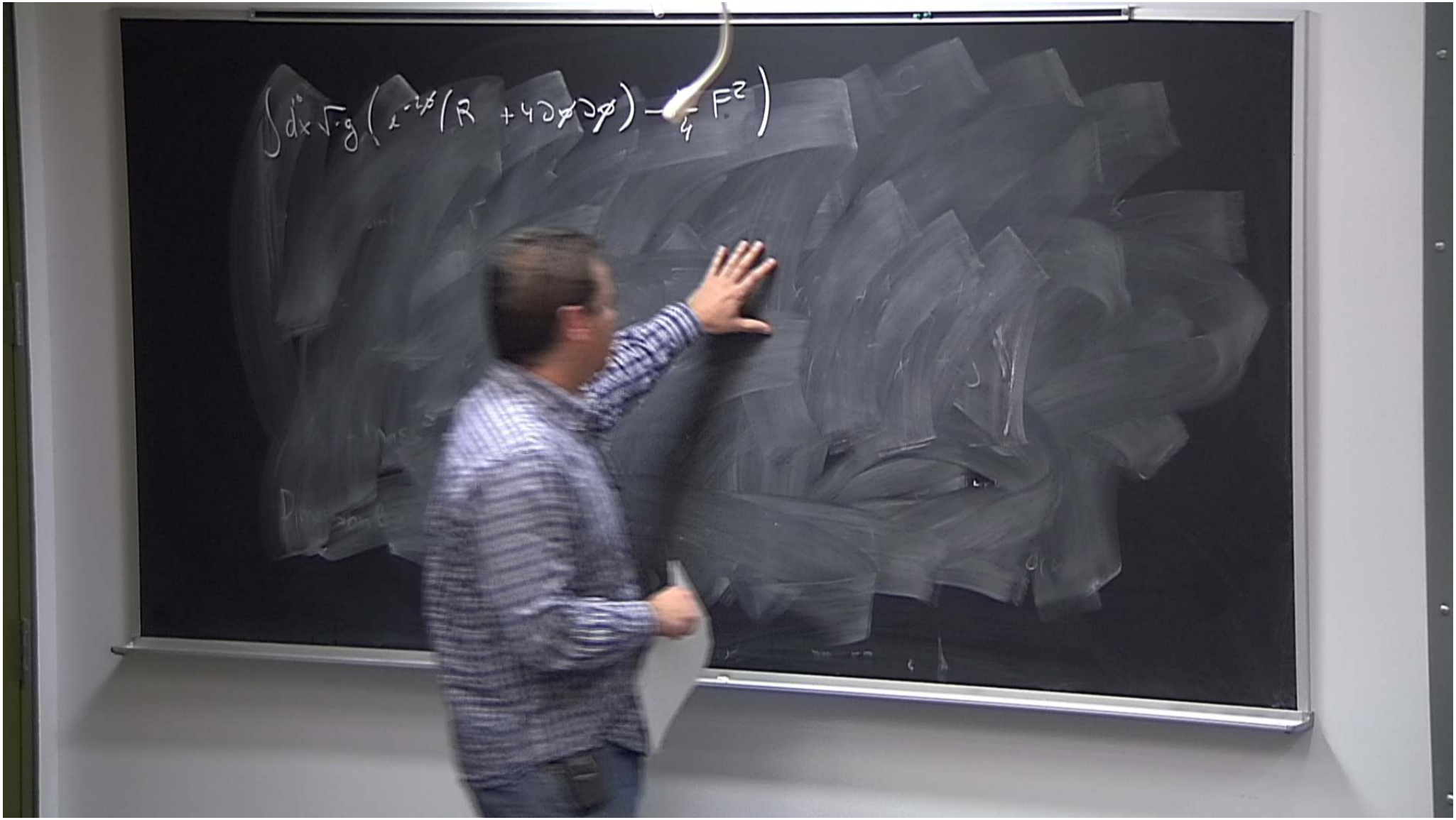
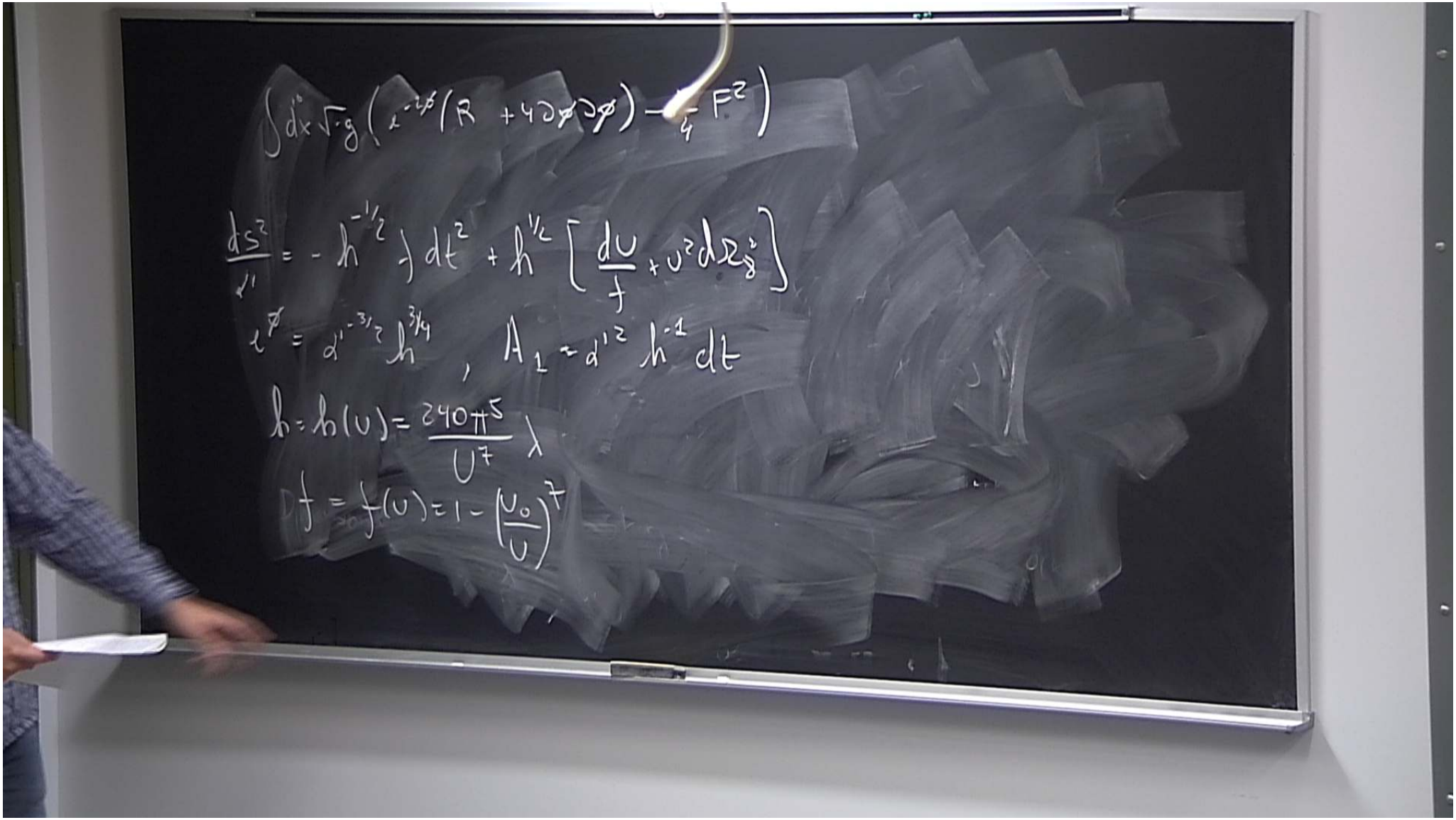


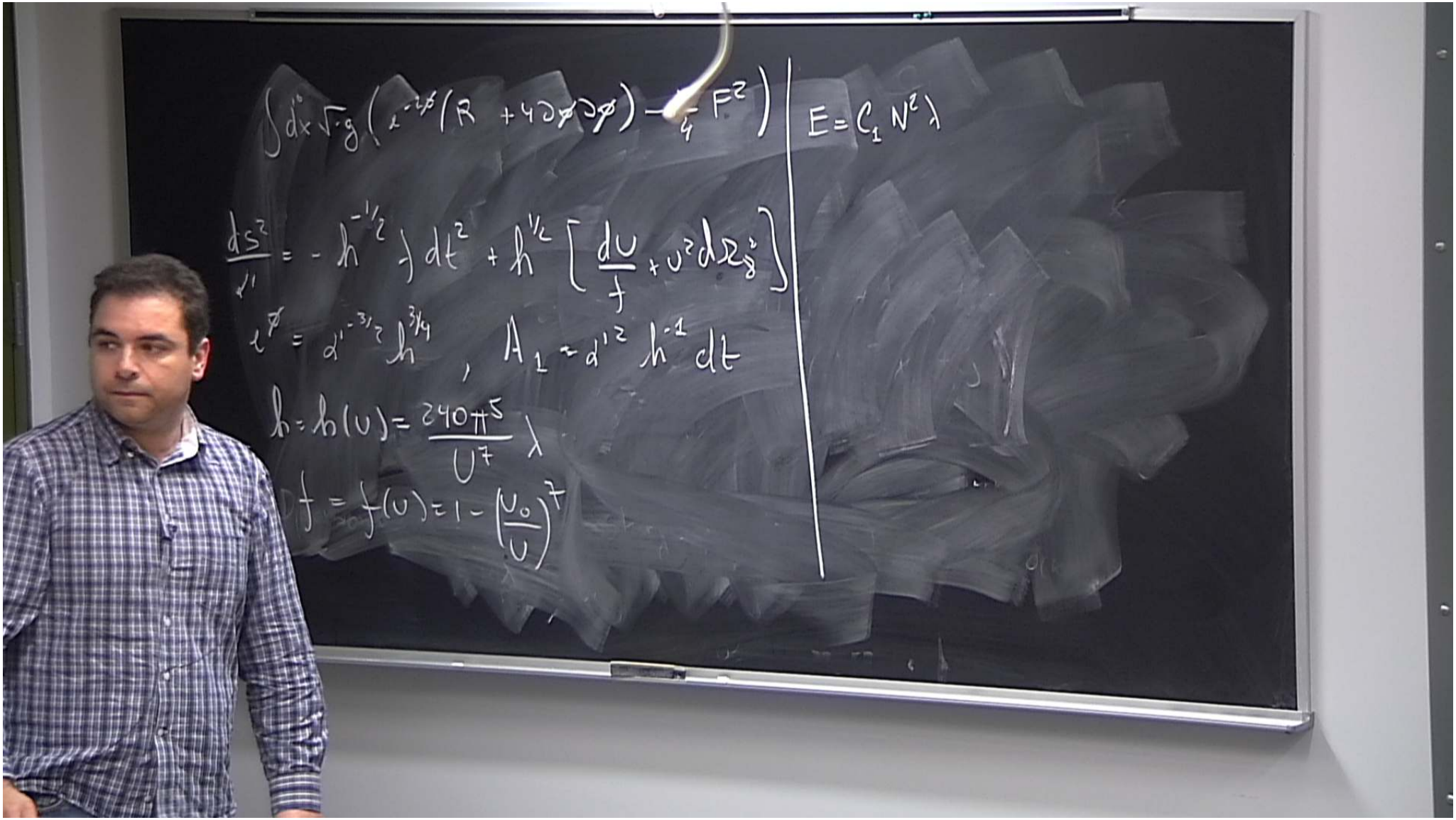

$\epsilon = \frac{E}{\lambda^{1/3}}$

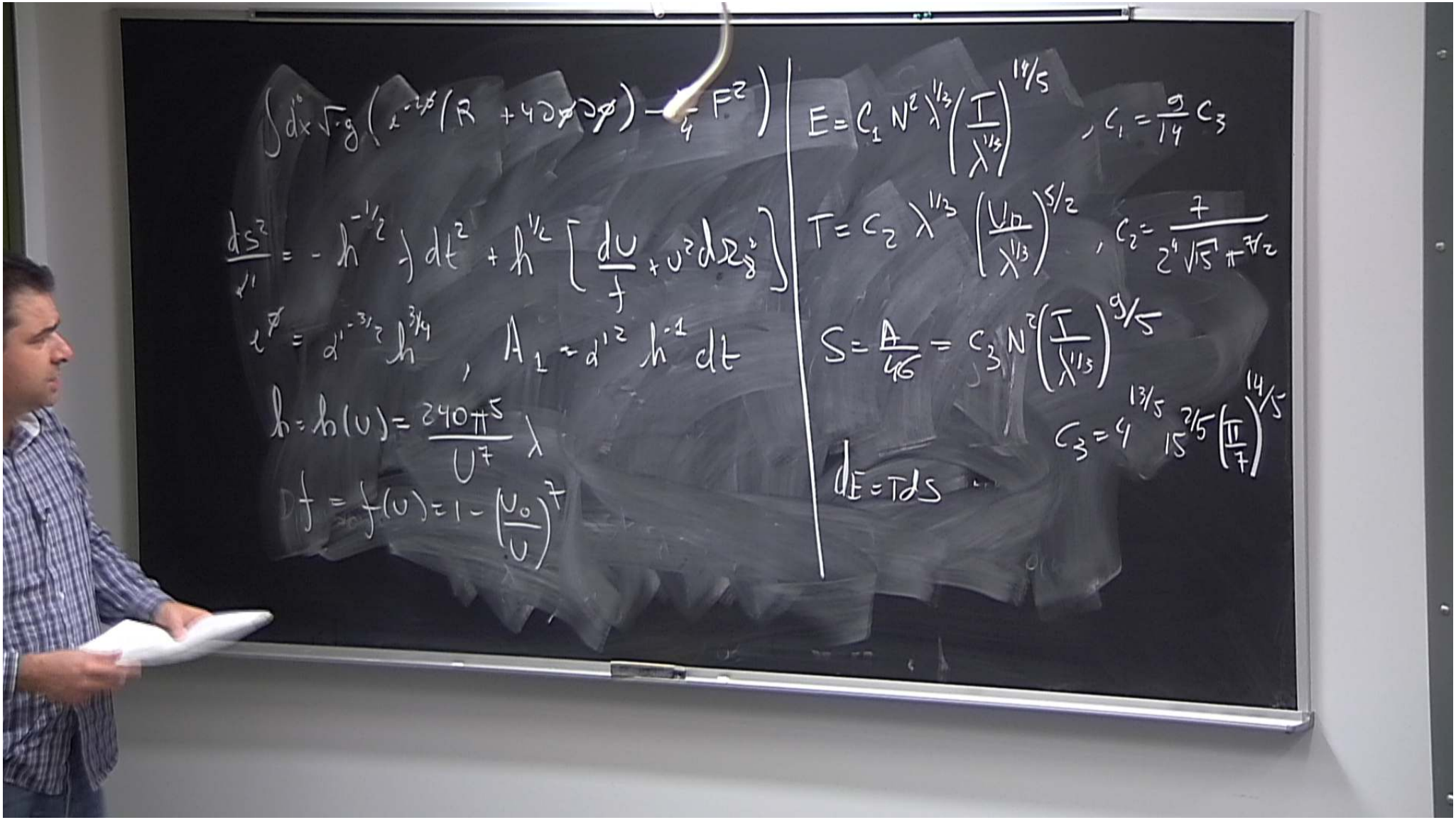
$7.41 t^{2.8} - 5.58 t^{9.6}$

Caveat: Canonical ensemble not well defined


$\int d^4x \sqrt{-g} \left( e^{-2\phi} (R + 4 \partial\phi \partial\phi) - \frac{1}{4} F^2 \right)$


$\int d^{10}x \sqrt{-g} \left( e^{-2\phi} (R + 4 \partial\phi \partial\phi) - \frac{1}{4} F^2 \right)$
$\frac{ds^2}{\alpha'} = -h^{-1/2} f dt^2 + h^{1/2} \left[ \frac{du}{f} + u^2 d\Omega_8^2 \right]$
$e^{\phi} = \alpha'^{-3/2} h^{3/4}$, $A_t = \alpha'^{-2} h^{-1} dt$
$h = h(u) = \frac{240\pi^5}{u^7} \lambda$
$f = f(u) = 1 - \left(\frac{u_0}{u}\right)^7$


$E = C_1 N^2 \lambda$
$A_1 \sim \alpha'^2 h^{-1} dt$
$h = h(U) = \frac{240\pi^5}{U^7} \lambda$
$f = f(U) = 1 - \left(\frac{U_0}{U}\right)^7$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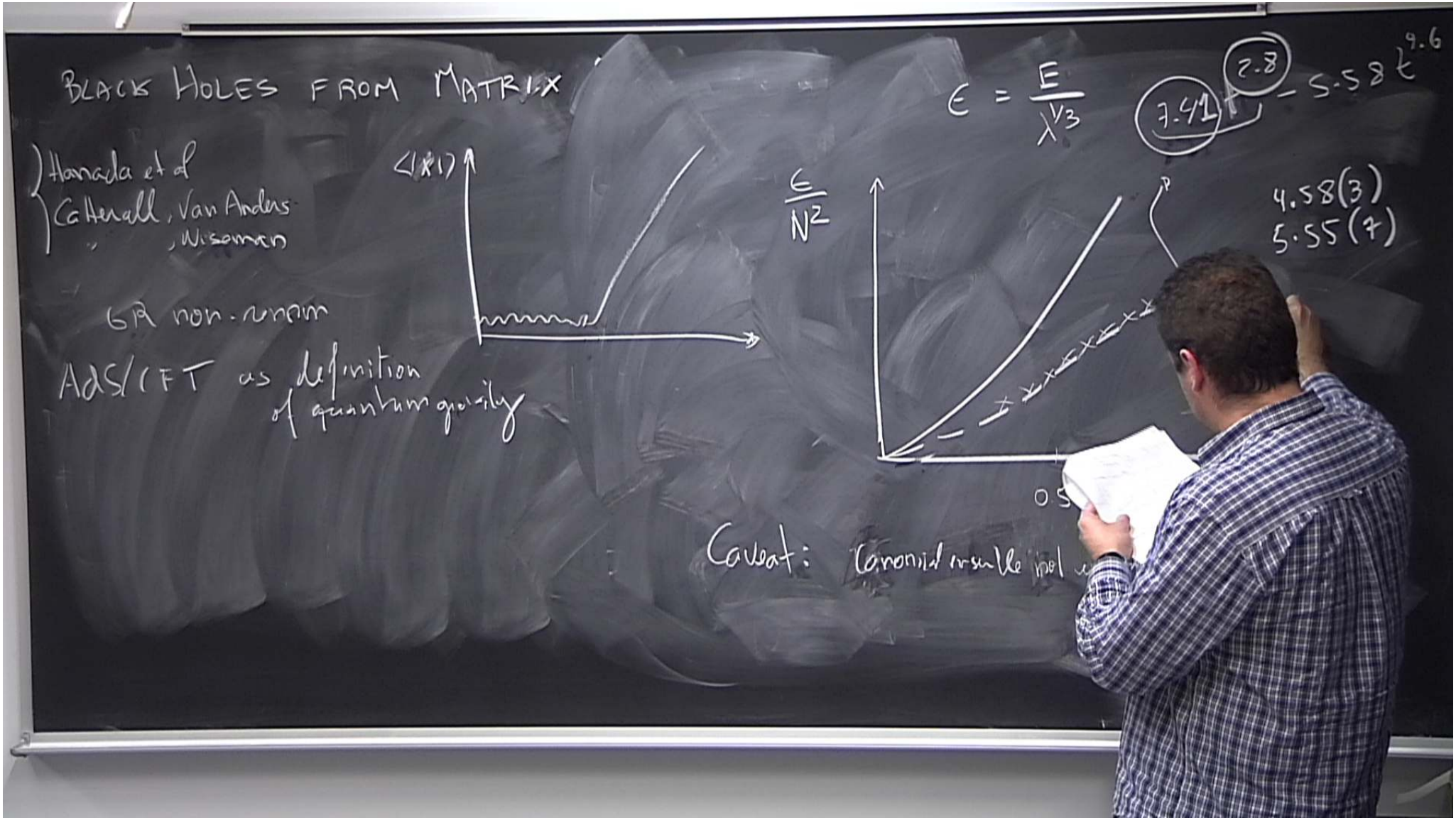
$h = h(U) = \frac{240\pi^5}{U^7} \lambda$
$f = f(U) = 1 - \left(\frac{U_0}{U}\right)^7$
$E = C_1 N^2 \lambda^{1/3} \left(\frac{T}{\lambda^{1/3}}\right)^{14/5}$, $C_1 = \frac{9}{14} C_3$
$T = C_2 \lambda^{1/3} \left(\frac{U_0}{\lambda^{1/3}}\right)^{5/2}$, $C_2 = \frac{7}{2^4 \sqrt{15}\, \pi^{7/2}}$
$S = \frac{A}{4G} = C_3 N^2 \left(\frac{T}{\lambda^{1/3}}\right)^{9/5}$
$C_3 = 4^{13/5} 15^{2/5} \left(\frac{\pi}{7}\right)^{14/5}$
$dE = TdS$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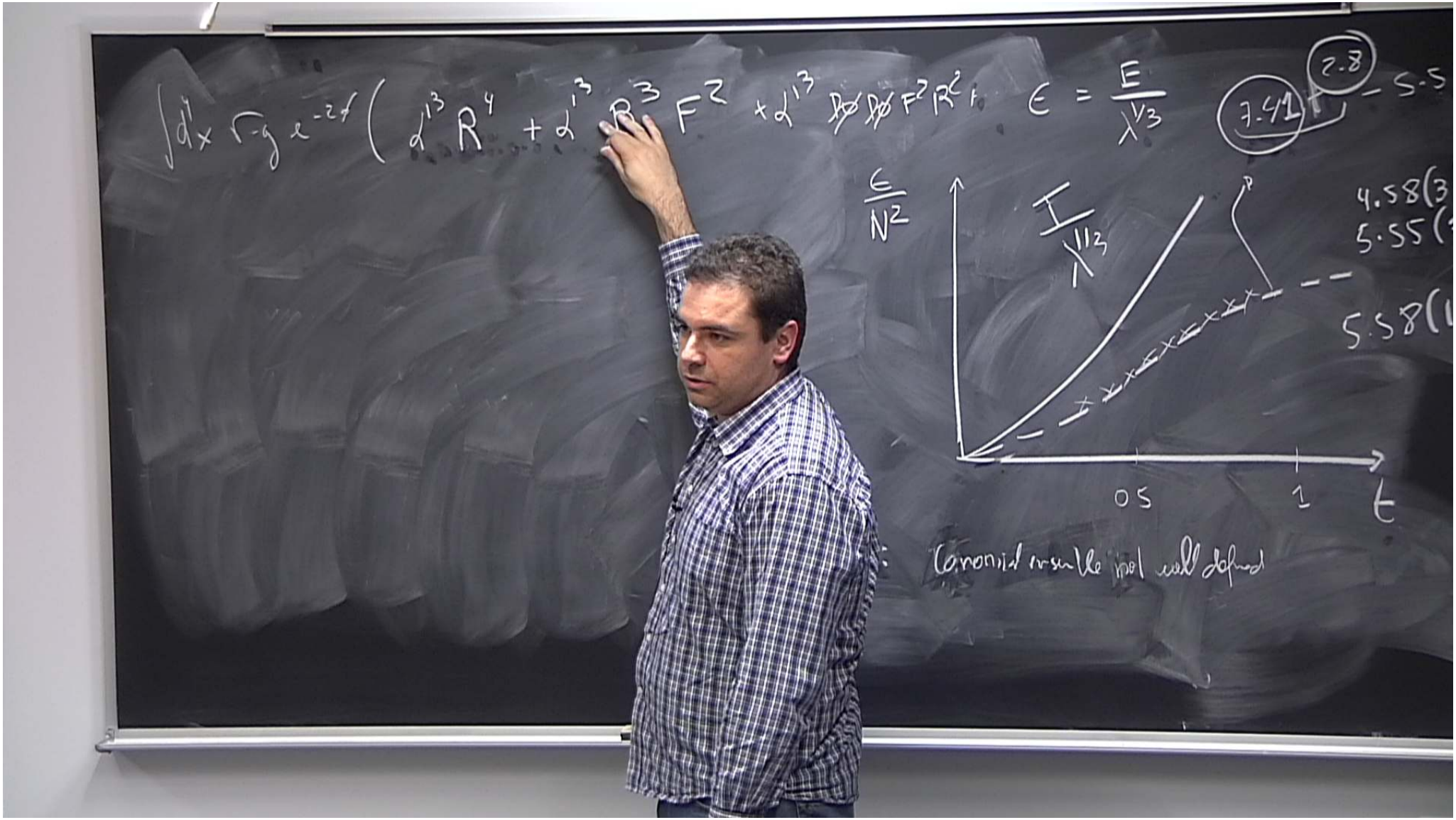
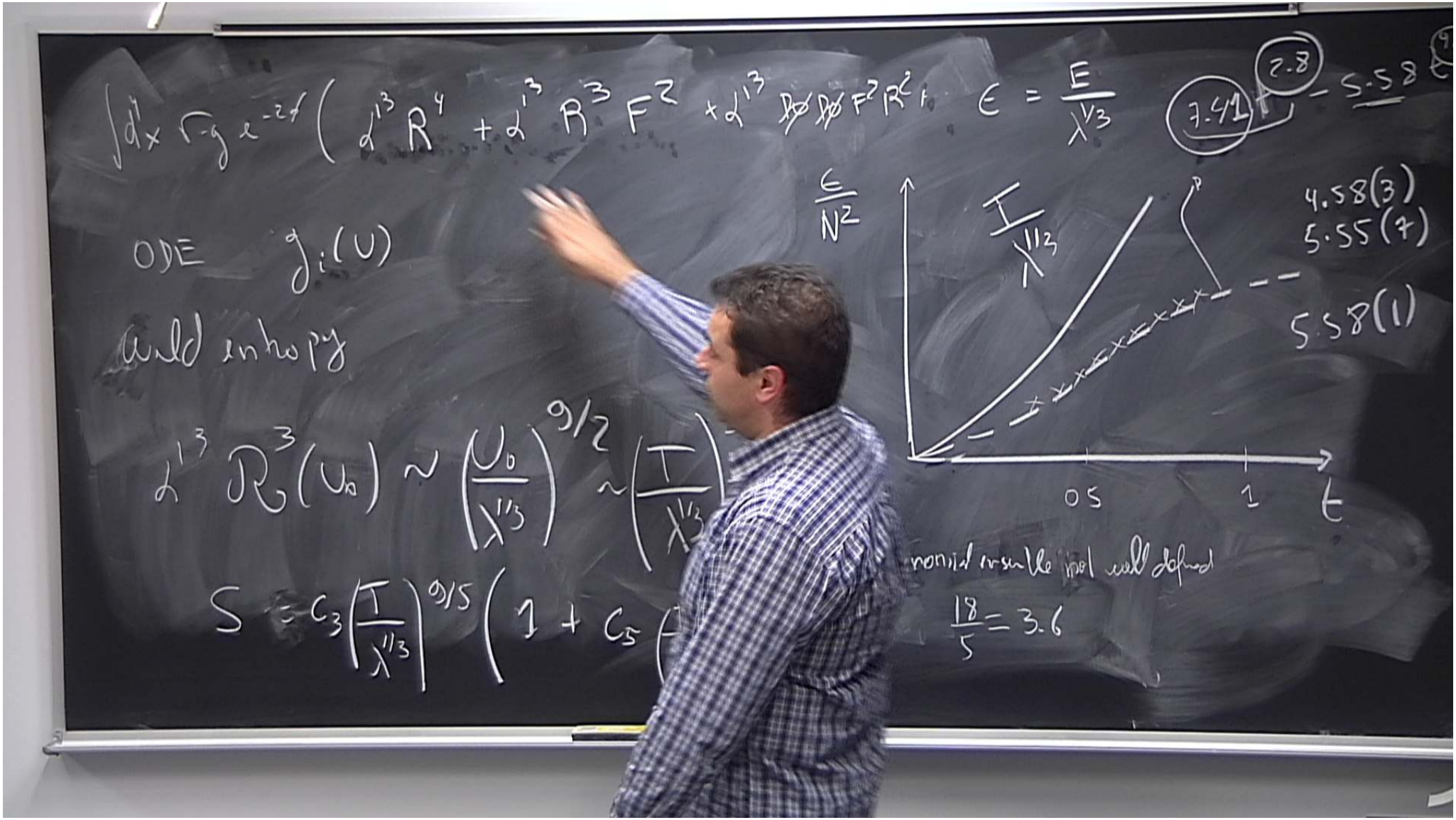
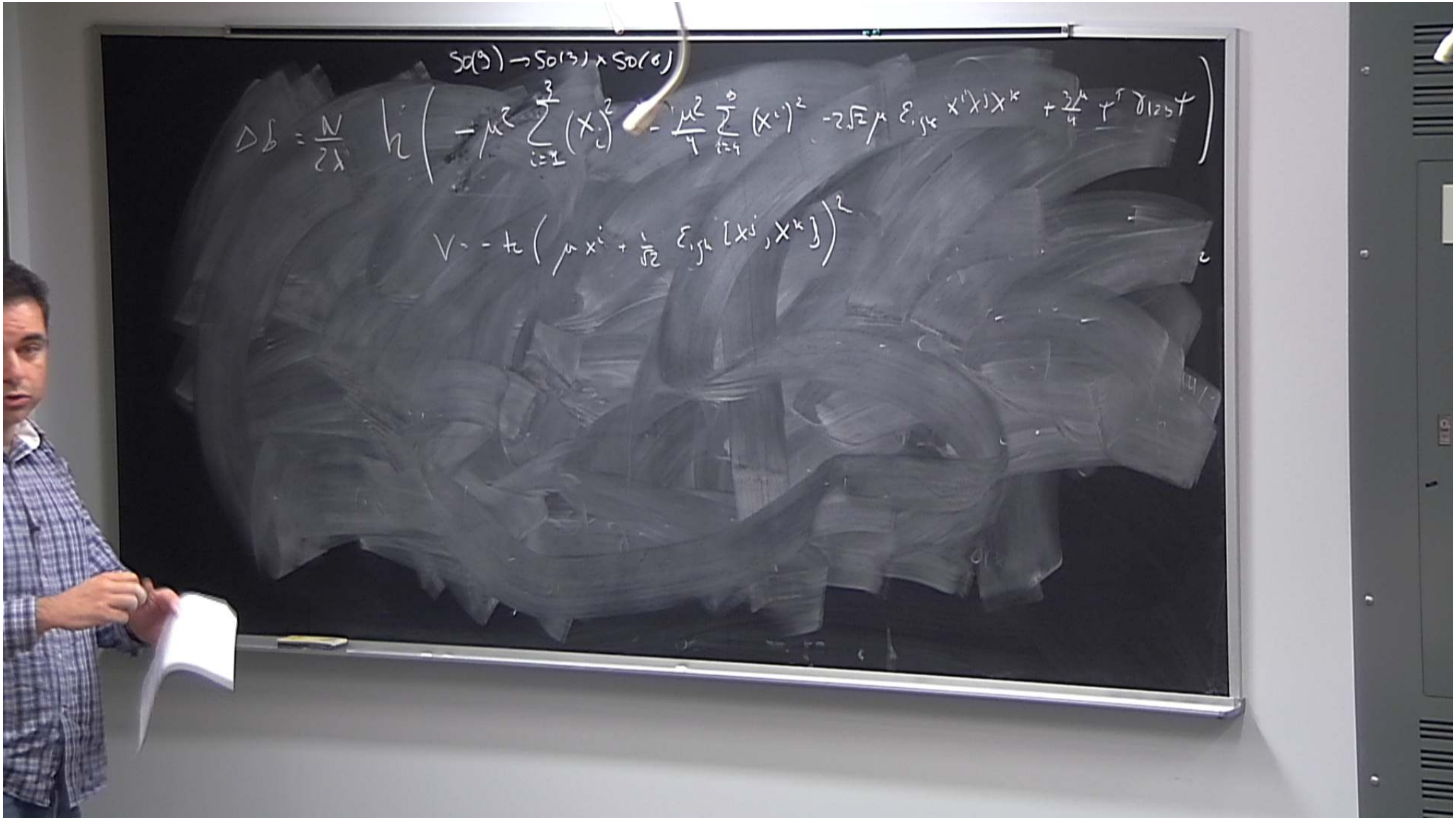
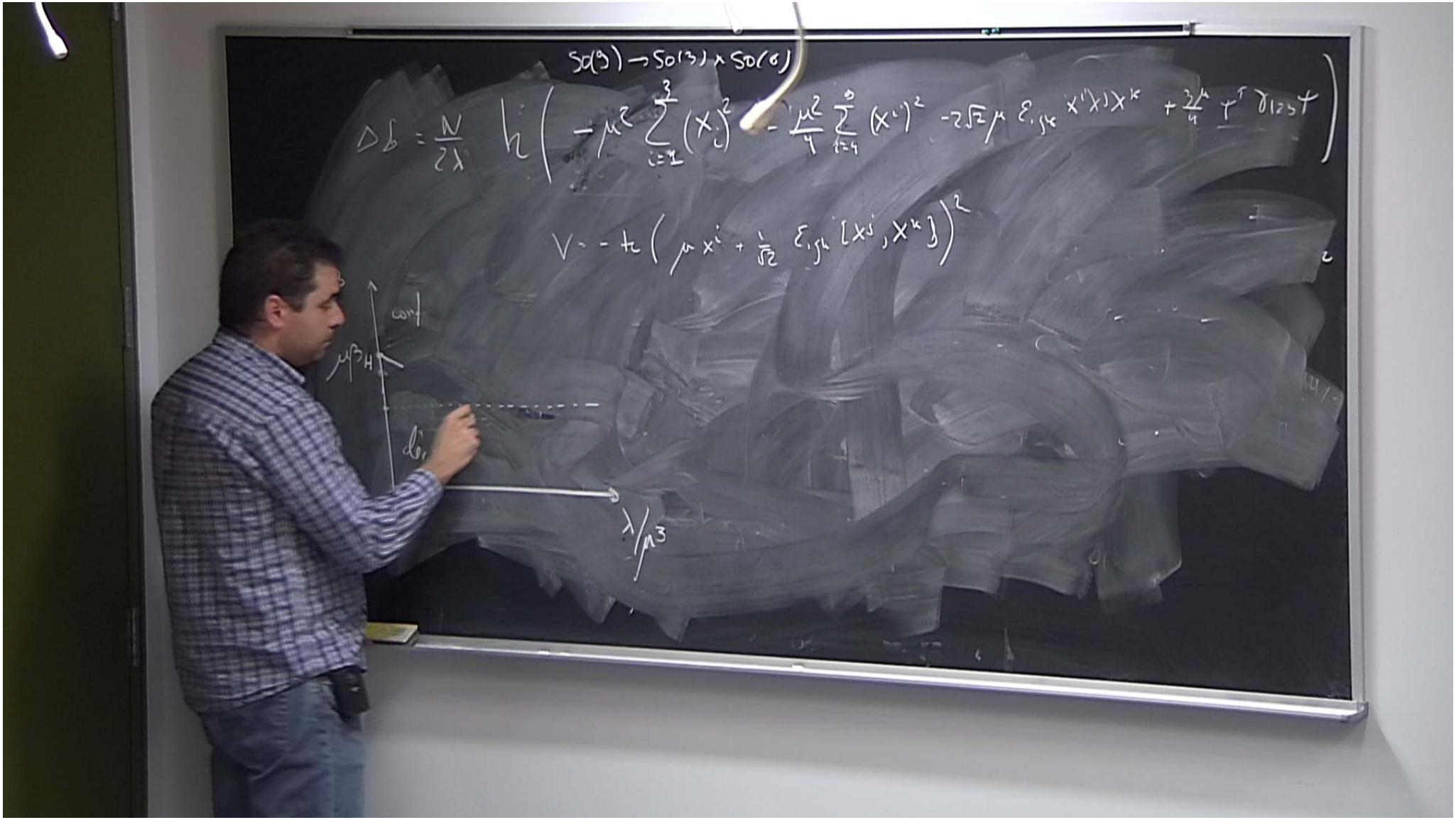
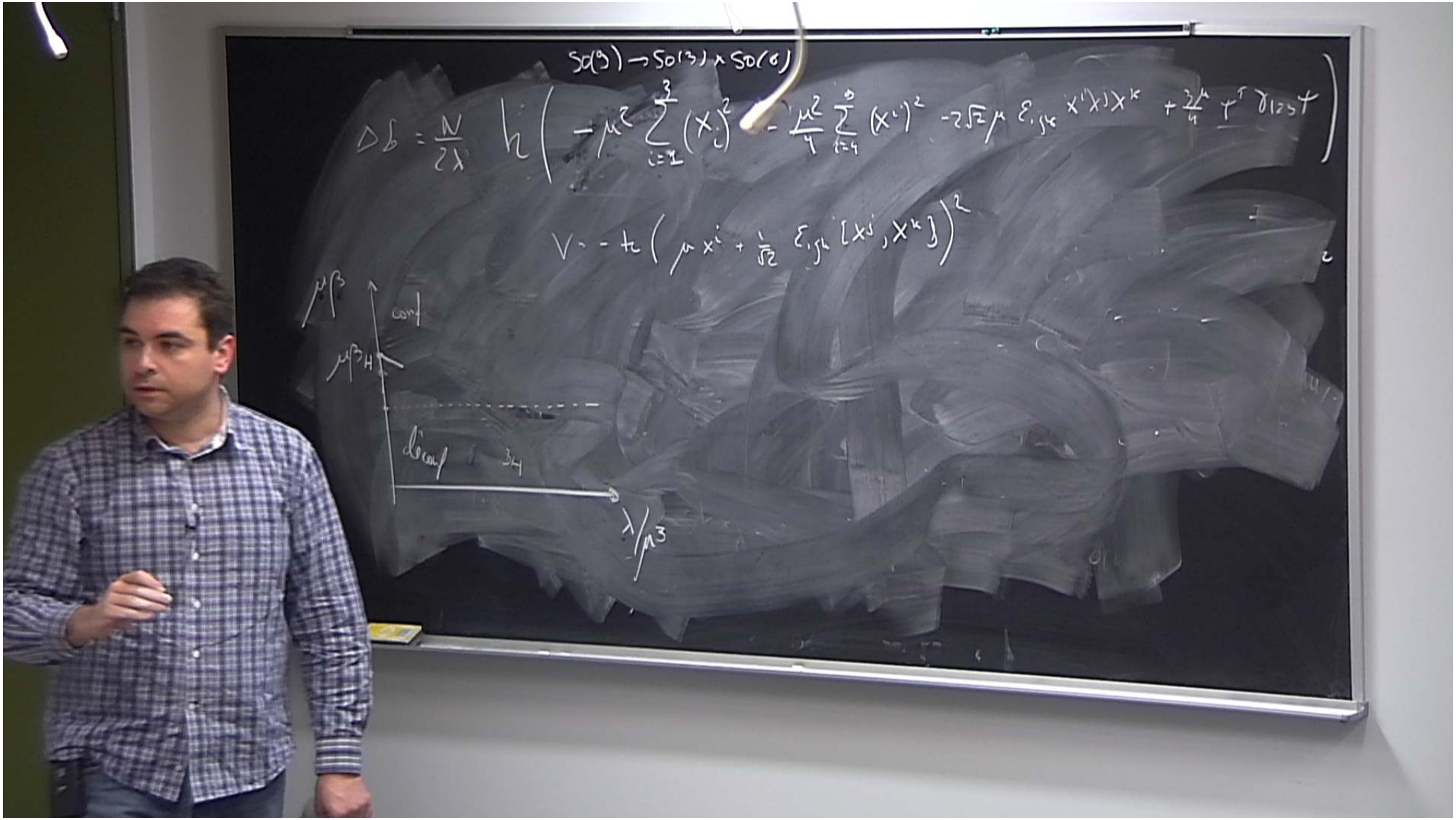
$\epsilon = \frac{E}{\lambda^{1/3}}$
$\frac{\epsilon}{N^2}$
7.41
2.8
$-5.58\,t^{9.6}$
4.58(3)
5.55(7)
Caveat:


$\int d^4x \sqrt{-g} e^{-2\phi} ( \alpha'^3 R^4 + \alpha'^3 R^3 F^2 + \alpha'^3 \ldots F^2 R^2 + \ldots$
$\epsilon = \frac{E}{\lambda^{1/3}}$
7.41
2.8
5.5
$\frac{\epsilon}{N^2}$
$\frac{I}{\lambda^{11/3}}$
4.58(3
5.55(
5.58(
0.5
1
t
Canonical ensemble not well defined


ODE
Wald entropy
nonical ensemble not well defined
4.58(3)
5.55(7)
5.58(1)
7.41
2.8
5.58
0.5
1
t
18/5 = 3.6


SO(9) → SO(3) × SO(6)


SO(9) → SO(3) × SO(6)
$\Delta b = \frac{N}{2\lambda} \, h \left( -\mu^2 \sum_{i=1}^{3} (X_i)^2 - \frac{\mu^2}{4} \sum_{i=4}^{9} (X^i)^2 - 2\sqrt{2}\mu \, \varepsilon_{ijk} X^i X^j X^k + \frac{3\mu}{4} \psi^T \gamma_{123} \psi \right)$
$V = -\mathrm{tr}\left( \mu X^i + \frac{1}{\sqrt{2}} \varepsilon_{ijk} [X^j, X^k] \right)^2$
conf
$\mu\beta_H$
$\lambda/\mu^3$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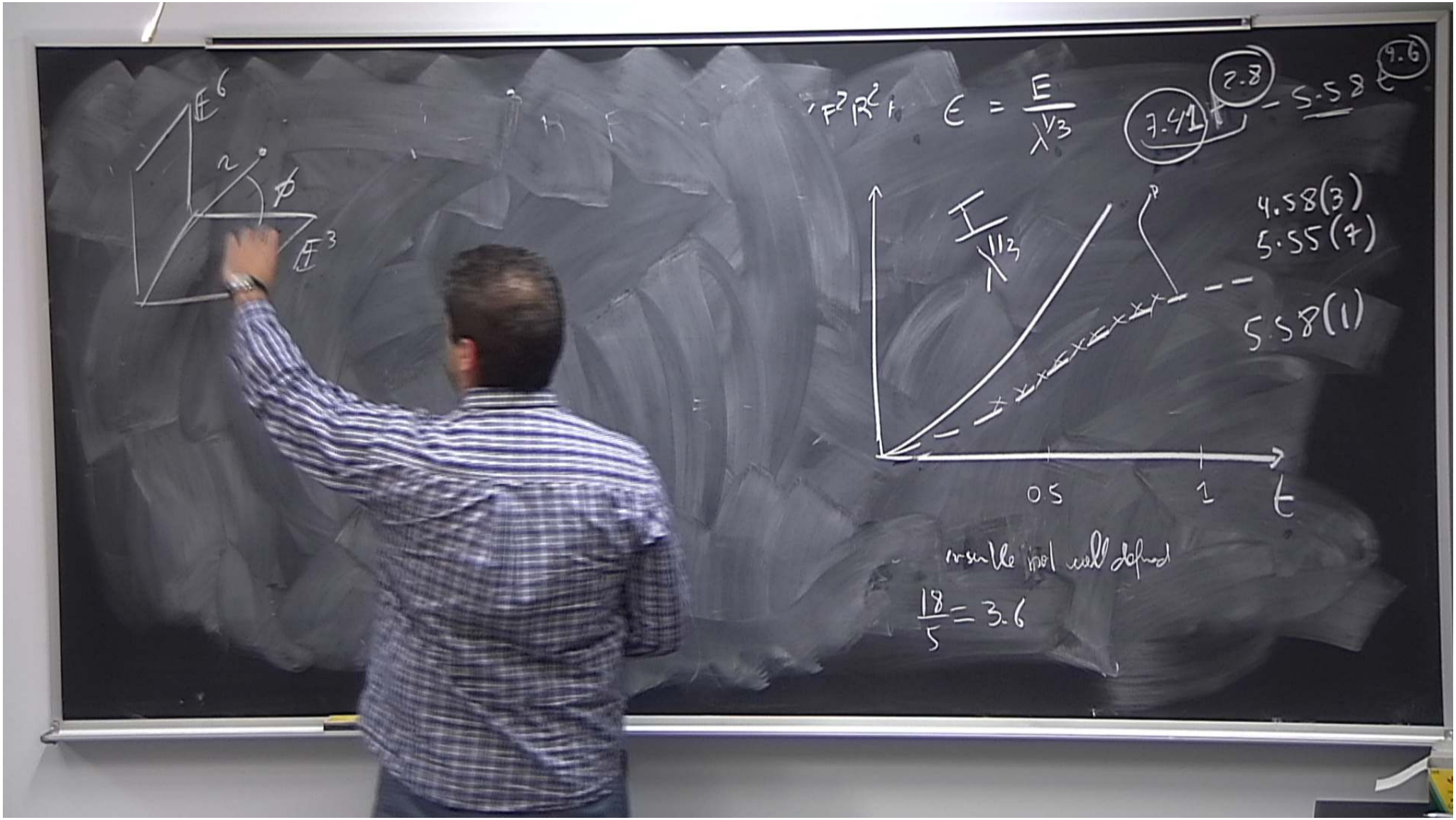
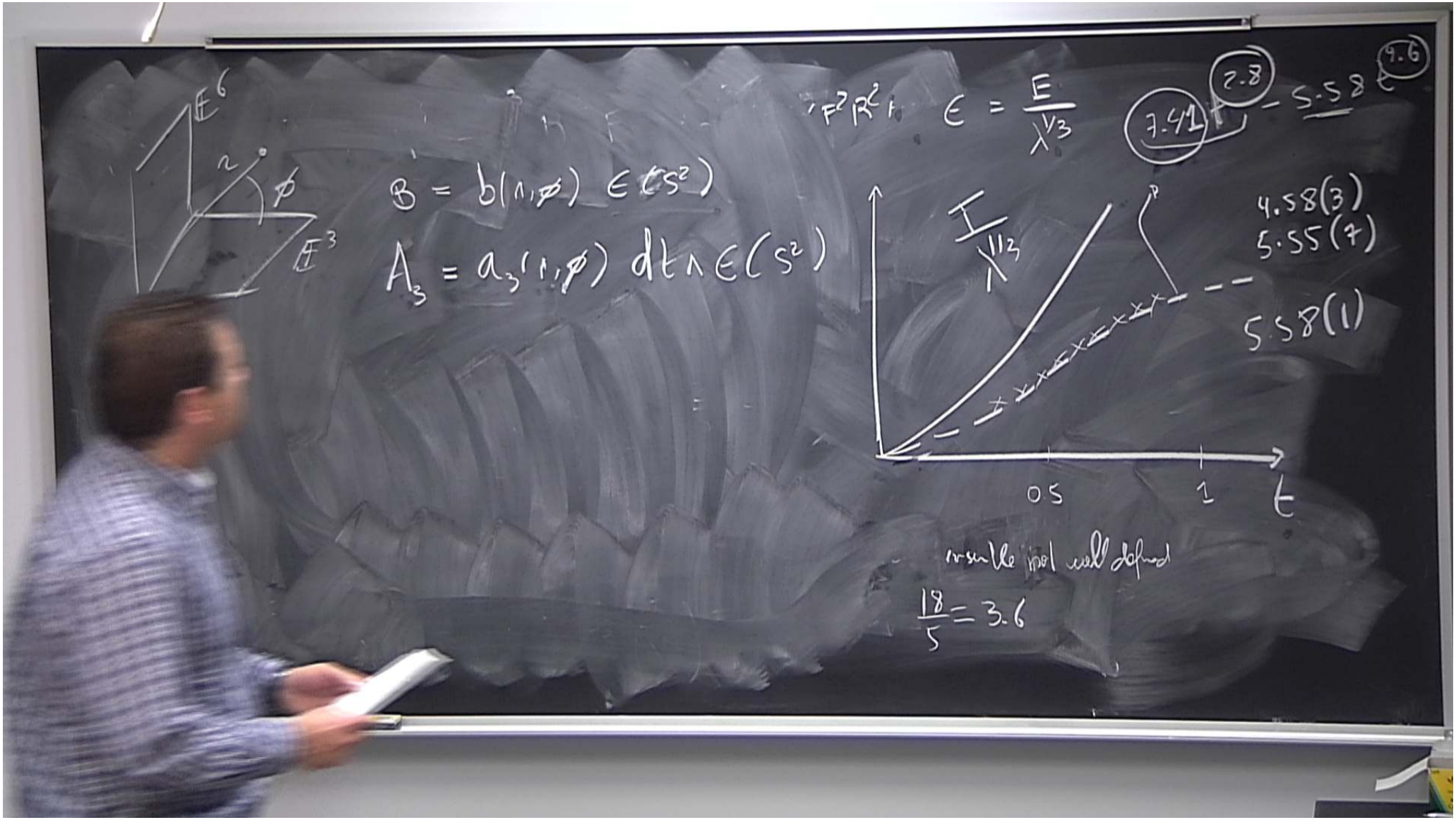
$\Delta b = \frac{N}{2\lambda} \, h \left( -\mu^2 \sum_{i=1}^{3} (X_i)^2 - \frac{\mu^2}{4} \sum_{i=4}^{9} (X^i)^2 - 2\sqrt{2}\mu \, \varepsilon_{ijk} X^i X^j X^k + \frac{3\mu}{4} \psi^T \gamma_{123} \psi \right)$
$V = -\mathrm{tr}\left( \mu X^i + \frac{1}{\sqrt{2}} \varepsilon_{ijk} [X^j, X^k] \right)^2$
$\mu\beta$
conf
$\mu\beta_H$
deconf
$\lambda/\mu^3$


$\epsilon = \frac{E}{\lambda^{1/3}}$
7.41
2.8
5.58
9.6
$\frac{I}{\lambda^{1/3}}$
4.58(3)
5.55(7)
5.58(1)
0.5
1
t
$\frac{18}{5} = 3.6$


$E^6$
2
$\phi$
$E^3$
$B = b(1,\phi) \in (S^2)$
$A_3 = a_3(1,\phi)\, dt \wedge \in (S^2)$
$F^2 R^2$
$\epsilon = \frac{E}{\lambda^{1/3}}$
7.41
2.8
5.58
9.6
$\frac{I}{\lambda^{1/3}}$
4.58(3)
5.55(7)
5.58(1)
0.5
1
t
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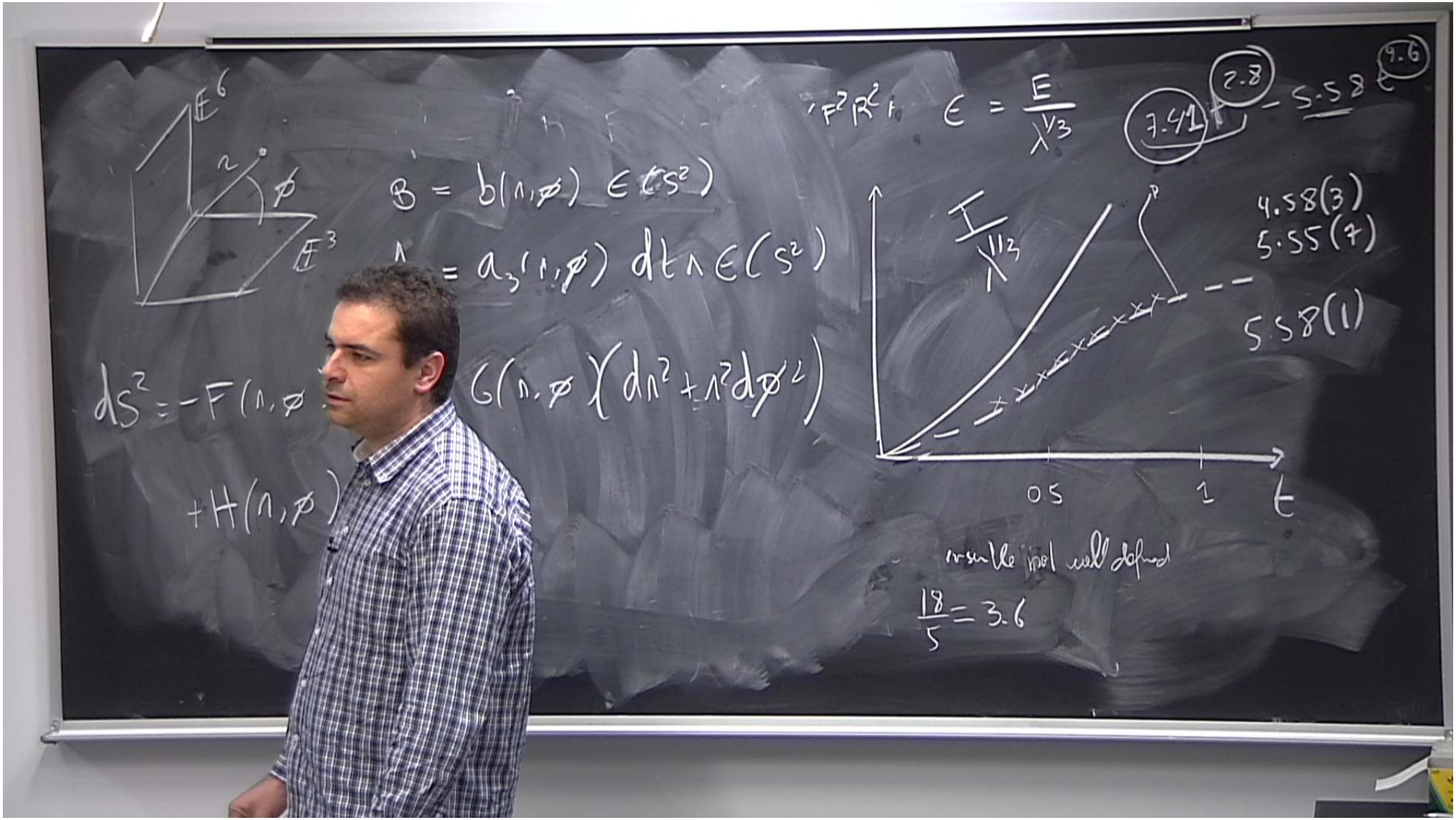
$E^6$
$E^3$
$B = b(r,\phi) \in C(S^2)$
$= a_3(r,\phi)\, dt \wedge \in C(S^2)$
$ds^2 = -F(r,\phi)$
$+H(r,\phi)$
$G(r,\phi)(dr^2 + r^2 d\phi^2)$
$\epsilon = \frac{E}{\lambda^{1/3}}$
$\frac{I}{\lambda^{1/3}}$
7.41
2.8
5.58
9.6
4.58(3)
5.55(7)
5.58(1)
0.5
1
t
$\frac{18}{5} = 3.6$