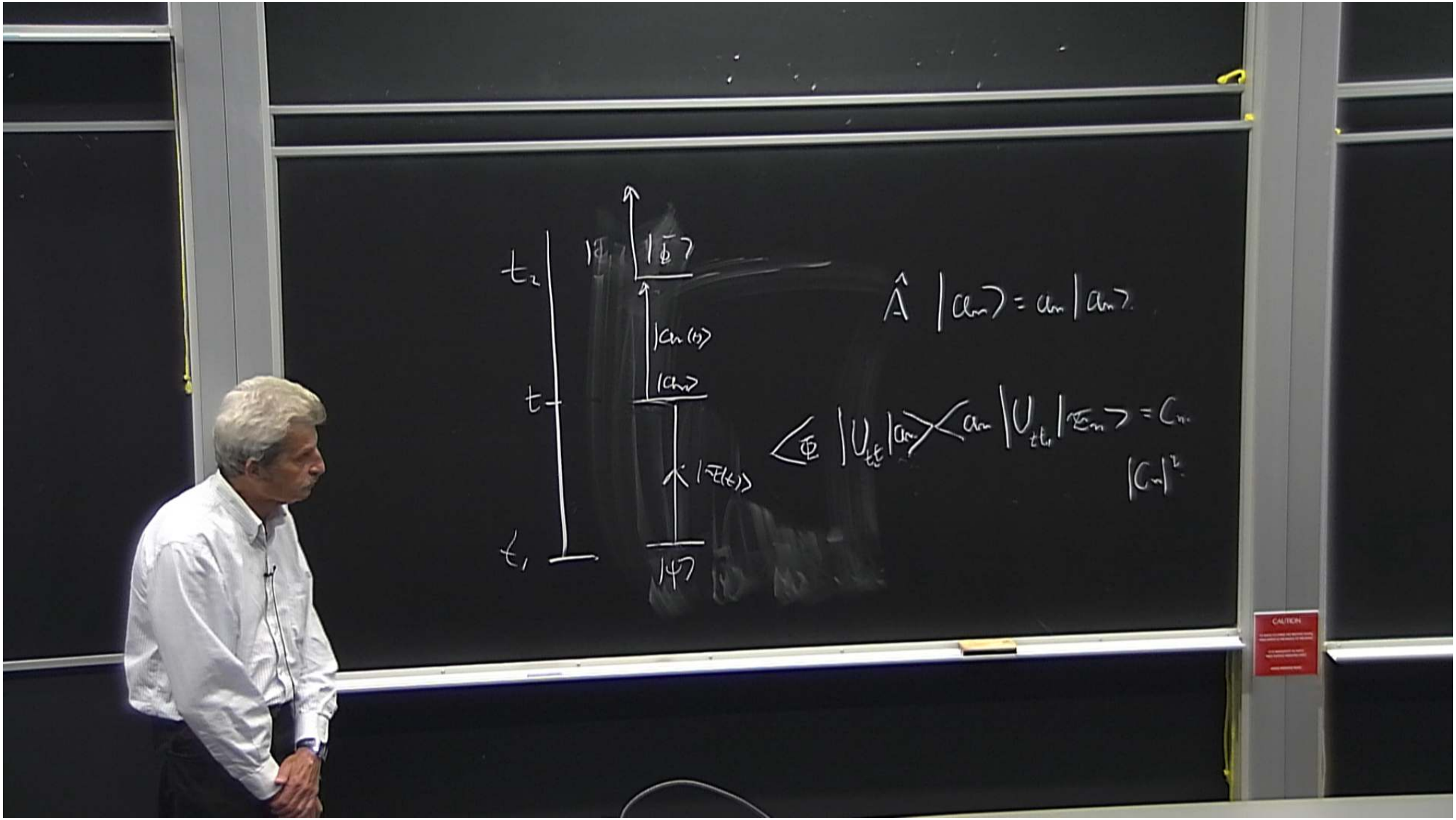
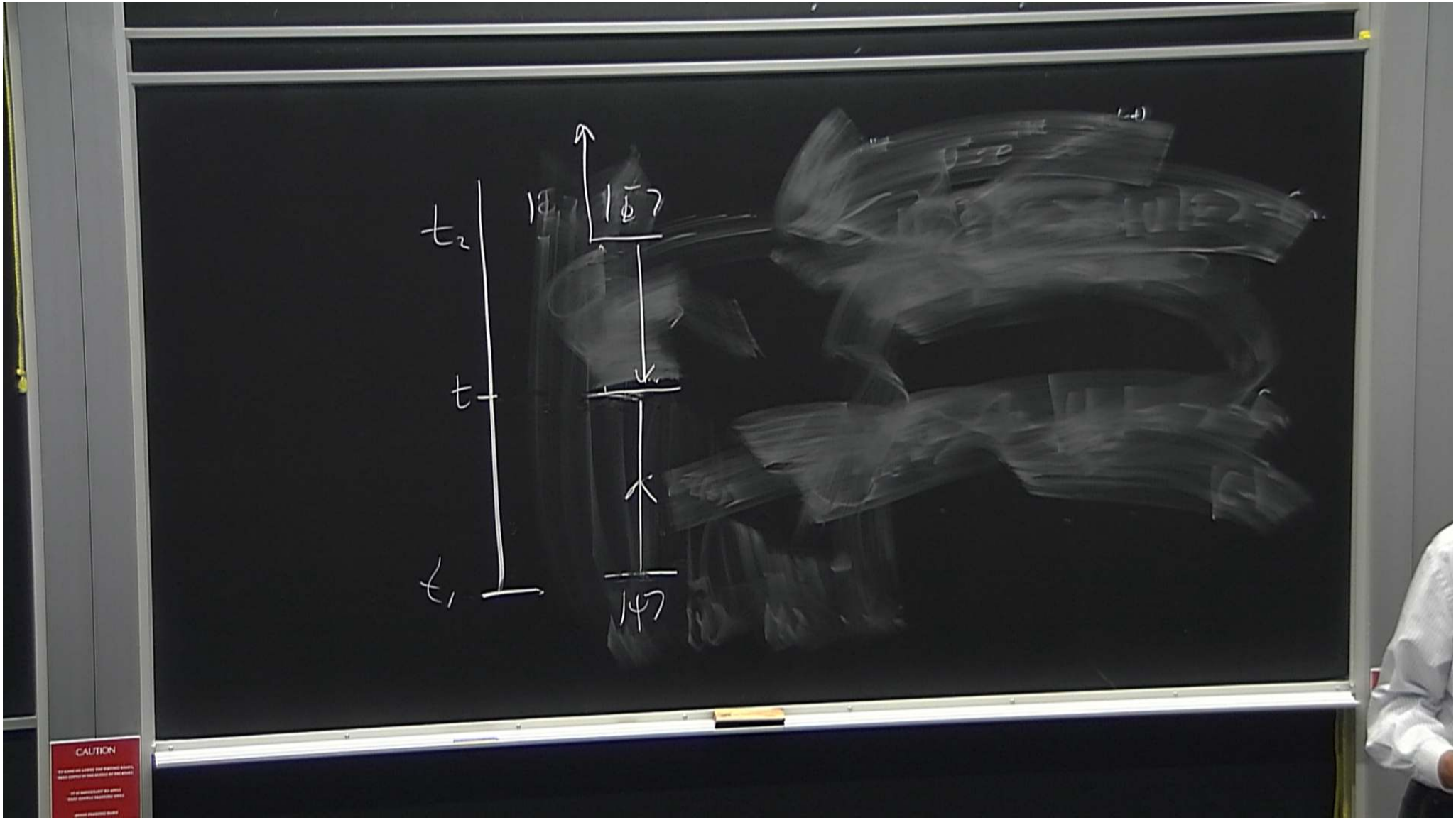
Title: 14/15 PSI - Yakir Aharonov

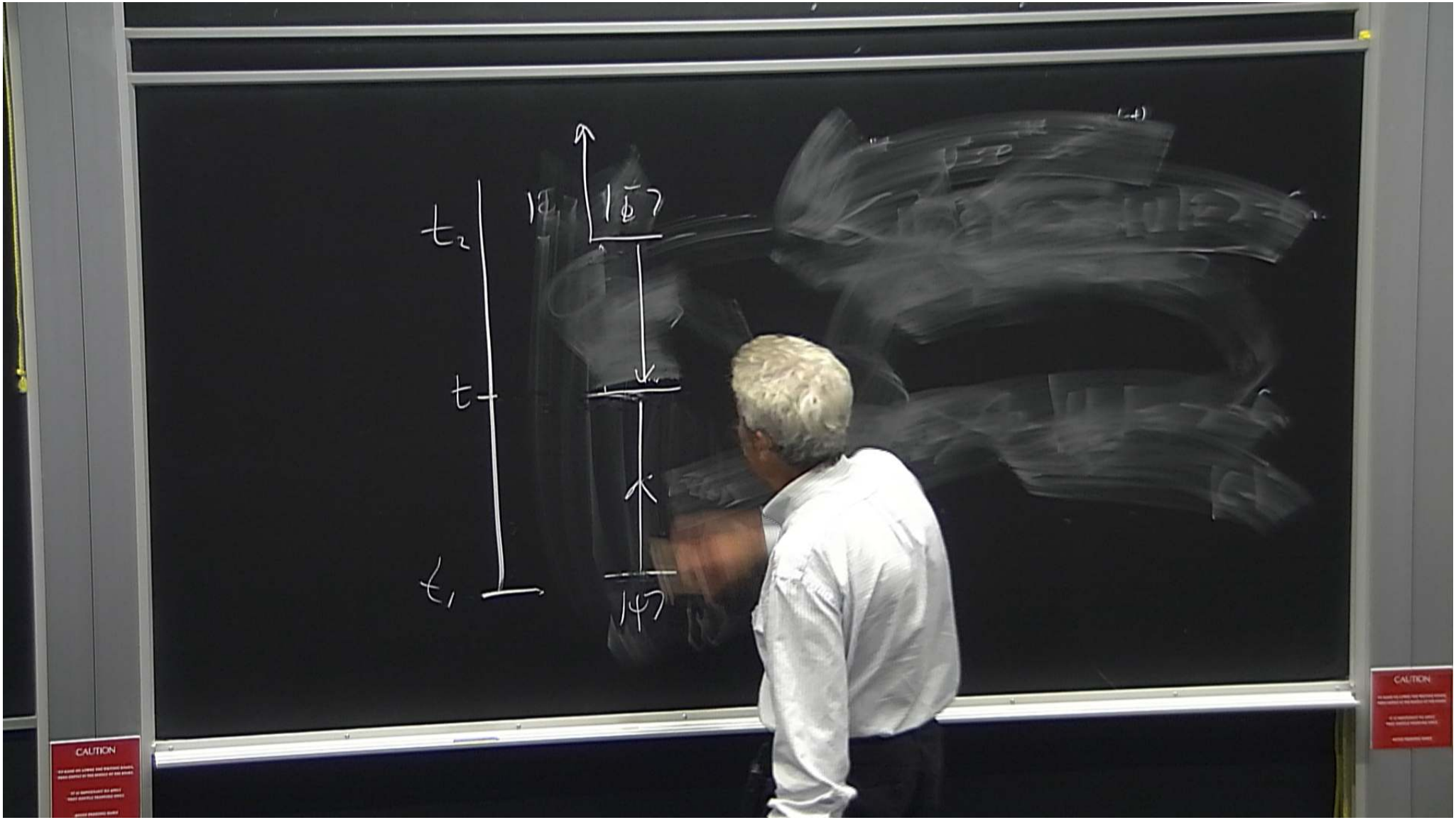
Date: Aug 19, 2014 02:00 PM

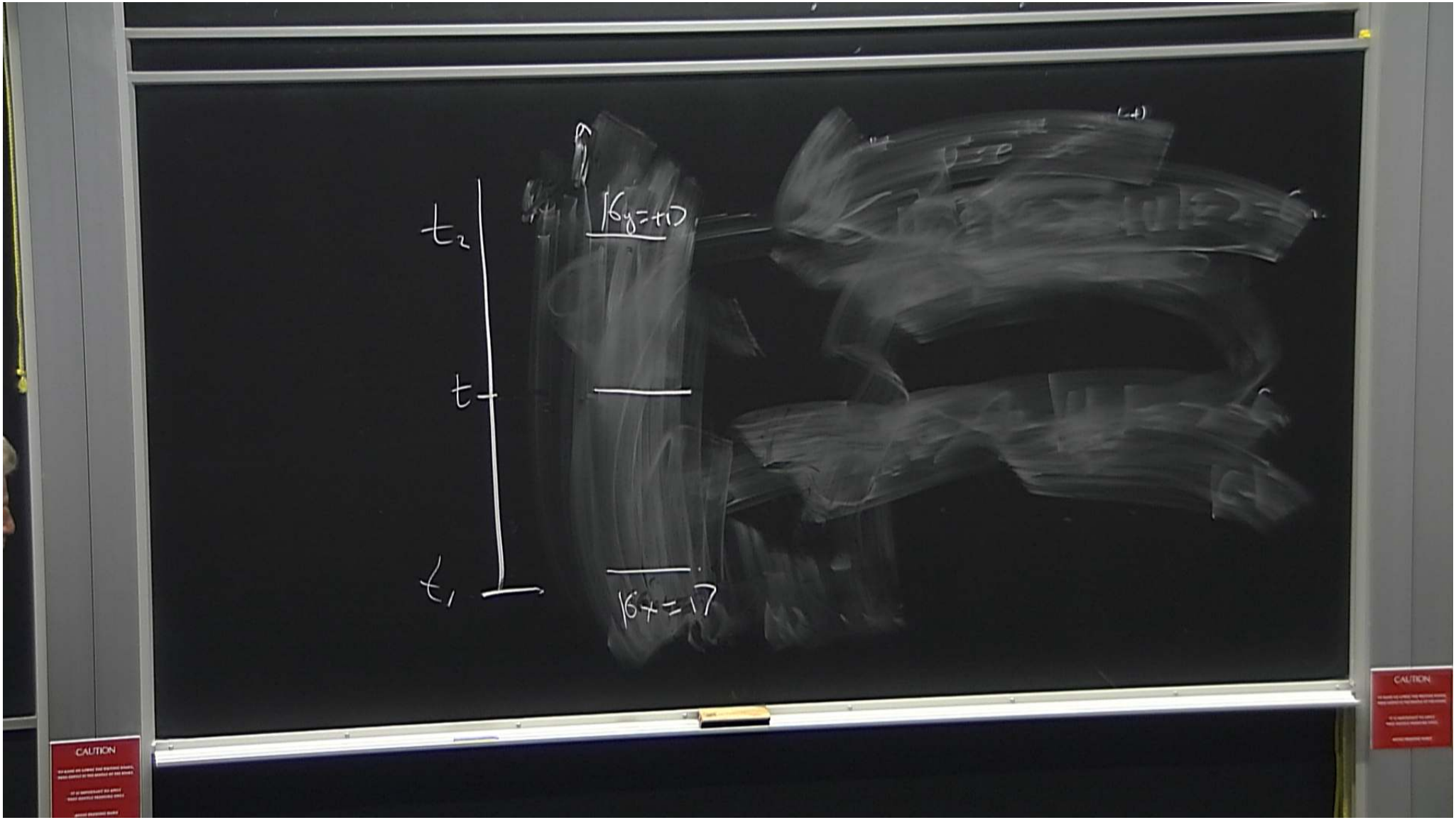
URL: http://pirsa.org/14080040

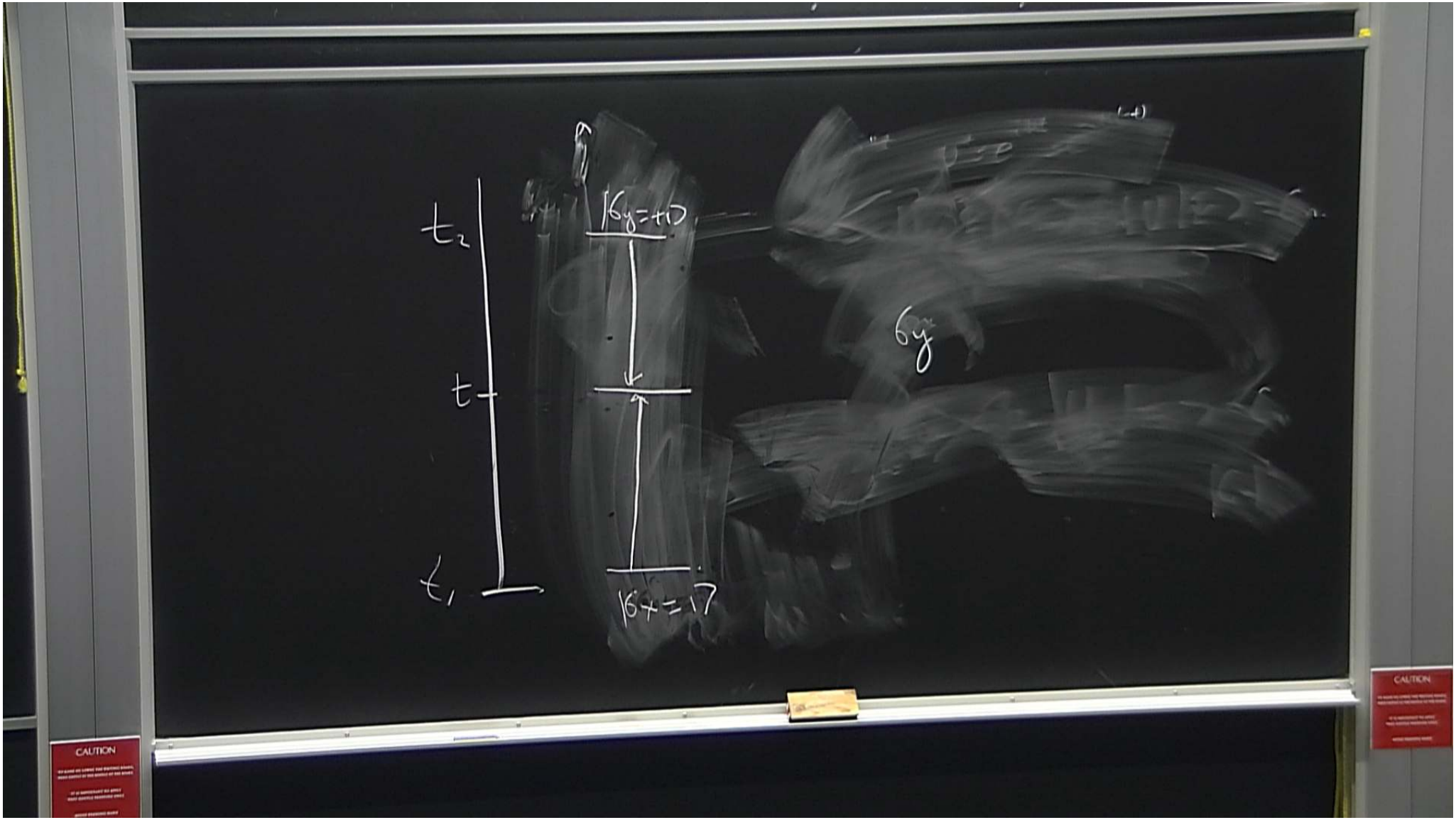
Abstract:

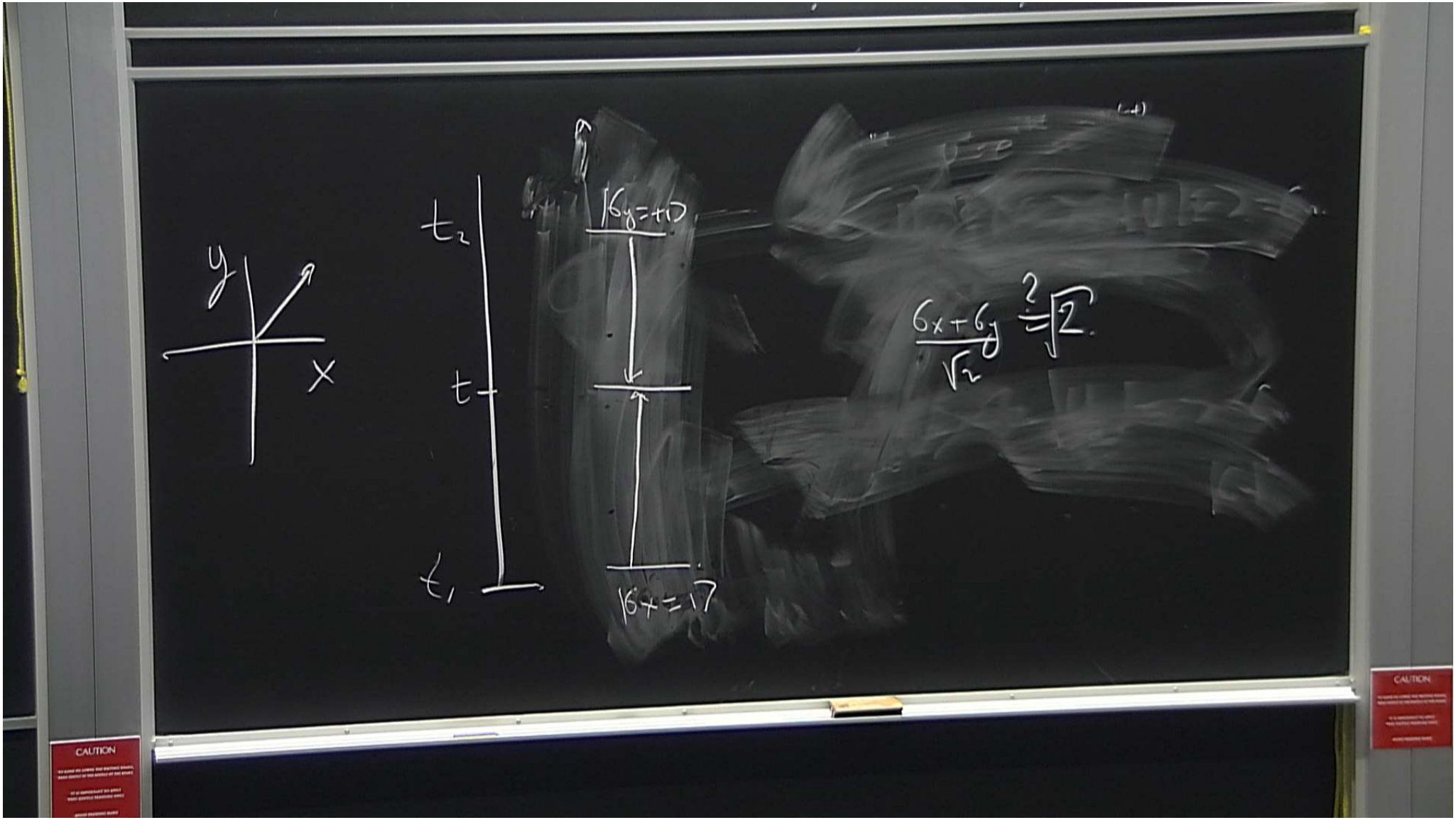

t_2
t
t_1
$|\Phi\rangle$
$|a_n(t)\rangle$
$|a_n\rangle$
$|\psi\rangle$
$\hat{A}\,|a_n\rangle = a_n\,|a_n\rangle$
$\langle\Phi|U_{tt}|a_n\rangle\langle a_n|U_{tt_1}|\Psi_n\rangle = C_n$
$|C_n|^2$

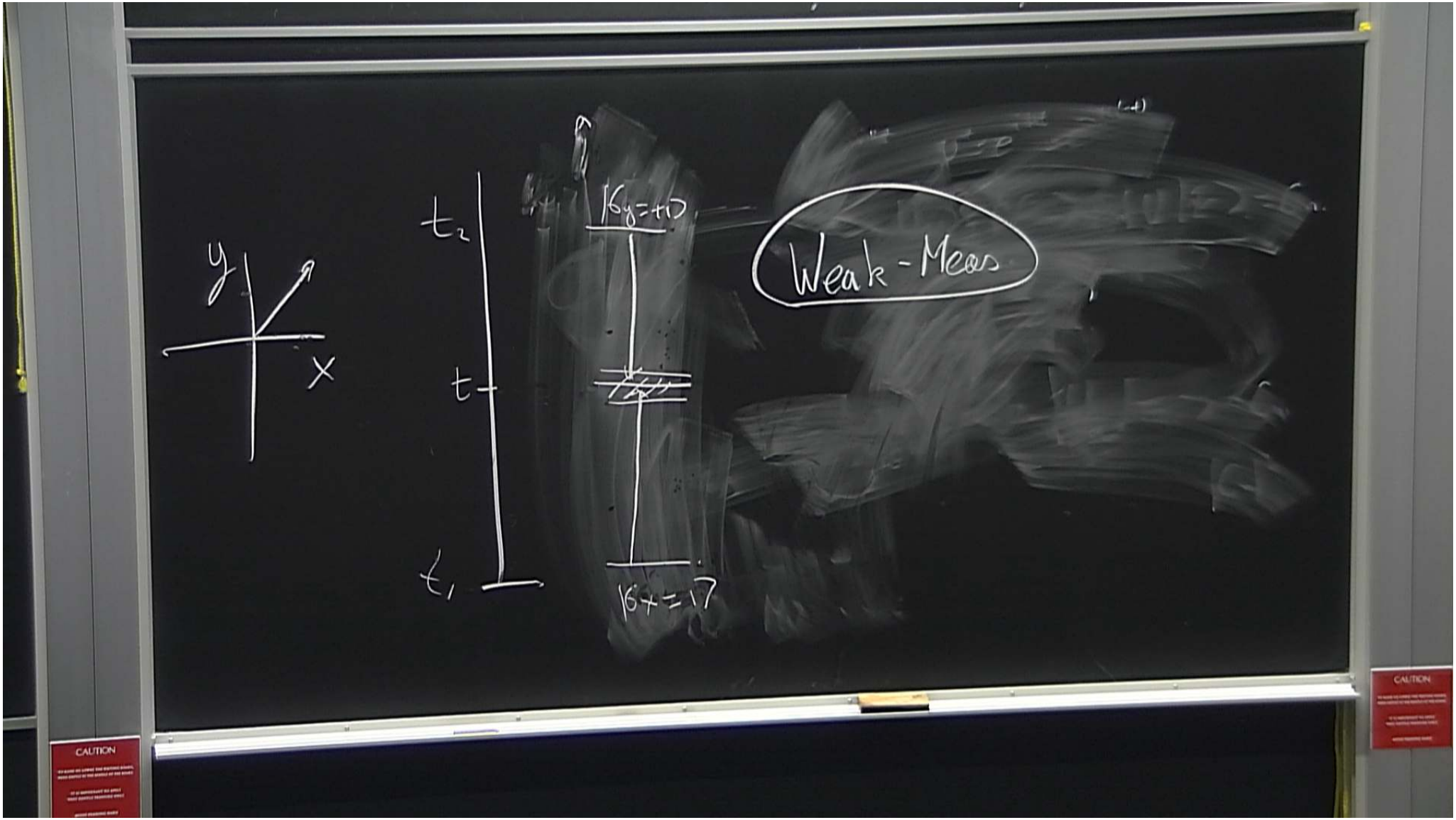

t_2
t_1
CAUTION

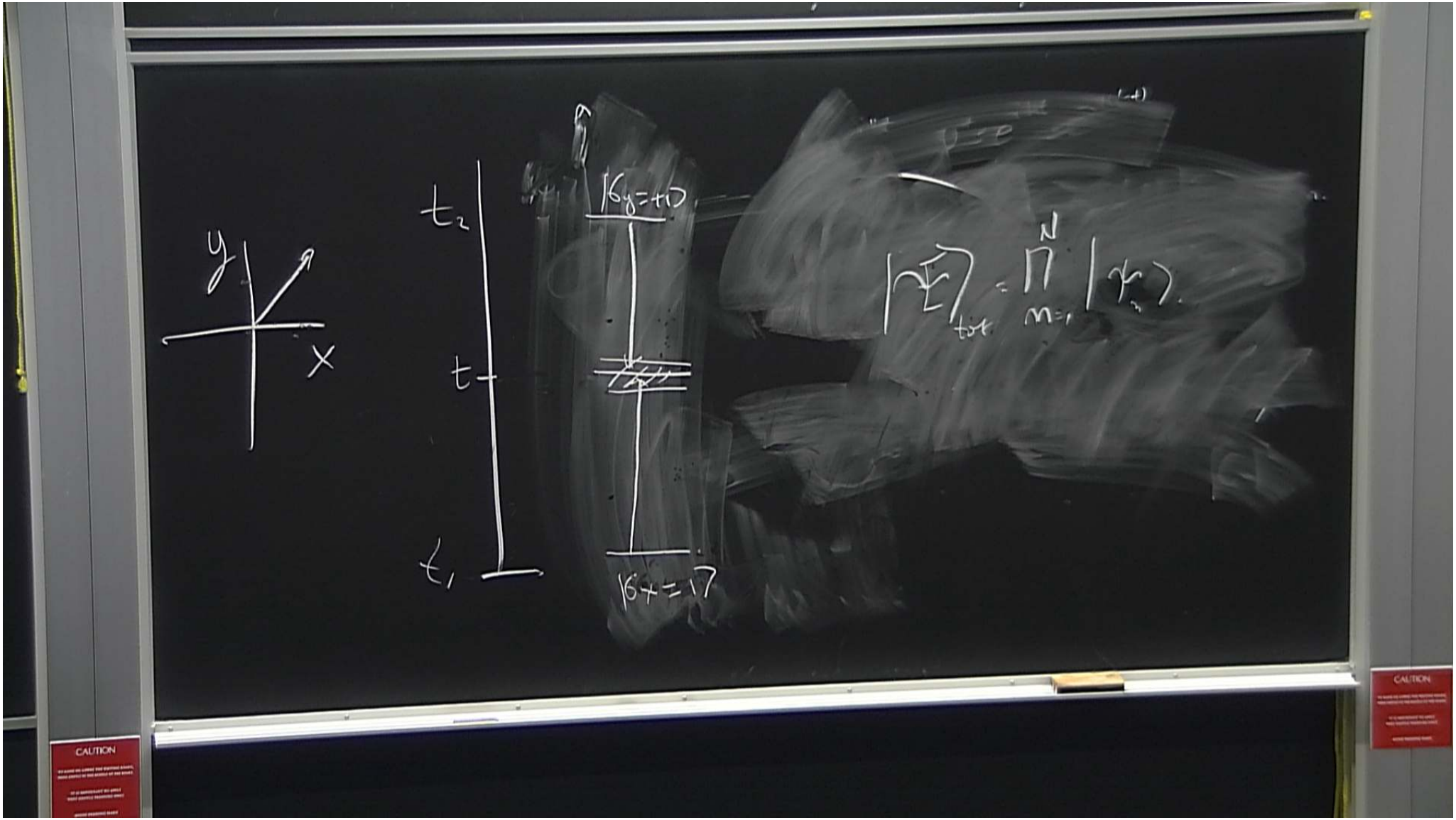

t_2
t_1
CAUTION
CAUTION

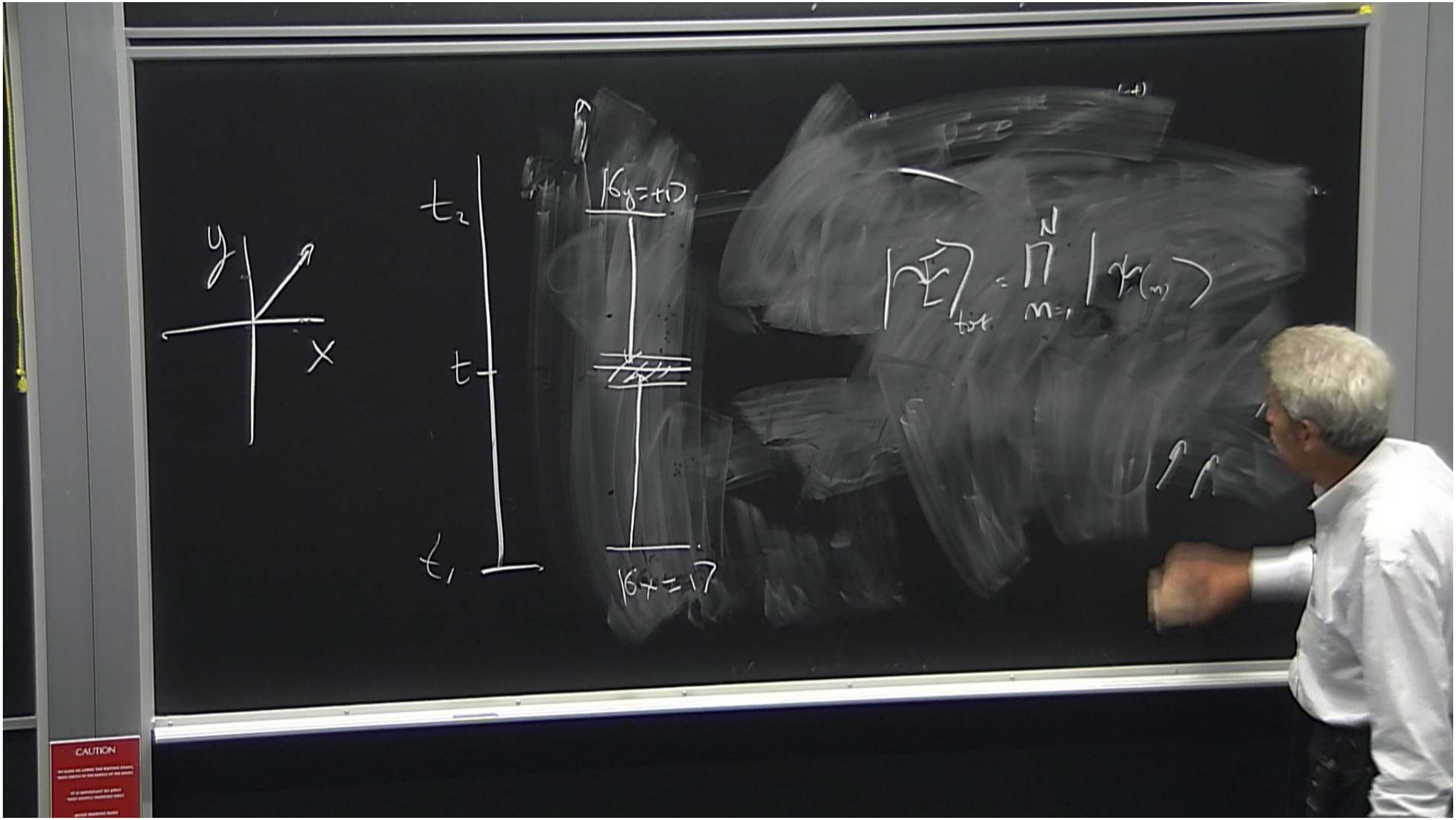

t_2
t
t_1
$|6_y = +1\rangle$
$|6_x = -1\rangle$

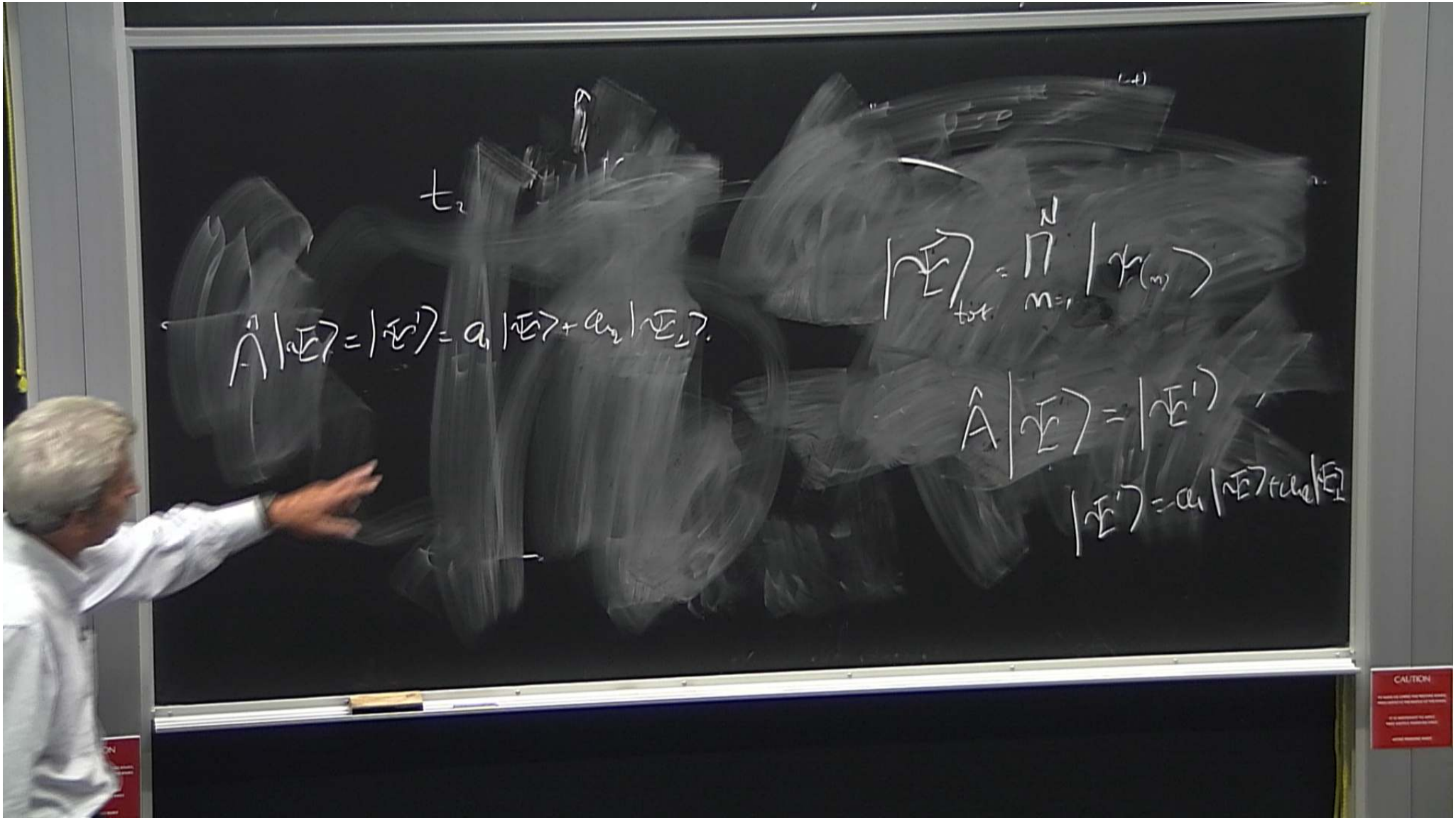

t_2
t
t_1
$\Delta y = +D$
Δy
$\Delta x = 17$
CAUTION
CAUTION

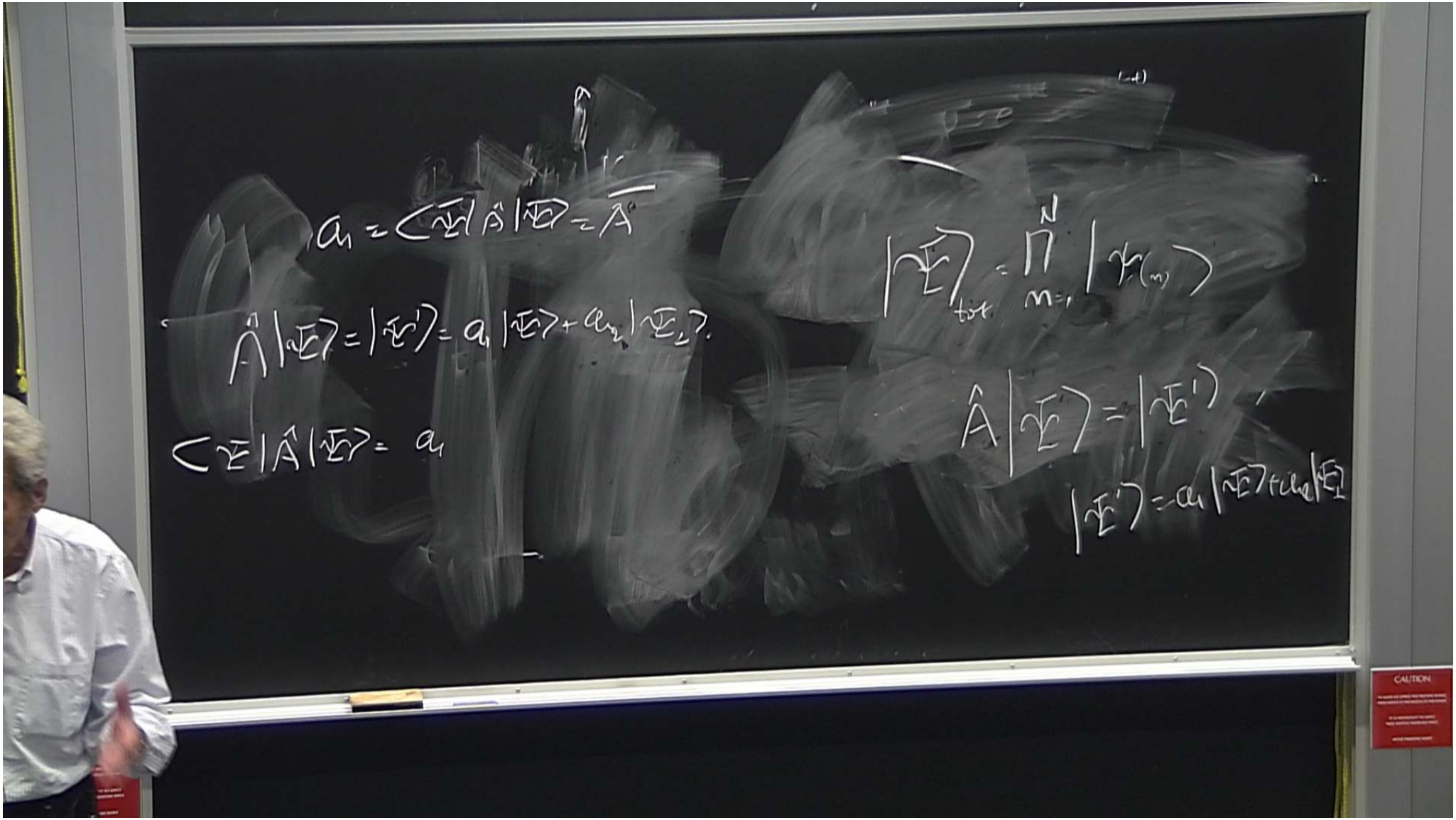

y
x
t_2
t_1
$16_y = +17$
$16_x = 17$
$\frac{6_x + 6_y}{\sqrt{2}} \stackrel{?}{=} \sqrt{2}$

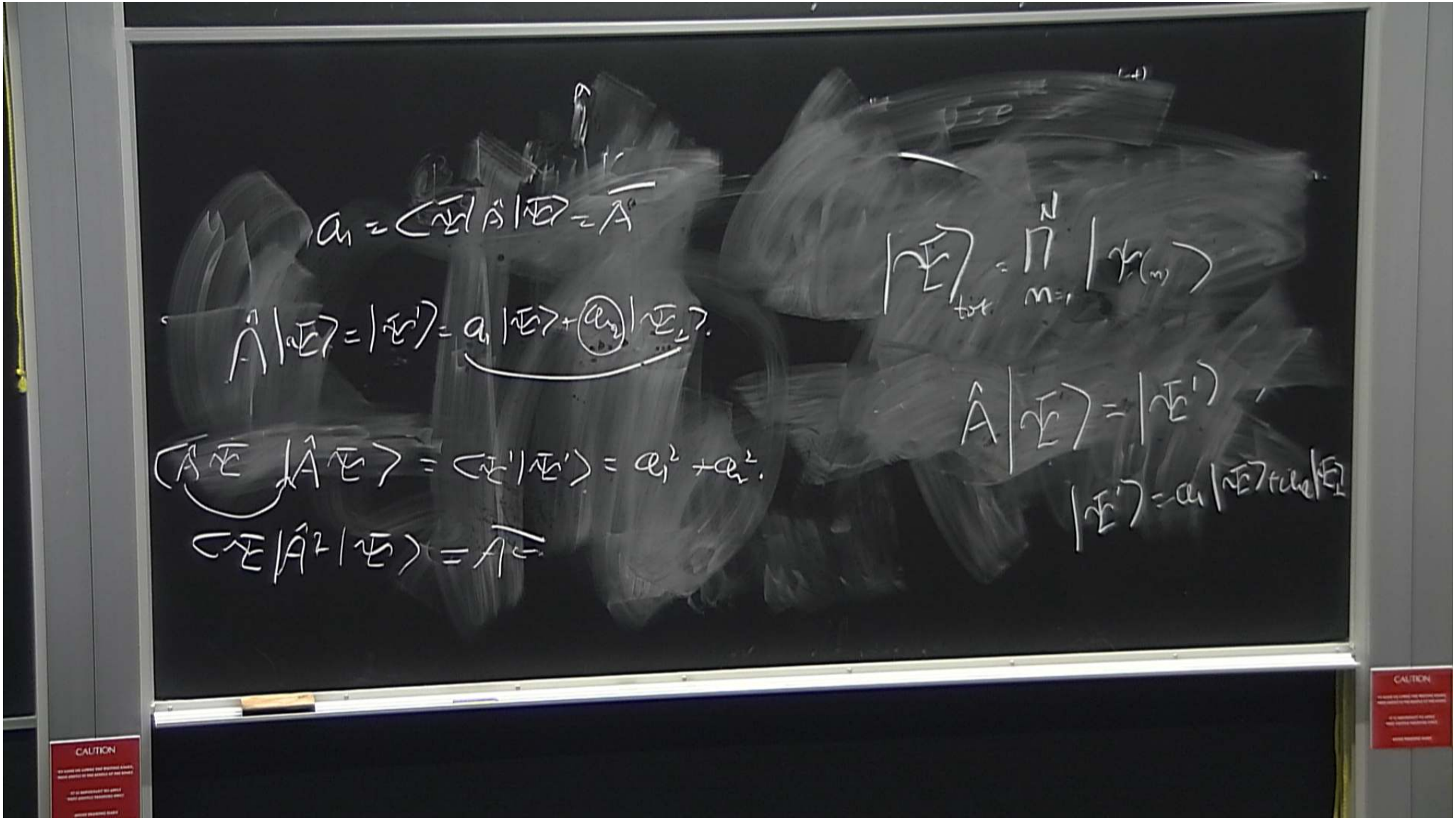

y
x
t_2
t_1
$|6_y=+1\rangle$
$|6_+=1\rangle$
Weak-Meas

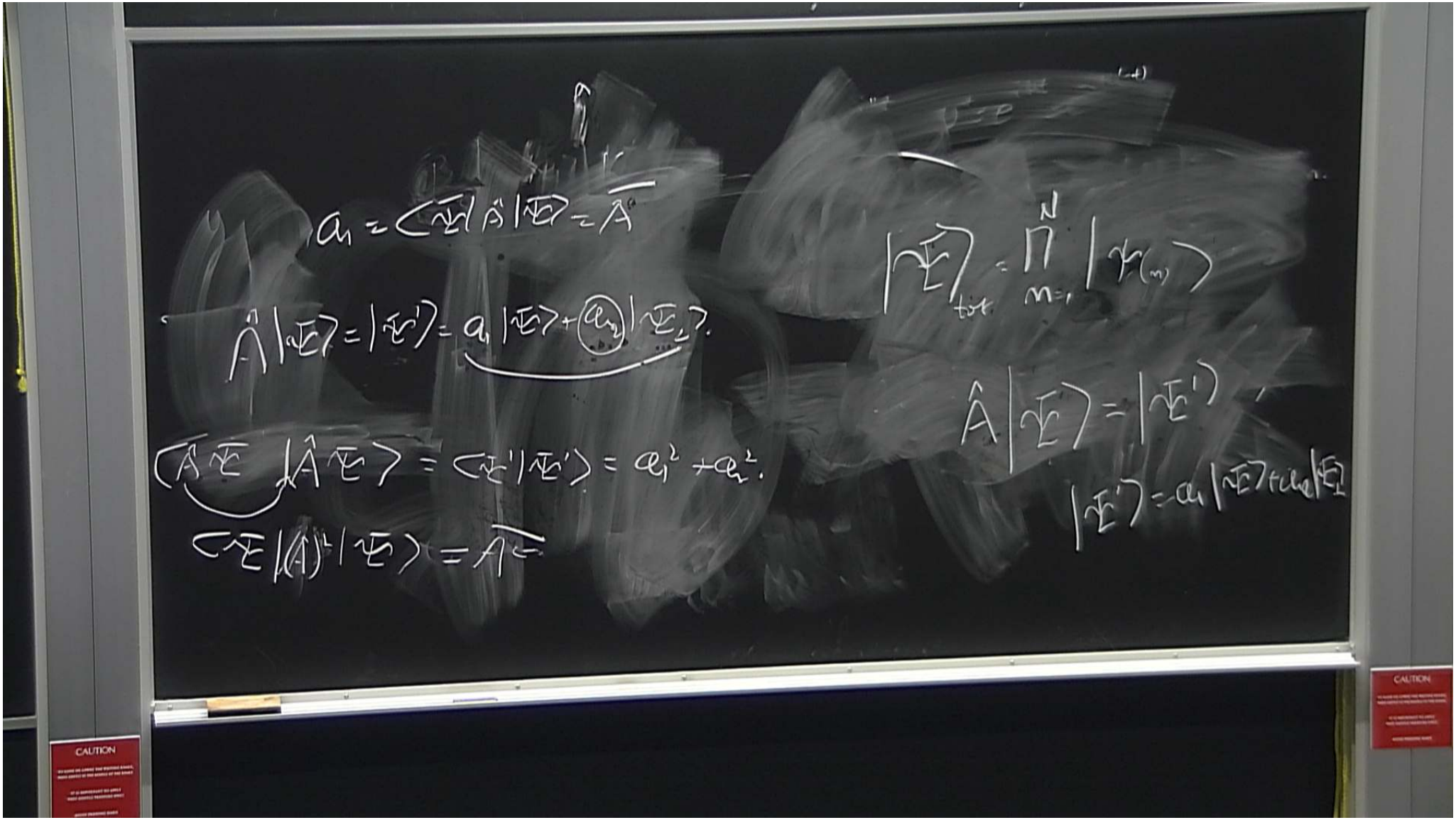

y
x
t2
t
t1
|6y=+1⟩
|6x=1⟩
|Ψ⟩tot = ∏ |ψn⟩
CAUTION

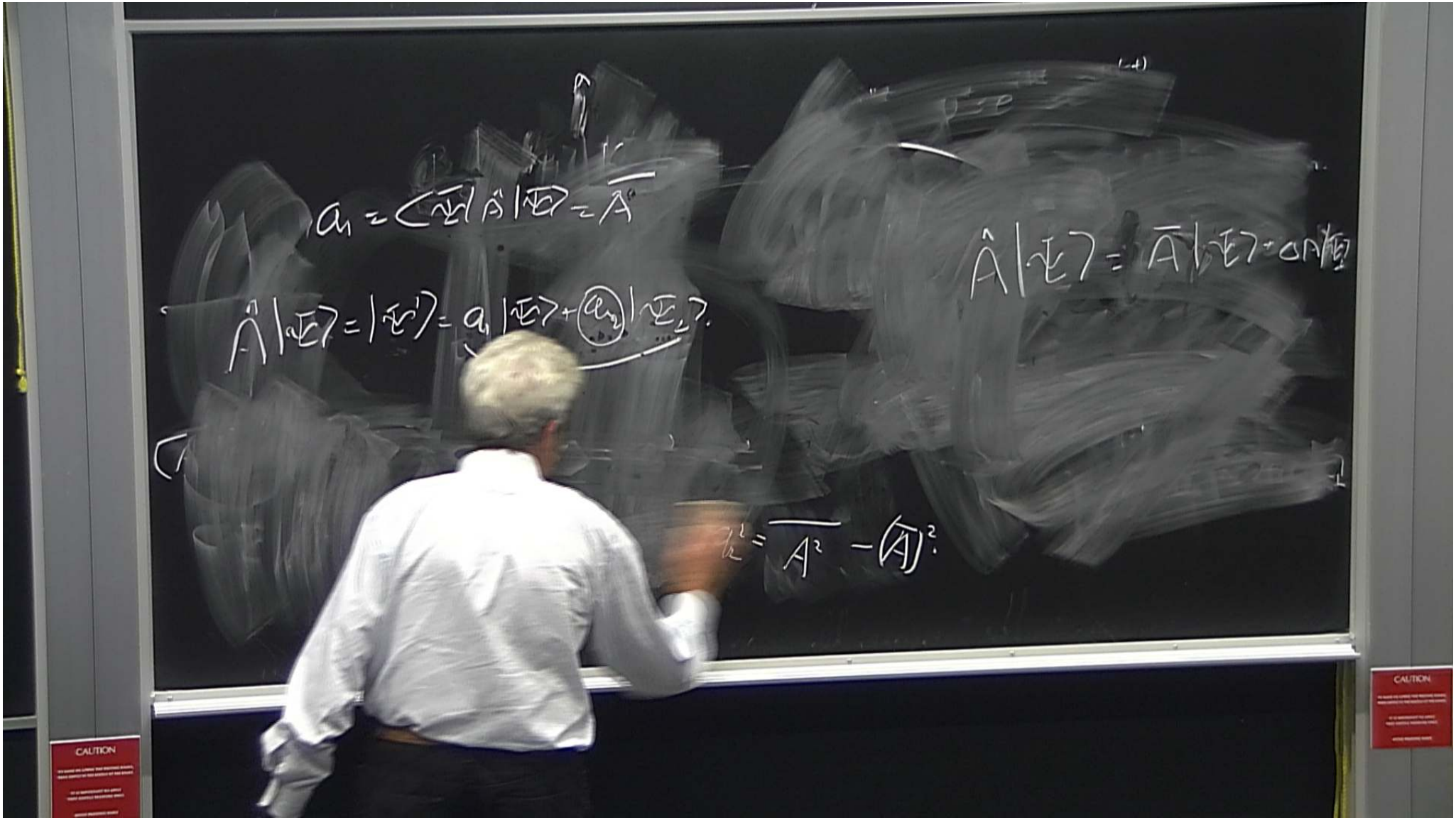

y
x
t2
t
t1
|6y=+1⟩
|6x=1⟩
|Ψ⟩tot = ∏ |ψ(n)⟩
CAUTION

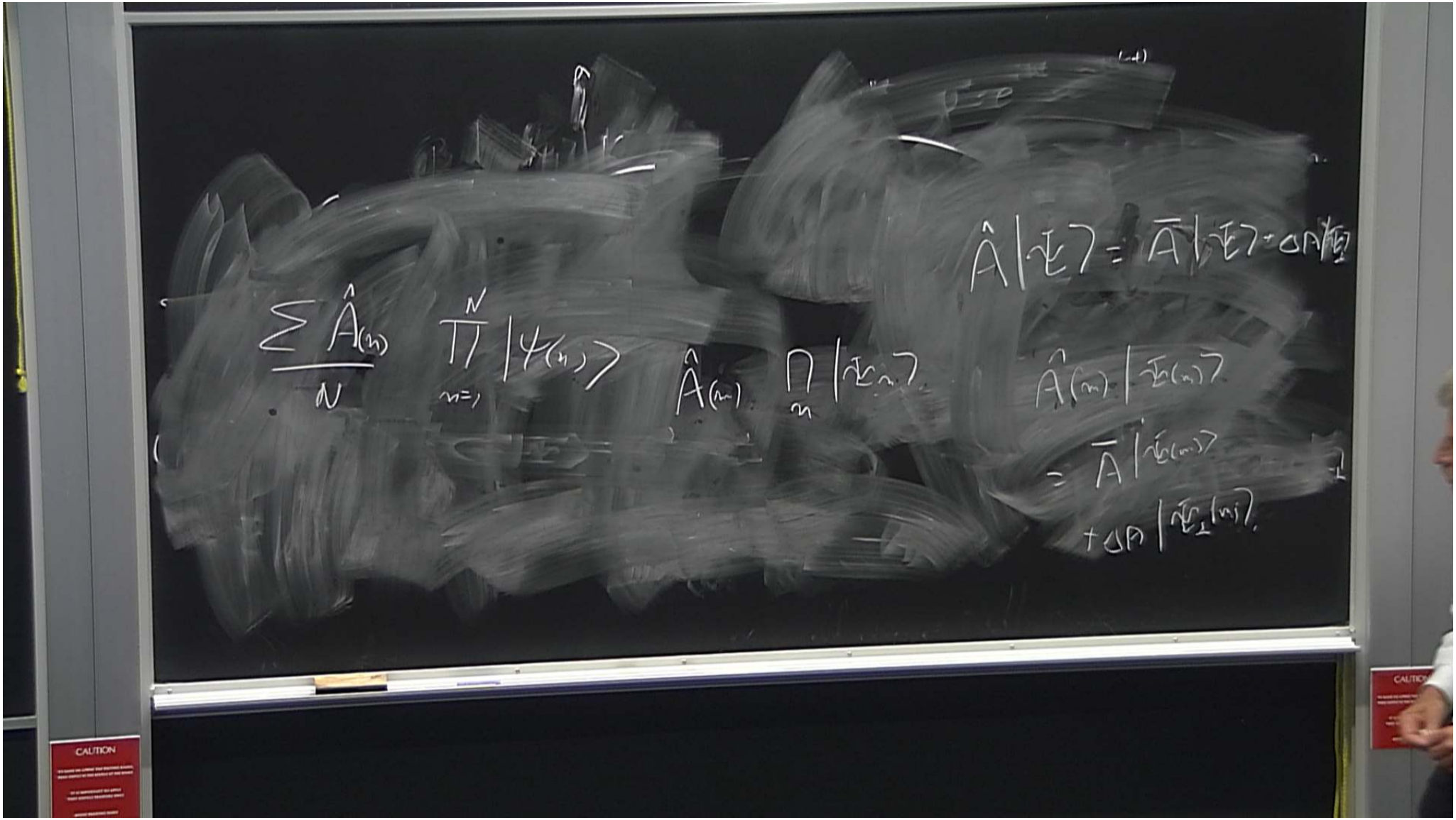

t_2
$\hat{A}|\psi\rangle = |\psi'\rangle = a_1|\psi\rangle + a_2|\psi_\perp\rangle$
$|\psi\rangle_{tot} = \prod_{n=1}^{N} |\psi_{(n)}\rangle$
$\hat{A}|\psi\rangle = |\psi'\rangle$
$|\psi'\rangle = a_1|\psi\rangle + a_2|\psi_\perp\rangle$
CAUTION

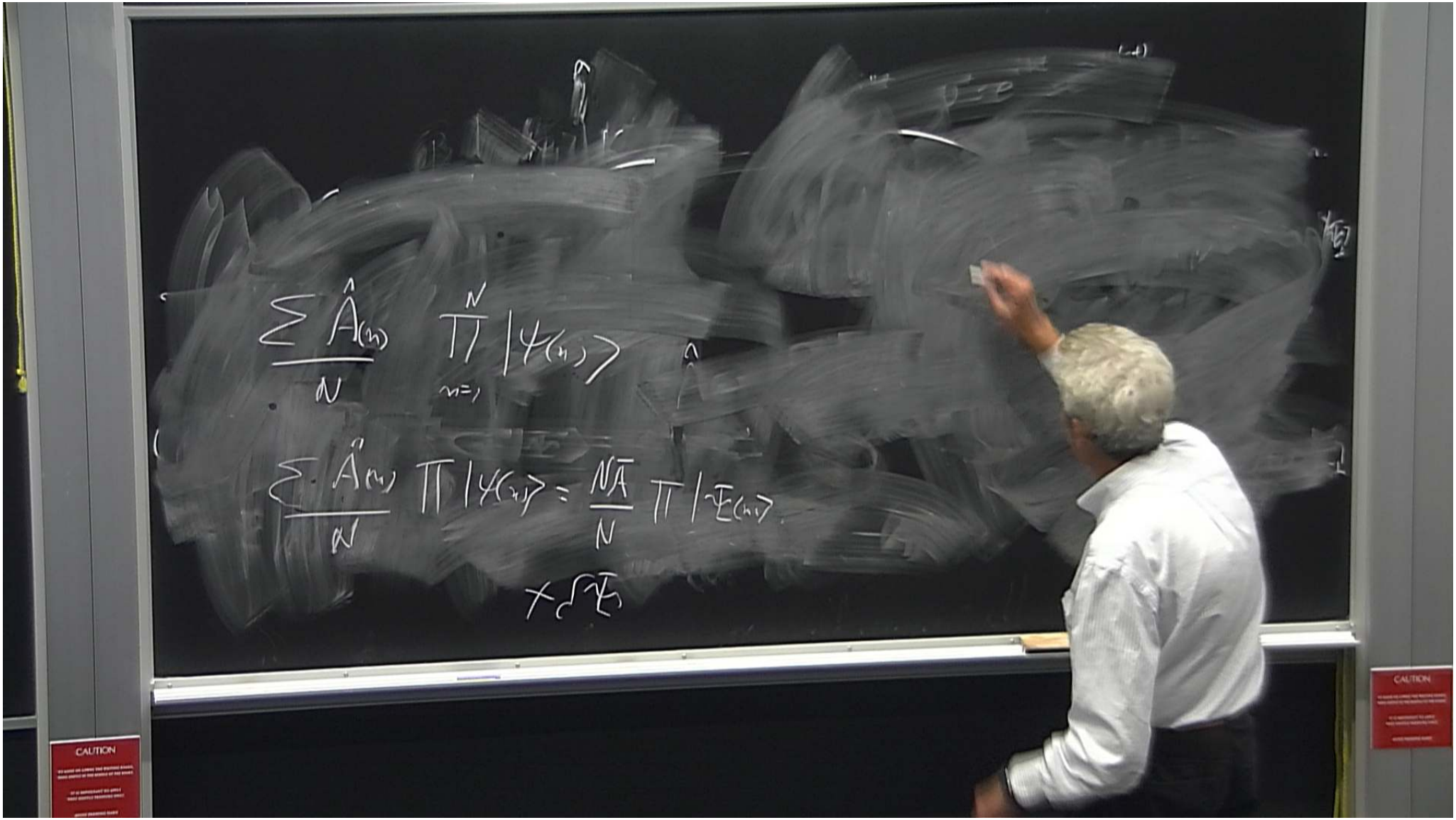

$a_1 = \langle \Sigma | \hat{A} | \Sigma \rangle = \bar{A}$
$\hat{A}|\Sigma\rangle = |\Sigma'\rangle = a_1|\Sigma\rangle + a_2|\Sigma_2\rangle$
$\langle \Sigma | \hat{A} | \Sigma \rangle = a_1$
$|\Sigma\rangle_{tot} = \prod_{n=1}^{N} |x_{(n)}\rangle$
$\hat{A}|\Sigma\rangle = |\Sigma'\rangle$
$|\Sigma'\rangle = a_1|\Sigma\rangle + c_2|\Sigma_2\rangle$
CAUTION

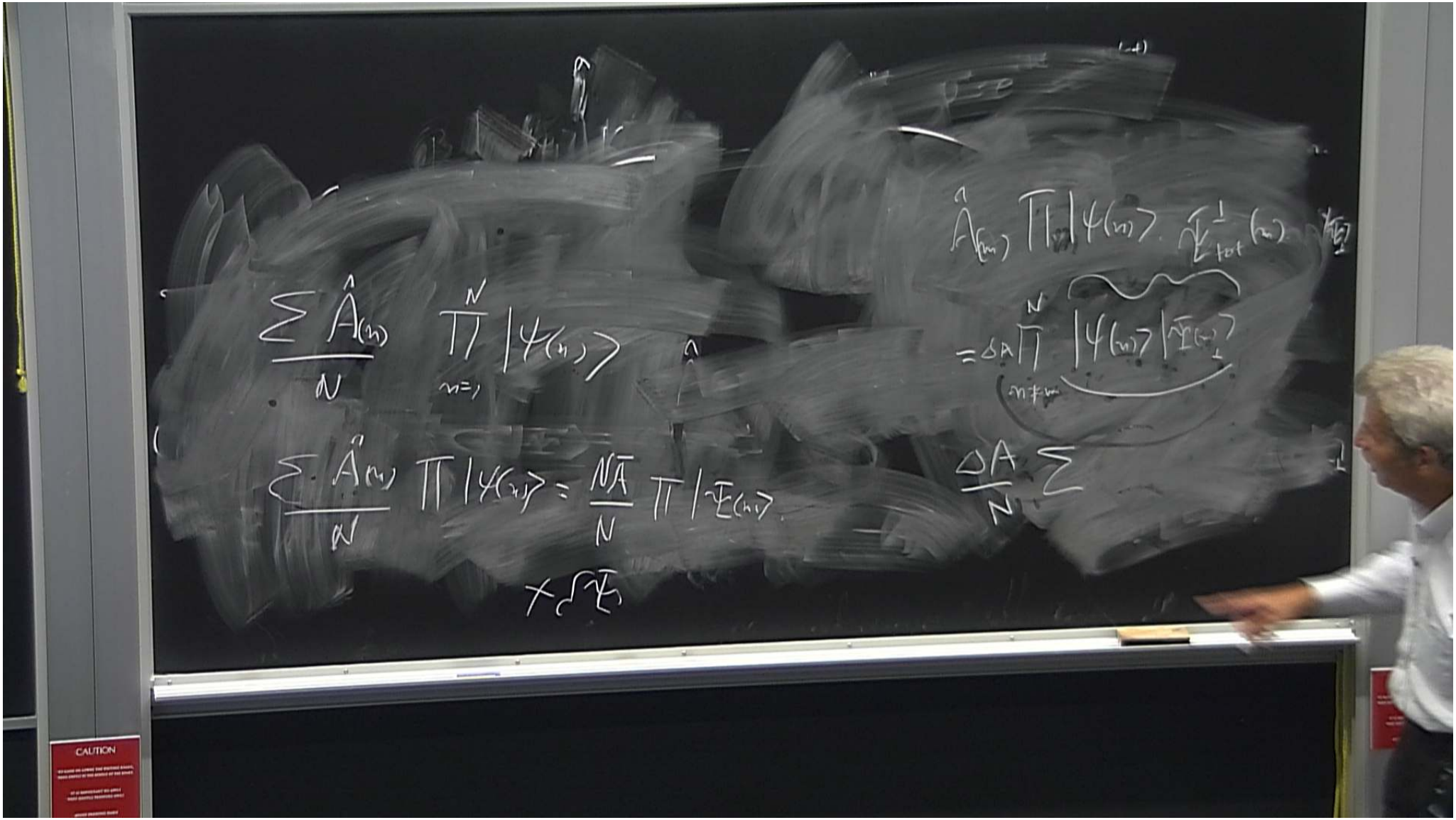

$a_1 = \langle \psi | \hat{A} | \psi \rangle = \bar{A}$
$\hat{A}|\psi\rangle = |\psi'\rangle = a_1|\psi\rangle + a_2|\psi_\perp\rangle$
$\langle \hat{A}\psi | \hat{A}\psi \rangle = \langle \psi' | \psi' \rangle = a_1^2 + a_2^2$
$\langle \psi | \hat{A}^2 | \psi \rangle = \overline{A^2}$
$|\psi\rangle_{tot} = \sum_{n=1}^{N} |\psi_{(n)}\rangle$
$\hat{A}|\psi\rangle = |\psi'\rangle$
$|\psi'\rangle = a_1|\psi\rangle + a_2|\psi_\perp\rangle$
CAUTION
CAUTION

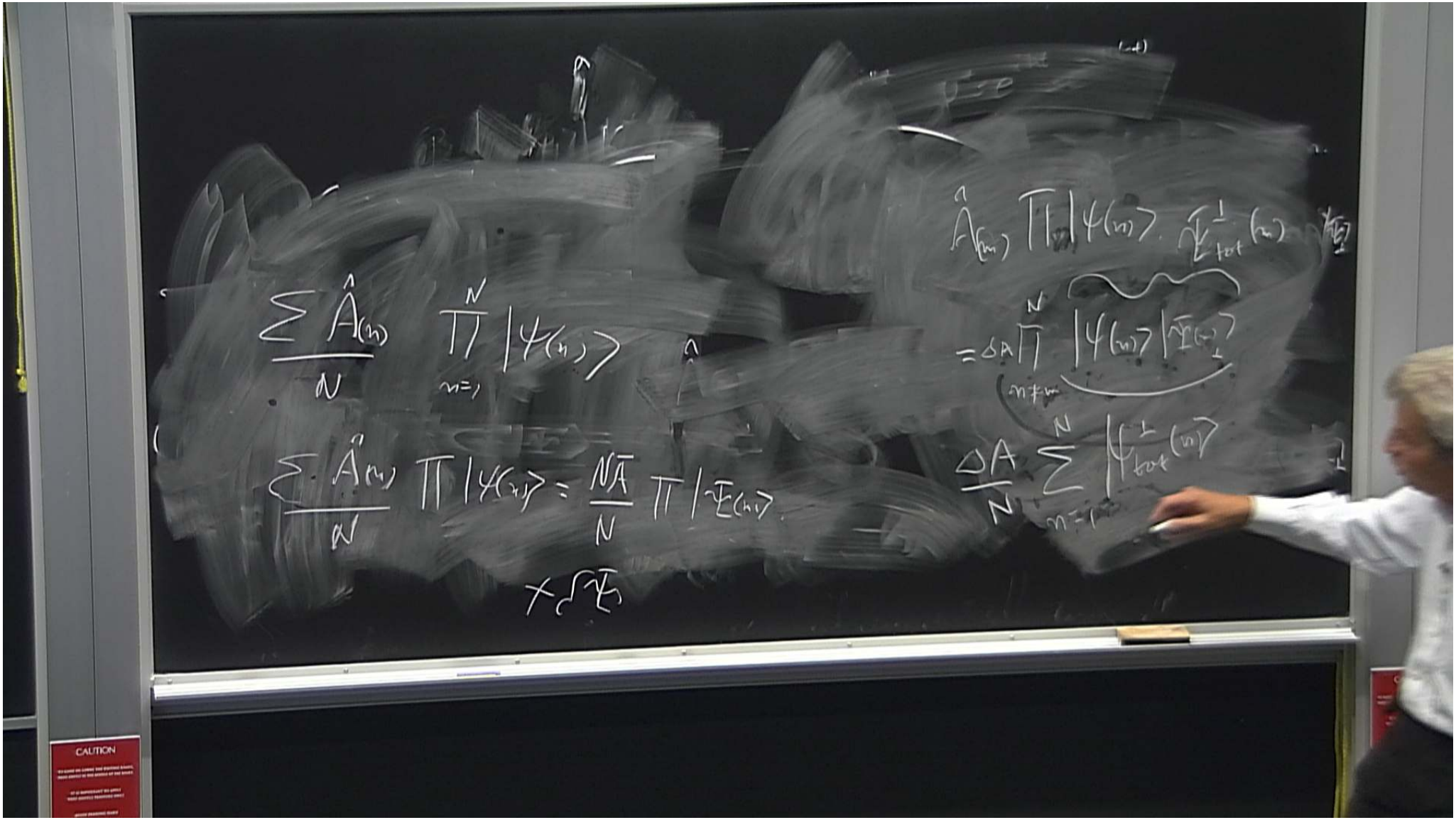

$a_1 = \langle \vec{x}_1 | \hat{A} | \vec{x} \rangle = \vec{A}$
$\hat{A}|\vec{x}\rangle = |\vec{x}'\rangle = a_1|\vec{x}\rangle + a_2|\vec{x}_2\rangle$
$\langle \vec{x}|\hat{A}^\dagger\hat{A}|\vec{x}\rangle = \langle \vec{x}'|\vec{x}'\rangle = a_1^2 + a_2^2$
$\langle \vec{x}|(\hat{A}^\dagger)^{-1}|\vec{x}\rangle = \vec{A}^{-1}$
$|\vec{x}\rangle_{tot} = \sum_{n=1}^{N} |x_{(n)}\rangle$
$\hat{A}|\vec{x}\rangle = |\vec{x}'\rangle$
$|\vec{x}'\rangle = a_1|\vec{x}\rangle + a_2|\vec{x}_2\rangle$
CAUTION
CAUTION

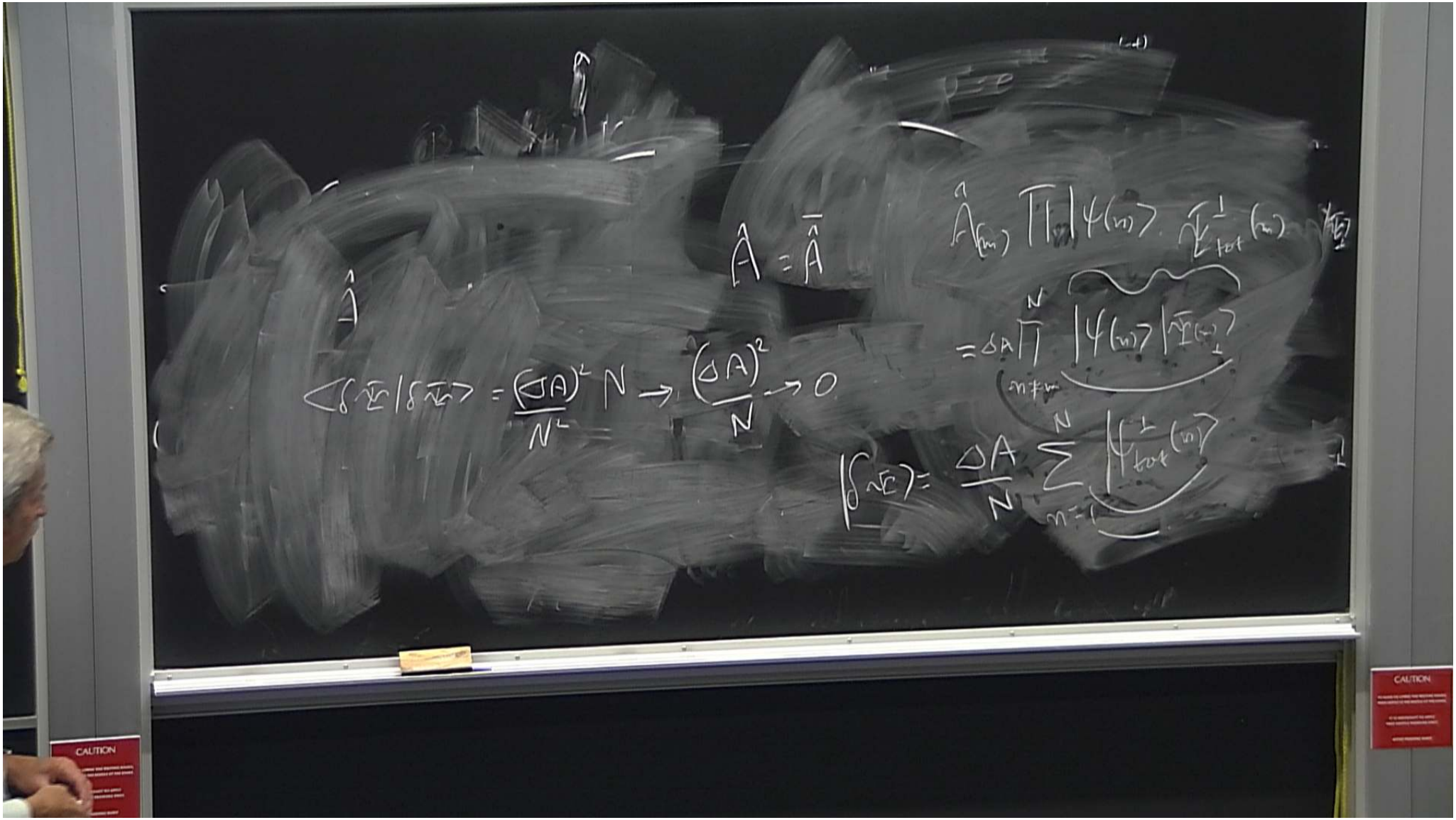

CAUTION
CAUTION

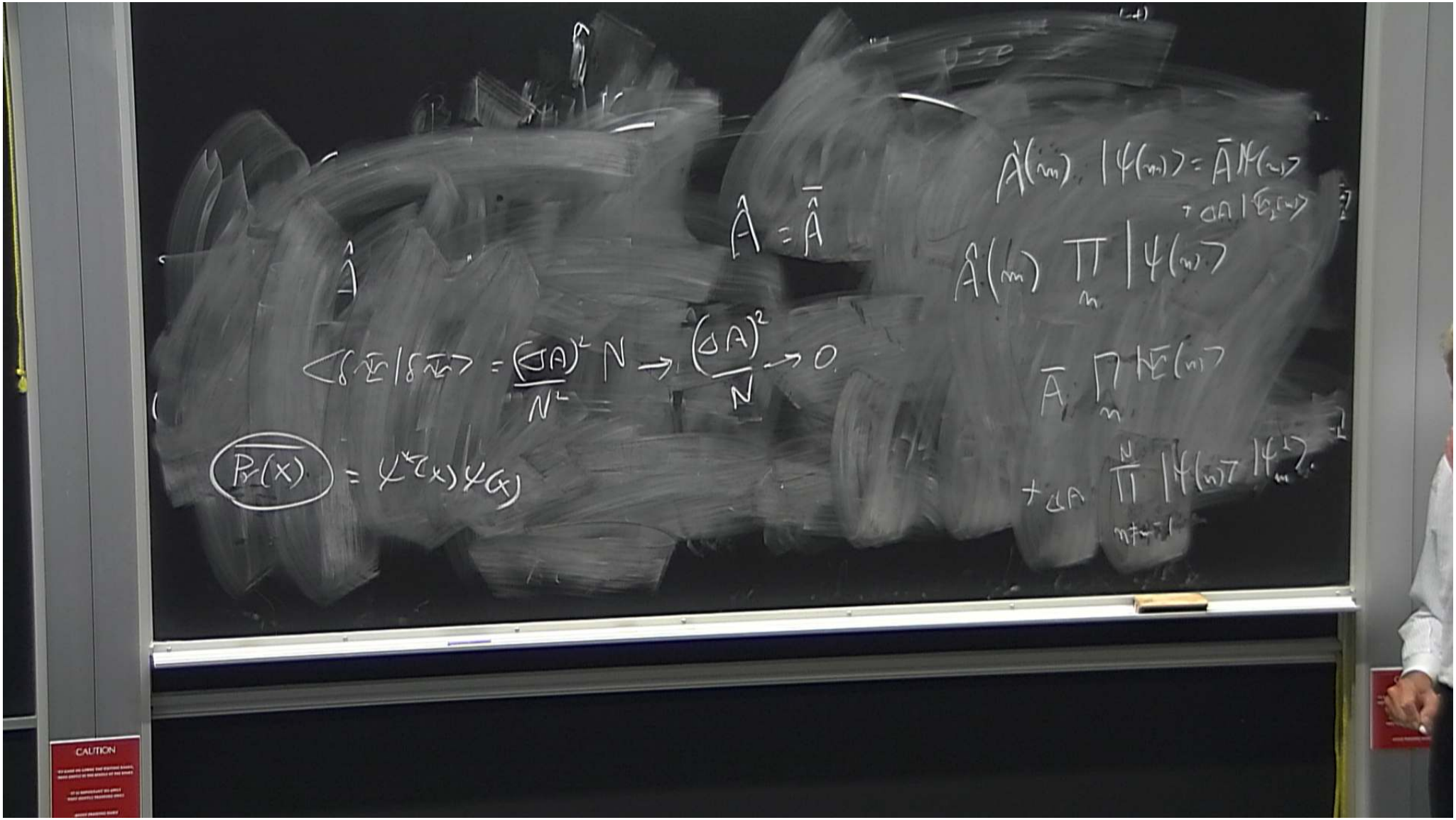

$\frac{\sum \hat{A}_{(n)}}{N} \prod_{n=1}^{N} |\psi_{(n)}\rangle$
$\hat{A}_{(n)} \prod_{n} |\psi_{(n)}\rangle$
$\hat{A}|\psi\rangle = \bar{A}|\psi\rangle + \Delta A|\psi_\perp\rangle$
$\hat{A}_{(n)}|\psi_{(n)}\rangle$
$= \bar{A}|\psi_{(n)}\rangle$
$+ \Delta A|\psi_{\perp(n)}\rangle$

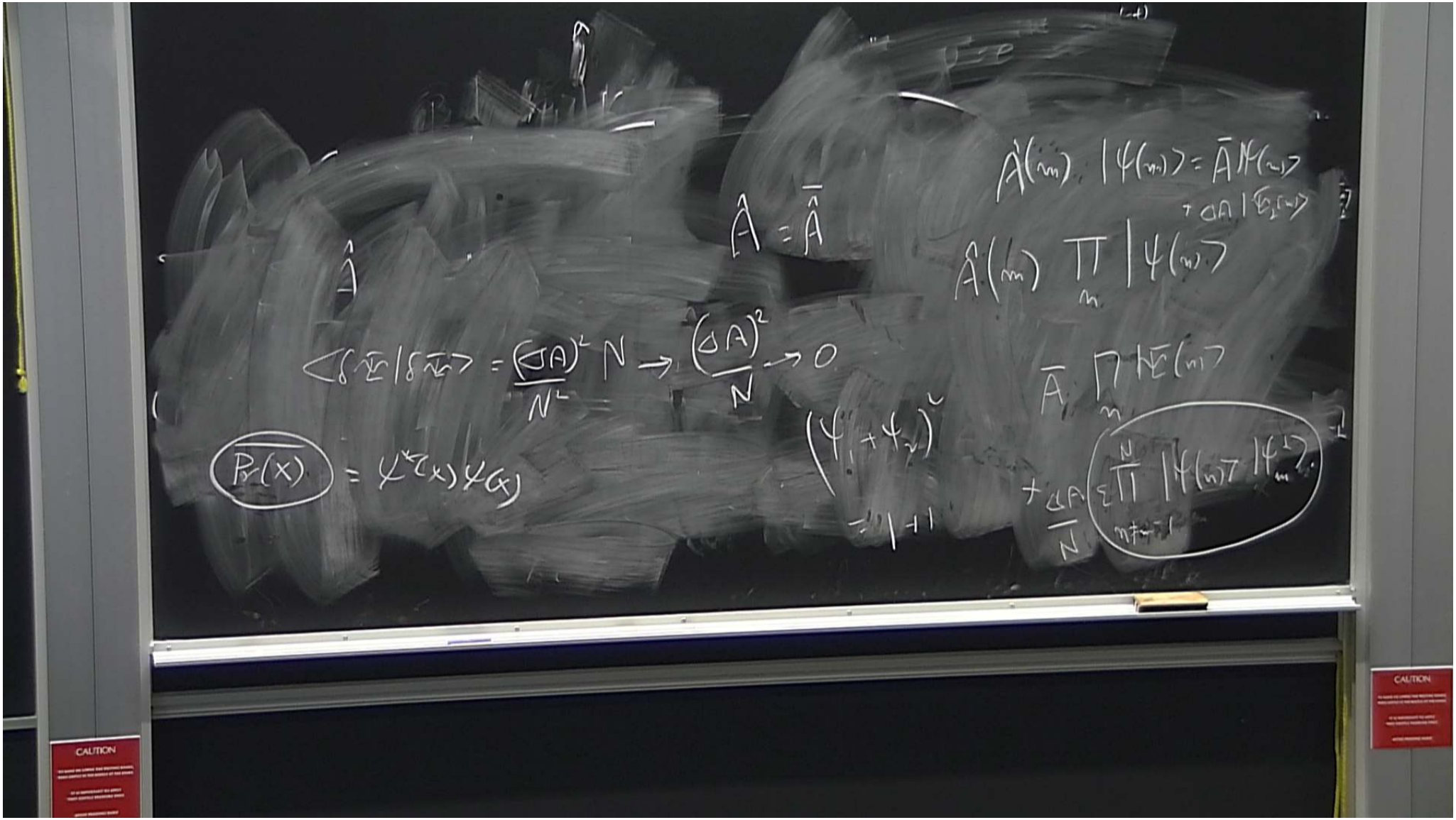

$\sum \frac{\hat{A}_{(n)}}{N} \prod_{n=1}^{N} |\psi_{(n)}\rangle$
$\sum \frac{\hat{A}_{(n)}}{N} \prod |\psi_{(n)}\rangle = \frac{N\bar{A}}{N} \prod |\psi_{(n)}\rangle$
CAUTION
CAUTION

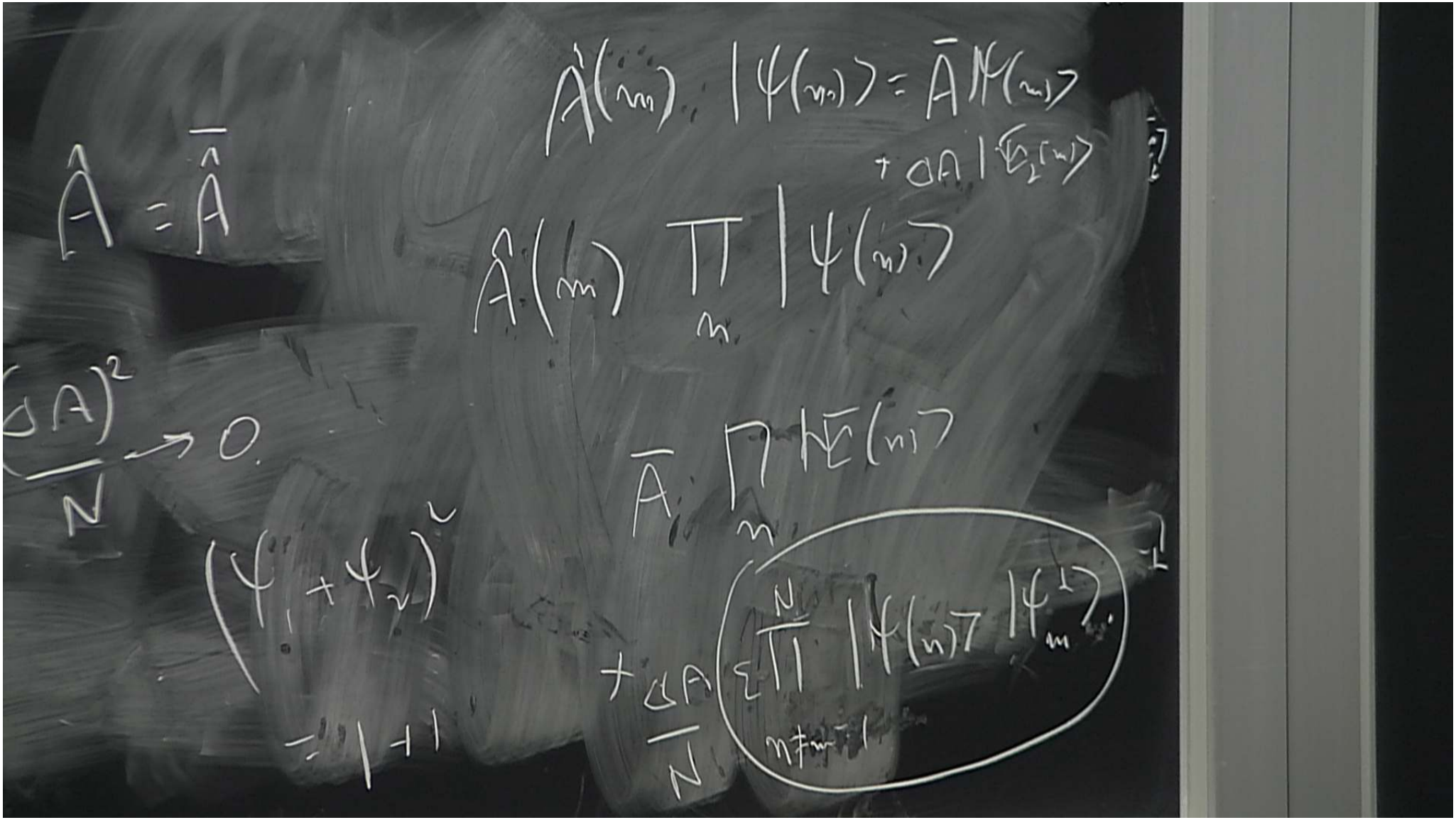

CAUTION


CAUTION


$\hat{A} = \bar{\hat{A}}$
$\langle \delta\Sigma | \delta\Sigma \rangle = \frac{(\Delta A)^2}{N^2} N \to \frac{(\Delta A)^2}{N} \to 0$
$\hat{A}_{(m)} \prod_{n \neq m} |\psi_{(n)}\rangle \, \Sigma^{-1}_{tot\,(m)}$
$= \Delta A \prod_{n \neq m}^{N} |\psi_{(n)}\rangle |\Sigma^{-1}_{(n)}\rangle$
$|\delta\Sigma\rangle = \frac{\Delta A}{N} \sum_{n=1}^{N} |\psi^{\perp}_{tot\,(n)}\rangle$
CAUTION
CAUTION


$\hat{A}$
$\hat{A} = \bar{\hat{A}}$
$\langle \delta\Sigma | \delta\Sigma \rangle = \frac{(\delta A)^2}{N^2} N \to \frac{(\delta A)^2}{N} \to 0$
$\overline{P_\Psi(x)} = \Psi^*(x)\Psi(x)$
$\hat{A}(m) |\psi(m)\rangle = \bar{A} |\psi(m)\rangle + \delta A |\Sigma_1(m)\rangle$
$\hat{A}(m) \prod_m |\psi(m)\rangle$
$\bar{A} \prod_m |\psi(m)\rangle$
$+ \delta A \prod_{n \neq m}^{N} |\psi(m)\rangle |\psi_m|^2$
CAUTION


$\hat{A} = \bar{\hat{A}}$
$\hat{A}(m)\,|\psi(m)\rangle = \bar{A}\,|\psi(m)\rangle + \Delta A\,|\Psi_\perp(m)\rangle$
$\hat{A}(m) \prod_m |\psi(m)\rangle$
$\langle \delta\Psi | \delta\Psi \rangle = \frac{(\Delta A)^2}{N^2} N \to \frac{(\Delta A)^2}{N} \to 0$
$\bar{A} \prod_m |\Psi(m)\rangle$
$\overline{Pr(x)} = \psi^*(x)\psi(x)$
$(\psi_1 + \psi_2)^2$
$+ \frac{\Delta A}{N} \sum_{m \neq n} \prod^{N} |\psi(m)\rangle |\psi_m^\perp\rangle$
CAUTION



$$\hat{A} = \bar{\hat{A}}$$

$$\hat{A}(m)\,|\psi(m)\rangle = \bar{A}\,|\psi(m)\rangle + \Delta A\,|\Psi_2(m)\rangle$$

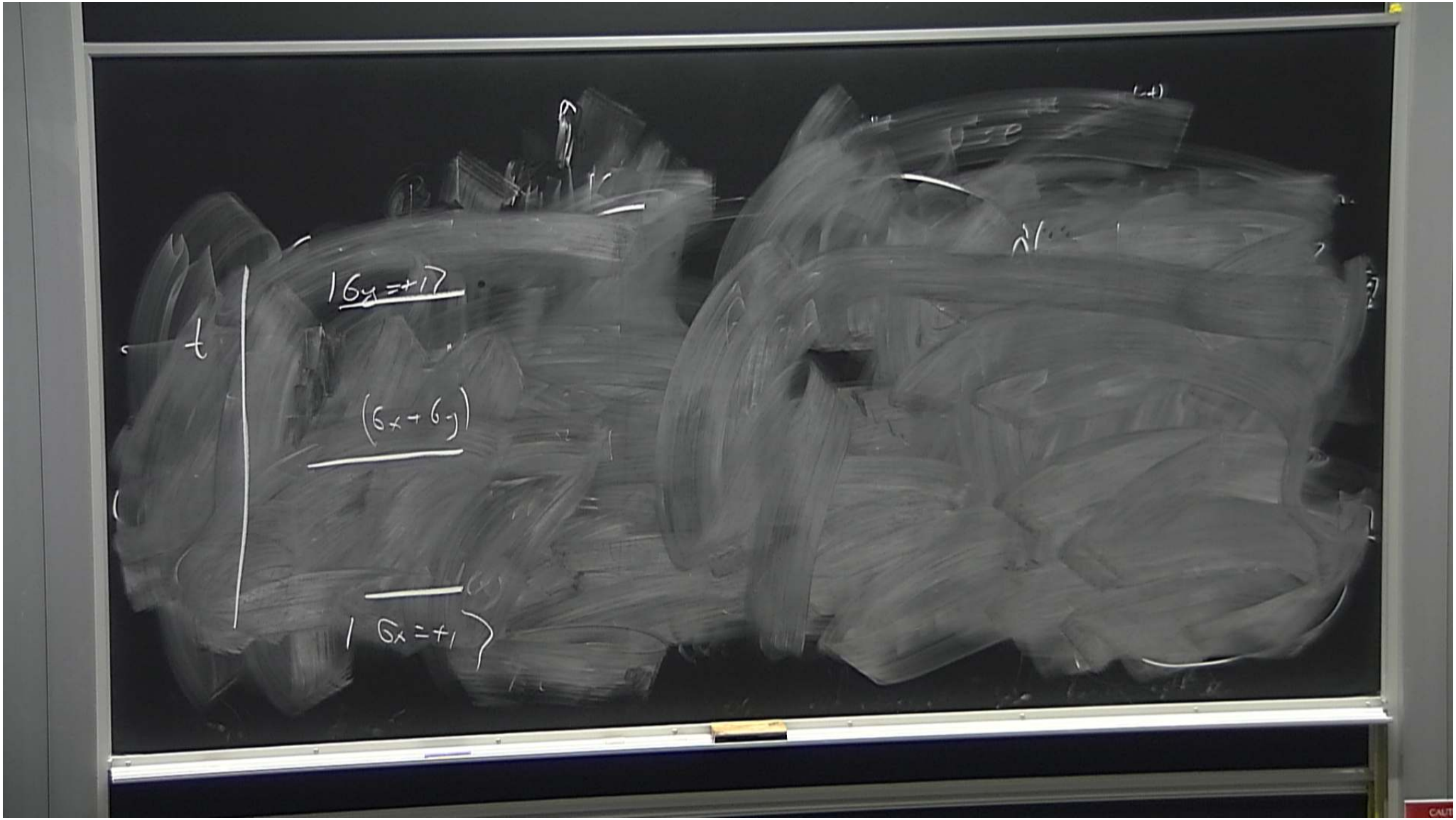
$$\hat{A}(m) \prod_n |\psi(n)\rangle$$

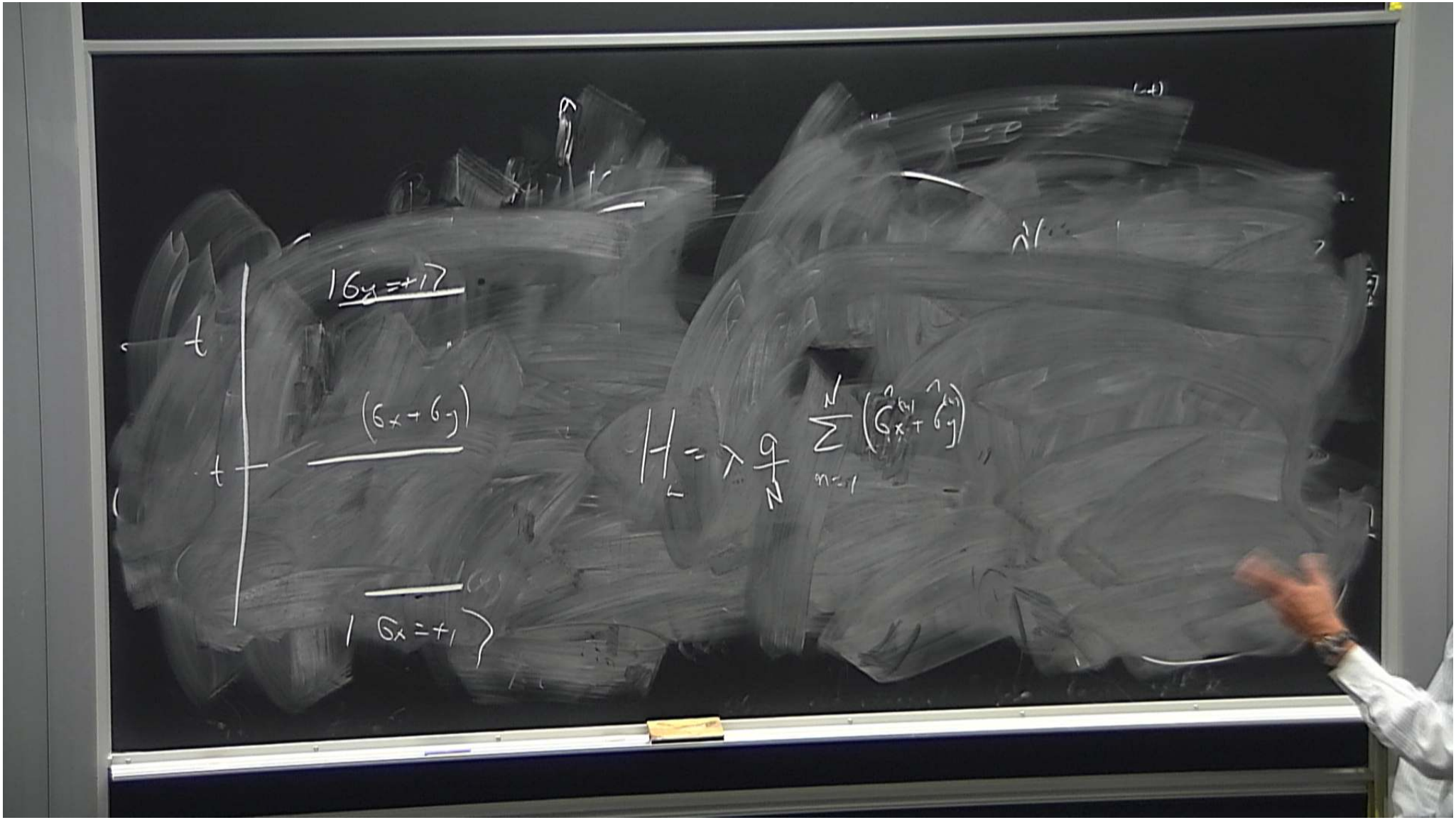
$$\frac{(\Delta A)^2}{N} \to 0$$

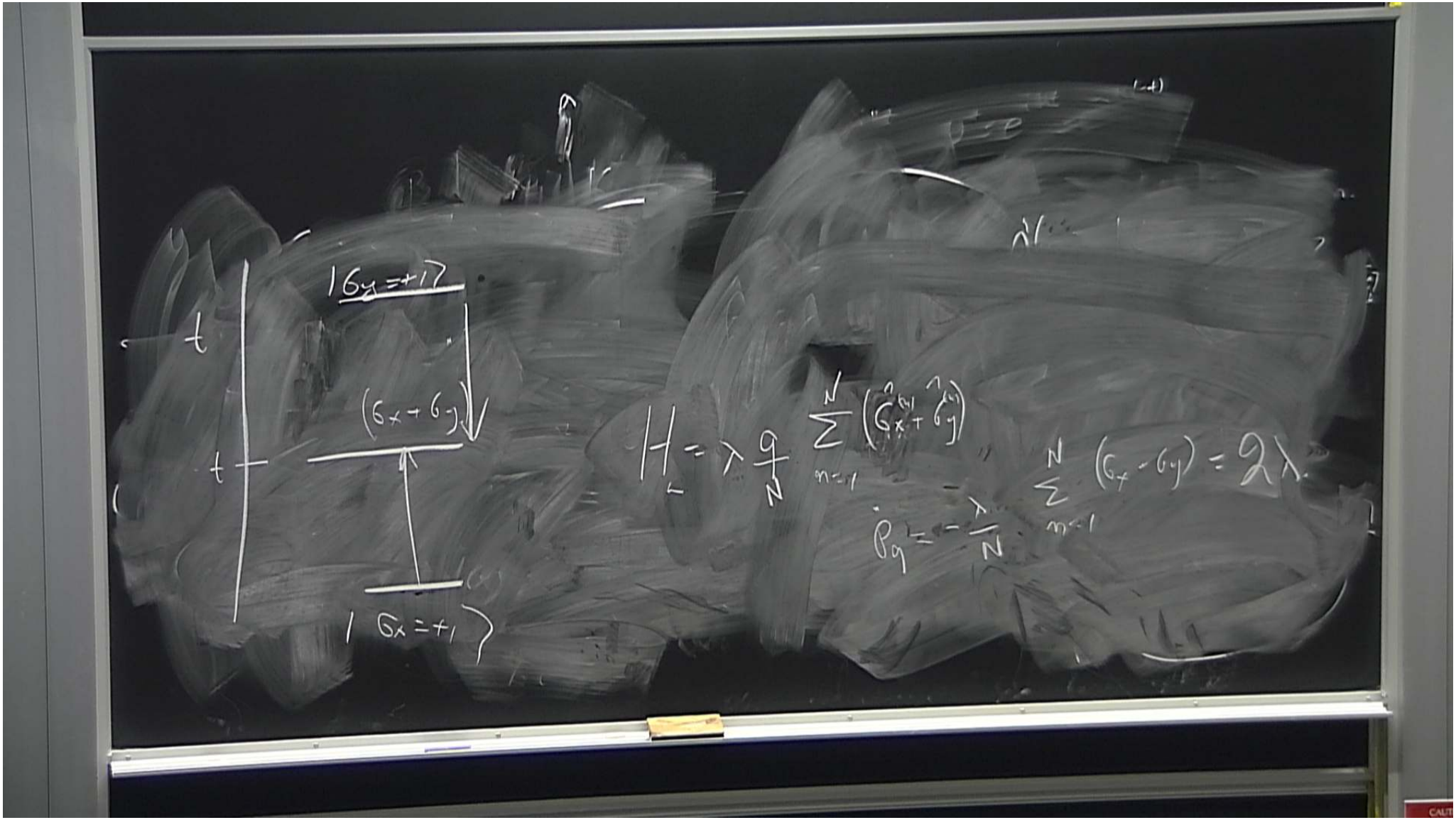
$$\bar{A} \prod_n |\Psi(n)\rangle$$

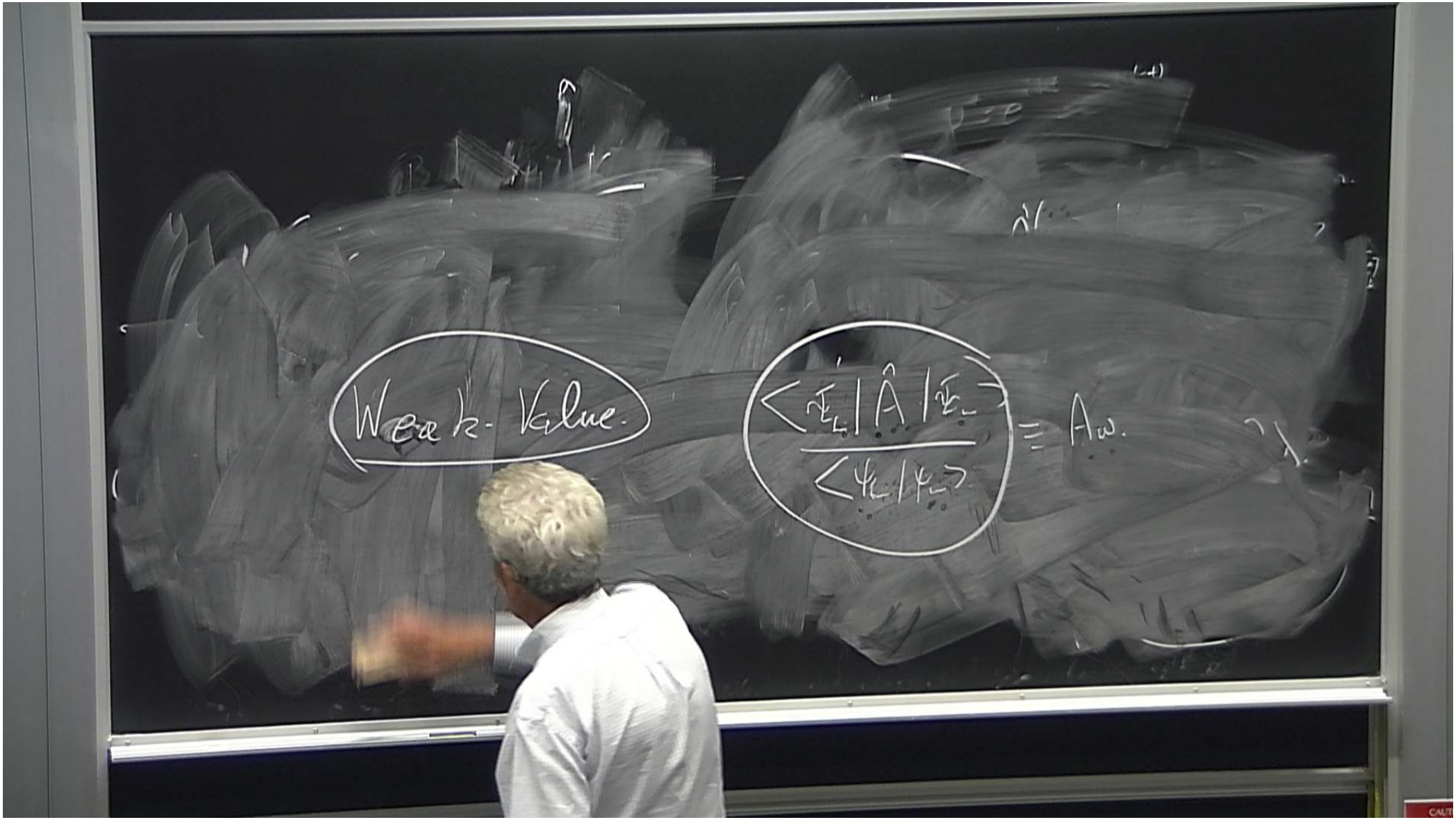
$$(\psi_1 + \psi_2)^2 = 1 + 1$$

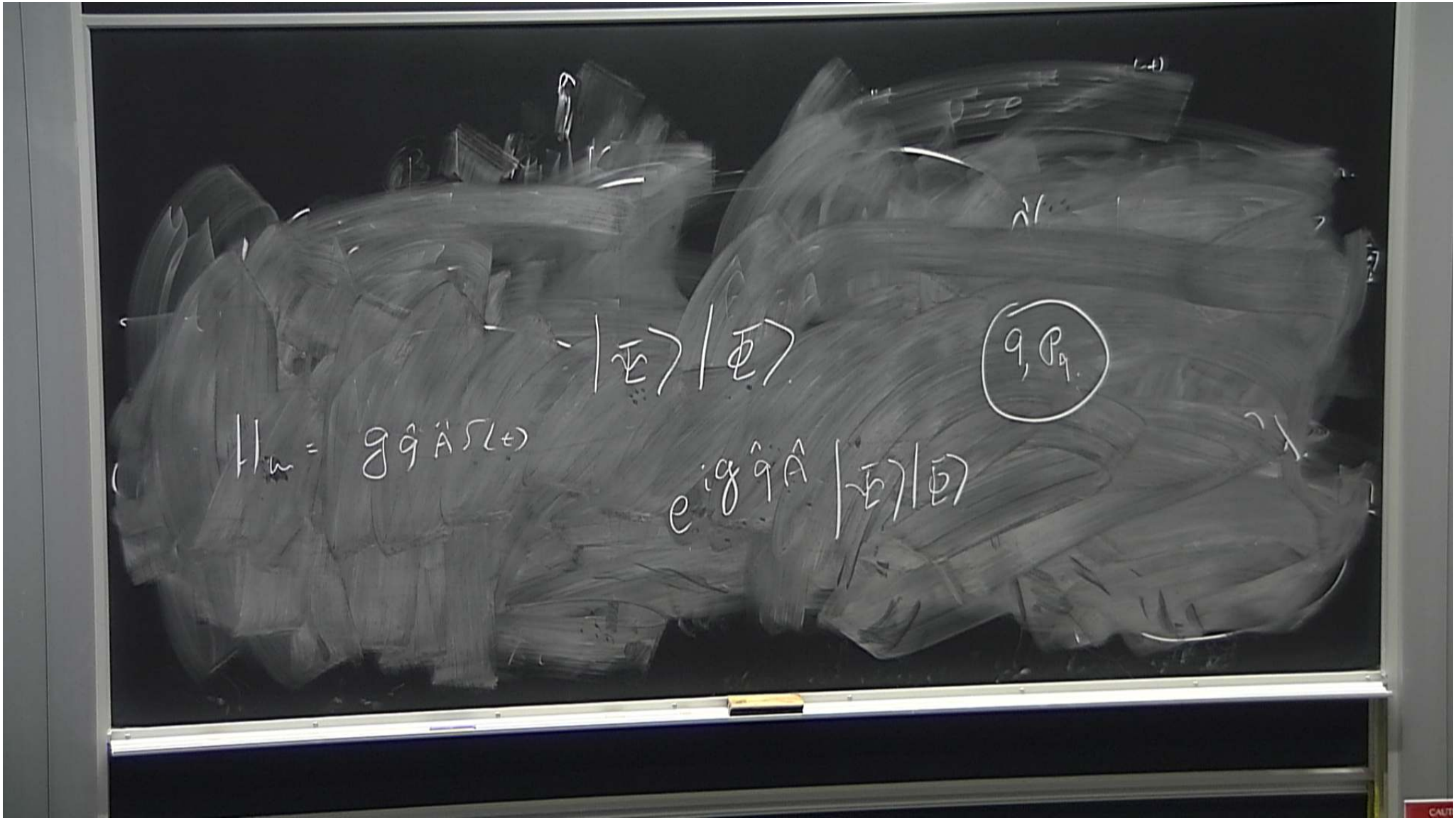
$$+ \frac{\Delta A}{N} \sum_{n \neq m} \prod^{N} |\psi(n)\rangle\,|\psi_m^{\perp}\rangle$$

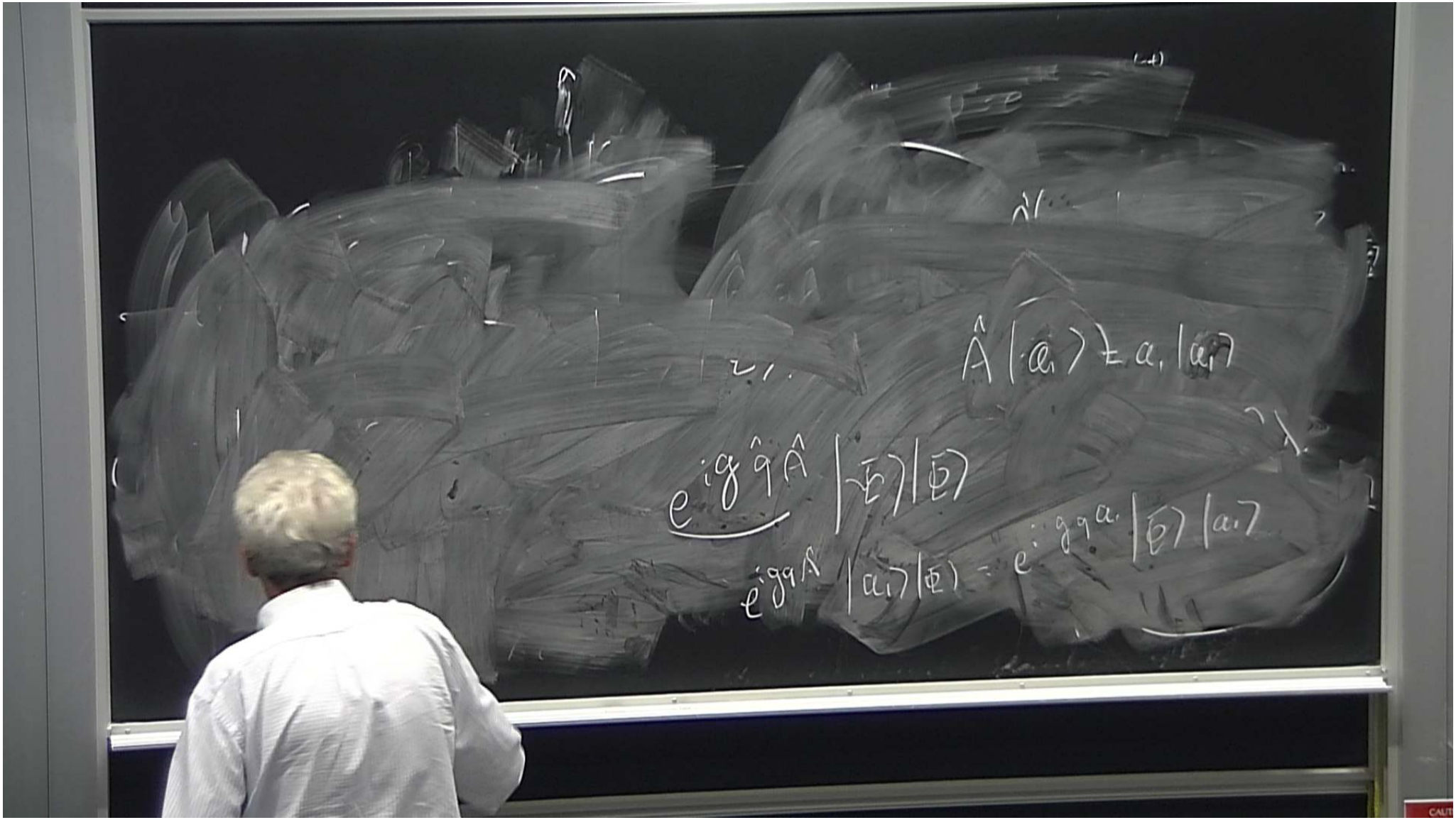

$|6_y = +1\rangle$
$(6_x + 6_y)$
$|6_x = +1\rangle$

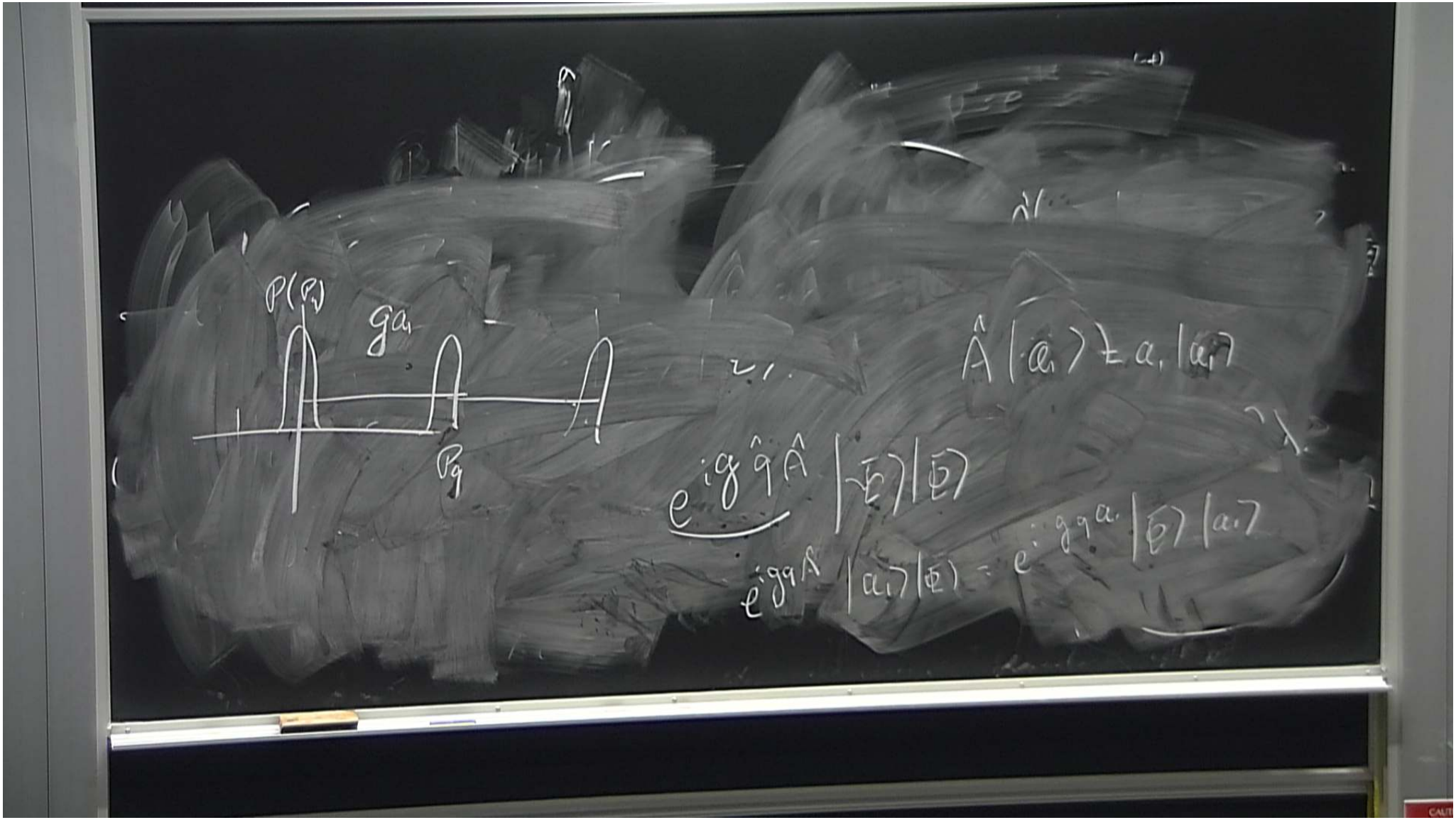

$|\sigma_y = +1\rangle$
$(\sigma_x + \sigma_y)$
$|\sigma_x = +1\rangle$
$H_z = \lambda \frac{g}{N} \sum_{n=1}^{N} (\hat{\sigma}_x^{(n)} + \hat{\sigma}_y^{(n)})$

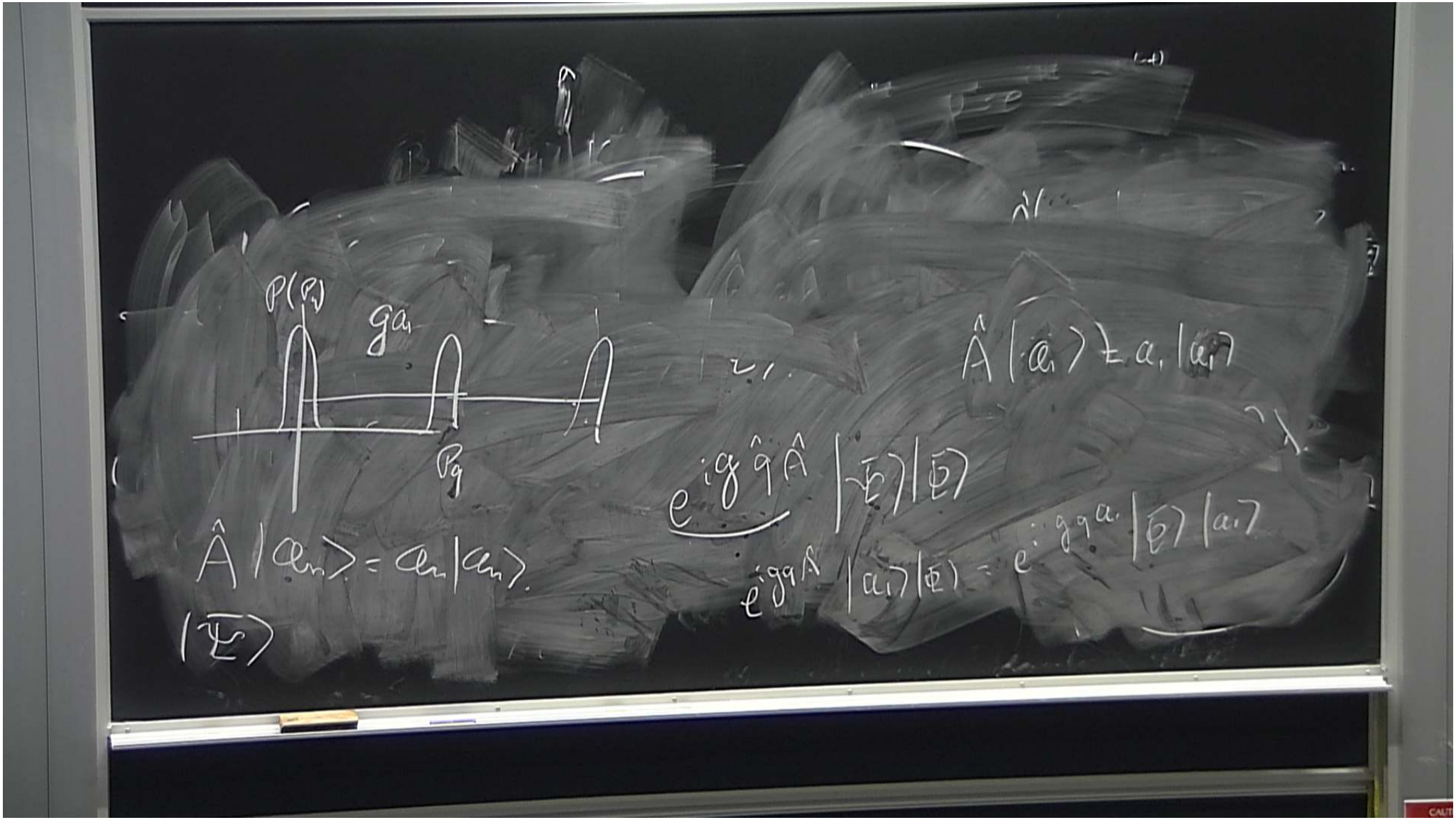

$|G_y=+1\rangle$
(G_x+G_y)
$|G_x=+1\rangle$
$H_L = \lambda \frac{q}{N} \sum_{n=1}^{N} (\hat{G}_x^{(n)} + \hat{G}_y^{(n)})$
$\sum_{n=1}^{N} (G_x - G_y) = 2\lambda$
$p_q = -\frac{\lambda}{N}$

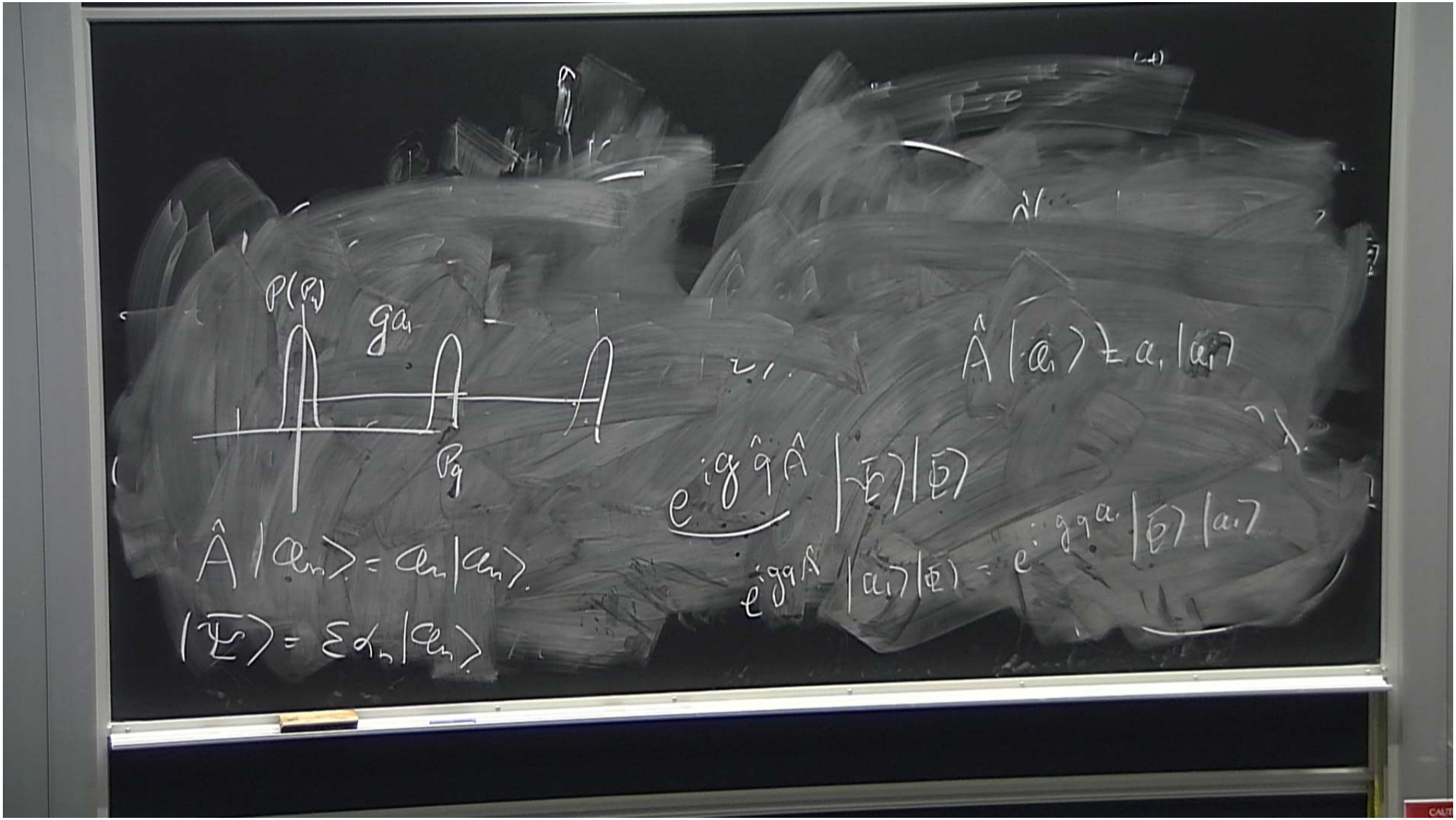

Weak Value.
$\frac{\langle \psi_f | \hat{A} | \psi_i \rangle}{\langle \psi_f | \psi_i \rangle} = A_w.$

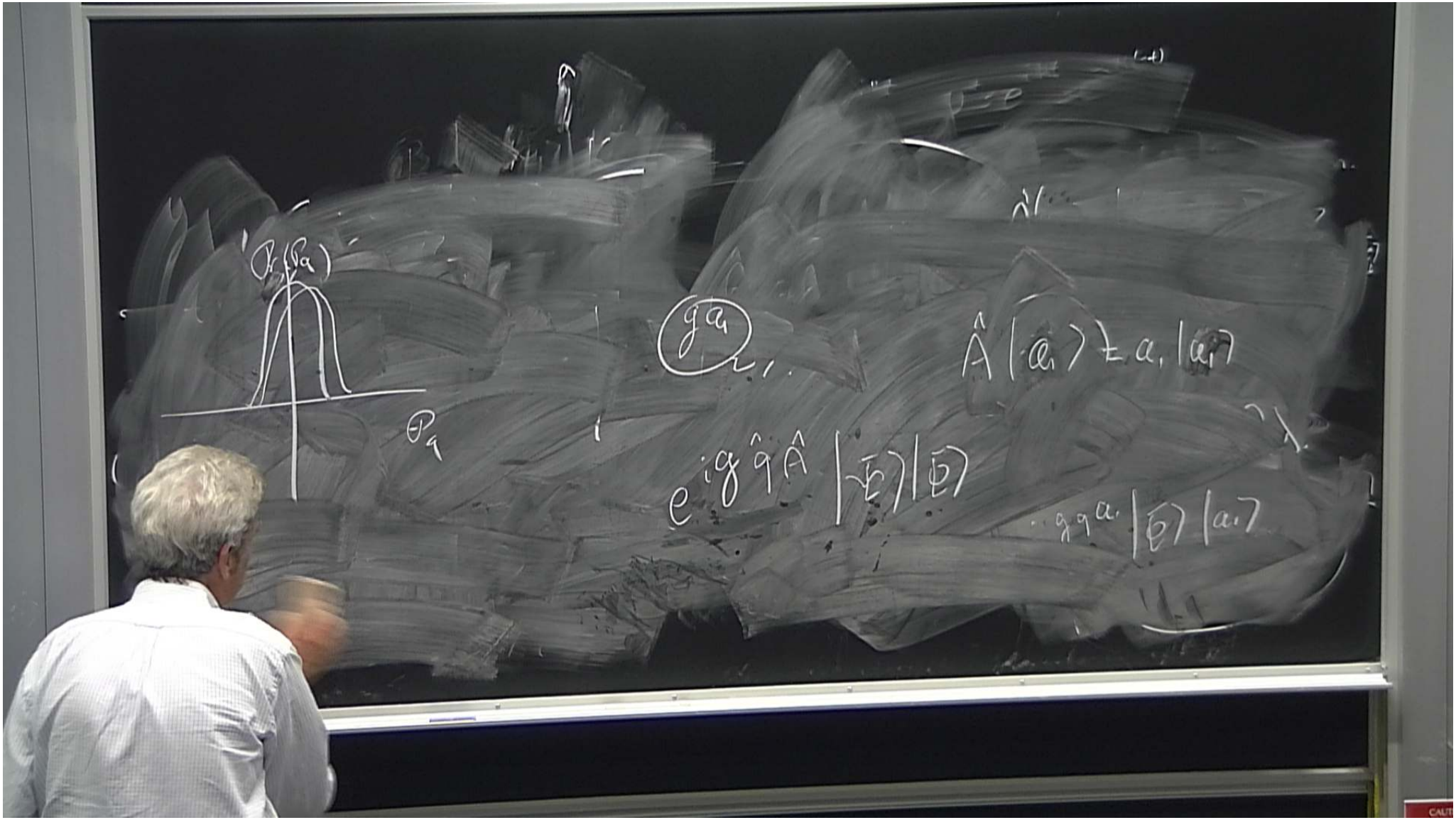

$|\Psi\rangle|\Phi\rangle$
q, p_q
$H_{in} = g\hat{q}\hat{A}\delta(t)$
$e^{ig\hat{q}\hat{A}}|\Psi\rangle|\Phi\rangle$

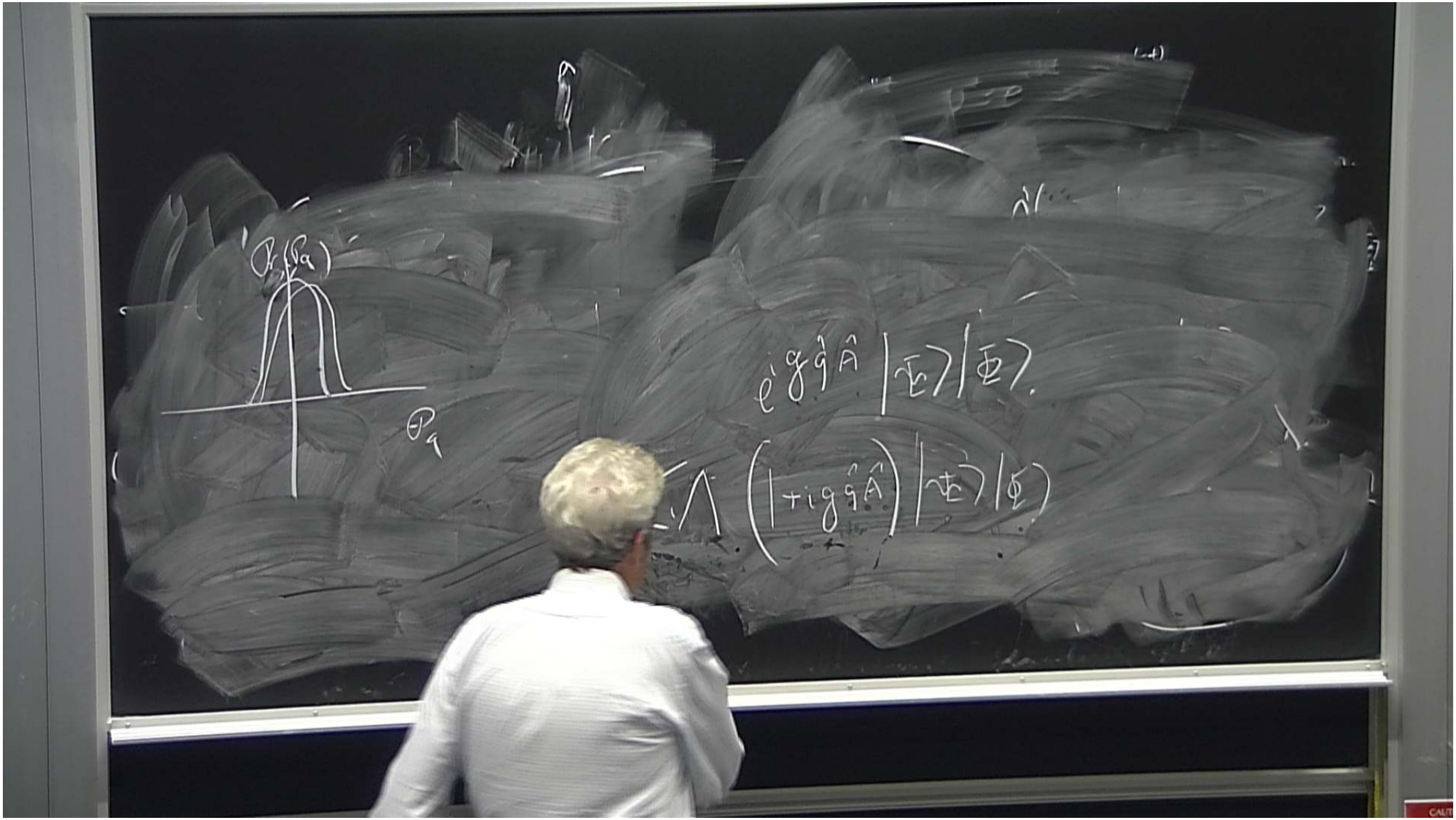

$\hat{A}|a_i\rangle = a_i|a_i\rangle$
$e^{ig\hat{q}\hat{A}}|E\rangle|E\rangle$
$e^{igq\hat{A}}|a_i\rangle|E\rangle = e^{igqa_i}|E\rangle|a_i\rangle$

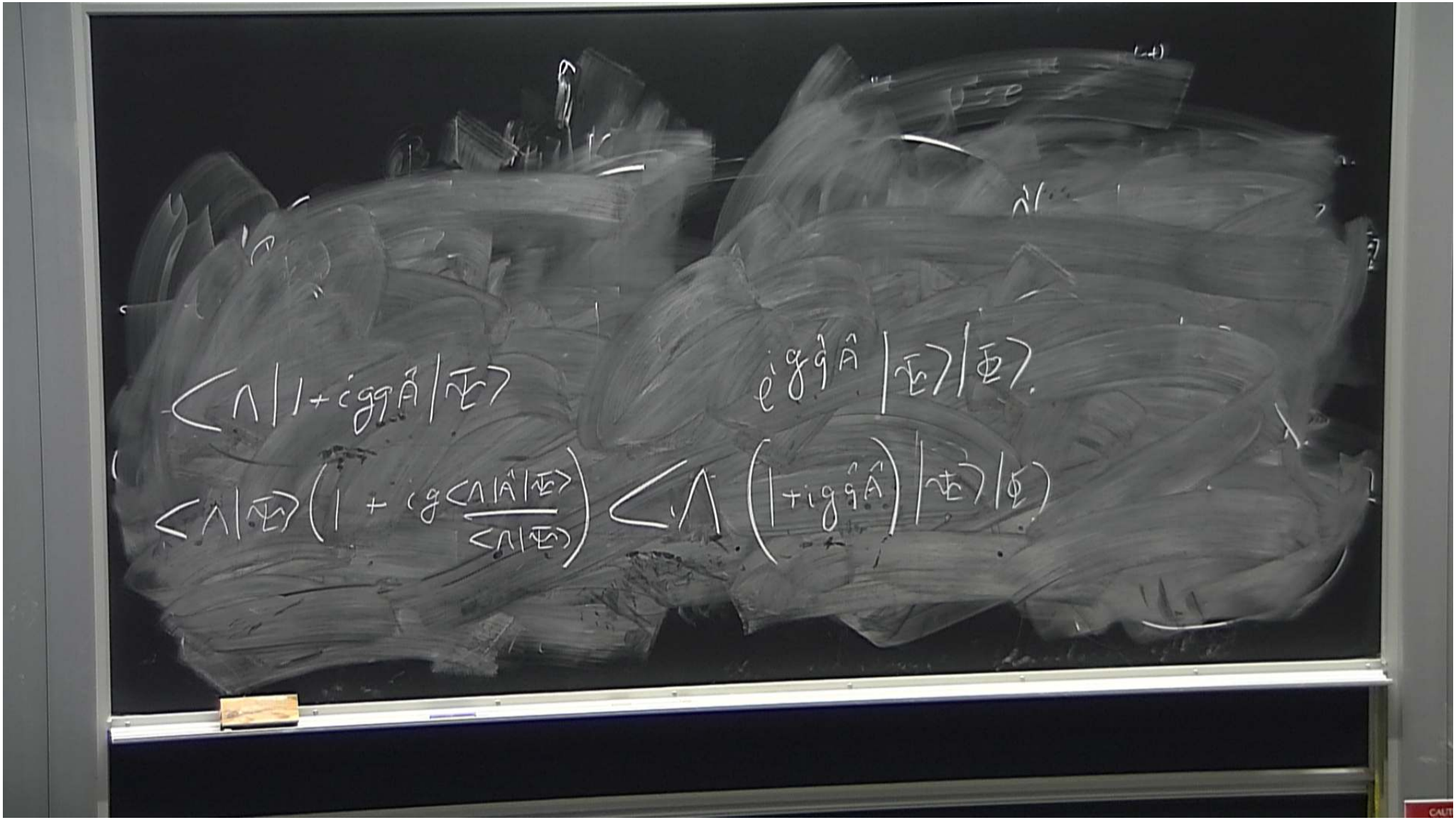

P(p)
$g a_i$
p_q
$\hat{A}|a_i\rangle = a_i|a_i\rangle$
$e^{ig\hat{q}\hat{A}}|\Xi\rangle|\Phi\rangle$
$e^{igq\hat{A}}|a_i\rangle|\Phi\rangle = e^{igqa_i}|\Phi\rangle|a_i\rangle$

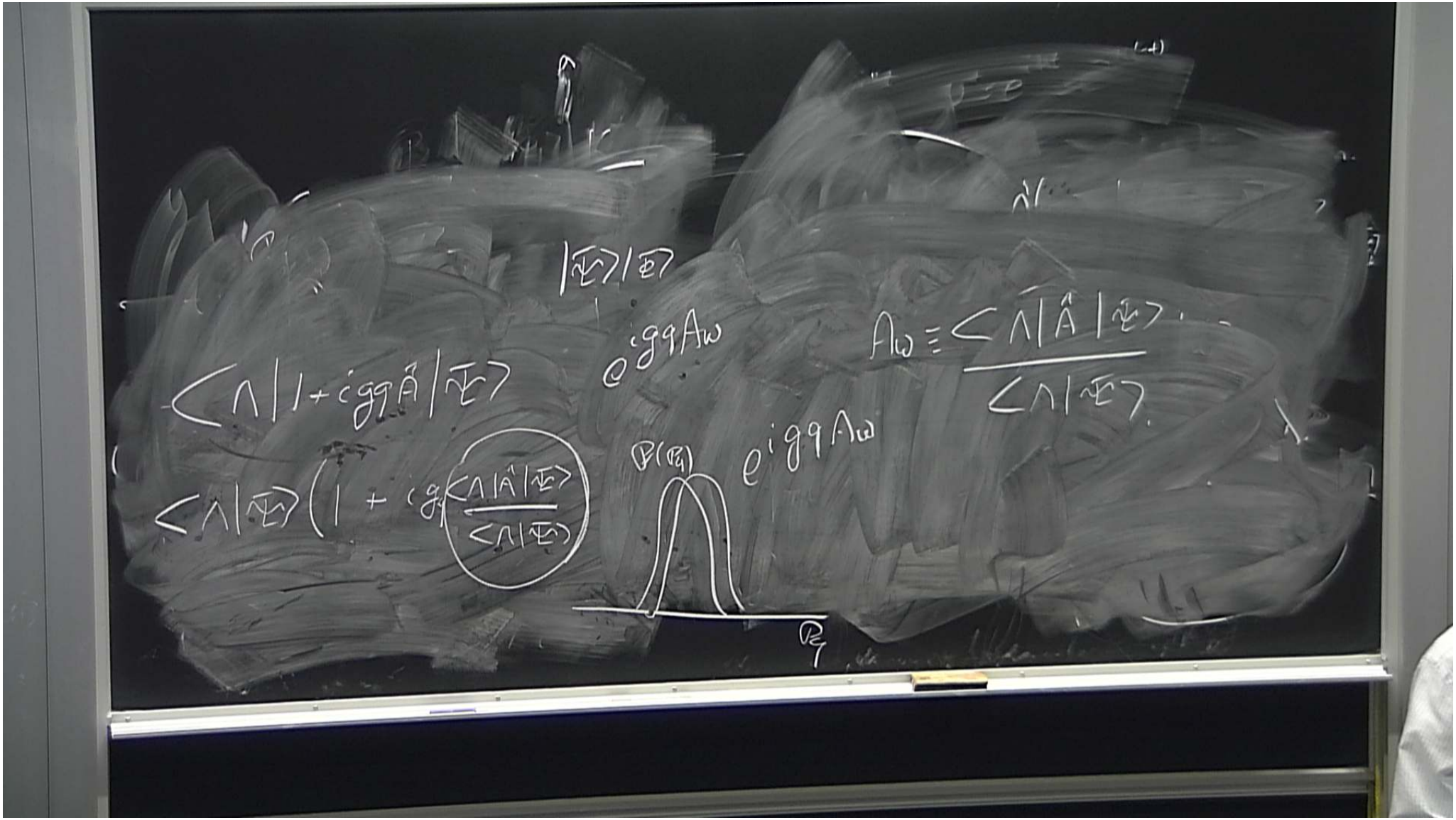

P(q)
$g a_1$
q_q
$\hat{A}|a_n\rangle = a_n|a_n\rangle$
$|\Psi\rangle$
$e^{ig\hat{q}\hat{A}}|\Psi\rangle|\Phi\rangle$
$e^{igq\hat{A}}|a_1\rangle|\Phi\rangle = e^{igqa_1}|\Phi\rangle|a_1\rangle$
$\hat{A}|a_1\rangle = a_1|a_1\rangle$

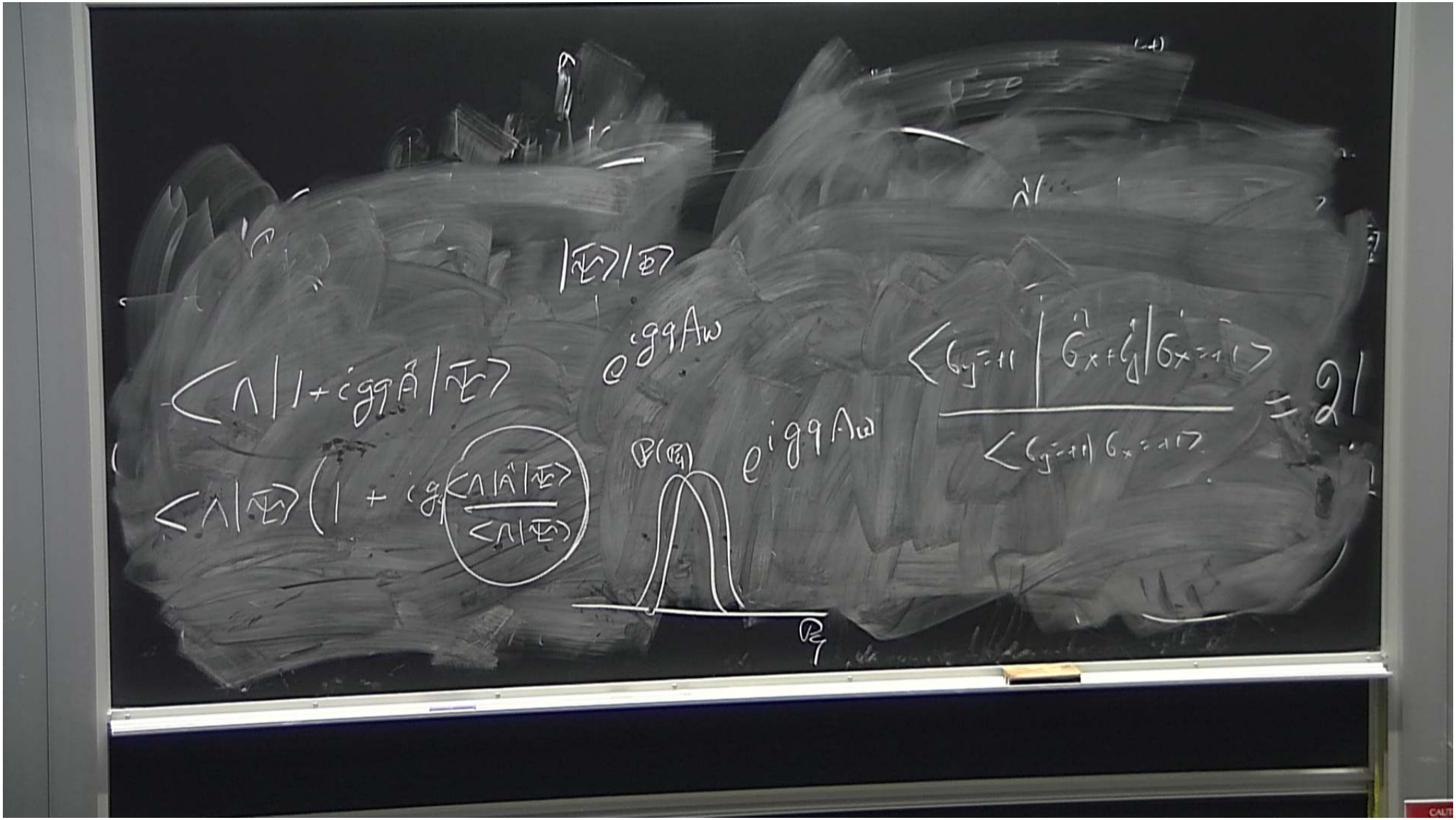

P(q)
$g a_1$
q
$\hat{A}|a_n\rangle = a_n|a_n\rangle$
$|\Sigma\rangle = \Sigma \alpha_n |a_n\rangle$
$\hat{A}|a_i\rangle = a_i|a_i\rangle$
$e^{igq\hat{A}}|\Sigma\rangle|\Phi\rangle$
$e^{igq\hat{A}}|a_i\rangle|\Phi\rangle = e^{igqa_i}|\Phi\rangle|a_i\rangle$

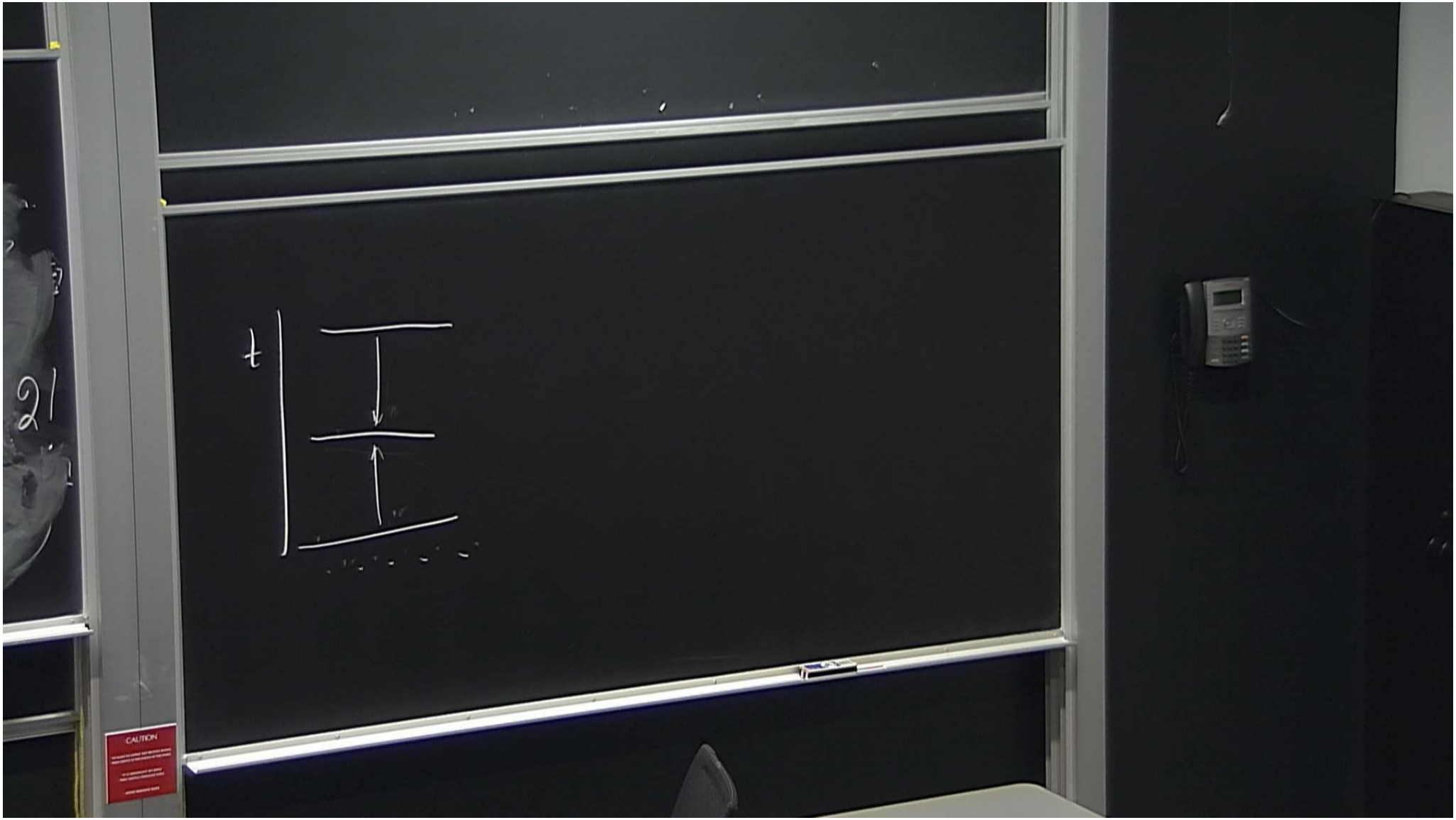

$\hat{A}|a_i\rangle = a_i|a_i\rangle$
$e^{ig\hat{q}\hat{A}}|\Psi\rangle|0\rangle$
$|\Psi\rangle|a_i\rangle$

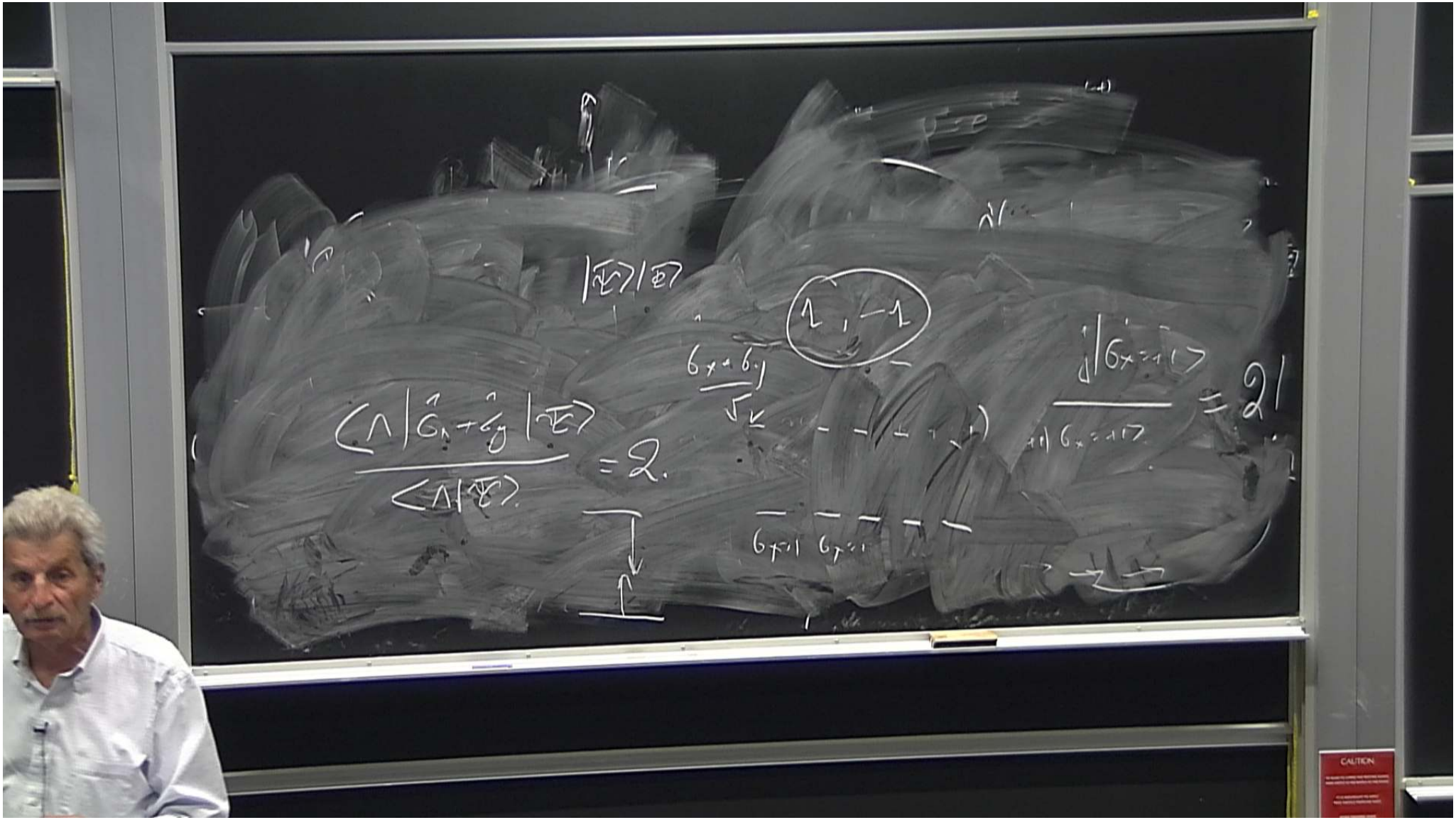

$e^{ig\hat{q}\hat{A}}|\Psi\rangle|\Phi\rangle$
$\Lambda\left(1+ig\hat{q}\hat{A}\right)|\Psi\rangle|\Phi\rangle$


$\langle \Lambda | 1 + i g q \hat{A} | \Psi \rangle$
$\langle \Lambda | \Psi \rangle \left(1 + i g \frac{\langle \Lambda | \hat{A} | \Psi \rangle}{\langle \Lambda | \Psi \rangle} \right)$
$e^{i g q \hat{A}} | \Psi \rangle | \Phi \rangle$.
$\langle \Lambda \left(1 + i g q \hat{A} \right) | \Psi \rangle | \Phi \rangle$


$\langle \Lambda | 1 + i g q \hat{A} | \Sigma \rangle$
$|\Sigma\rangle |\Sigma\rangle$
$e^{i g q A_\omega}$
$A_\omega \equiv \frac{\langle \Lambda | \hat{A} | \Sigma \rangle}{\langle \Lambda | \Sigma \rangle}$
$\langle \Lambda | \Sigma \rangle \left(1 + i g \frac{\langle \Lambda | \hat{A} | \Sigma \rangle}{\langle \Lambda | \Sigma \rangle}\right)$
$P(q)$
$e^{i g q A_\omega}$
q


|Ψ⟩|Ψ⟩
e^{igqAω}
⟨Λ|1+igqÂ|Ψ⟩
⟨Λ|Ψ⟩(1 + ig ⟨Λ|Â|Ψ⟩ / ⟨Λ|Ψ⟩)
P(Pq)
e^{igqAω}
Pq
⟨σy=+1|σx+σy|σx=+1⟩ / ⟨σy=+1|σx=+1⟩ = 2!


t
CAUTION


1, -1
= 2.
= 2!