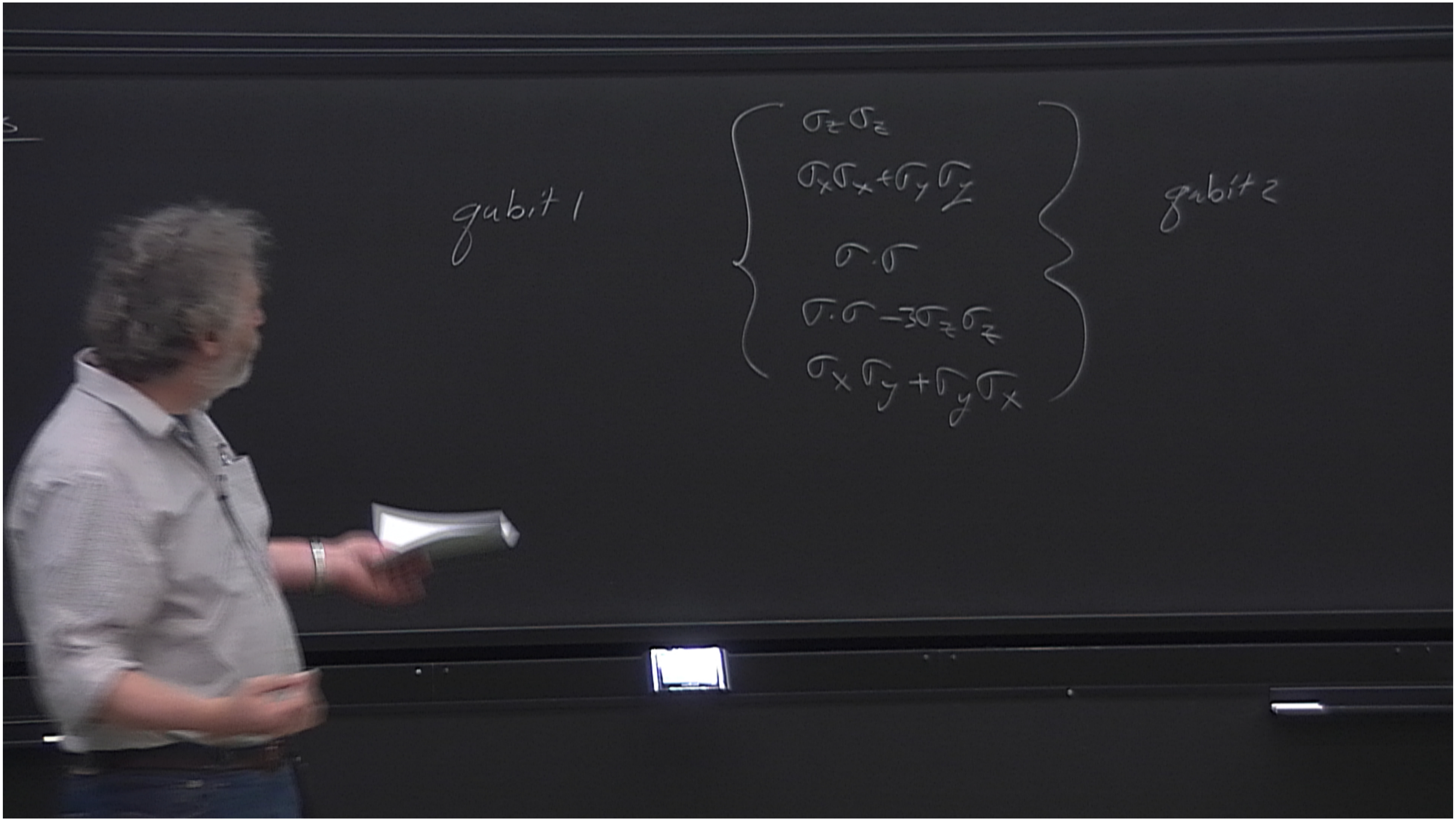
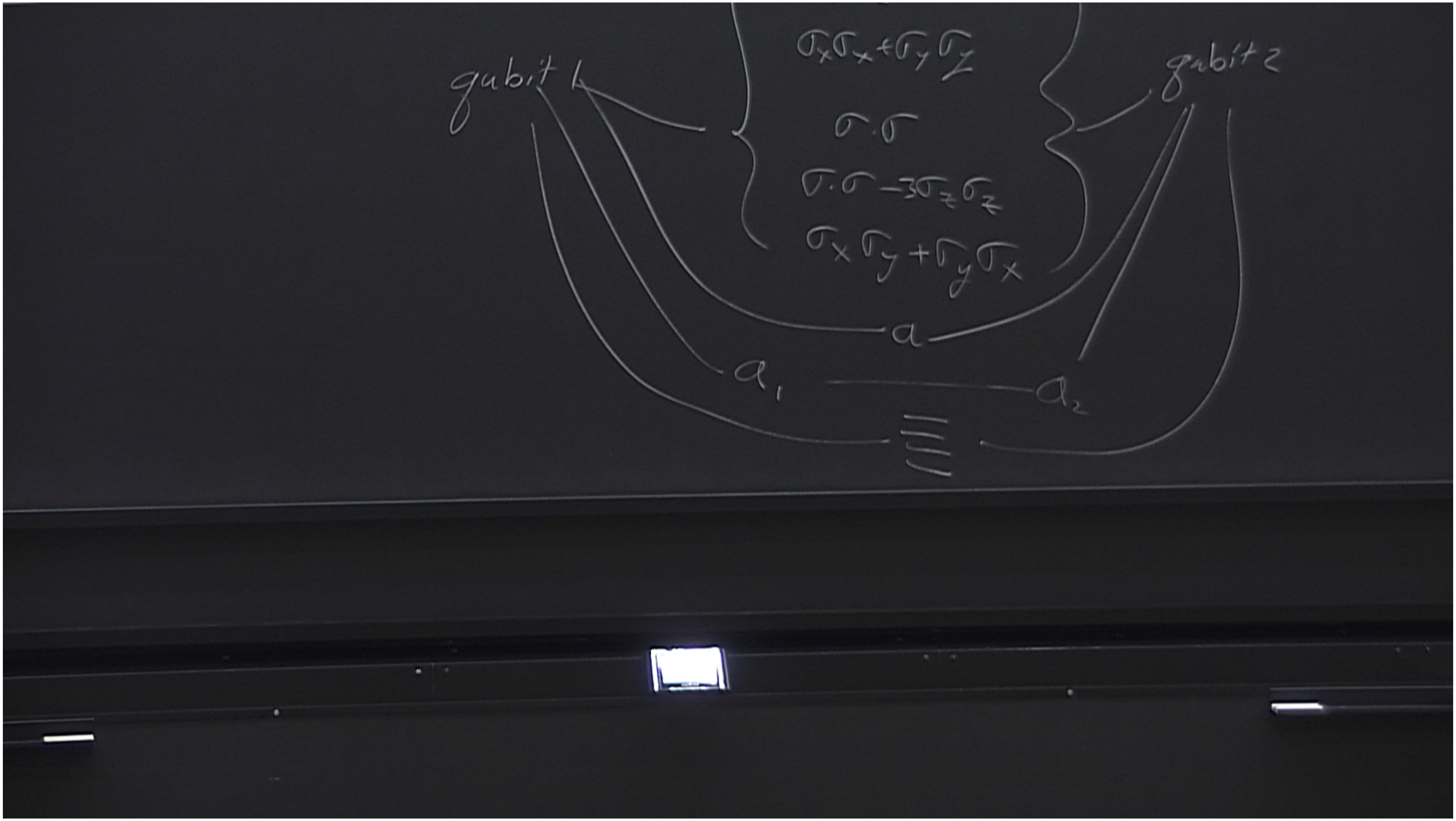
Title: Explorations in Quantum Information-13

Date: Apr 01, 2015 09:00 AM

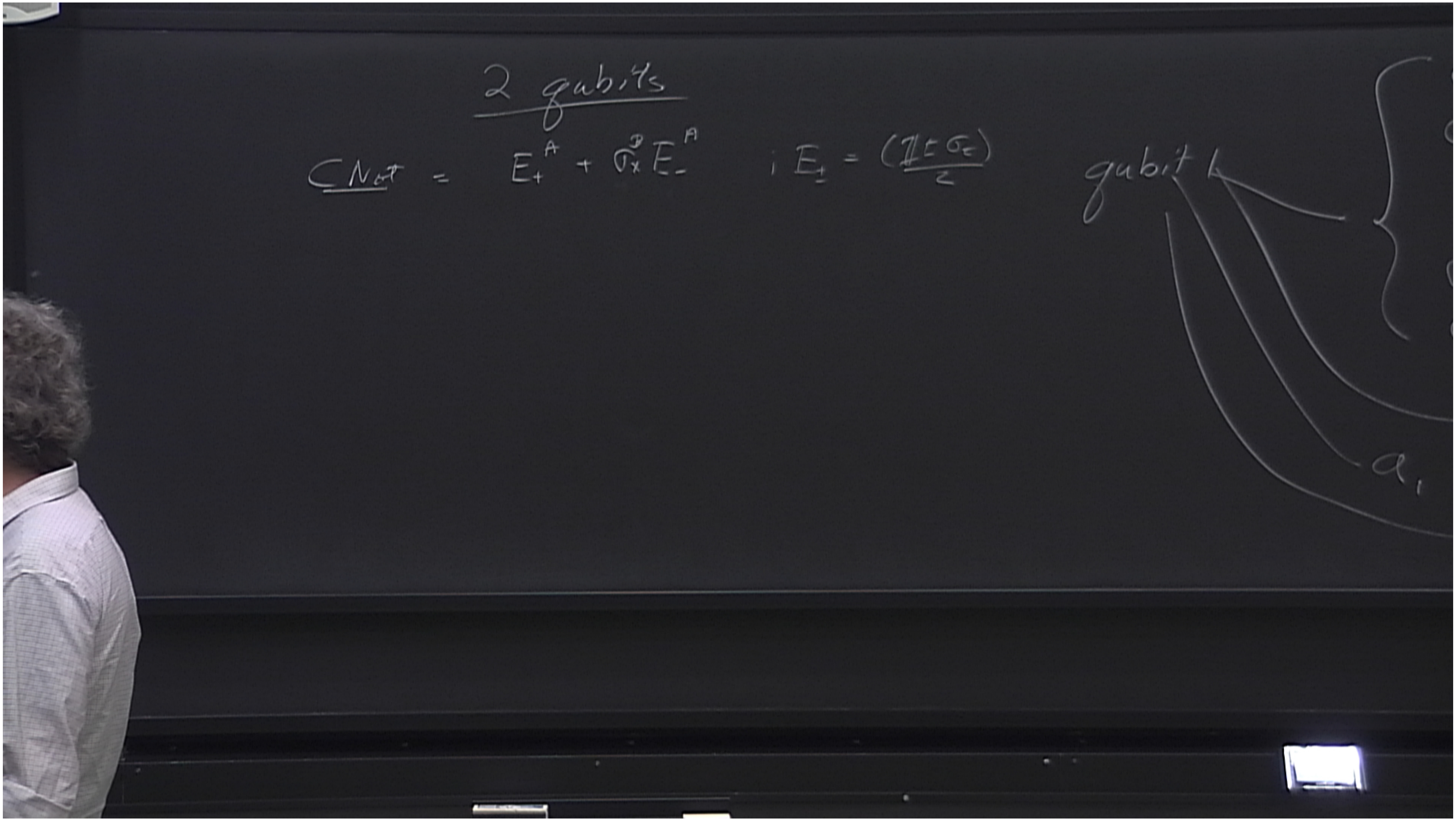
URL: http://pirsa.org/15040000

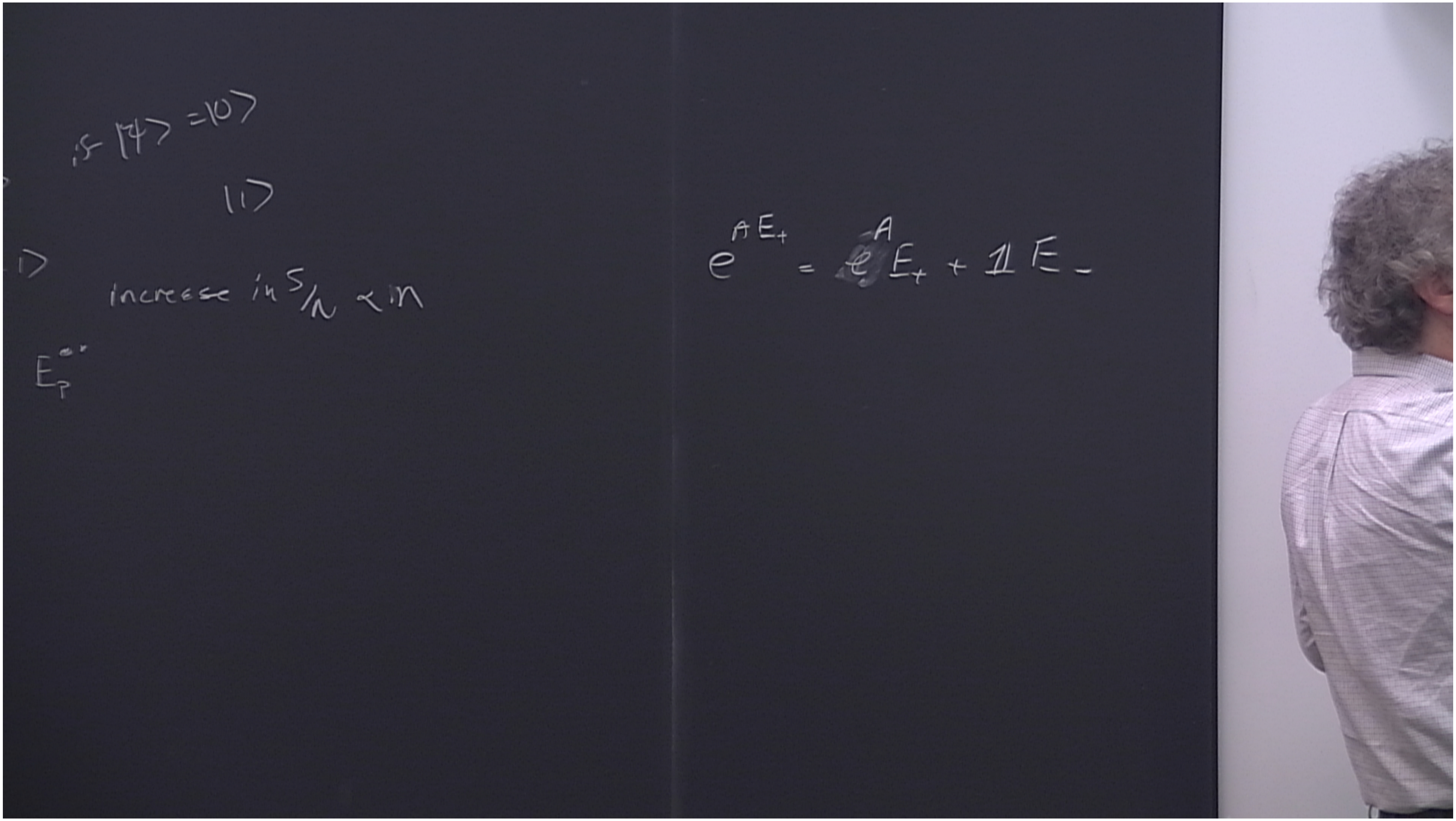
Abstract:

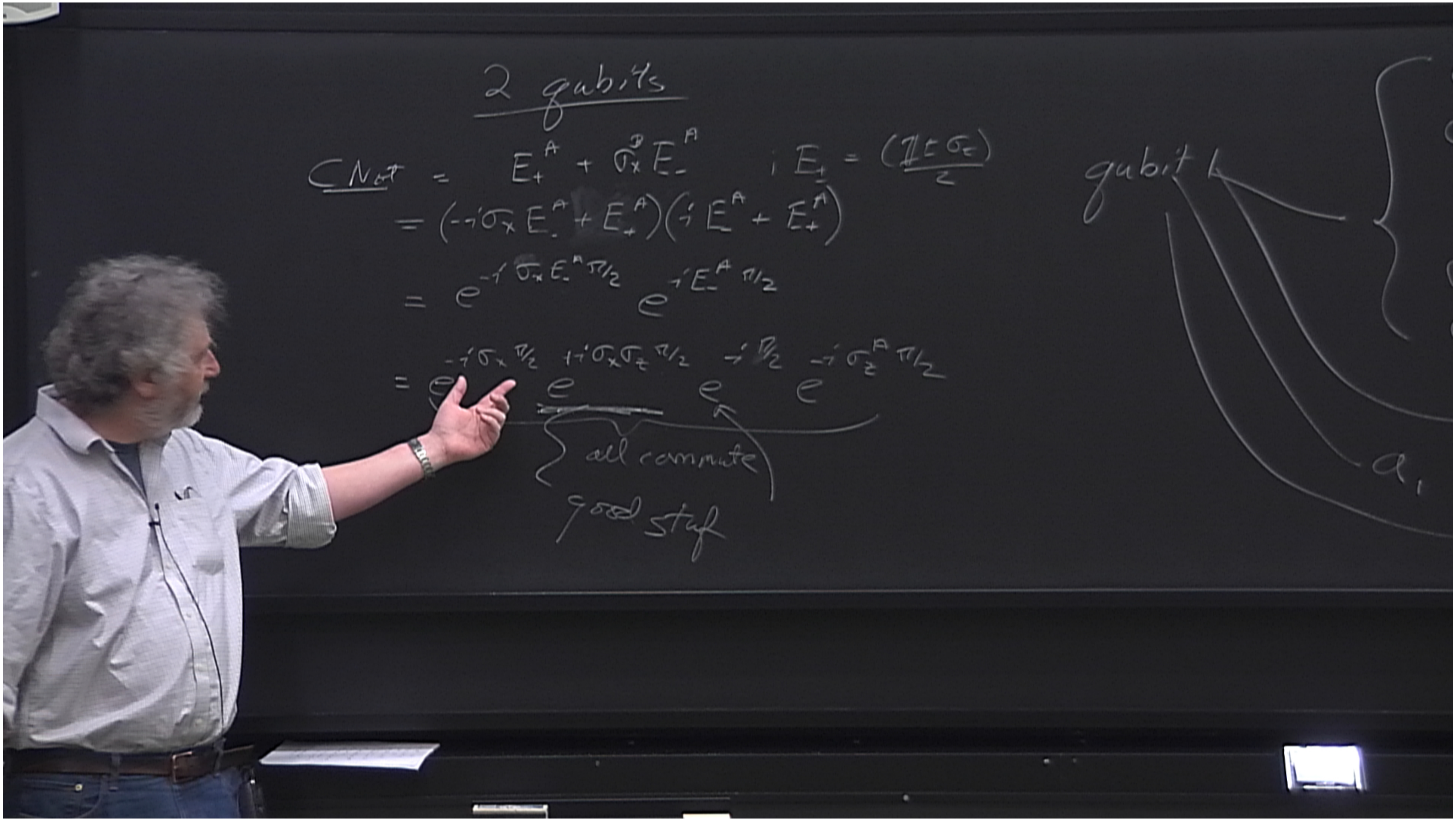

qubit 1
$\sigma_z \sigma_z$
$\sigma_x \sigma_x + \sigma_y \sigma_y$
$\sigma \cdot \sigma$
$\sigma \cdot \sigma - 3\sigma_z \sigma_z$
$\sigma_x \sigma_y + \sigma_y \sigma_x$
qubit 2

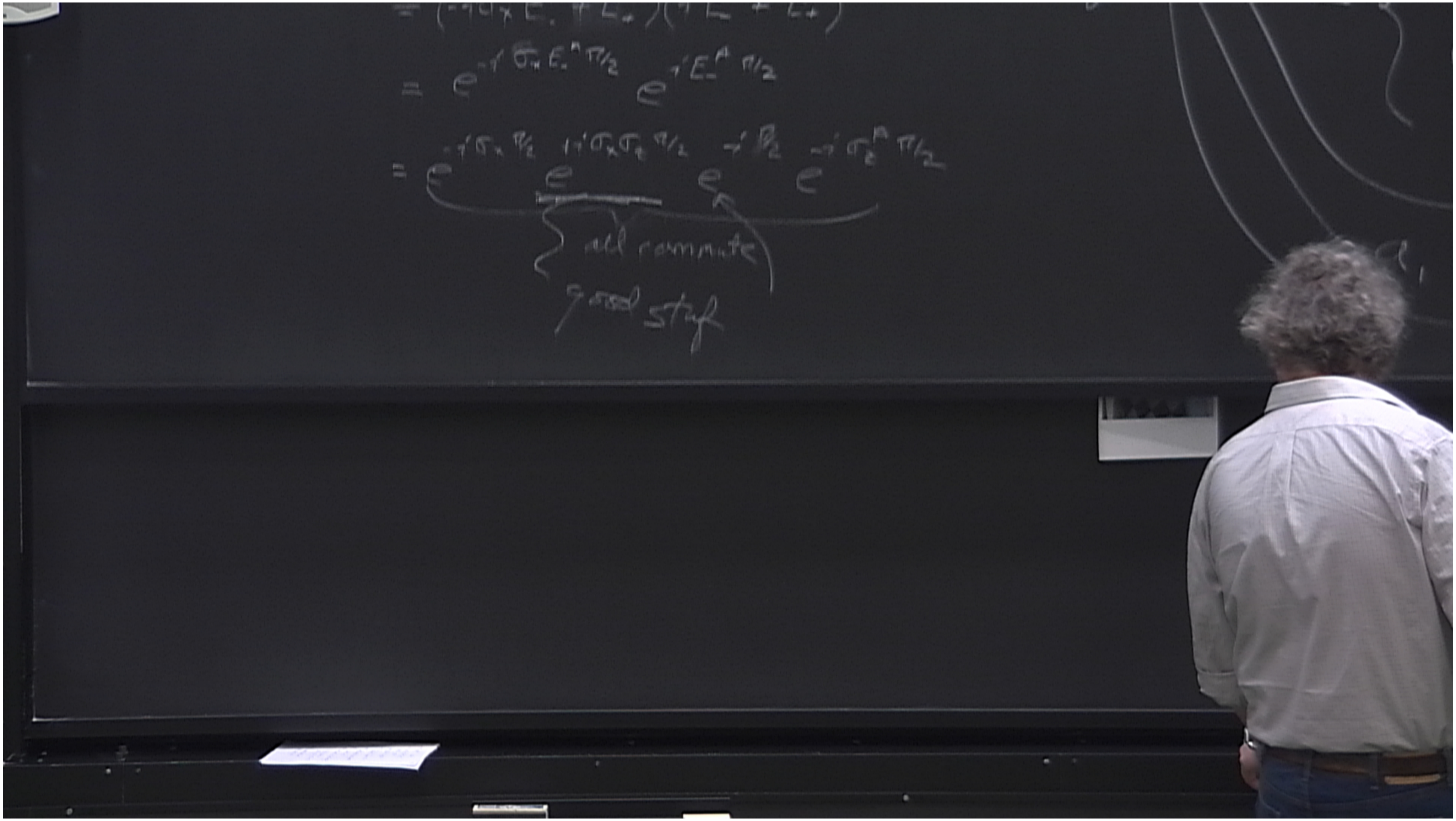


qubit 1
qubit 2
$\sigma_x\sigma_x + \sigma_y\sigma_z$
$\sigma\cdot\sigma$
$\sigma\cdot\sigma - 3\sigma_z\sigma_z$
$\sigma_x\sigma_y + \sigma_y\sigma_x$
a
a_1
a_2


2 qubits
CNot = E+^A + σx^B E-^A ; E± = (𝟙 ± σz)/2
qubit 1
a1


is $|\psi\rangle = |0\rangle$
$|1\rangle$
increase in $S/n \propto n$
$e^{AE_+} = e^{-A}E_+ + \mathbb{1}E_-$


2 qubits
$CNot = E_+^A + \sigma_x^B E_-^A \quad ; E_\pm = \frac{(\mathbb{I} \pm \sigma_z)}{2}$
$= (-i\sigma_x E_-^A + E_+^A)(i E_-^A + E_+^A)$
$= e^{-i\sigma_x E_-^A \pi/2} e^{-i E_-^A \pi/2}$
$= e^{-i\sigma_x \pi/2} e^{+i\sigma_x\sigma_z \pi/2} e^{-i \pi/2} e^{-i\sigma_z^A \pi/2}$
all commute
good stuf
qubit
a_1


all commute
good stuf

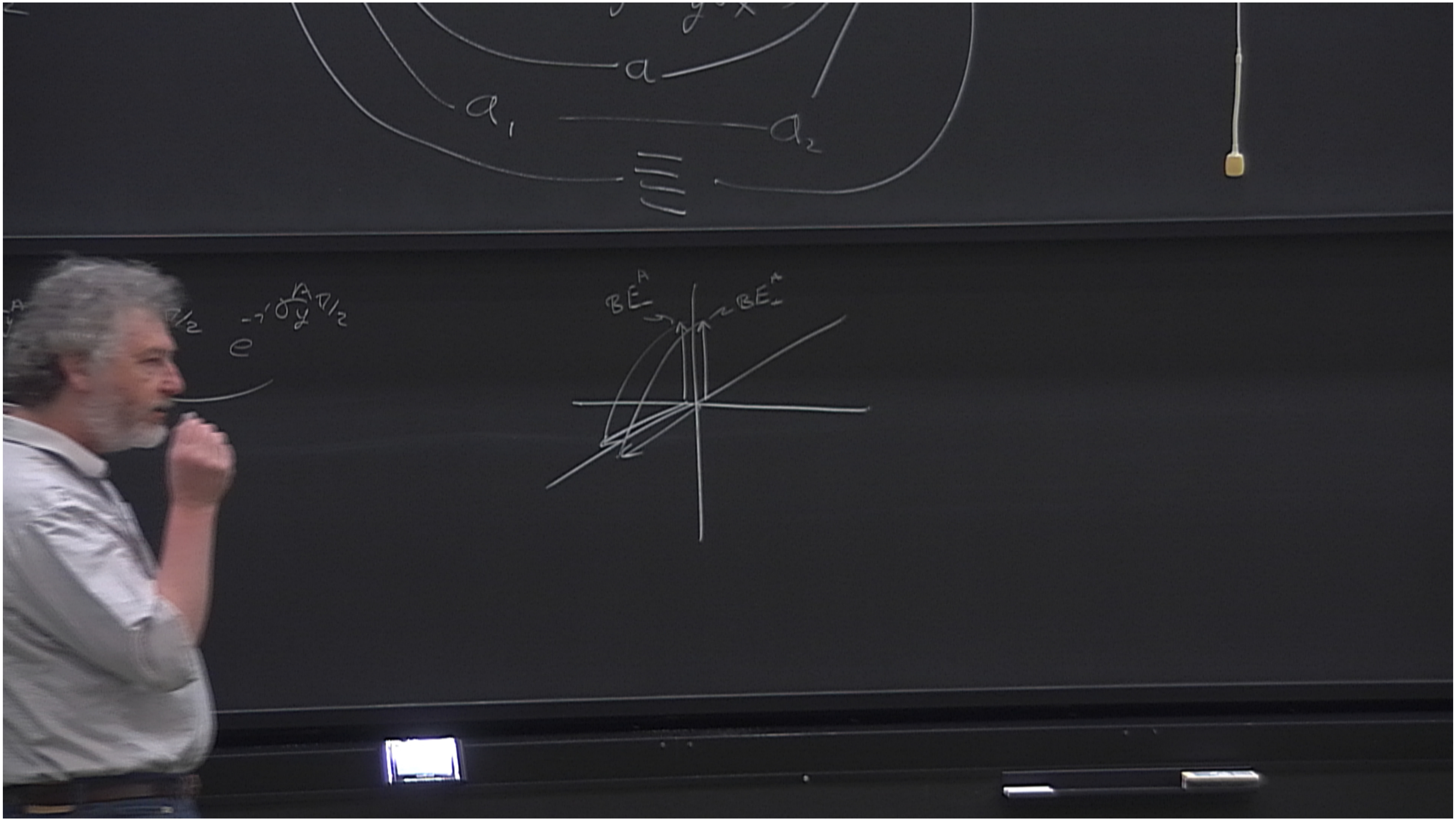
$$= e \quad e \quad e \quad e$$

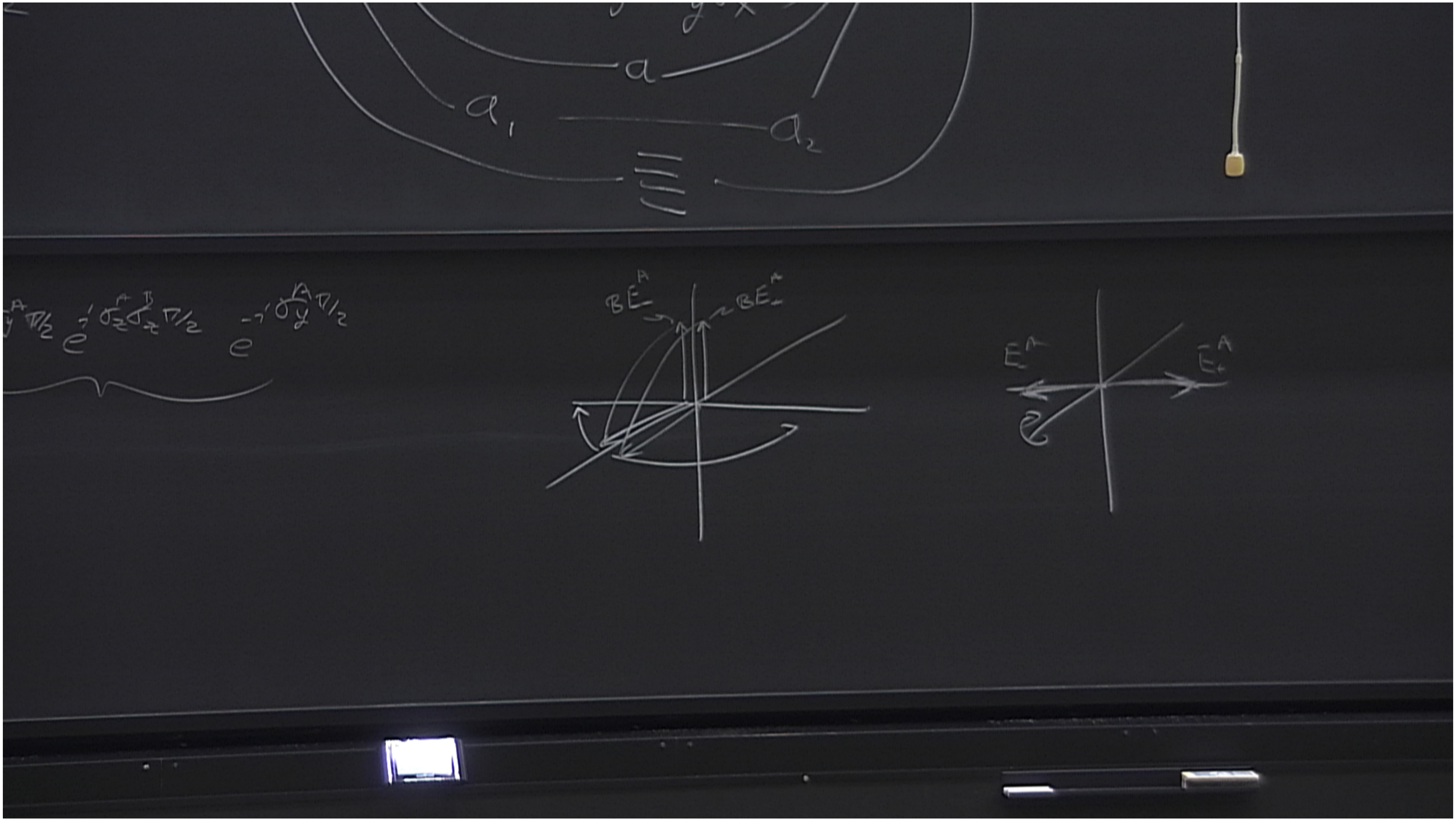
all commute

good stuf

a_1

$$e^{i\sigma_x^A \sigma_z^B \pi/2} = \underbrace{e^{i\sigma_y^A \pi/2}\, e^{i\sigma_z^A \sigma_z^B \pi/2}\, e^{-i\sigma_y^A \pi/2}}$$


a
a1
a2
BE
BE


a
a1
a2

$$\mathcal{H} = \sigma_x \sigma_x + \sigma_y \sigma_y$$

$$\sigma_z \mathbb{1} \longrightarrow e^{-i\frac{\sigma_y \sigma_x \theta}{2}} \underbrace{e^{-i\frac{\sigma_y \sigma_x \theta}{2}} \sigma_z \, e}\; e^{-i \sigma_x \sigma_x \theta/2} e^{-i \sigma_y \sigma_y \theta/2}$$

$$\cos\theta \, \sigma_z - \sin\theta \, \sigma_y \sigma_x$$

$$\cos^2\theta \, \sigma_z \mathbb{1} - \cos\theta \sin\theta \left(\sigma_x \sigma_y + \sigma_y \sigma_x \right) + \sin^2\theta \, \mathbb{1} \sigma_z$$

$$\mathcal{H} = \sigma_x \sigma_x + \sigma_y \sigma_y$$

$$\sigma_z \mathbb{1} \longrightarrow e^{\frac{-i\sigma_y\sigma_x\theta}{2}}\, \underbrace{e^{\frac{-i\sigma_y\sigma_x\theta}{2}}\,\sigma_z\, e}\ ^{-i\sigma_x\sigma_x\theta/2}\, e^{-i\sigma_y\sigma_y\theta/2}$$

$$\cos\theta\, \sigma_z - \sin\theta\, \sigma_y \sigma_x$$

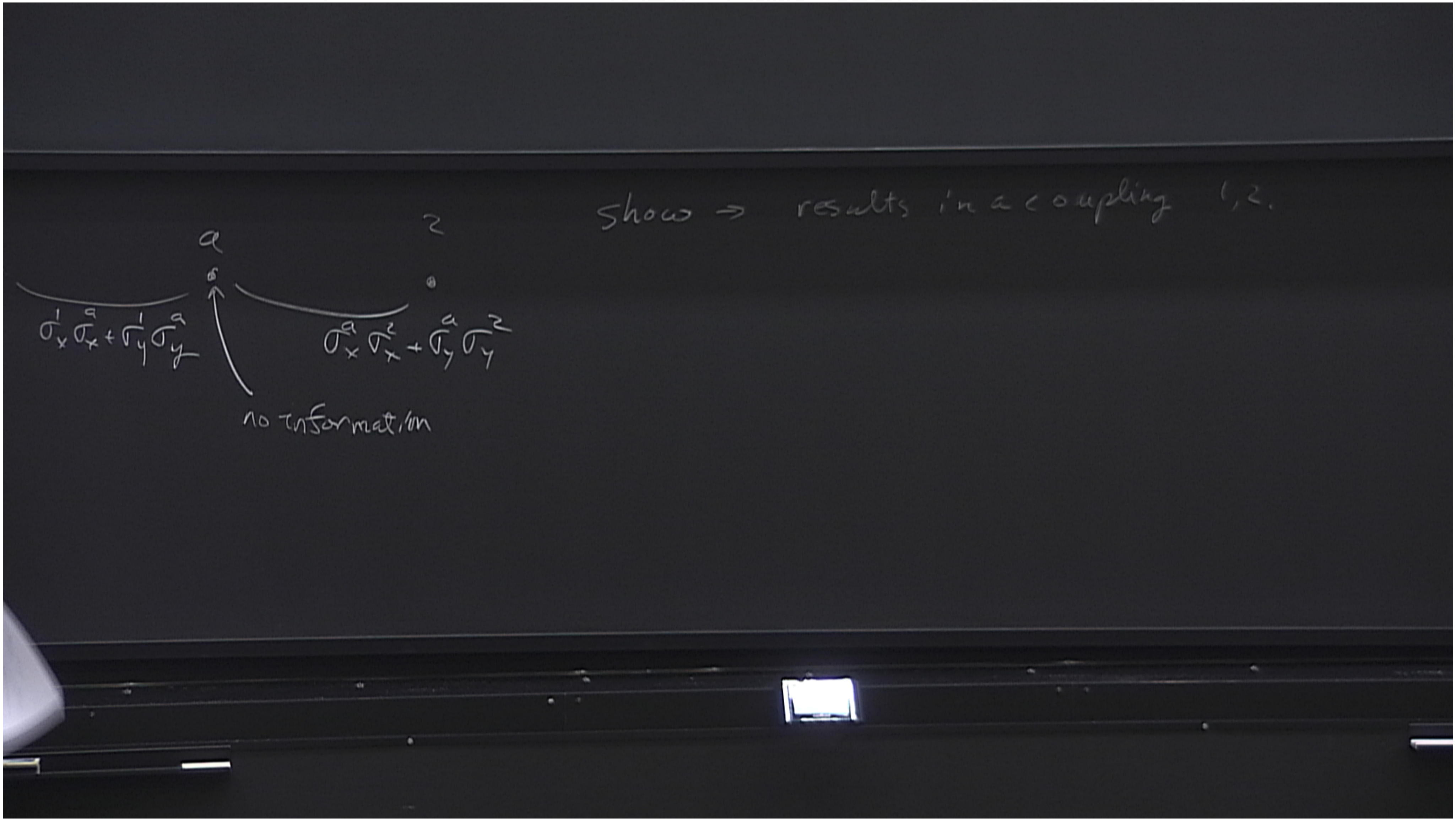
$$\cos^2\theta\, \sigma_z \mathbb{1} - \cos\theta\sin\theta\left(\sigma_x\sigma_y + \sigma_y\sigma_x\right) + \sin^2\theta\, \mathbb{1}\sigma_z$$

$$\mathcal{H} = \sigma_x\sigma_x + \sigma_y\sigma_y$$

$$\sigma_z \mathbb{1} \longrightarrow e^{-i\frac{\sigma_y\sigma_x\theta}{2}} \underbrace{e^{-i\frac{\sigma_x\sigma_x\theta}{2}}\sigma_z e^{-i\sigma_x\sigma_x\theta/2}} e^{-i\sigma_y\sigma_y\theta/2}$$

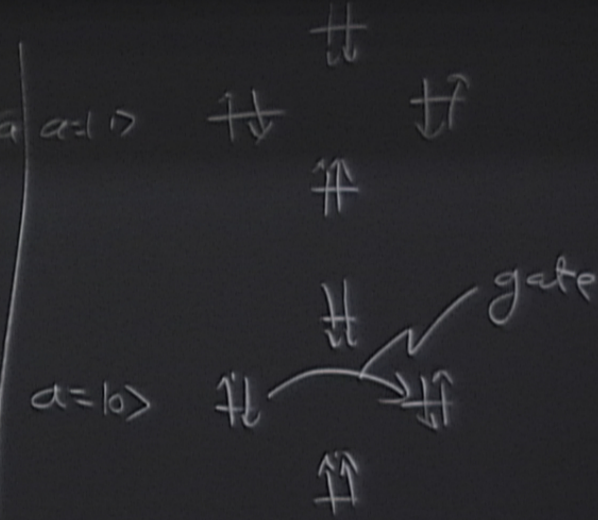
$$\cos\theta\,\sigma_z - \sin\theta\,\sigma_y\sigma_x$$

$$\cos^2\theta\,\sigma_z\mathbb{1} - \cos\theta\sin\theta\left(\sigma_x\sigma_y + \sigma_y\sigma_x\right) + \sin^2\theta\,\mathbb{1}\sigma_z$$


show → results in a coupling 1,2.
a
2
$\sigma_x^1 \sigma_x^a + \sigma_y^1 \sigma_y^a$
$\sigma_x^a \sigma_x^2 + \sigma_y^a \sigma_y^2$
no information

show → results in a coupling 1,2.

$$[\,1a\,,\,2a\,] = (\sigma_x^1\sigma_y^2 - \sigma_y^1\sigma_x^2)\,\sigma_z^a$$



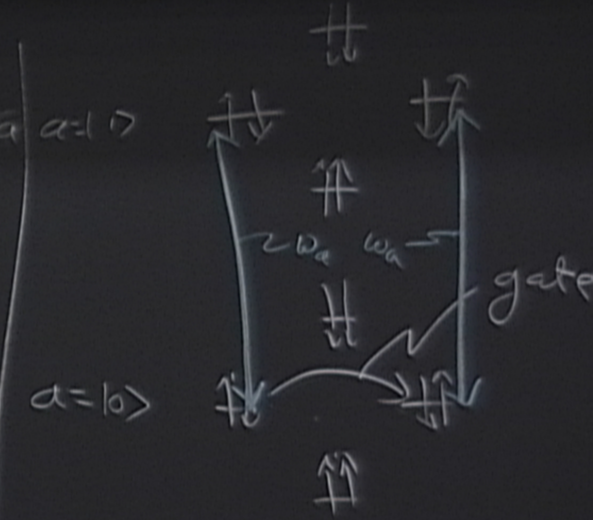
$\sigma_y^2)$

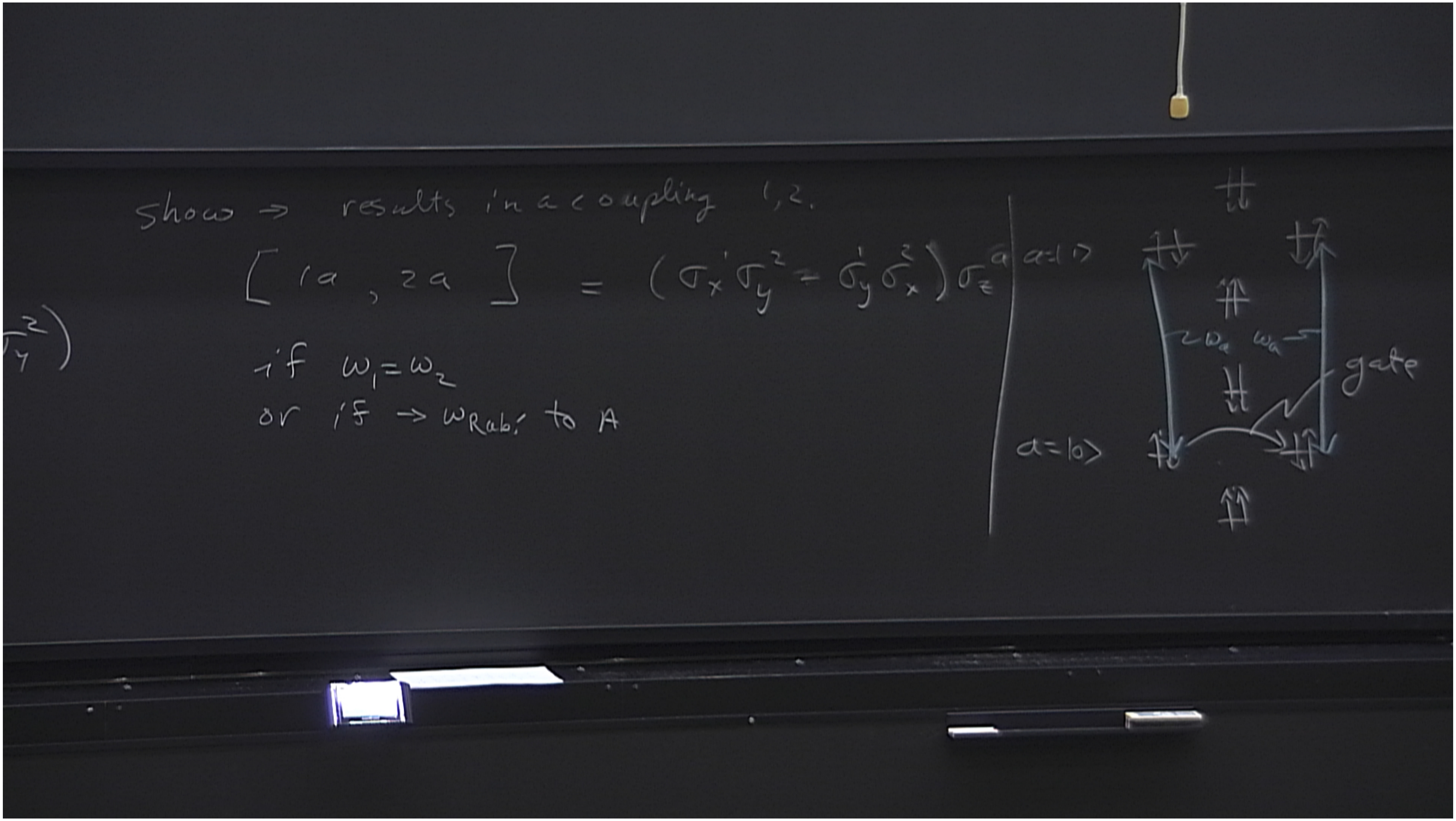
show ⇒ results in a coupling 1, 2.

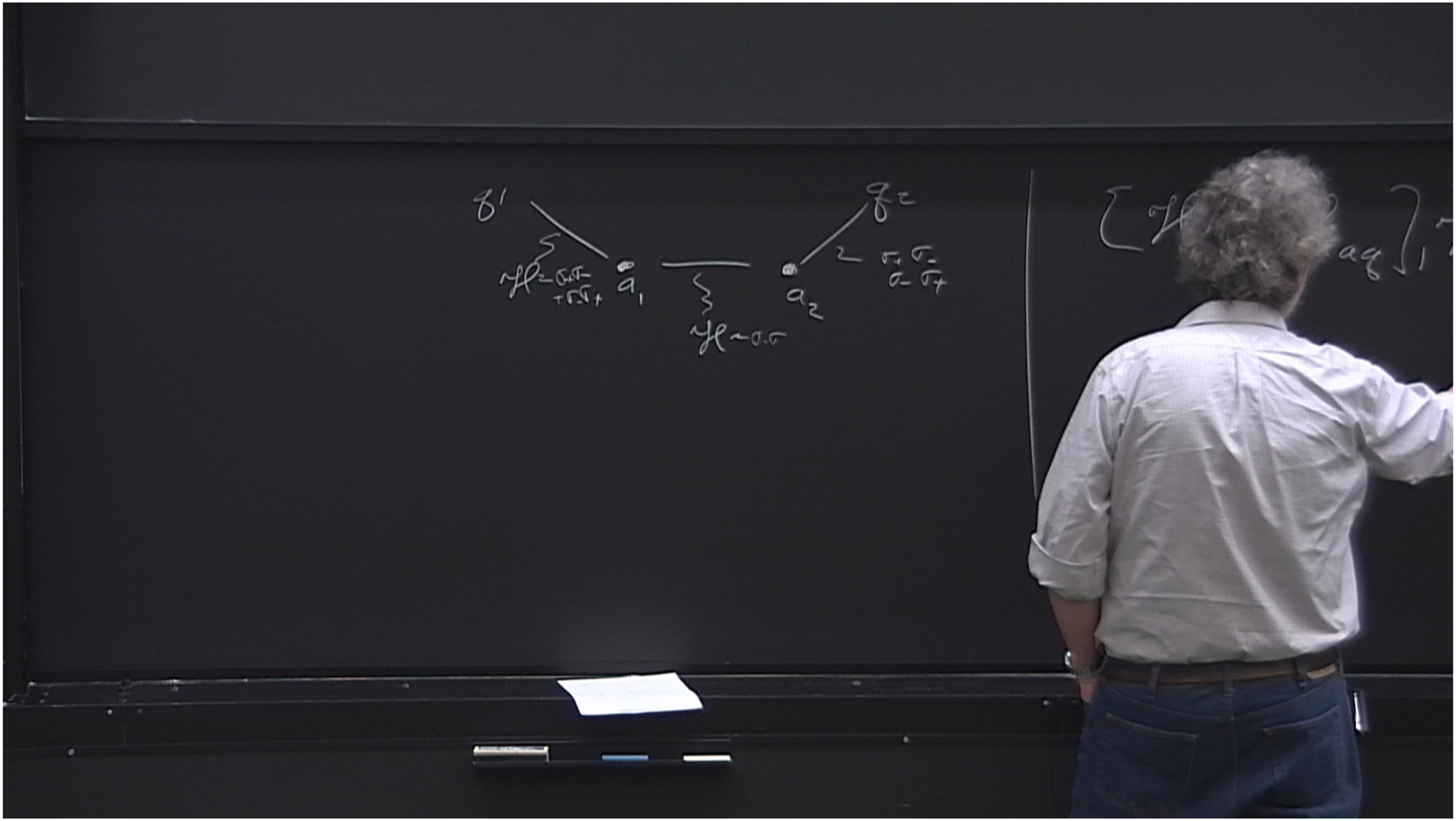
$$[\,1a\,,\,2a\,] = (\sigma_x^1\sigma_y^2 - \sigma_y^1\sigma_x^2)\,\sigma_z^a$$

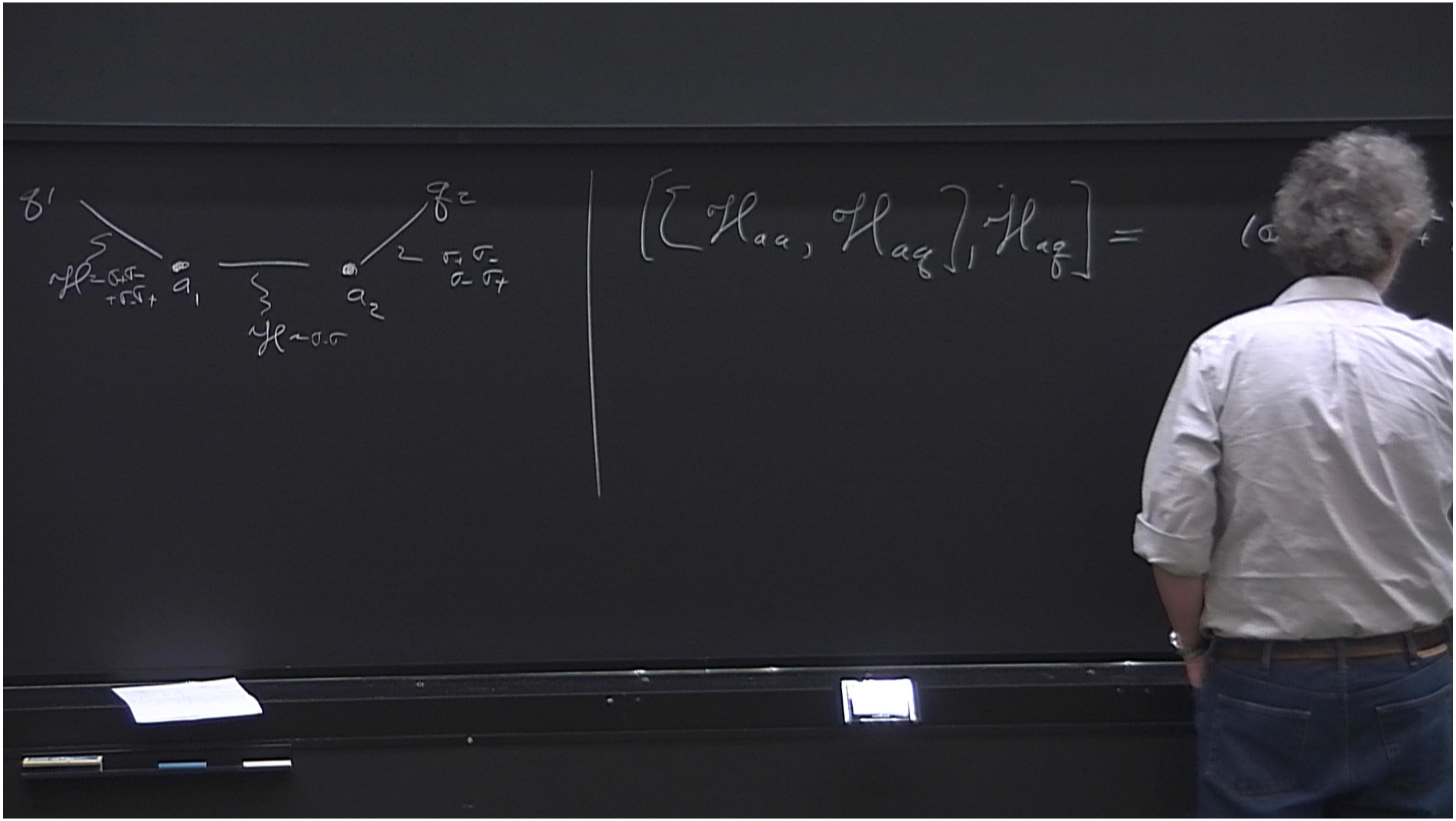
if $\omega_1 = \omega_2$

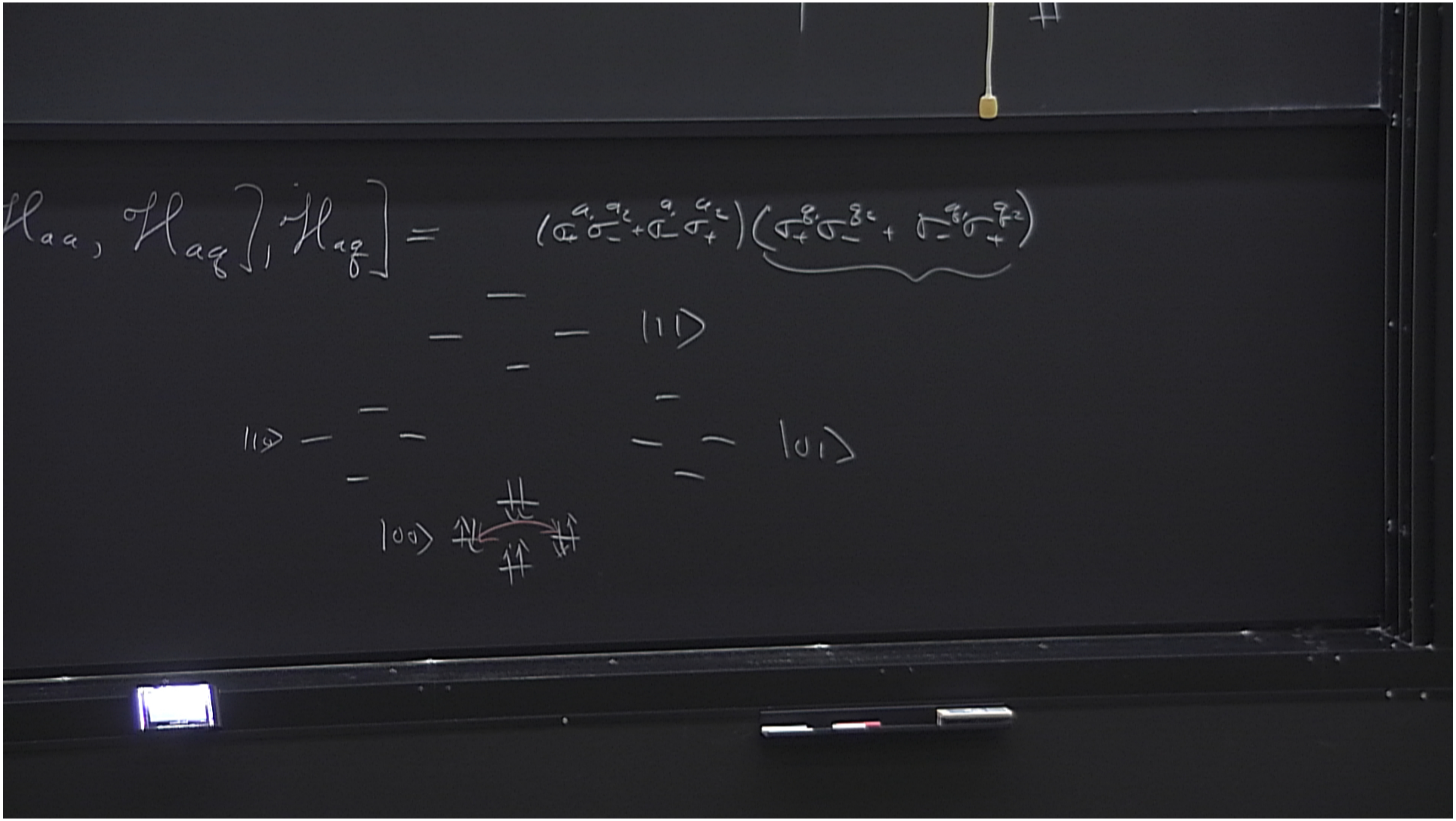
or if

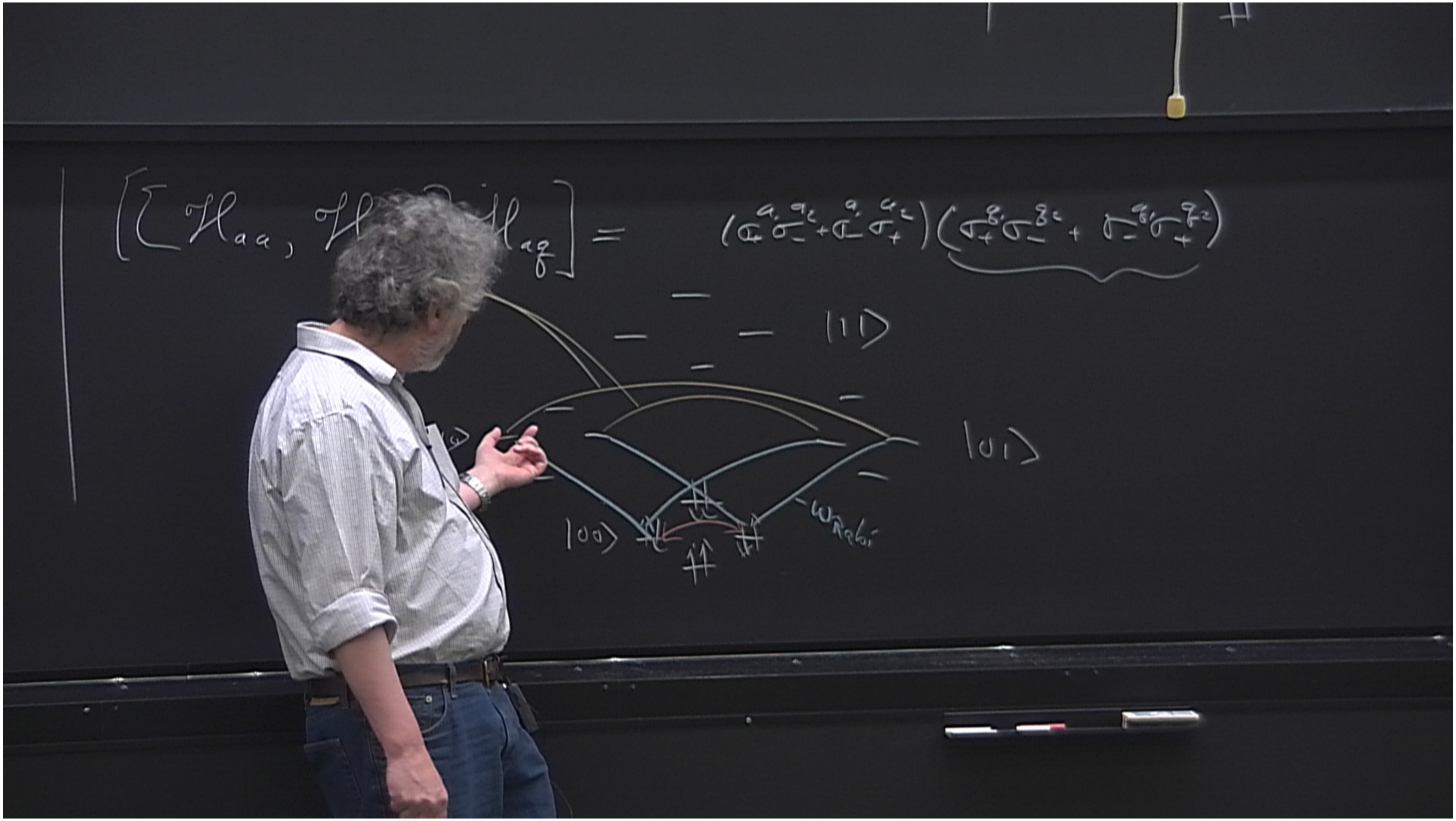


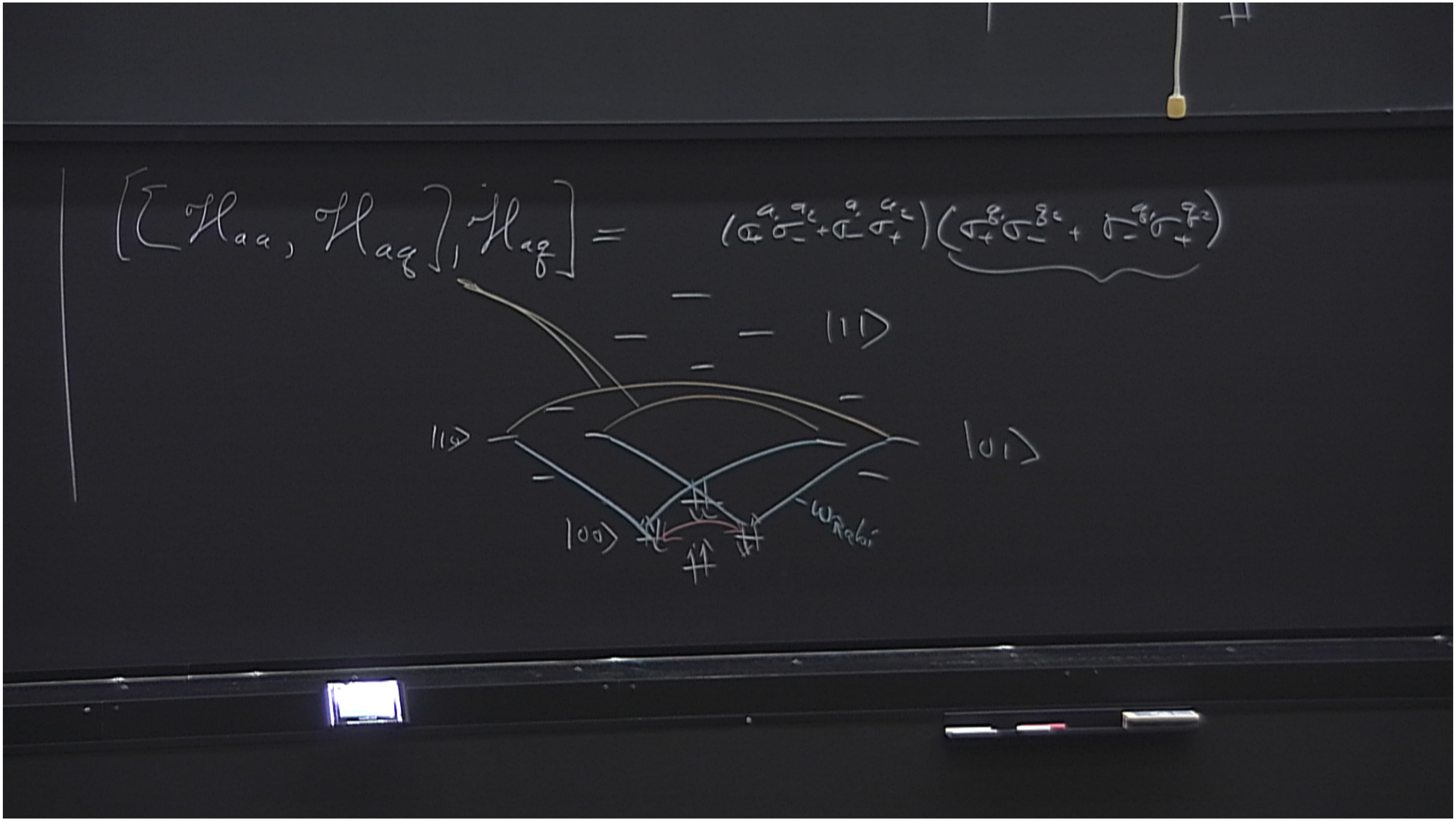

show → results in a coupling 1,2.
$[1a, 2a] = (\sigma_x^1 \sigma_y^2 - \sigma_y^1 \sigma_x^2)\sigma_z^a$
if $\omega_1 = \omega_2$
or if → ω_{Rabi} to A
$a=|1\rangle$
$2\omega_a$
ω_a
gate
$a=|0\rangle$

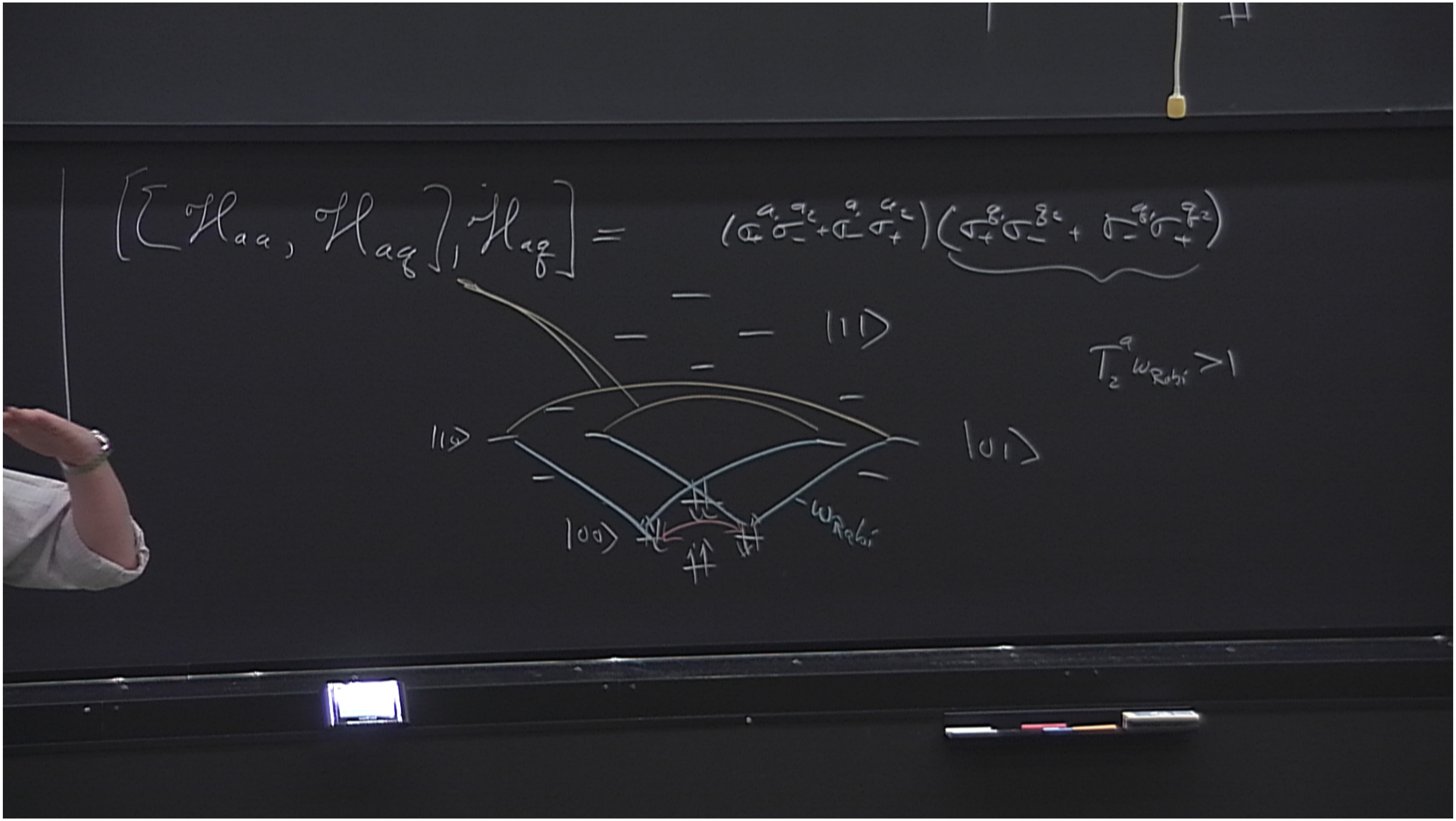


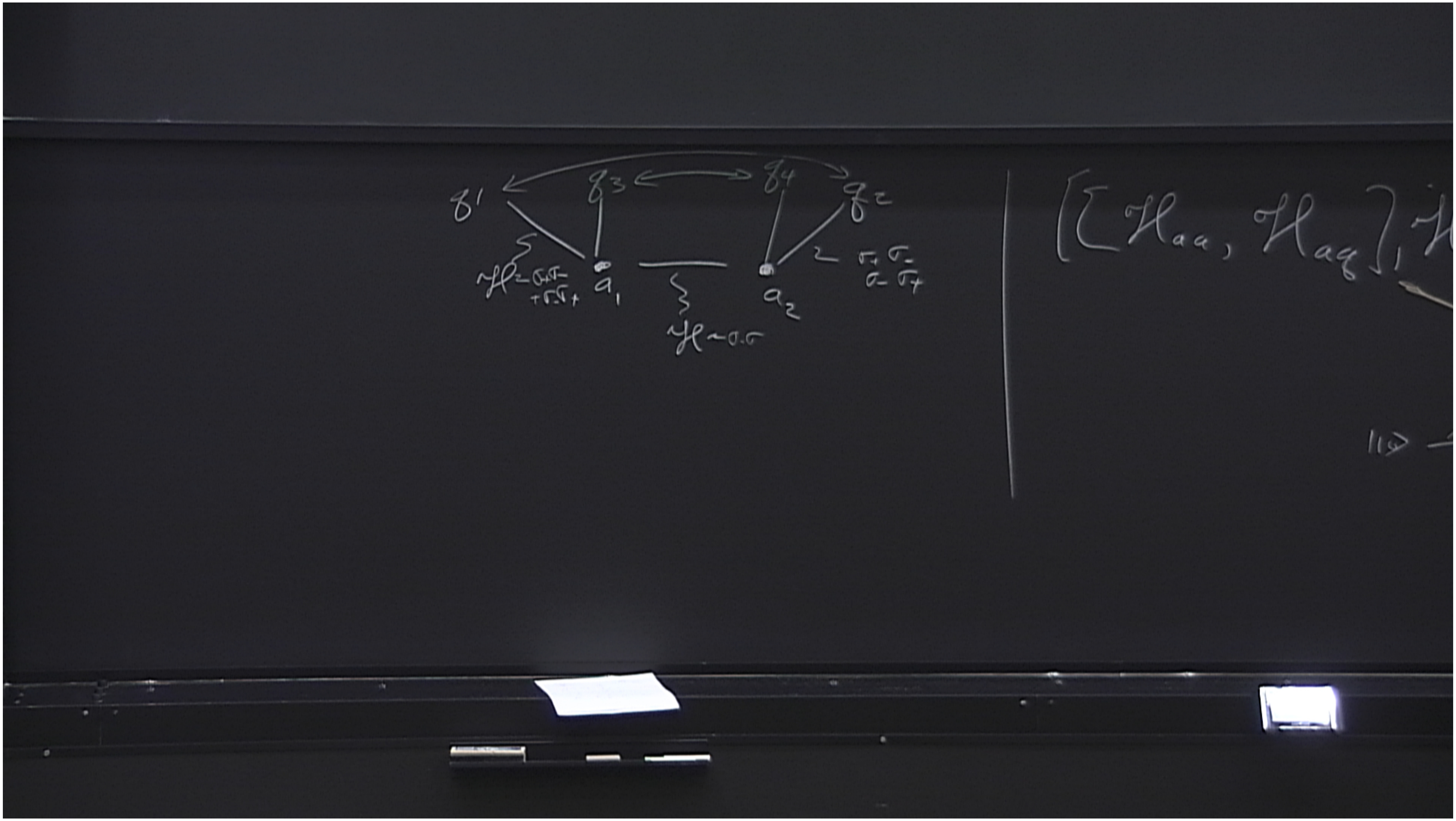

$[[H_{aa}, H_{aq}], H_{aq}] =$
a_1
a_2
$H \sim \sigma\cdot\sigma$


$\mathcal{H}_{aa}, \mathcal{H}_{aq}], \mathcal{H}_{aq}] = (\sigma_+^{a_1}\sigma_-^{a_2} + \sigma_-^{a_1}\sigma_+^{a_2})(\sigma_+^{q_1}\sigma_-^{q_2} + \sigma_-^{q_1}\sigma_+^{q_2})$
$|11\rangle$
$|10\rangle$
$|01\rangle$
$|00\rangle$


|11⟩
|01⟩
|00⟩
−ω_Rabi


$[[H_{aa}, H_{aq}], H_{aq}] = (\sigma_+^{a_1}\sigma_-^{a_2} + \sigma_-^{a_1}\sigma_+^{a_2})(\underbrace{\sigma_+^{q_1}\sigma_-^{q_2} + \sigma_-^{q_1}\sigma_+^{q_2}})$
|11⟩
|10⟩
|01⟩
|00⟩
ω_{Rabi}


$[[\mathcal{H}_{aa}, \mathcal{H}_{aq}], \mathcal{H}_{aq}] = (\sigma_+^{a_1}\sigma_-^{a_2} + \sigma_-^{a_1}\sigma_+^{a_2})(\sigma_+^{q_1}\sigma_-^{q_2} + \sigma_-^{q_1}\sigma_+^{q_2})$
|11⟩
$T_2^q \omega_{Rabi} > 1$
|10⟩
|01⟩
|00⟩
ω_{Rabi}


q1
q3
q4
q2
a1
a2