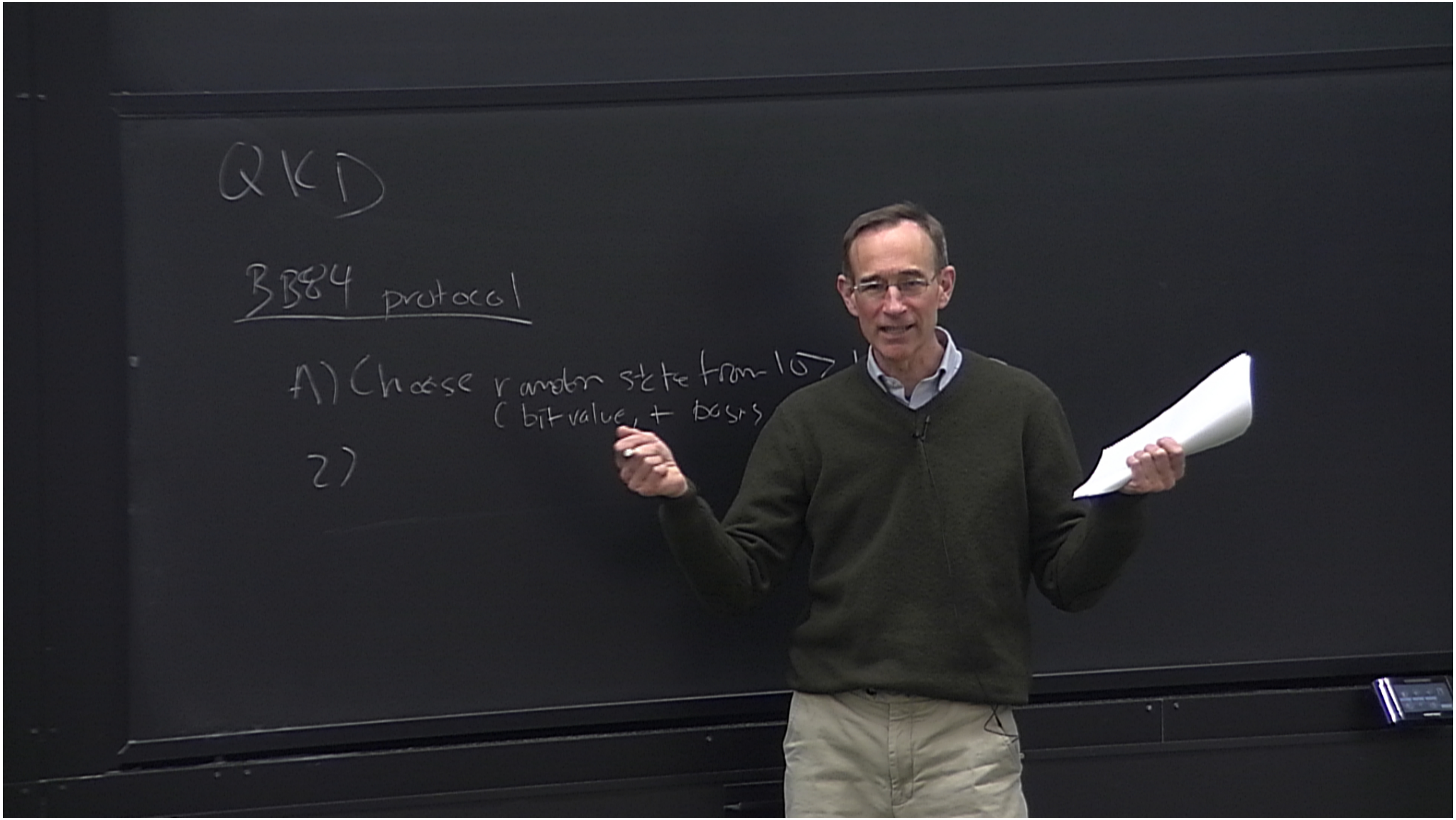
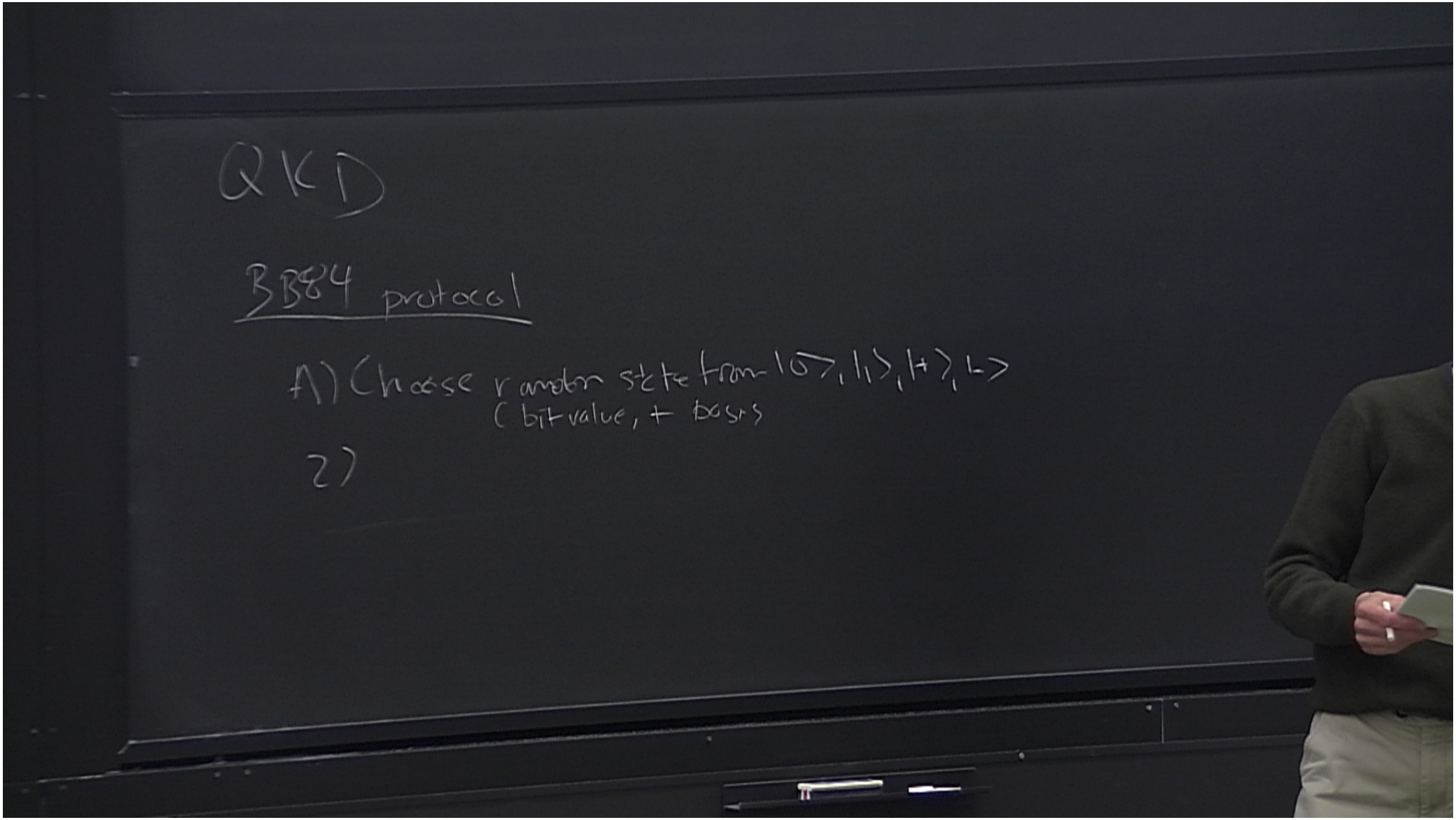
Title: PSI 2015/2016 Quantum Information - Lecture 15

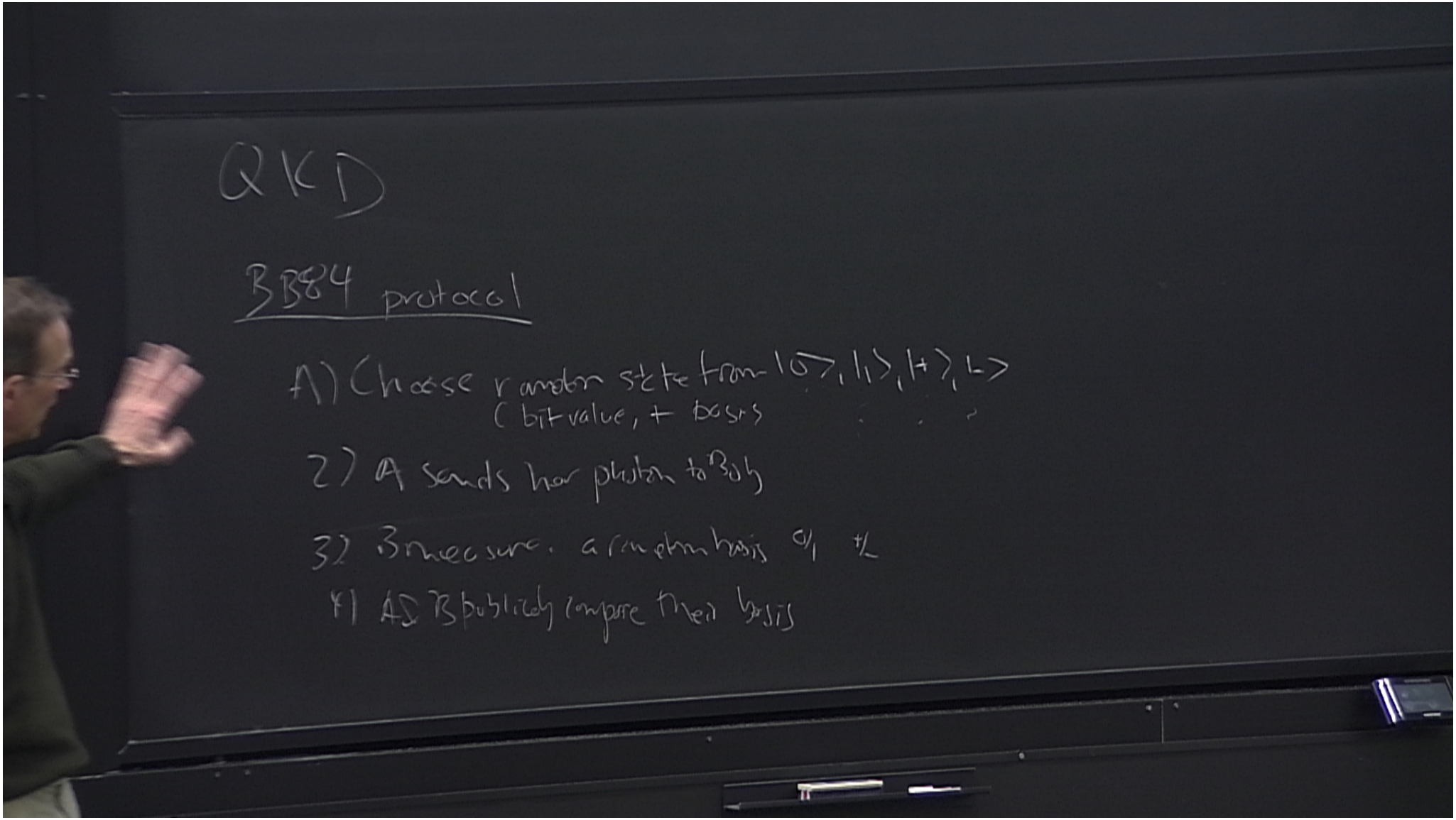
Date: Mar 11, 2016 11:30 AM

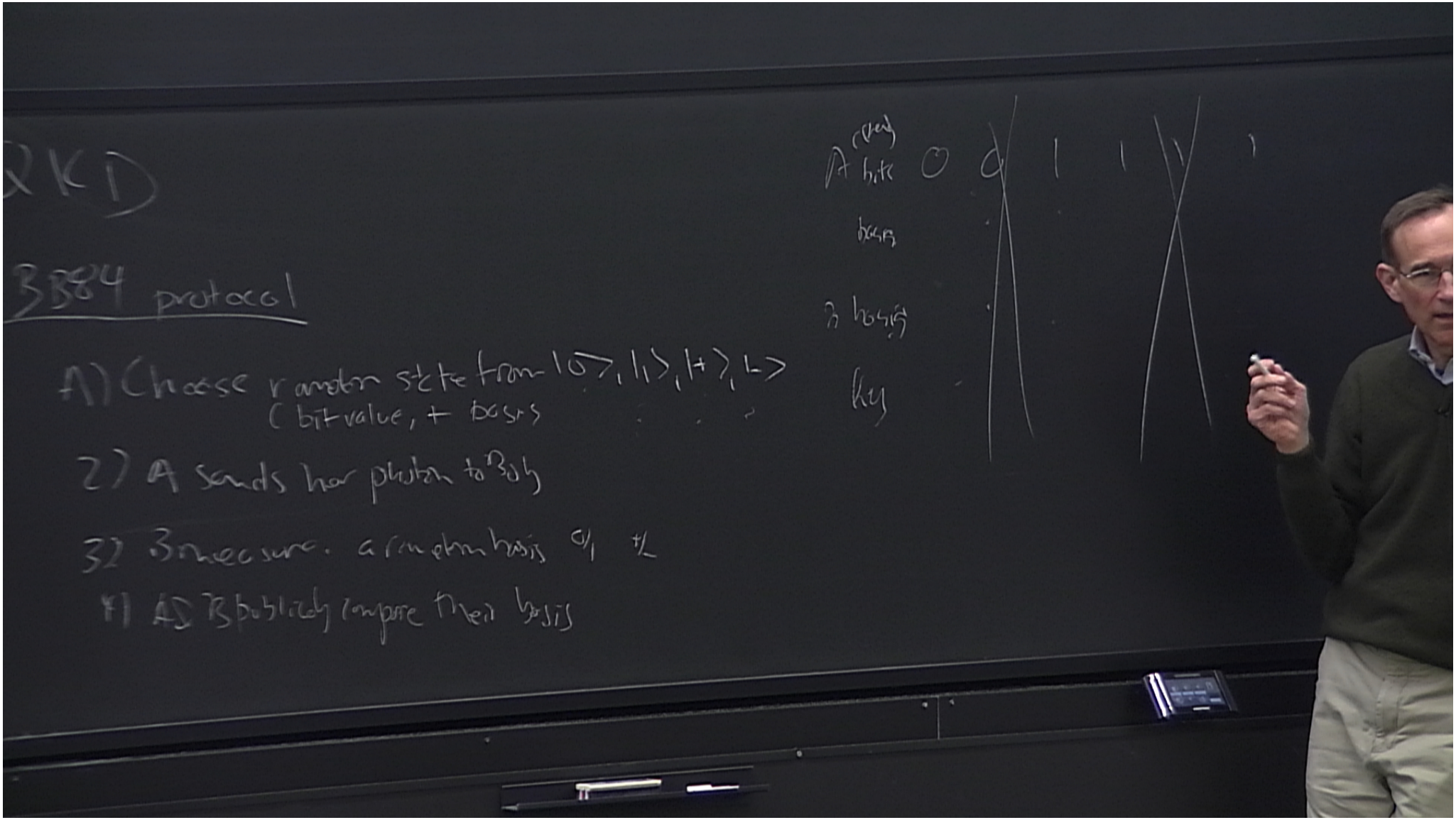
URL: http://pirsa.org/16030062

Abstract:


QKD
BB84 protocol
1) Choose r
2)


QKD
BB84 protocol
1) Choose random state from |0>, |1>, |+>, |->
(bit value, + basis
2)


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3) B measures a random basis ⊙/ +/-
4) A & B publicly compare their basis


QKD
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(bit value, + basis
2) A sends her photon to Bob
3) Measure. a random basis 0/1 +/-
4) A, B publicly compare their basis
A (Alice) bits
bases
2 bases
key

QKD

3584 protocol



A (key) bits 0 0 1 1 1 1

bases

Eve

2 bases

key

M

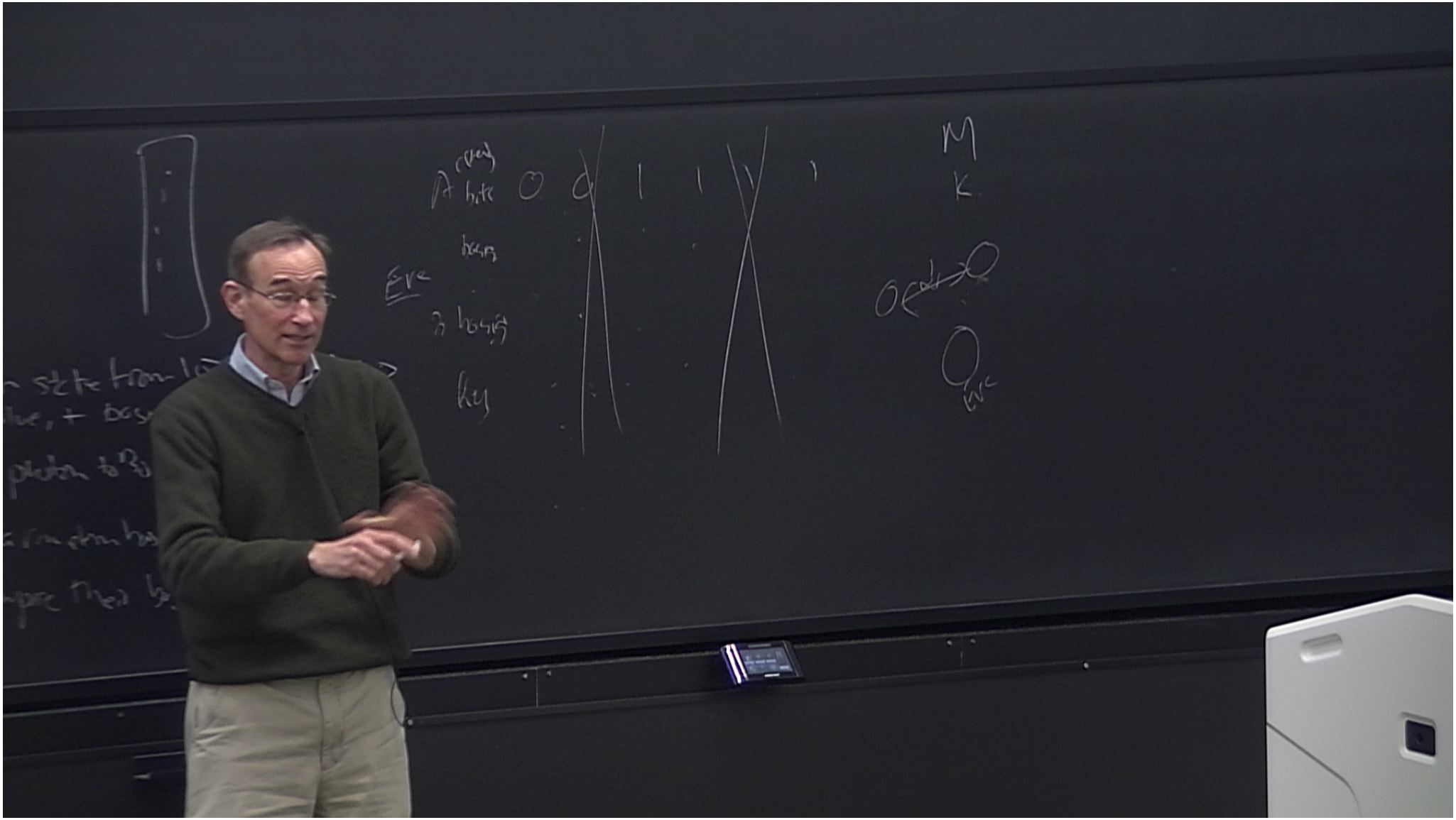
K

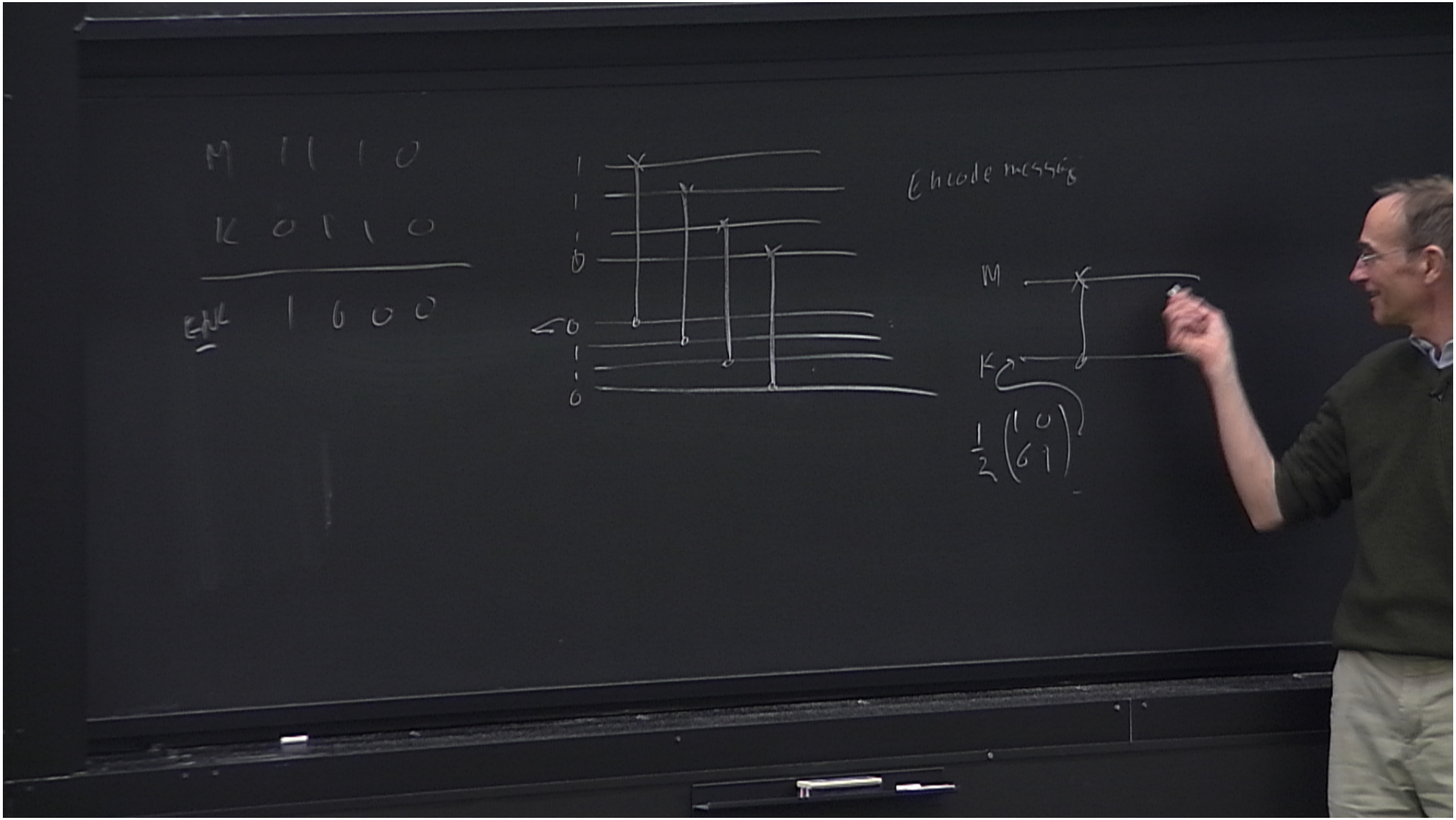
1) Choose random state from $|0\rangle, |1\rangle, |+\rangle, |-\rangle$
(bit value, + bases

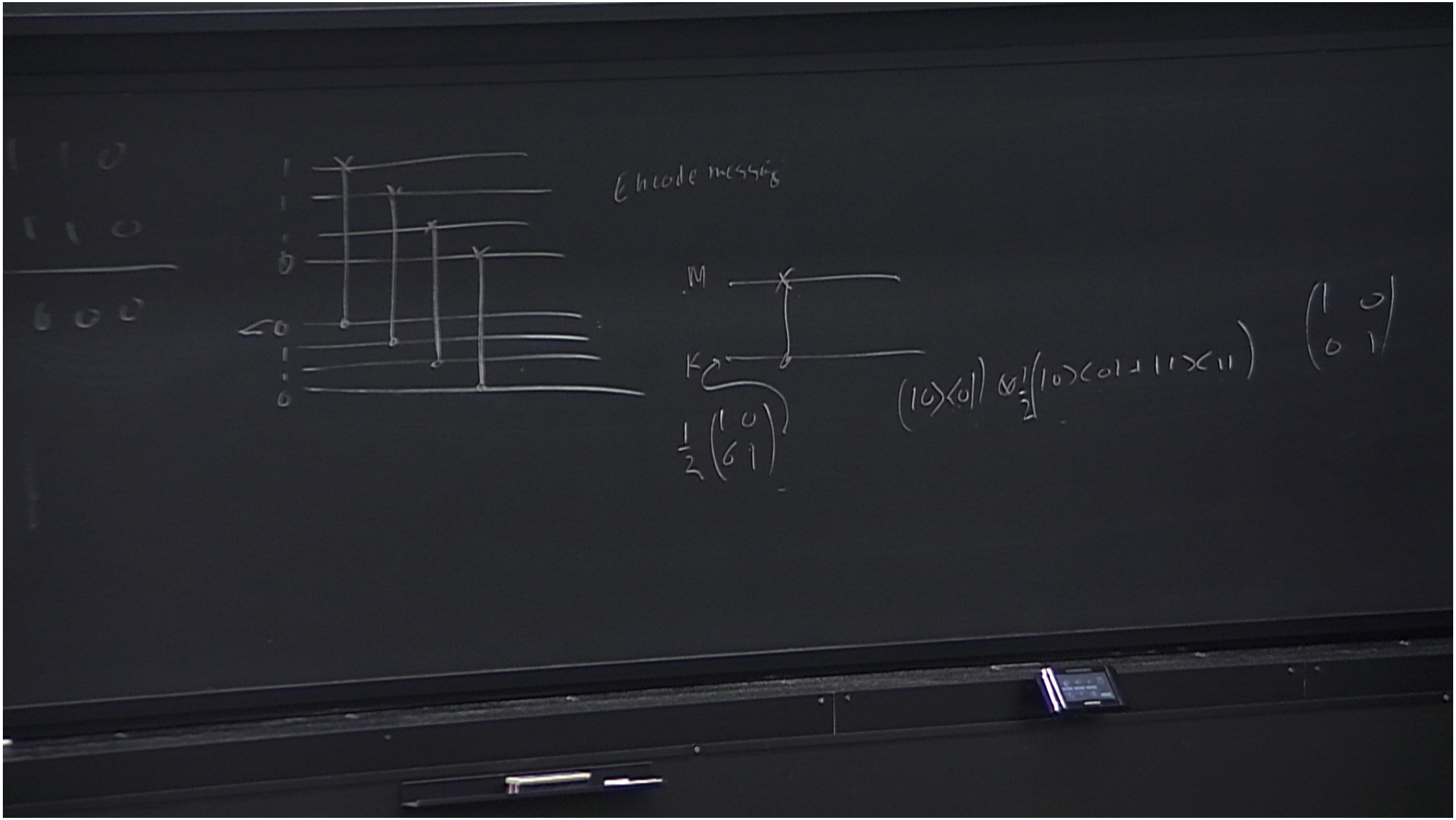
2) A sends her photon to Bob

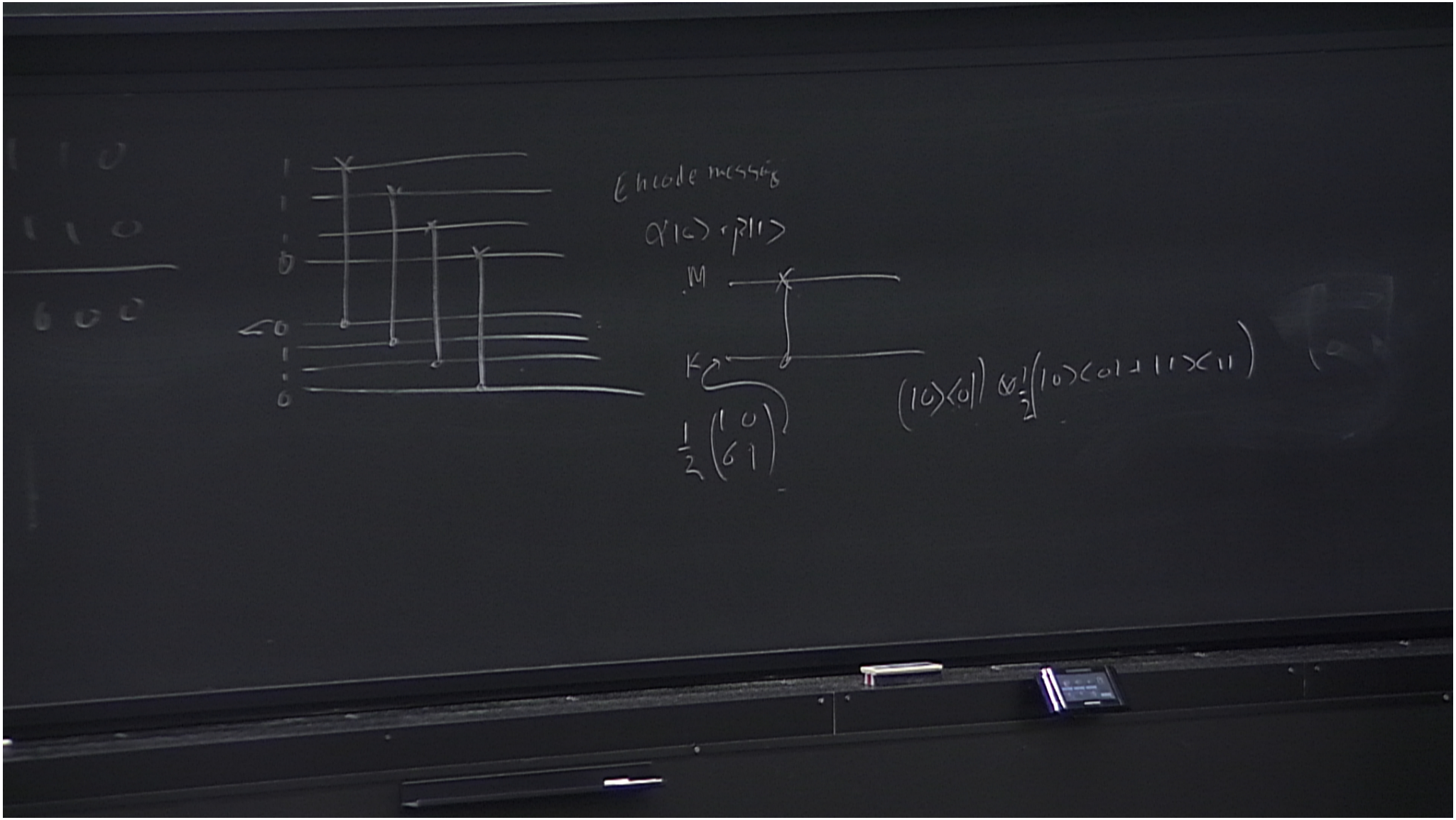
3) B measure. a random basis 0/1 +/-

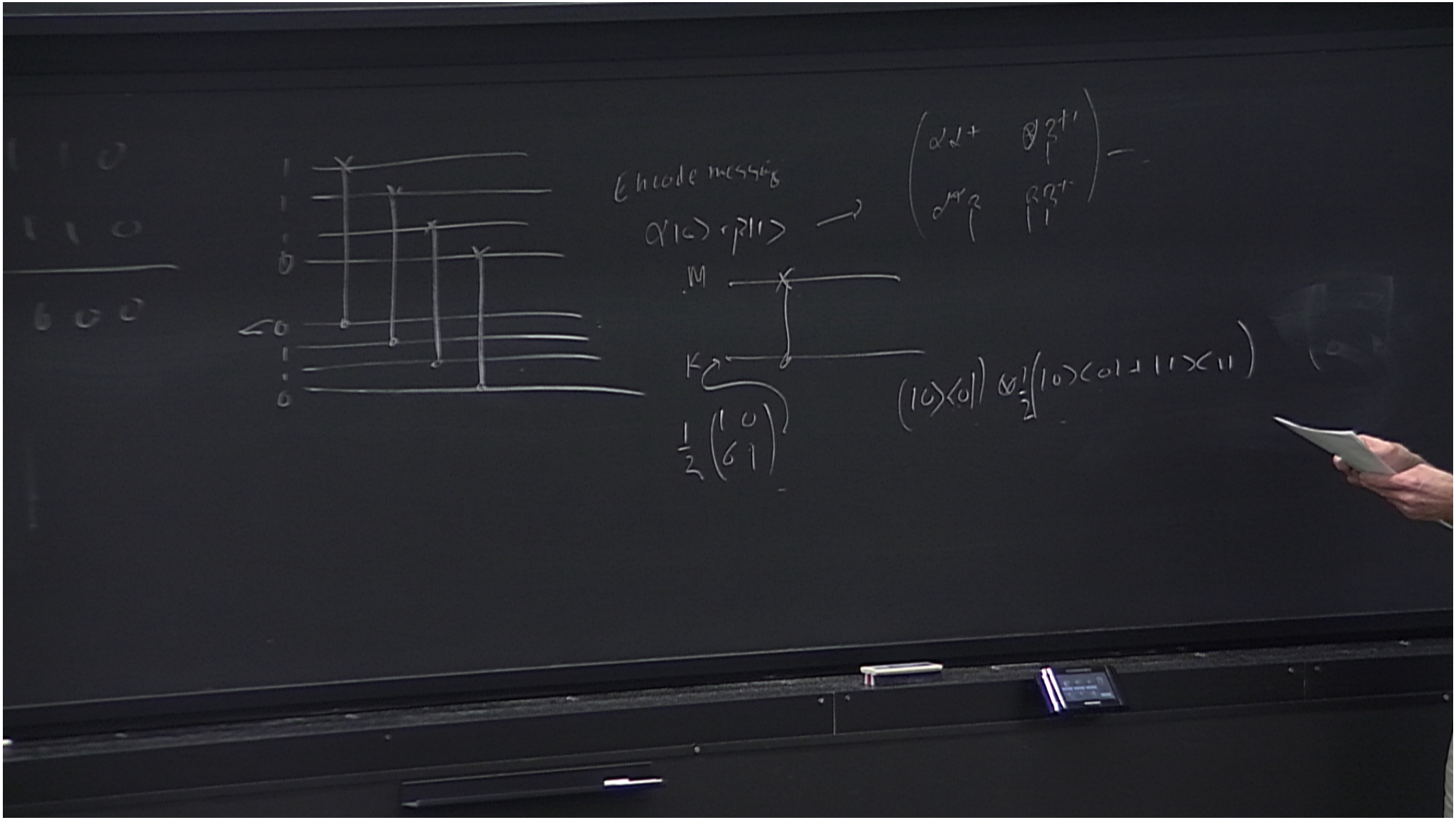
4) A, B publicly compare their bases

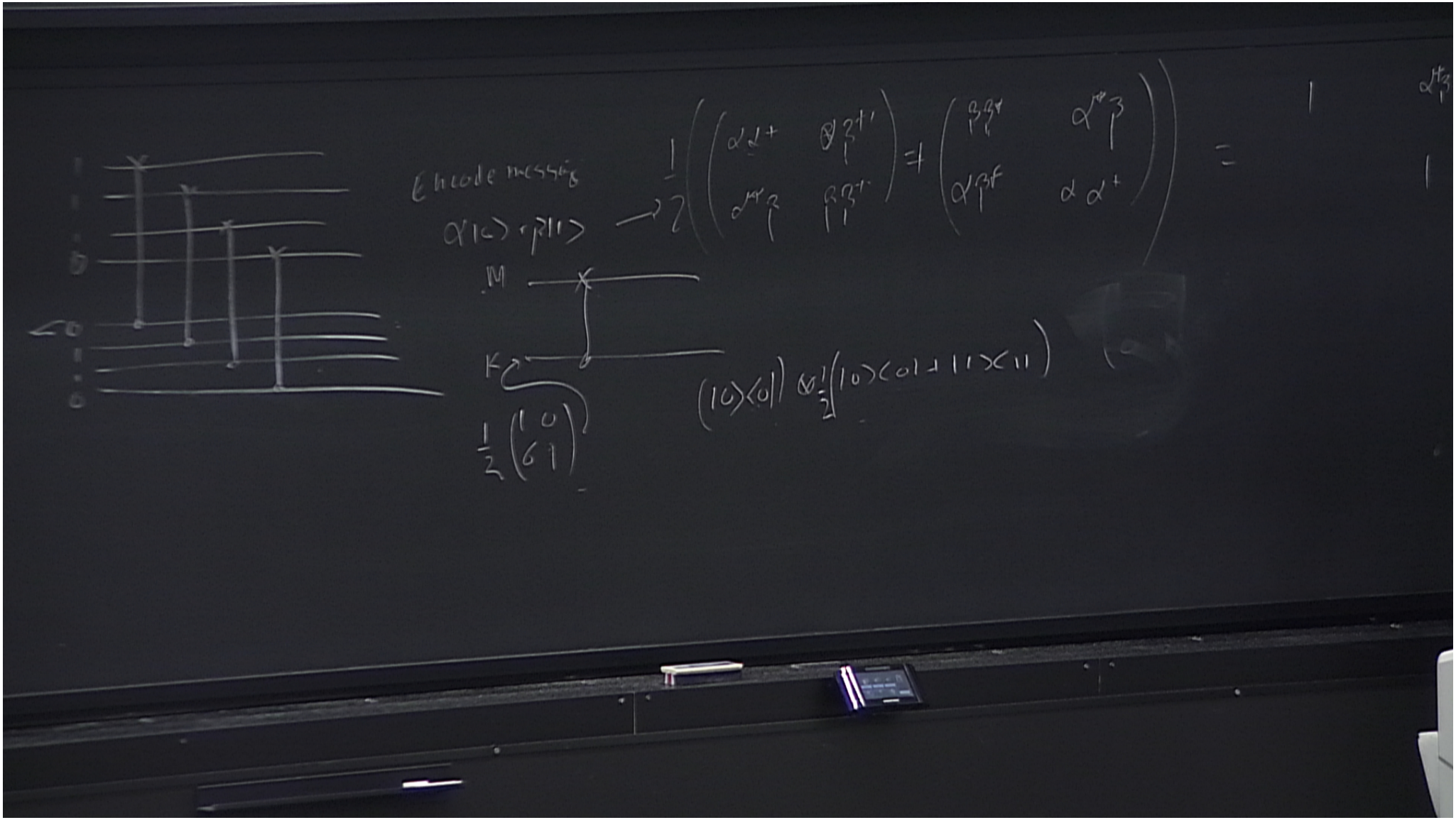


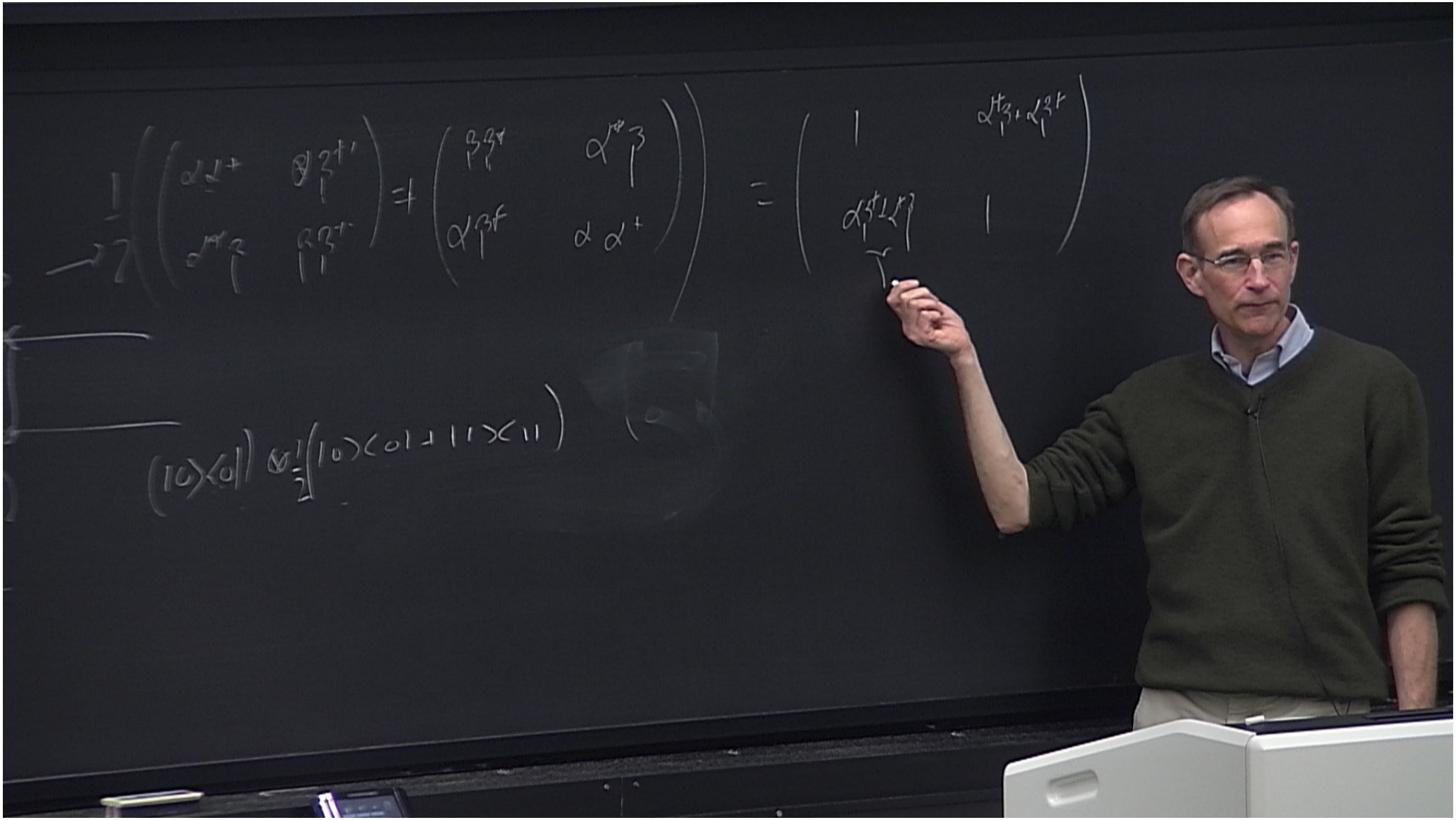

M 1 1 1 0
K 0 1 1 0
ENC 1 0 0 0
Encode message
M
K
1/2 (1 0 / 0 1)

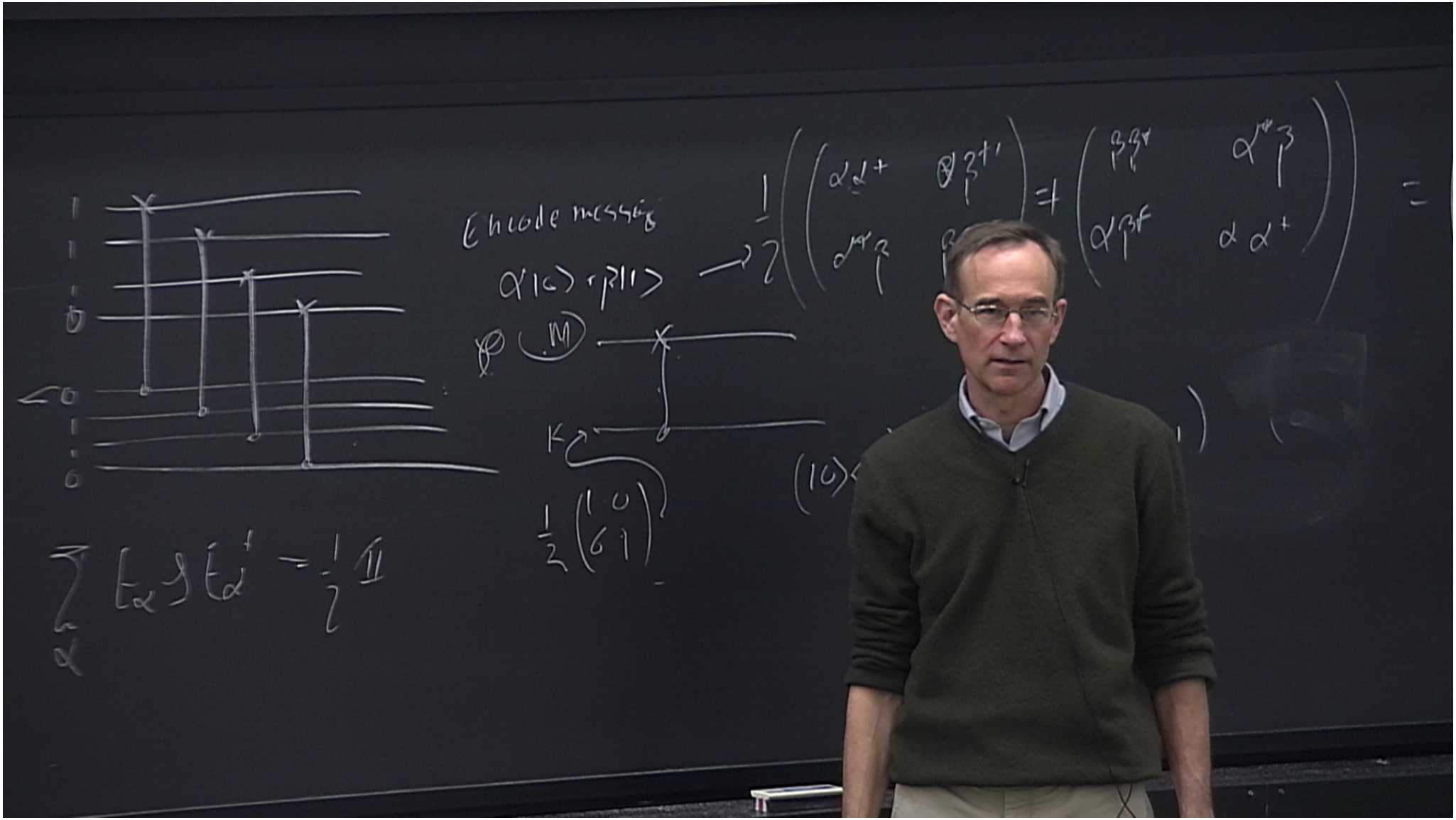

Encode message
M
K
$\frac{1}{2}\begin{pmatrix}1&0\\0&1\end{pmatrix}$
$|0\rangle\langle 0| \otimes \frac{1}{2}(|0\rangle\langle 0| + |1\rangle\langle 1|)$
$\begin{pmatrix}1&0\\0&1\end{pmatrix}$

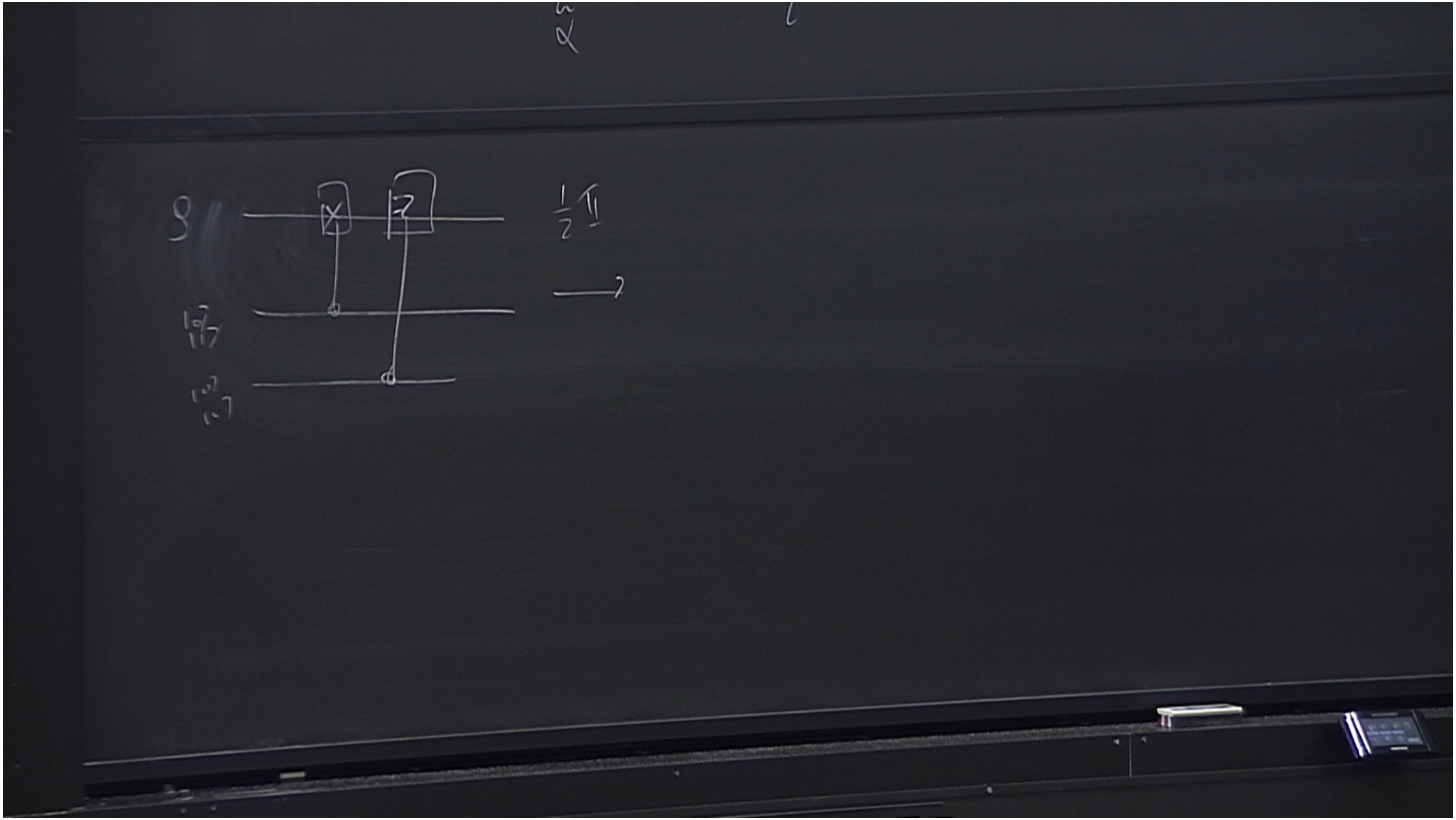

Encode message
M
K

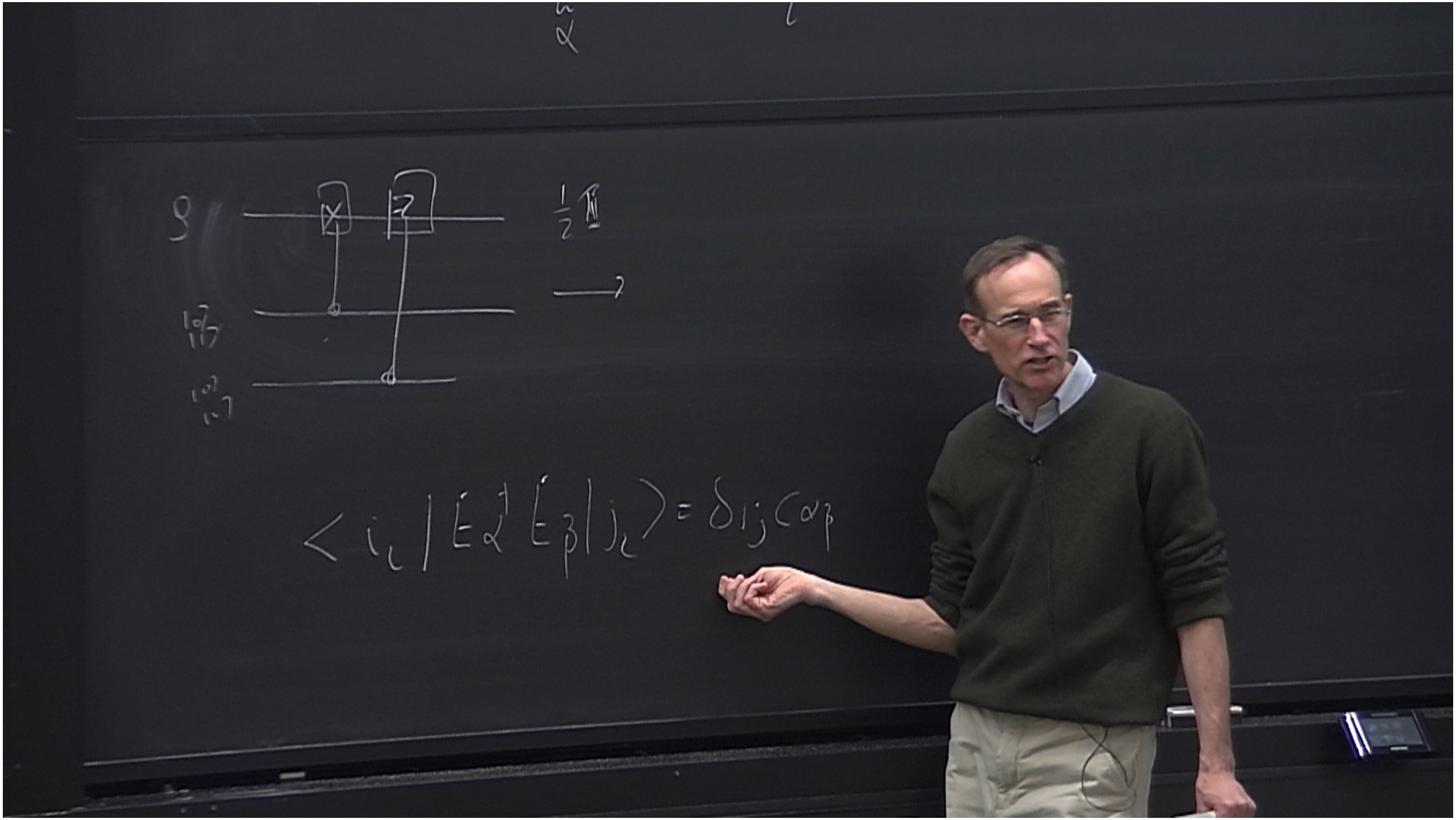

Encode message
M
K
|10><01| ⊗ 1/2(|10><01| + |11><11|)

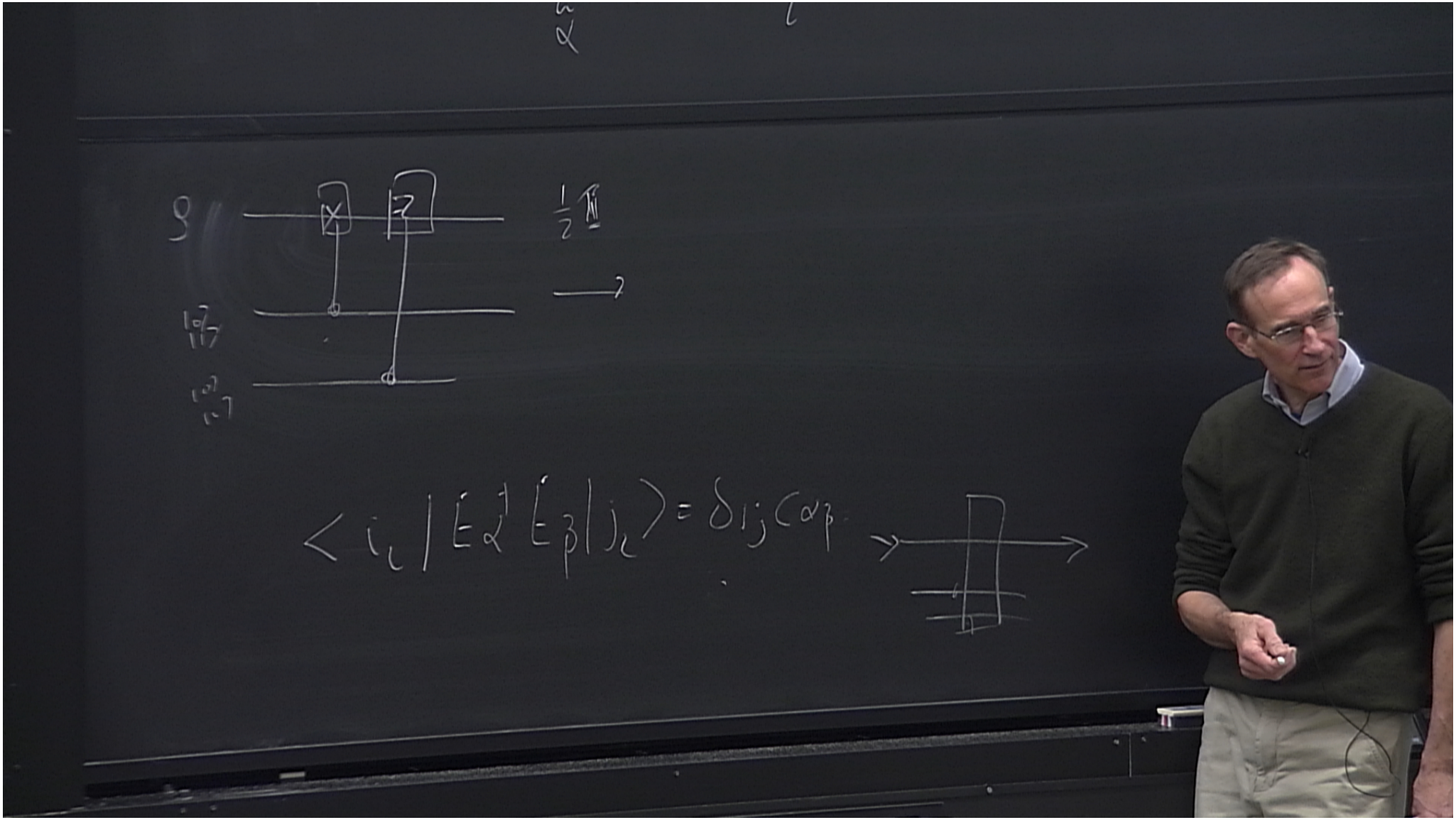

Encode message
M
K

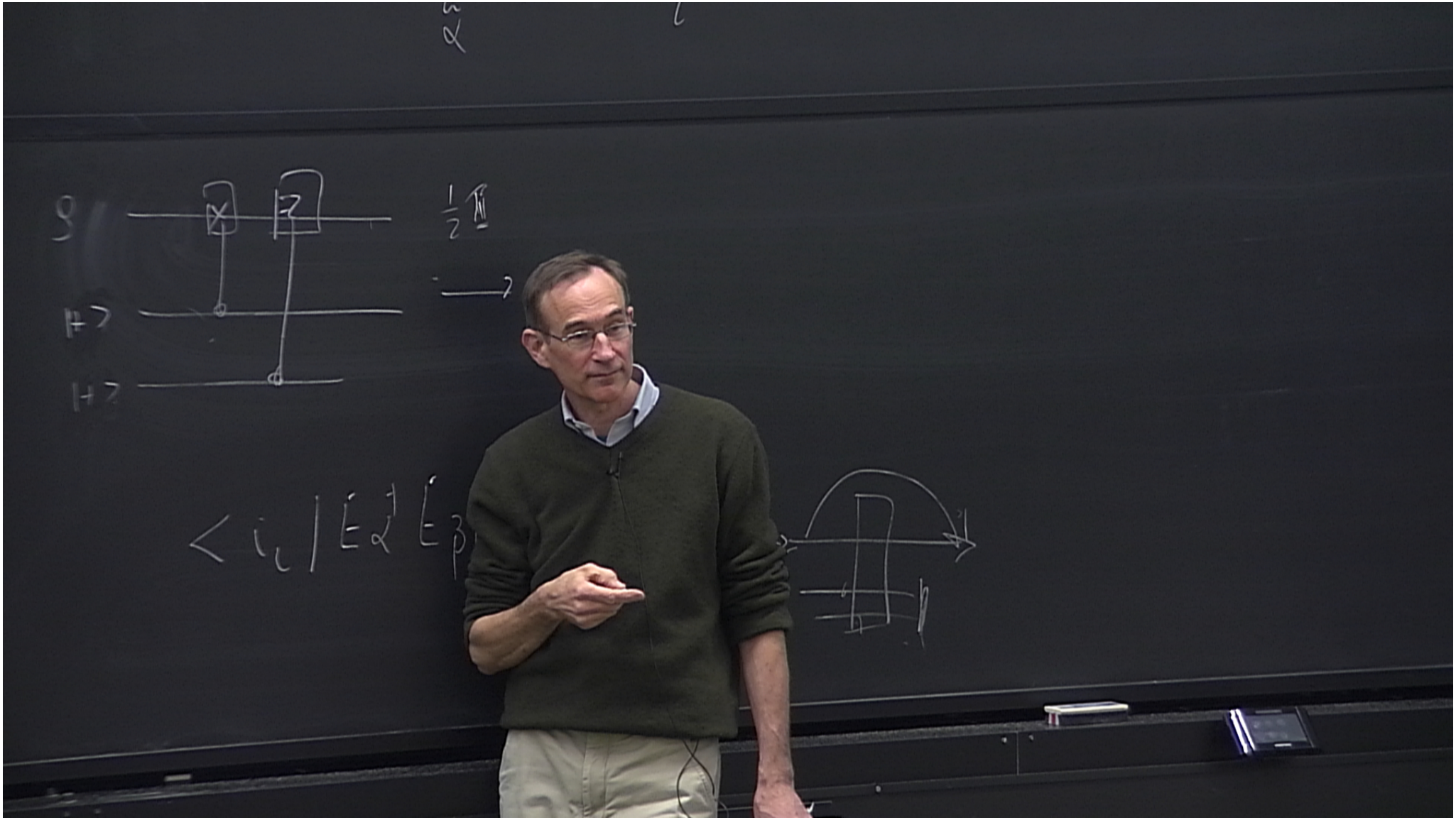


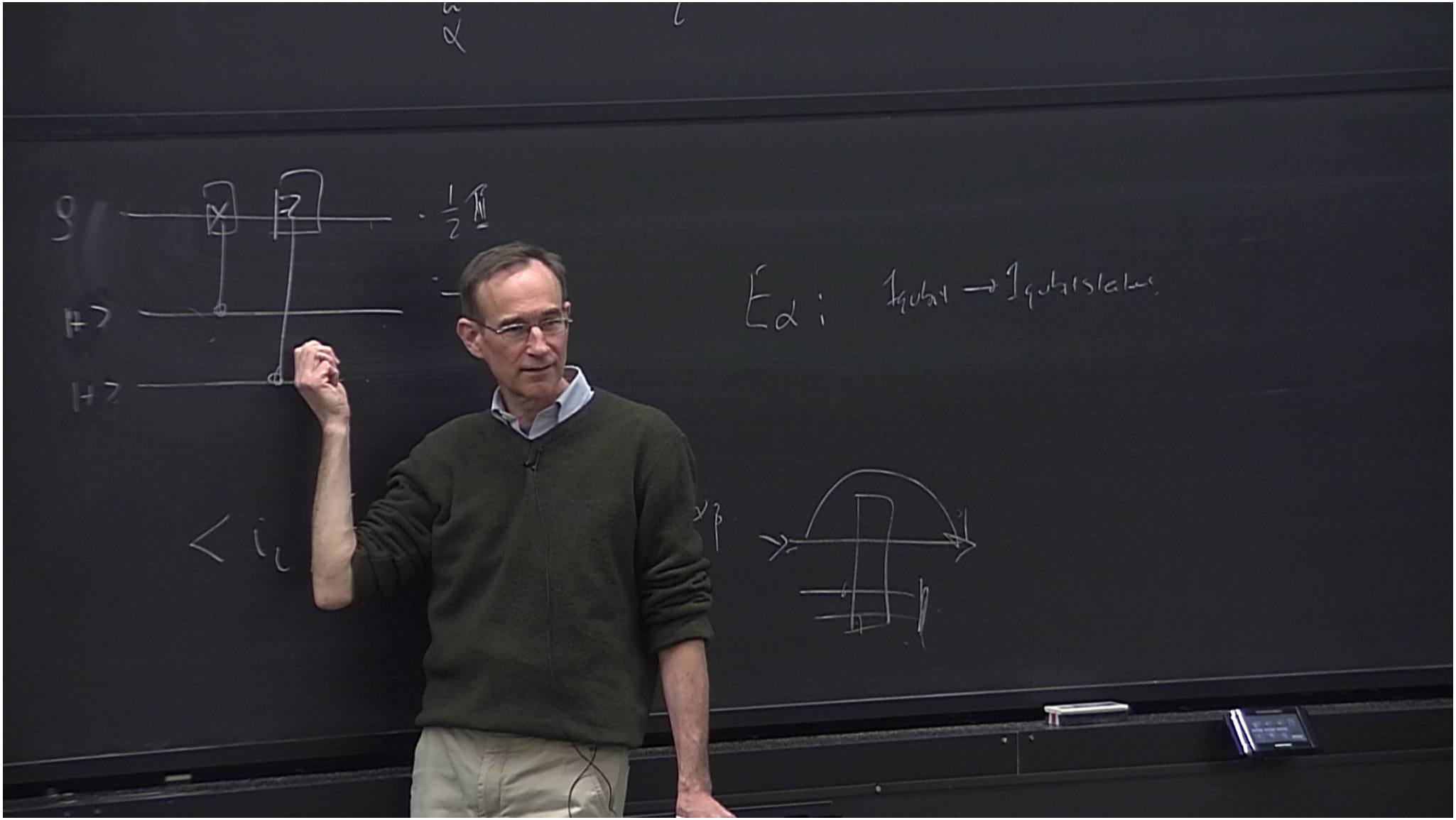

Encode message
M
K

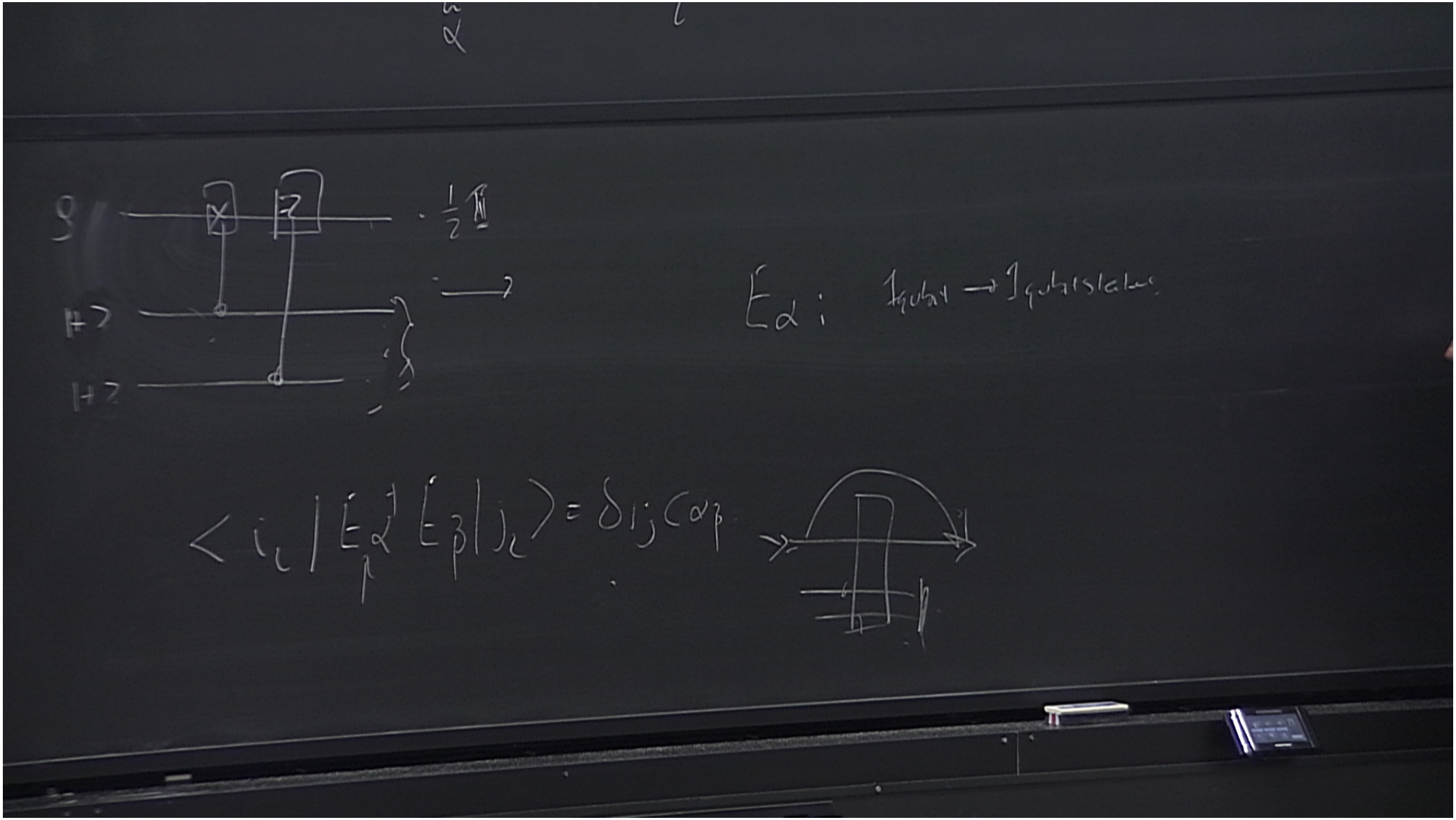


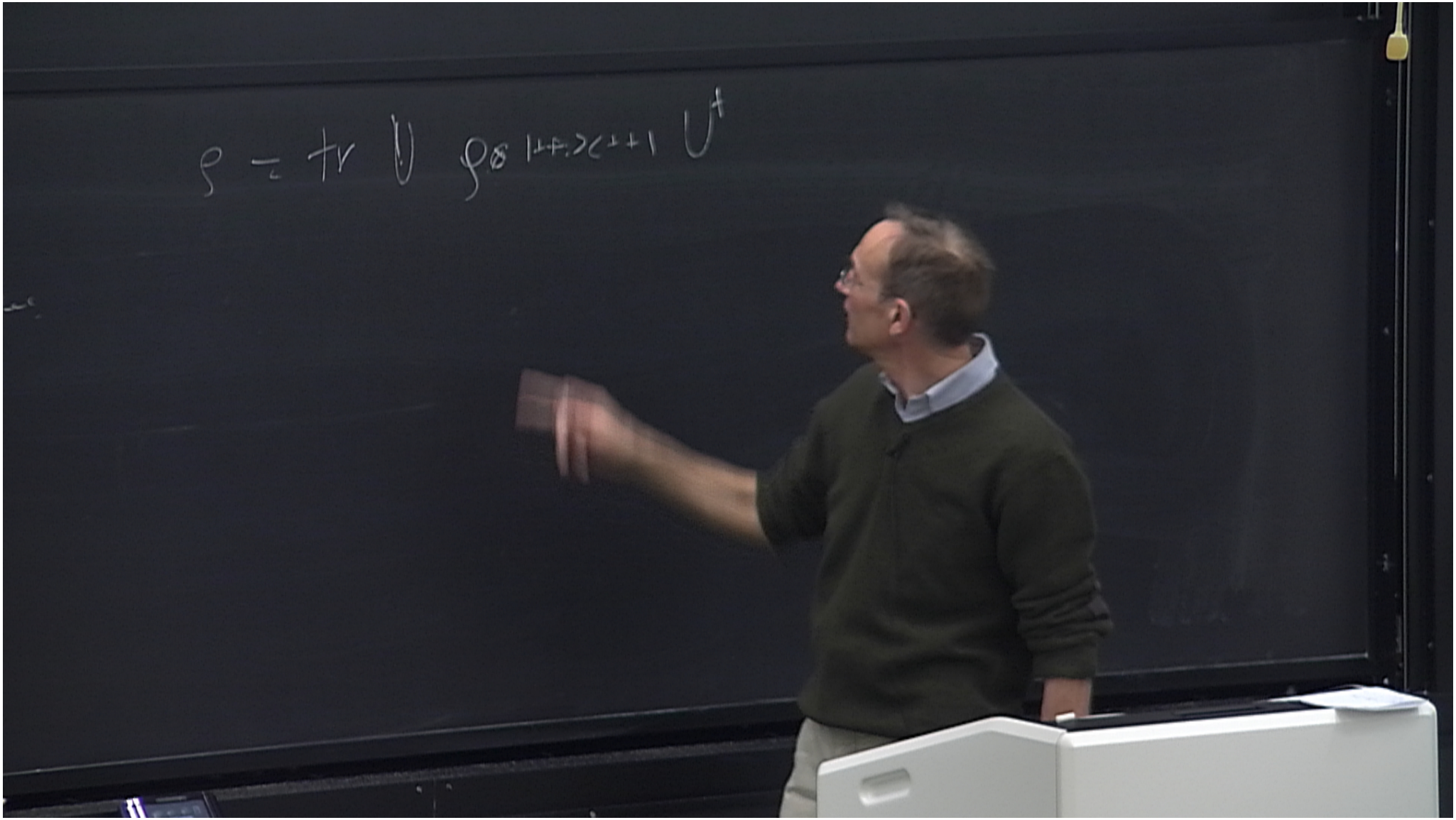

$\frac{1}{2}$
$\frac{1}{2}$
$\frac{3}{2}$
$\frac{1}{2}$
$\langle i_c | E_\alpha^\dagger E_\beta | j_c \rangle = \delta_{ij} C_{\alpha\beta}$

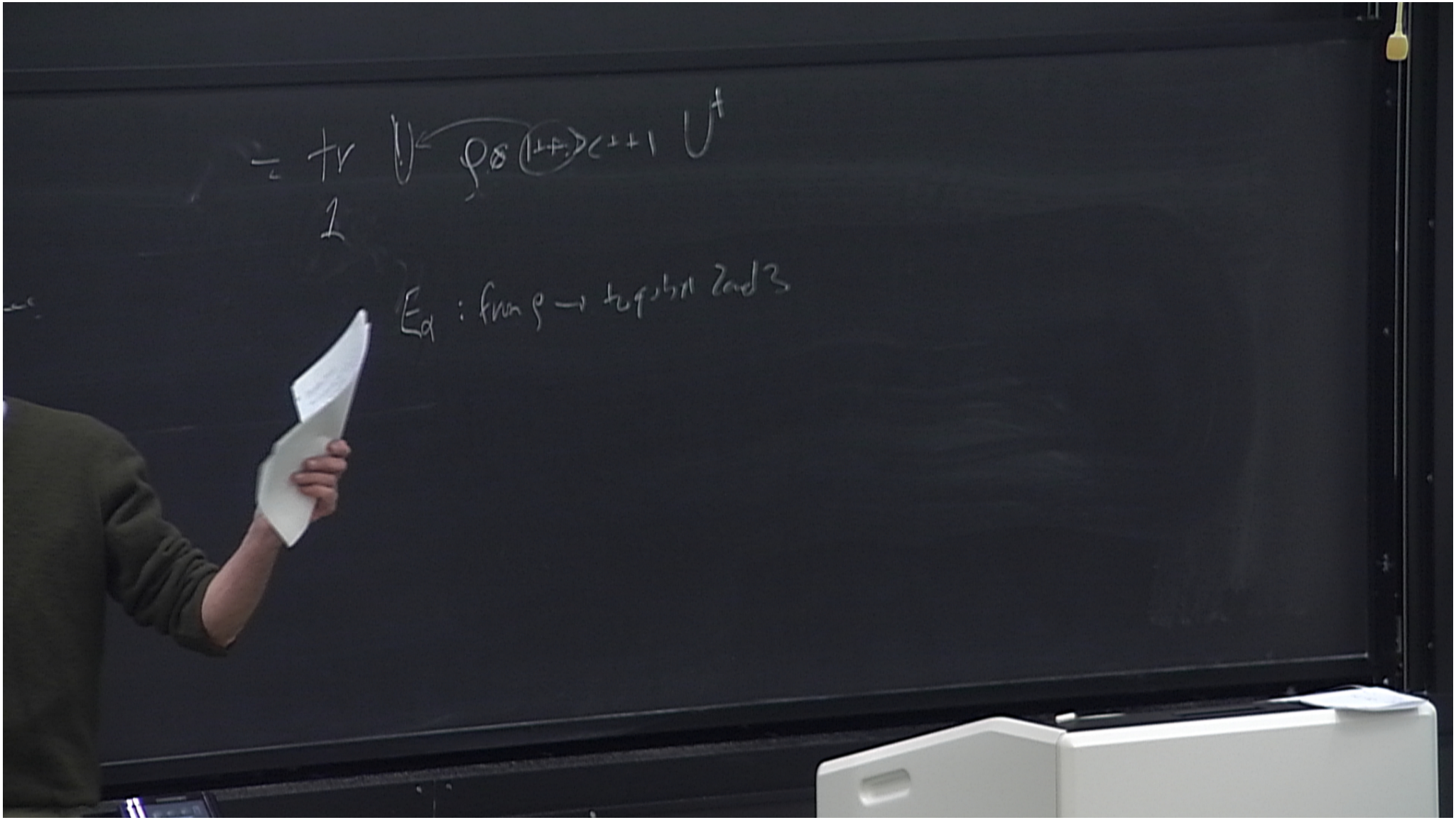

$\langle i_c | E_\alpha^1 E_\beta | j_c \rangle = \delta_{ij} c_{\alpha\beta}$

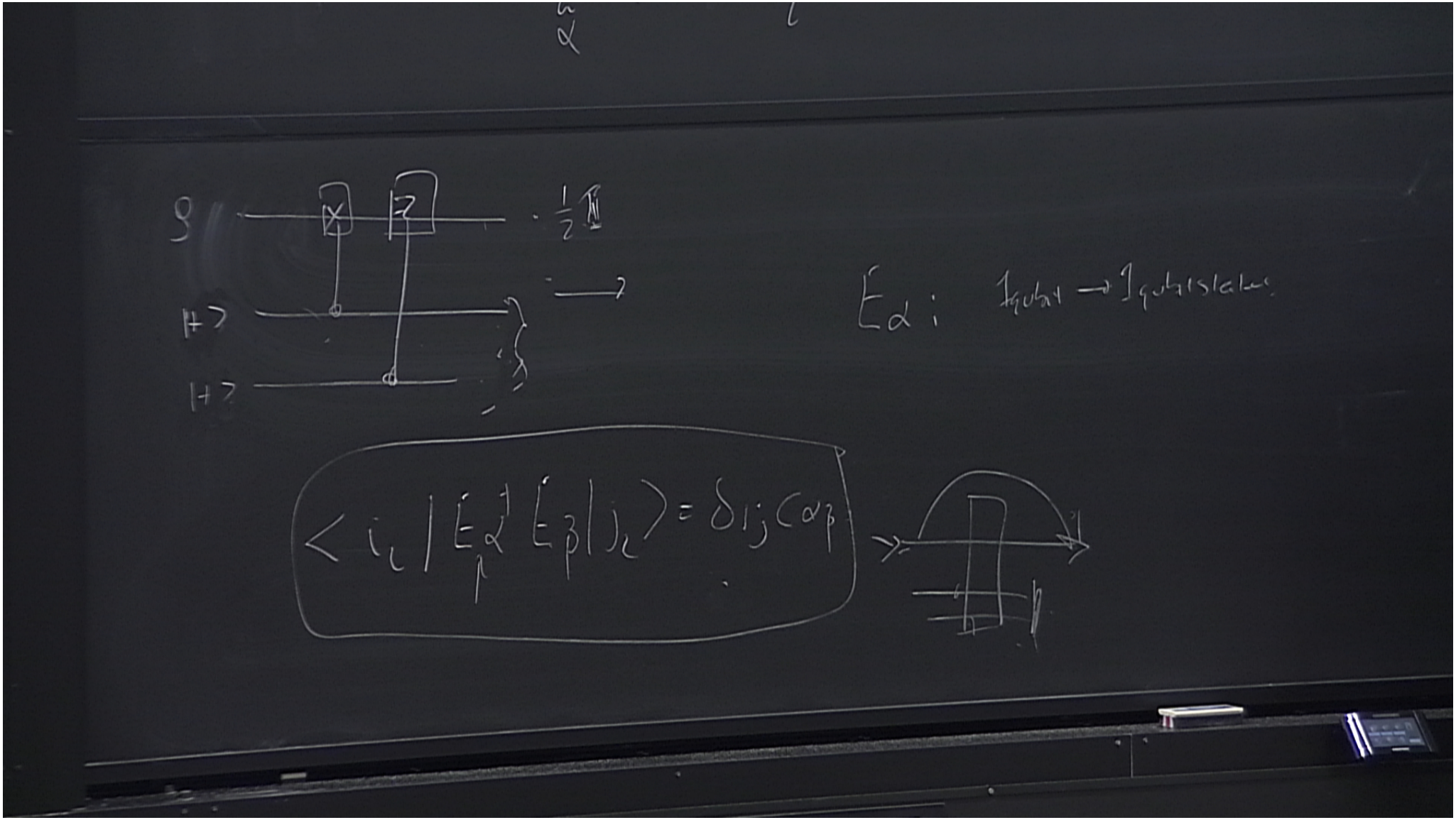


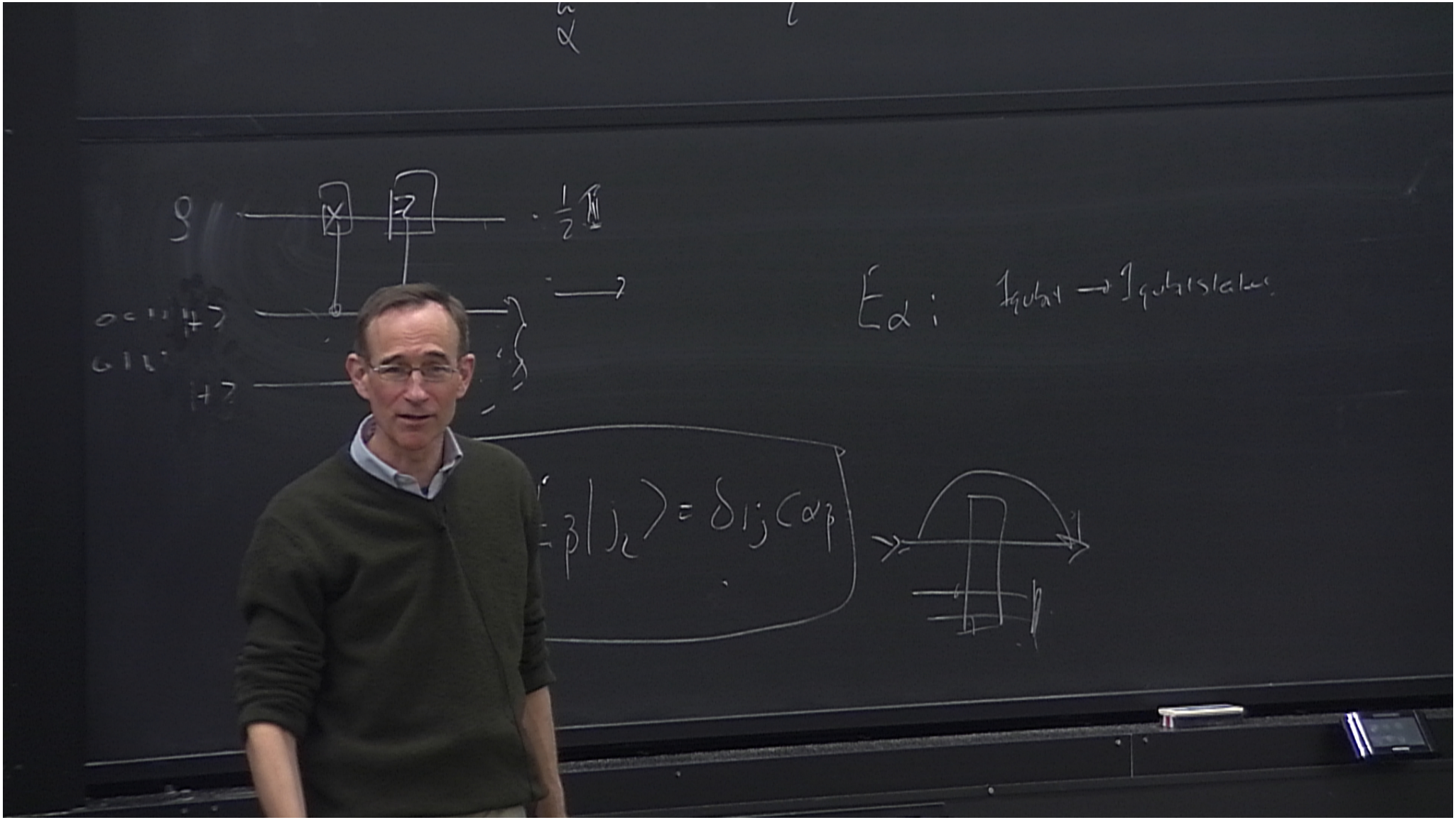

Eα ;

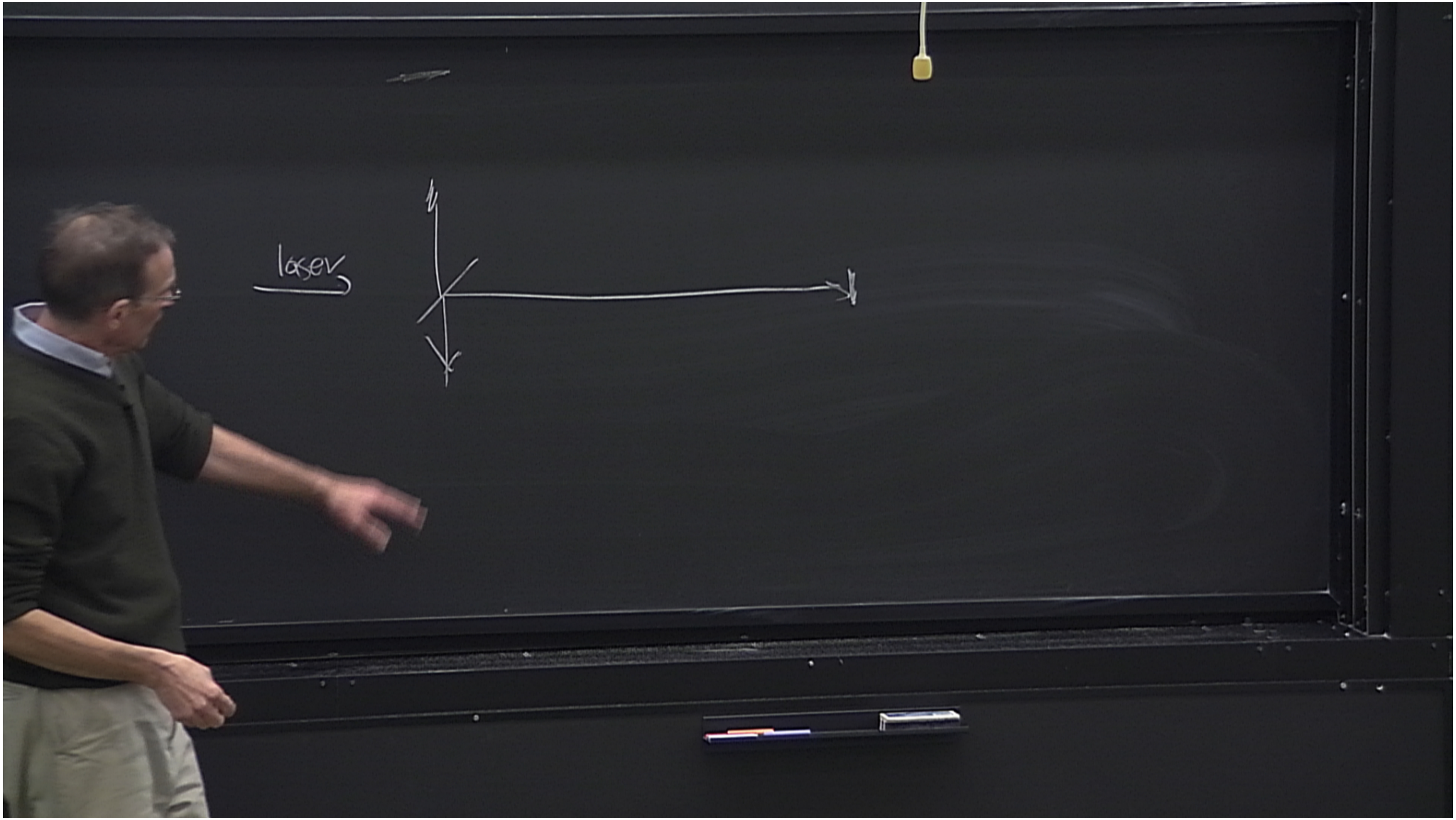

E_α ; Initial → Final states

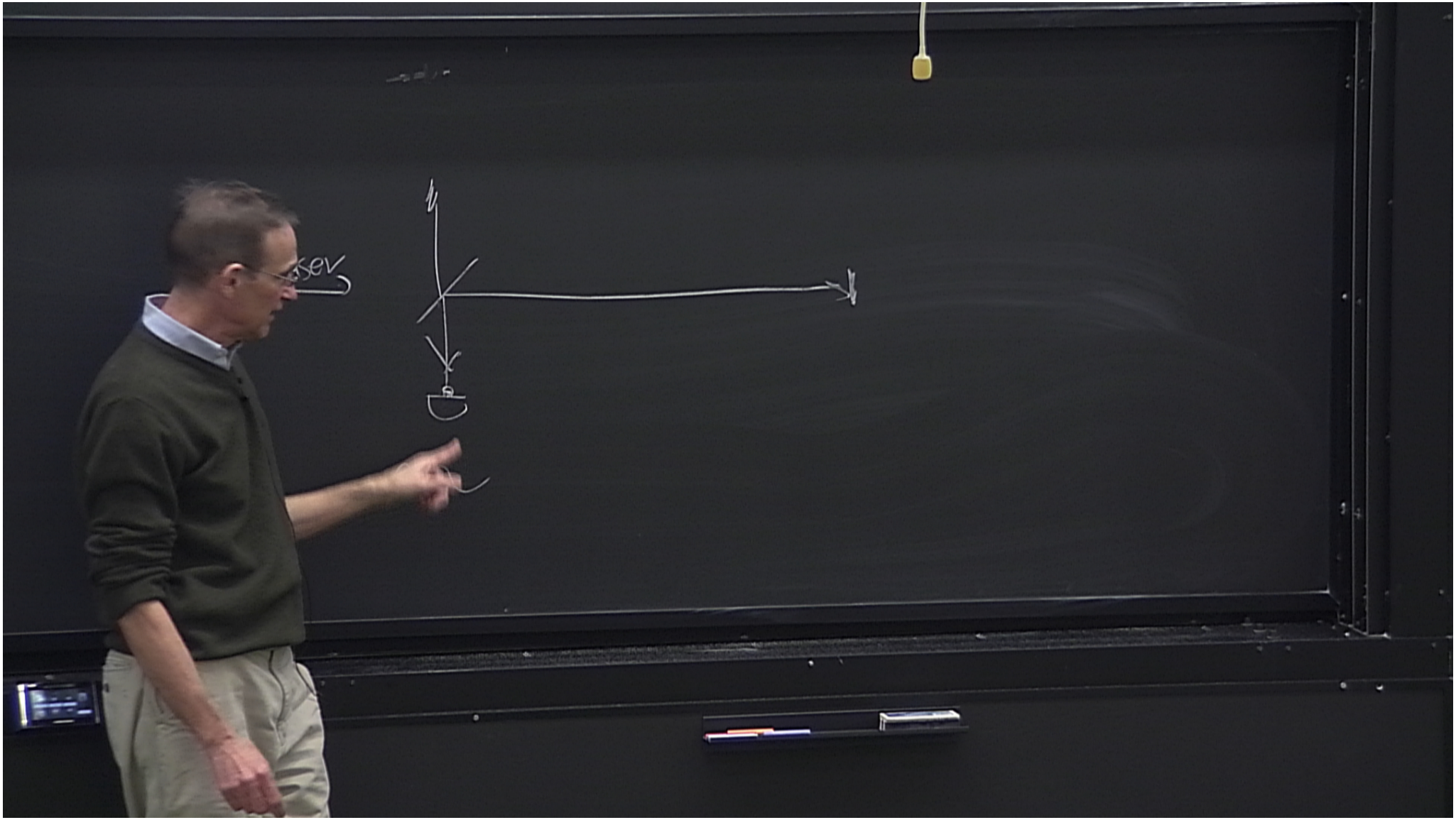

ρ = tr
U
ρ⊗
U†

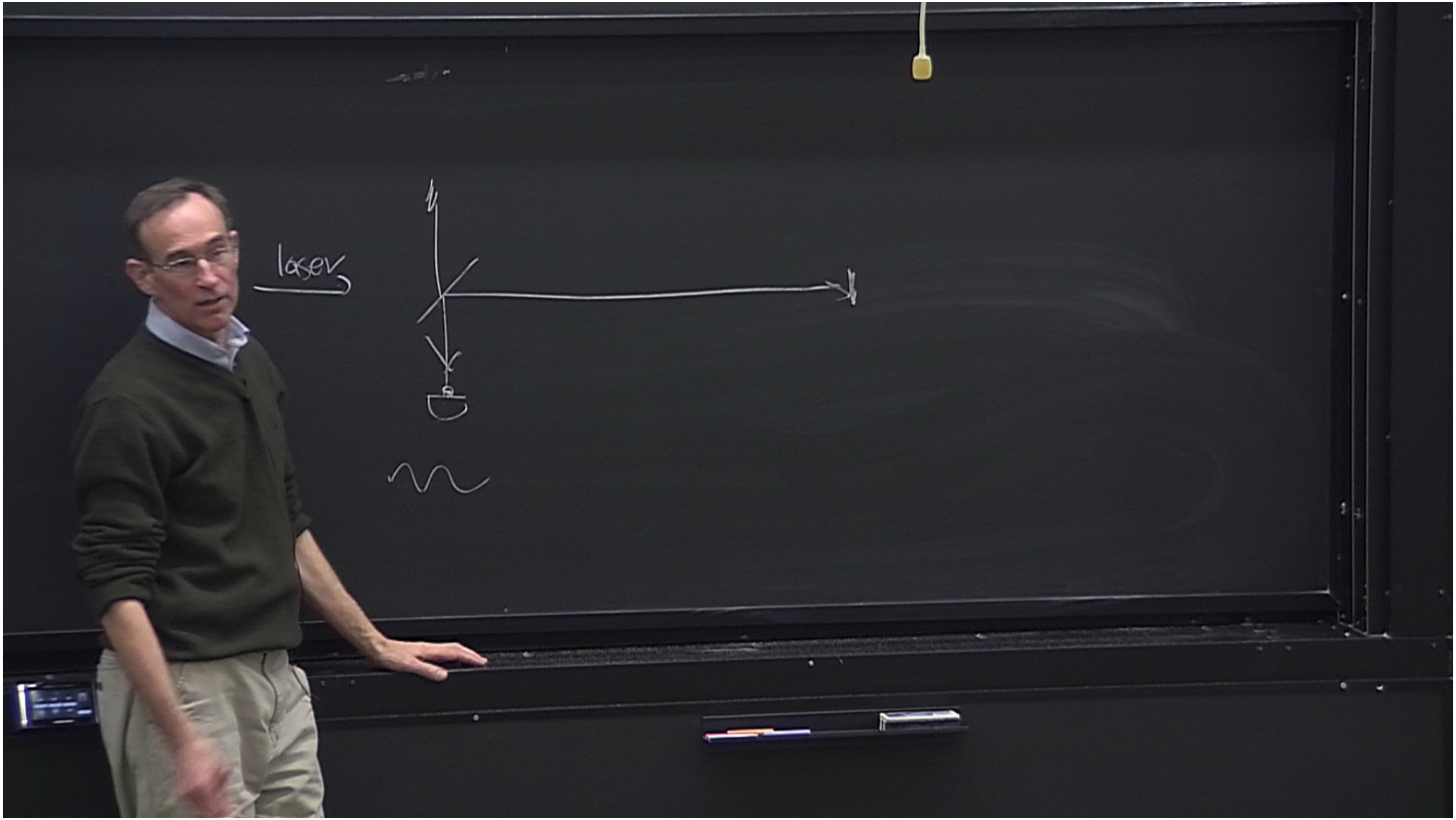

Eq : from ρ → to ρ, b/w 2 and 3

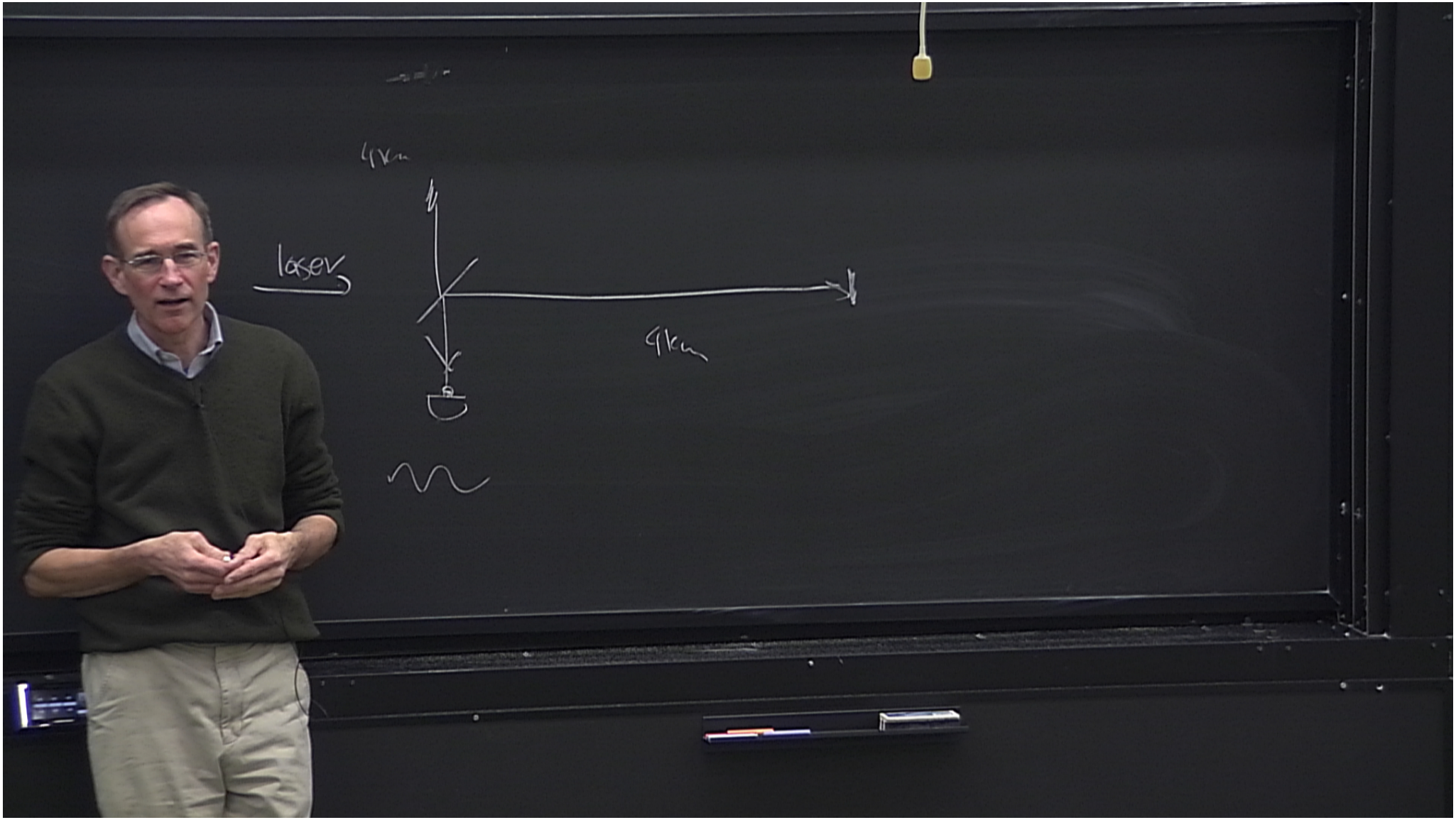

E_α : Initial → Final states
$\langle i_\ell | E^\dagger_\alpha E_\beta | j_\ell \rangle = \delta_{ij} C_{\alpha\beta}$

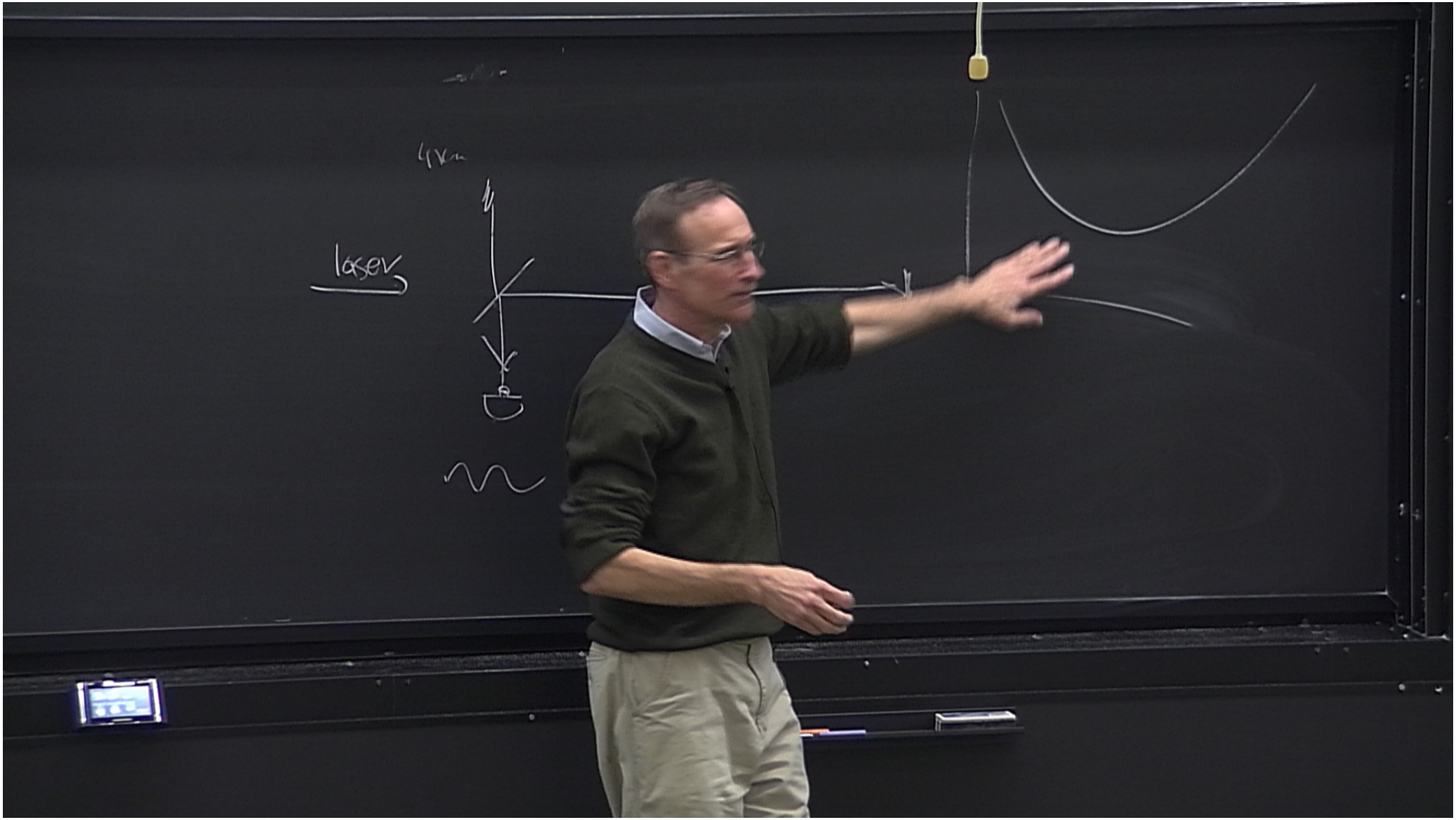

E_α :

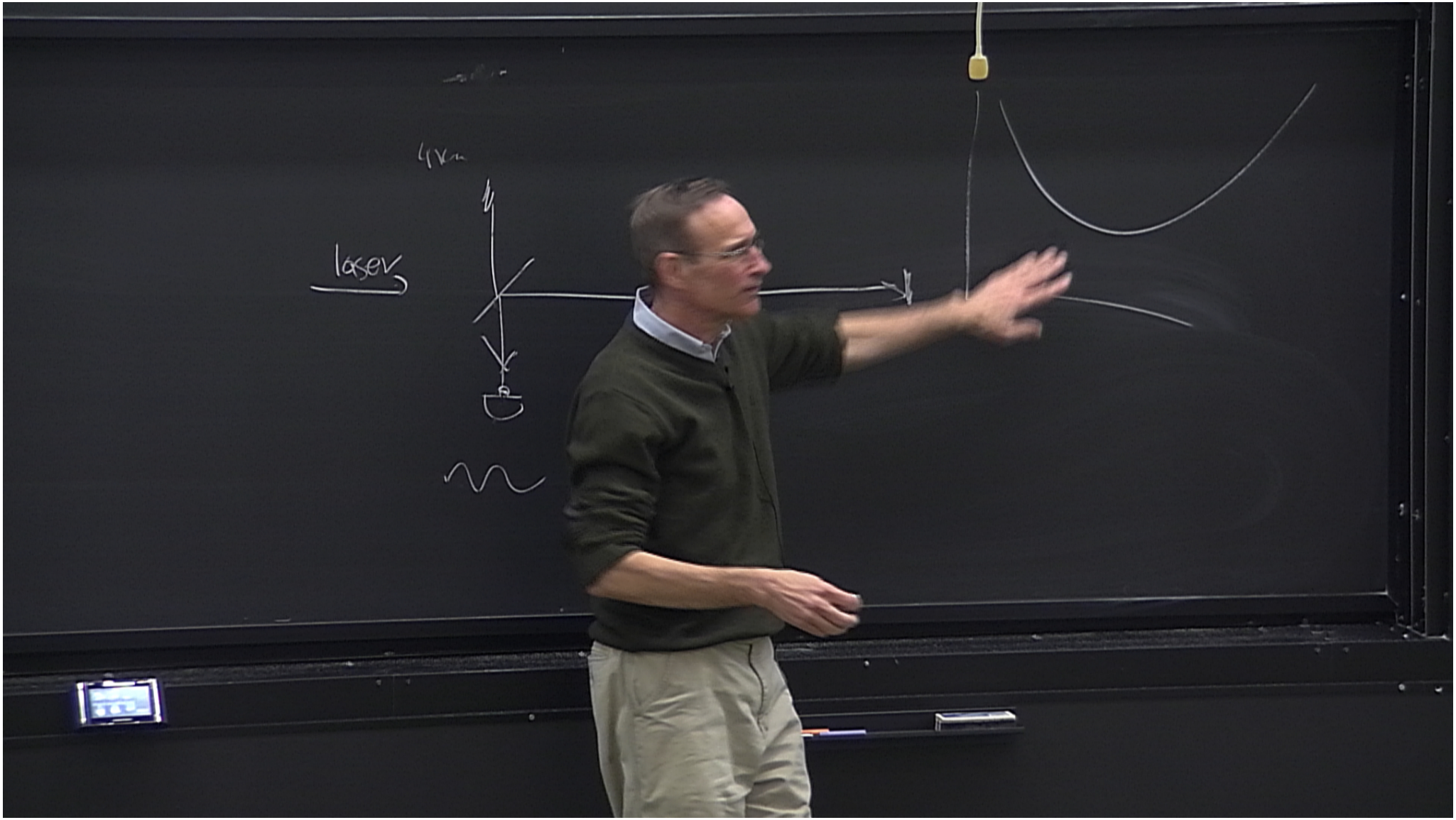

laser

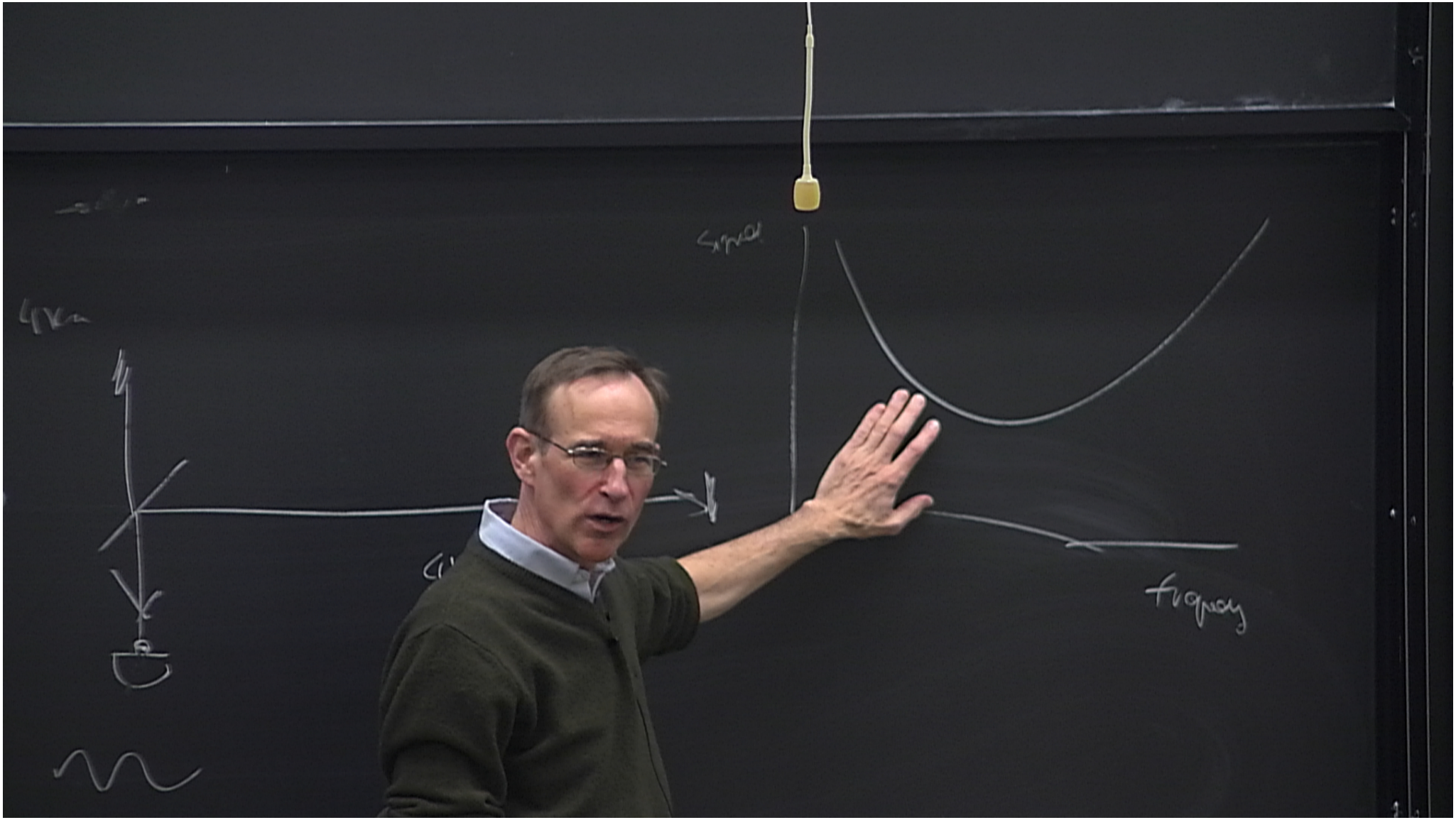


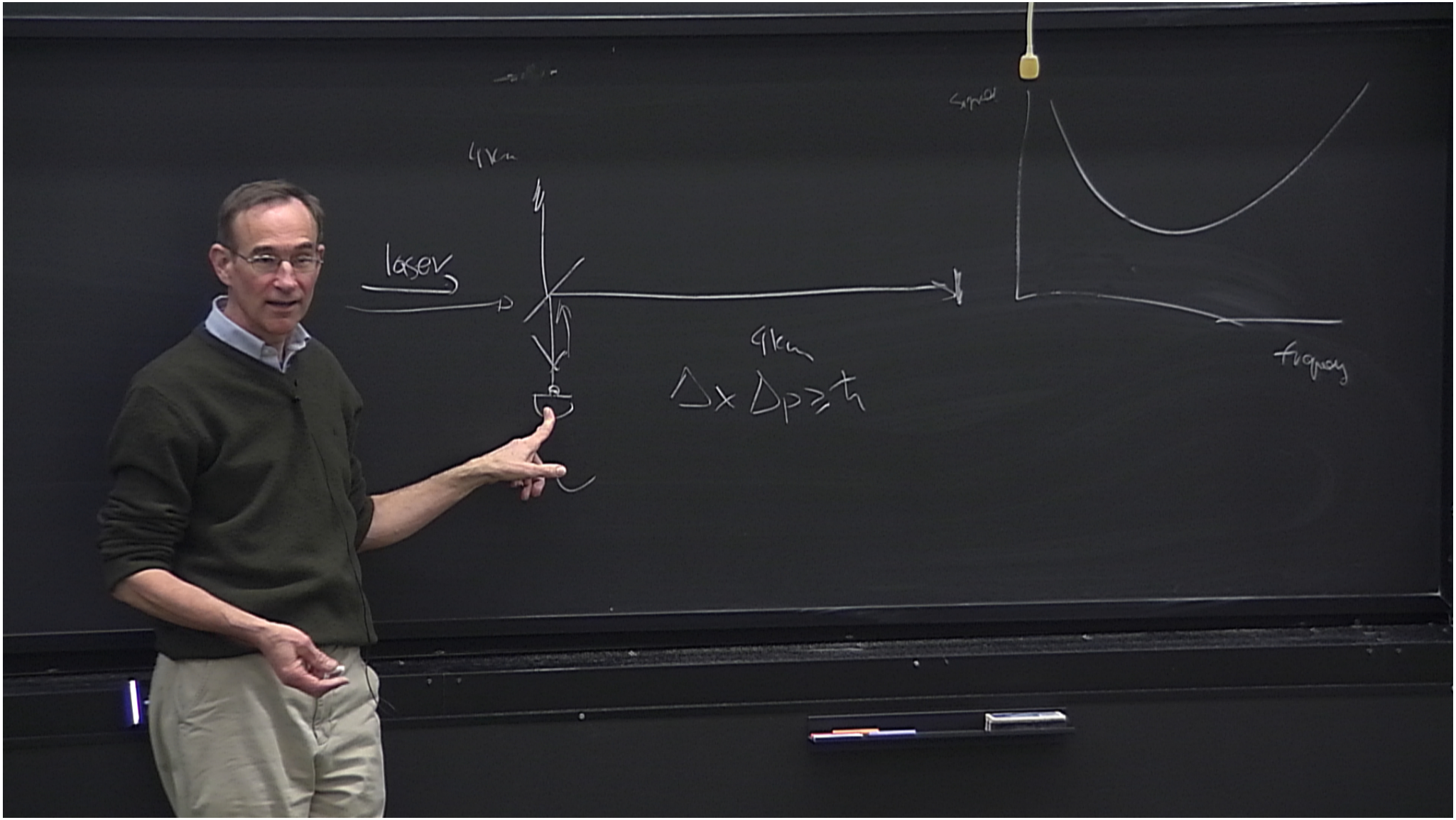

laser

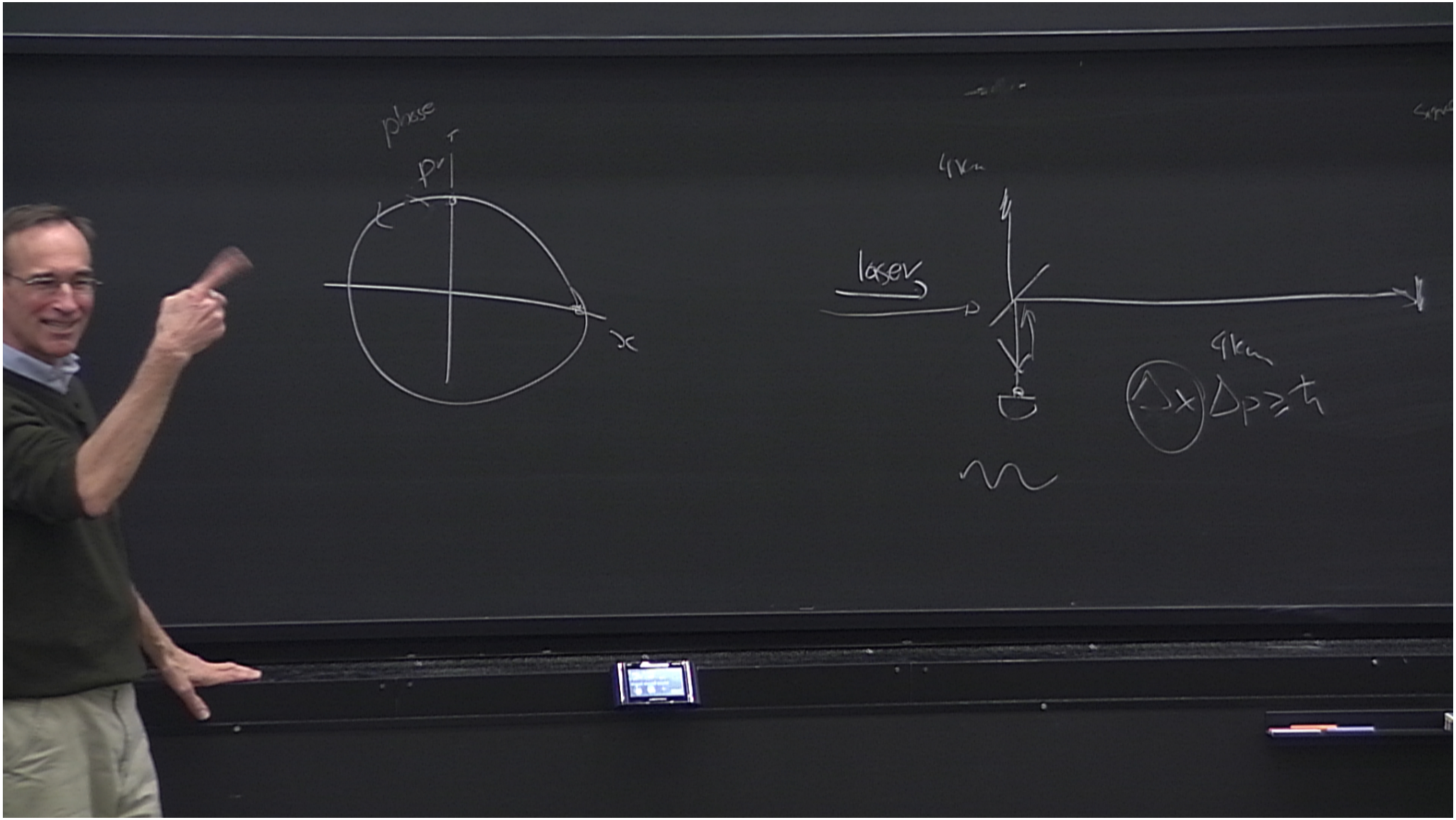

laser
4km
4km

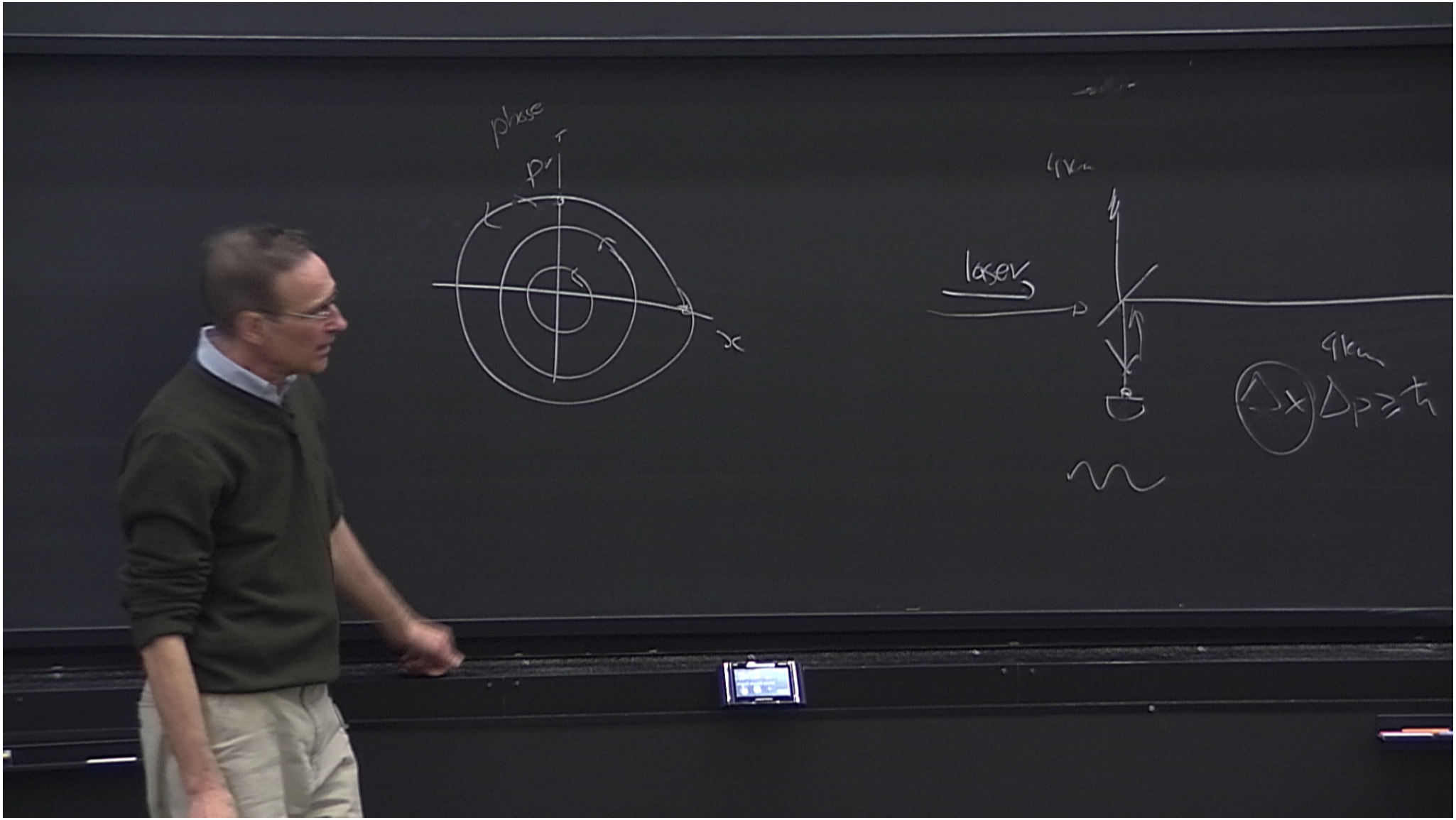

laser

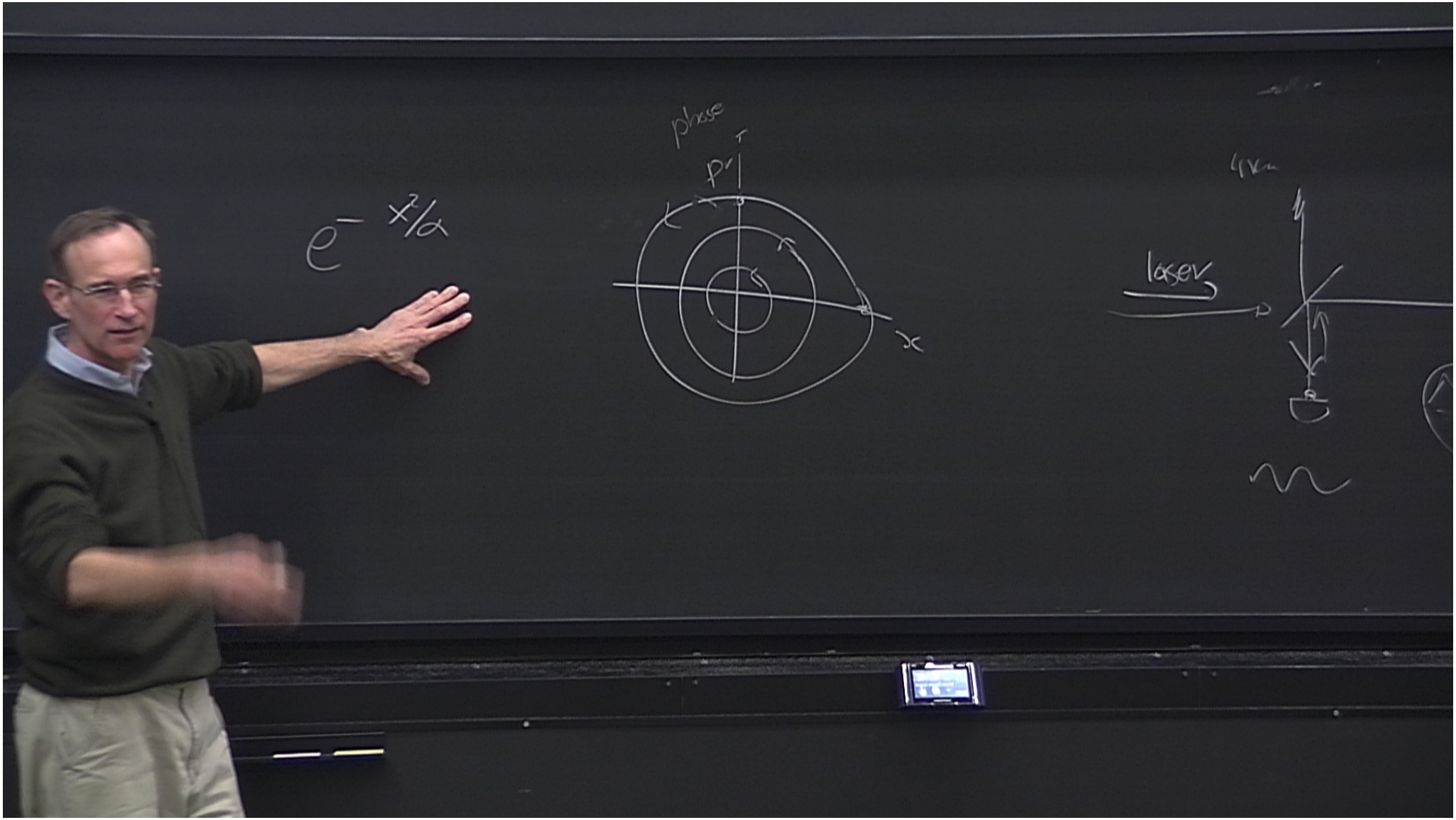

laser

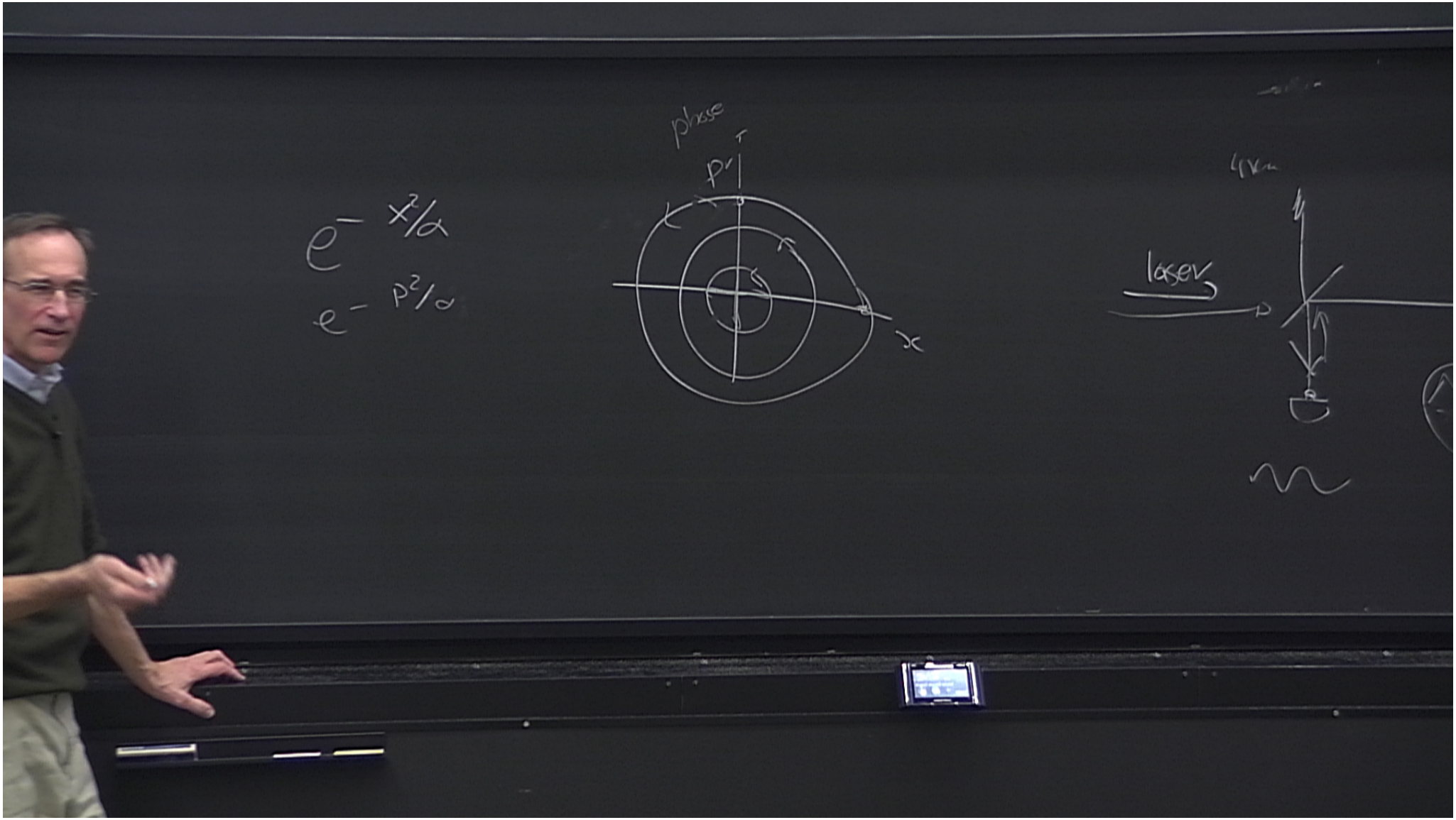

Signal
freq

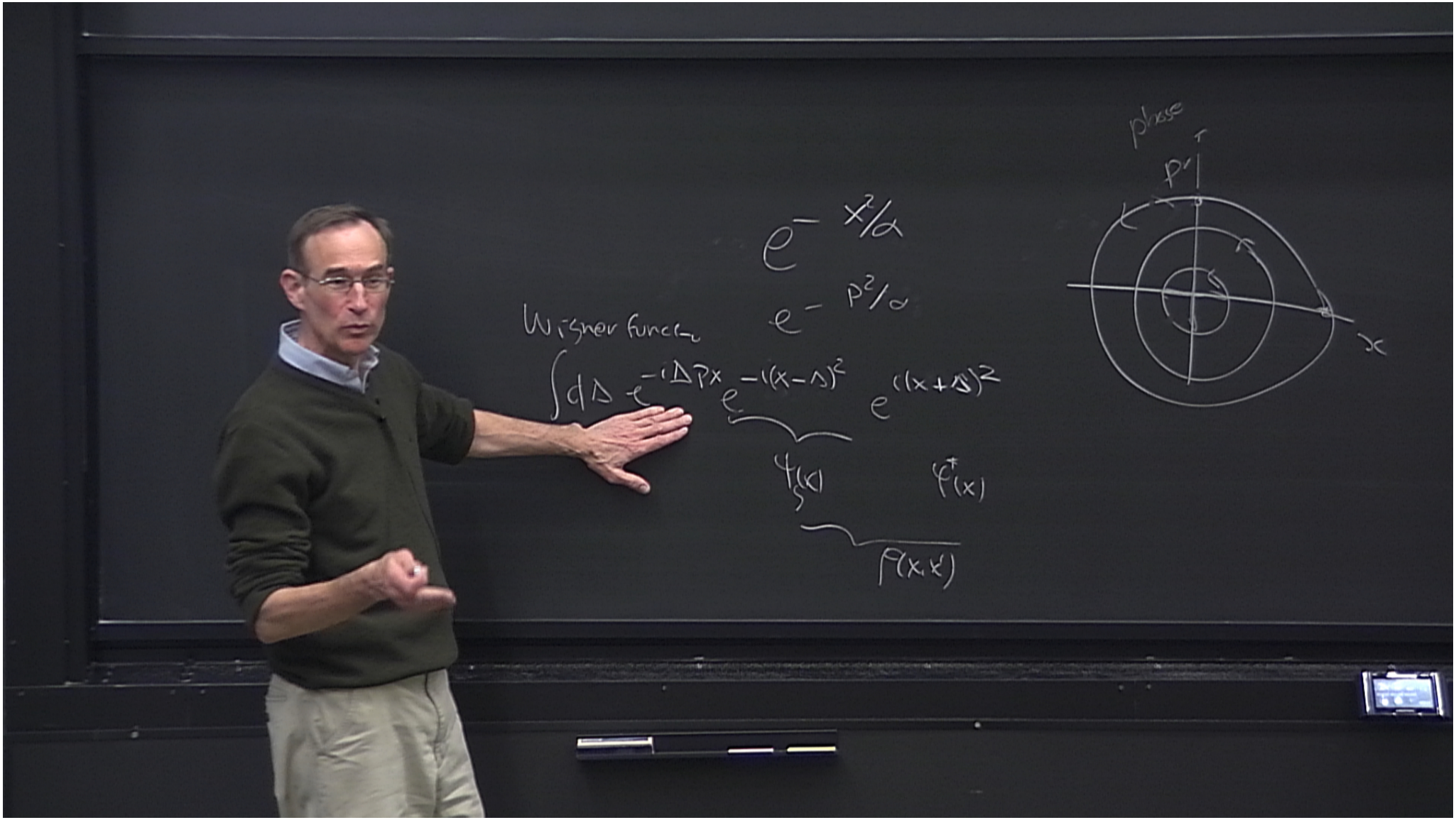

laser
4km
4km
Δx Δp ≥ ħ
frequency

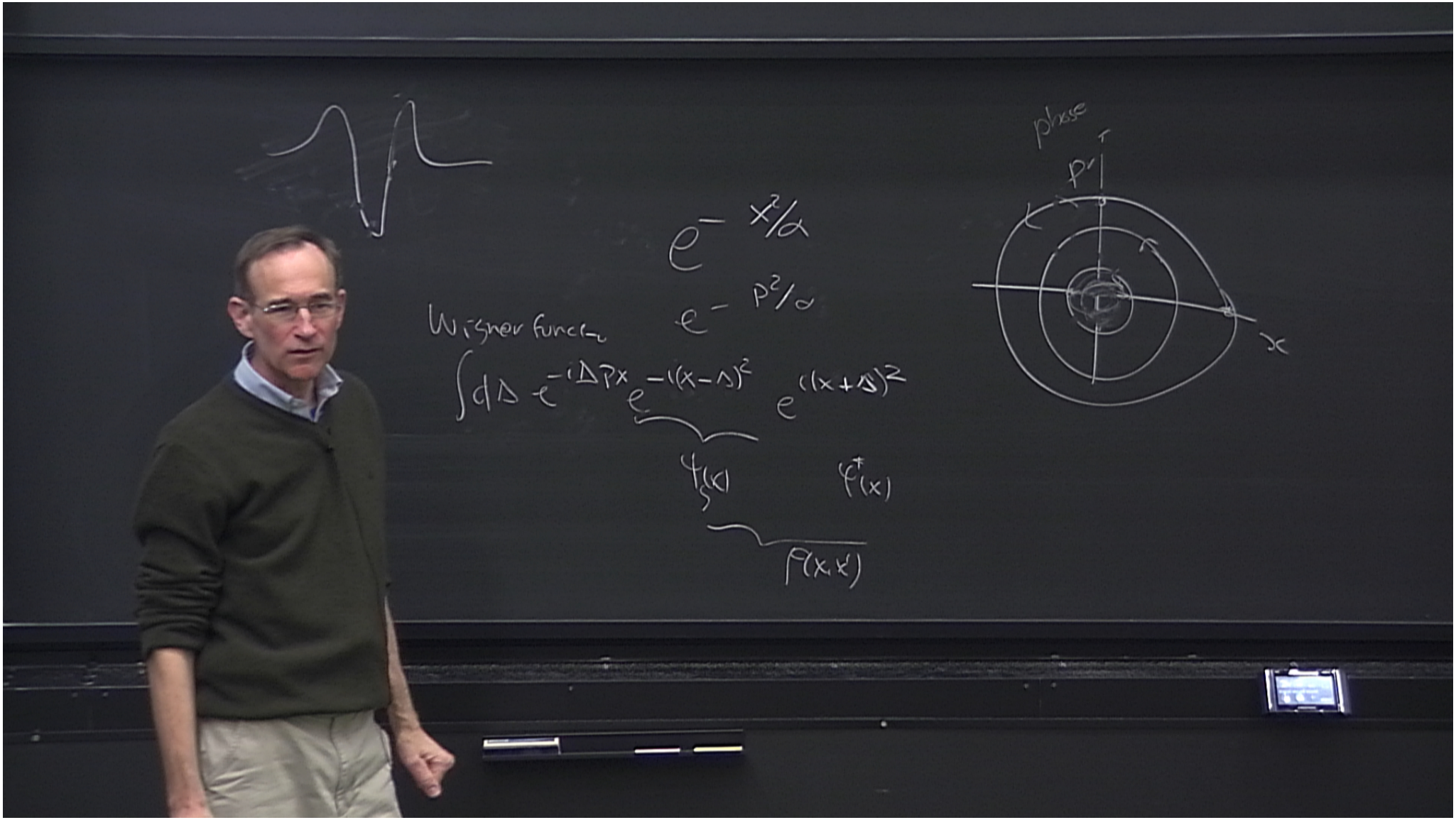

phase
p
x
laser
Δx Δp ≥ ħ

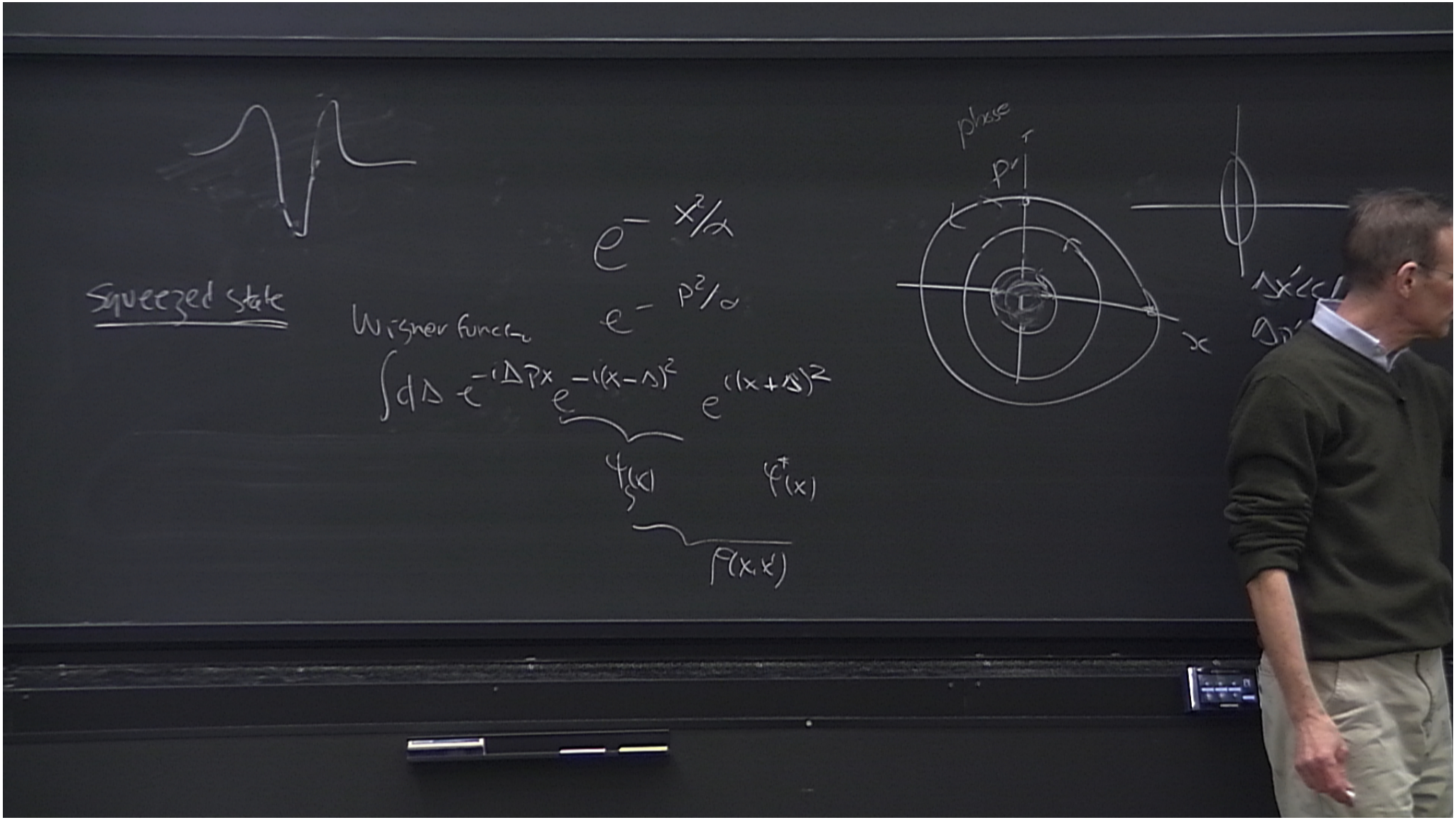

phase
p
x
laser
Δx Δp ≥ ħ

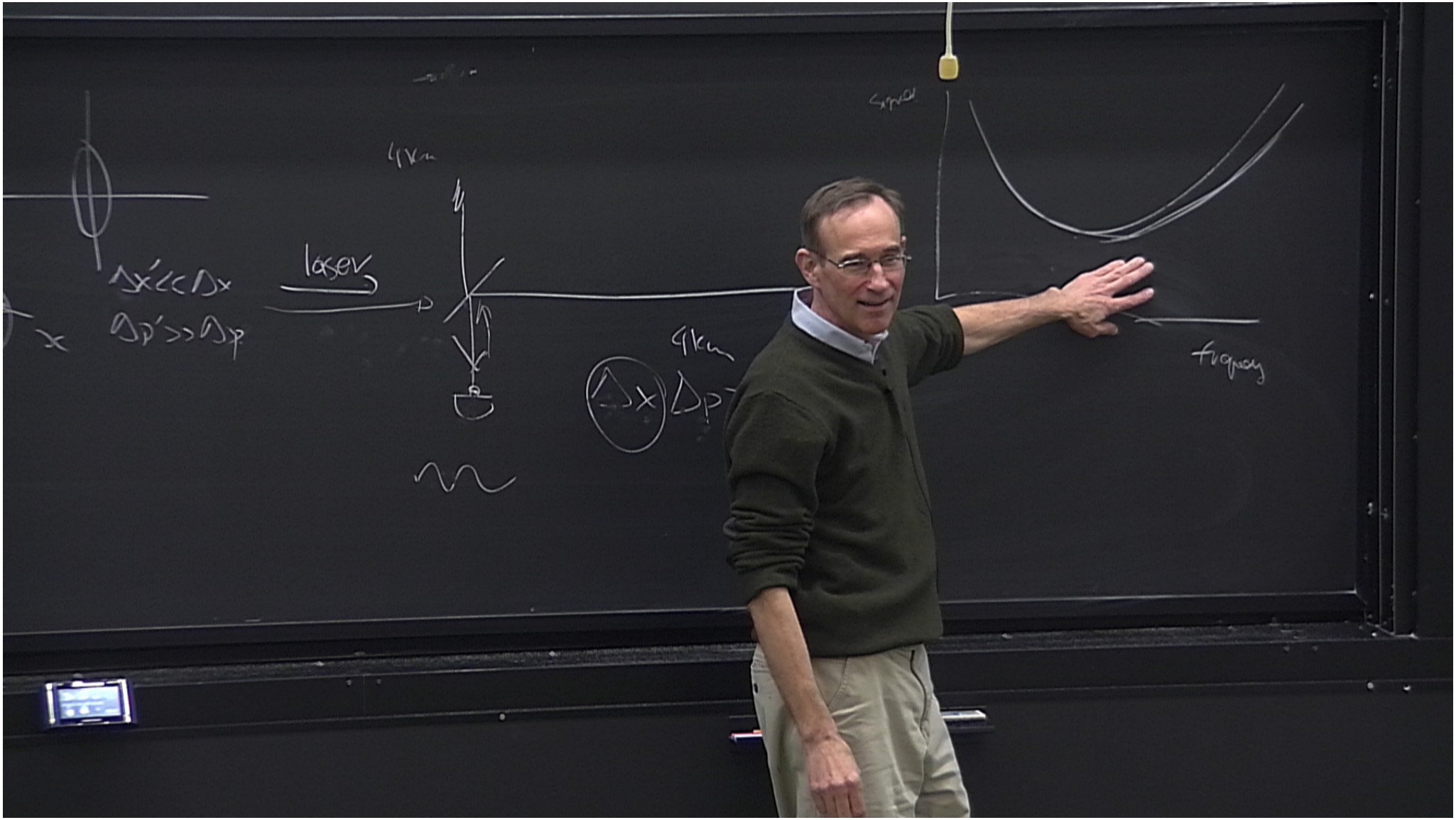

$e^{-x^2/a}$
phase
p
x
laser


$e^{-x^2/\alpha}$
$e^{-p^2/\alpha}$
phase
p
x
laser


Wigner funct
$e^{-x^2/\alpha}$
$e^{-p^2/\alpha}$
$\int d\Delta\, e^{-i\Delta p x}\, e^{-\alpha(x-\Delta)^2}\, e^{\alpha(x+\Delta)^2}$
$\psi(x)$
$\psi^*(x)$
$\rho(x,x')$
phase
p
x


phase
p
x
Wigner function
$e^{-x^2/\sigma}$
$e^{-p^2/\sigma}$
$\int d\Delta\, e^{-i\Delta p x} e^{-(x-\Delta)^2} e^{(x+\Delta)^2}$
$\psi(x)$
$\psi^*(x)$
$\rho(x,x')$


Squeezed state
Wigner function
$e^{-x^2/\alpha}$
$e^{-p^2/\alpha}$
$\int d\Delta\, e^{-i\Delta p x} e^{-(x-\Delta)^2} e^{(x+\Delta)^2}$
$\psi(x)$
$\psi^*(x)$
$\rho(x,x')$
phase
p
x


laser
frequency