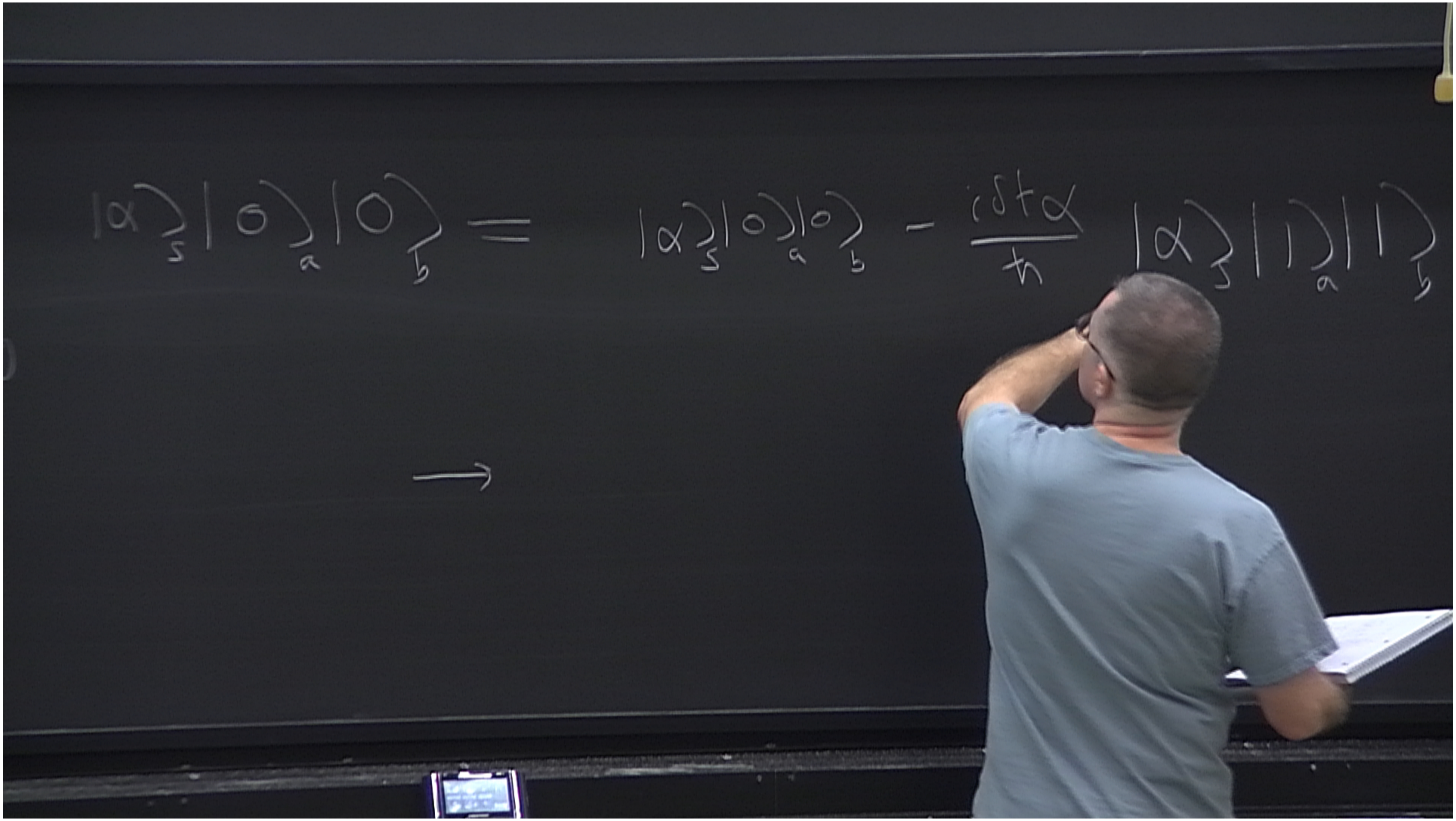
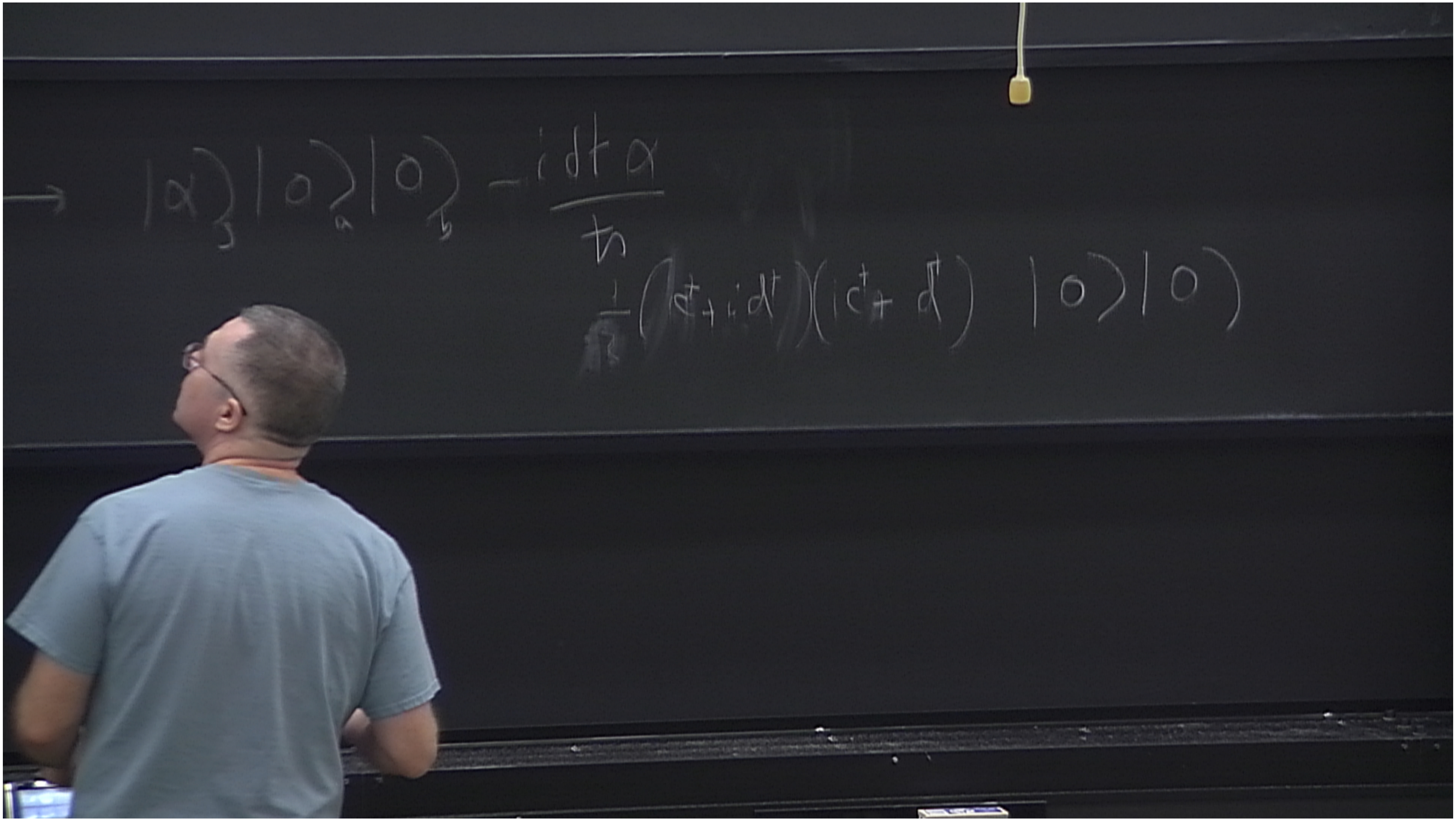
Title: PSI 2015/2016 Foundations of Quantum Mechanics - Lecture 4

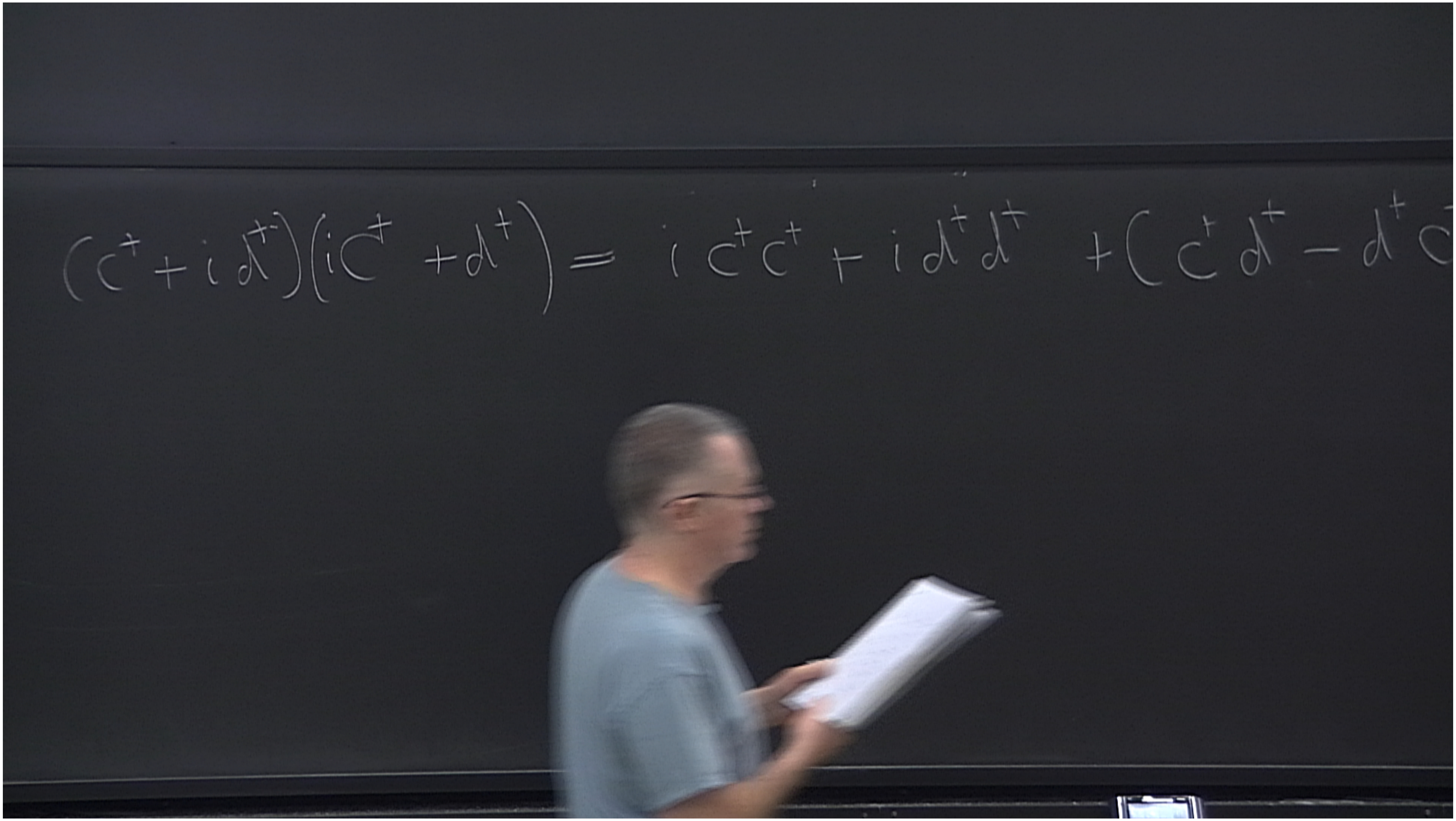
Date: Jan 07, 2016 11:30 AM

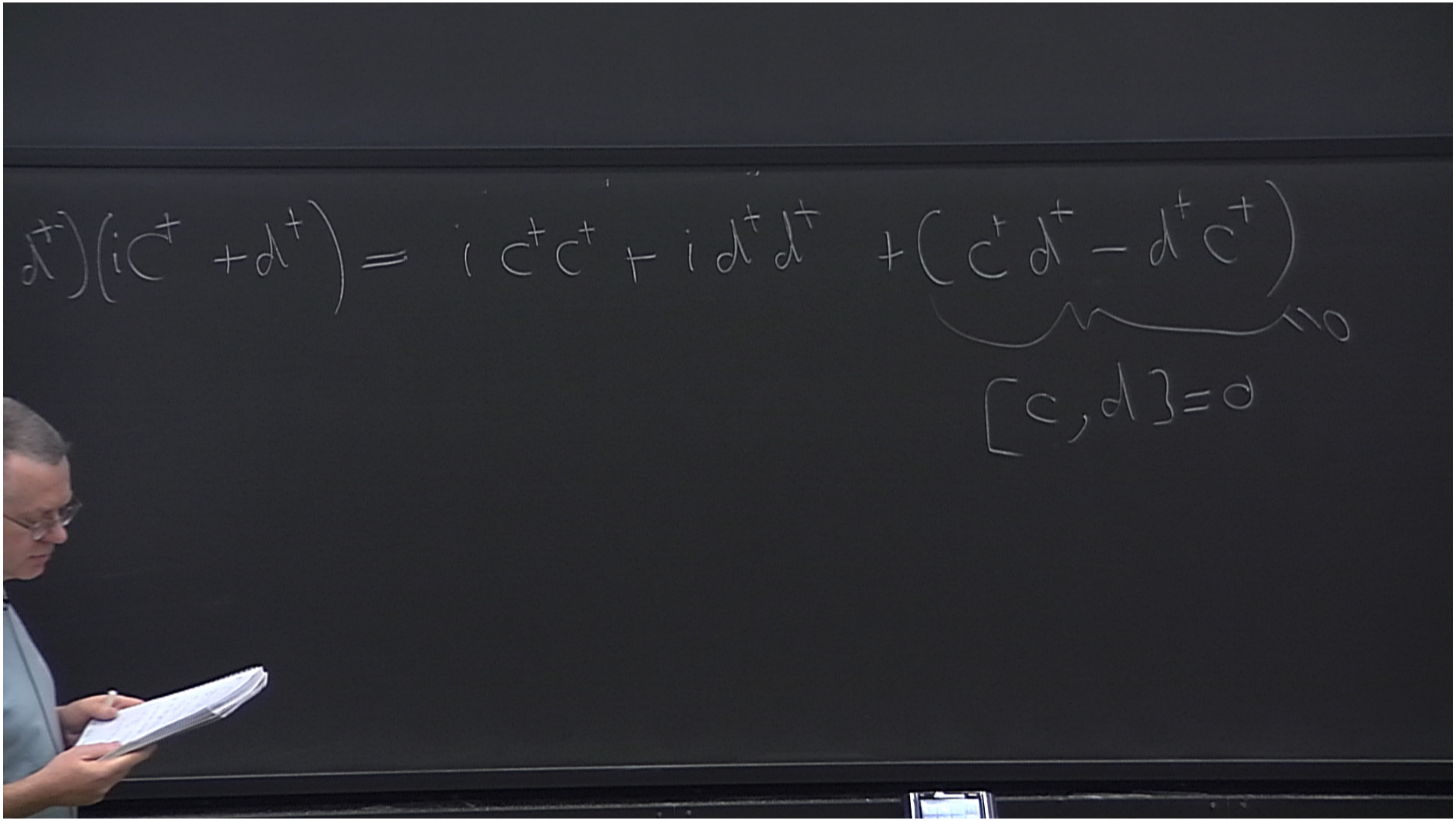
URL: http://pirsa.org/16010057

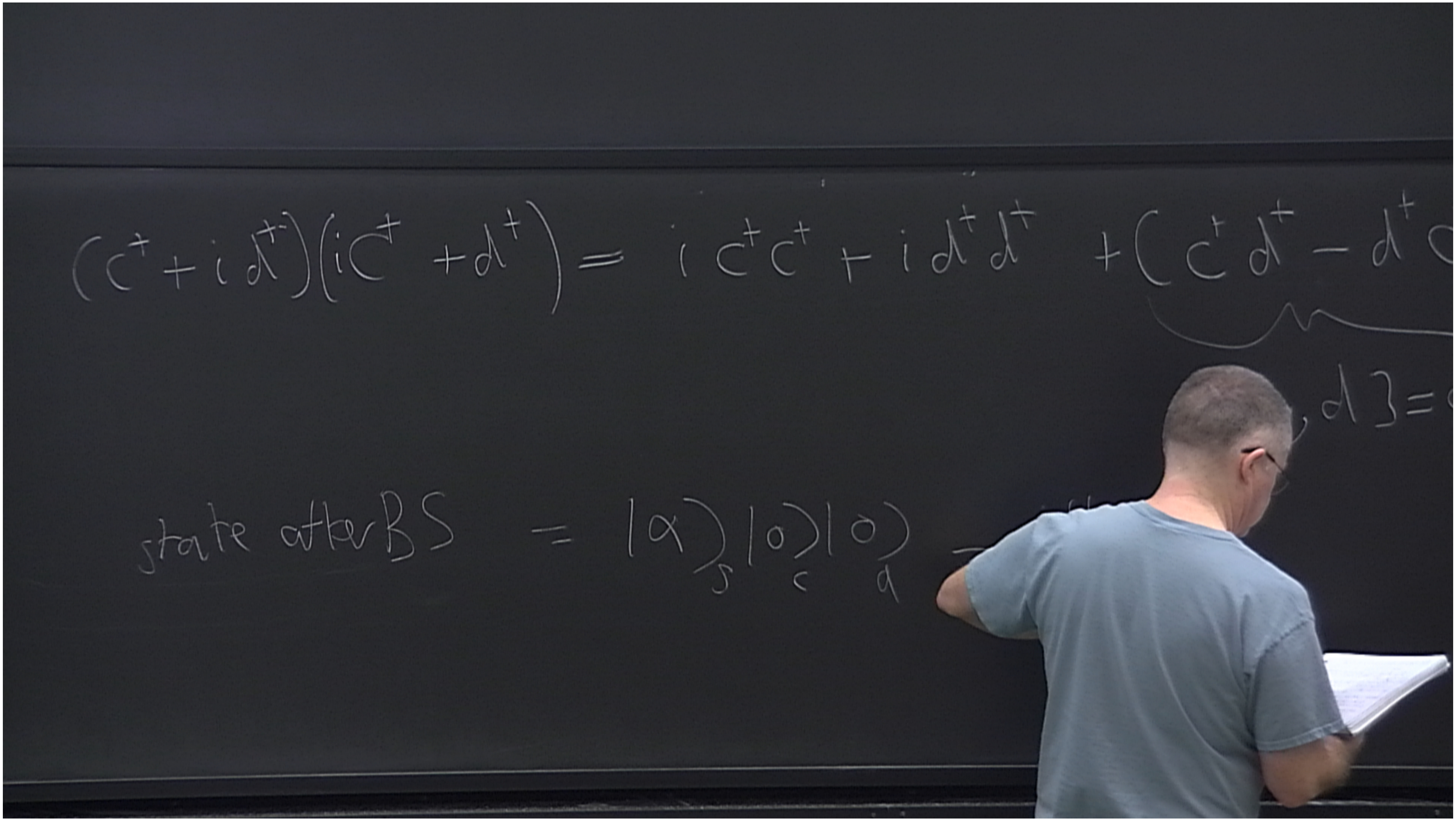
Abstract:

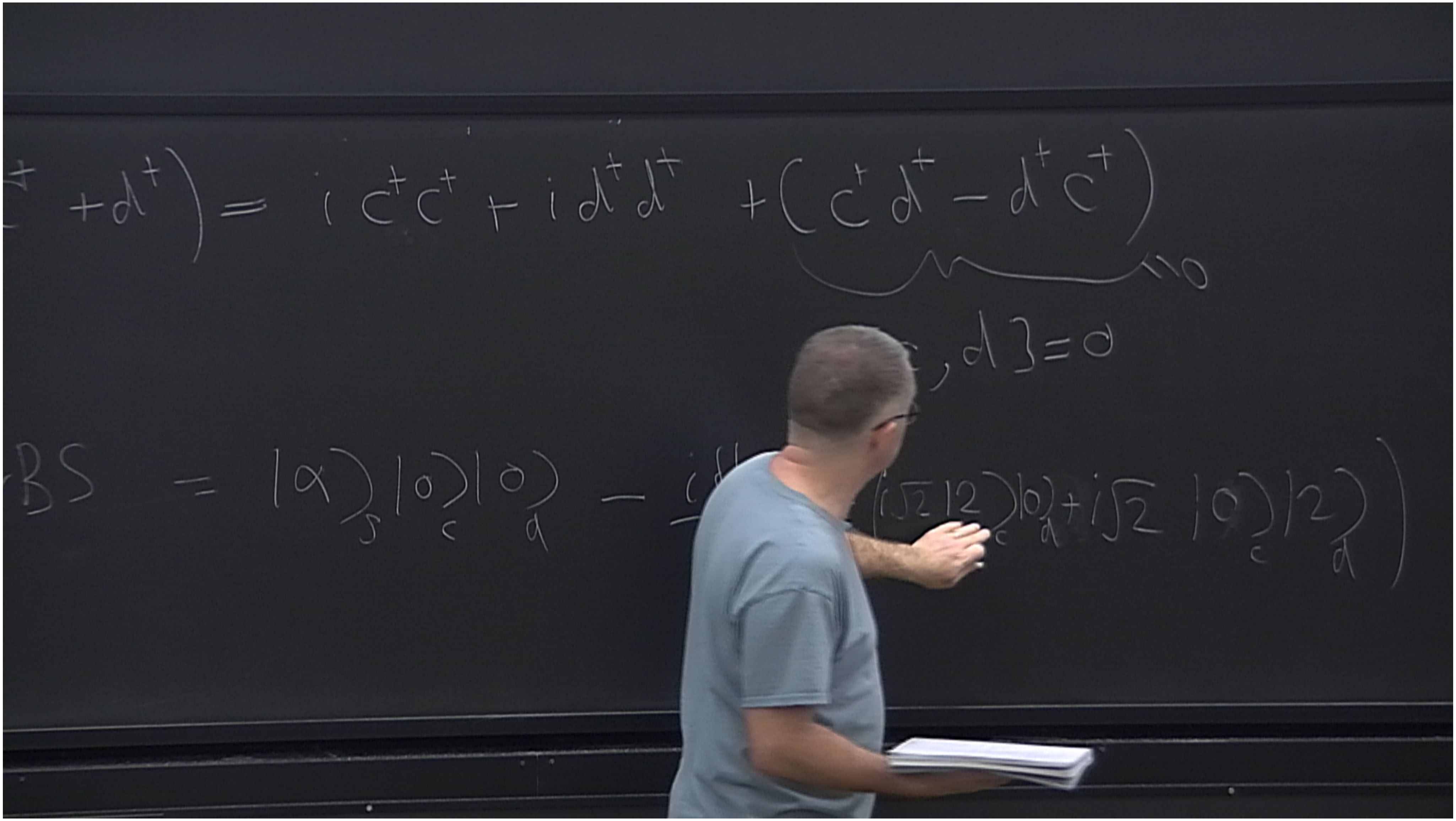

$|\alpha\rangle_s|0\rangle_a|0\rangle_b = |\alpha\rangle_s|0\rangle_a|0\rangle_b - \frac{i\delta t\alpha}{\hbar}|\alpha\rangle_s|1\rangle_a|1\rangle_b$
$\longrightarrow$


→ |α⟩_s |0⟩_a |0⟩_b − i dt α / ħ

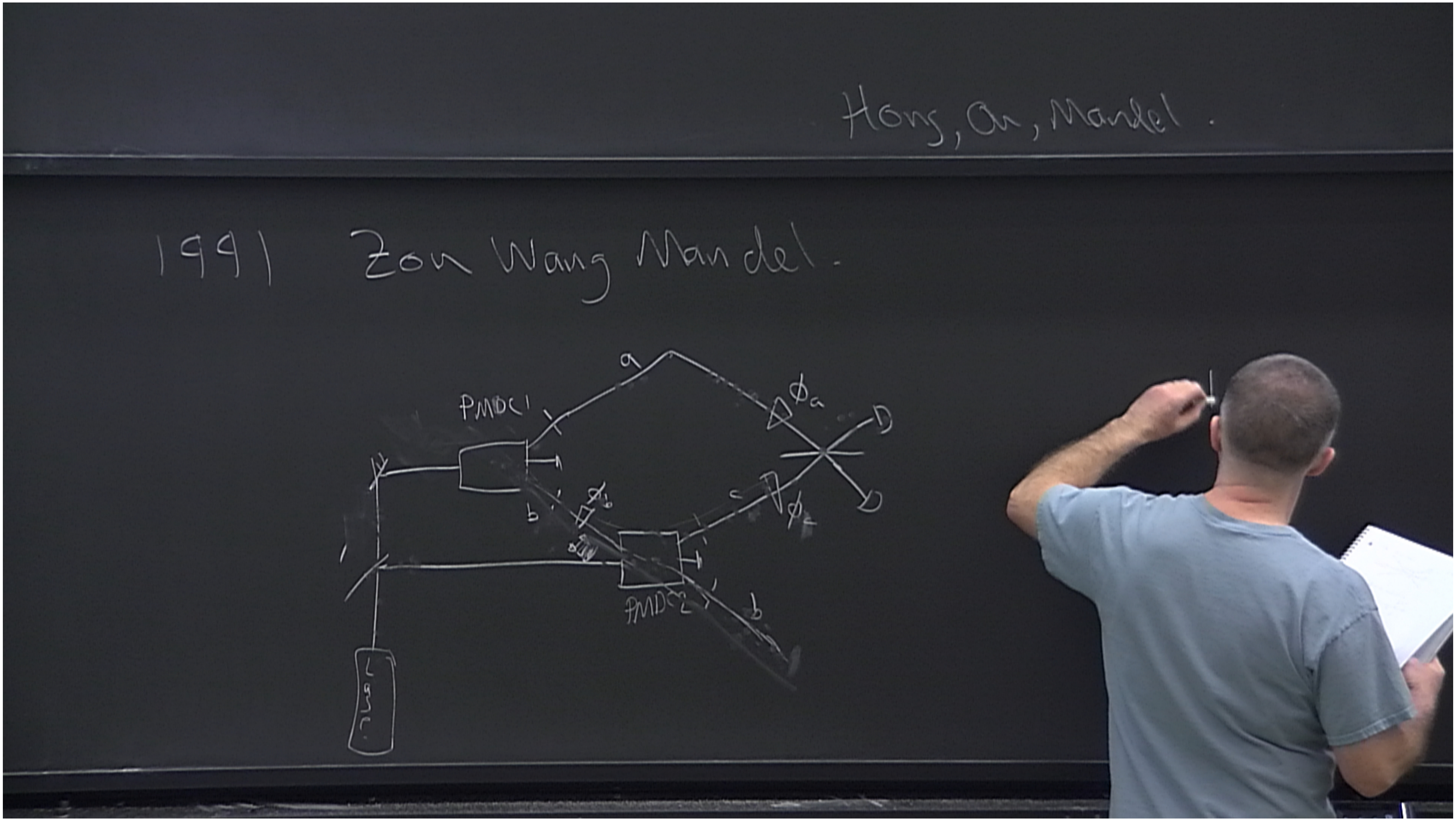

$(c^\dagger + i d^\dagger)(i c^\dagger + d^\dagger) = i c^\dagger c^\dagger + i d^\dagger d^\dagger + (c^\dagger d^\dagger - d^\dagger c$

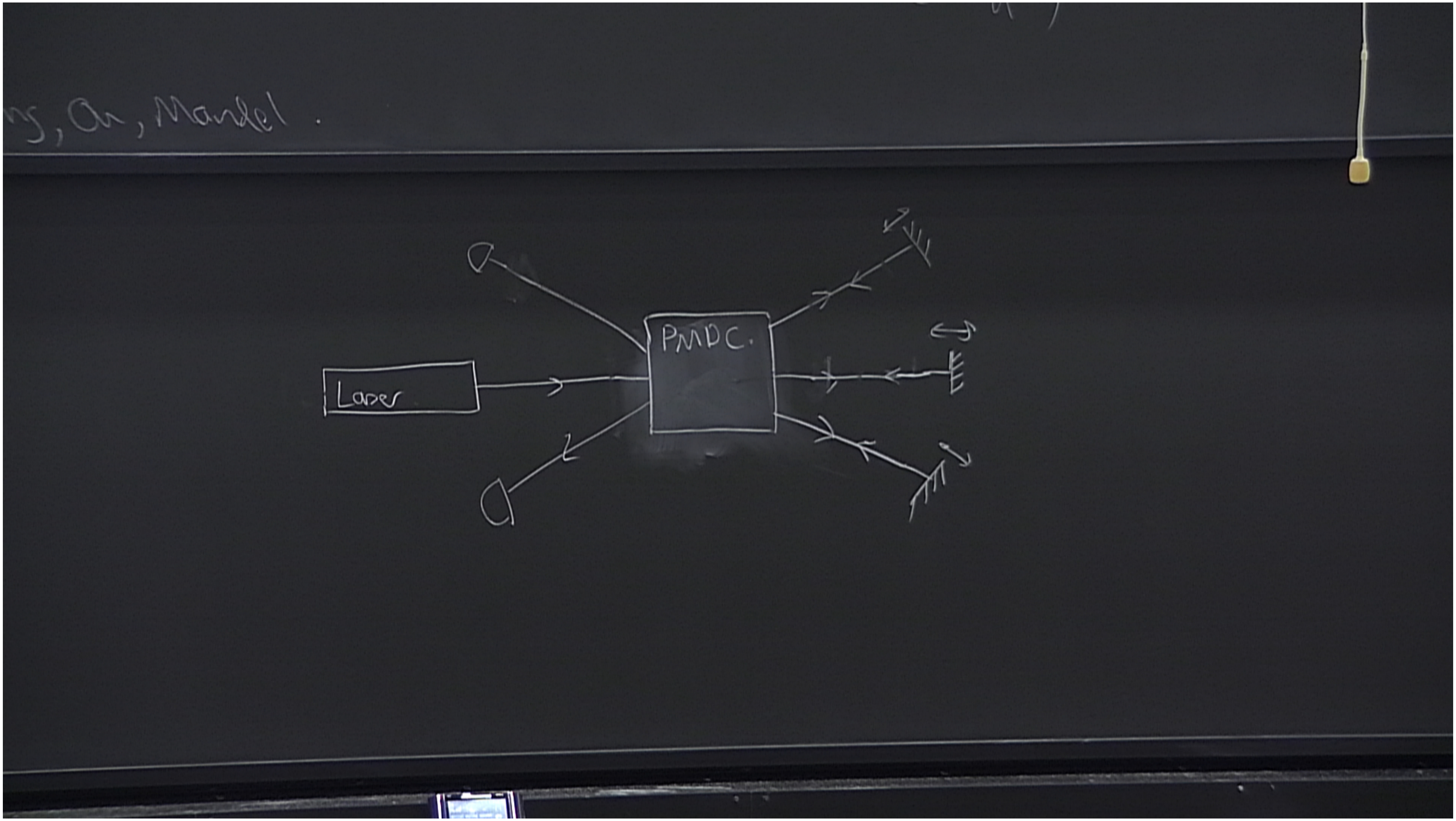

$d^\dagger)(i c^\dagger + d^\dagger) = i c^\dagger c^\dagger + i d^\dagger d^\dagger + \underbrace{(c^\dagger d^\dagger - d^\dagger c^\dagger)}_{=0}$
$[c, d] = 0$


$(c^\dagger + i d^\dagger)(i c^\dagger + d^\dagger) = i c^\dagger c^\dagger + i d^\dagger d^\dagger + (c^\dagger d^\dagger - d^\dagger$
state after BS $= |\alpha\rangle_s |0\rangle_c |0\rangle_d$

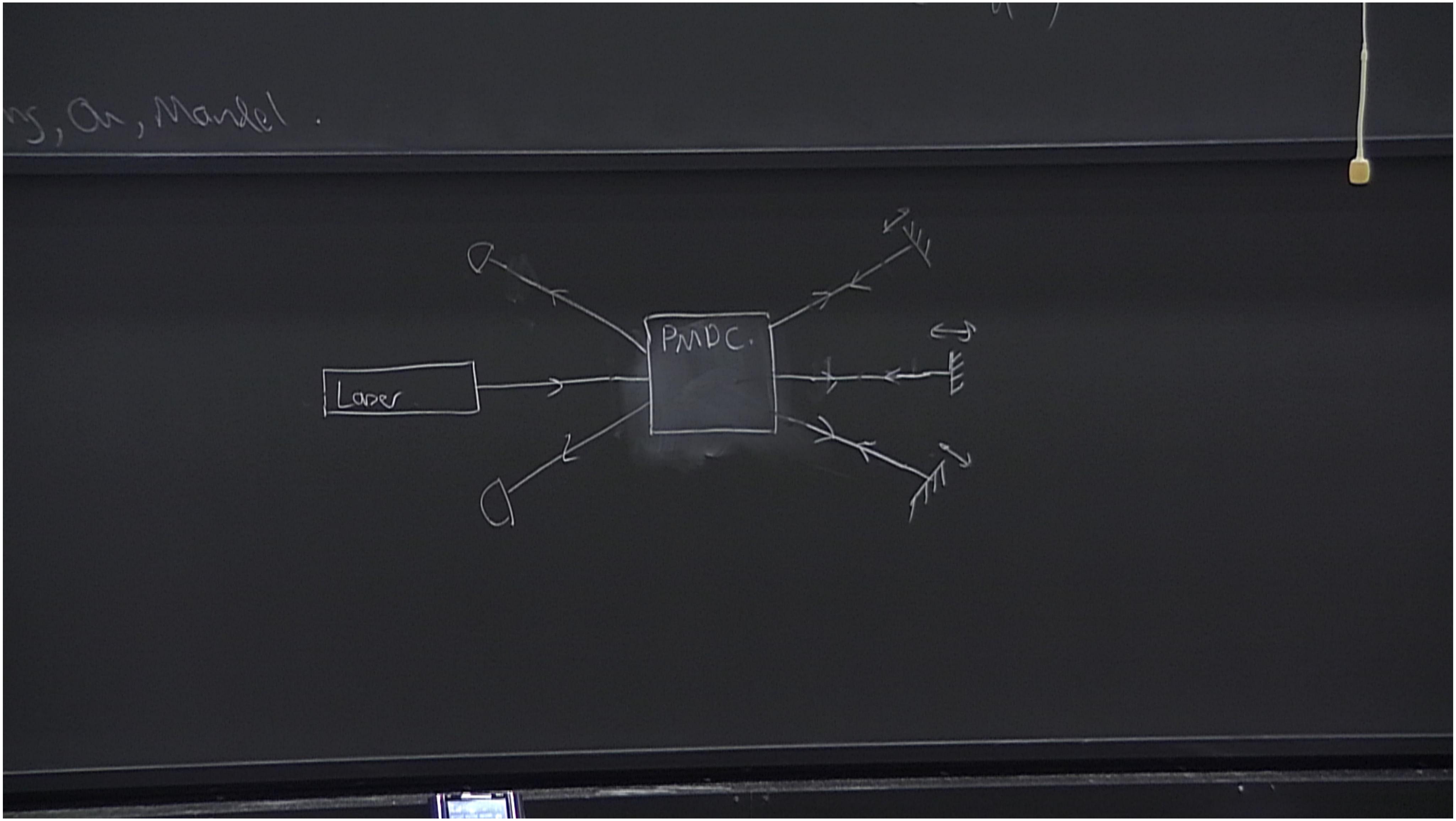


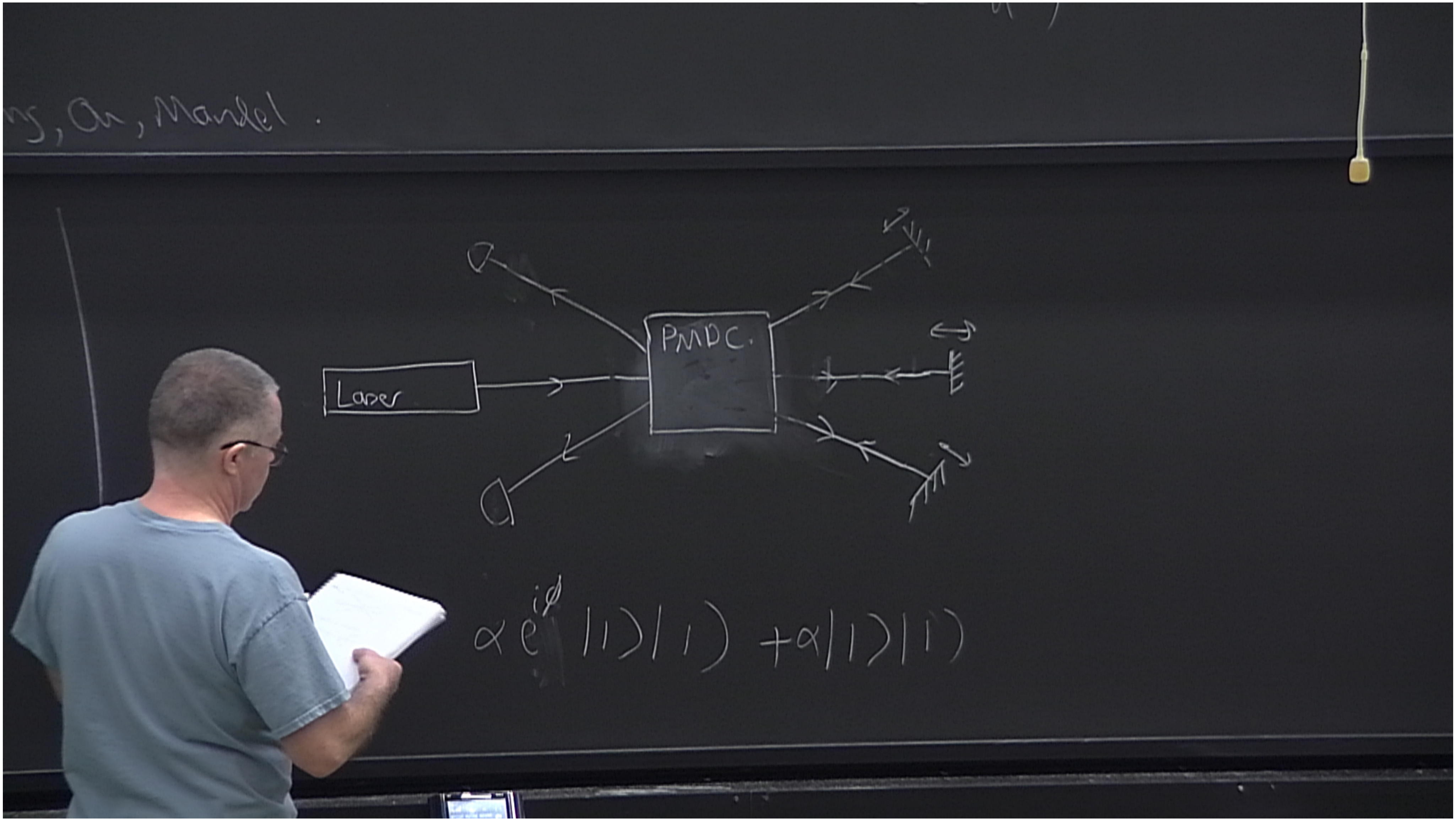
+d⁺) = i c⁺c⁺ + i d⁺d⁺ + (c⁺d⁺ − d⁺c⁺)
= 0
, d} = 0
BS = |α⟩_s |0⟩_c |0⟩_d

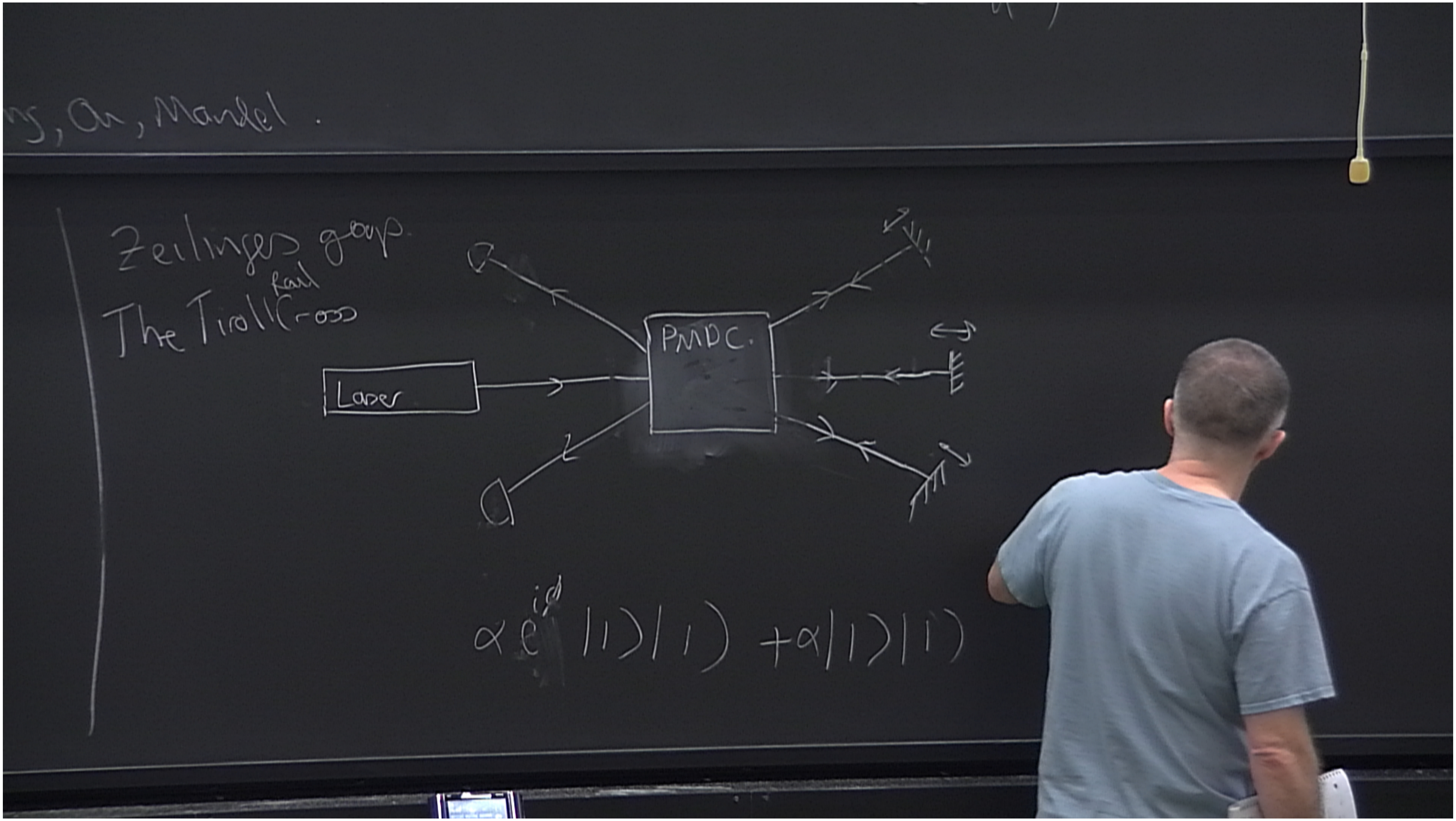

Hong, Ou, Mandel.
1991 Zou Wang Mandel.
a
PMDC1
ϕ_a
ϕ_b
b
ϕ_c
D
D
PMDC2
b



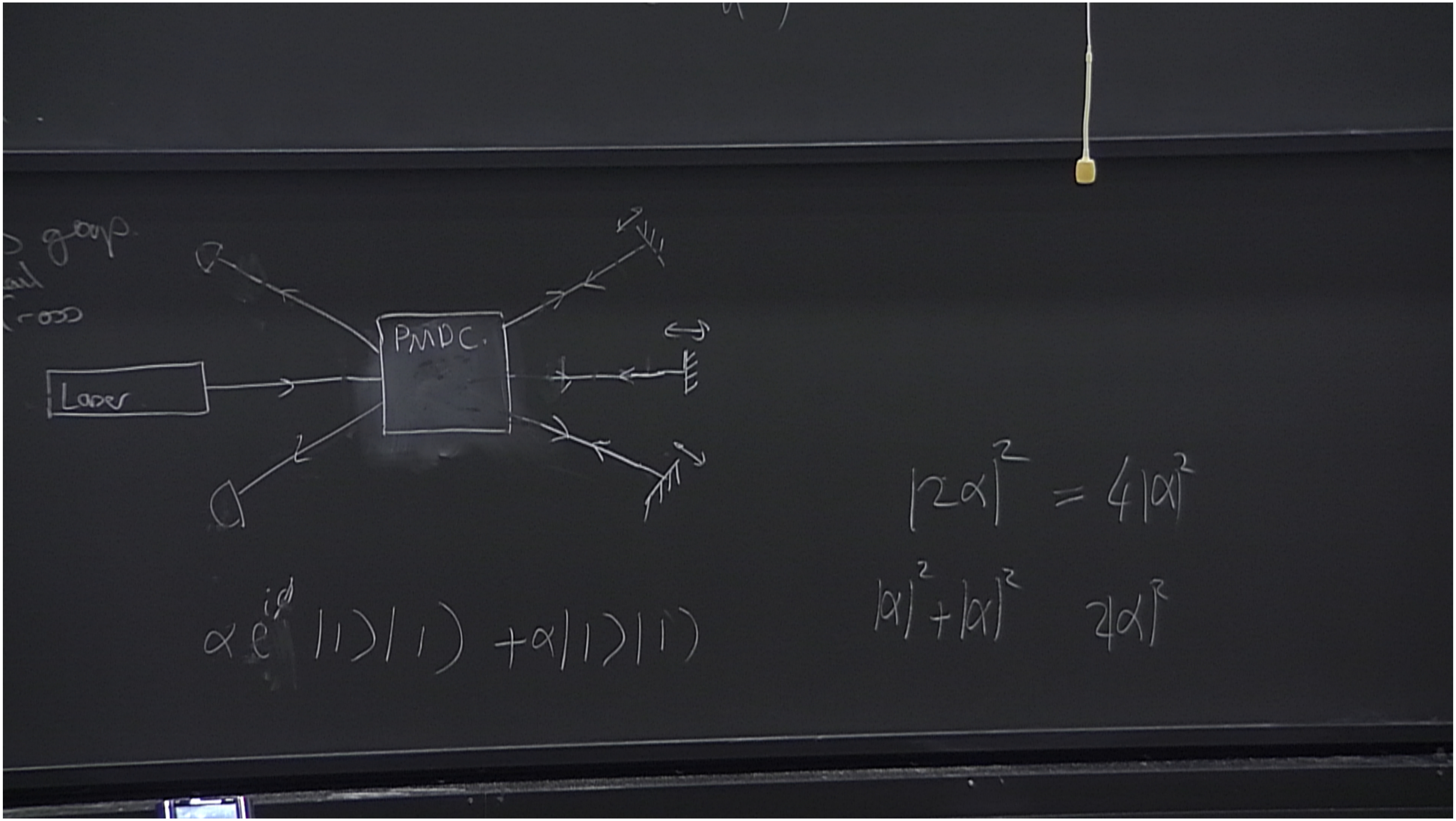
ng, Ou, Mandel .
PMDC.
Laser

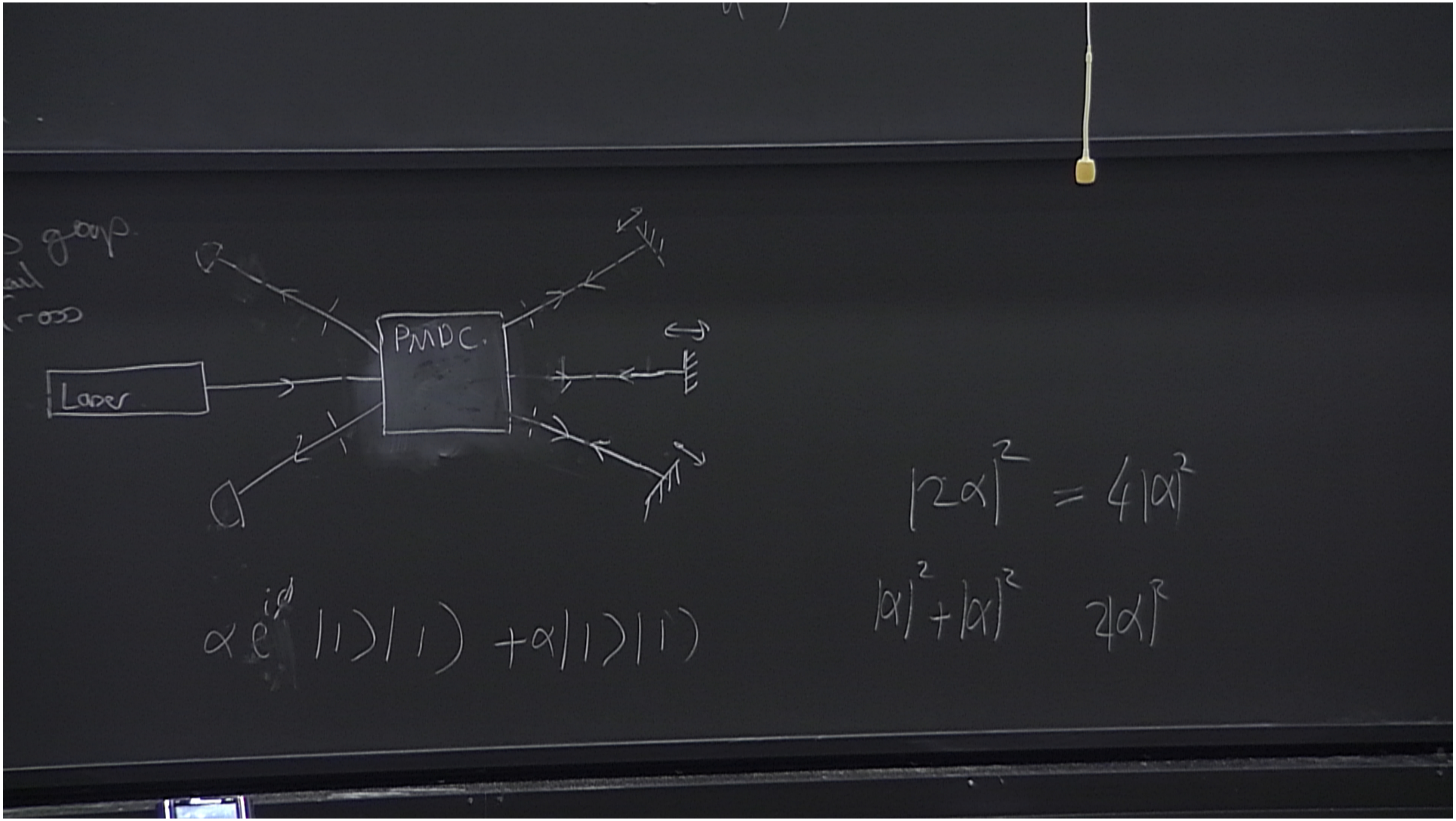

ng, Ou, Mandel .
Laser
PMDC.


Ou, Mandel
Laser
PMDC.
$\alpha e^{i\phi}|1\rangle|1\rangle + \alpha|1\rangle|1\rangle$



Zeilingers group.
The Tiroll Cross
Laser
PMDC.

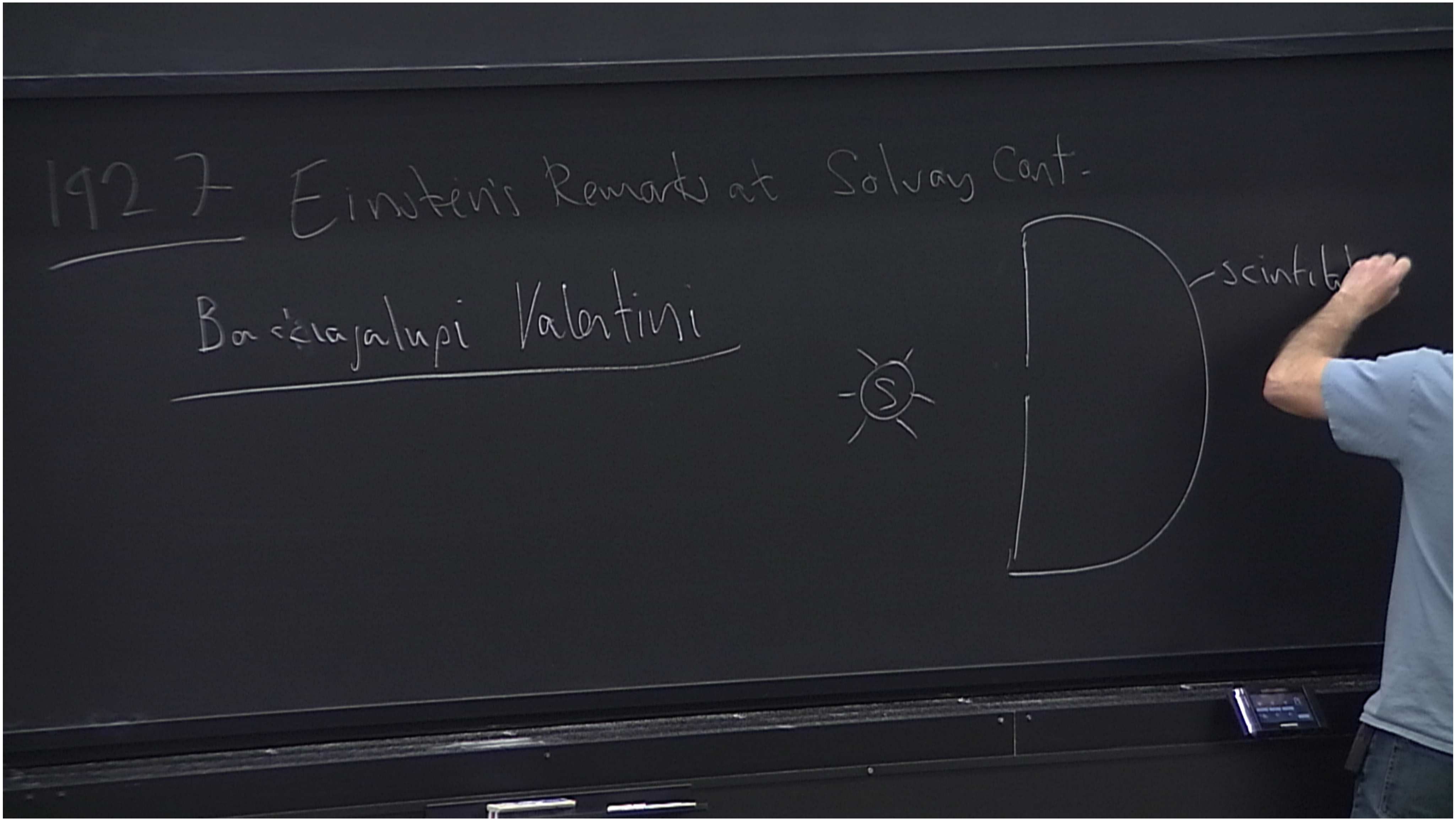

Laser
PMDC.
$\alpha e^{i\phi}|1\rangle|1\rangle + \alpha|1\rangle|1\rangle$
$|2\alpha|^2 = 4|\alpha|^2$
$|\alpha|^2 + |\alpha|^2$
$2|\alpha|^2$

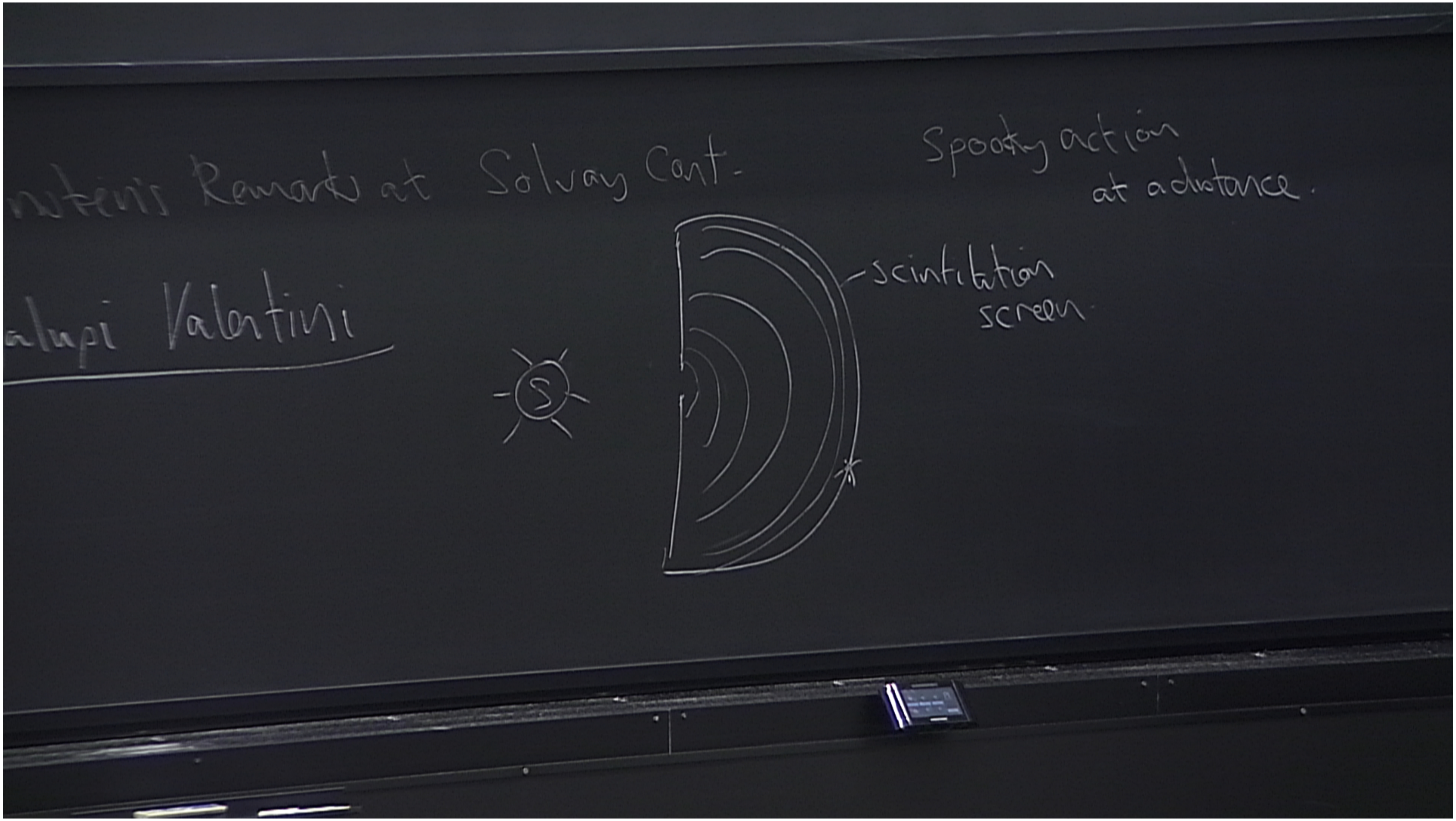

PMDC.
Laser
$|2\alpha|^2 = 4|\alpha|^2$
$|\alpha|^2 + |\alpha|^2 \quad 2|\alpha|^2$
$\alpha e^{i\phi}|1\rangle|1\rangle + \alpha|1\rangle|1\rangle$

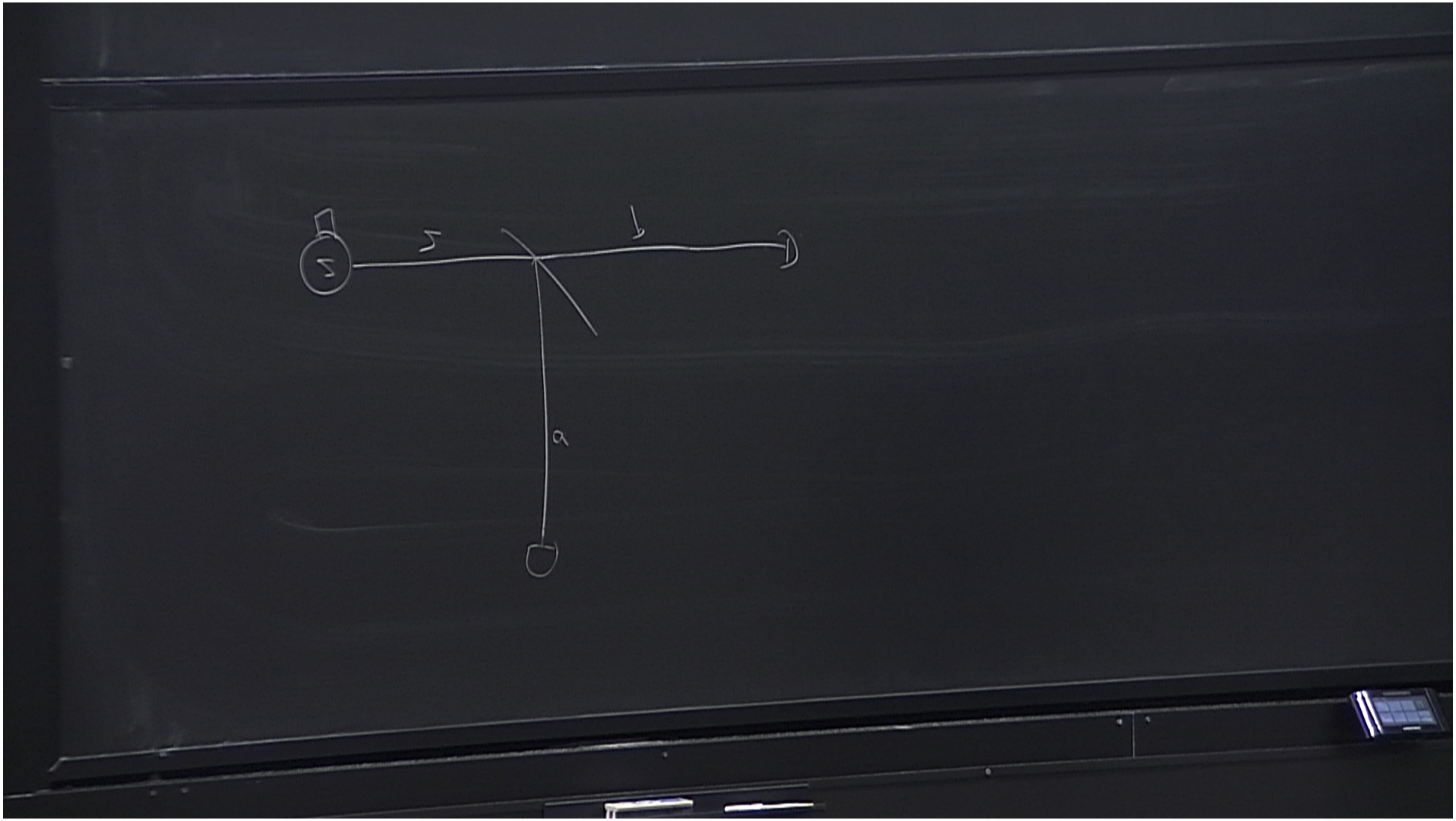
1927 Einstein's Remarks at Solvay Conf.

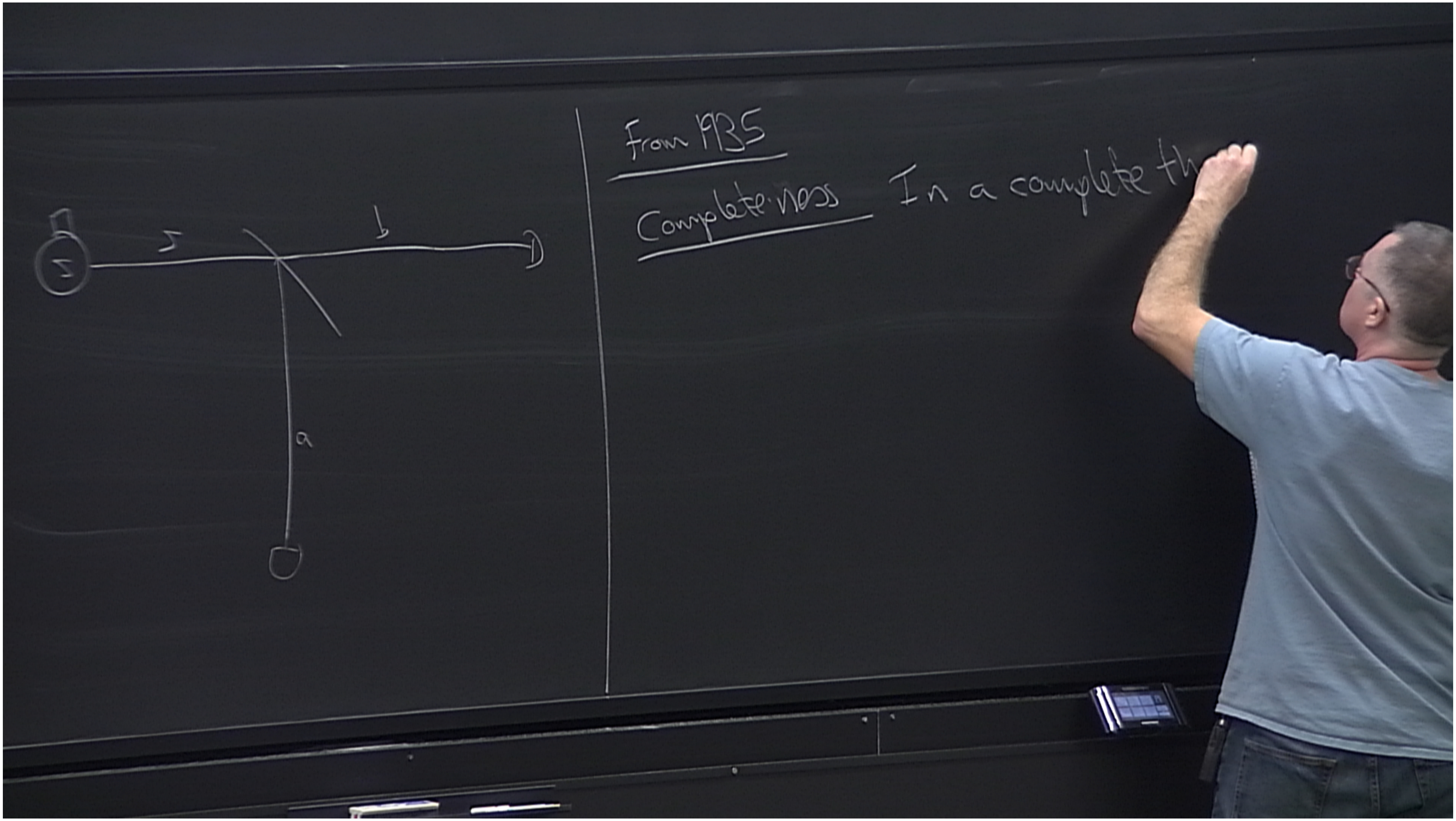
1927 Einstein's Remarks at Solvay Conf.

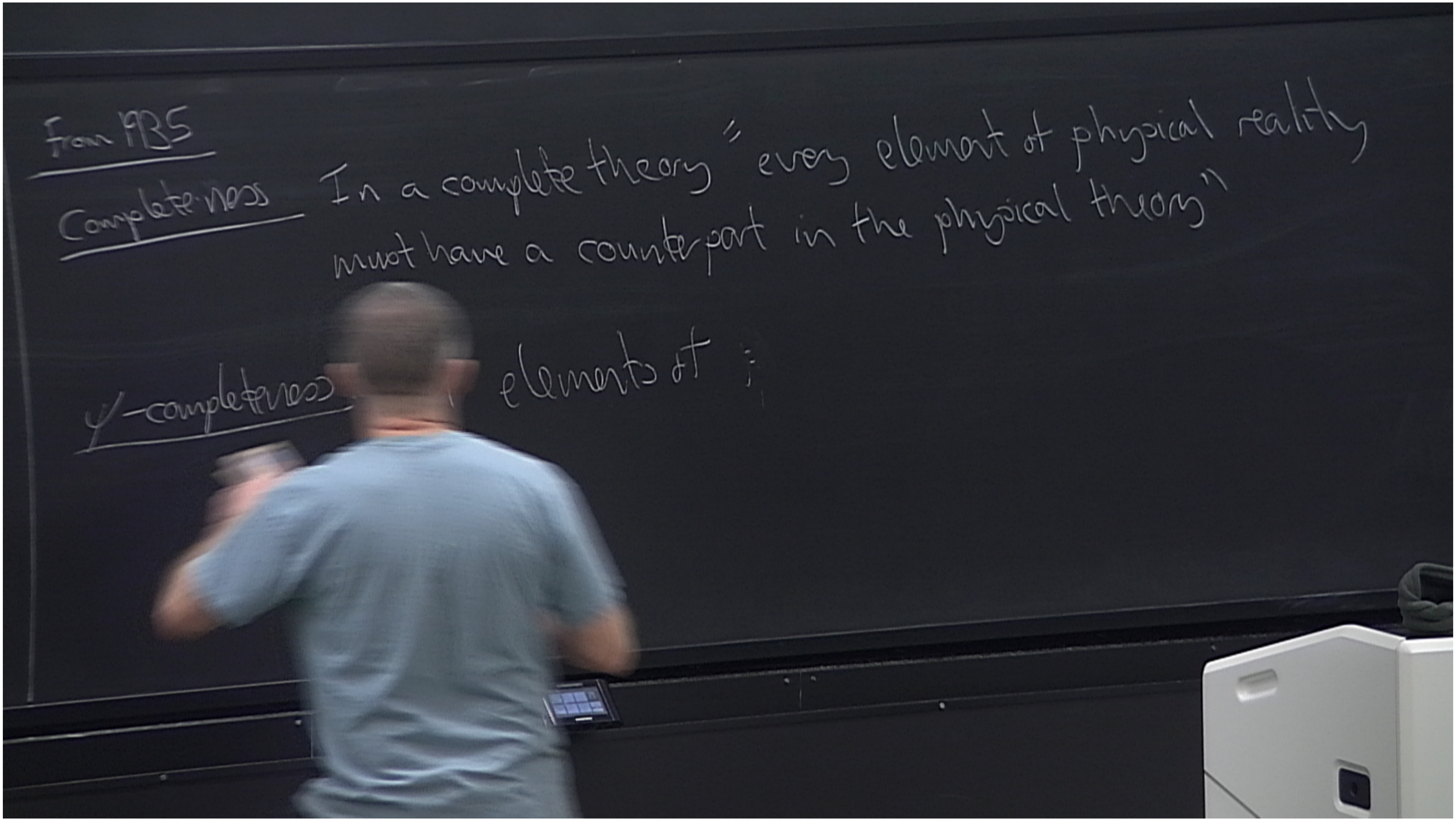
Bacciagalupi Valentini

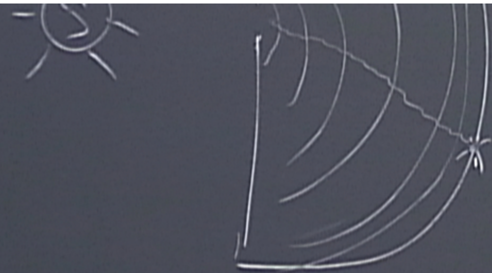

1927 Einstein's Remarks at Solvay Conf.
Bacciagalupi Valentini
S


nstein's Remarks at Solvay Conf.
Spooky action
at a distance.
alupi Valentini
scintillation
screen.
S


s
b
a


From 1935
Completeness
In a complete th
b
a


From 1935
Completeness
In a complete theory "every element of physical reality
must have a counterpart in the physical theory"
ψ-completeness
elements of

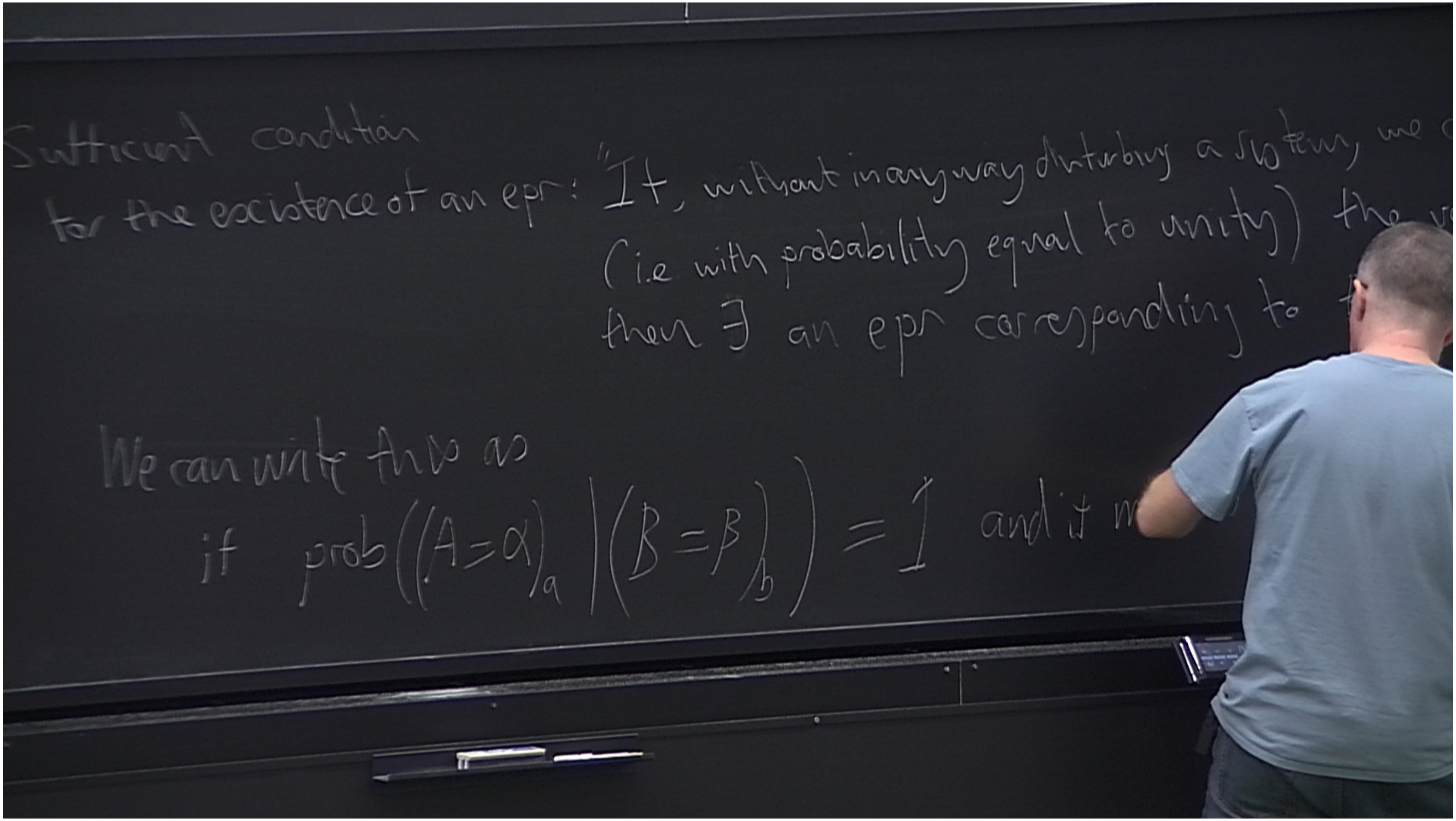


From 1935

Completeness: In a complete theory "every element of physical reality must have a counterpart in the physical theory"

ψ-completeness: All epr's follow from the state vector.

Sufficient condition
for the existence of an epr: If, without in any way disturbing a system, we c


Sufficient condition
for the existence of an epr: "If, without in any way disturbing a system, we
(i.e with probability equal to unity) the
then ∃ an epr corresponding to
We can write this as
if prob$\left((A=\alpha)_a \,\middle|\, (B=\beta)_b\right) = 1$ and it m

fficient condition
for the existence of an epr: "If, without in any way disturbing a system, we can

(i.e with probability equal to unity) the valu

then $\exists$ an epr corresponding to this qua

We can write this as

if $\text{prob}\left((A=\alpha)_a \,\middle|\, (B=\beta)_b\right) = 1$ and if meas of B does not disturb

... probability equal to unity) the value of a physical quantity
... an epr corresponding to this quantity."

... $)) = 1$ and if meas of B does not disturb a then $\exists$ an epr $[A =$

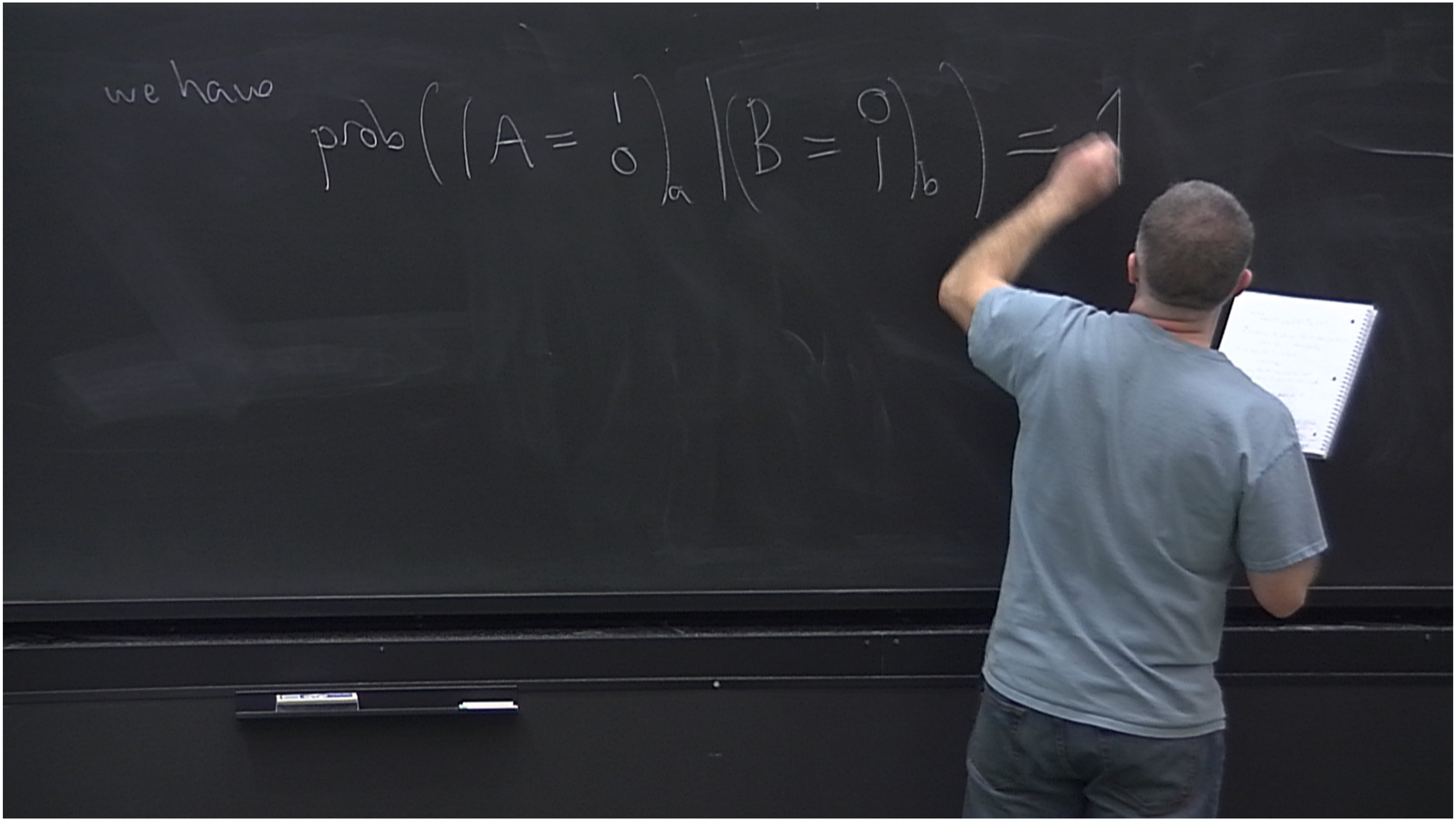
... EPRS
Completeness

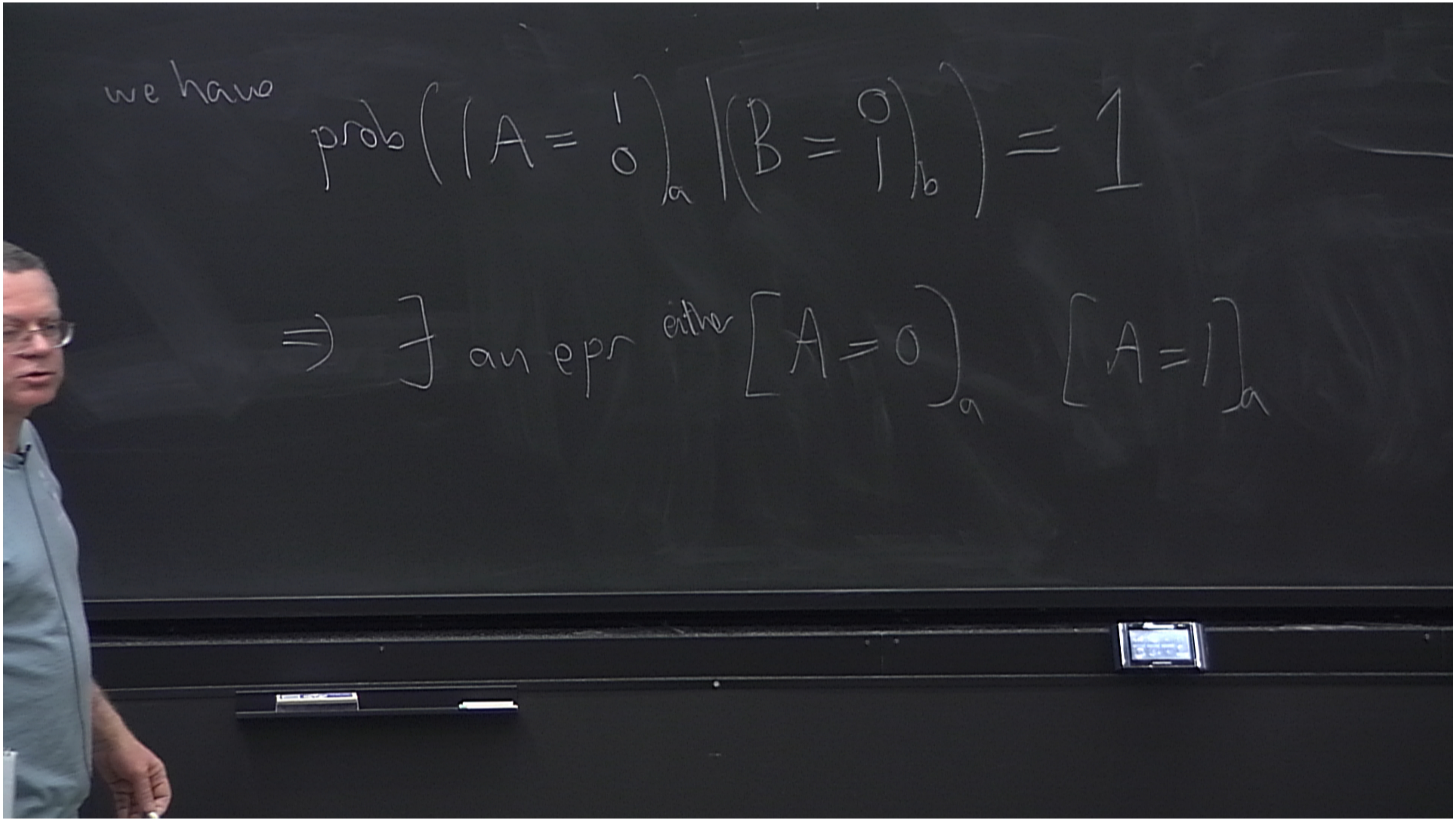
In a complete theory "every element of physical reality must have a counterpart in the physical theory"

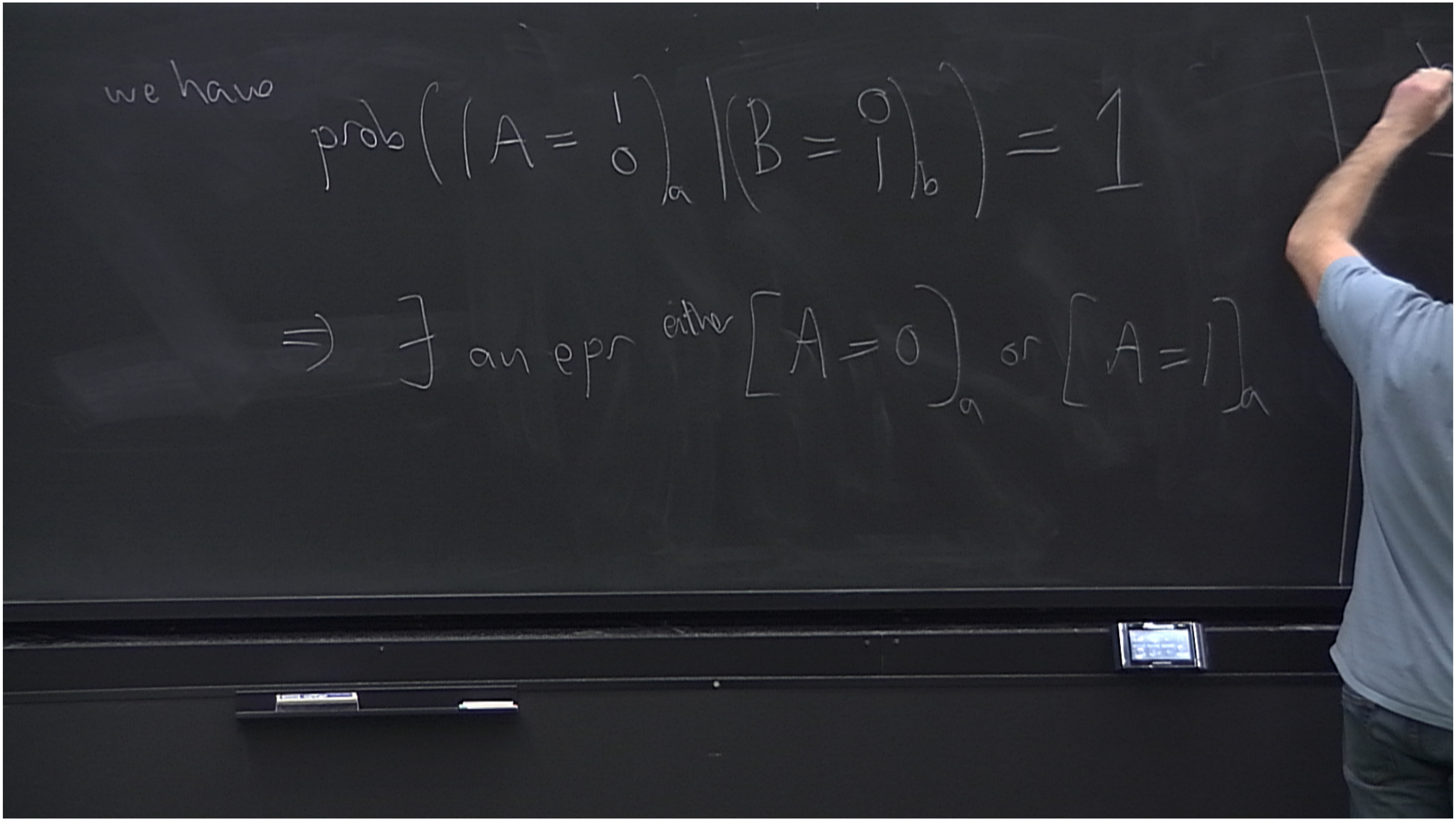
All "eprs" follow from the state vector.

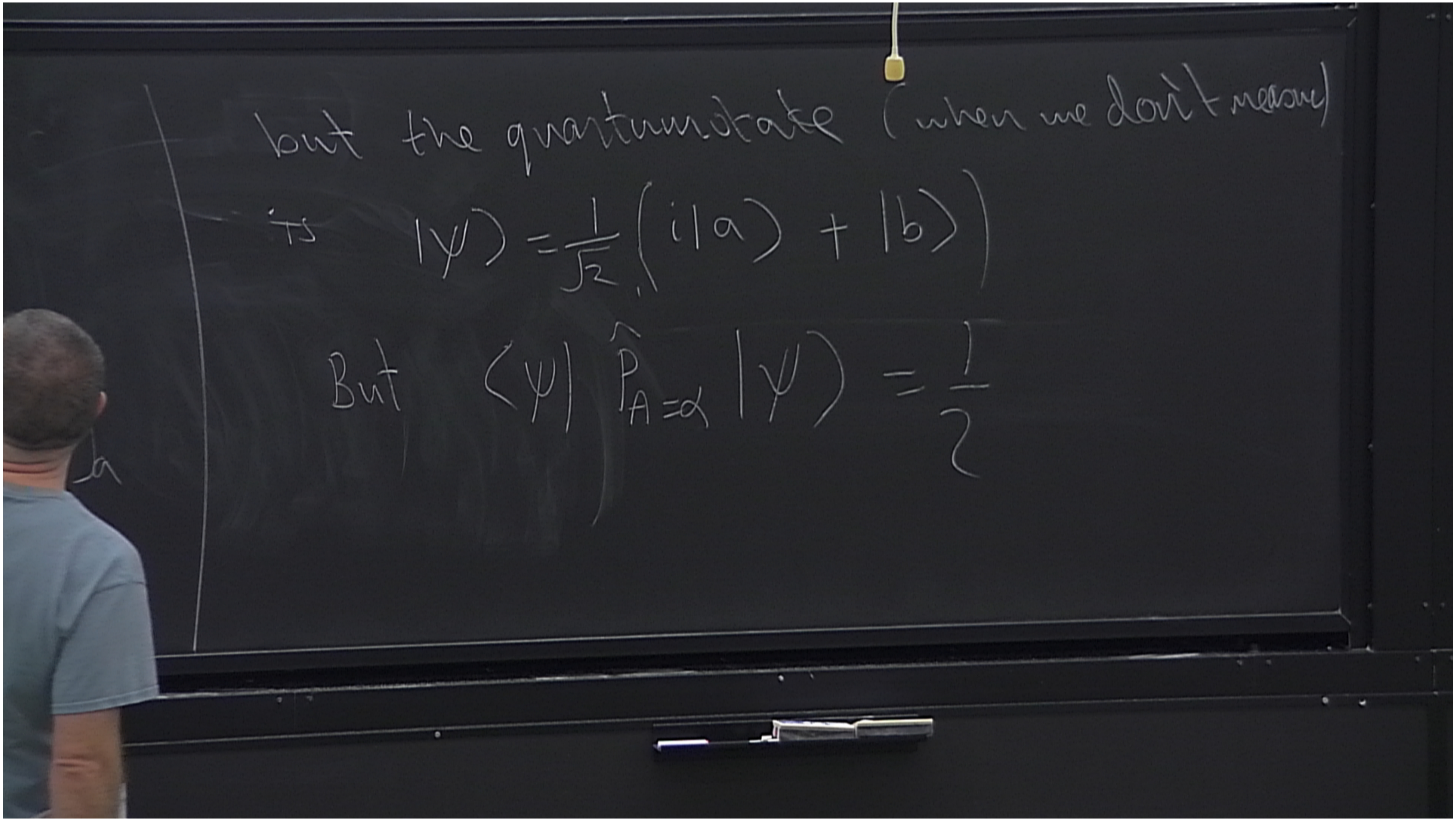
$\exists$ an epr $[A = \alpha]_a$

$|1\rangle + \alpha|1\rangle|1\rangle$


we have
prob((A = 1 0)a | (B = 0 1)b) = 1


we have
$\mathrm{prob}\left(\left(A = \substack{1 \\ 0}\right)_a \middle| \left(B = \substack{0 \\ 1}\right)_b\right) = 1$
$\Rightarrow \exists$ an epr either $[A=0]_a$ $[A=1]_a$


we have
prob (|A = 1/0)_a |(B = 0/1)_b) = 1
⇒ ∃ an epr either [A = 0]_a or [A = 1]_a


but the quantum state (when we don't measure)
is $|\psi\rangle = \frac{1}{\sqrt{2}}\left(i|a\rangle + |b\rangle\right)$
But $\langle\psi|\hat{P}_{A=\alpha}|\psi\rangle = \frac{1}{2}$