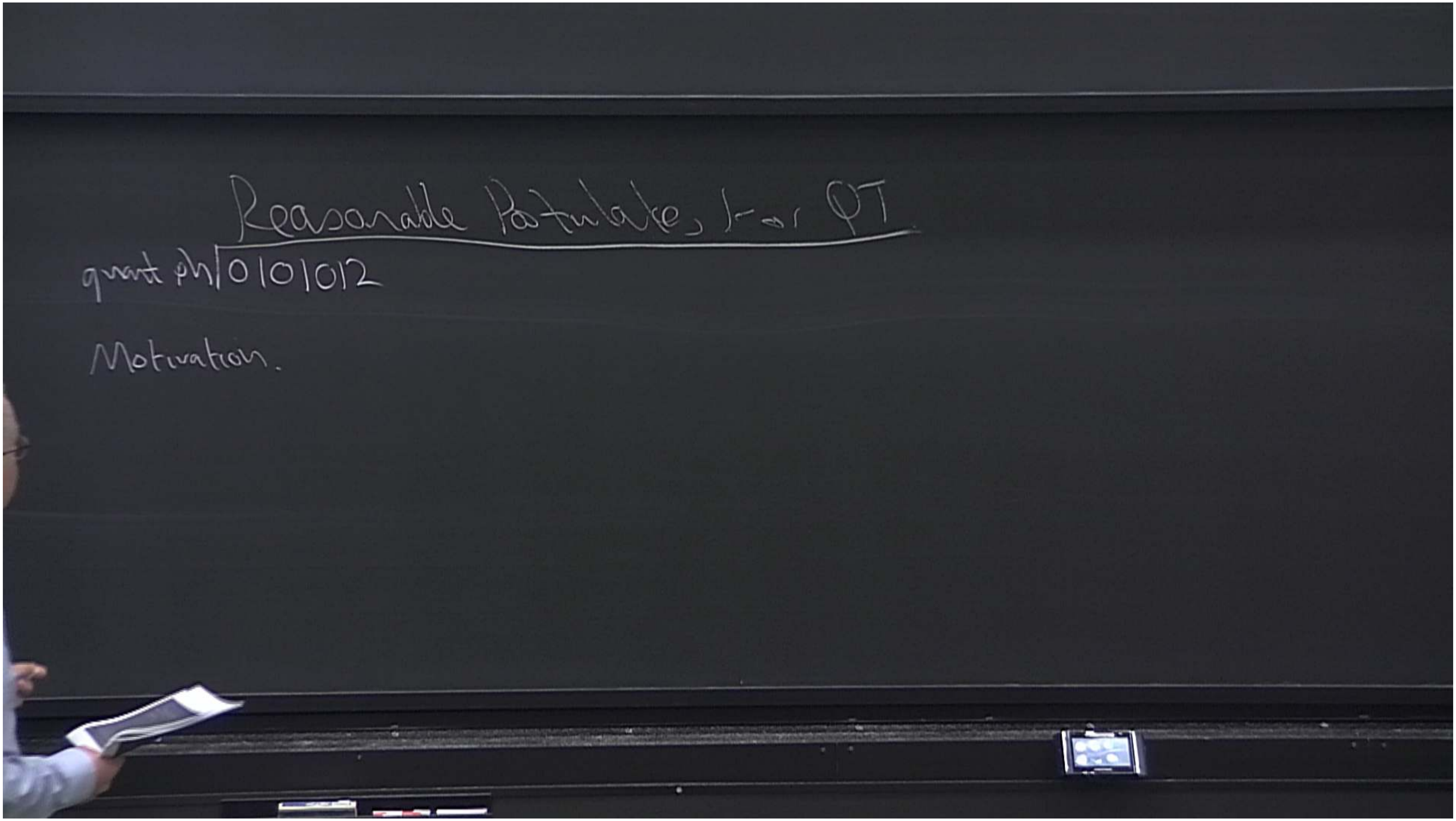
Title: PSI 2015/2016 Foundations of Quantum Mechanics - Lecture 13

Date: Jan 20, 2016 11:30 AM

URL: http://pirsa.org/16010067

Abstract:


Reasonable Postulates for QT
quant ph/0101012
Motivation.

Reasonable Postulates for QT

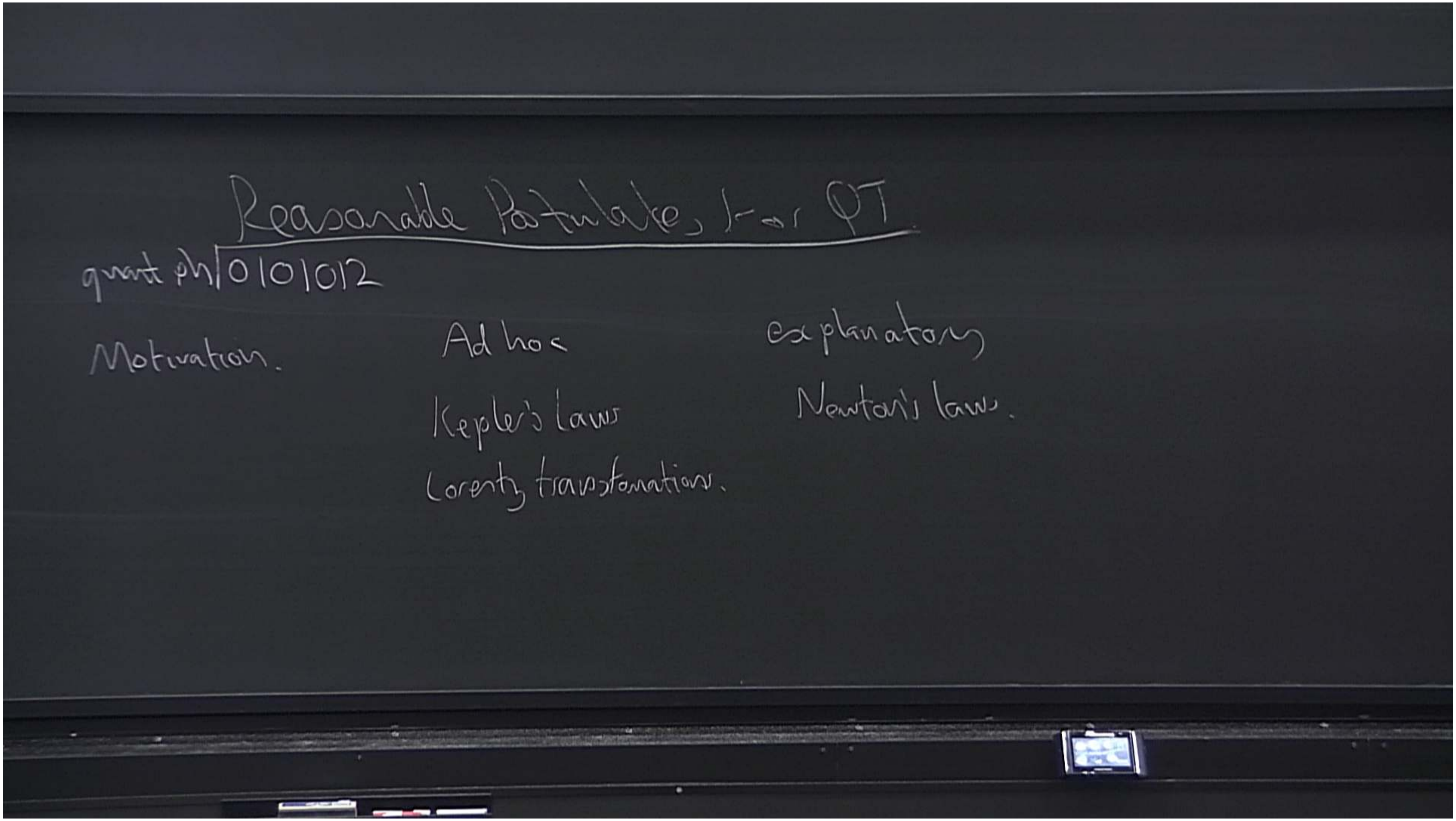
quant-ph/0101012

Motivation.

Ad hoc

Kepler's laws

explanatory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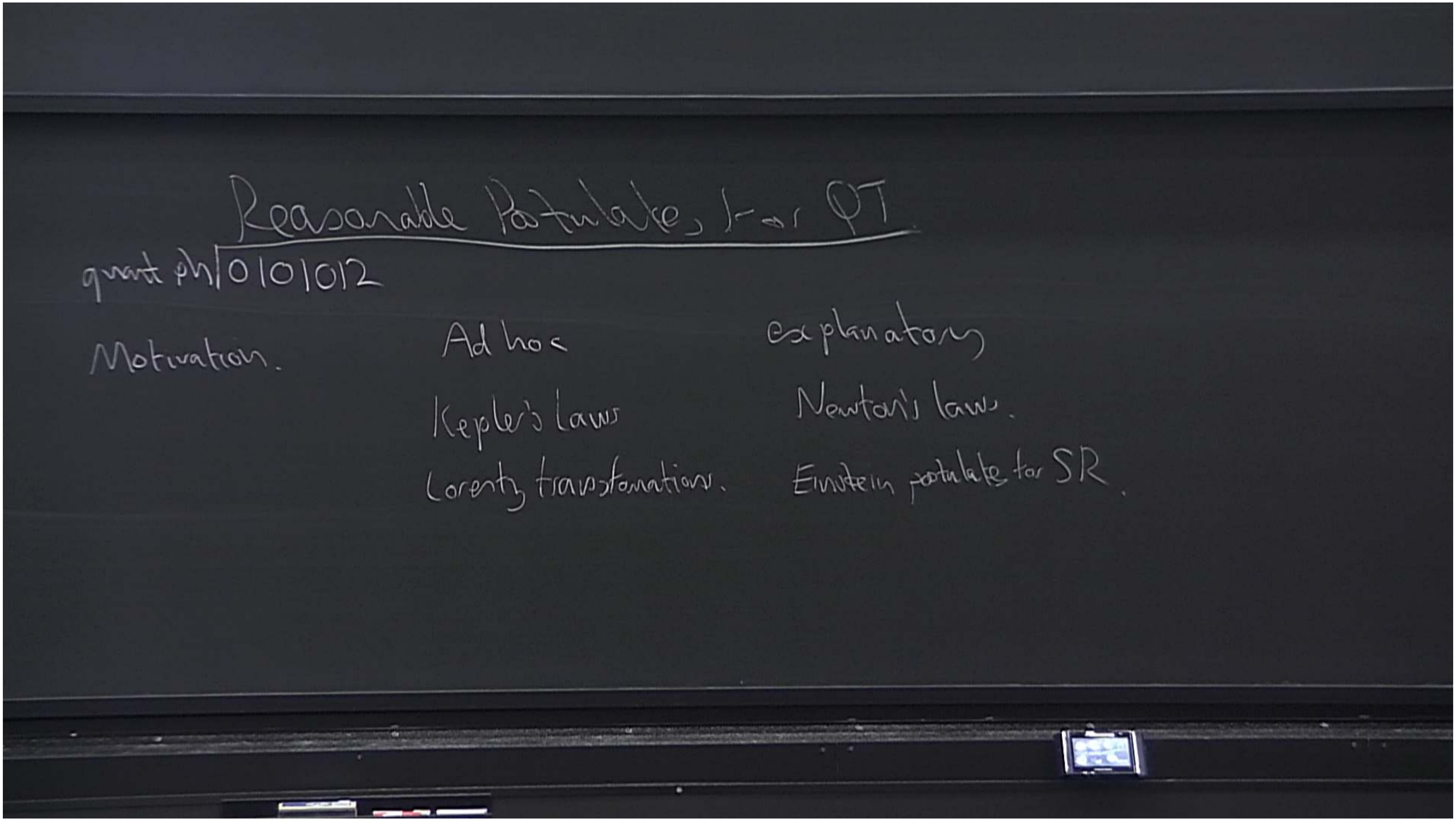
quant-ph/0101012
Motivation.
Ad hoc
explanatory
Kepler's laws
Newton's laws.
Lorentz transformations.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Kepler's laws
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Lorentz transformations.
Einstein postulate for SR.

Reasonable Postulates for QT

quant-ph/0101012

Motivation.

Ad hoc

Kepler's laws

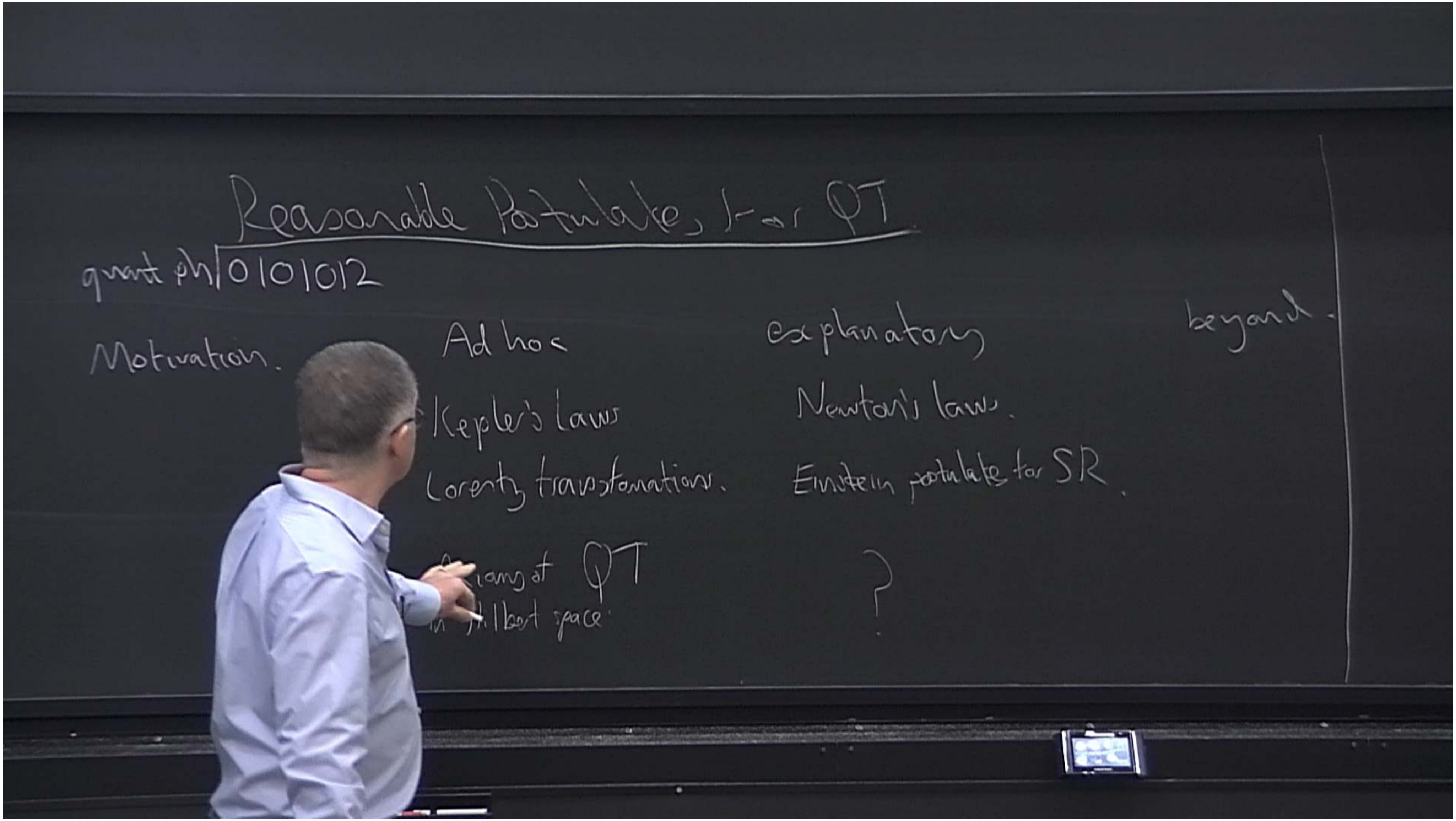
Lorentz transformations.

Axioms of QT
in Hilbert space

explanatory

Newton's laws.

Einstein postulate for SR.


Reasonable Postulates for QT
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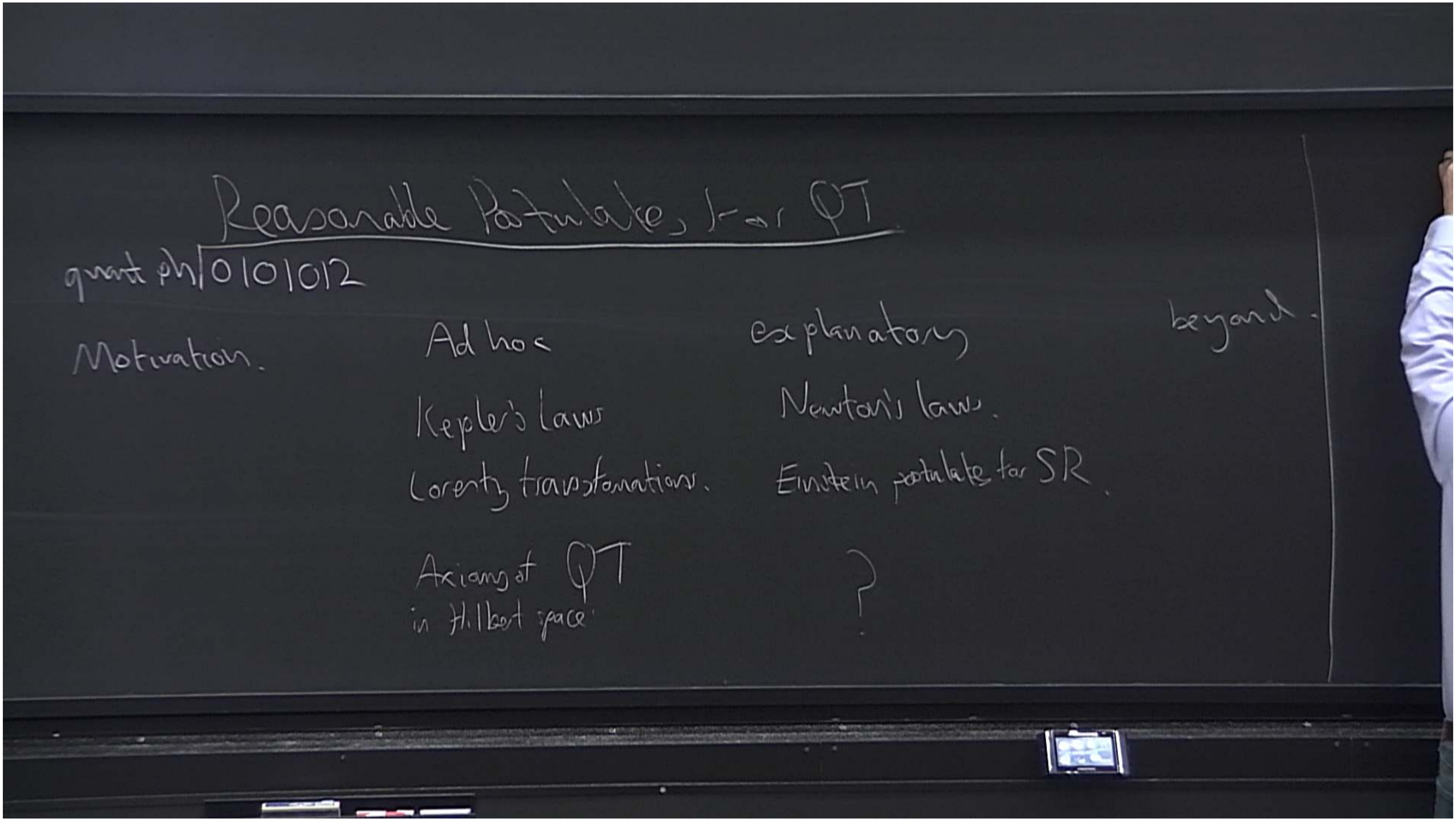
Ad hoc
explanatory
beyond.
Kepler's laws
Newton's laws.
Lorentz transformations.
Einstein postulate for SR.
QT
?


Reasonable Postulates for QT
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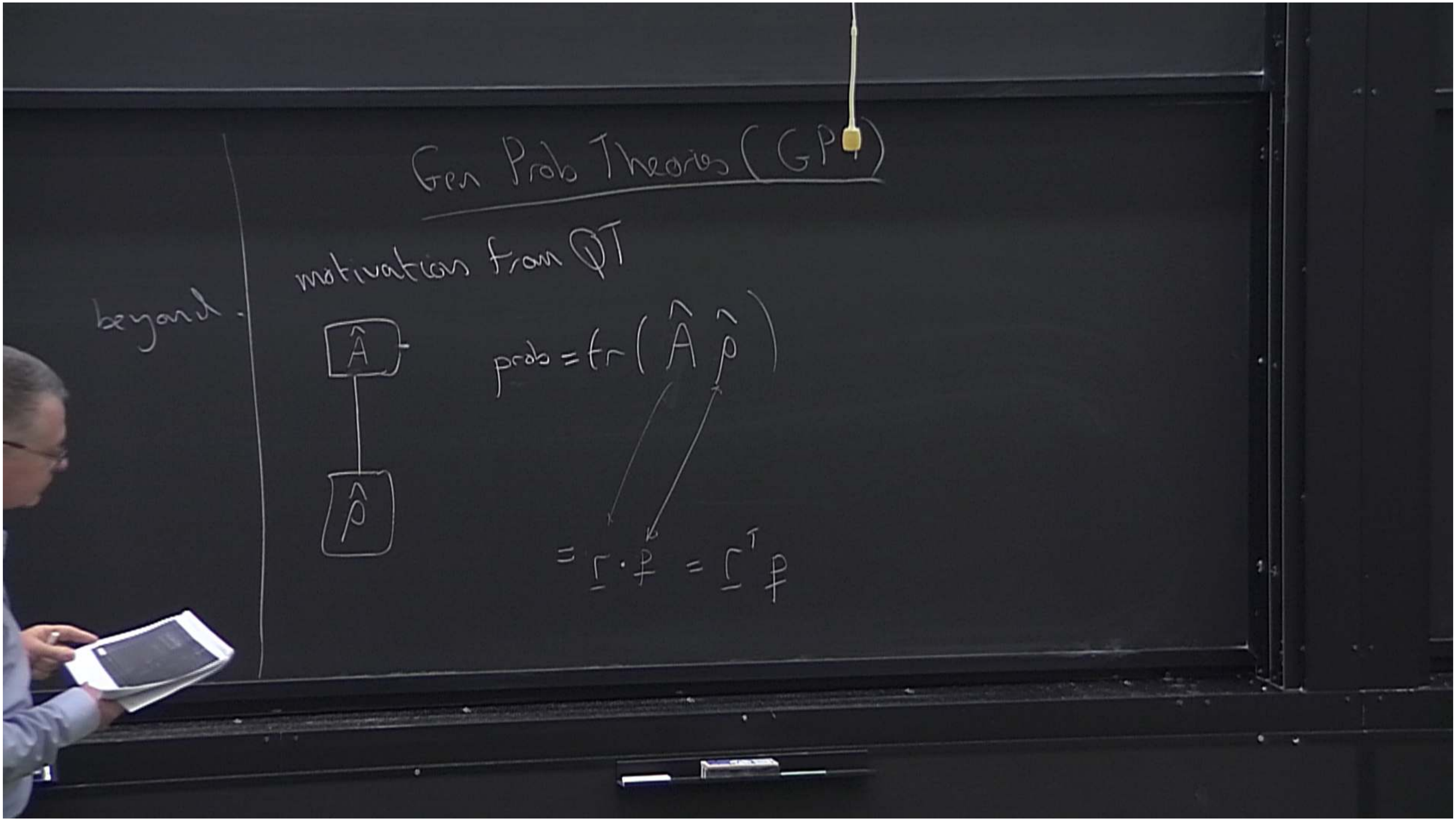
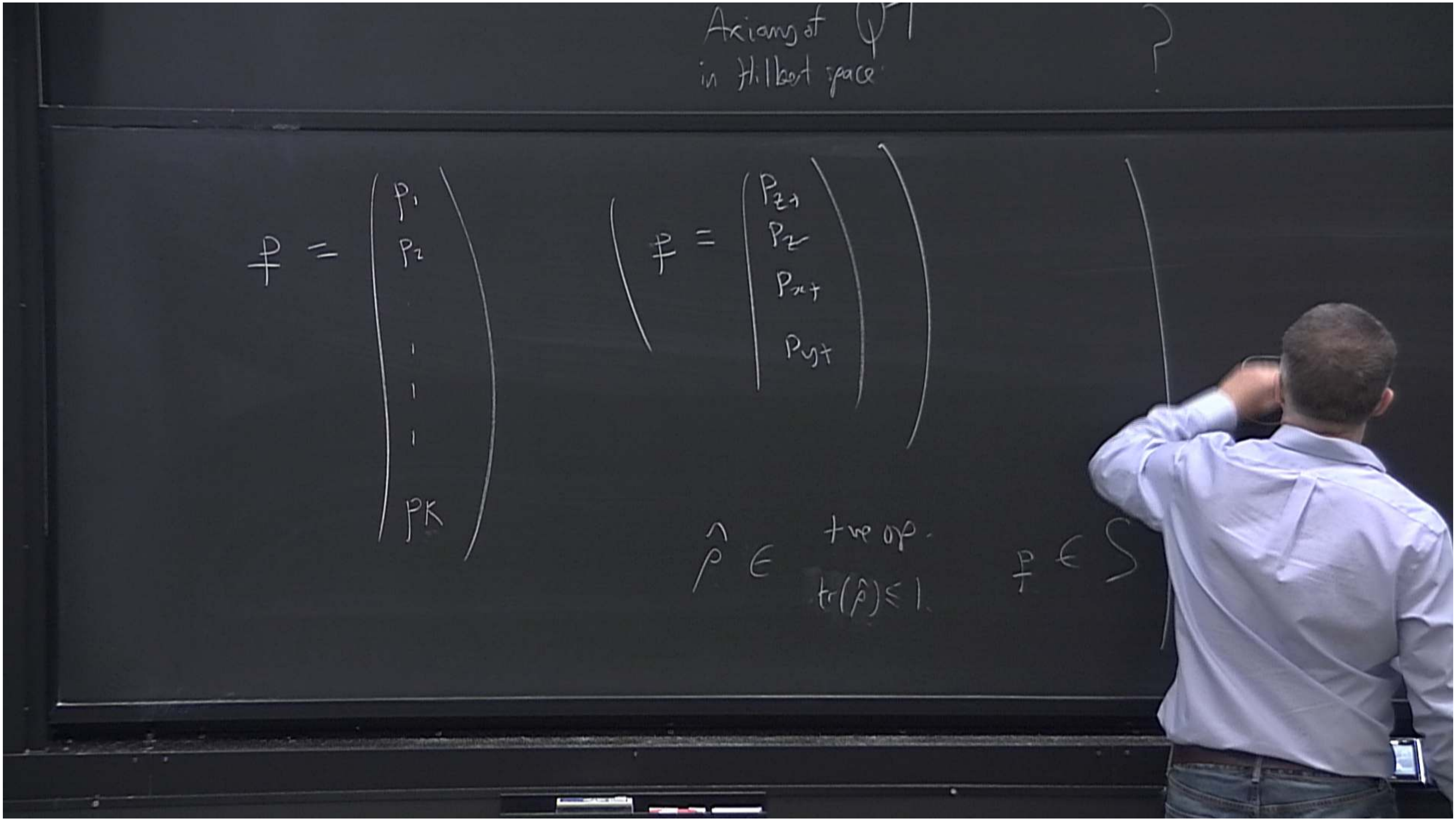
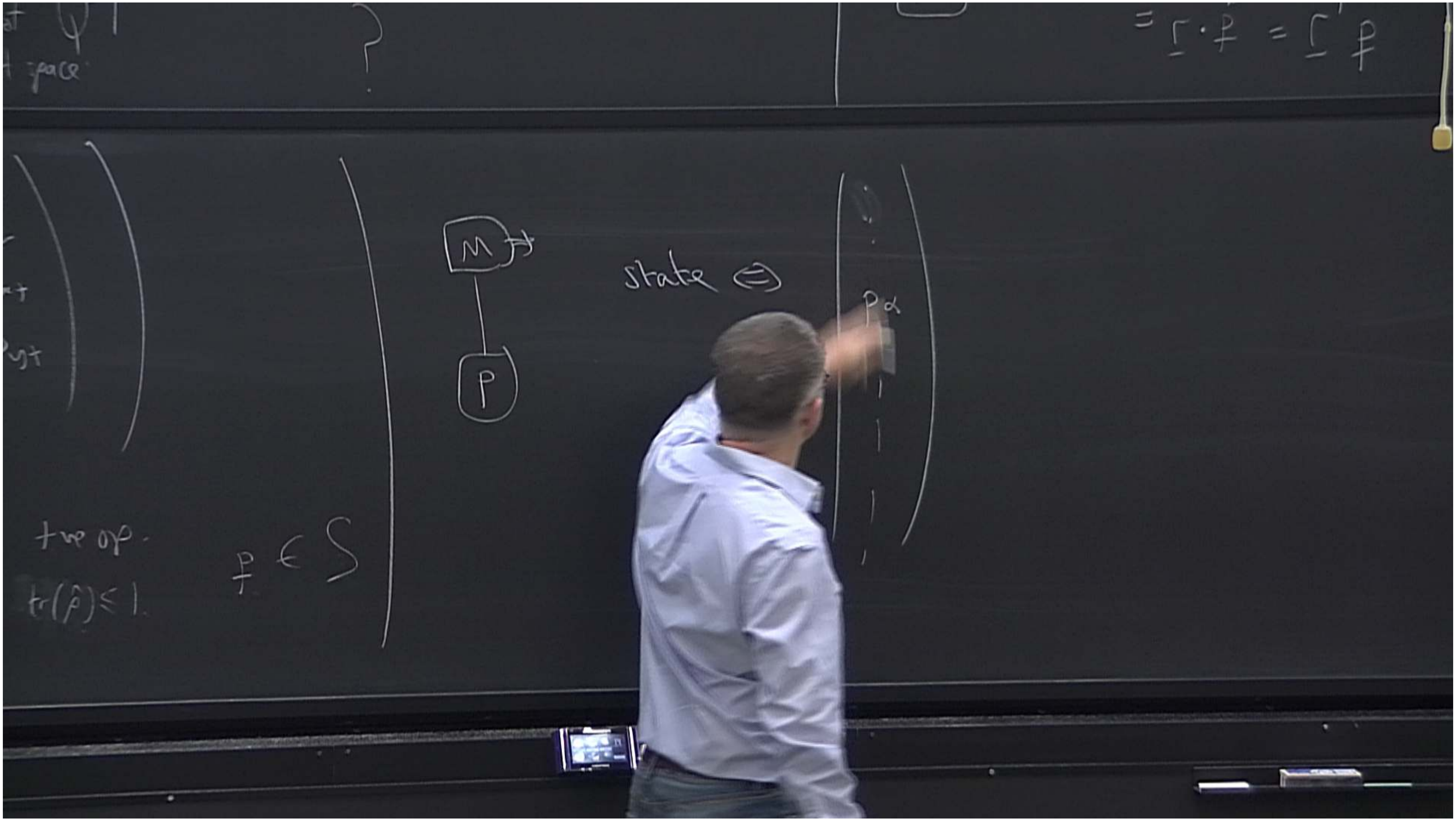
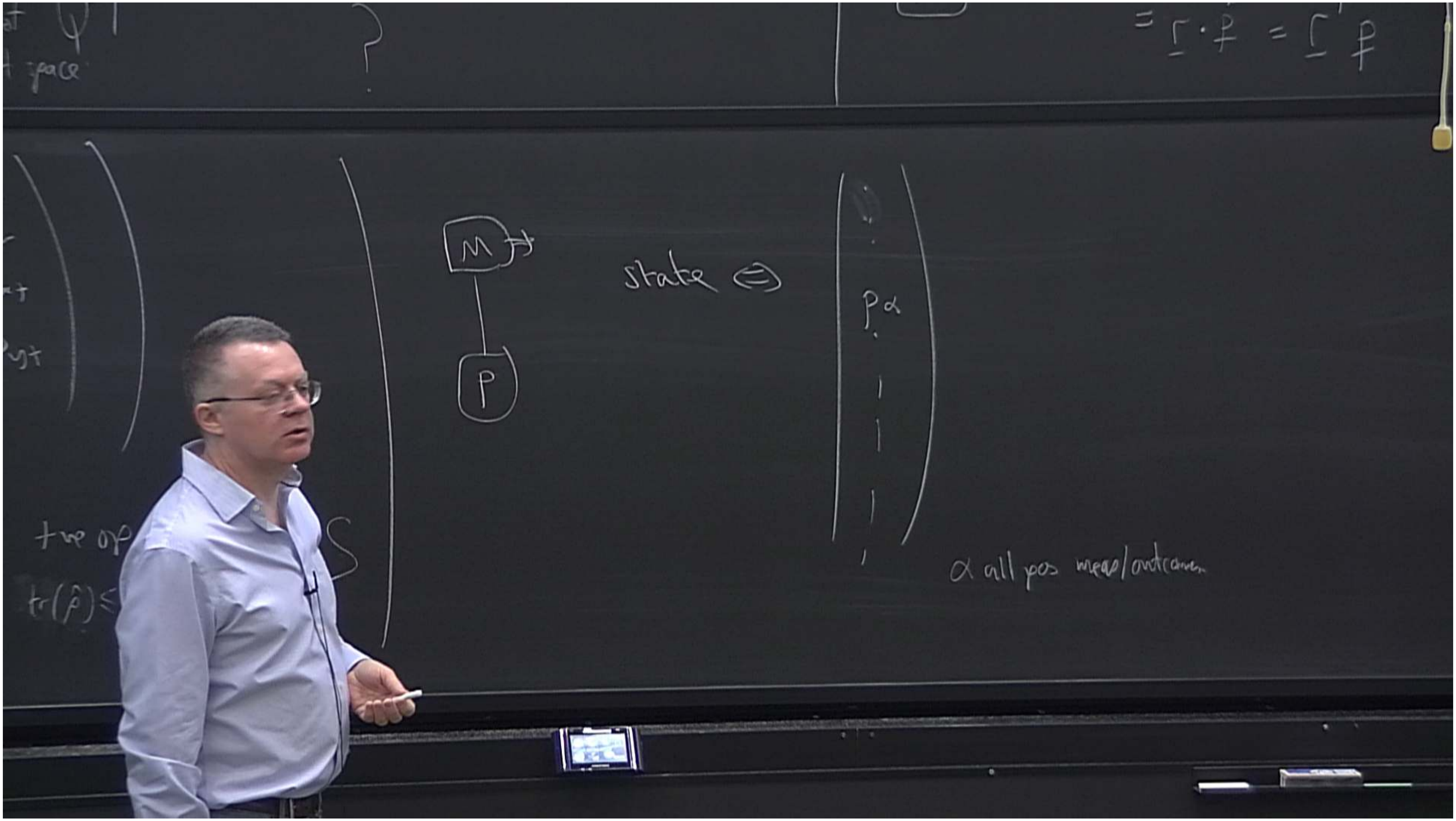
Axioms of QT in Hilbert space
?

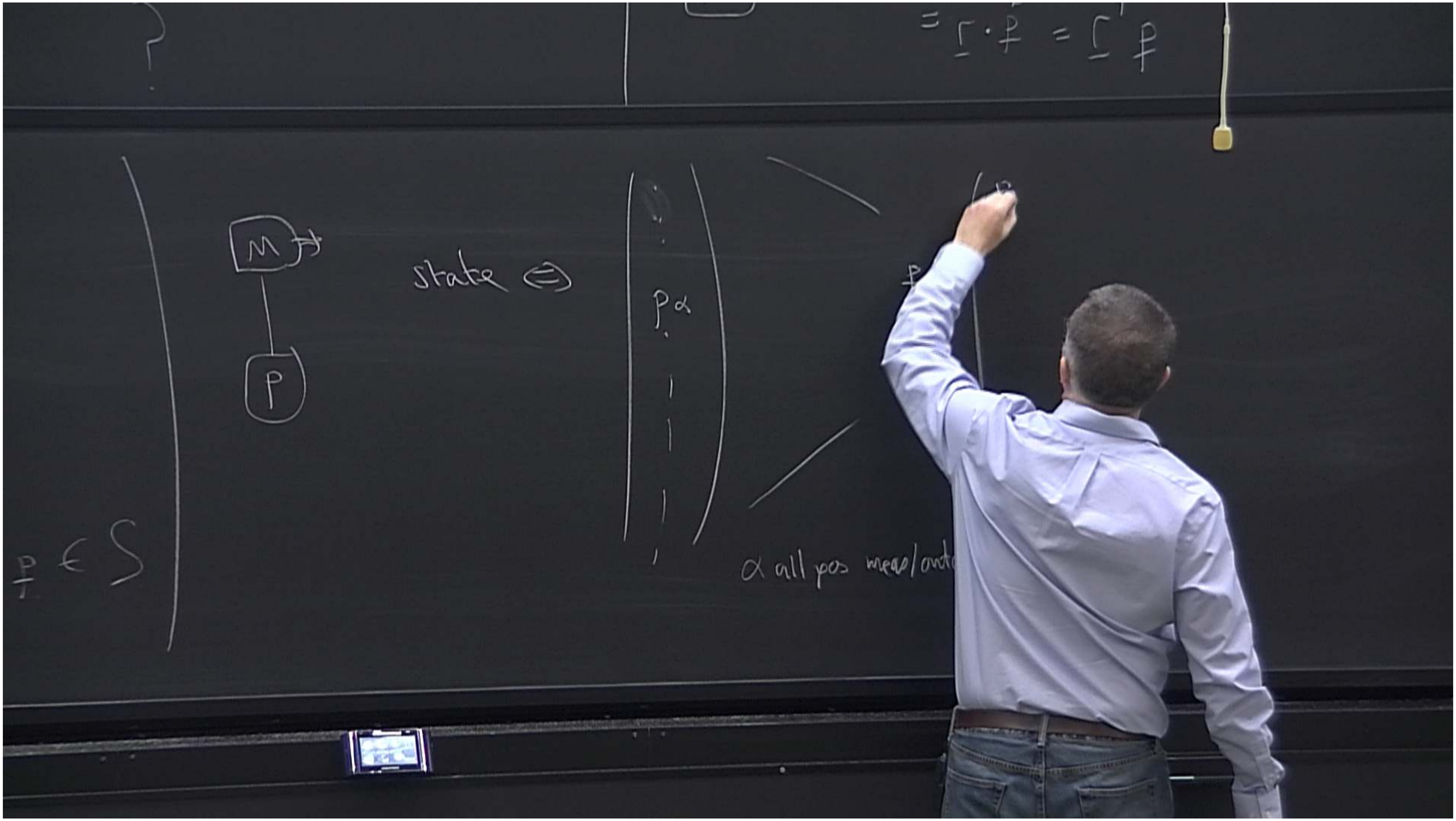

Gen Prob Theories (GP
motivation from QT
beyond.
$\hat{A}$
$\hat{\rho}$
prob = $tr(\hat{A}\hat{\rho})$
$= \underline{r} \cdot \underline{p} = \underline{r}^T \underline{p}$

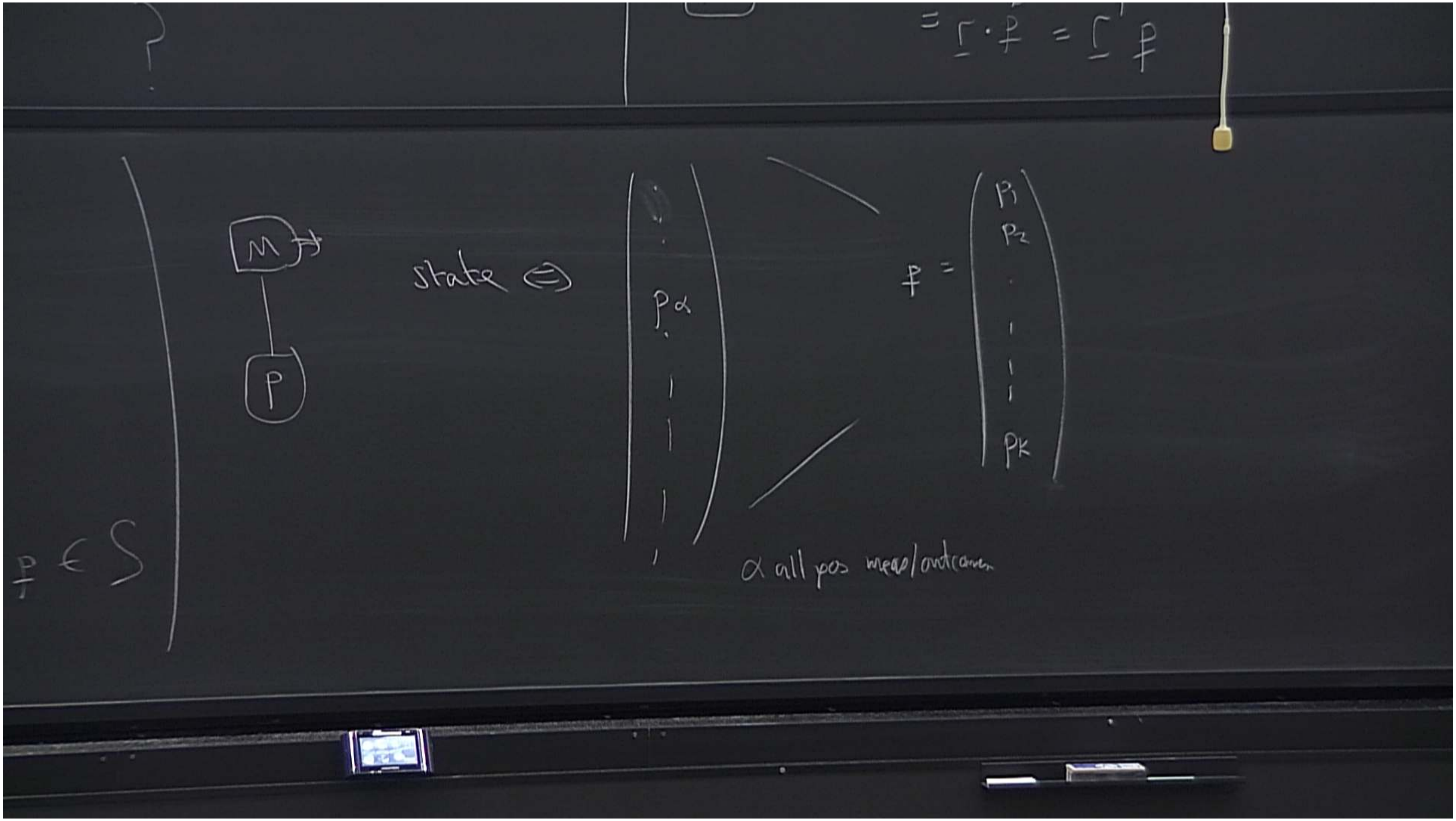


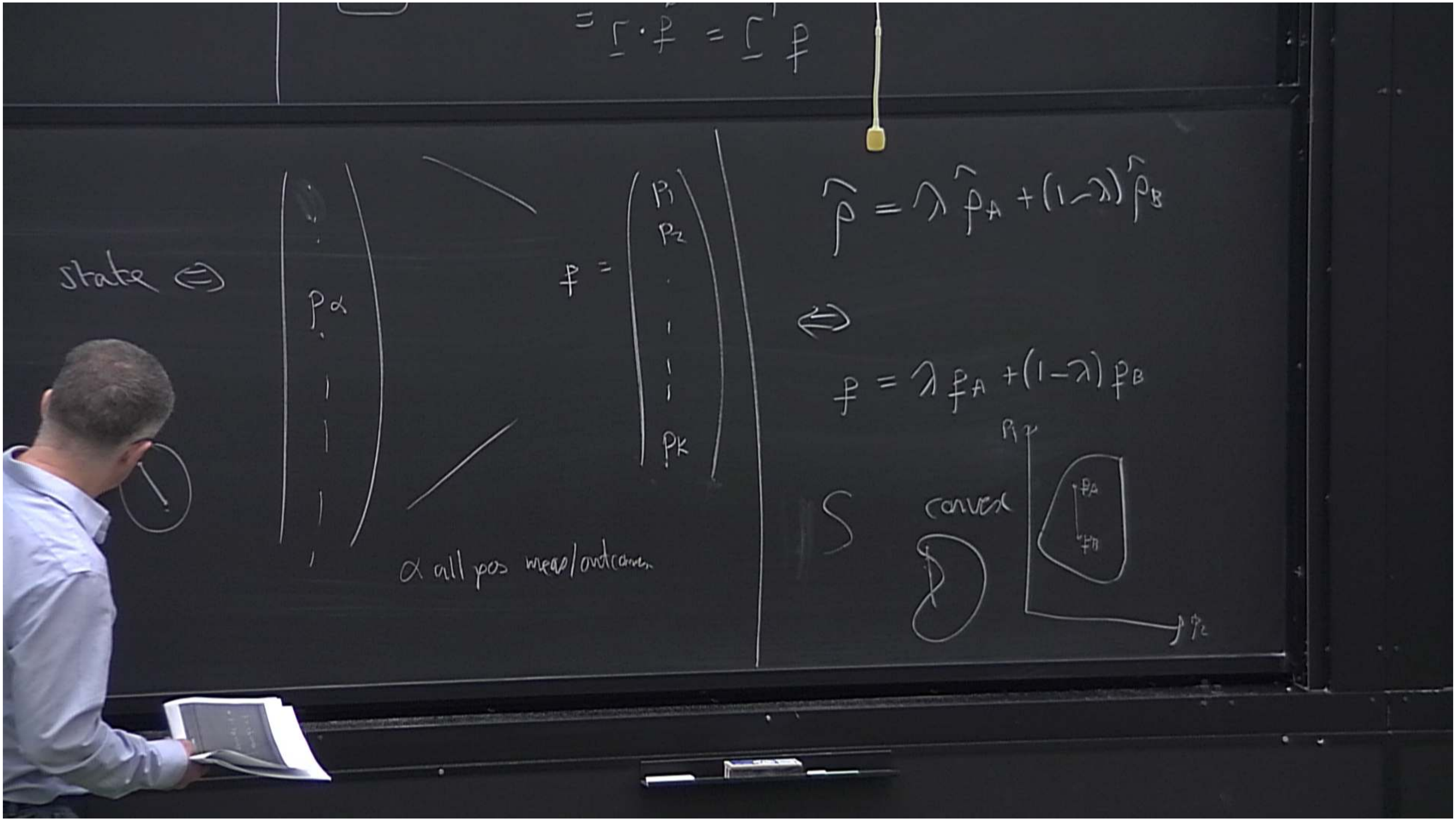
Axioms of QT
in Hilbert space
?
p = p1 p2 pK
p = Pz+ Pz- Px+ Py+
ρ̂ ∈ +ve op.
tr(ρ̂) ≤ 1
p ∈ S


state
M
P
ρ ∈ S
tr(ρ) ≤ 1

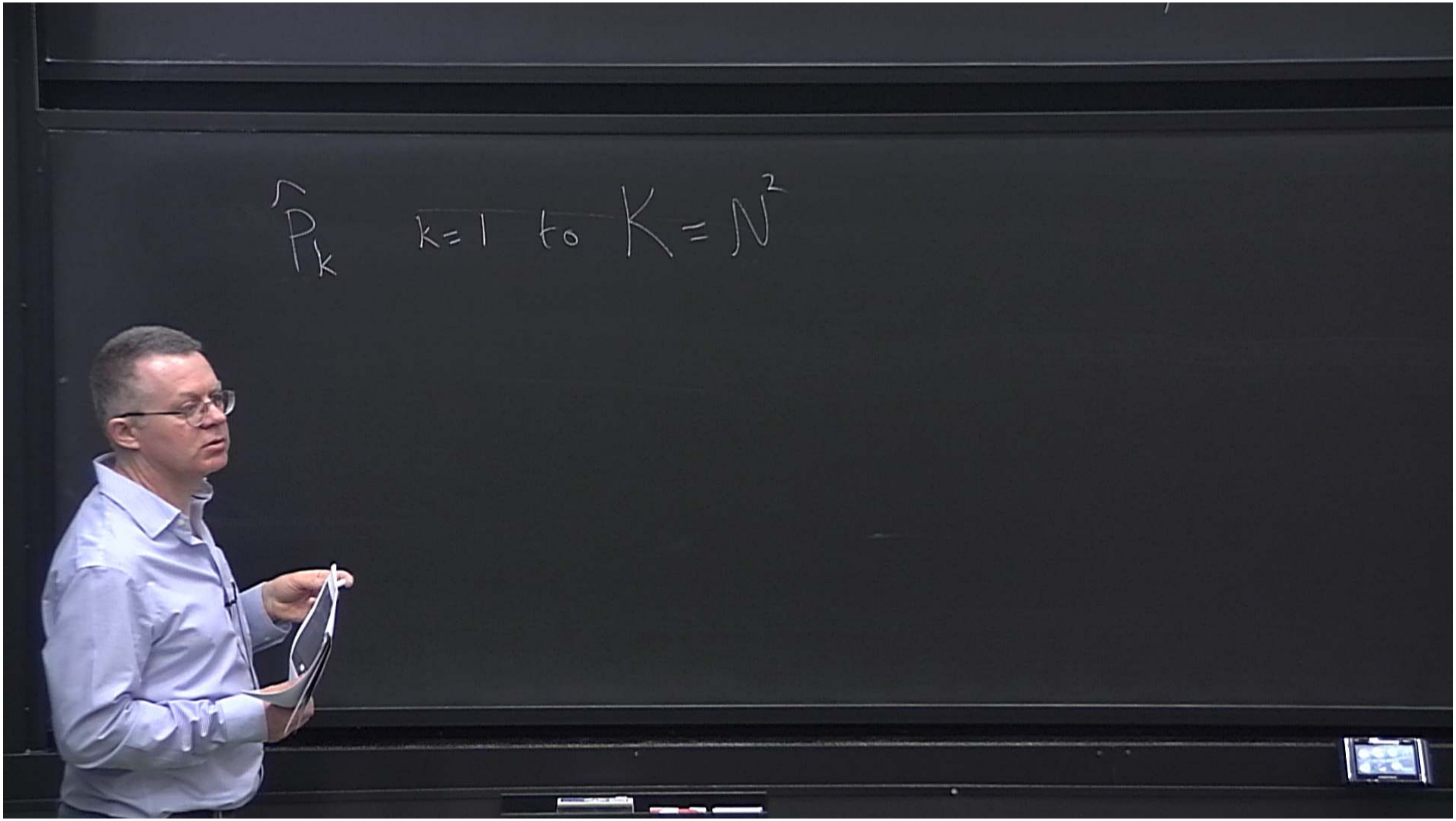

M
P
state ⟺
p α
α all pos meas/outcomes

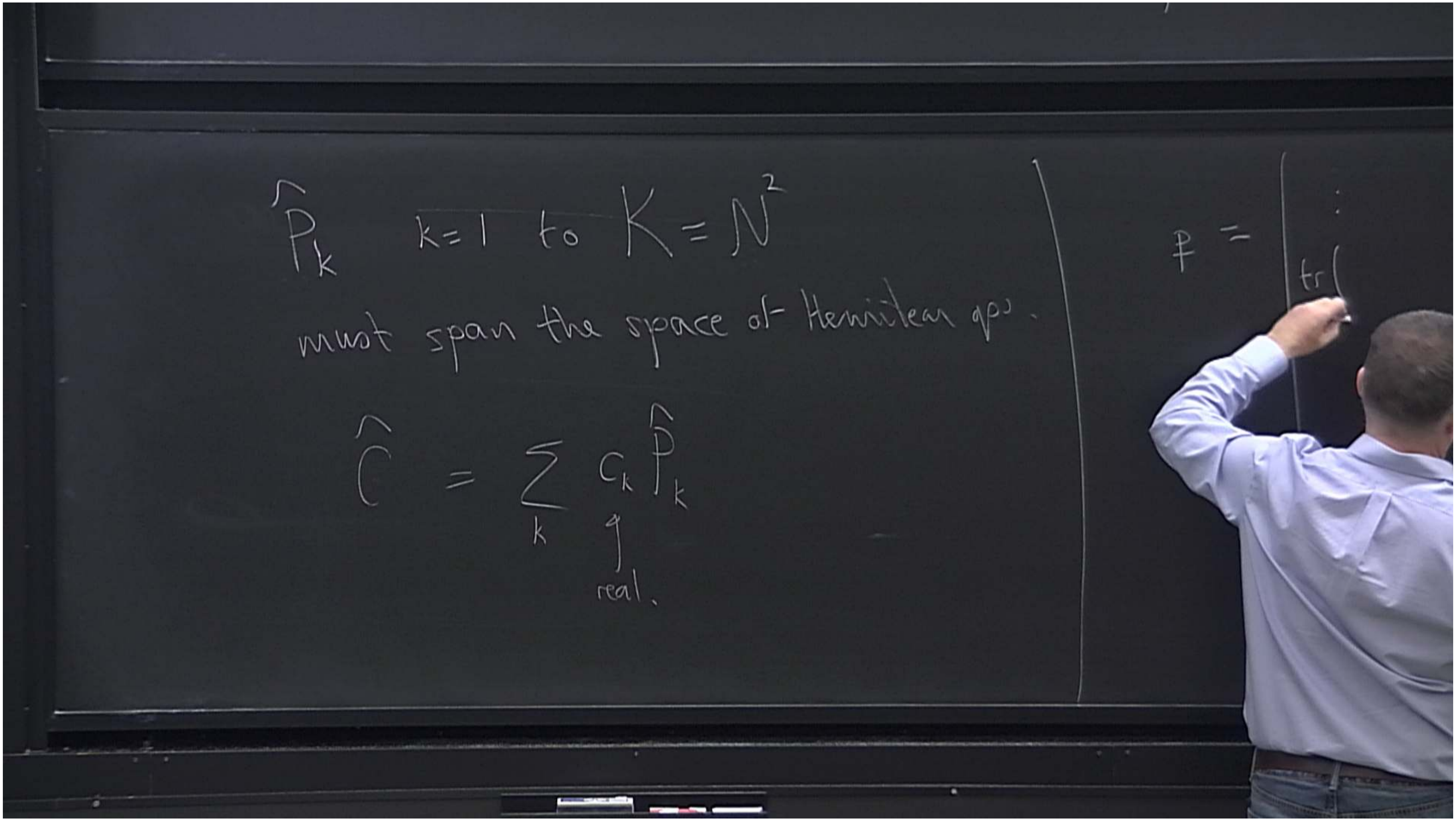

state
M
P
α all pos

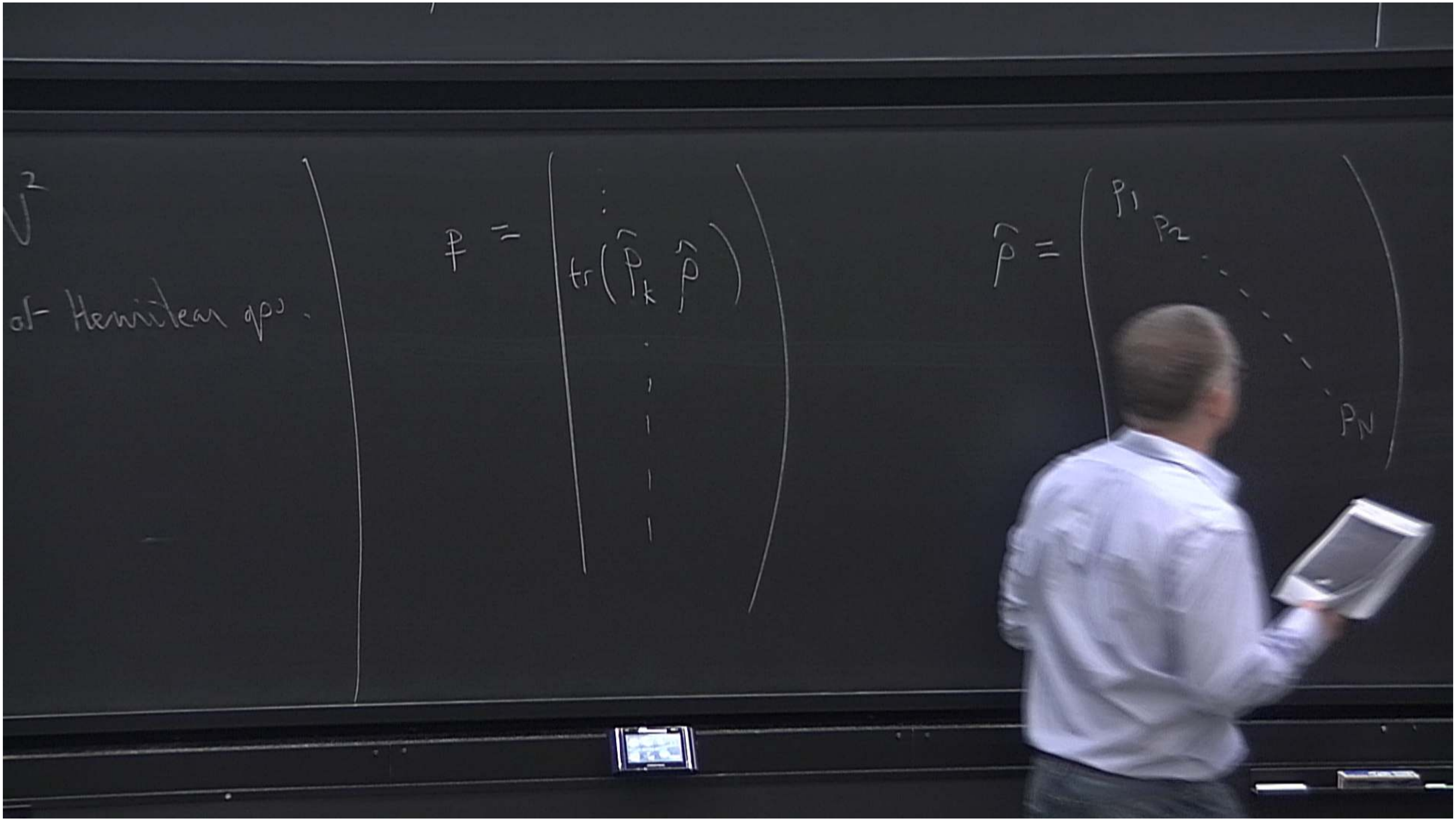

M
P
state
p_α
p = p1 p2 pK
α all pos meas/outcomes
p ∈ S



state ⟺
pα
α all pos meas/outcomes
p =
p1
p2
pK
ρ̂ = λ ρ̂A + (1−λ) ρ̂B
⟺
p = λ pA + (1−λ) pB
S
convex
p1
p2
pA
pB


$\hat{P}_k$ k=1 to $K=N^2$


$\hat{P}_k$ $k=1$ to $K=N^2$
must span the space of Hermitian ops.
$\hat{C} = \sum_k c_k \hat{P}_k$
real.
$p =$
tr(

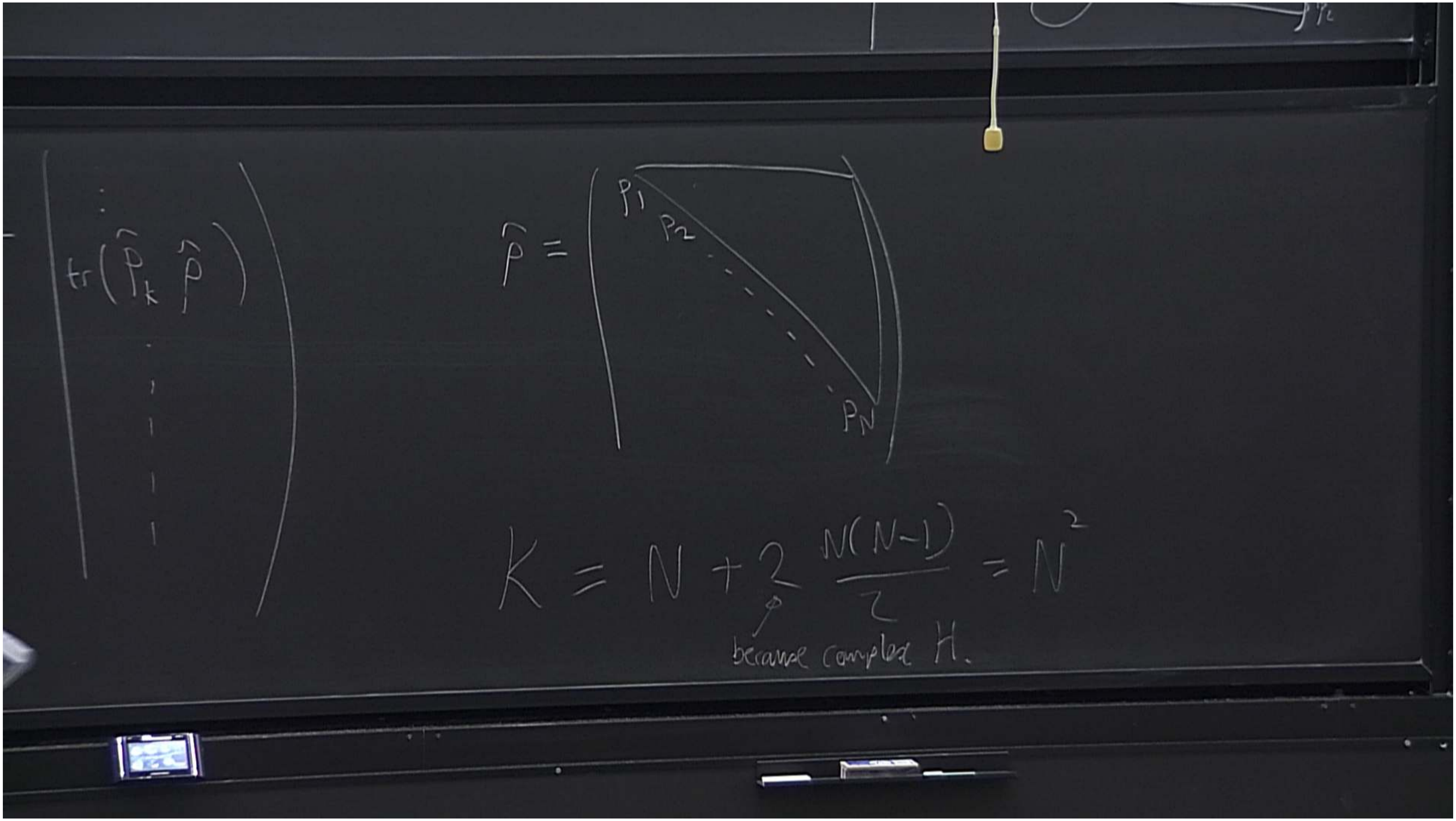

of Hermitean ops.
p =
tr(P̂_k ρ̂)
ρ̂ =
p_1
p_2
p_N

$$\begin{pmatrix} \vdots \\ \mathrm{tr}(\hat{\rho}_k \hat{\rho}) \\ \vdots \end{pmatrix}$$

$$\hat{\rho} = \begin{pmatrix} \rho_1 & & & \\ & \rho_2 & & \\ & & \ddots & \\ & & & \rho_N \end{pmatrix}$$

$$K = N + 2\,\frac{N(N-1)}{2} = N^2$$

because complex H.

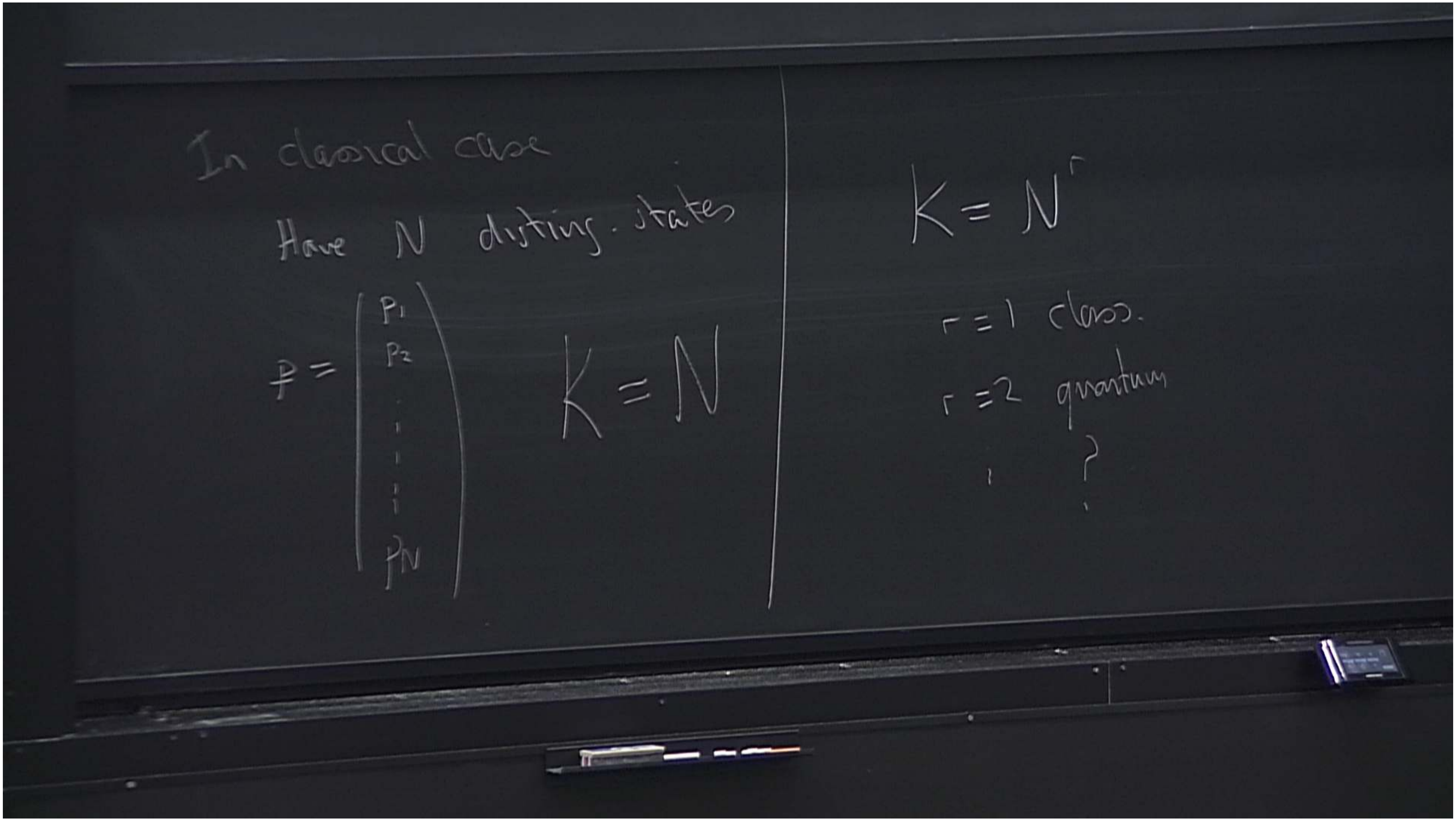

$\mathrm{tr}(\hat{P}_k \hat{\rho})$
$\hat{\rho} = $
p_1
p_2
p_N
$K = N + 2\frac{N(N-1)}{2} = N^2$
because complex H.

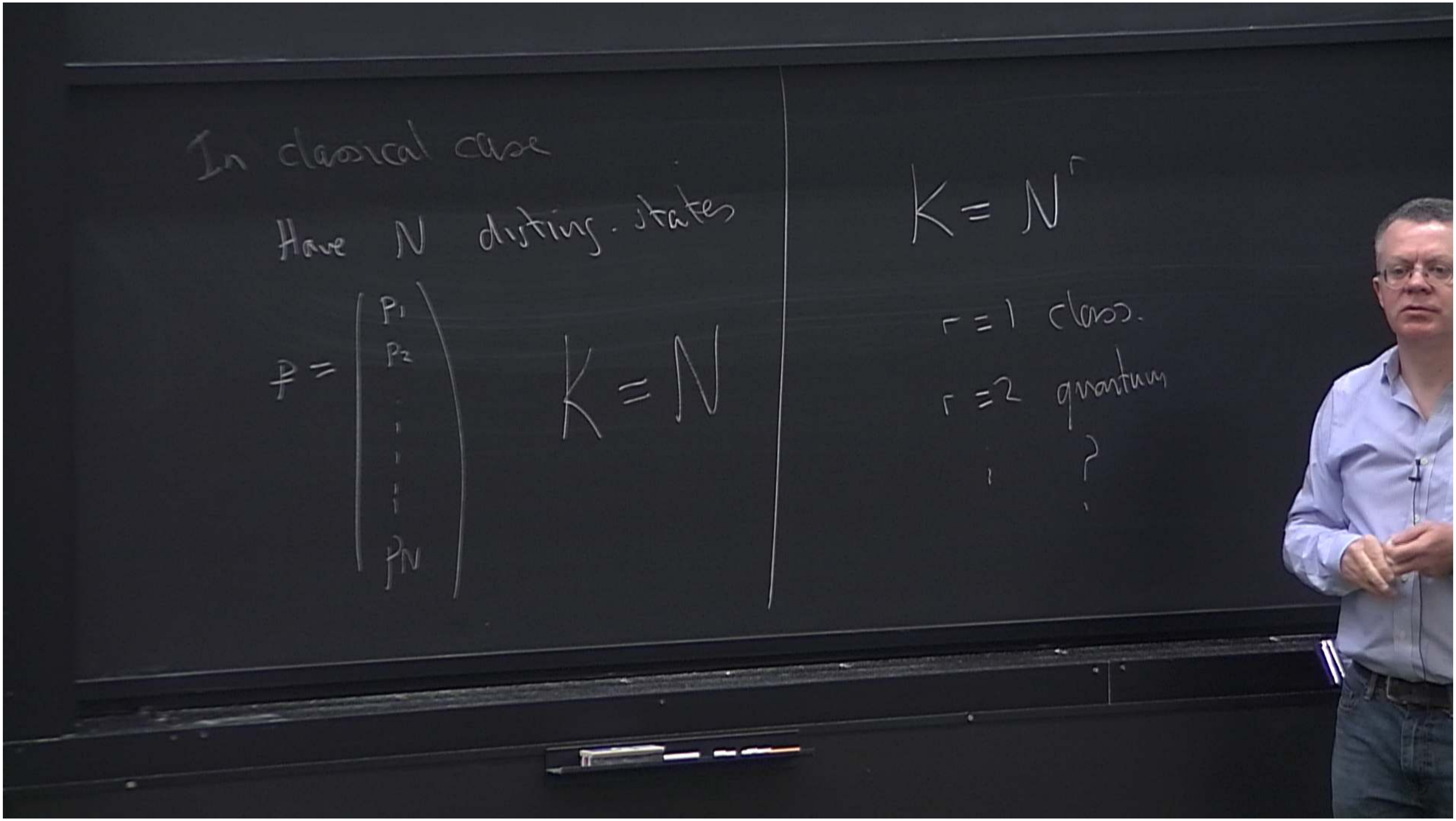
$$\begin{pmatrix} \vdots \\ \mathrm{tr}(\hat{P}_k \hat{\rho}) \\ \vdots \end{pmatrix}$$

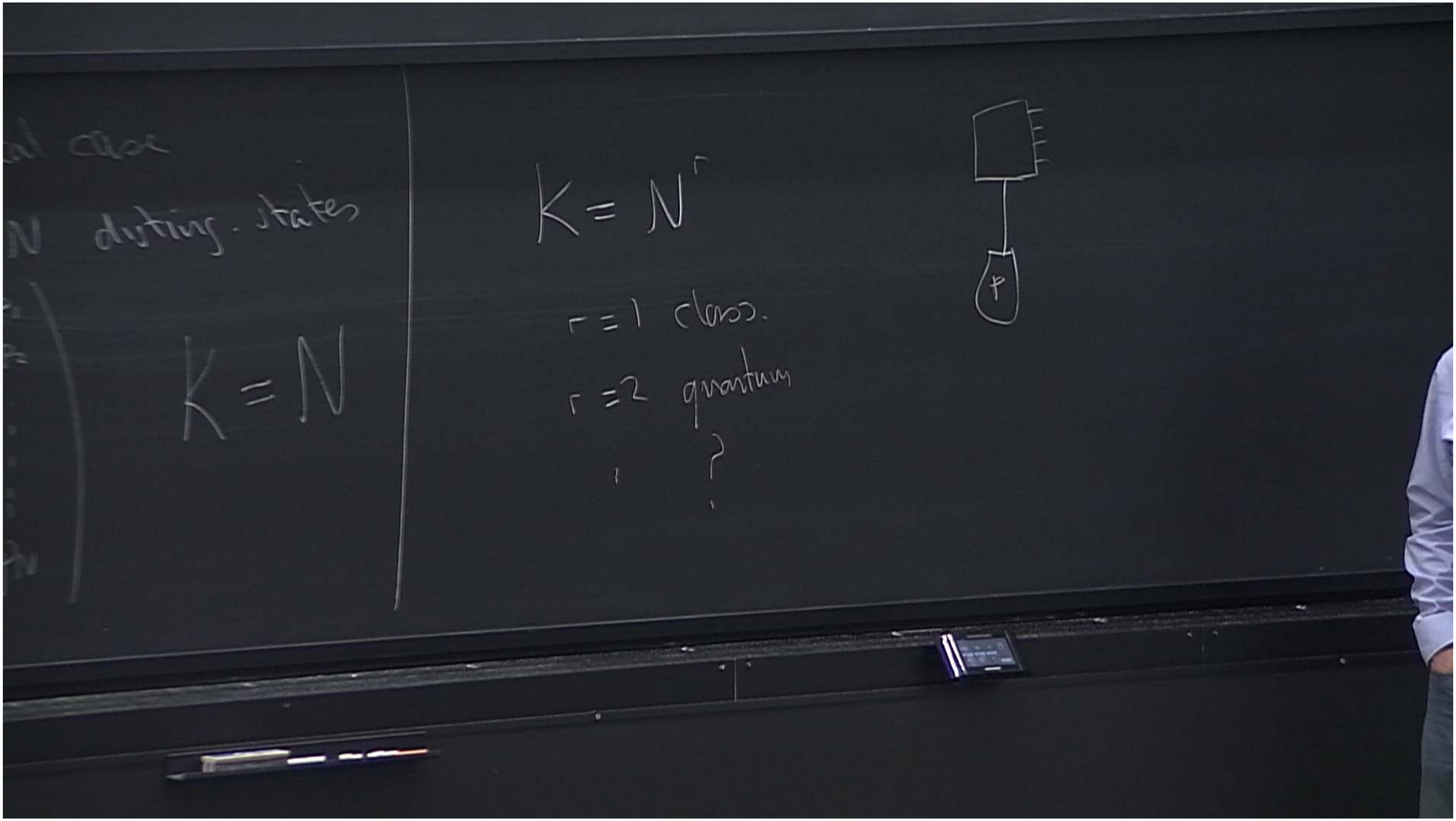
$$\hat{\rho} = \begin{pmatrix} p_1 & & & \\ & p_2 & & \\ & & \ddots & \\ & & & p_N \end{pmatrix}$$

N = max # of states that can be perfectly distinguished (in a single shot)

$$K = N + \underbrace{2}_{\text{because complex } H.} \frac{N(N-1)}{2} = N^2$$


In classical case
Have N disting. states
$\vec{p} = \begin{pmatrix} p_1 \\ p_2 \\ \vdots \\ p_N \end{pmatrix}$
$K = N$
$K = N^r$
$r = 1$ class.
$r = 2$ quantum
?


In classical case
Have N disting. states
p = (p1, p2, ..., pN)
K = N
K = N^r
r = 1 class.
r = 2 quantum
?


al case
N disting. states
K = N
K = N^r
r = 1 class.
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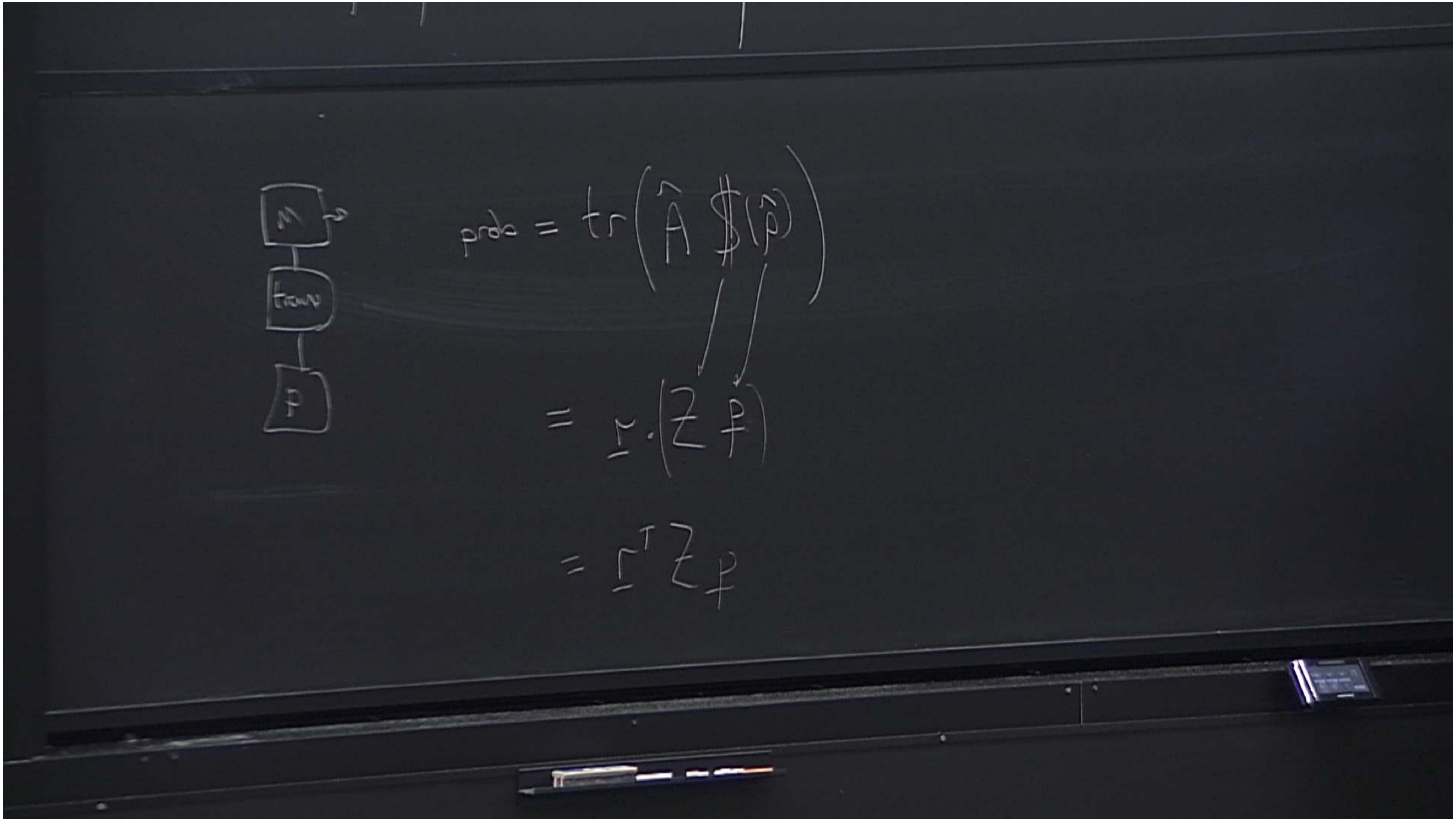
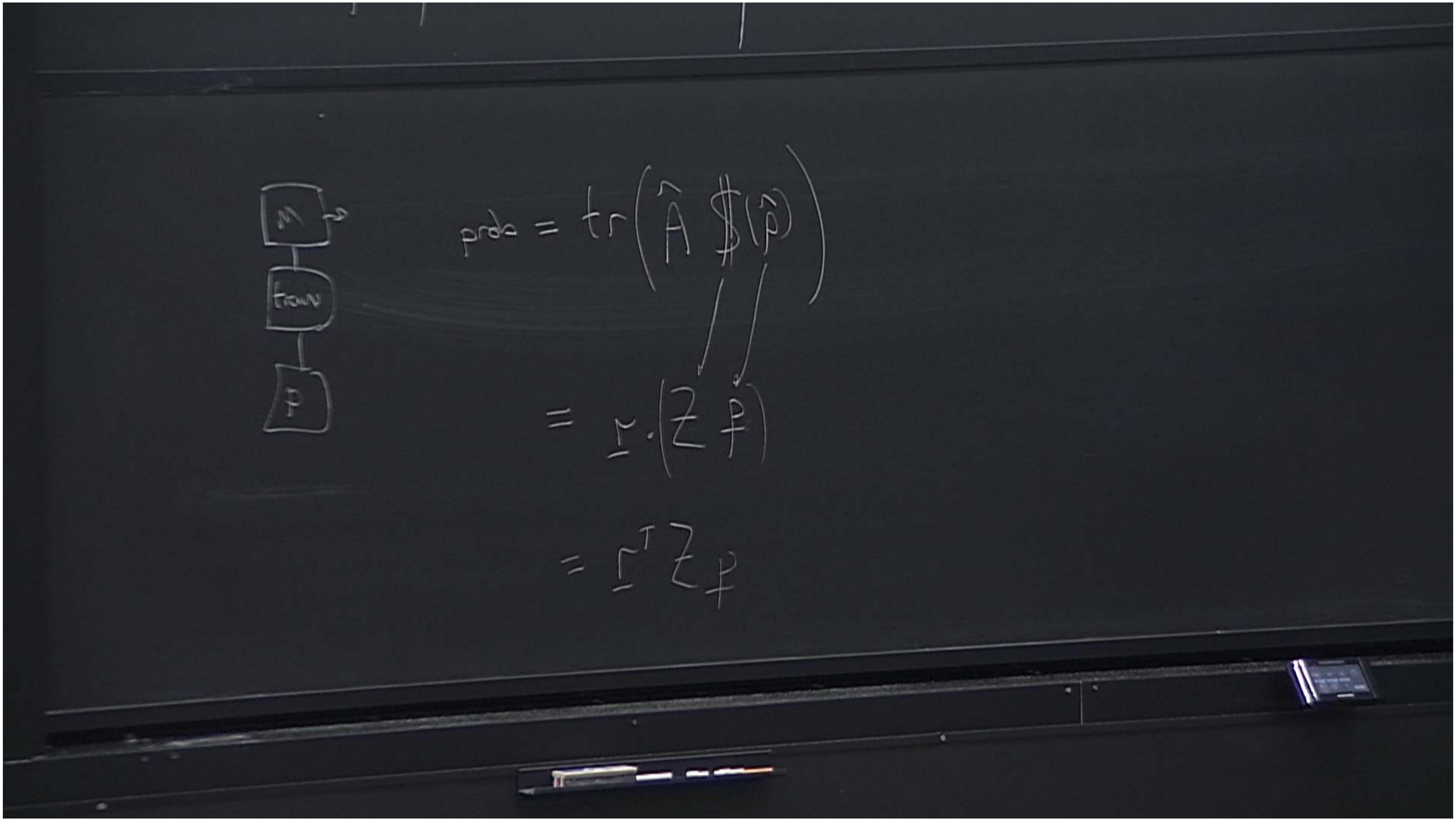
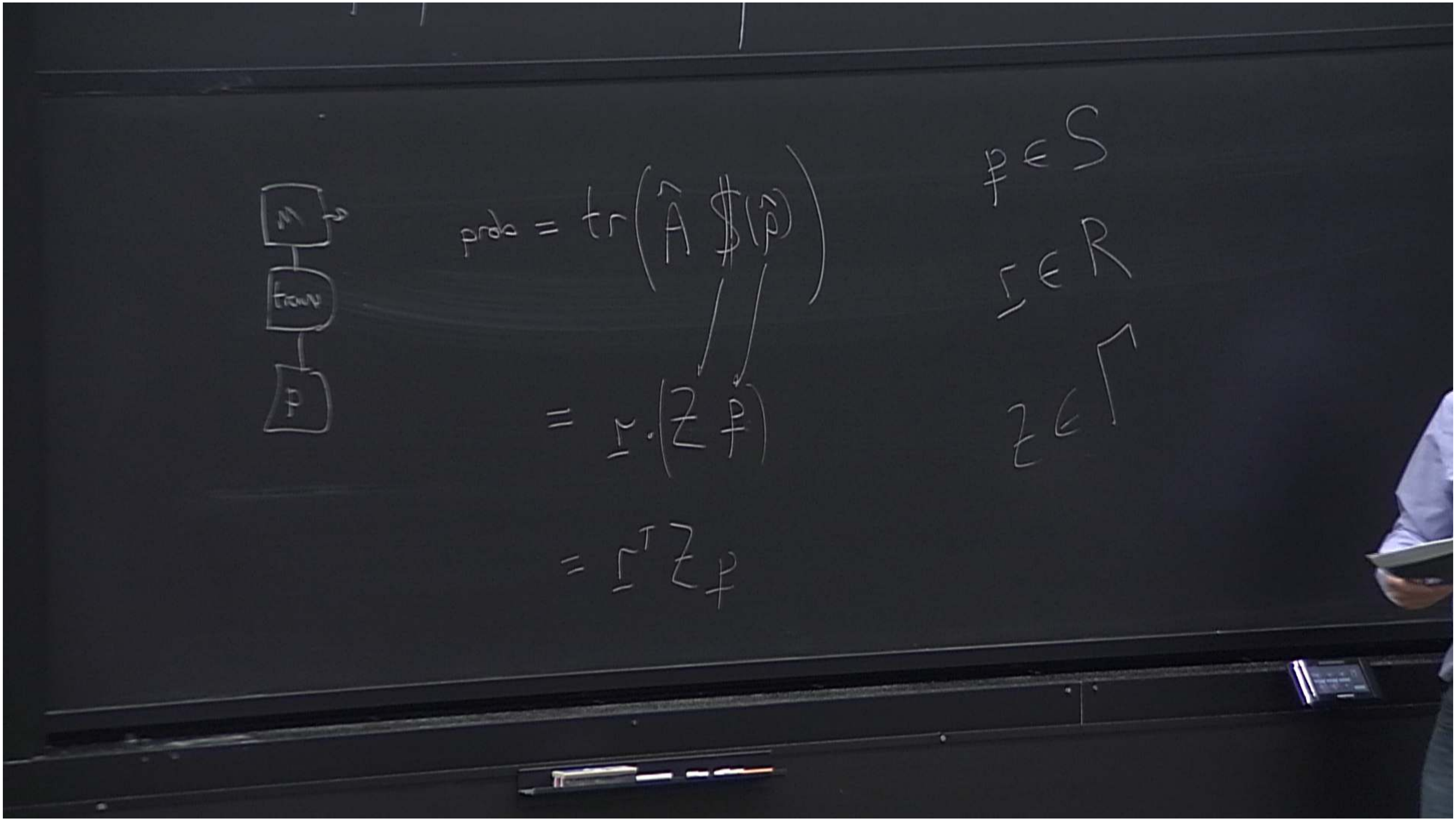
?


M
trans
p
prob = tr(Â $(p̂))
= r · (Z p)
= r^T Z p

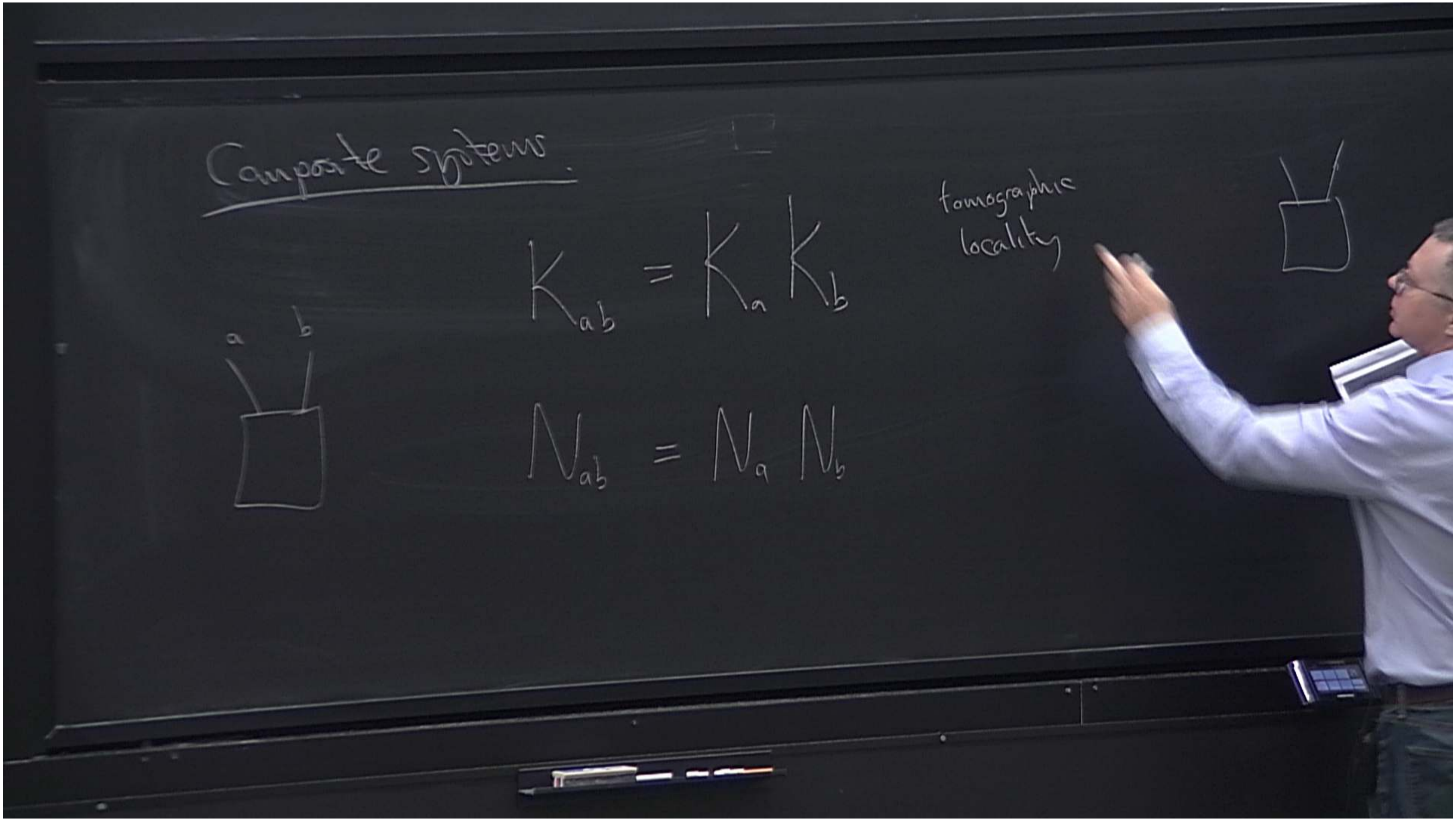

M
trans
p
prob = $\mathrm{tr}\left(\hat{A}\,\$(\hat{\rho})\right)$
$= \underline{r}\cdot\left(\underline{Z}\,\underline{p}\right)$
$= \underline{r}^T \underline{Z}\,\underline{p}$

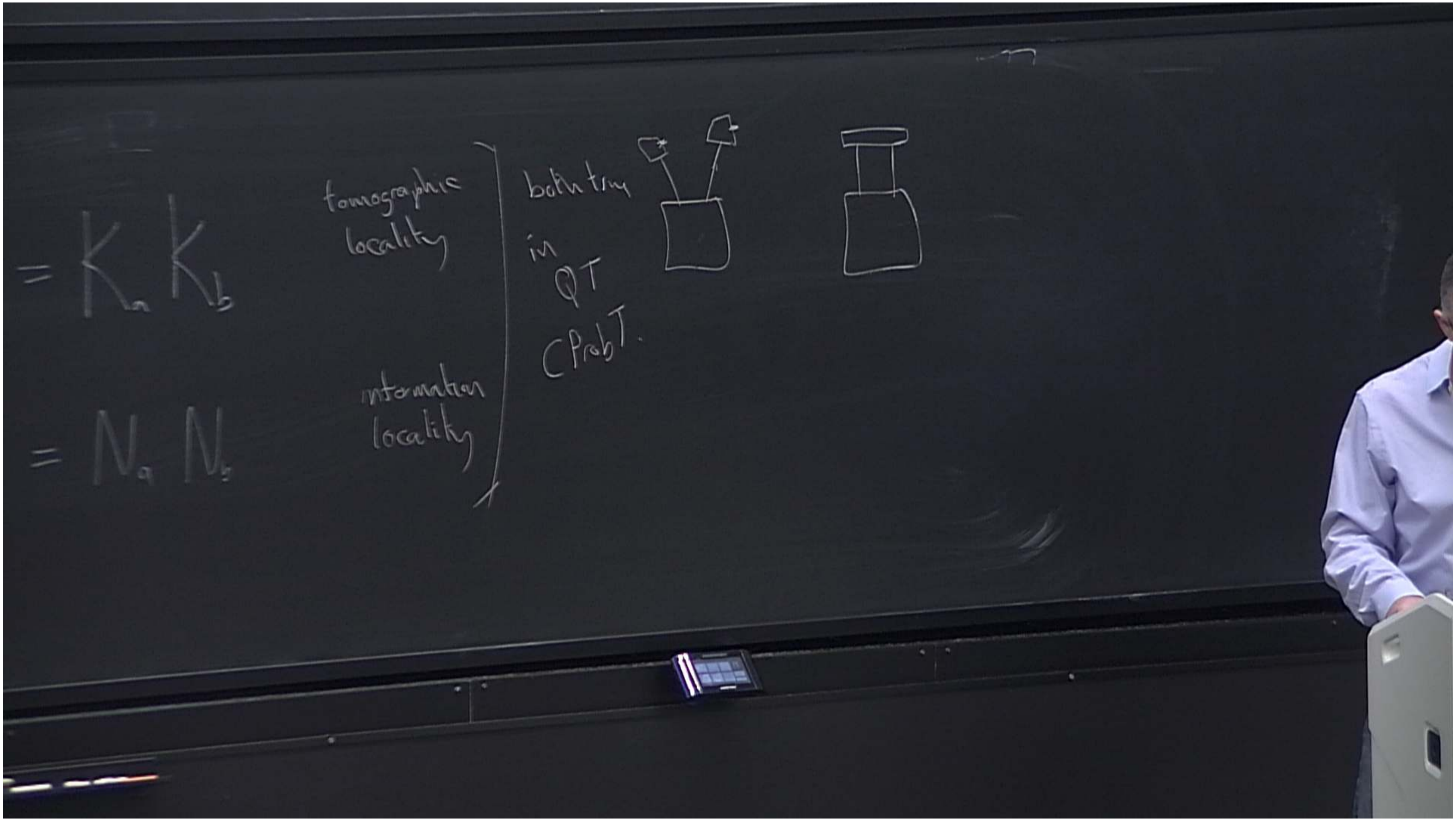

M
trans
p
prob = tr(Â $(p̂))
= r·(Z p)
= r^T Z p
p ∈ S
r ∈ R
Z ∈ Γ

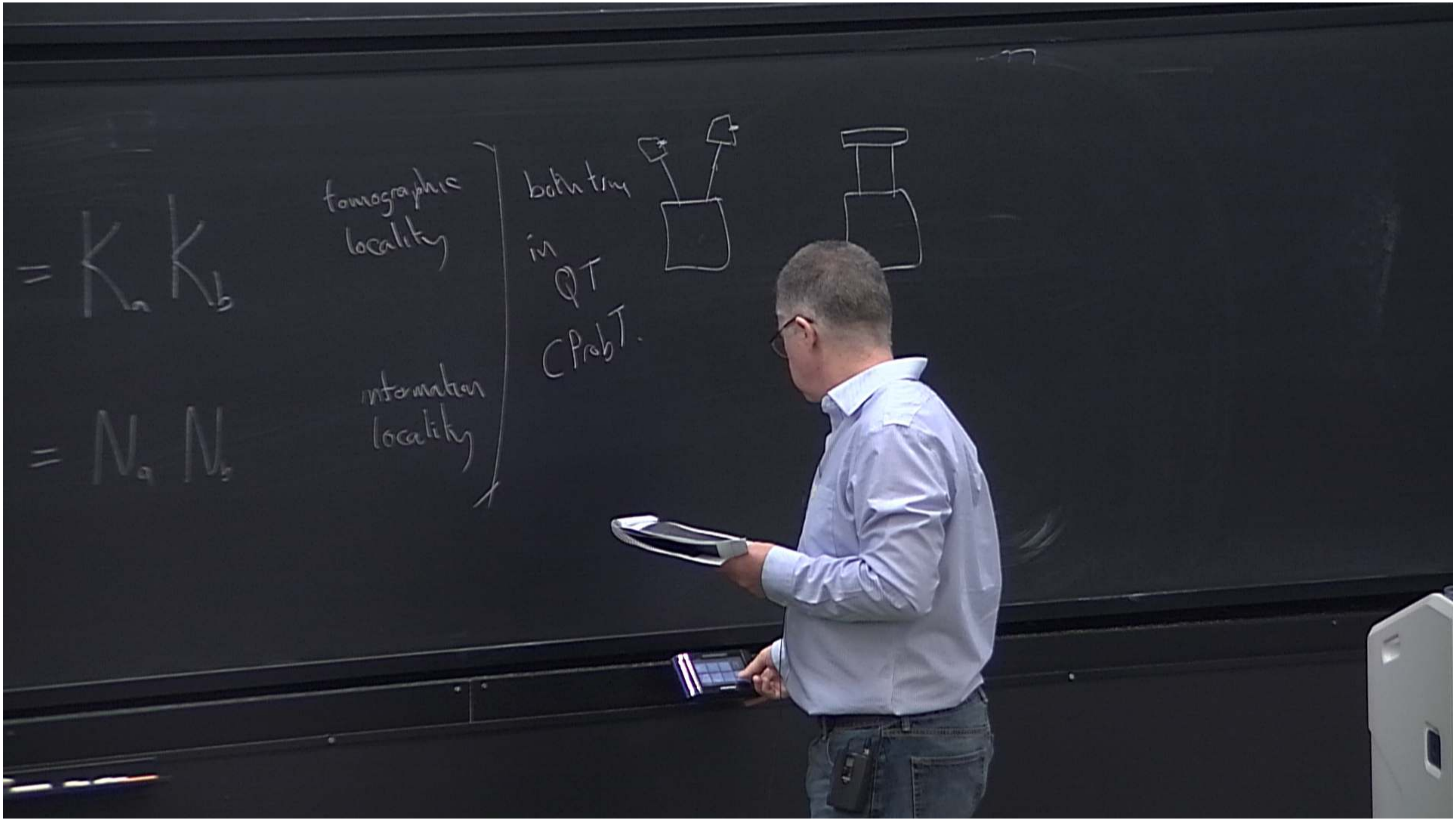
Composite systems.

$$K_{ab} = K_a K_b$$

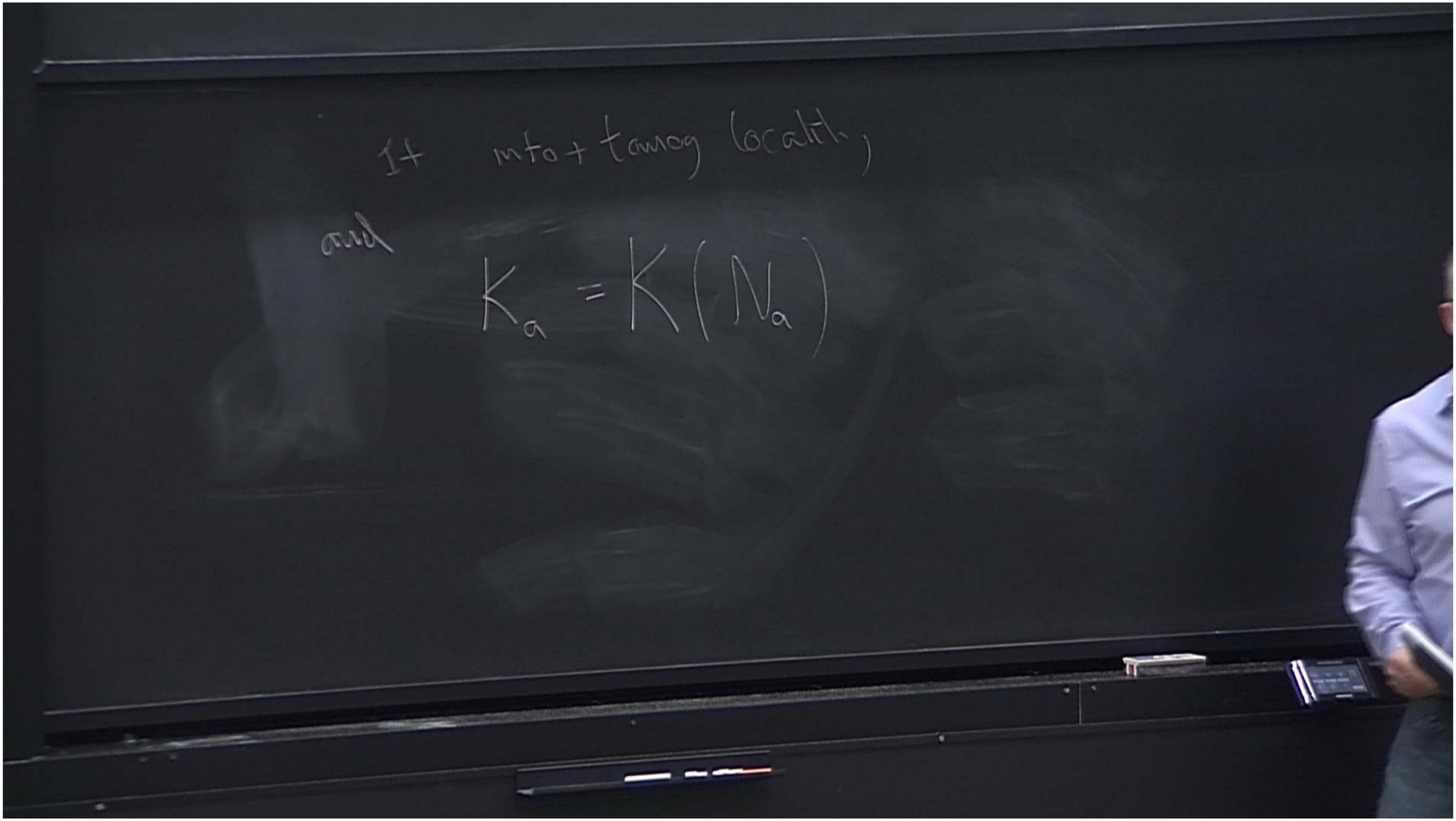
$$N_{ab} = N_a N_b$$

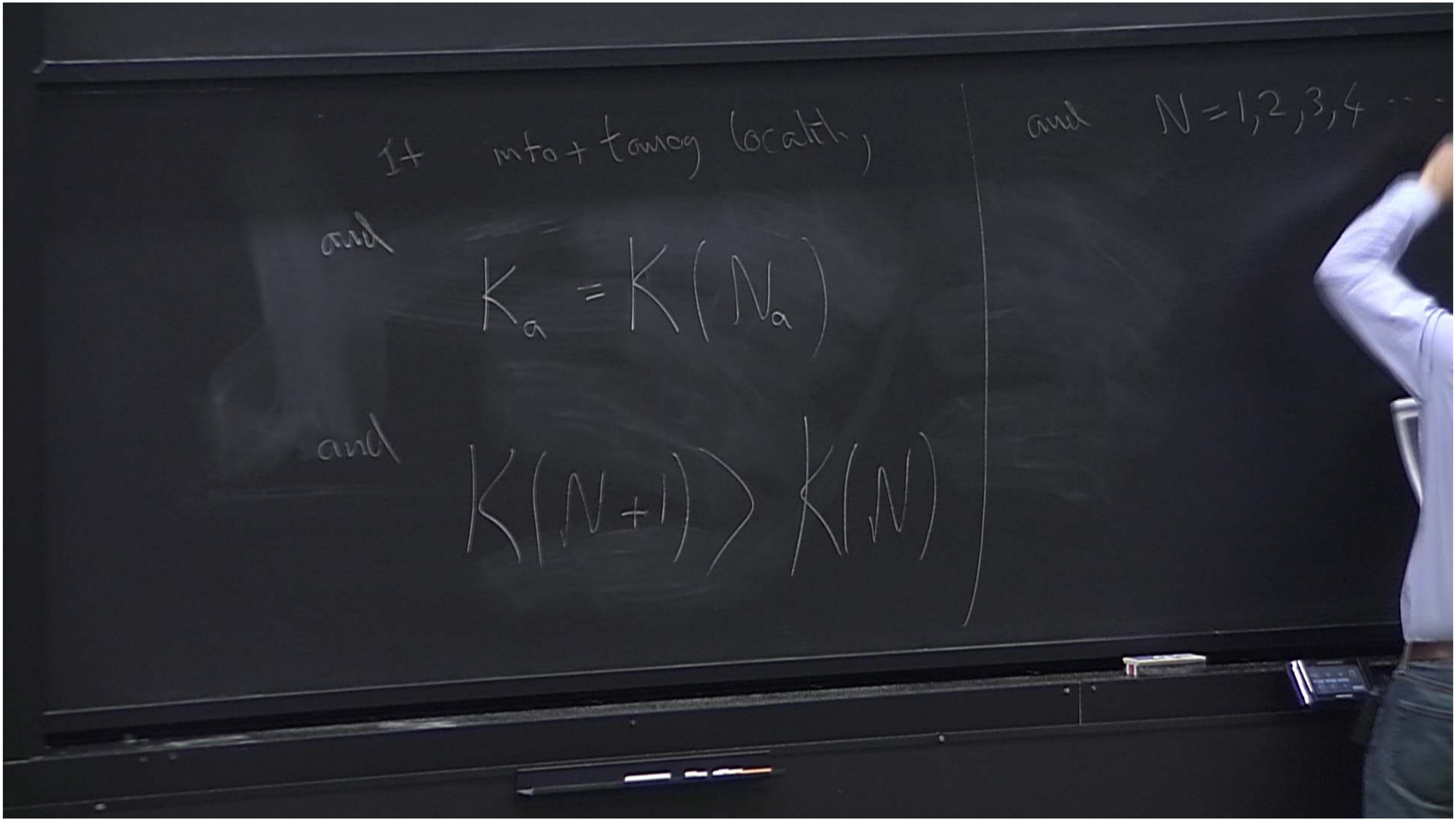

Composite systems
$K_{ab} = K_a K_b$
$N_{ab} = N_a N_b$
tomographic locality
a
b

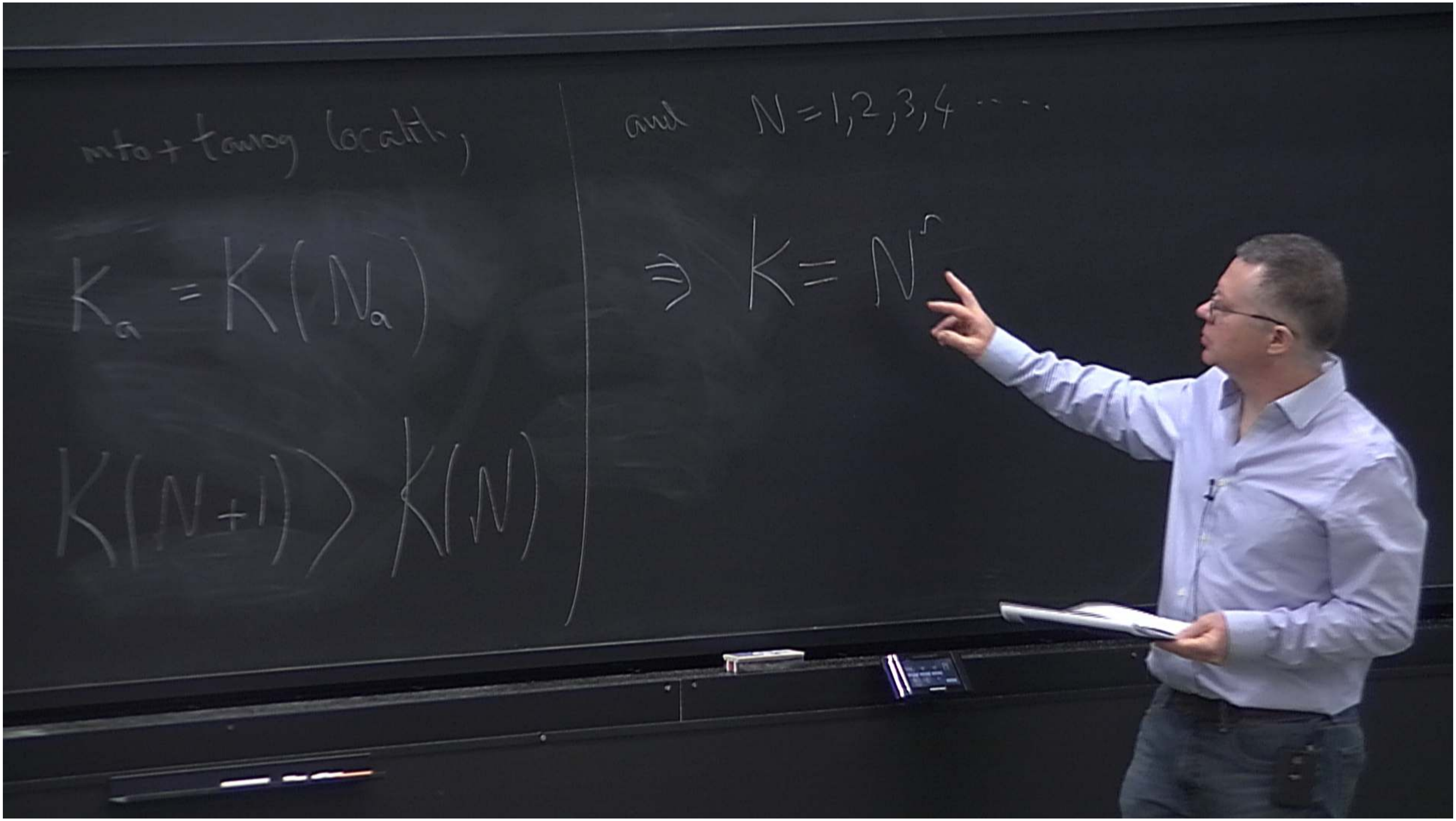

= K a K b
= N a N b
tomographic locality
information locality
both true in QT CProbT.

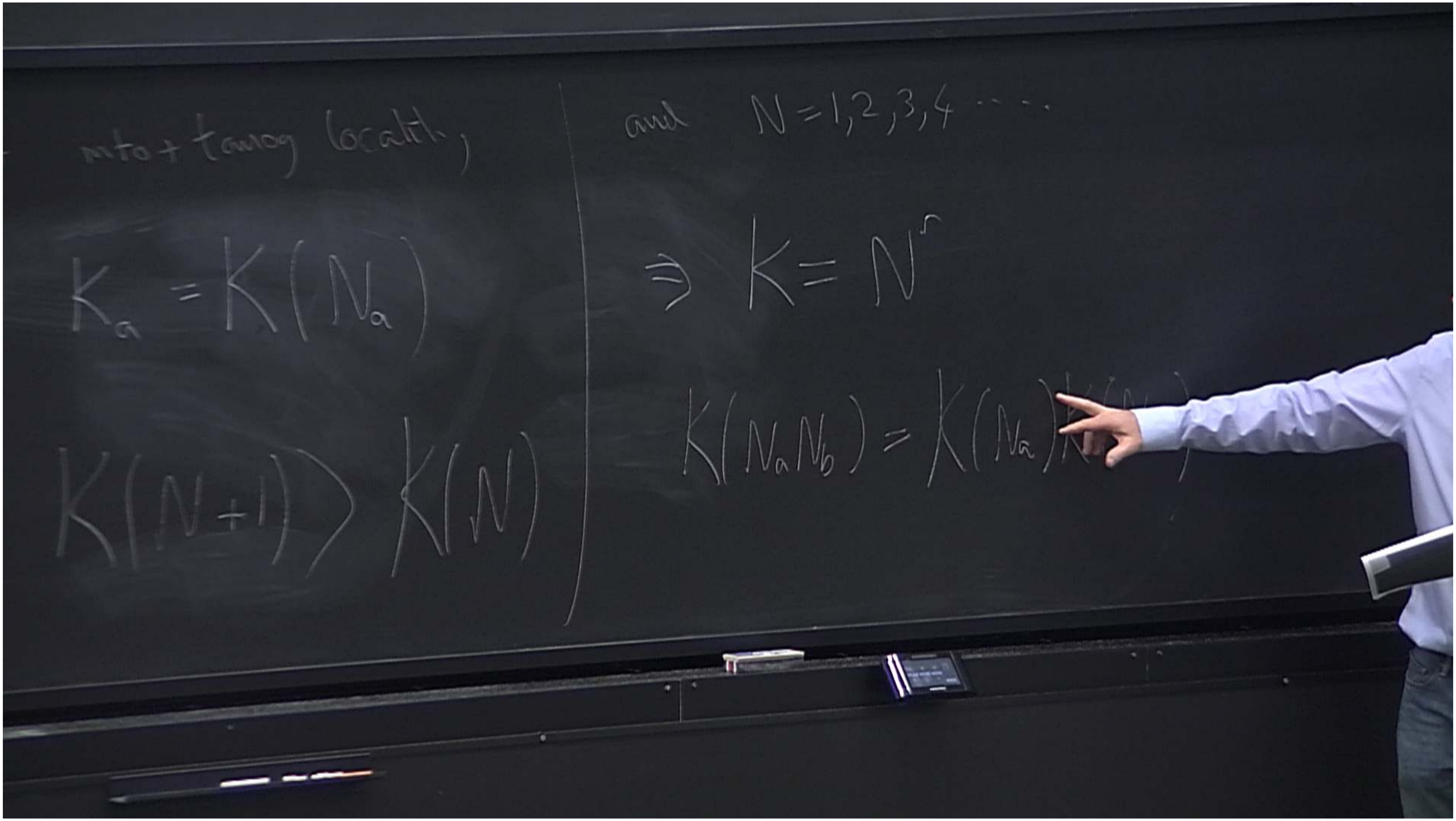


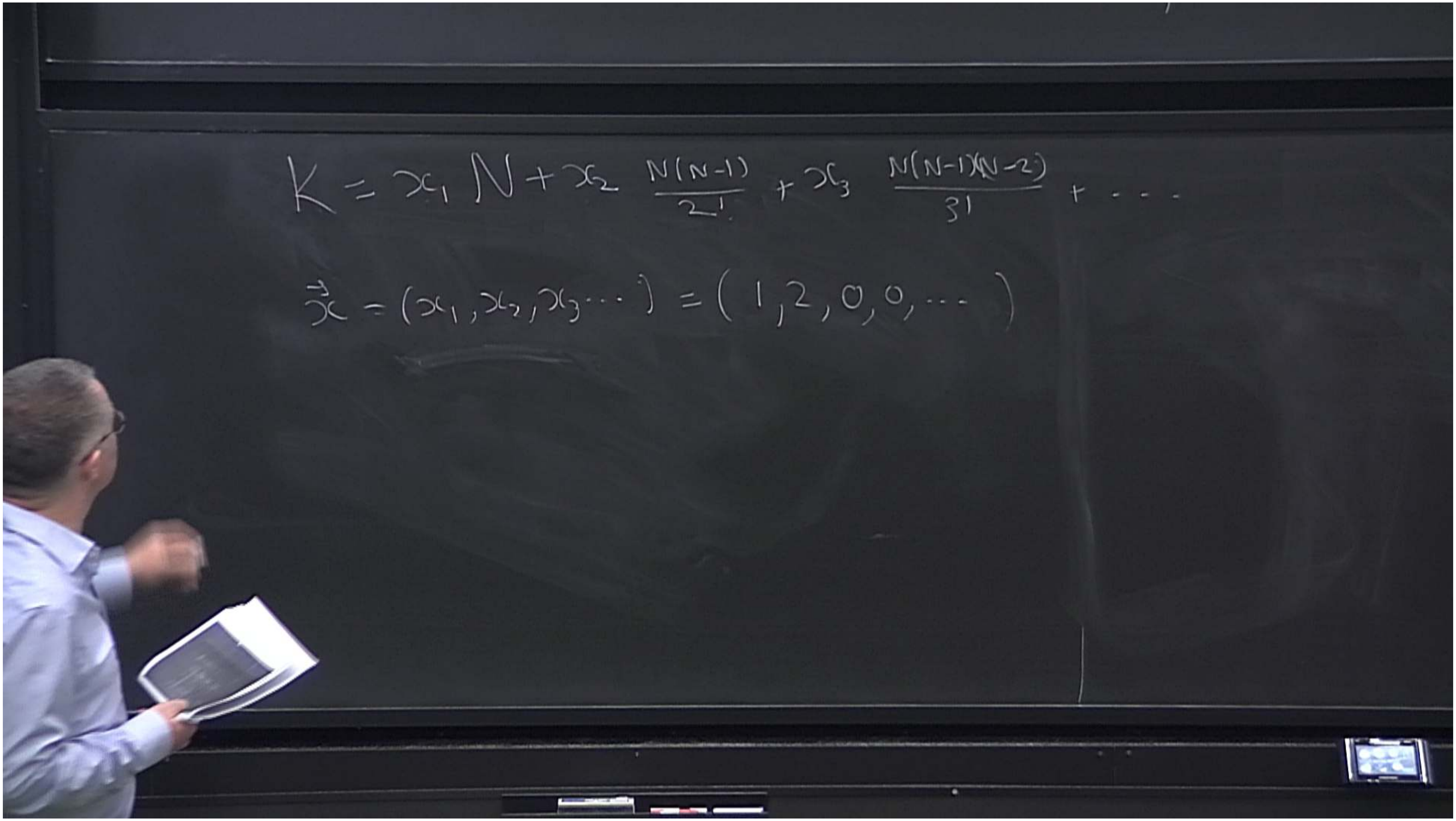
$= K_a K_b$
tomographic locality
both true in QT CProbT.
$= N_a N_b$
information locality


and
$K_a = K(N_a)$


and
$K_a = K(N_a)$
and
$K(N+1) > K(N)$
and $N = 1, 2, 3, 4 \ldots$


and N = 1, 2, 3, 4 ....
K_a = K(N_a)
⇒ K = N^n
K(N+1) > K(N)


and N = 1, 2, 3, 4 ....
K_a = K(N_a)
K(N+1) > K(N)
⇒ K = N^n
K(N_a N_b) = K(N_a)

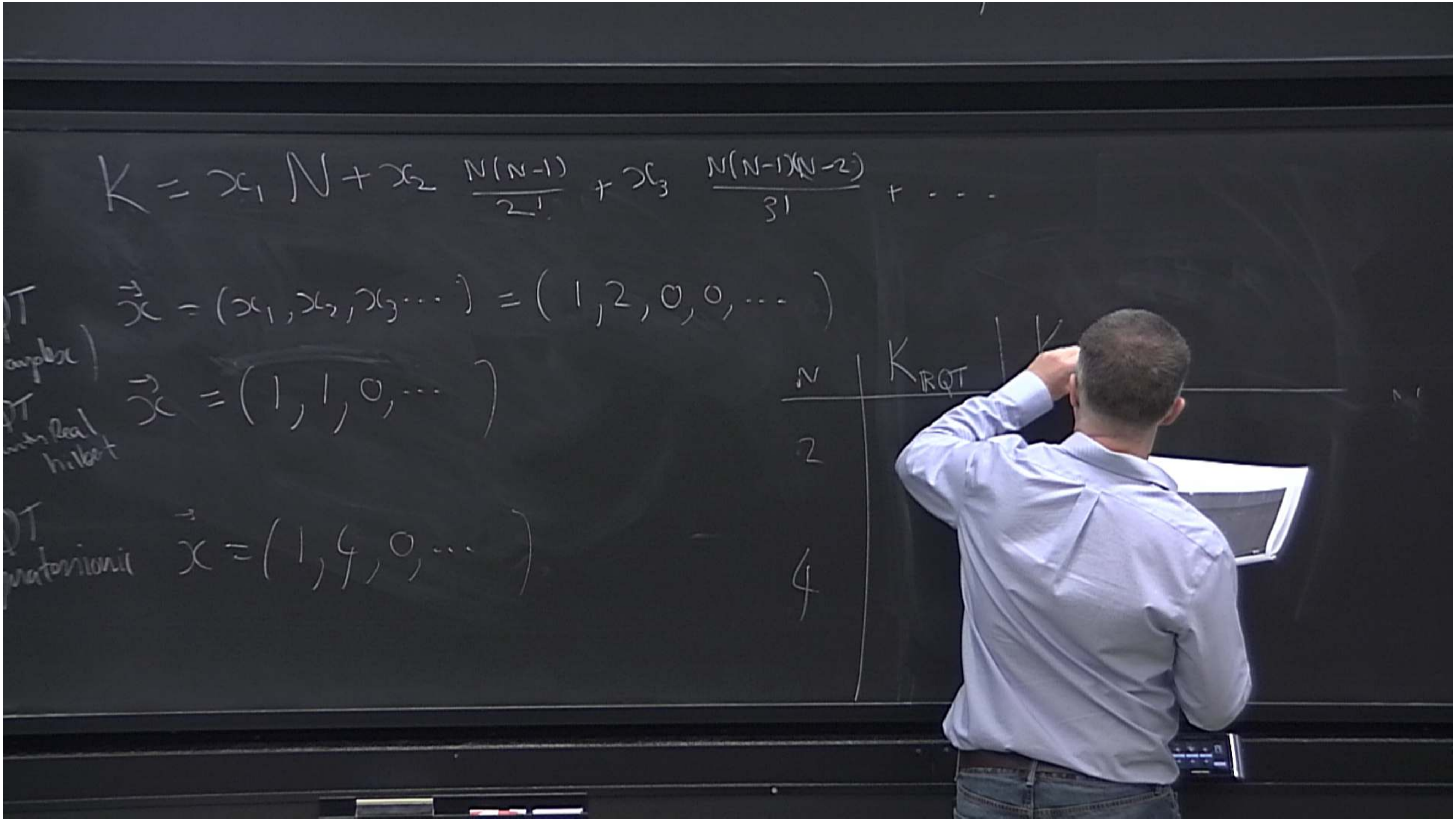

$K = x_1 N + x_2 \frac{N(N-1)}{2!} + x_3 \frac{N(N-1)(N-2)}{3!} + \dots$
$\vec{x} = (x_1, x_2, x_3 \cdots) = (1, 2, 0, 0, \dots)$

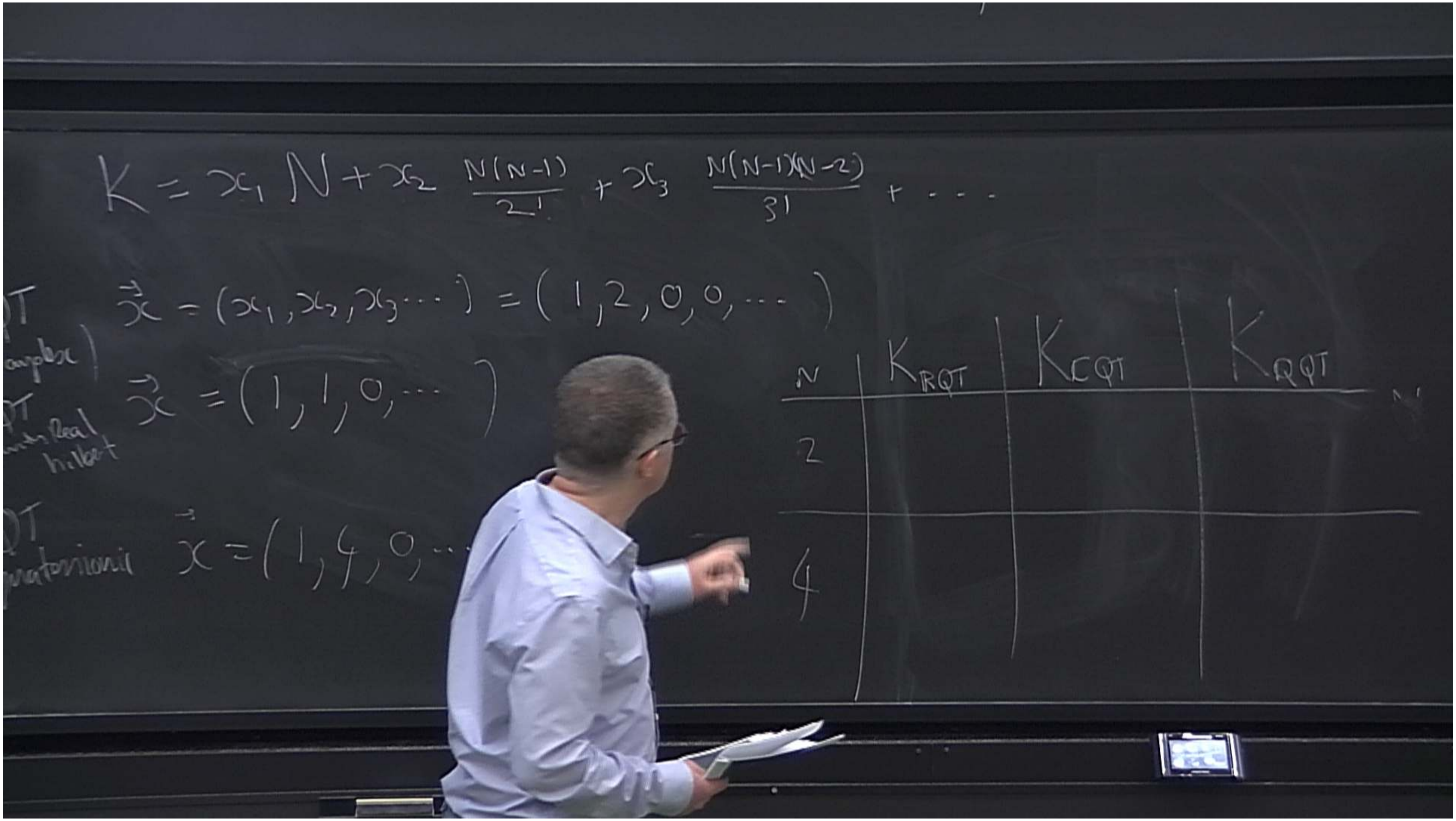
$$K = x_1 N + x_2 \frac{N(N-1)}{2!} + x_3 \frac{N(N-1)(N-2)}{3!} + \cdots$$

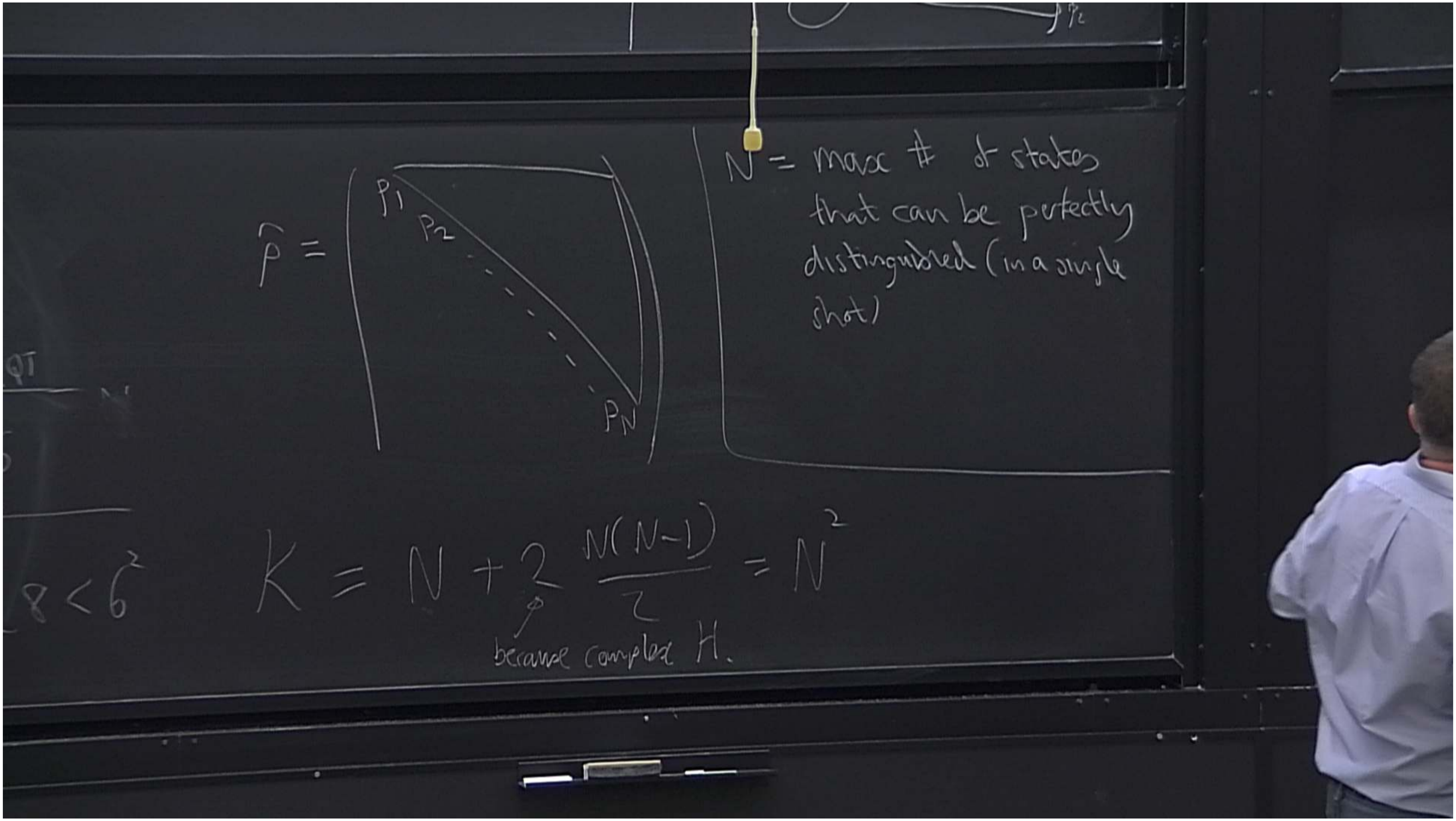
QT (Complex) $\vec{x} = (x_1, x_2, x_3 \cdots) = (1, 2, 0, 0, \cdots)$

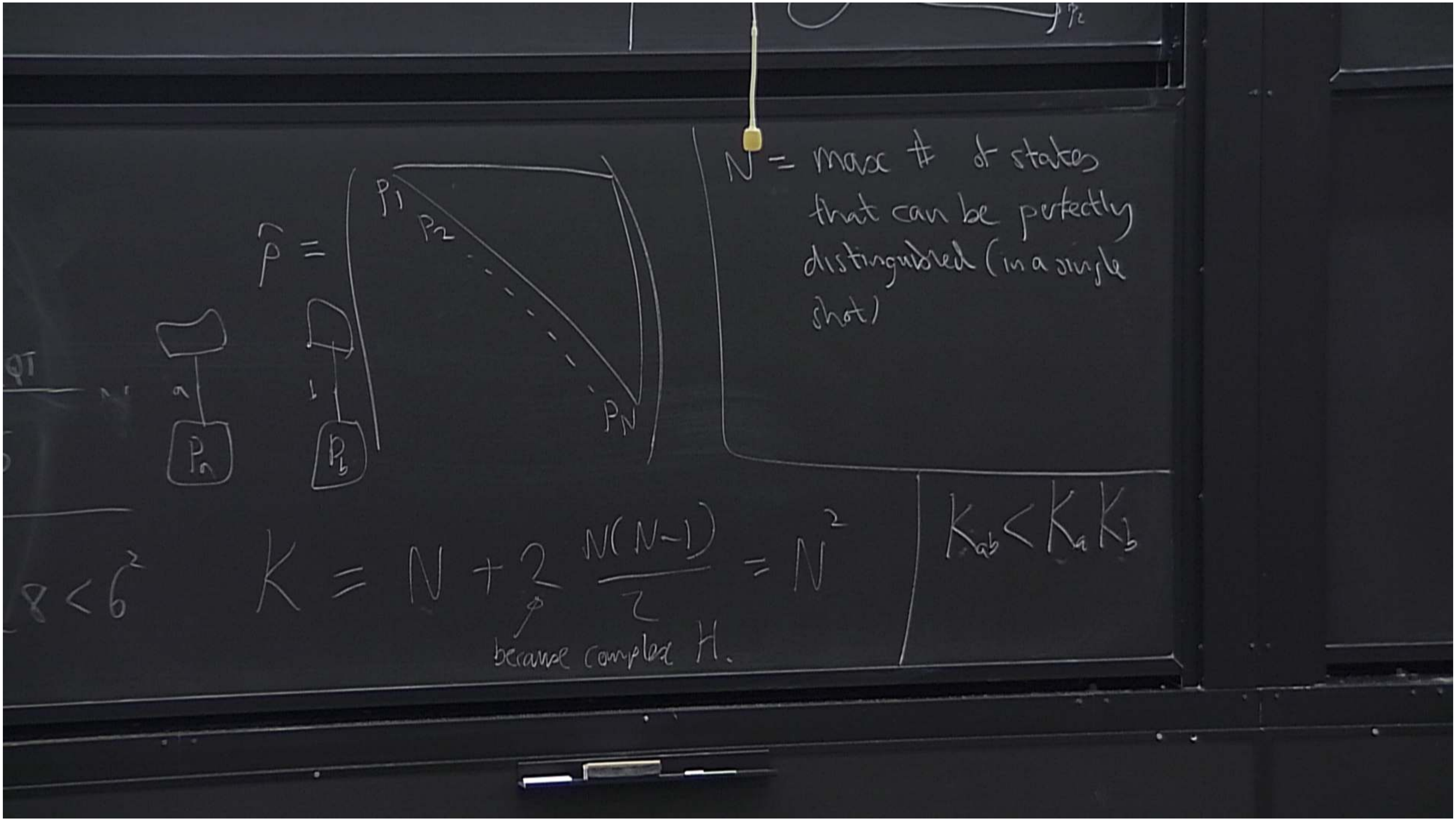
QT with Real hilbert $\vec{x} = (1, 1, 0, \cdots)$

QT quaternionic $\vec{x} = (1, 4, 0, \cdots)$


$K = x_1 N + x_2 \frac{N(N-1)}{2!} + x_3 \frac{N(N-1)(N-2)}{3!} + \cdots$
$\vec{x} = (x_1, x_2, x_3 \cdots) = (1, 2, 0, 0, \cdots)$
$\vec{x} = (1, 1, 0, \cdots)$
$\vec{x} = (1, 4, 0, \cdots)$
N | $K_{\mathbb{R}QT}$ | K
2
4


K = x1 N + x2 N(N-1)/2! + x3 N(N-1)(N-2)/3! + . . .
x = (x1, x2, x3 . . .) = (1, 2, 0, 0, . . .)
x = (1, 1, 0, . . .)
Real hilbert
x = (1, 4, 0, . .
N
K_RQT
K_CQT
K_QQT
2
4


ρ̂ =
ρ1
ρ2
ρN
N = max # of states
that can be perfectly
distinguished (in a single
shot)
8 < 6²
K = N + 2 N(N−1)/2 = N²
because complex H.


N = max # of states that can be perfectly distinguished (in a single shot)
$\hat{\rho} =$
p_1
p_2
p_N
P_a
P_b
$K = N + 2 \frac{N(N-1)}{2} = N^2$
because complex H.
$K_{ab} < K_a K_b$
$8 < 6^2$