Title: Quantum Foundations Lecture - 230203

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Collection: Quantum Foundations (2022/2023)

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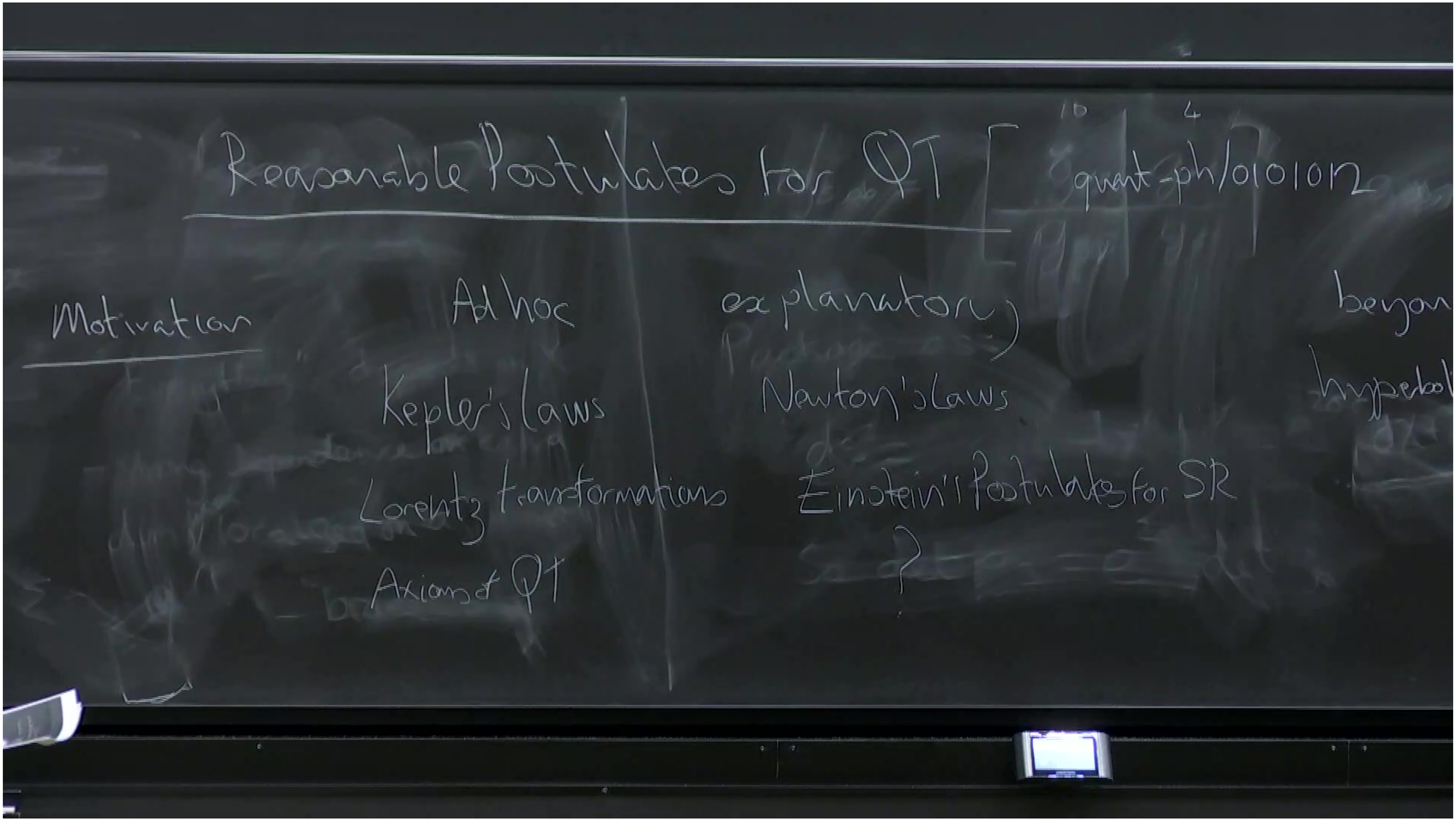
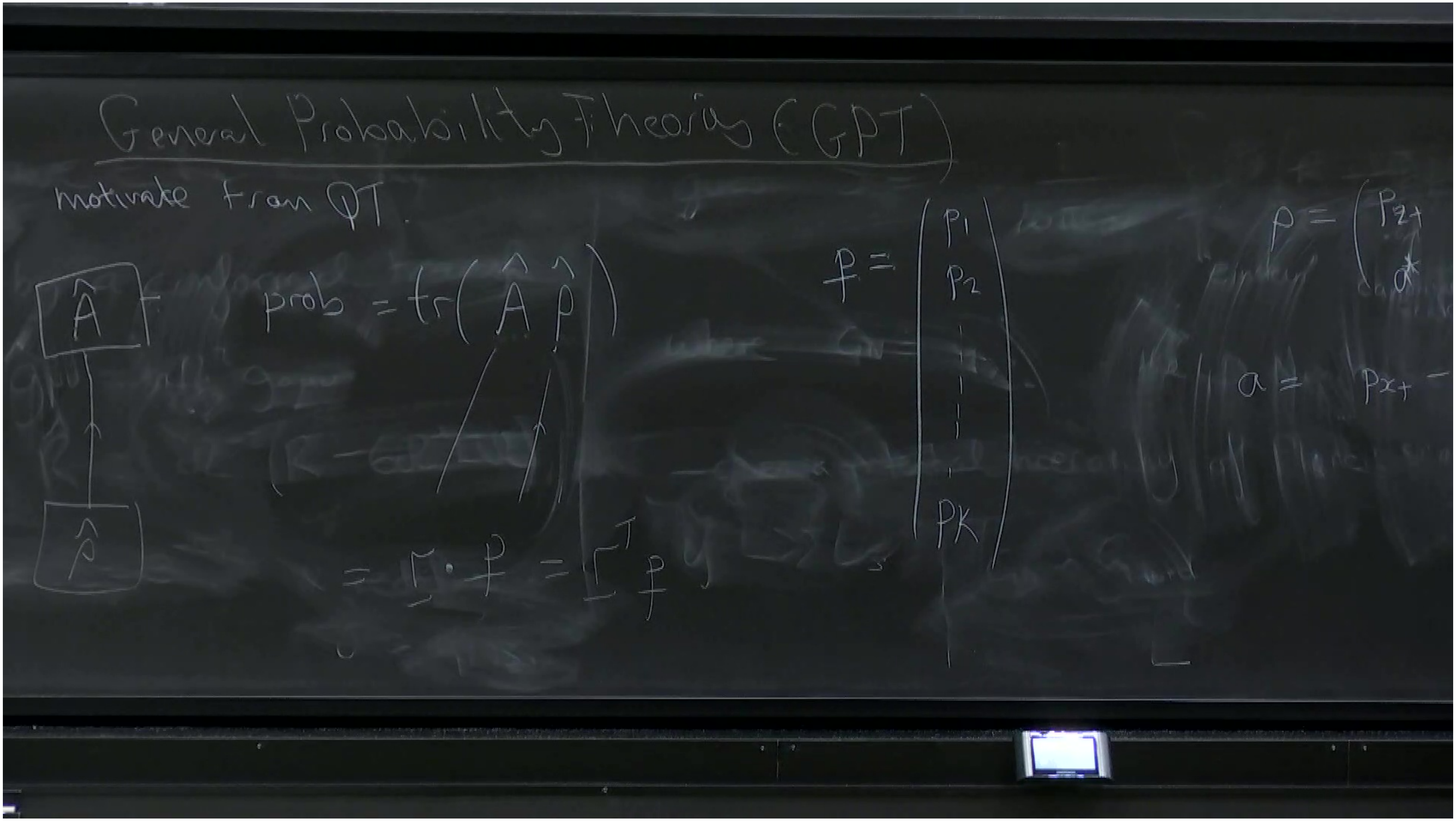

Reasonable Postulates for QT
quant-ph/0101012
Motivation
Ad hoc
explanatory
Kepler's laws
Newton's laws
Lorentz transformations
Einstein's Postulates for SR
Axioms of QT
?

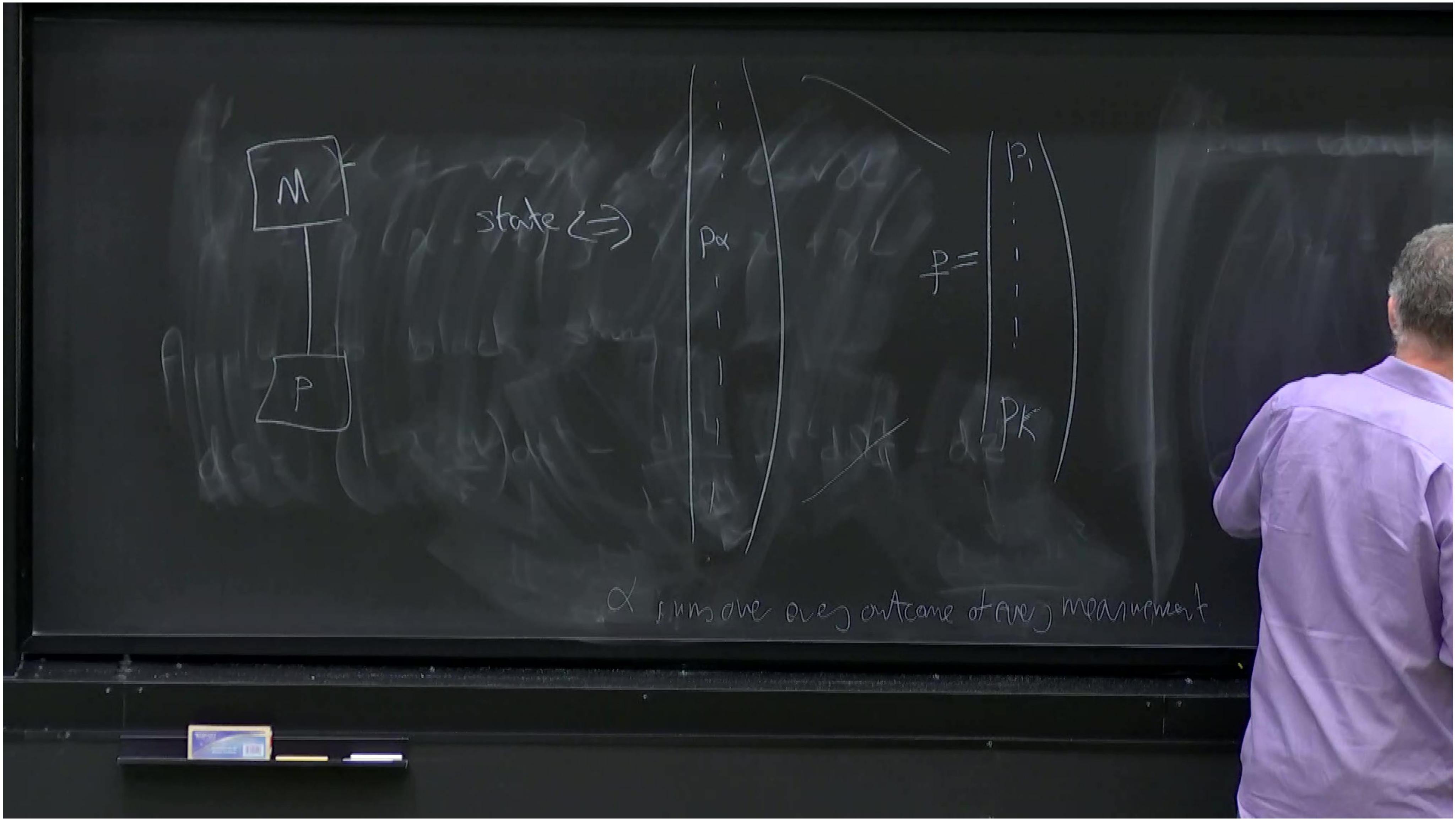

General Probability Theories (GPT)
motivate from QT
prob = tr(Â ρ̂)
= r · p = r^T p
p =
p1
p2
pK
ρ =
a =

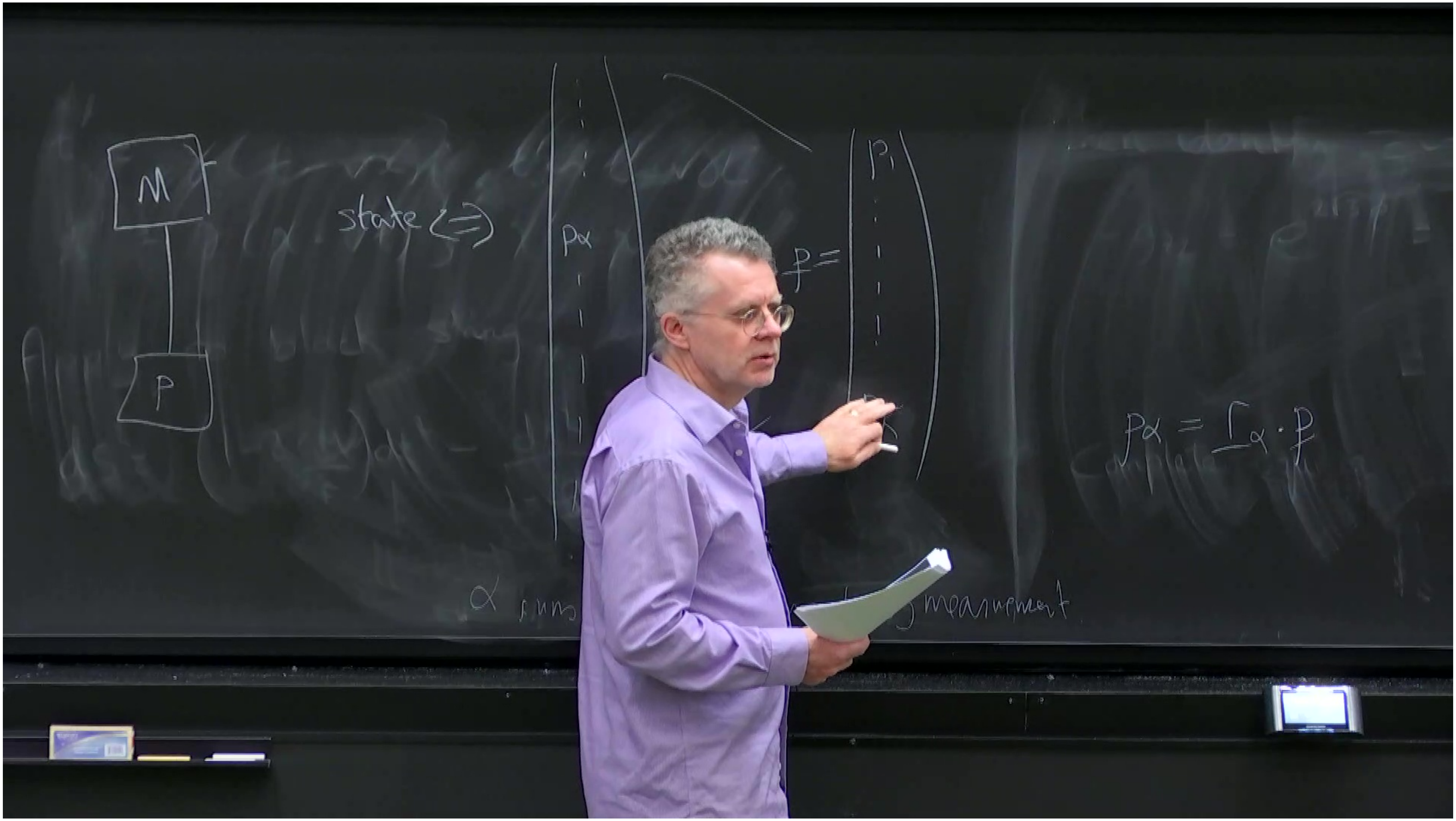
$$\rho = \begin{pmatrix} p_{z+} & a \\ a^* & p_{z-} \end{pmatrix}$$

$$\vec{p} = \begin{pmatrix} p_{z+} \\ p_{z-} \\ p_{x+} \\ p_{y+} \end{pmatrix}$$

$$a = p_{x+} - i p_{y+} - \frac{(1-i)}{2}\left(p_{z+} + p_{z-}\right)$$

$$p_{z+} + p_{z-} = p_{y+} + p_{y-}$$


M
P
state ⟺
pα
p =
p1
pK
α runs over every outcome of every measurement

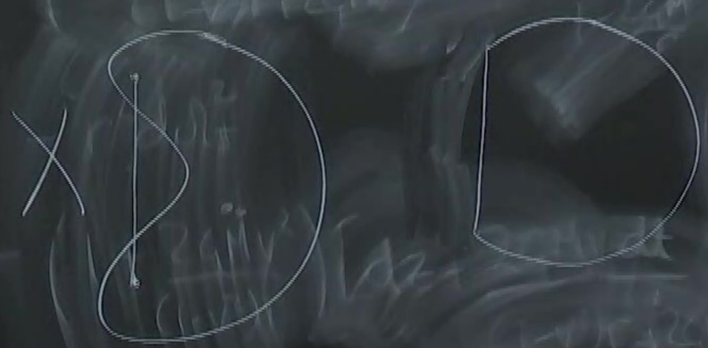

M
P
state ⟺
pα
p =
measurement
pα = Γα · p

$$\hat{\rho} = \lambda \rho_A + (1-\lambda)\rho_B \qquad 0 \leq \lambda \leq 1$$

pure state is not a mixture.

$$\rho = \lambda \rho_A + (1-\lambda)\rho_B$$

Sets of states are convex.



$\hat{P}_k \quad k=1$ to $K=N^2$ N is Hilbert space dim.

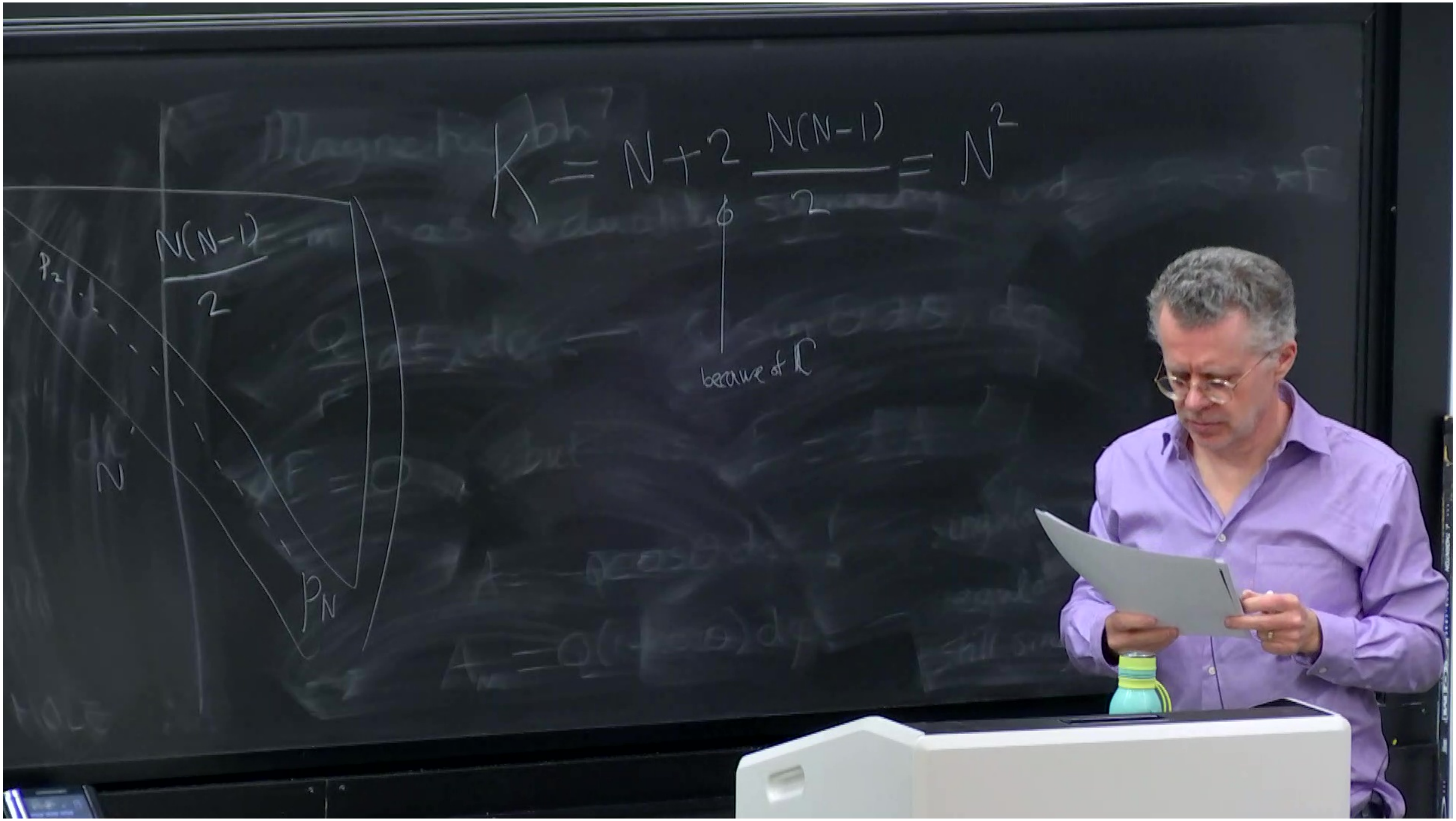
a spanning set of the space of Hermitean operators.

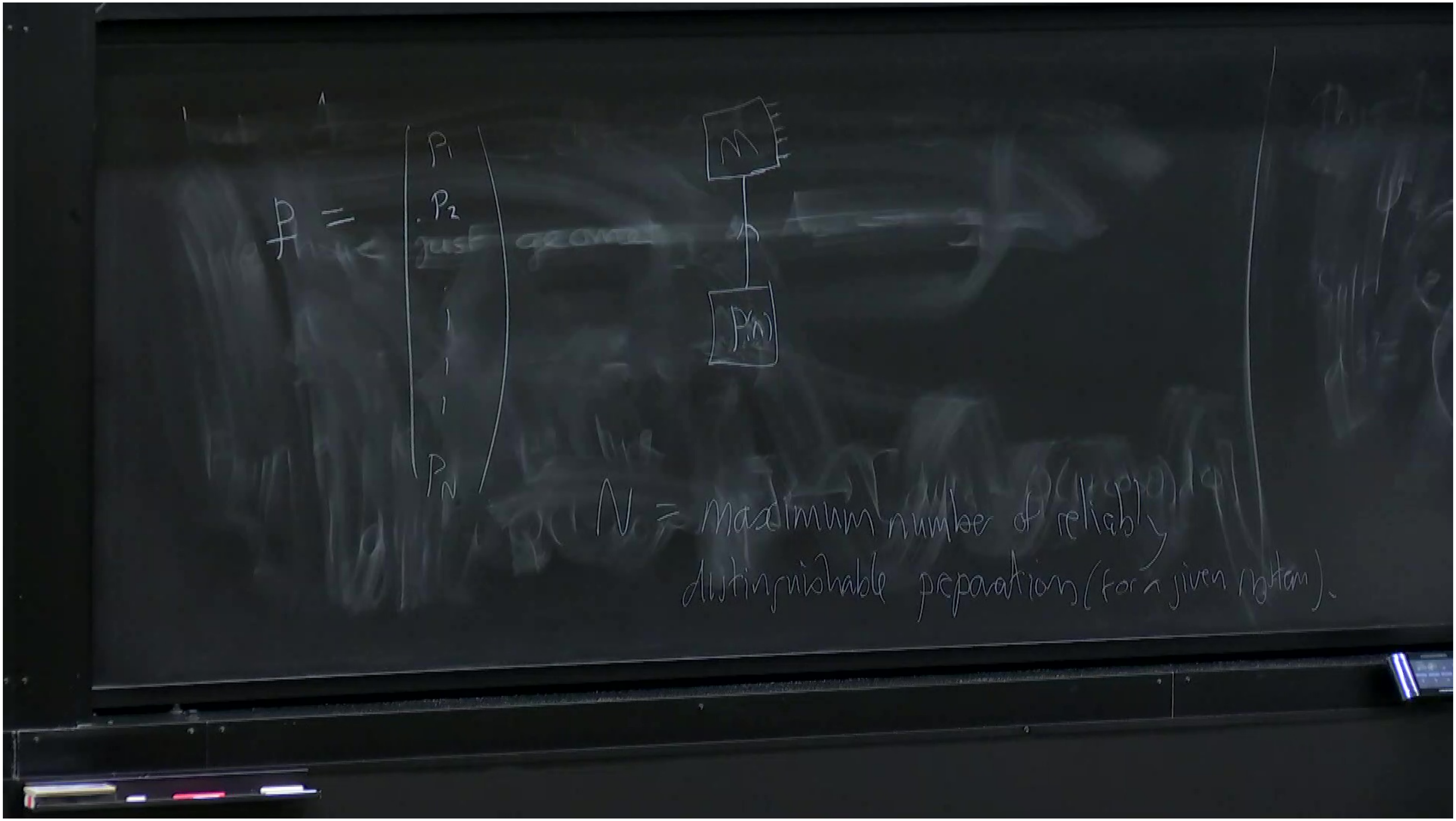
$$\hat{\rho} = \sum_k c_k \hat{P}_k$$

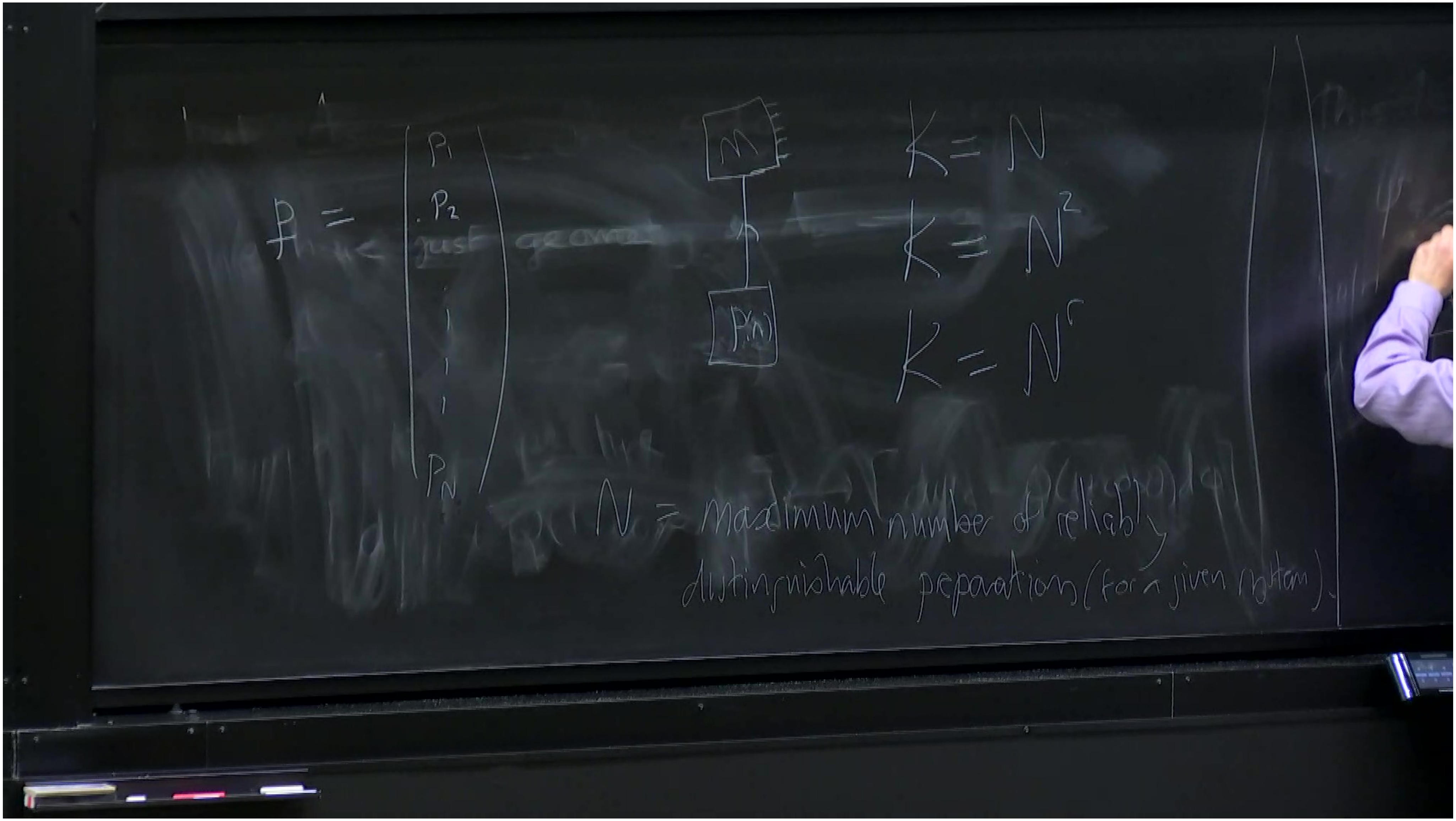
real.

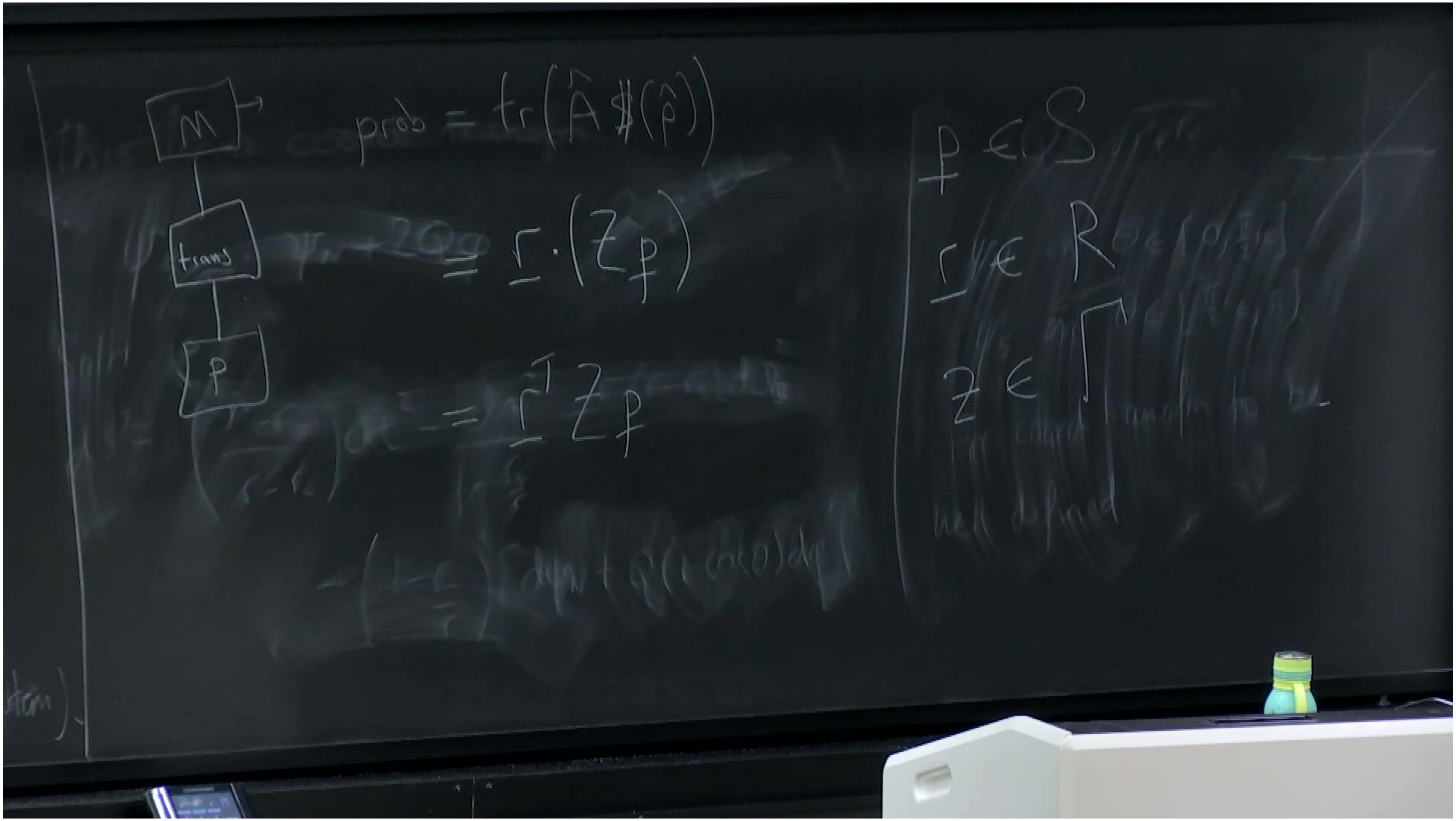
$$p = \begin{pmatrix} \vdots \\ tr(\hat{P}_k \rho) \\ \vdots \end{pmatrix}$$

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


K = N + 2 N(N−1)/2 = N²
because of ℂ
N(N−1)/2
p₂
p_N
N


ρ = (p1, p2, ..., pN)
M
p(n)
N = maximum number of reliably distinguishable preparation (for a given system).

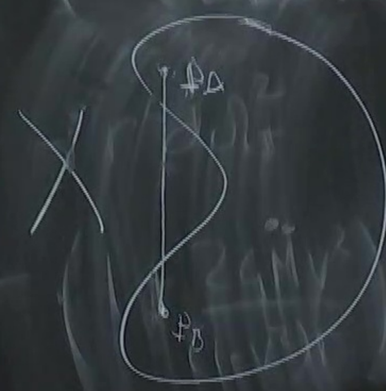

ρ =
p1
p2
pN
M
p(n)
K = N
K = N2
K = Nr
N = maximum number of reliably distinguishable preparations (for a given system).


M
trans
p
prob = tr(Â $(p̂))
= r · (Z p)
= r⁻¹ Z p
p ∈ S
r ∈ R
Z ∈ Γ
well defined

$$\hat{\rho} = \lambda \rho_A + (1-\lambda)\rho_B \qquad 0 \le \lambda \le 1$$

pure state is not a mixture.

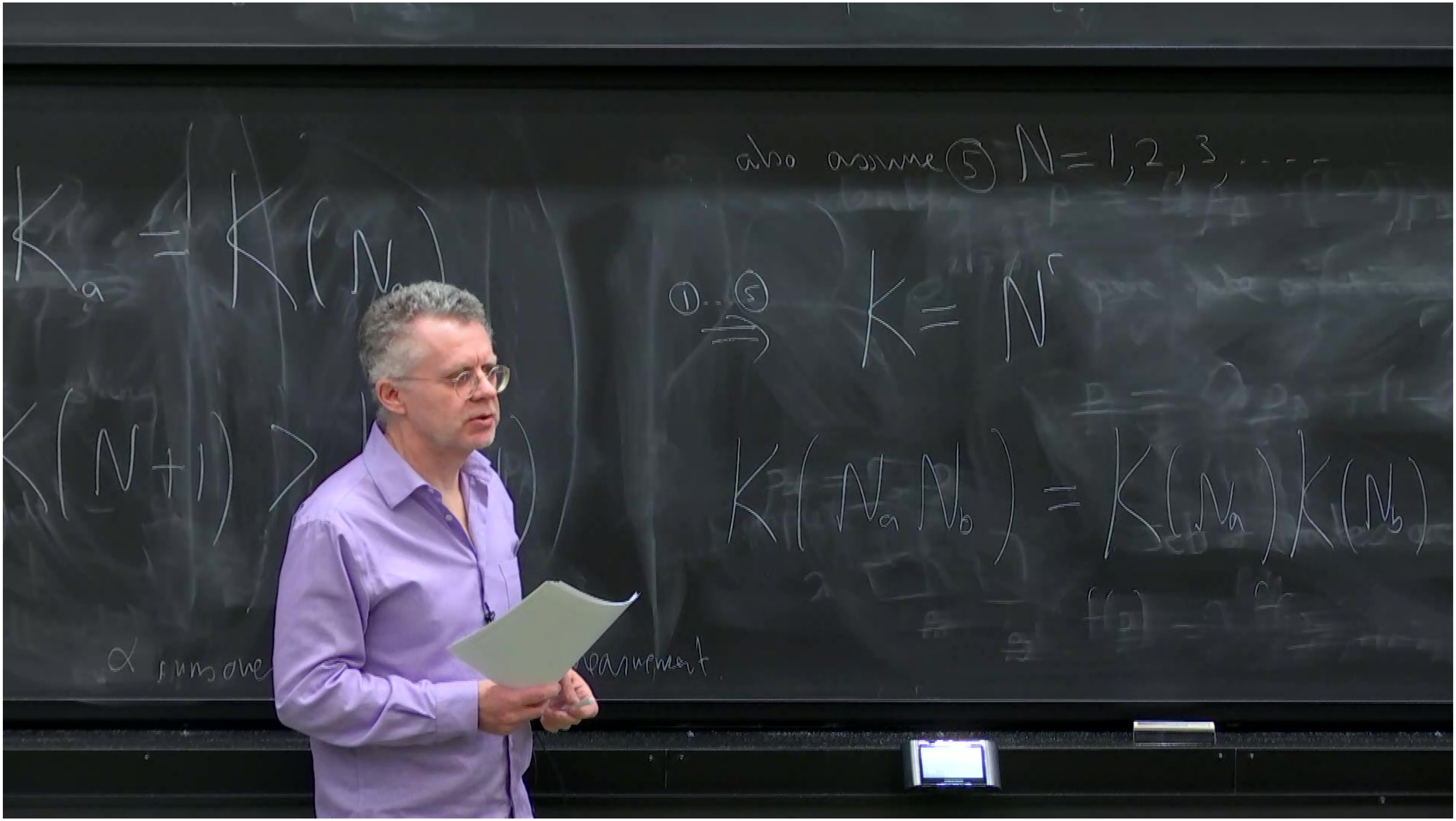
$$p = \lambda p_A + (1-\lambda) p_B$$

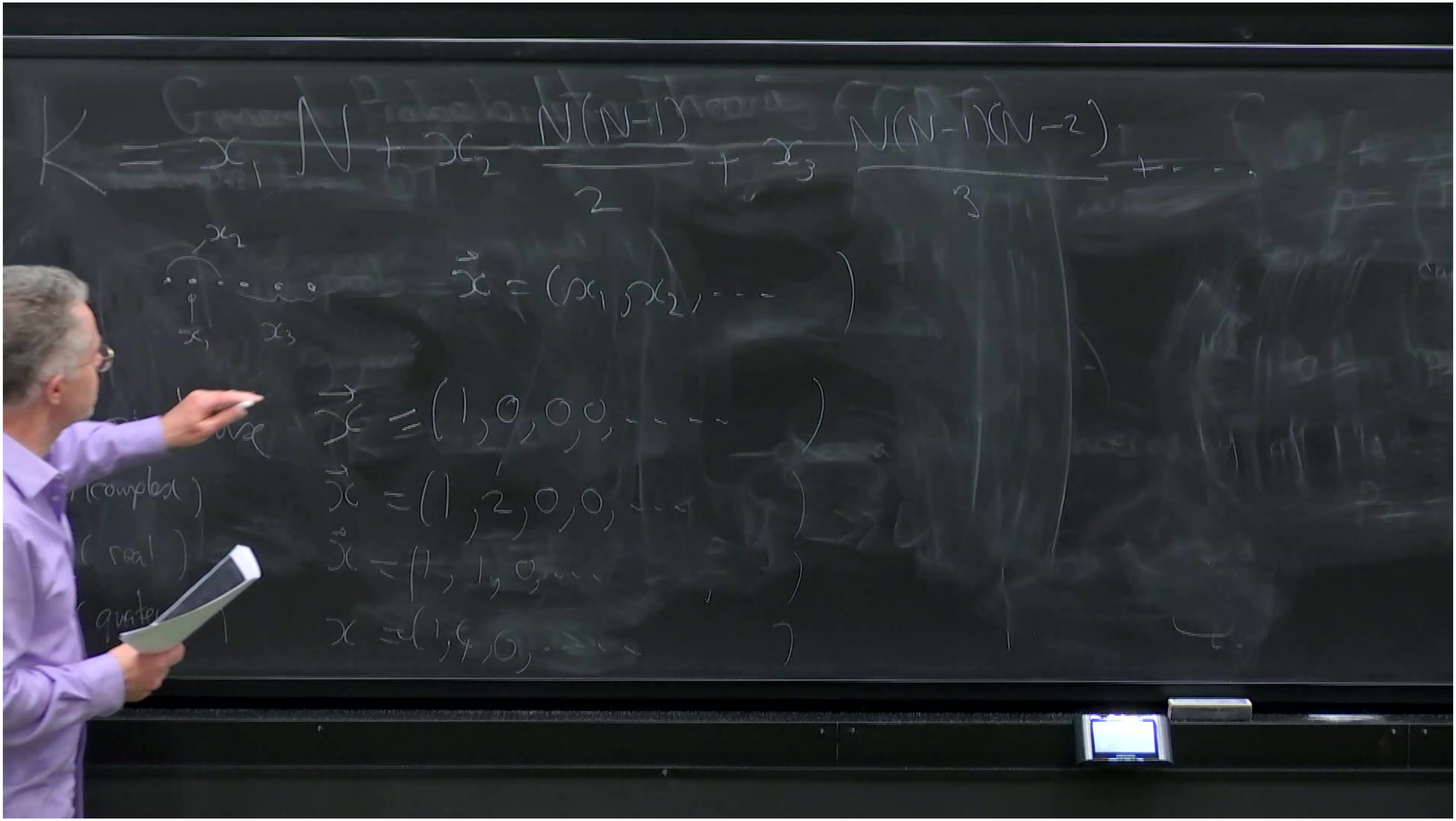


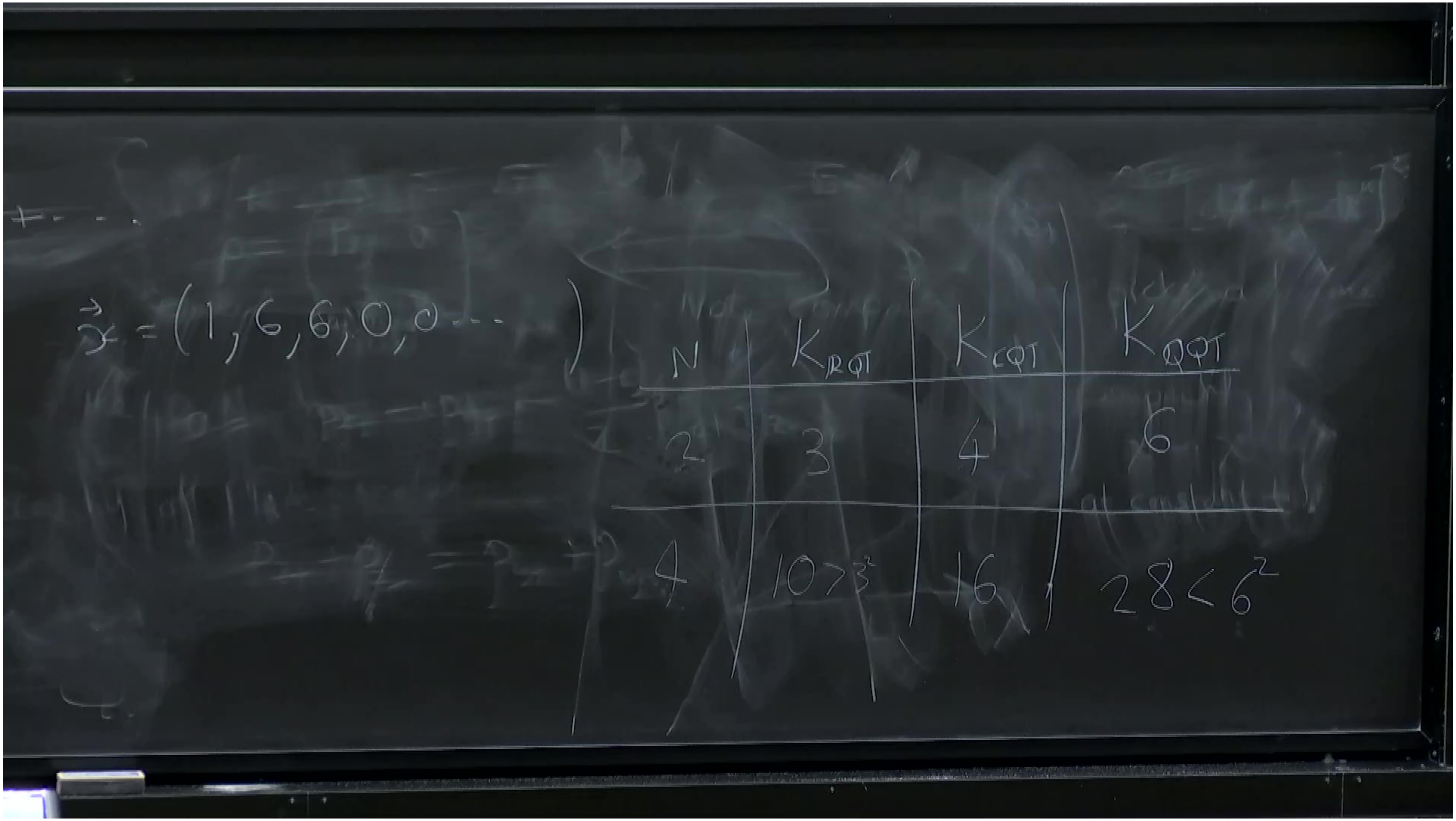
sets of states are convex.

$$f(p) = \lambda f(p_A) + (1-\lambda) f(p_B)$$

$$\hat{p}_k = \lambda p_k^A + (1-\lambda) p_k^B$$


also assume 5 N=1,2,3,....
1...5 ⇒ K = N^r
K(N_a N_b) = K(N_a) K(N_b)


K = x_1 N + x_2 N(N-1)/2 + x_3 N(N-1)(N-2)/3 + ...
x = (x_1, x_2, ...)
x = (1, 0, 0, 0, ...)
(complex)
x = (1, 2, 0, 0, ...)
(real)
x = (1, 1, 0, ...)
x = (1, 4, 0, ...)


x⃗ = (1, 6, 6, 0, 0 ...)
N | K_RQT | K_CQT | K_QQT
2 | 3 | 4 | 6
4 | 10 > 3^2 | 16 | 28 < 6^2