Title: PSI 17/18 - Foundations of Quantum Mechanics - Lecture 7

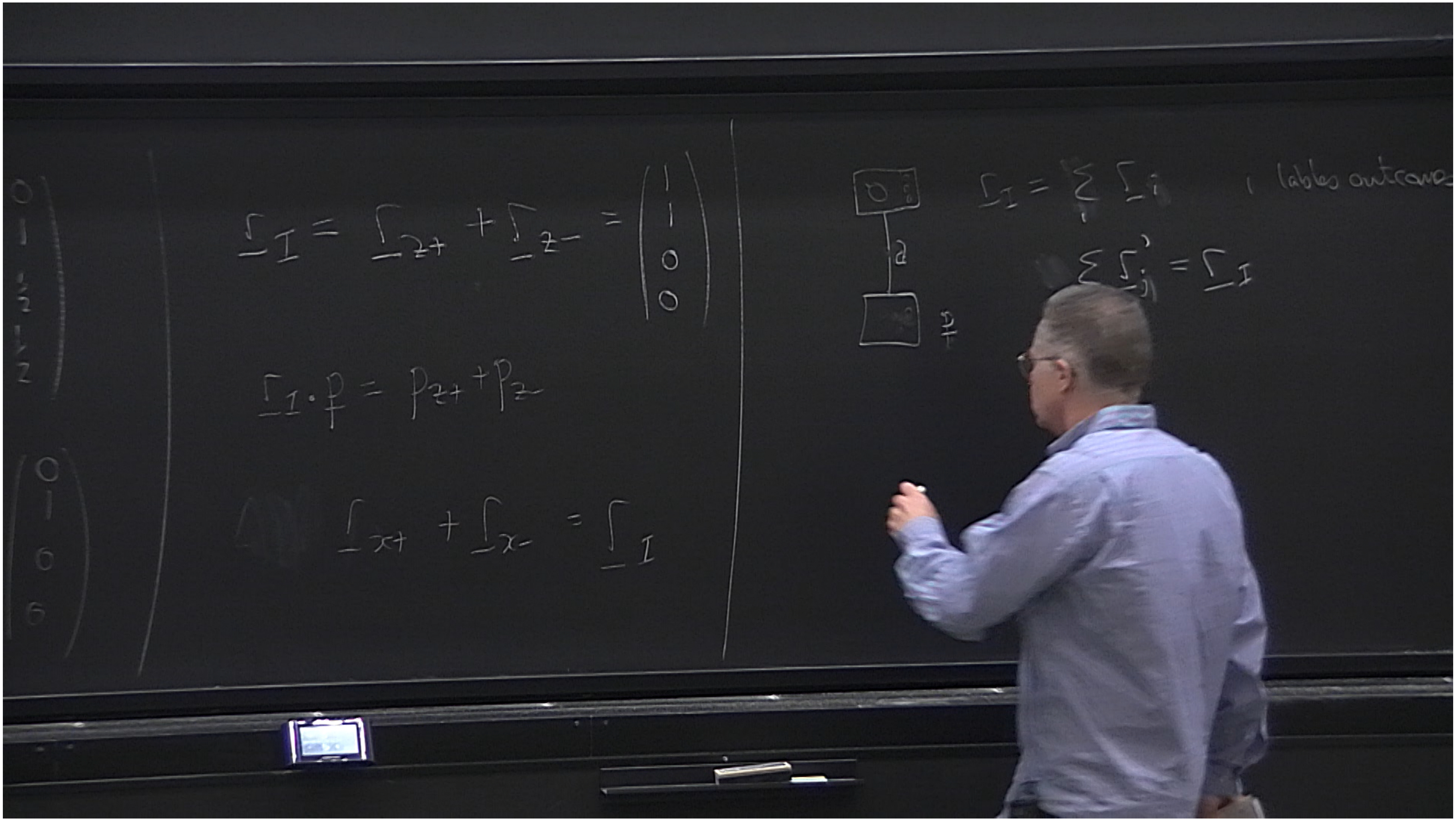
Date: Feb 06, 2018 10:15 AM

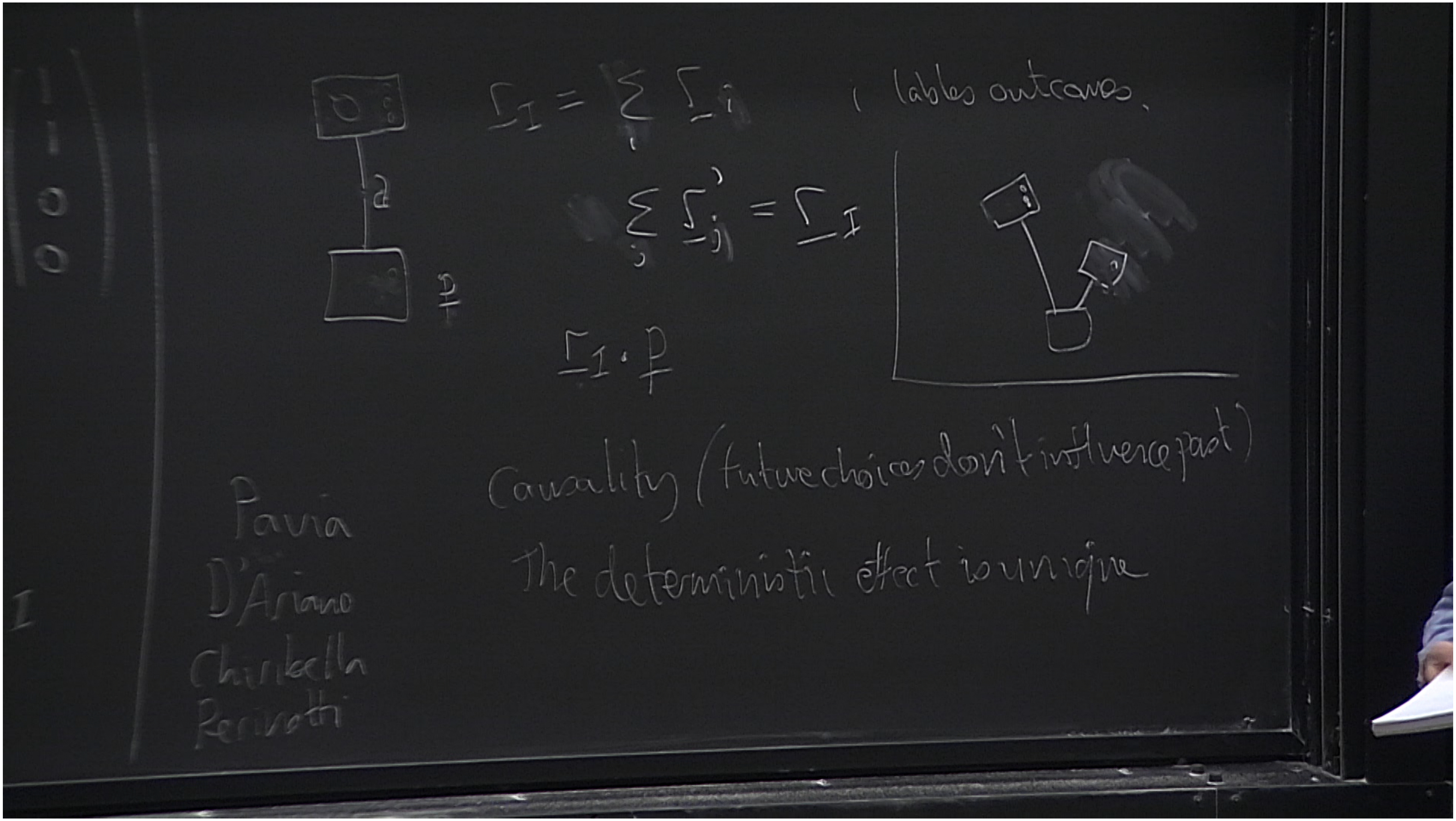
URL: http://pirsa.org/18020066

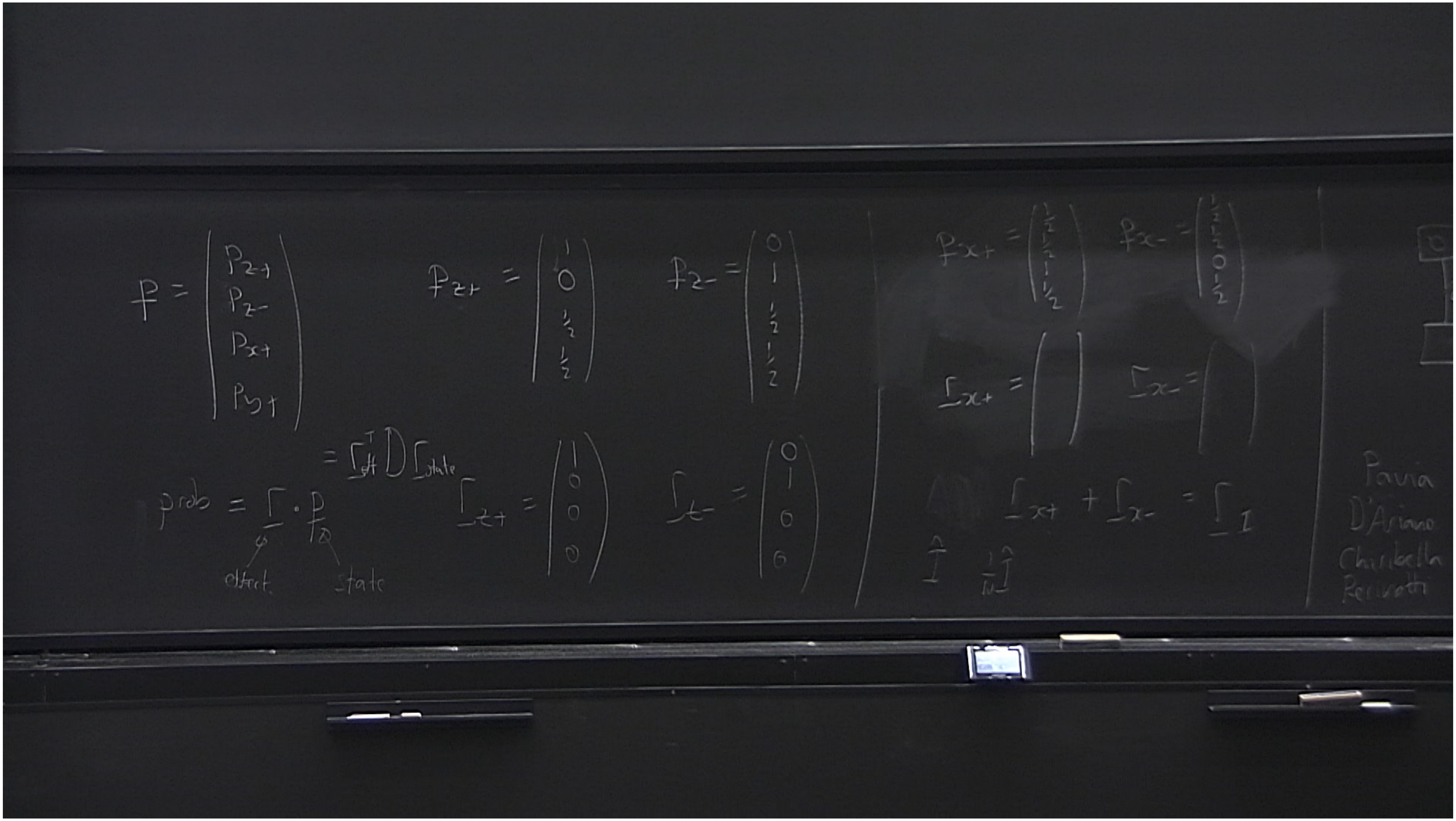
Abstract:

$$\underline{P} = \begin{pmatrix} p_{z+} \\ p_{z-} \\ p_{x+} \\ p_{y+} \end{pmatrix} \qquad \underline{P}_{z+} = \begin{pmatrix} 1 \\ 0 \\ \frac{1}{2} \\ \frac{1}{2} \end{pmatrix} \qquad \underline{P}_{z-} = \begin{pmatrix} 0 \\ 1 \\ \frac{1}{2} \\ \frac{1}{2} \end{pmatrix}$$

$$\text{prob} = \underbrace{\underline{r}_{\varphi}}_{\text{effect}} \cdot \underbrace{\underline{P}_{\Omega}}_{\text{state}} \qquad \underline{r}_{z+} = \begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \end{pmatrix} \qquad \underline{r}_{z-} = \begin{pmatrix} 0 \\ 1 \\ 0 \\ 0 \end{pmatrix}$$




$\Gamma_I = \sum_i \Gamma_i$
i lables outcomes.
$\sum_j \Gamma'_j = \Gamma_I$
a
p
$\Gamma_I \cdot p$
Causality (future choices don't influence past)
The deterministic effect is unique
Pavia
D'Ariano
Chiribella
Perinotti


prob
effect
state
Pavia
D'Ariano
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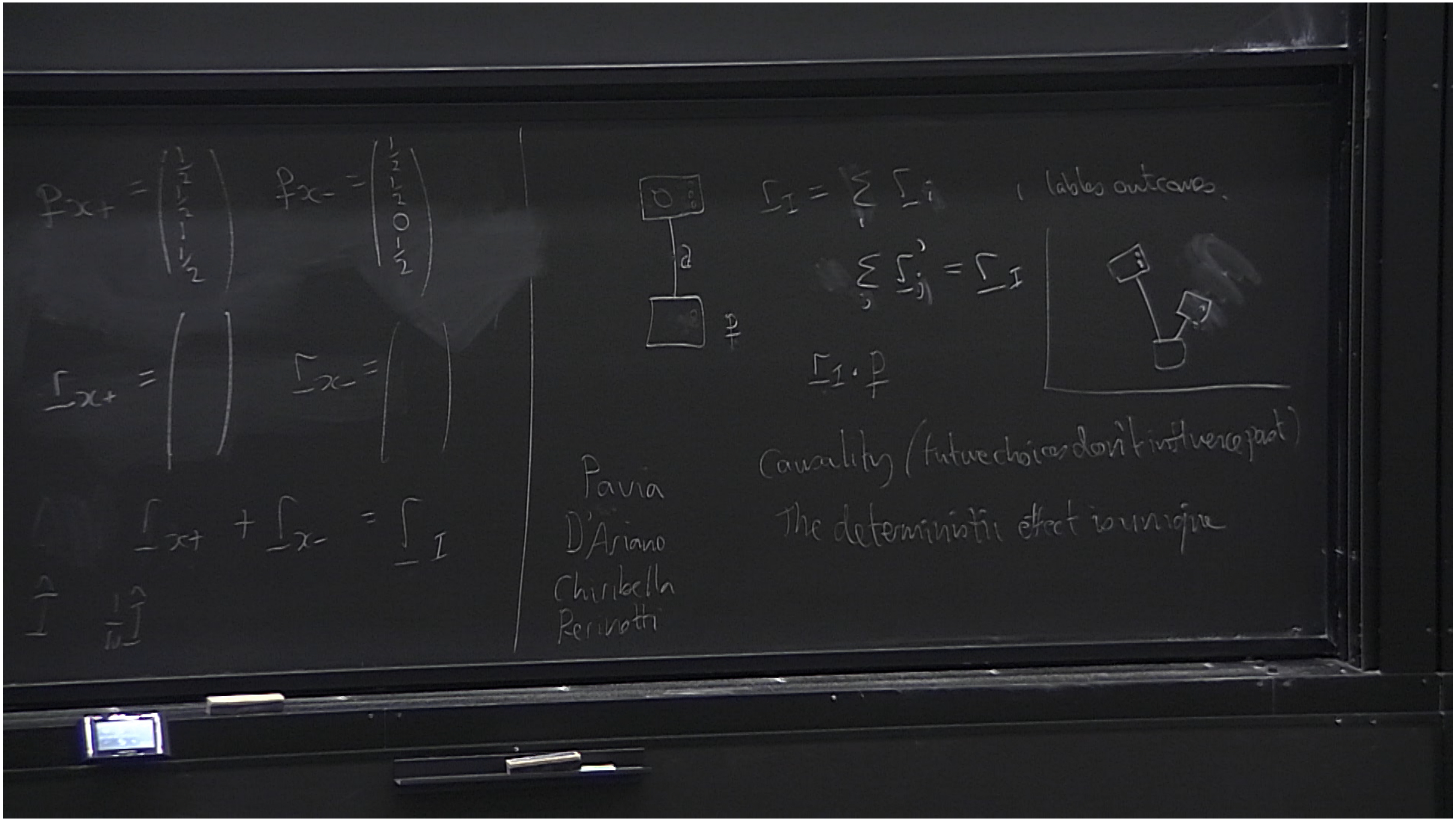
Perinotti



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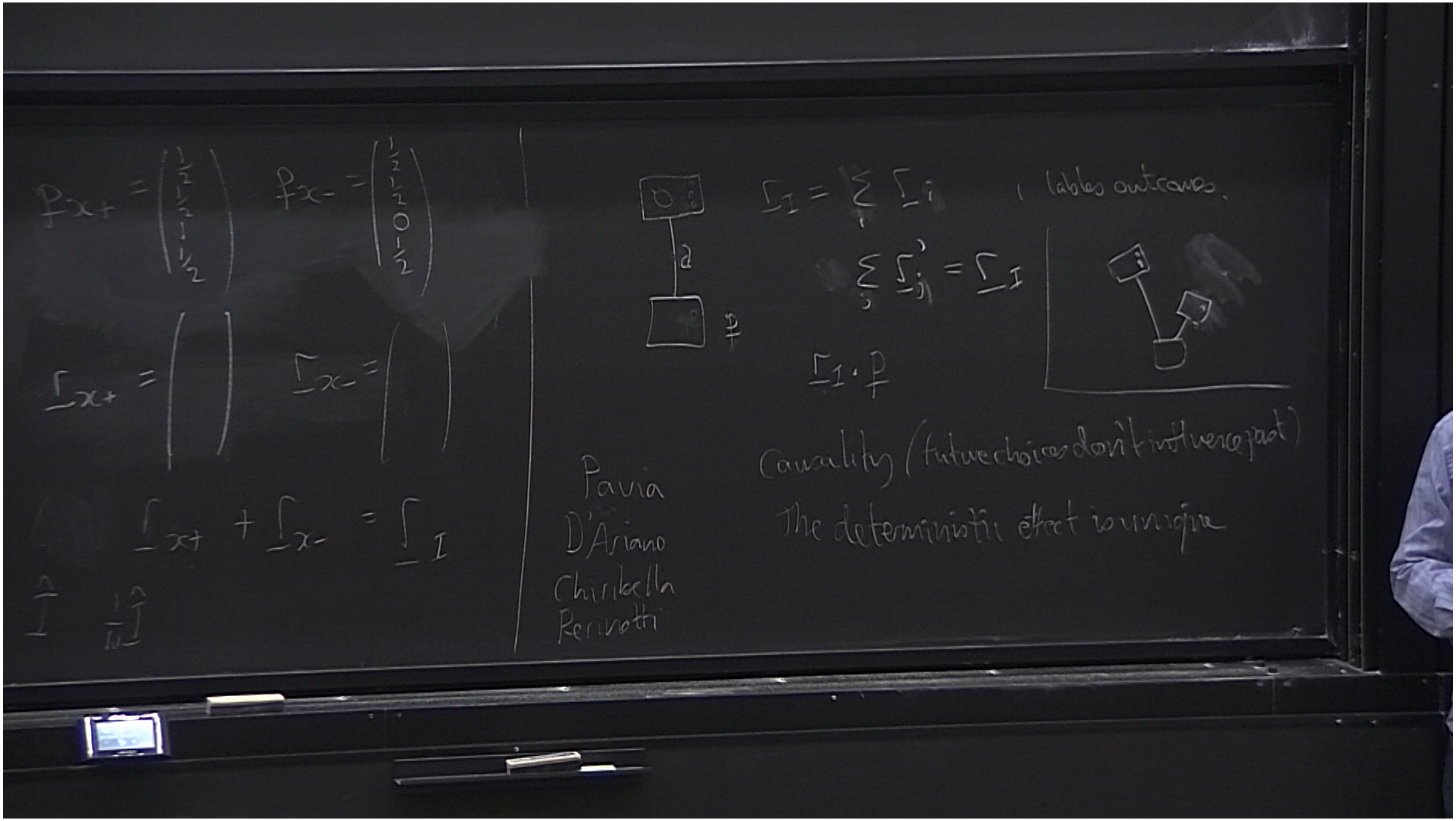
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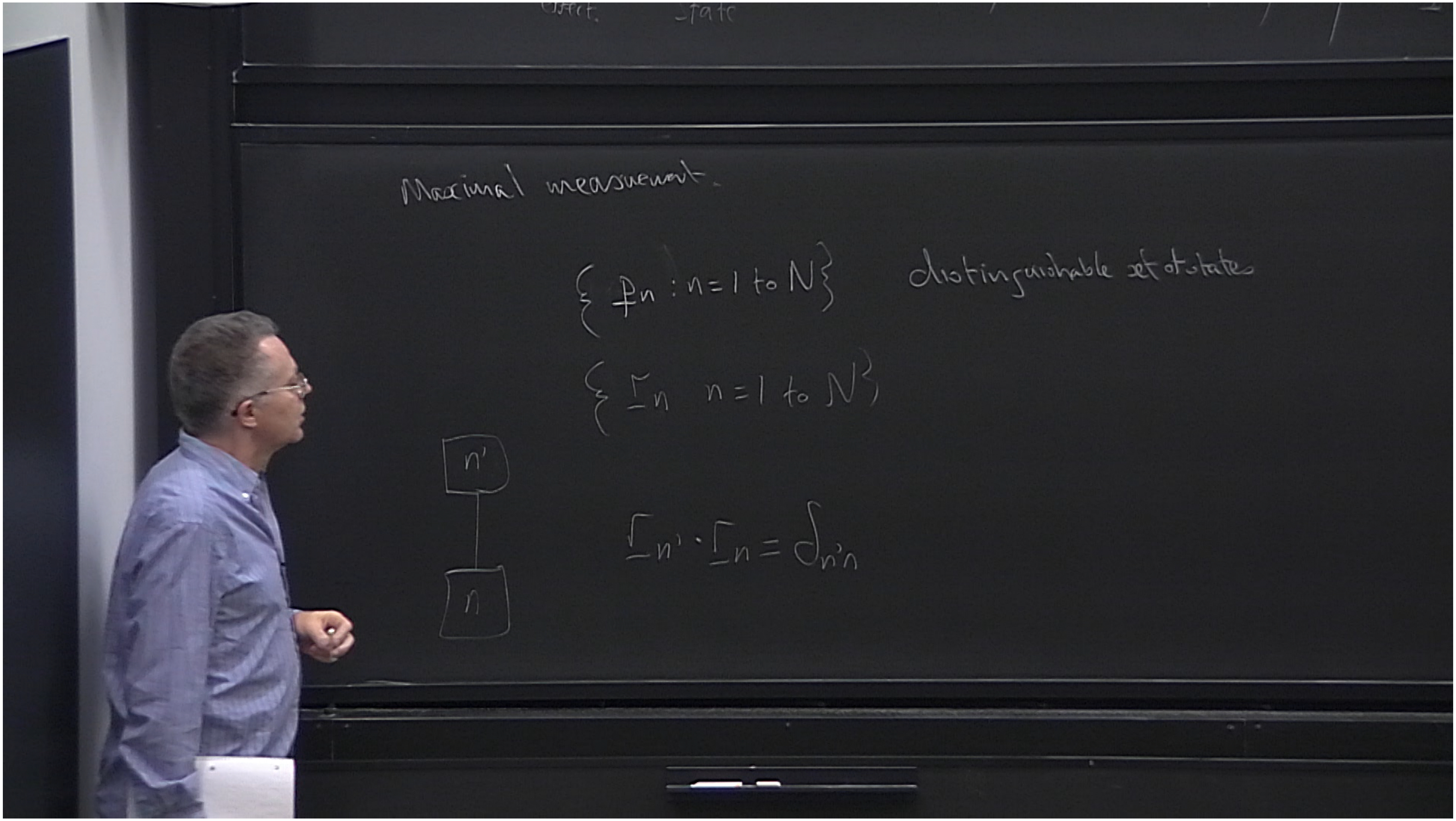

Maximal measurement.
{ $\underline{p}_n$: n=1 to N }
distinguishable set of states
{ $\underline{r}_n$ n=1 to N }
$\underline{r}_{n'} \cdot \underline{r}_n = \delta_{n'n}$
n'
n

effect. State

Maximal measurement.

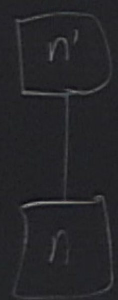
$\{ \rho_n : n = 1 \text{ to } N \}$ distinguishable set of states
maximal if there doesn't exist a set with more elements (for given system type)

$\{ \underline{r}_n \;\; n = 1 \text{ to } N \}$ ← there is a maximal measurement.

ρ_n maximal states.

$\underline{r}_{n'} \cdot \underline{r}_n = \delta_{n'n}$ $\underline{r}_n$ maximal effects.

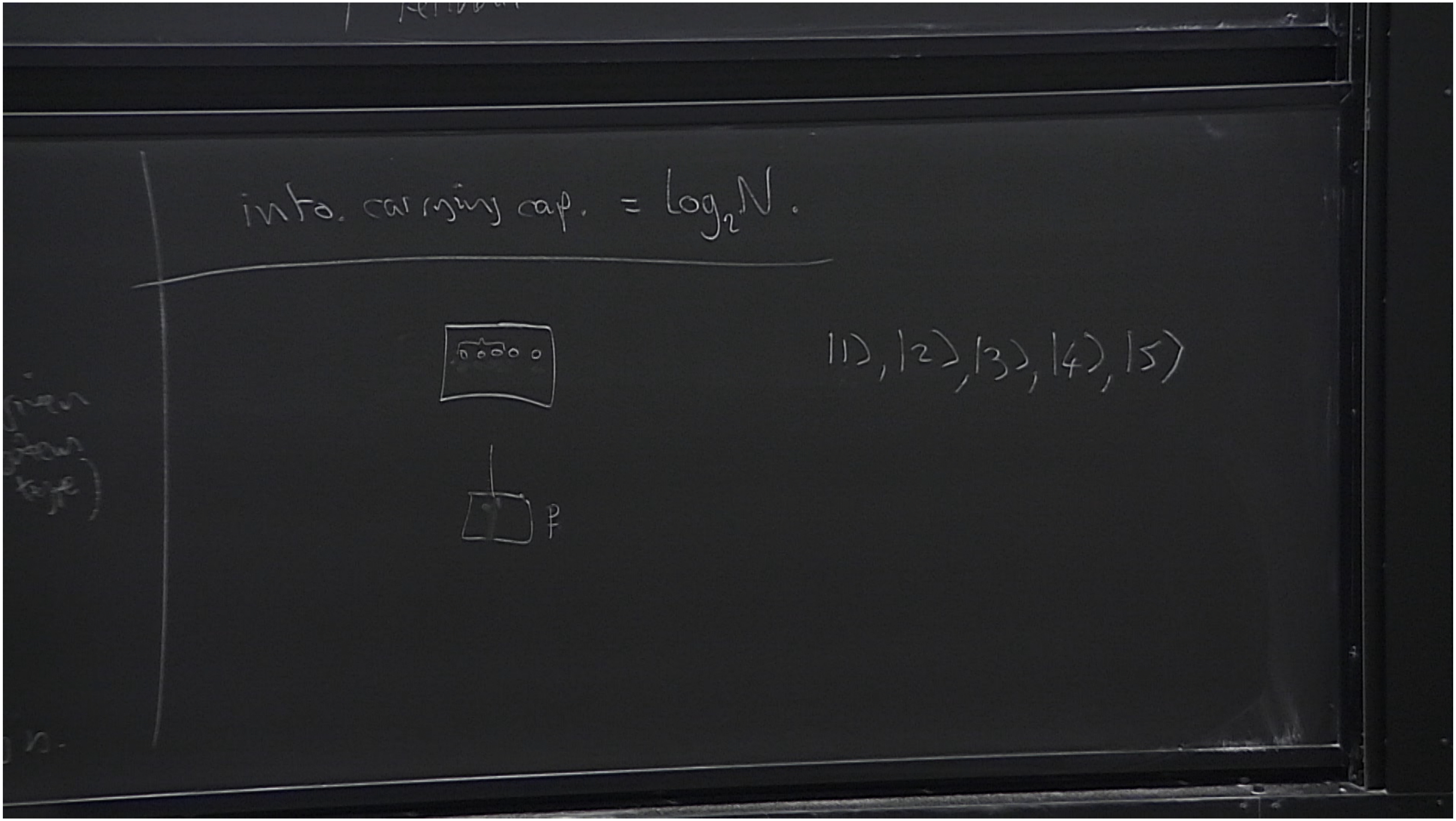
N tells us what the information carrying capacity is.

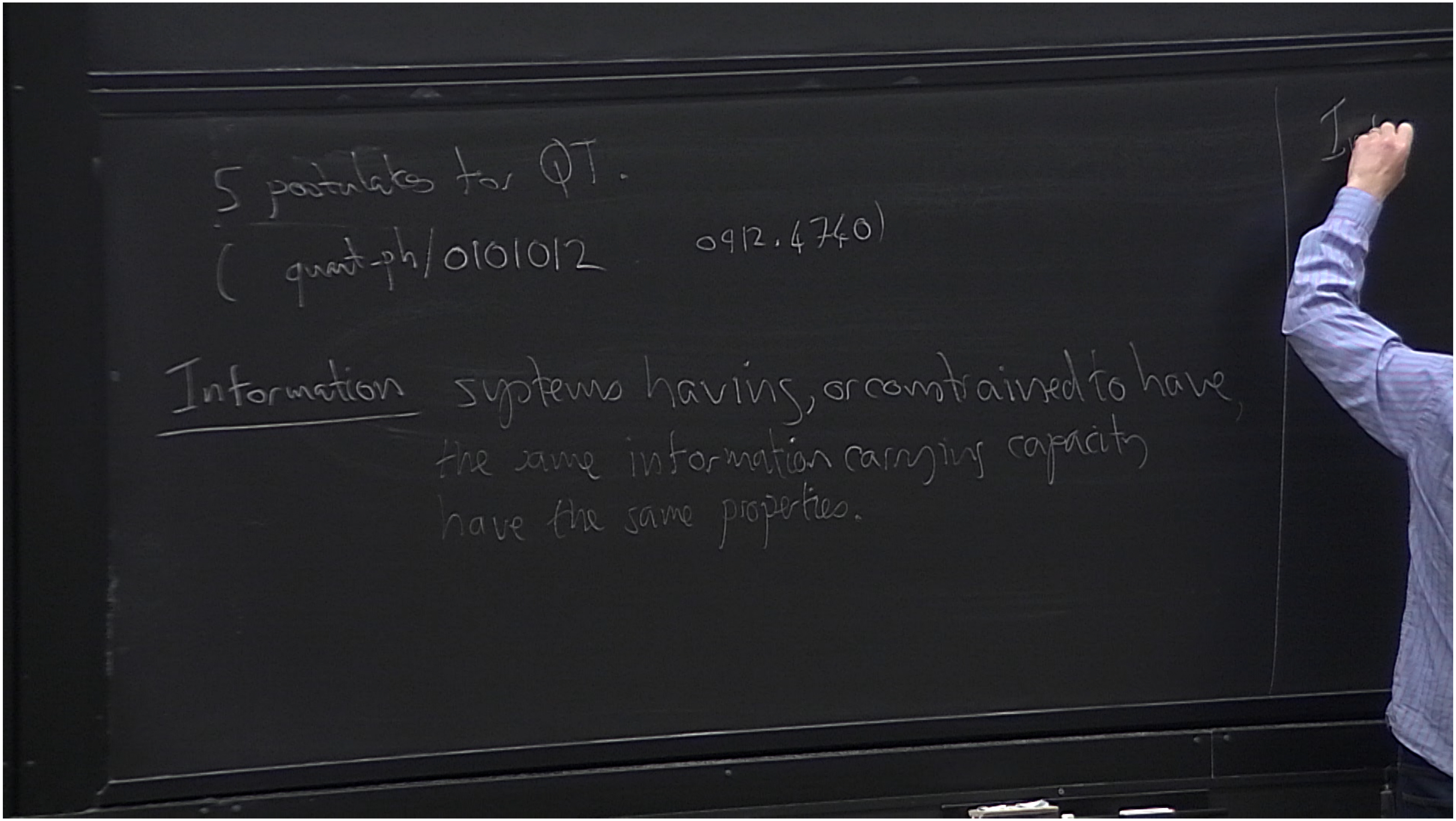


5 postulates for QT.

(quant-ph/0101012   0912.4740)

<u>Information</u> systems having, or constrained to have, the same information carrying capacity have the same properties.


info. carrying cap. = log₂N.
|1⟩, |2⟩, |3⟩, |4⟩, |5⟩
p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(quant-ph/0101012 0912.4740)
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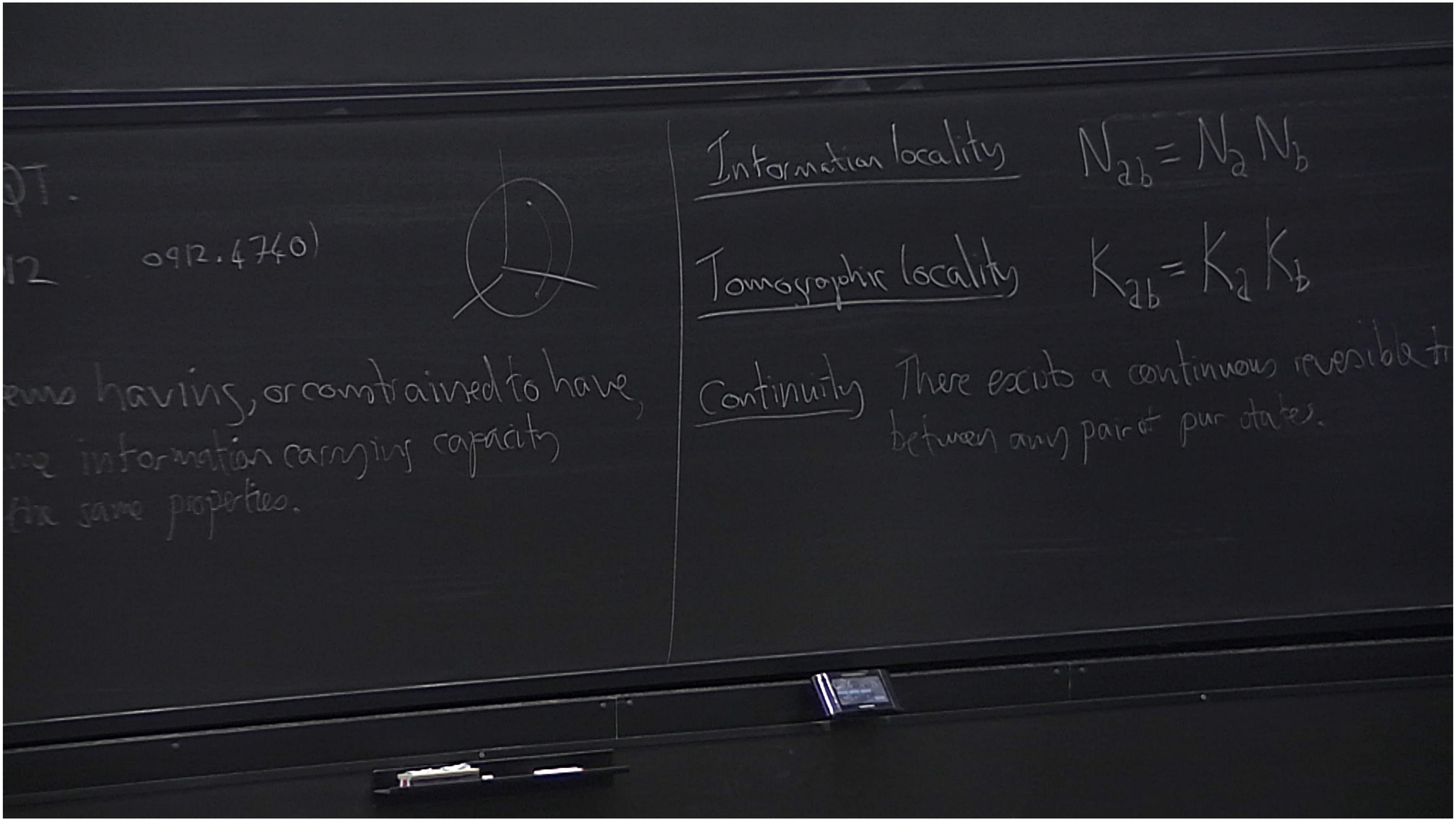
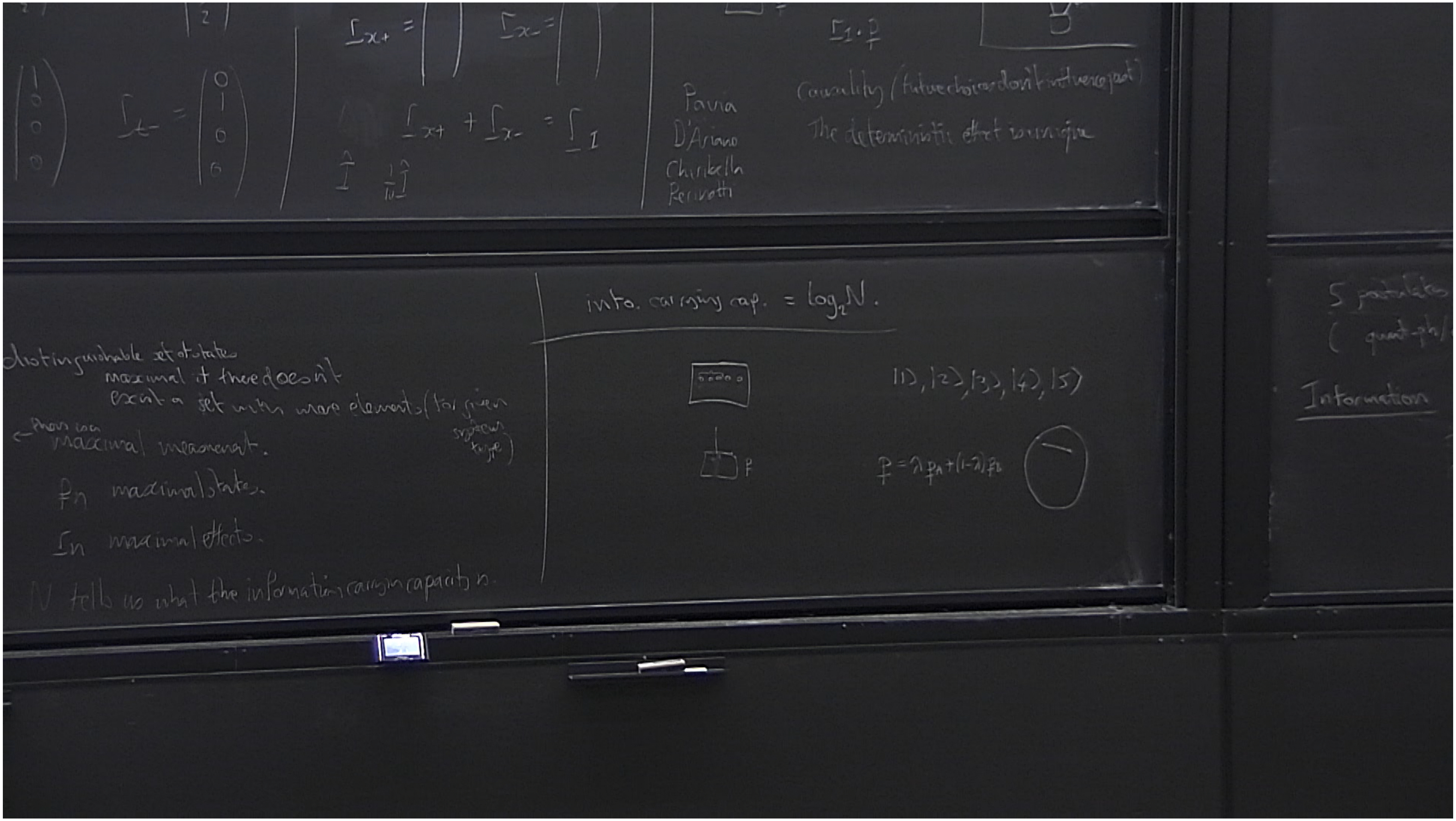

QT.
0912.4740)
having, or constrained to have,
information carrying capacity
the same properties.
Information locality $N_{ab} = N_a N_b$
Tomographic locality $K_{ab} = K_a K_b$
Continuity There exists a continuous reversible
between any pair of pure states.


Pavia
D'Ariano
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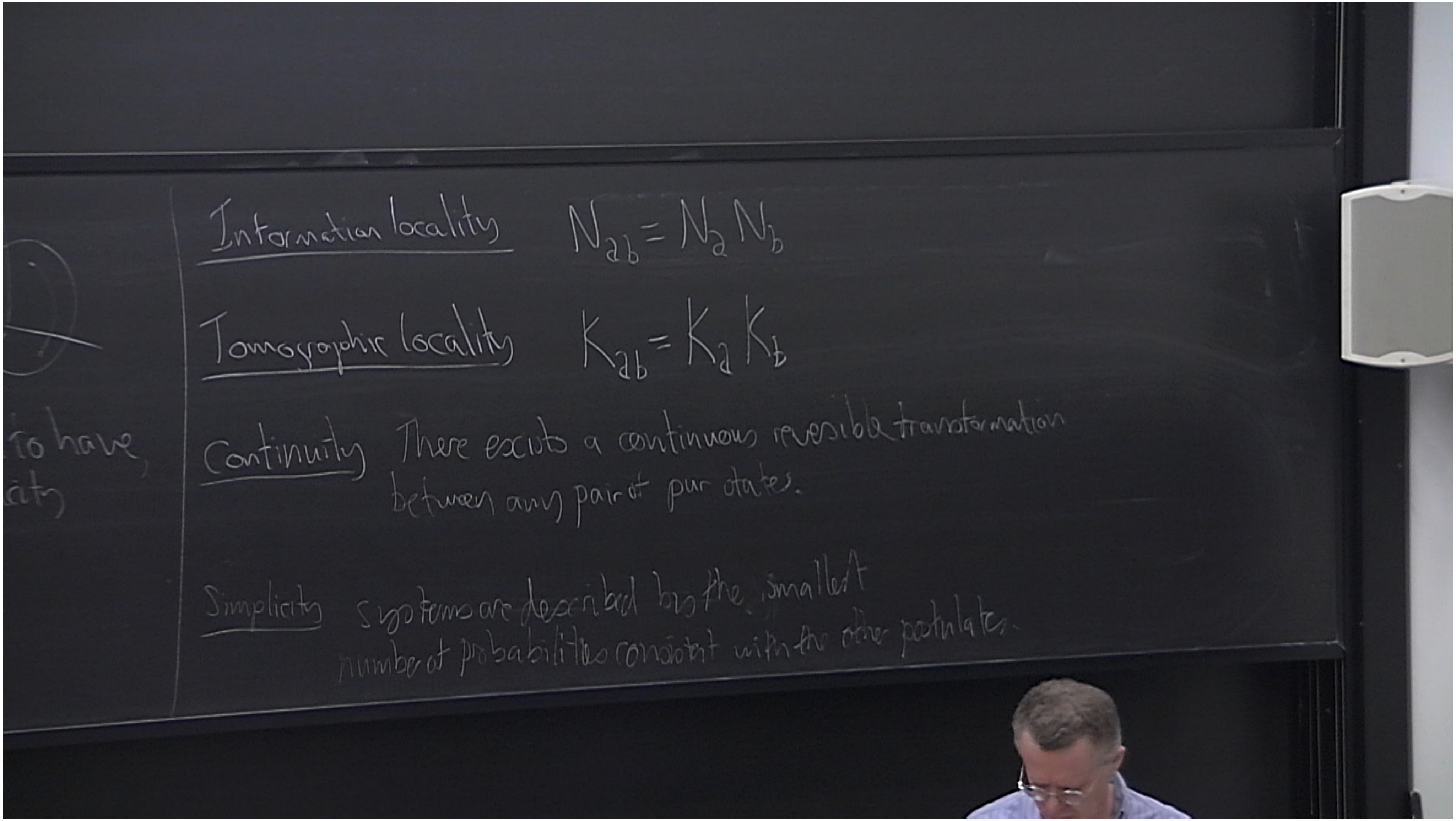
Causality (future choices don't influence past)
The deterministic effect is unique
info. carrying cap. = log2 N.
|1⟩, |2⟩, |3⟩, |4⟩, |5⟩
distinguishable set of states
maximal if there doesn't
exist a set with more elements (for given
system type)
maximal measurement.
maximal states.
maximal effects.
N tells us what the information carrying capacity is.
5 postulates
Information

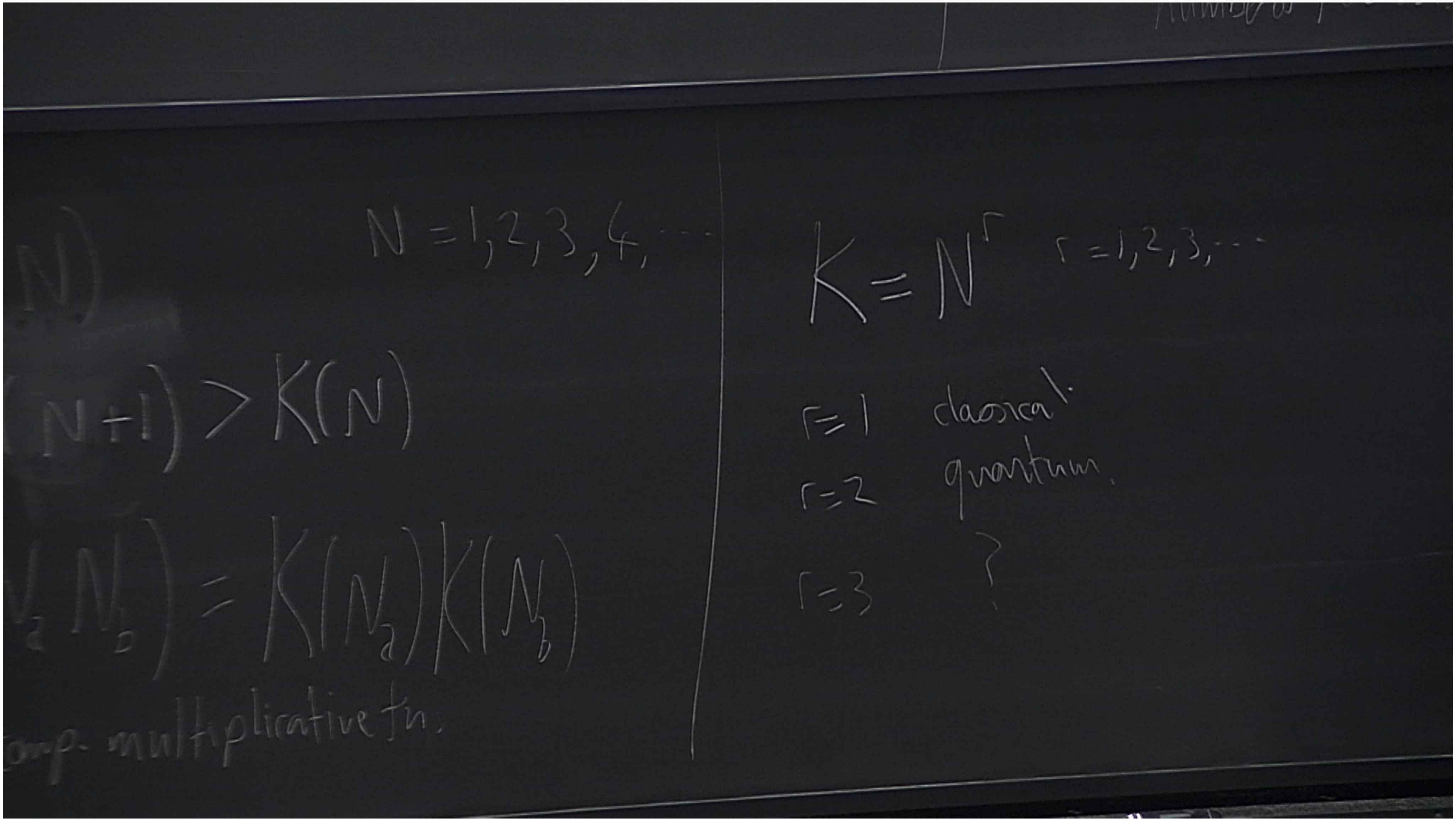

Information locality $N_{ab} = N_a N_b$
Tomographic locality $K_{ab} = K_a K_b$
Continuity There exists a continuous reversible transformation between any pair of pure states.
Simplicity systems are described by the smallest number of probabilities consistent with the other postulates.
to have,

$K(N)$ $N = 1, 2, 3, 4, \cdots$

$$K(N+1) > K(N)$$

$$K(N_a N_b) = K(N_a) K(N_b)$$

comp. multiplicative fn.


$N = 1, 2, 3, 4, \cdots$
$K(N+1) > K(N)$
$K(N_a N_b) = K(N_a) K(N_b)$
comp. multiplicative fn.
$K = N^r$ $r = 1, 2, 3, \cdots$
$r = 1$ classical
$r = 2$ quantum
$r = 3$?

first consider $N=2$ case.

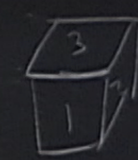
$K = N^2 = 4$. continuity $\Rightarrow$ Bloch ball.

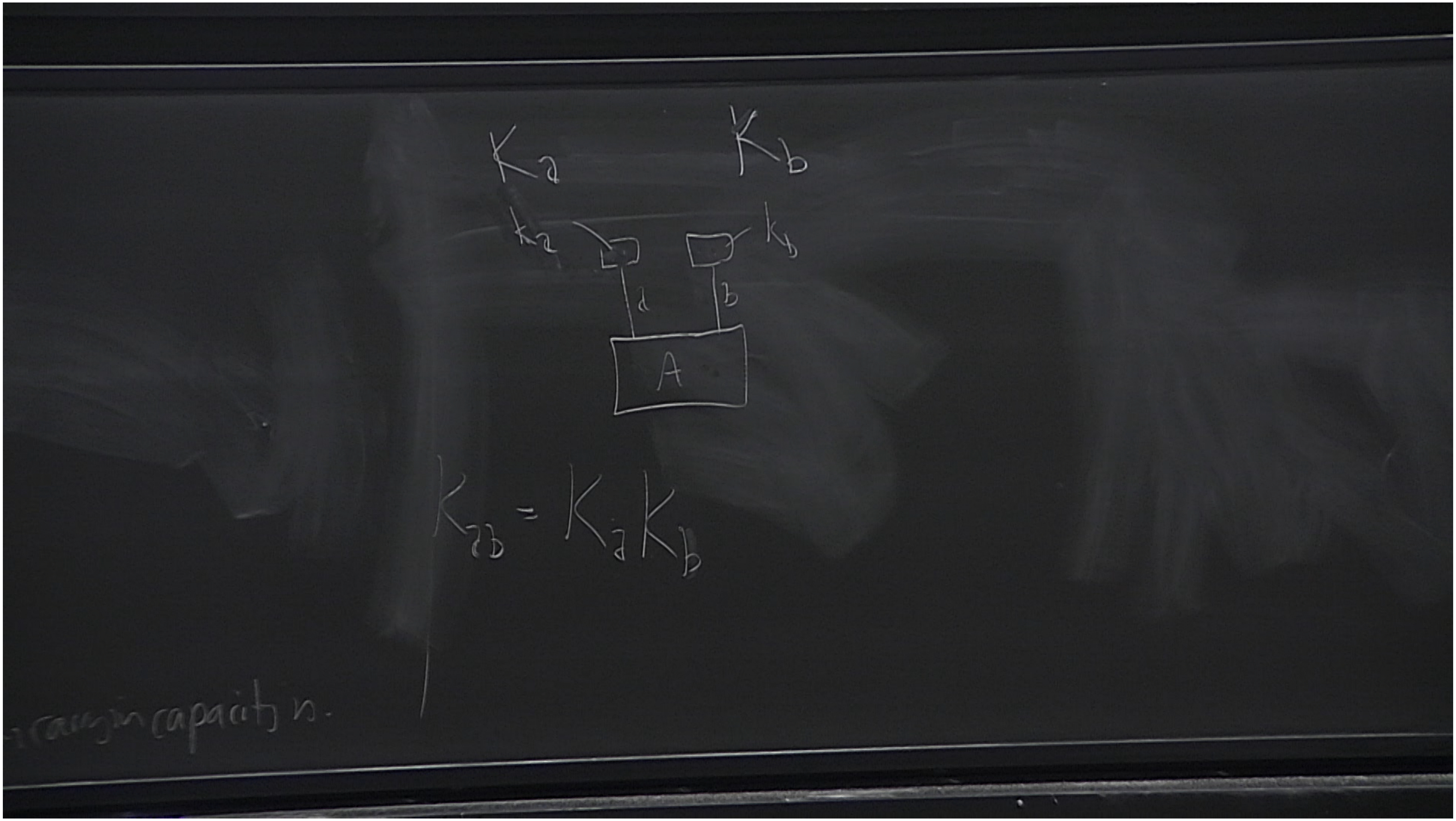
comp. multiplicative fn.

first consider $N=2$ case.

$K = N^2 = 4$. continuity $\not\Rightarrow$ Bloch ball .

H




K_a
K_b
k_a
k_b
a
b
A
$K_{ab} = K_a K_b$
capacity is.

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

$$\begin{pmatrix} p_1 & & a_{nm} \\ & \ddots & \\ a^*_{nm} & & p_N \end{pmatrix}$$

1

4

$N_a = 2,\ N_b = 2,\ N_{ab} = 4.$

N	$K_{quantum}$	$K_{real\,QT}$	$K_{quaternionic\,QT}$
2	4	3	6
4	$16 = 4^2$	$10 > 3^2$	$28 < 6^2$

$$K_{ab} \geq K_a K_b$$