Title: Lecture - Quantum Foundations, PHYS 639

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Subject: Quantum Foundations

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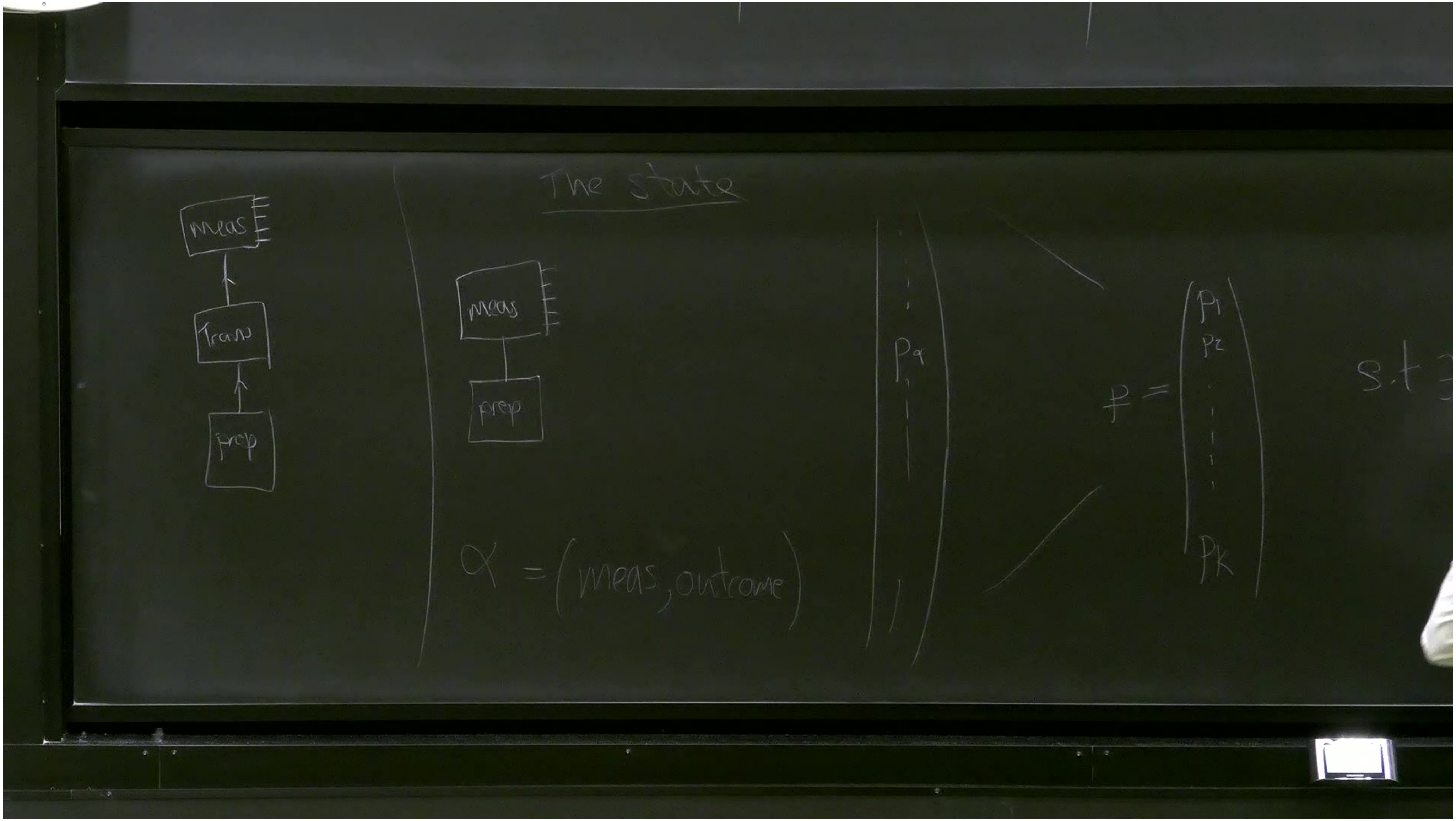
quant-ph/0101012

Operational Reconstructions of QT

		Beyond.
Kepler's laws	Newton's UG + laws	→
Lorentz transf^{n}'s	SR	→ GR
QT	?	→


The state
meas
Trans
prep
meas
prep
α = (meas, outcome)
p_α
p = (p1, p2, …, pk)
s.t.

$$\begin{pmatrix} \vdots \\ p_\alpha \\ \vdots \end{pmatrix} \qquad \underline{p} = \begin{pmatrix} p_1 \\ p_2 \\ \vdots \\ p_K \end{pmatrix}$$

s.t. $\exists\ \underline{\Gamma}_\alpha$ with $p_\alpha = \underline{\Gamma}_\alpha \cdot \underline{p}$

K minimum.

fiducial

fiducial

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

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

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

$$p_\alpha = \mathrm{tr}$$

meas, outcome)

fiducial

$\frac{(1-c)}{2}\left(P_{Z+} + P_{Z-}\right)$

$$\underline{p} = \begin{pmatrix} P_{Z+} \\ P_{Z-} \\ P_{X+} \\ P_{Y+} \end{pmatrix}$$

$$p_\alpha = tr\left(\hat{A}_\alpha \, \hat{\rho}\right)$$

$$\Updownarrow \quad \Updownarrow$$

$$= \underline{r}_\alpha \cdot \underline{p}$$

pure states $|\psi\rangle\langle\psi|$

not mixed states.

mixed states

$$\underline{p} = \lambda \, \underline{p}_A + (1-\lambda) \, \underline{p}_B$$

$0 < \lambda < 1 \qquad \underline{p}_A \neq \underline{p}_B$

$P_{Z+} + P_{Z-} = 1$

fiducial

$$p_\alpha = \mathrm{tr}\left(\hat{A}_\alpha \hat{\rho}\right)$$

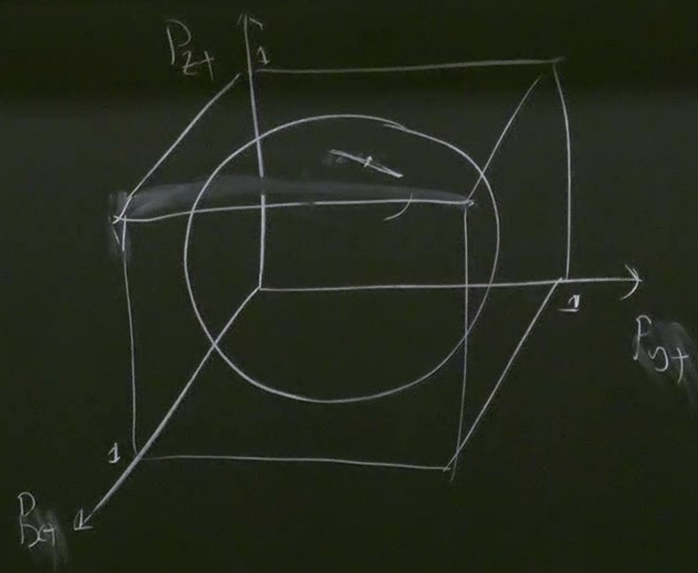
$$\Updownarrow \quad \Updownarrow$$

$$= \underline{\Gamma}_\alpha \cdot \underline{p}$$

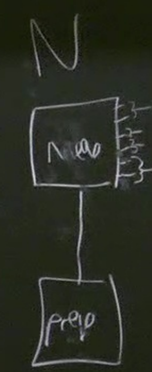
mixed states

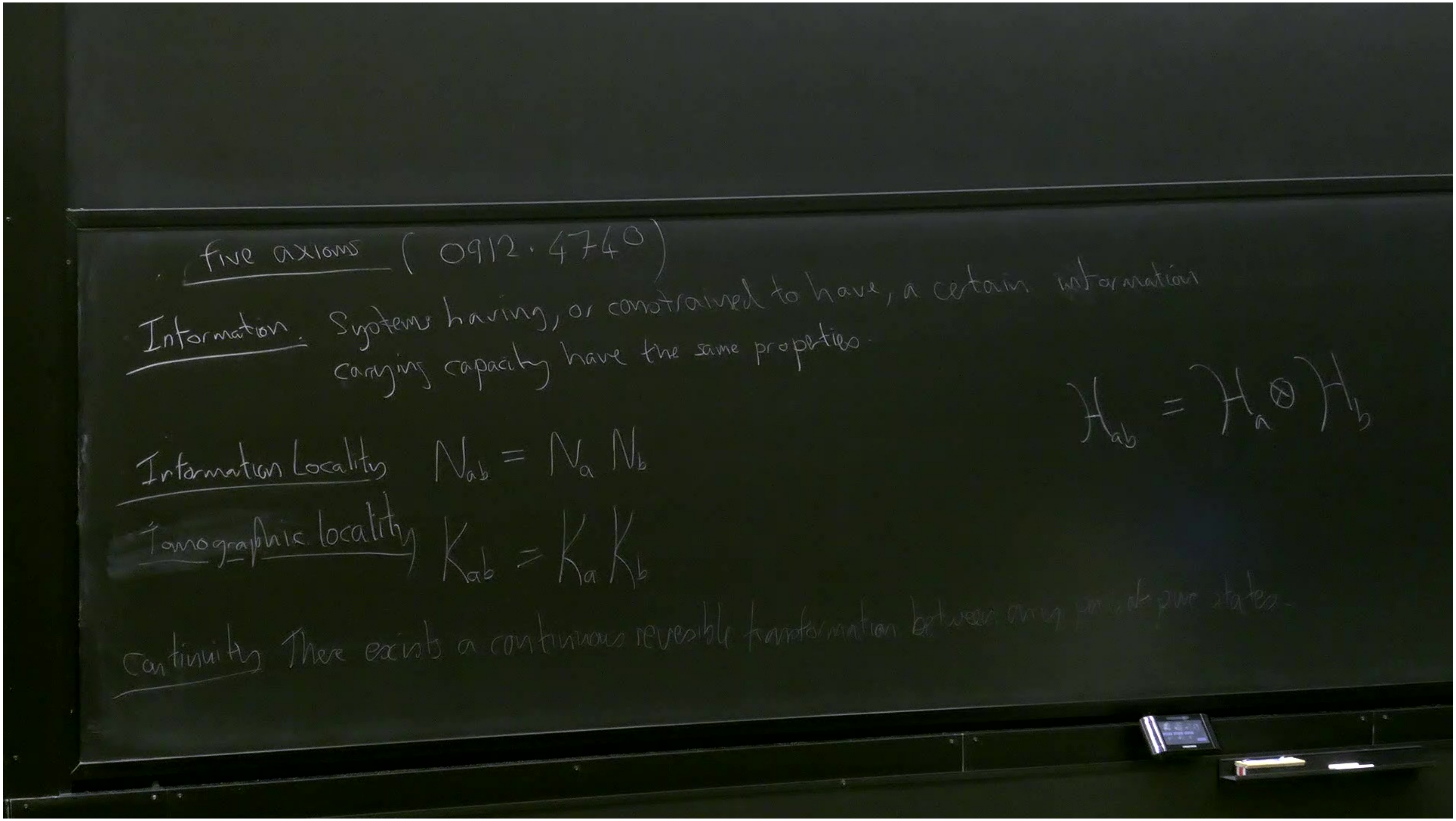
$$\rho = \lambda \rho_A + (1-\lambda)\rho_B$$

$0<\lambda<1 \qquad \rho_A \neq \rho_B$



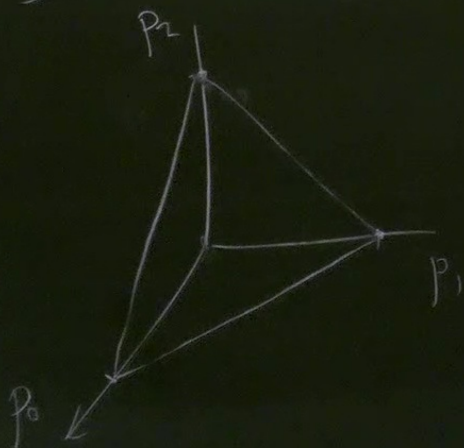
$P_{z+} + P_{z-} = 1$




five axioms (0912.4740)
Information. Systems having, or constrained to have, a certain information carrying capacity have the same properties.
$\mathcal{H}_{ab} = \mathcal{H}_a \otimes \mathcal{H}_b$
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.

Continuity There exists a continuous reversible transformation between ...

Simplicity Systems are described by the smallest number of probabilities consistent with the other postulates.

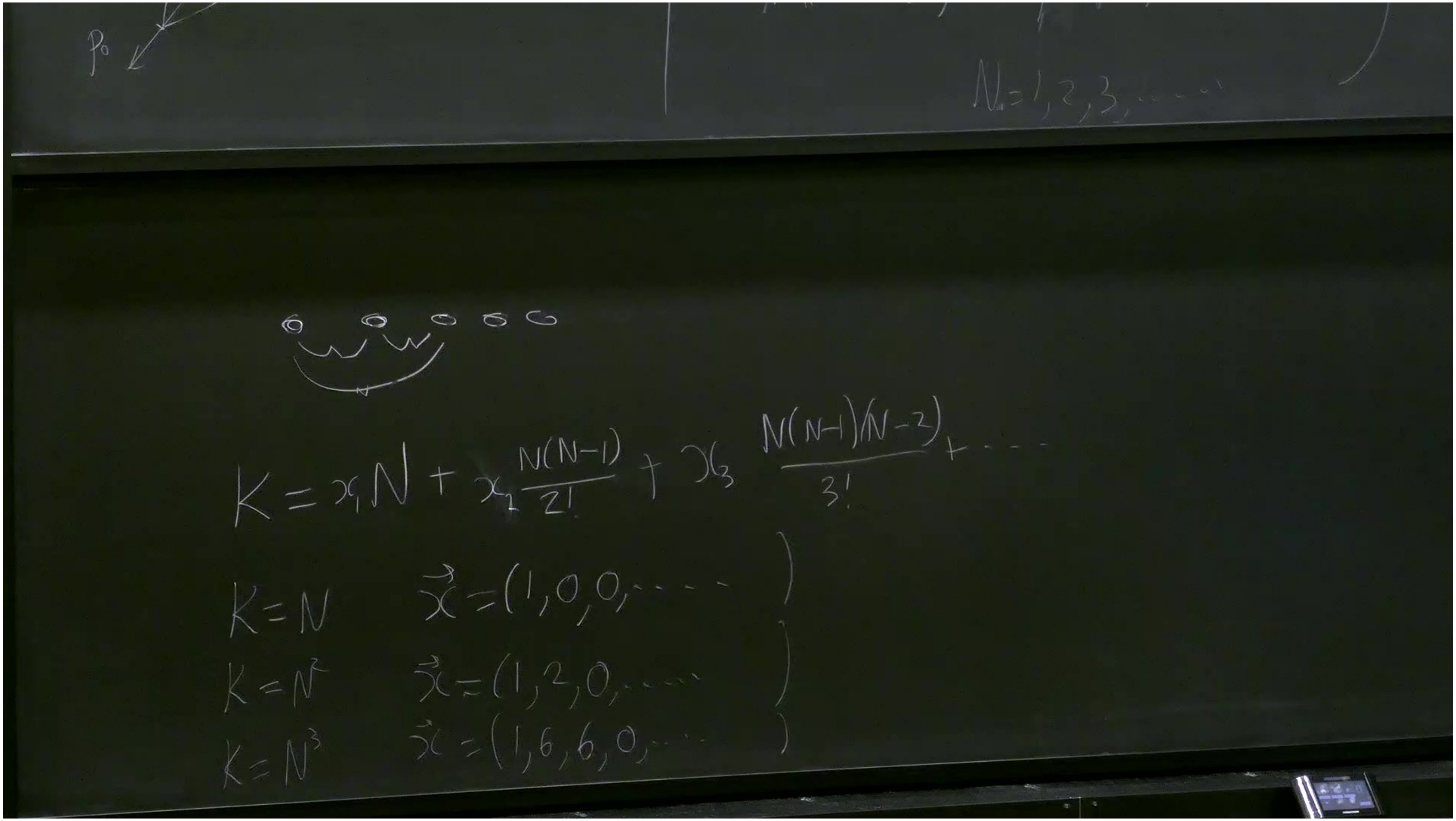


$$K = N$$

$$K(N), \quad K(N+1) > K(N)$$

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

$$N_a = 1, 2, 3, \ldots$$



p_0
$N_a = 1, 2, 3, \ldots$
$K = x_1 N + x_2 \frac{N(N-1)}{2!} + x_3 \frac{N(N-1)(N-2)}{3!} + \ldots$
$K = N \quad \vec{x} = (1, 0, 0, \ldots)$
$K = N^2 \quad \vec{x} = (1, 2, 0, \ldots)$
$K = N^3 \quad \vec{x} = (1, 6, 6, 0, \ldots)$