Title: Quantum Foundations Lecture - 230127

Speakers: Lucien Hardy

Collection: Quantum Foundations (2022/2023)

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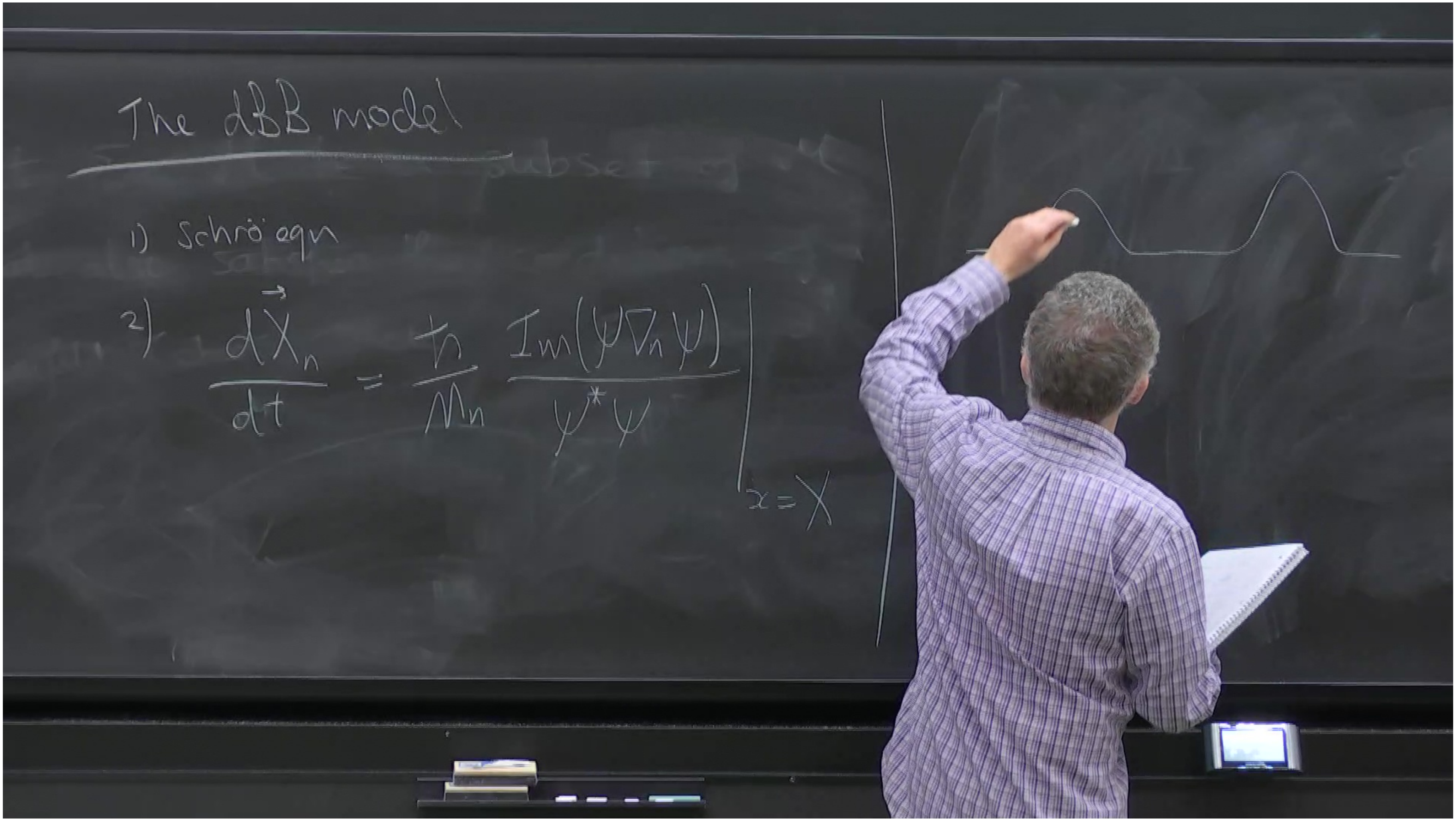
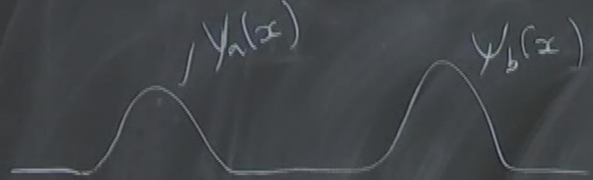
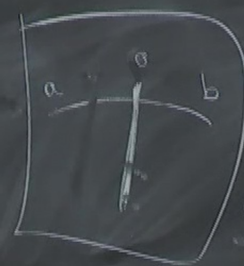

The dBB model
1) Schrö eqn
2) $\frac{d\vec{X}_n}{dt} = \frac{\hbar}{m_n} \frac{\mathrm{Im}(\psi \nabla_n \psi)}{\psi^* \psi} \Big|_{x=X}$

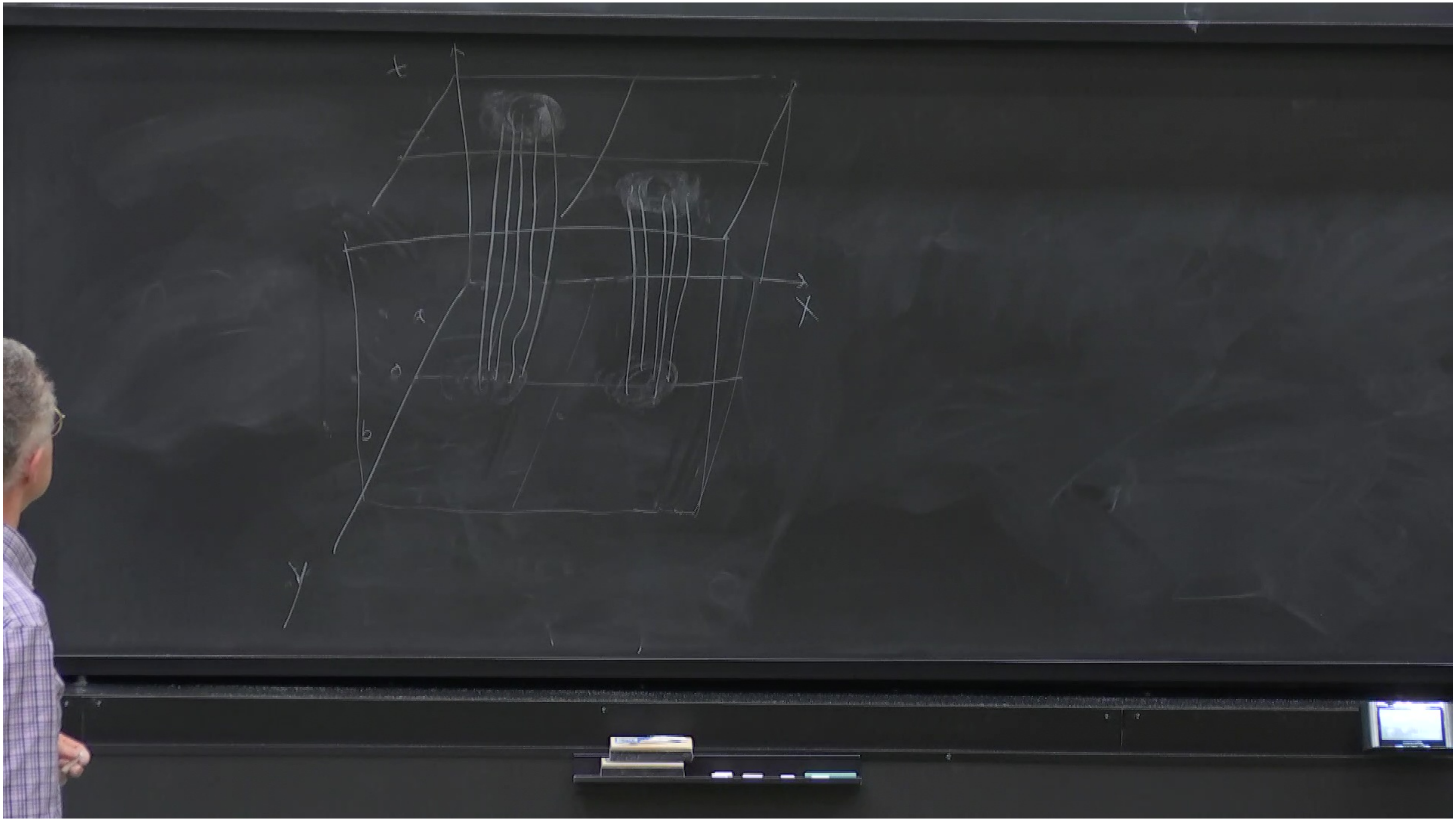
$= X$



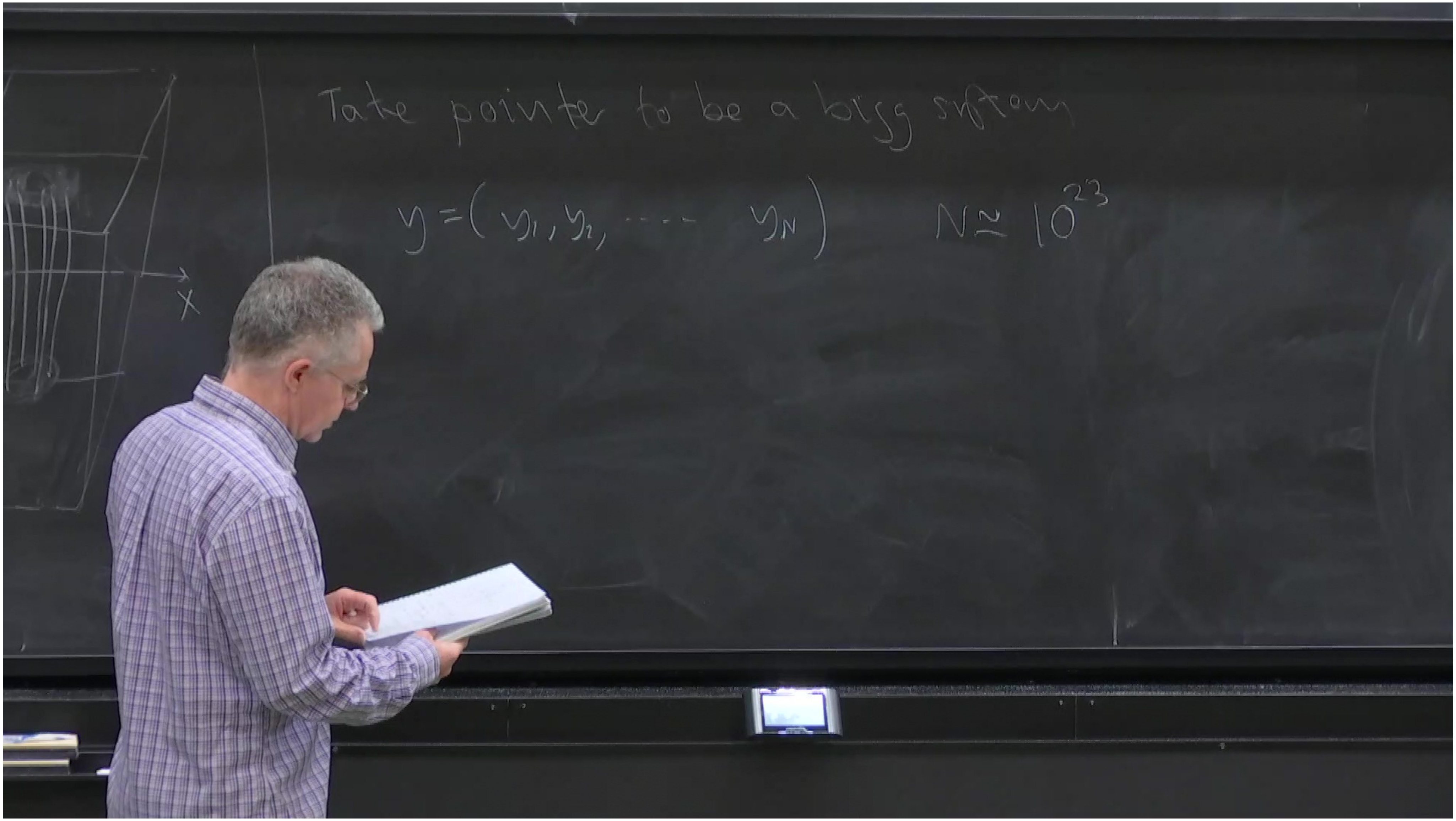


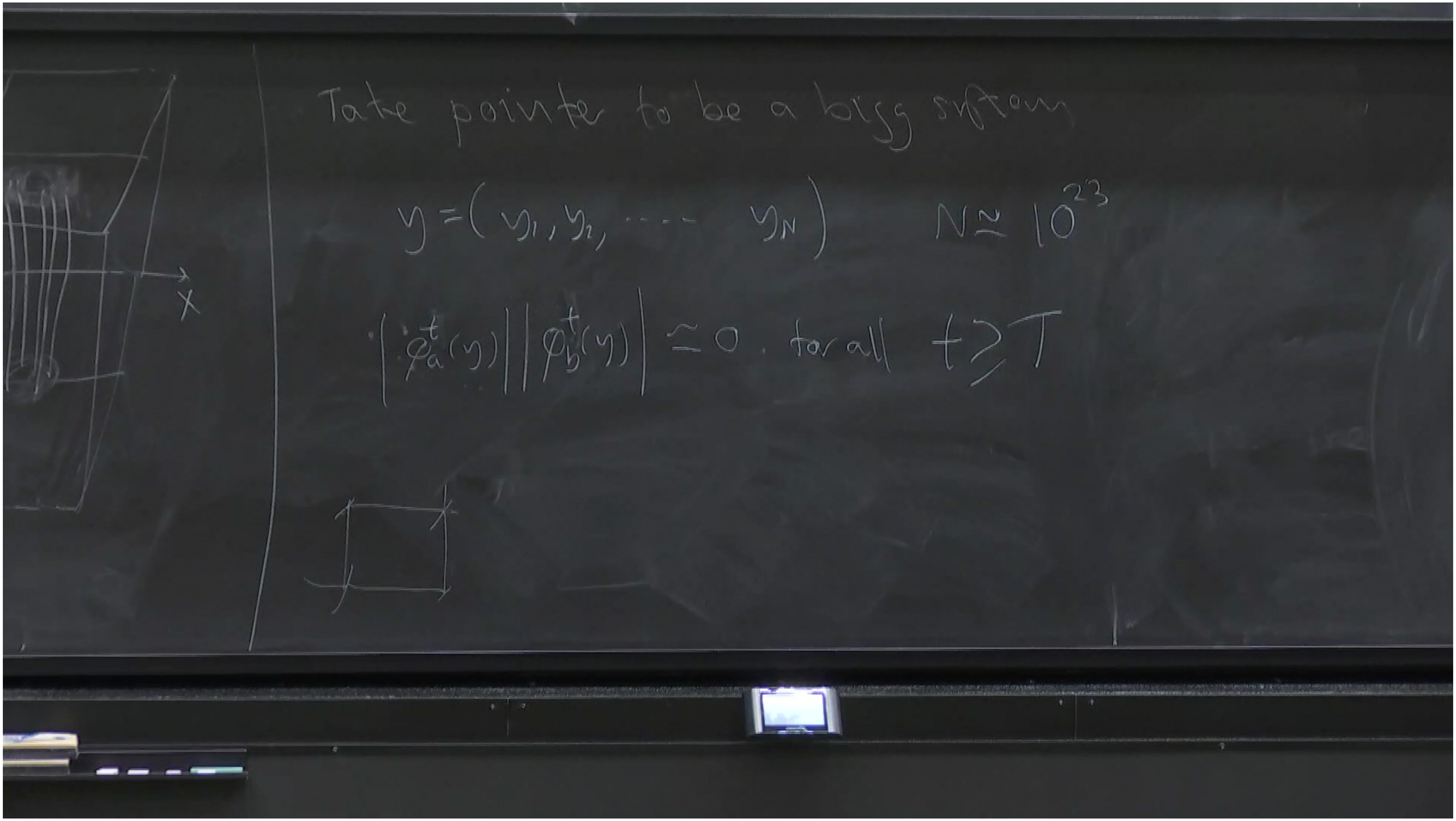
$$\psi(x) = \alpha\, \psi_a(x) + \beta\, \psi_b(x)$$

$$\psi(x)\,\varphi_0(y) \longrightarrow \alpha\, \psi_a(x)\,\varphi_a(y) + \beta\, \psi_b(x)\,\varphi_b(y)$$



t
X
a
o
b
y


Take pointe to be a big system
y = (y1 , y2 , ... yN)
N ≃ 10^23
X


Take pointer to be a big system
$y = (y_1, y_2, \dots\ y_N)$ $N \simeq 10^{23}$
$|\varphi_a^t(y)|\,|\varphi_b^t(y)| \simeq 0$ for all $t \gtrsim T$
x

...oigg system

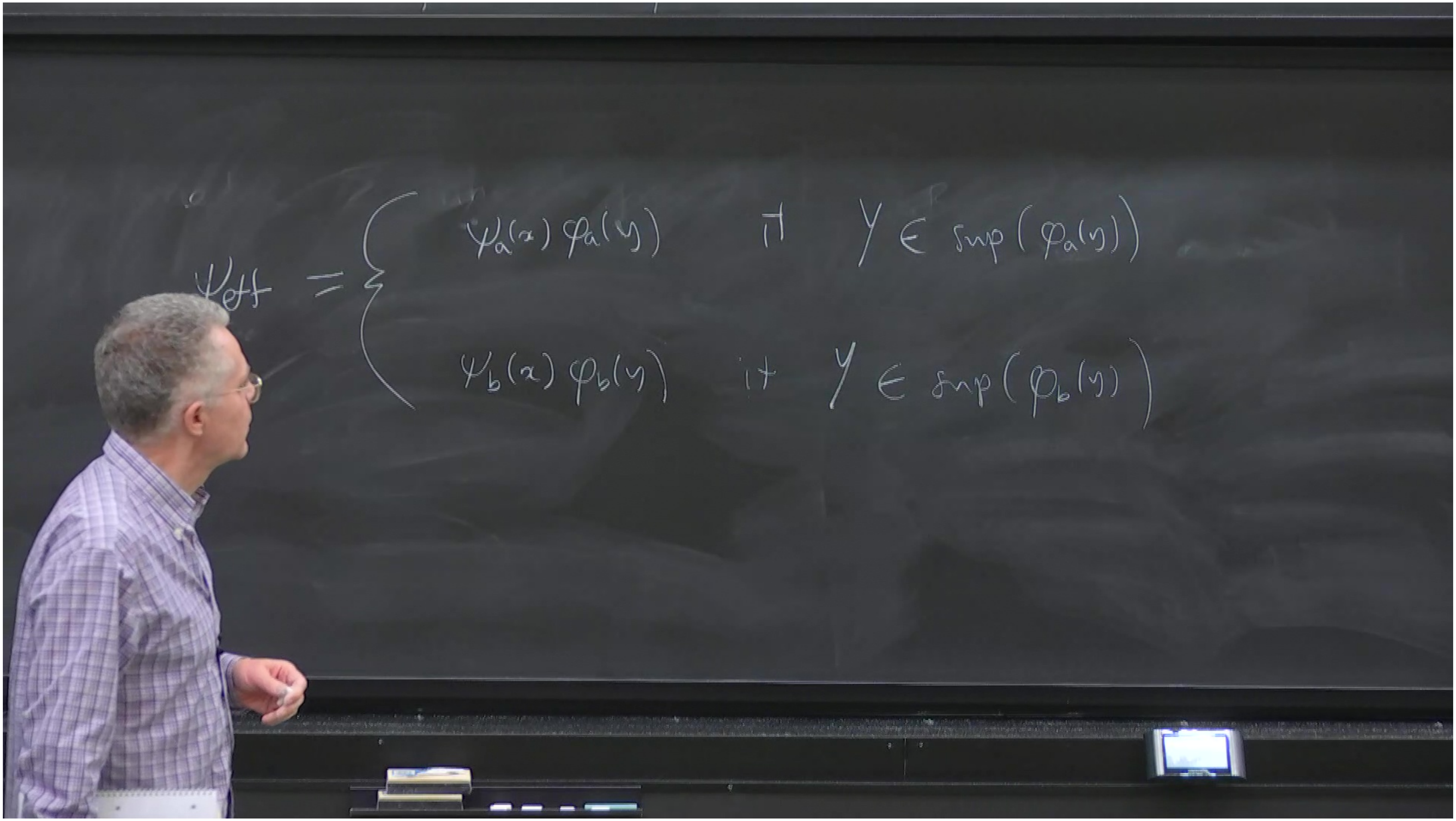
$N \simeq 10^{23}$

all $t \geq T$

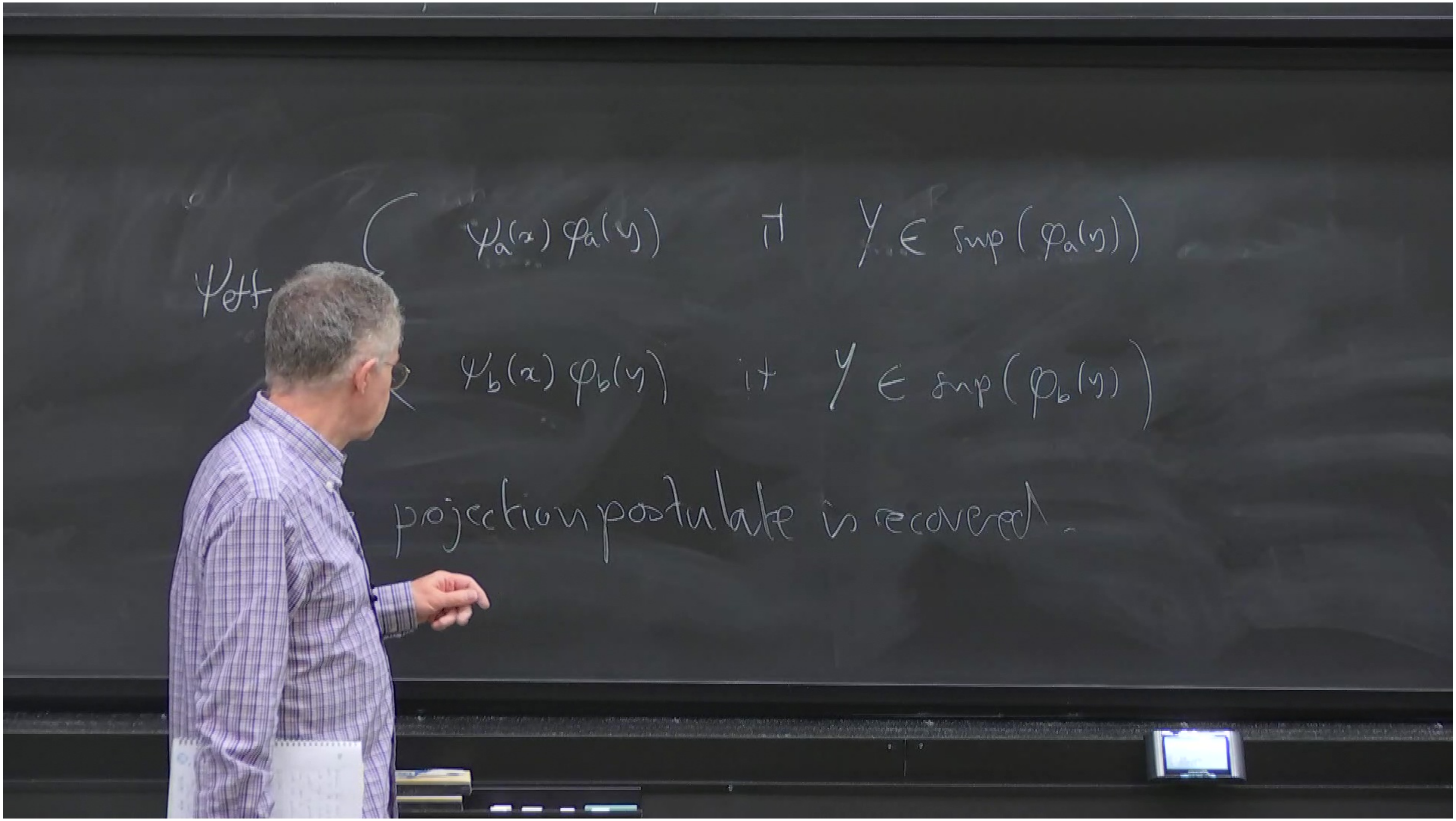
$$\frac{d\vec{X}}{dt}$$

If have a outcome then $\vec{x}, \vec{y}$ depend only

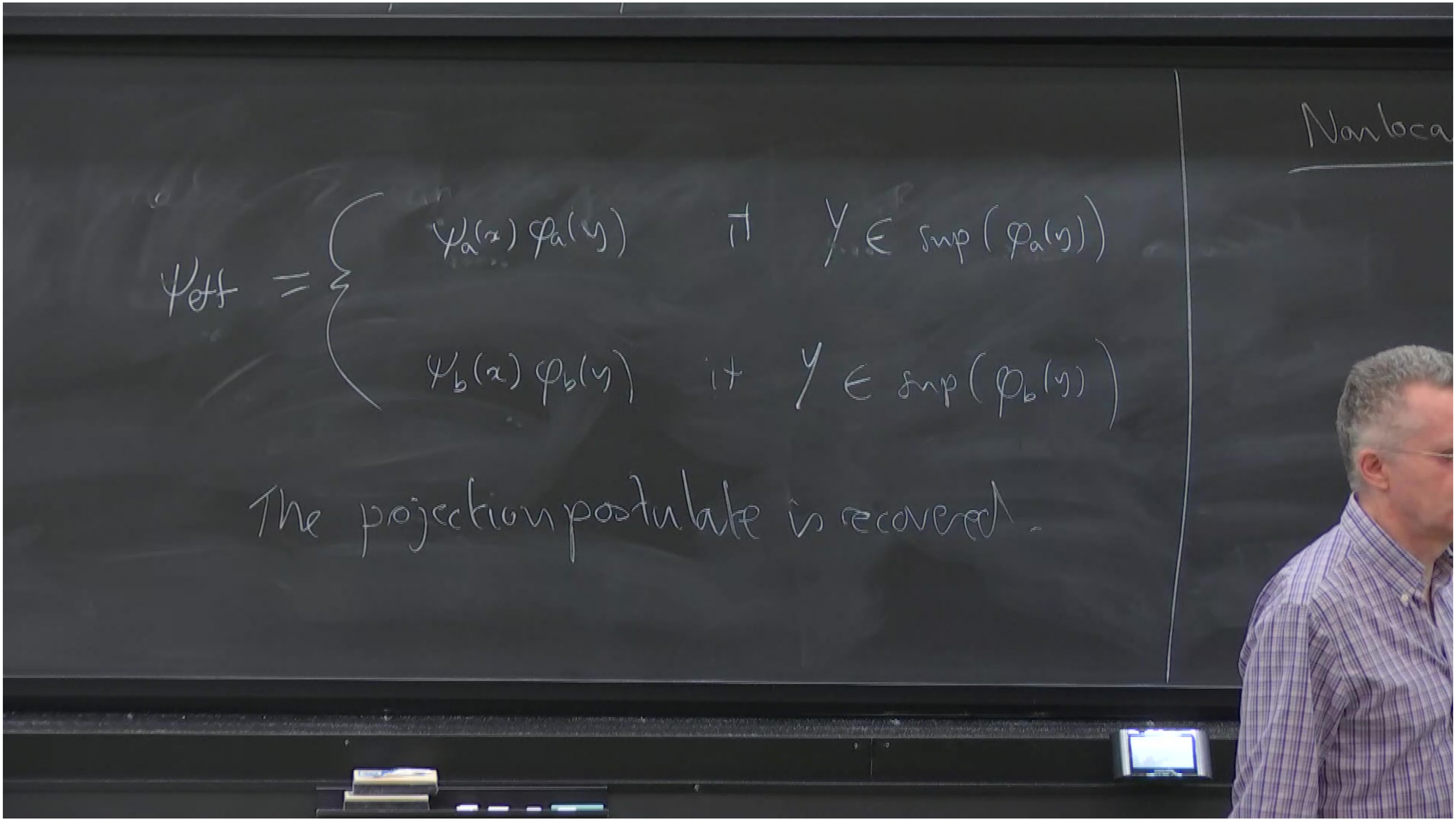
on $\psi_a(x)\,\phi_a(y)$

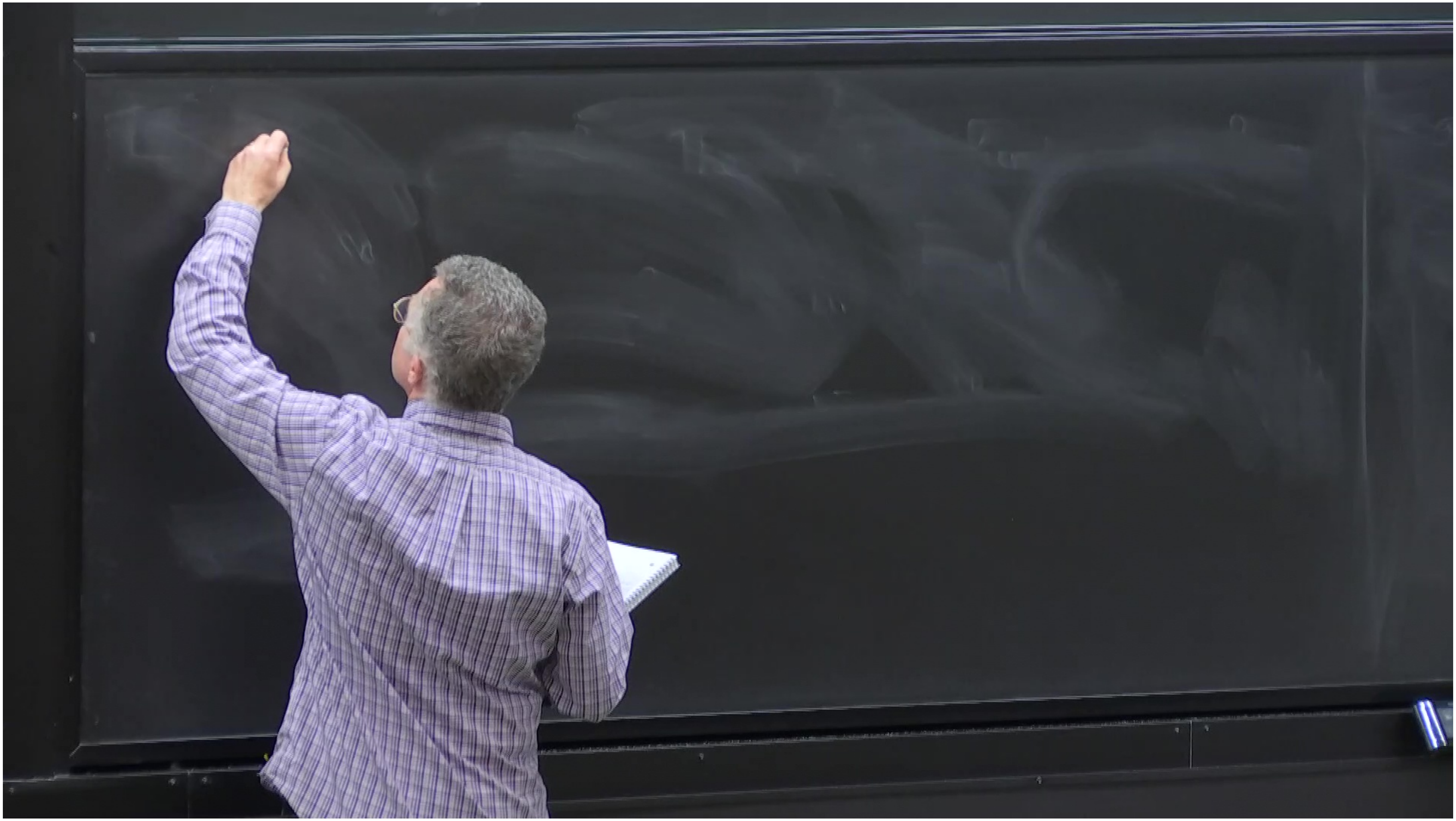

$\psi_{eff} = \begin{cases} \psi_a(x)\,\varphi_a(y) & \text{if } y \in \sup(\varphi_a(y)) \\ \psi_b(x)\,\varphi_b(y) & \text{if } y \in \sup(\varphi_b(y)) \end{cases}$

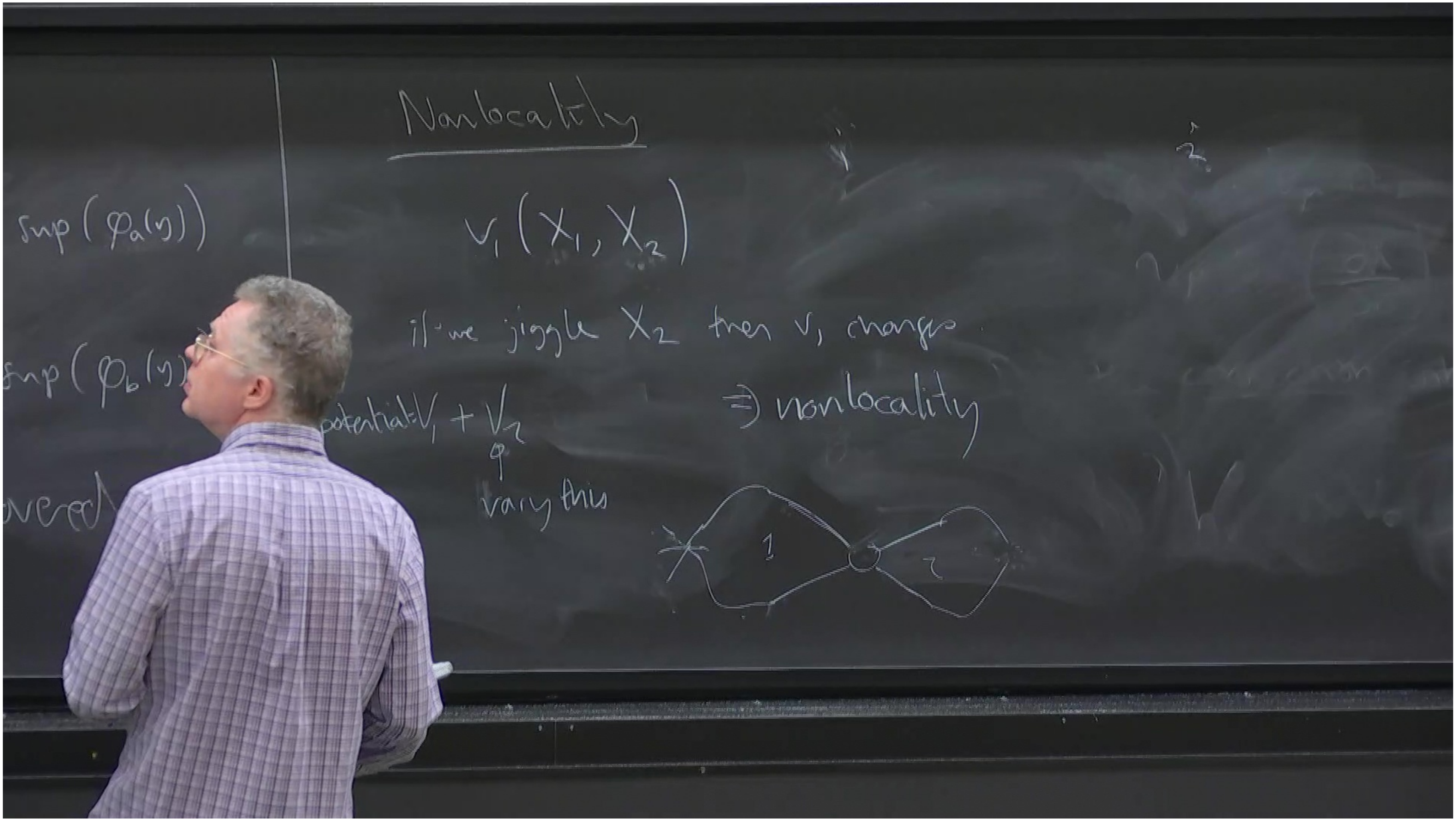
$$\psi_{eff} = \begin{cases} \psi_a(x)\,\varphi_a(y) & \text{if } y \in \mathrm{sup}(\varphi_a(y)) \\ \psi_b(x)\,\varphi_b(y) & \text{if } y \in \mathrm{sup}(\varphi_b(y)) \end{cases}$$

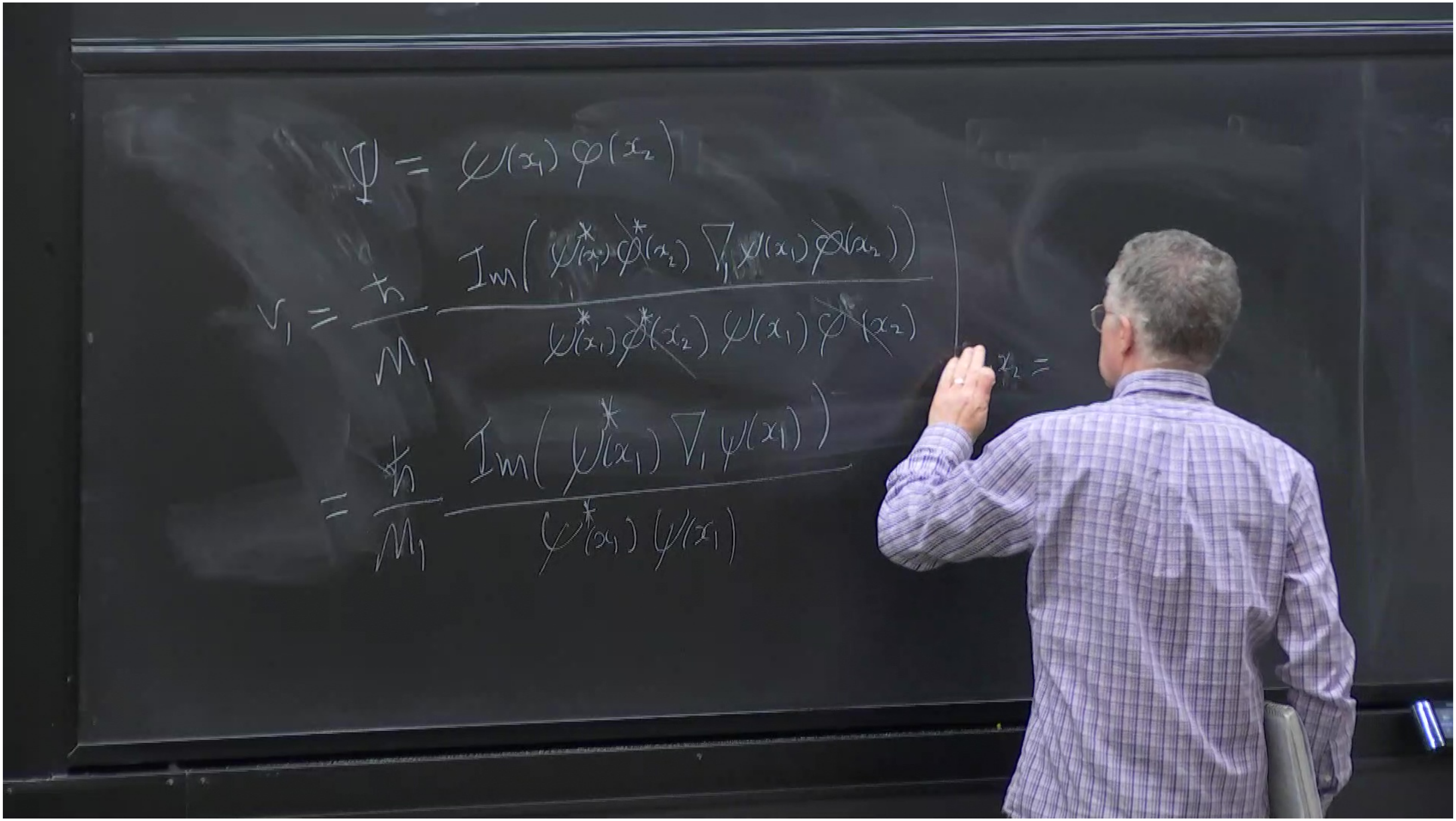


$\psi_{eff} = \begin{cases} \psi_a(x)\,\varphi_a(y) & \text{if } y \in \mathrm{supp}(\varphi_a(y)) \\ \psi_b(x)\,\varphi_b(y) & \text{if } y \in \mathrm{supp}(\varphi_b(y)) \end{cases}$
projection postulate is recovered.


Nonloca
$\psi_{eff} = \begin{cases} \psi_a(x)\,\varphi_a(y) & \text{if } y \in \operatorname{sup}(\varphi_a(y)) \\ \psi_b(x)\,\varphi_b(y) & \text{if } y \in \operatorname{sup}(\varphi_b(y)) \end{cases}$
The projection postulate is recovered.



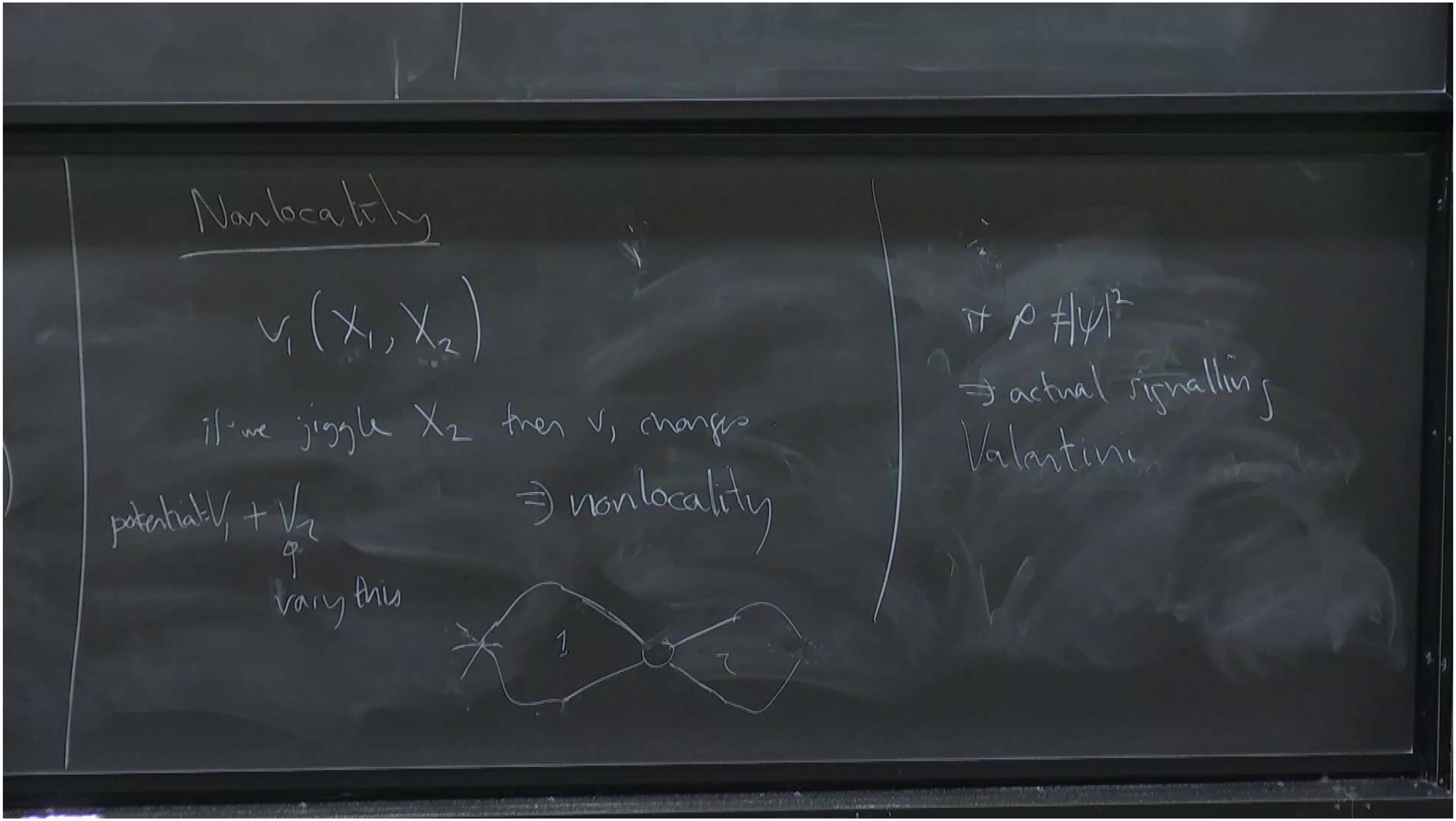

Nonlocality
sup (φa(y))
v1 (X1 , X2)
if we jiggle X2 then v1 changes
sup (φb(y))
⇒ nonlocality
potential: V1 + V2
vary this
1
2


$\Psi = \psi(x_1)\,\varphi(x_2)$
$v_1 = \frac{\hbar}{m_1} \frac{\mathrm{Im}\left(\psi^*(x_1)\cancel{\varphi^*(x_2)}\,\nabla_1 \psi(x_1)\cancel{\varphi(x_2)}\right)}{\psi^*(x_1)\cancel{\varphi^*(x_2)}\,\psi(x_1)\cancel{\varphi(x_2)}}$
$= \frac{\hbar}{m_1} \frac{\mathrm{Im}\left(\psi^*(x_1)\,\nabla_1 \psi(x_1)\right)}{\psi^*(x_1)\,\psi(x_1)}$
$x_2 =$

$$\Psi = \psi(x_1)\,\varphi(x_2)$$

$$v_1 = \frac{\hbar}{m_1}\,\frac{\mathrm{Im}\left(\psi^*(x_1)\,\cancel{\varphi^*(x_2)}\,\nabla_1\psi(x_1)\,\cancel{\varphi(x_2)}\right)}{\psi^*(x_1)\,\cancel{\varphi^*(x_2)}\,\psi(x_1)\,\cancel{\varphi(x_2)}}\Bigg|_{x_1,x_2 = X_1,X_2}$$

$$= \frac{\hbar}{m_1}\,\frac{\mathrm{Im}\left(\psi^*(x_1)\,\nabla_1\psi(x_1)\right)}{\psi^*(x_1)\,\psi(x_1)}\Bigg|_{x_1 = X_1}$$


Nonlocality
v1 (X1 , X2)
if we jiggle X2 then v1 changes
potential: V1 + V2
φ
vary this
⇒ nonlocality
1
2
if ρ ≠ |ψ|²
⇒ actual signalling
Valentini

Criticisms

① Don't need the guidance eqn to make predictions

② Where does guidance eqn come from?
 - it is a "bolt on"

③ No back reaction of particles on waves.

4 The many worlds in denial attack.

Deutsch | Brown Wallace

The wave fn is real – it really exists.

It contains stories about what happens.