Title: Quantum Foundations Lecture

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Collection: Quantum Foundations

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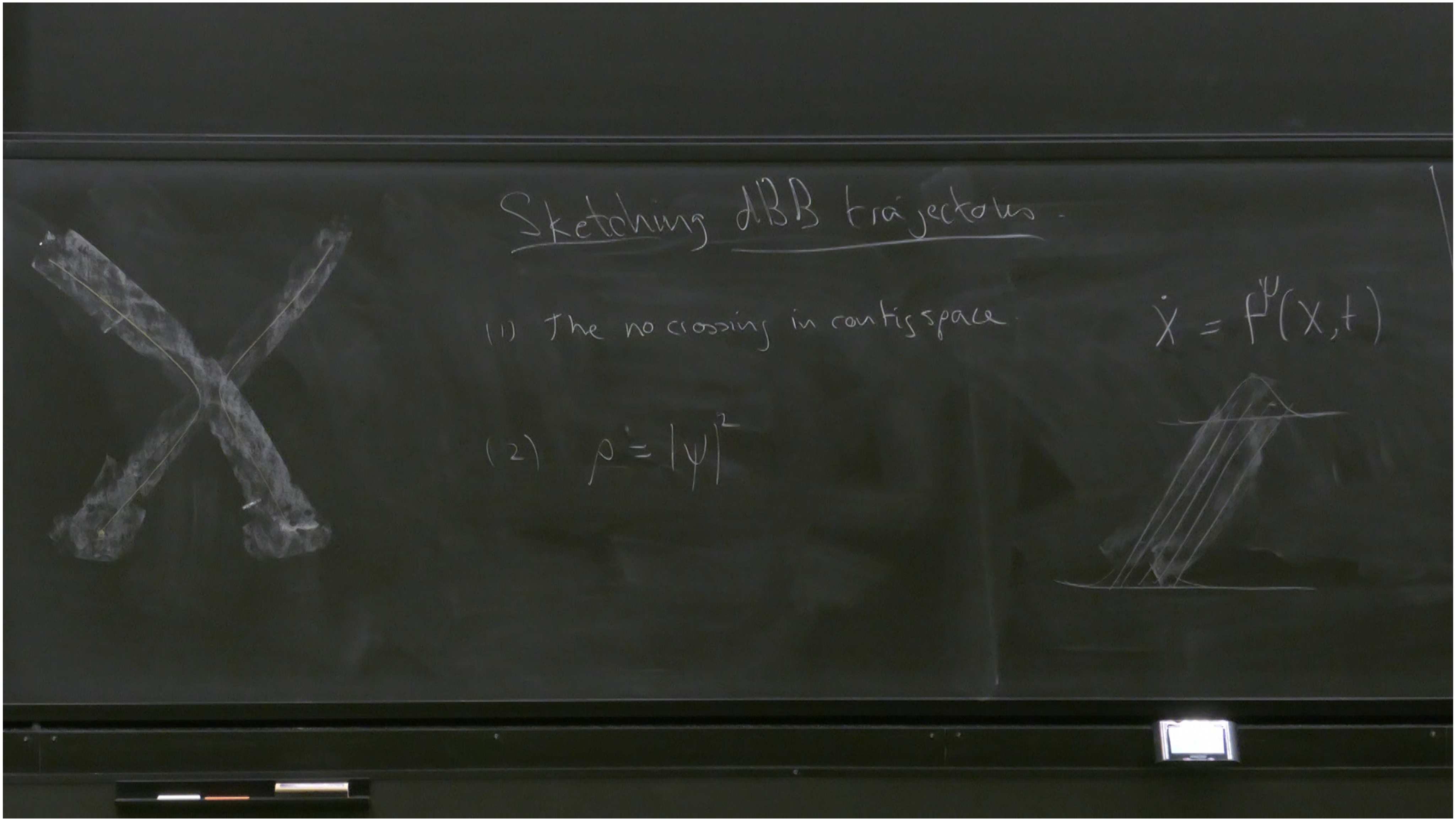
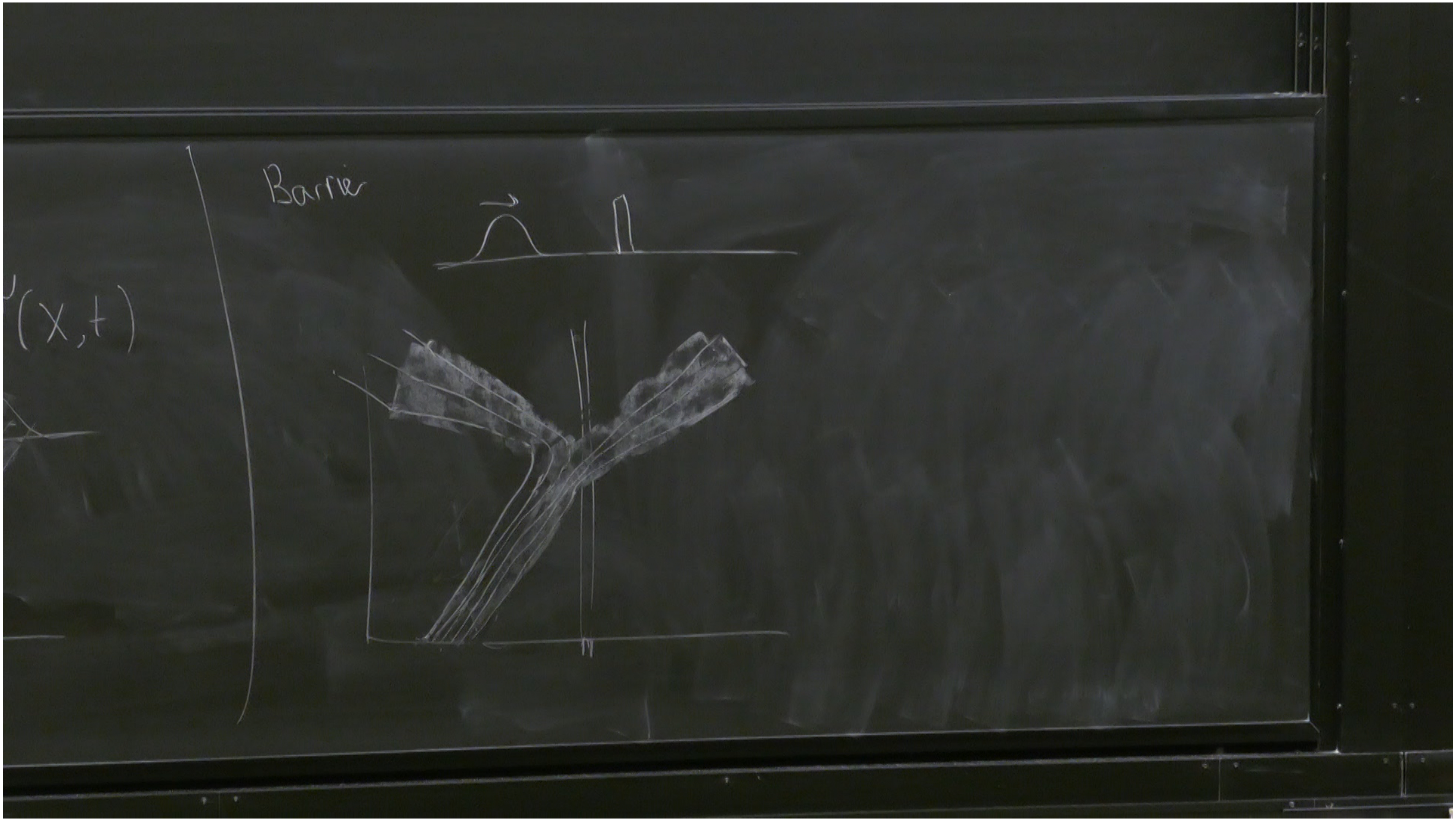

Sketching dBB trajectories.
(1) The no crossing in config space.
$\dot{X} = f^{\psi}(X,t)$
(2) $\rho \doteq |\psi|^2$

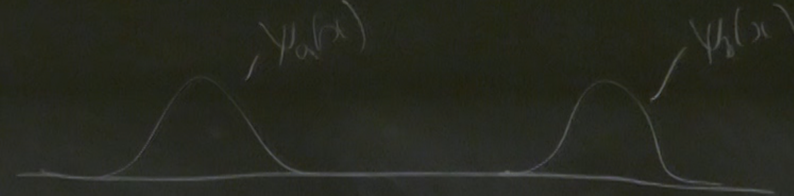

Barrier
(x,t)

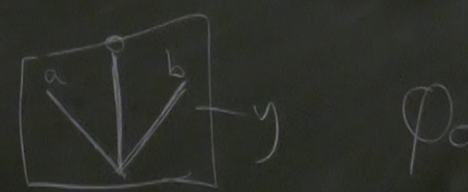
Measurement in dBB

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

$$\psi_a(x)\,\varphi_0(y) \longrightarrow \psi_a(x)\,\varphi_a(y)$$

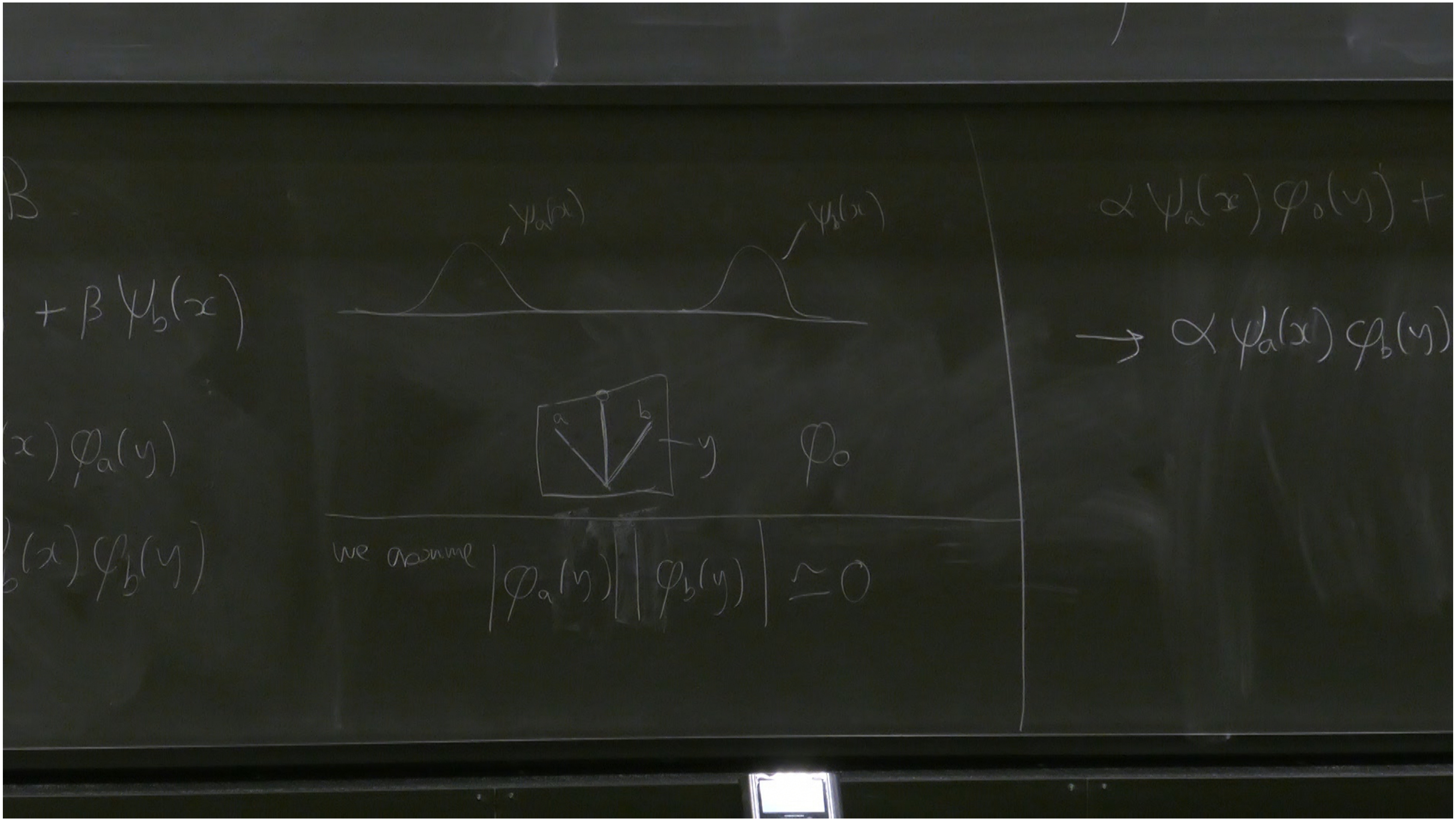
$$\psi_b(x)\,\varphi_0(y) \longrightarrow \psi_b(x)\,\varphi_b(y)$$



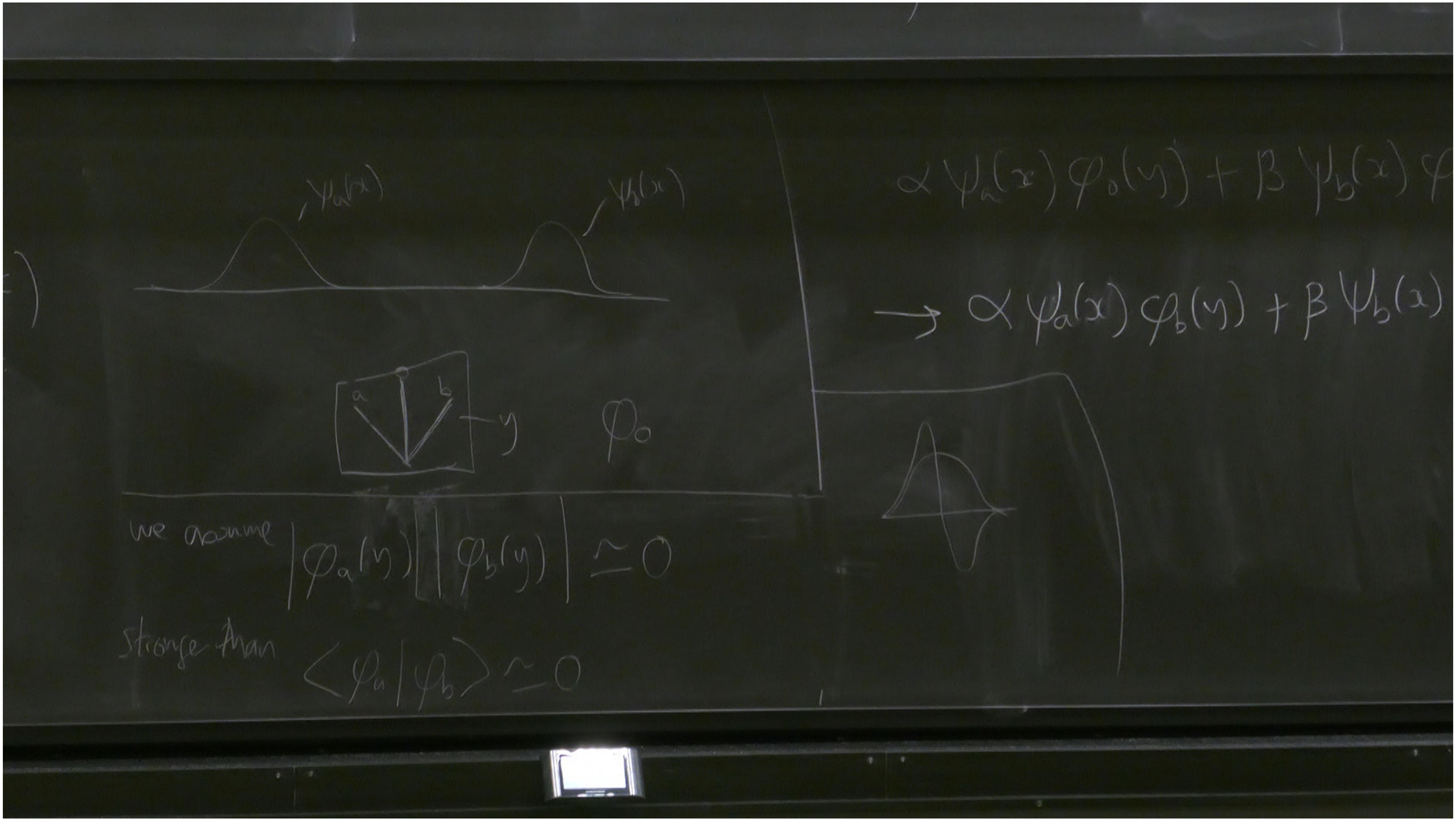


$$\alpha\,\psi_a(x)\,\varphi_0(y) + \beta\,\psi_b(x)\,\varphi_0(y)$$

$$\rightarrow \alpha\,\psi_a(x)\,\varphi_b(y) + \beta\,\psi_b(x)\,\varphi_b(y)$$



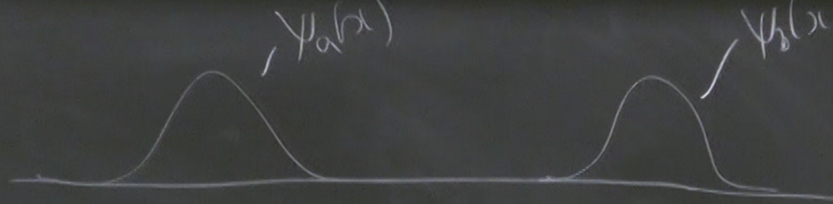
β
$+ \beta \psi_b(x)$
$(x)\, \varphi_a(y)$
$(x)\, \varphi_b(y)$
$\psi_a(x)$
$\psi_b(x)$
a
b
y
φ_0
we assume $|\varphi_a(y)|\,|\varphi_b(y)| \simeq 0$
$\alpha\, \psi_a(x)\, \varphi_0(y) +$
$\rightarrow \alpha\, \psi_a(x)\, \varphi_b(y)$

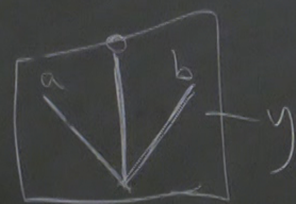

$\psi_a(x)$
$\psi_b(x)$
a
b
y
φ_0
we assume $|\varphi_a(y)|\,|\varphi_b(y)| \simeq 0$
Stronger than $\langle\varphi_a|\varphi_b\rangle \simeq 0$
$\alpha\,\psi_a(x)\,\varphi_0(y) + \beta\,\psi_b(x)\,\varphi$
$\to \alpha\,\psi_a(x)\,\varphi_b(y) + \beta\,\psi_b(x)$

$\beta\, \psi_b(x))$

$\varphi_a(y)$

$\varphi_b(y))$





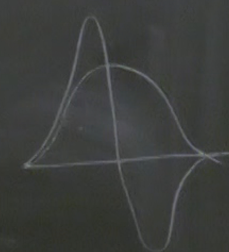
φ_0

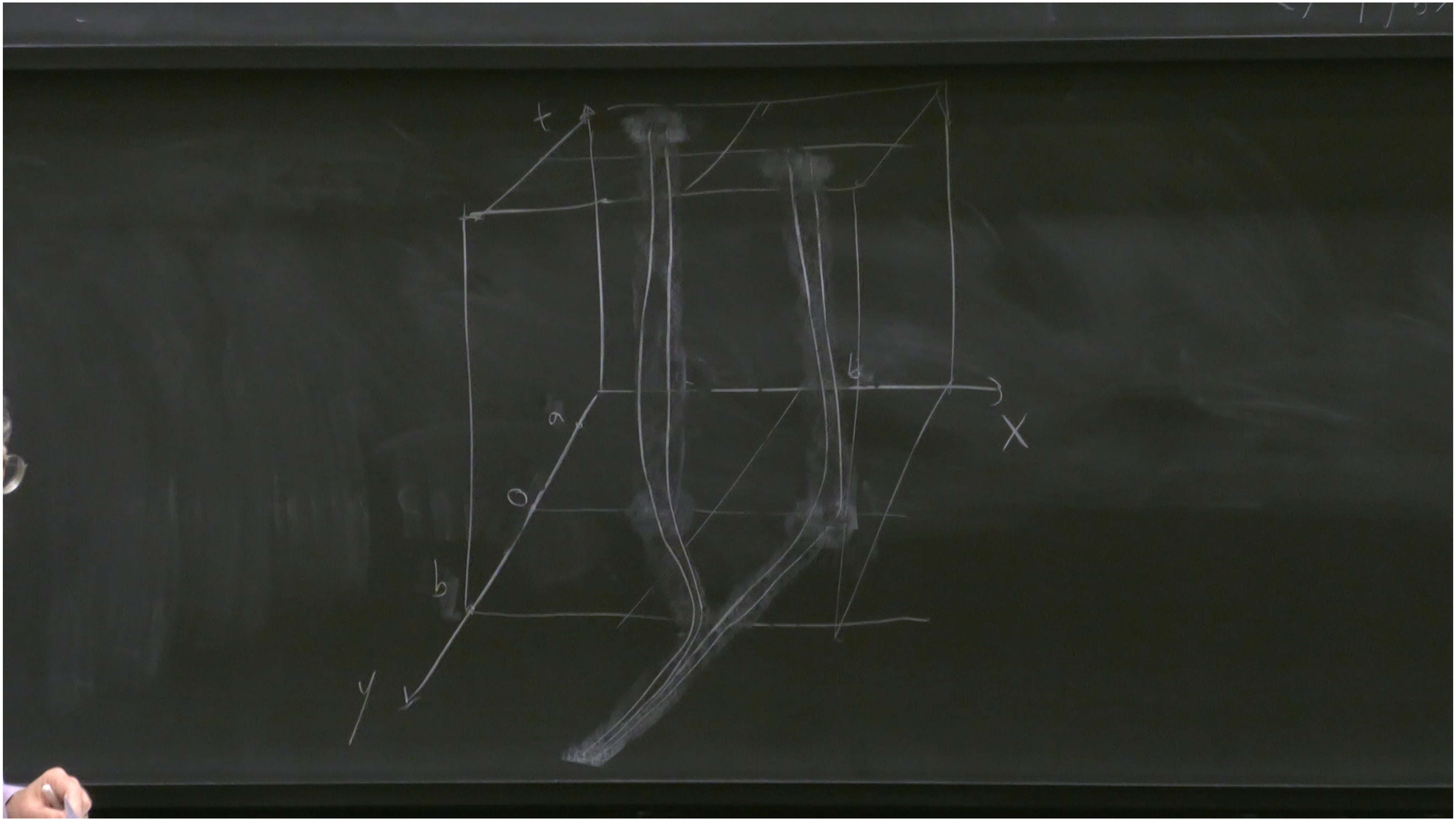
we assume $\left|\varphi_a(y)\right| \left|\varphi_b(y)\right| \simeq 0$

stronger than $\langle \varphi_a | \varphi_b \rangle \simeq 0$

$\alpha\, \psi_a(x)\, \varphi_0(y))$

$\rightarrow \alpha\, \psi_a(x)\, \varphi_b$




t
a
0
b
b
y
X

Stronger than $\langle \varphi_a | \varphi_b \rangle \simeq 0$

$$y = (y_1, y_2, \cdots y_N) \qquad N = 10^{23}$$

$$\dot{X} = \frac{\hbar \, \mathrm{Im}(\Psi^* \nabla_x \Psi)}{m \quad \Psi^* \Psi} \Bigg|_{\substack{x=X \\ y=Y}}$$

$$\dot{Y}_n =$$

$$\ldots\ y_N) \qquad N \simeq 10^{23}$$

$$\left.\frac{\nabla\Psi)}{\Psi}\right|_{\substack{x=X\\ y=Y}}$$

$$\Psi_{\text{eff}} = \begin{cases} \psi_a(x)\,\varphi_a(y) & \text{if } Y \text{ in } \operatorname{supp}(\varphi_a(y)) \\ \psi_b(x)\,\varphi_b(y) & \text{if } Y \text{ in } \operatorname{supp}(\varphi_b(y)) \end{cases}$$

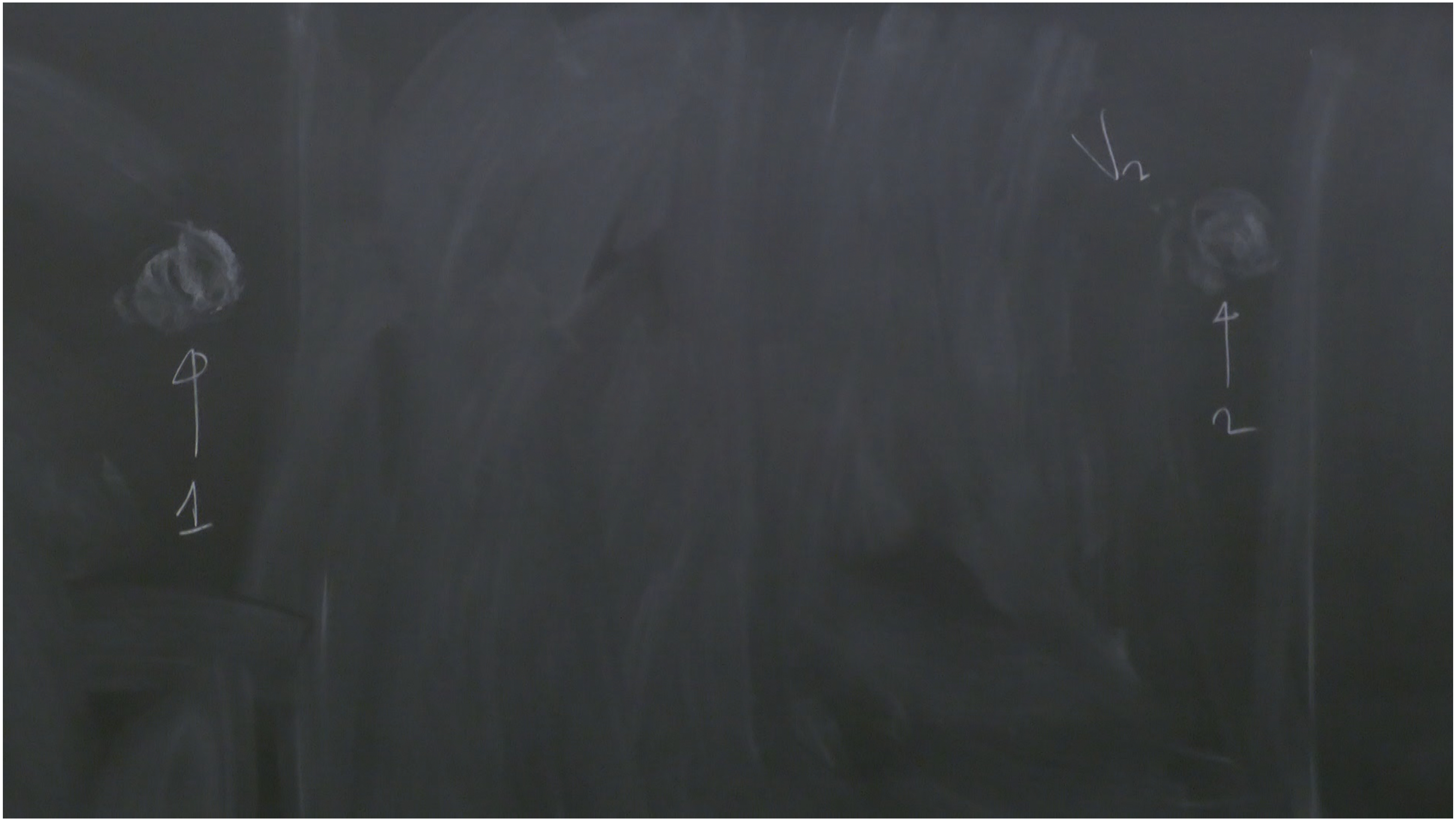
projection postulate recovered.

Nonlocality in dBB

$v_1^{\psi}(X_1, X_2)$ $\quad$ v_1 depends on X_2.

Could jiggle particle 2 using potential

$$V = V_1 + V_2$$



If $\Psi_{12}(x_1, x_2) = \psi_1(x_1)\,\varphi_2(x_2)$

$$v_1 = \frac{\hbar}{m_1} \frac{\left(\psi_1^*(x_1)\,\cancel{\varphi_2^*(x_2)}\,\nabla_1\left(\psi_1(x_1)\,\cancel{\varphi_2(x_2)}\right)\right)}{\psi_1^*(x_1)\,\cancel{\varphi_2^*(x_2)}\;\psi_1(x_1)\,\cancel{\varphi_2(x_2)}}\Bigg|_{\substack{x_1 = X_1 \\ x_2 = X_2}} = \frac{\hbar}{m_1}\ \psi_1$$

$$\ldots)\,\varphi_2(x_2)\big)$$

$$\frac{\ldots(x_2)\big)\big)}{\ldots\varphi_2(x_2)}\Bigg|_{\substack{x_1=X_1\\ x_2=X_2}} = \frac{\hbar}{m_1}\,\frac{\psi_1^*(x_1)\,\nabla_1\,\psi_1(x_1)}{\psi_1^*(x_1)\,\psi_1(x_1)}\Bigg|_{x_1=X_1}$$

4 Criticisms

(1) Don't actually need guidance eqn to make predictions.

(2) Where does guidence eqn come from?

(3) No back reaction of particles on waves.

$y_N)$ $\quad N \simeq 10^{23}$

$\Psi))\Big|_{\substack{x=X \\ y=Y}}$

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

projection postulate recovered.

(4) Subject to the "many worlds in denial" attack

$\underline{\Psi}$ is a real thing.