Title: Lecture - Quantum Foundations, PHYS 639

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Collection/Series: Quantum Foundations (Elective), PHYS 639, January 6 - February 5, 2025

Subject: Quantum Foundations

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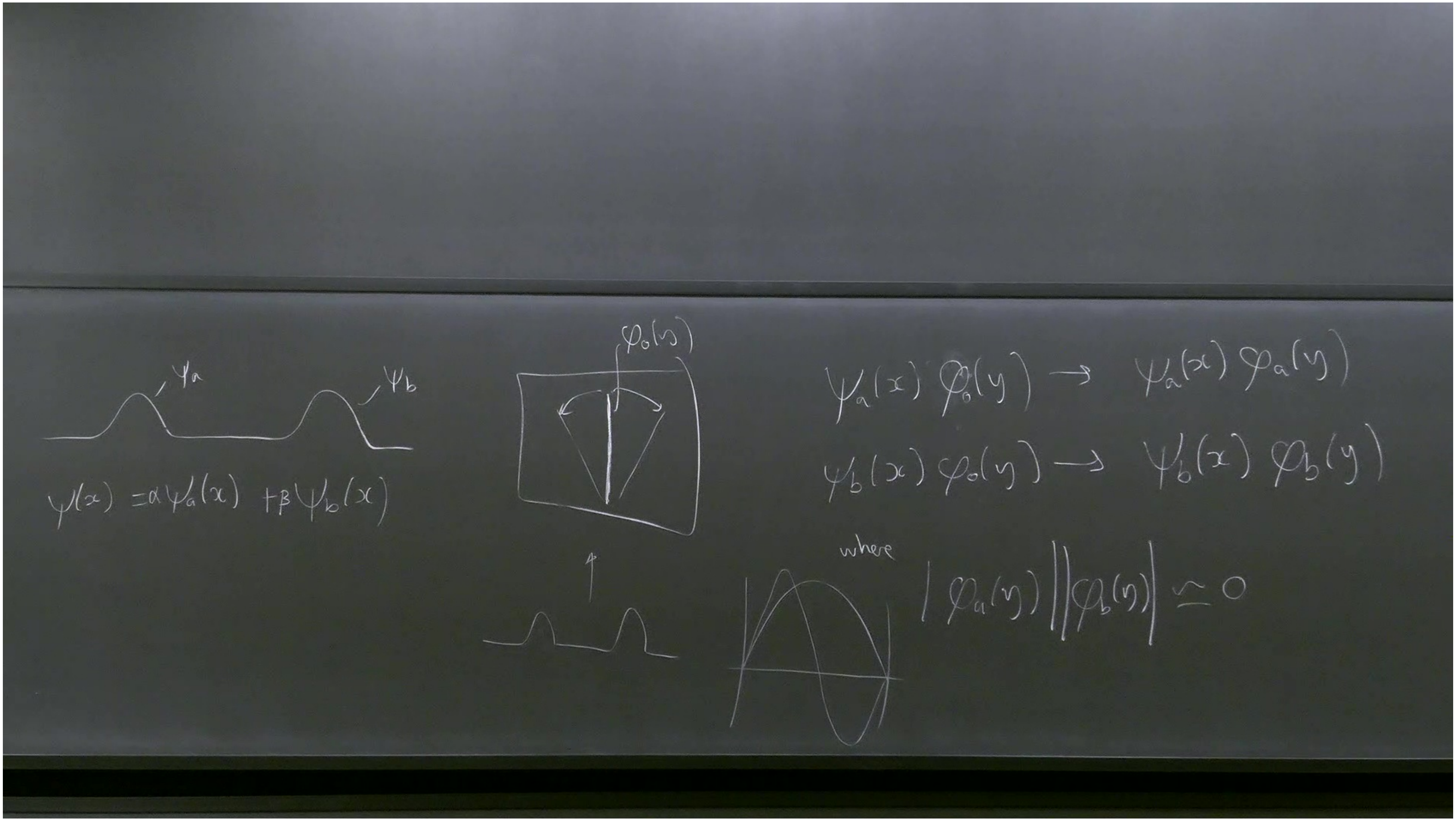
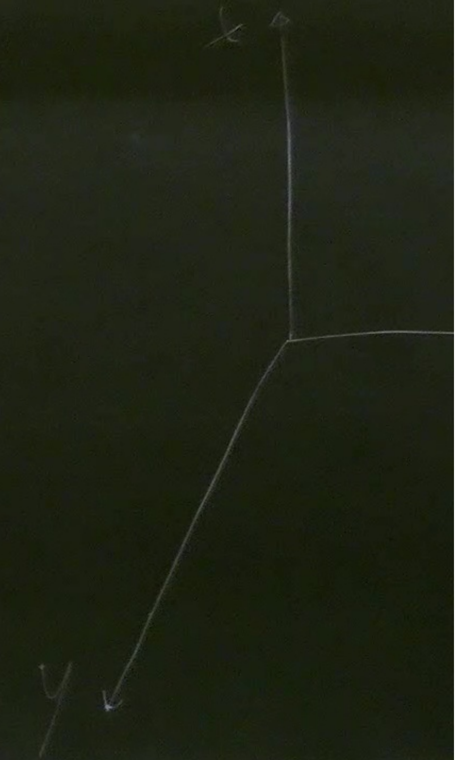
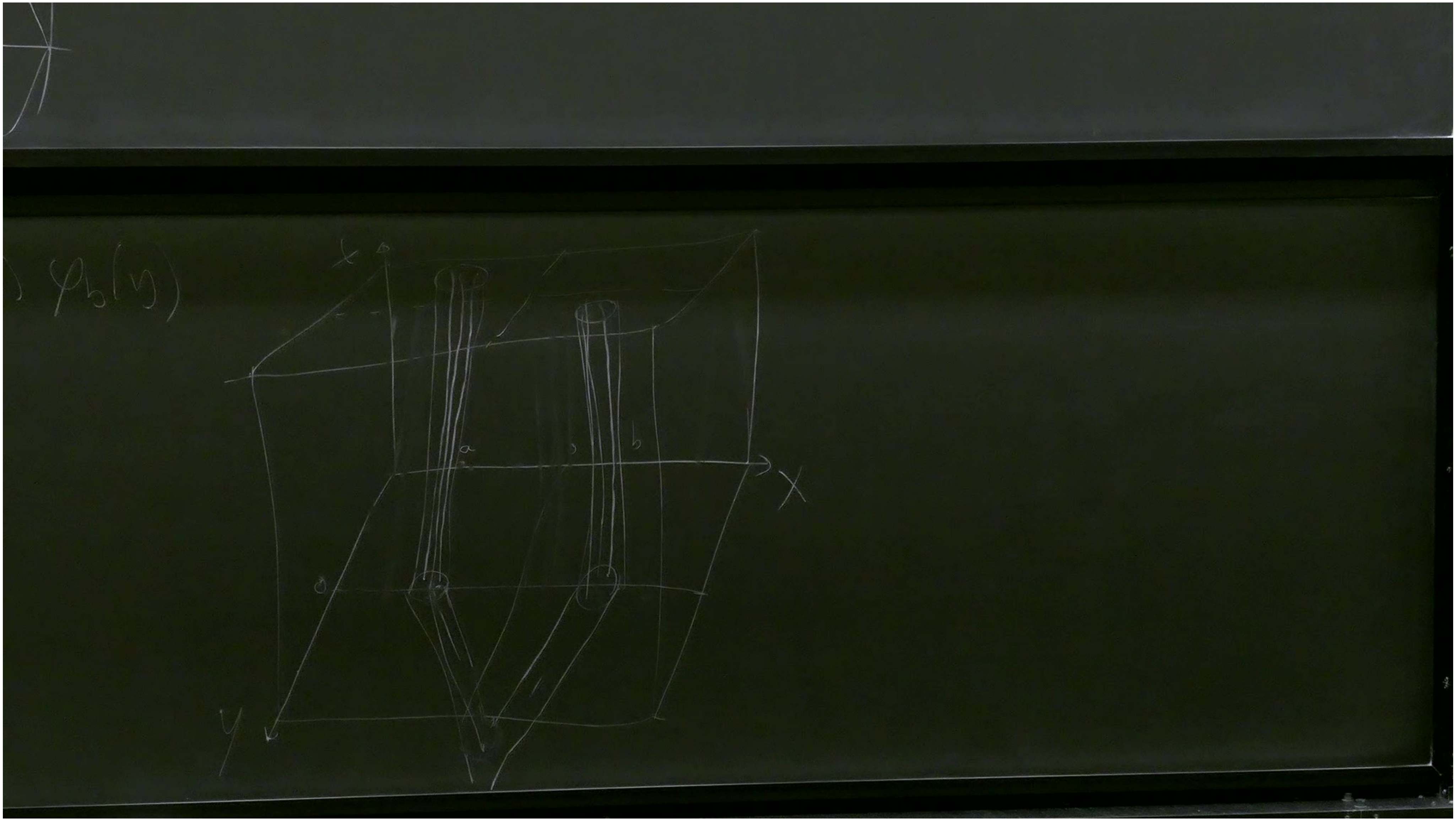

ψ_a
ψ_b
$\psi(x) = \alpha \psi_a(x) + \beta \psi_b(x)$
$\varphi_0(y)$
$\psi_a(x)\,\varphi_0(y) \rightarrow \psi_a(x)\,\varphi_a(y)$
$\psi_b(x)\,\varphi_0(y) \rightarrow \psi_b(x)\,\varphi_b(y)$
where
$|\langle\varphi_a(y)|\varphi_b(y)\rangle| \simeq 0$

$$\Psi(x,y,t) = \alpha\, \psi_a(x)\, \varphi_a(y) + \beta\, \psi_b(x)\, \varphi_b(y)$$





φb(y)
x
a
b
X
y

$$\Psi(x,y,t) = \alpha\, \psi_a(x)\, \varphi_a(y) + \beta\, \psi_b(x)\, \varphi_b(y)$$

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

$$r = f^{\Psi}(X,Y) \simeq f^{\Psi_{eff}}(X,Y) \qquad t \geq T$$

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

$$\Psi(x,y,t) = \alpha\, \psi_a(x)\, \varphi_a(y) + \beta\, \psi_b(x)\, \varphi_b(y)$$

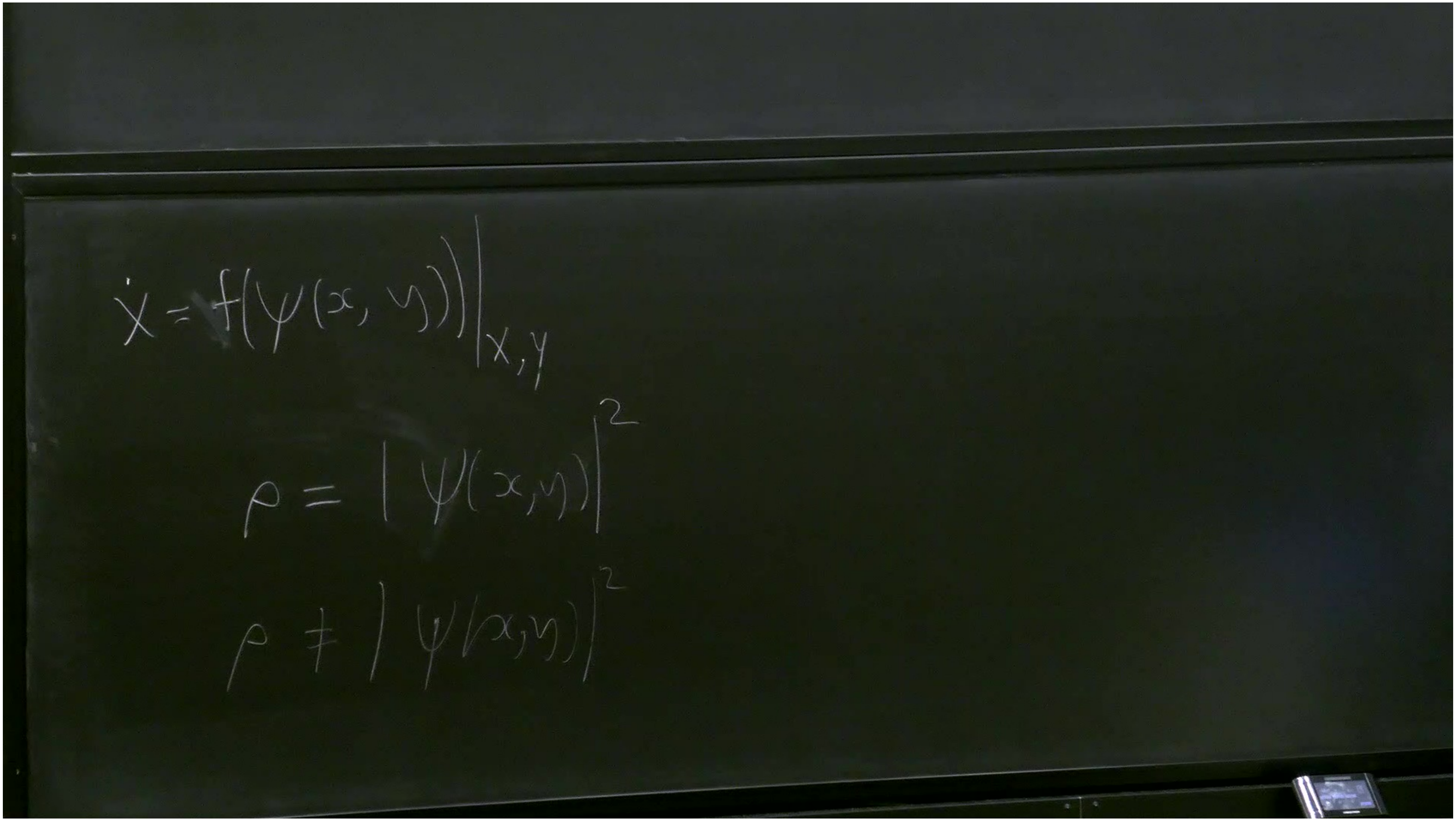
$$y = (y_1, y_2, \dots, y_N) \qquad N \simeq 10^{23}$$

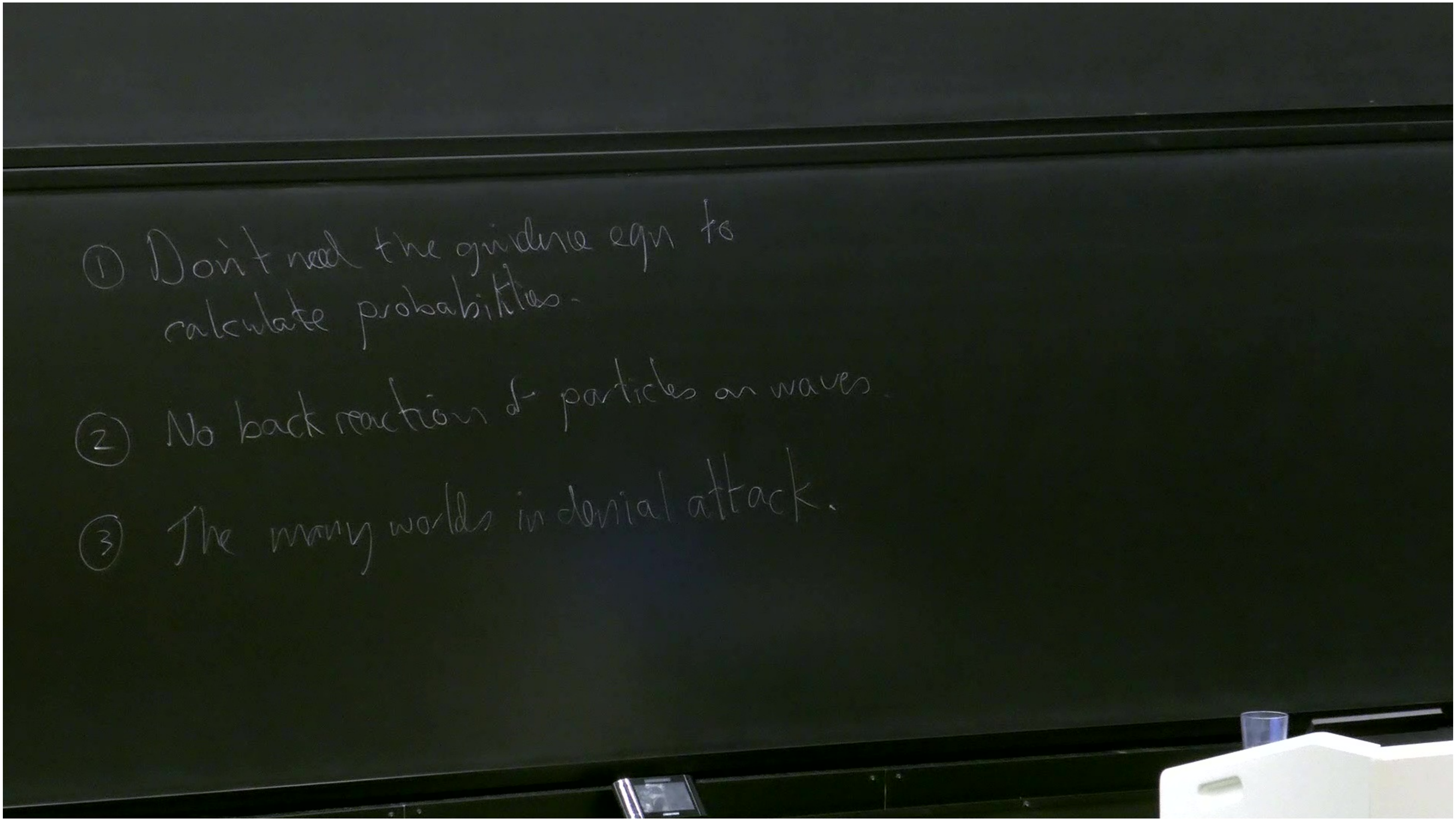
$$r = f^{\Psi}(X,Y) \simeq f^{\psi_{eff}}(X,Y) \qquad t \geq T$$

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

X, Y

Y


$\dot{x} = f(\psi(x, y))\big|_{x,y}$
$\rho = |\psi(x,y)|^2$
$\rho \neq |\psi(x,y)|^2$


① Don't need the guidance eqn to calculate probabilities.
② No back reaction of particles on waves.
③ The many worlds in denial attack.

$\phi_b(x)\,\phi_b(y)$ if y in supp$(\phi_b(y))$

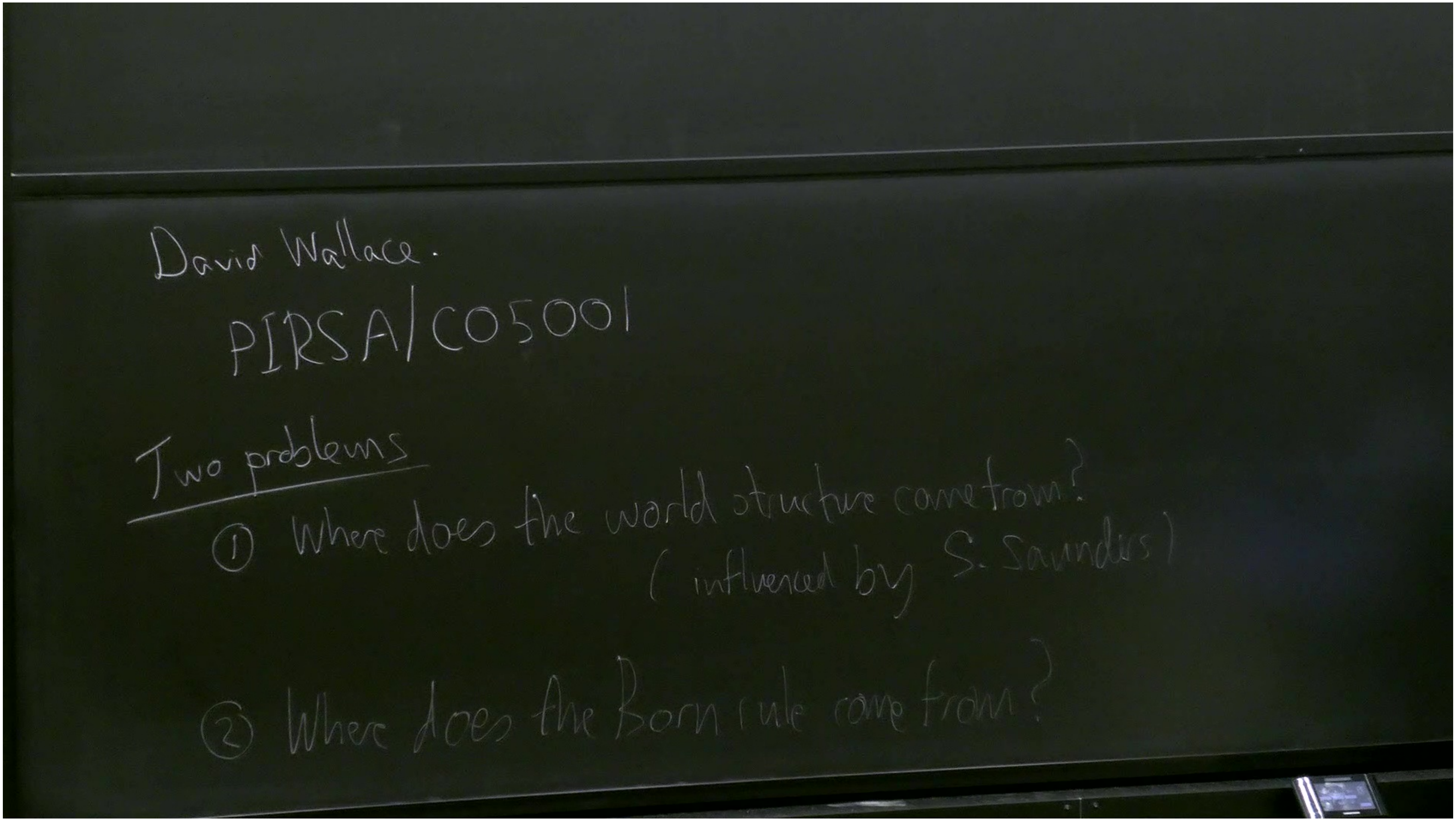
The Many Worlds Interpretation (Everett 1957)

The axioms

① The ontology, at time t, is given by the wave fn $|\psi\rangle$

② The wavefn evolves according to the Schrö eqn.

$$i\hbar \frac{d|\psi\rangle}{dt} = \hat{H}|\psi\rangle$$


David Wallace.
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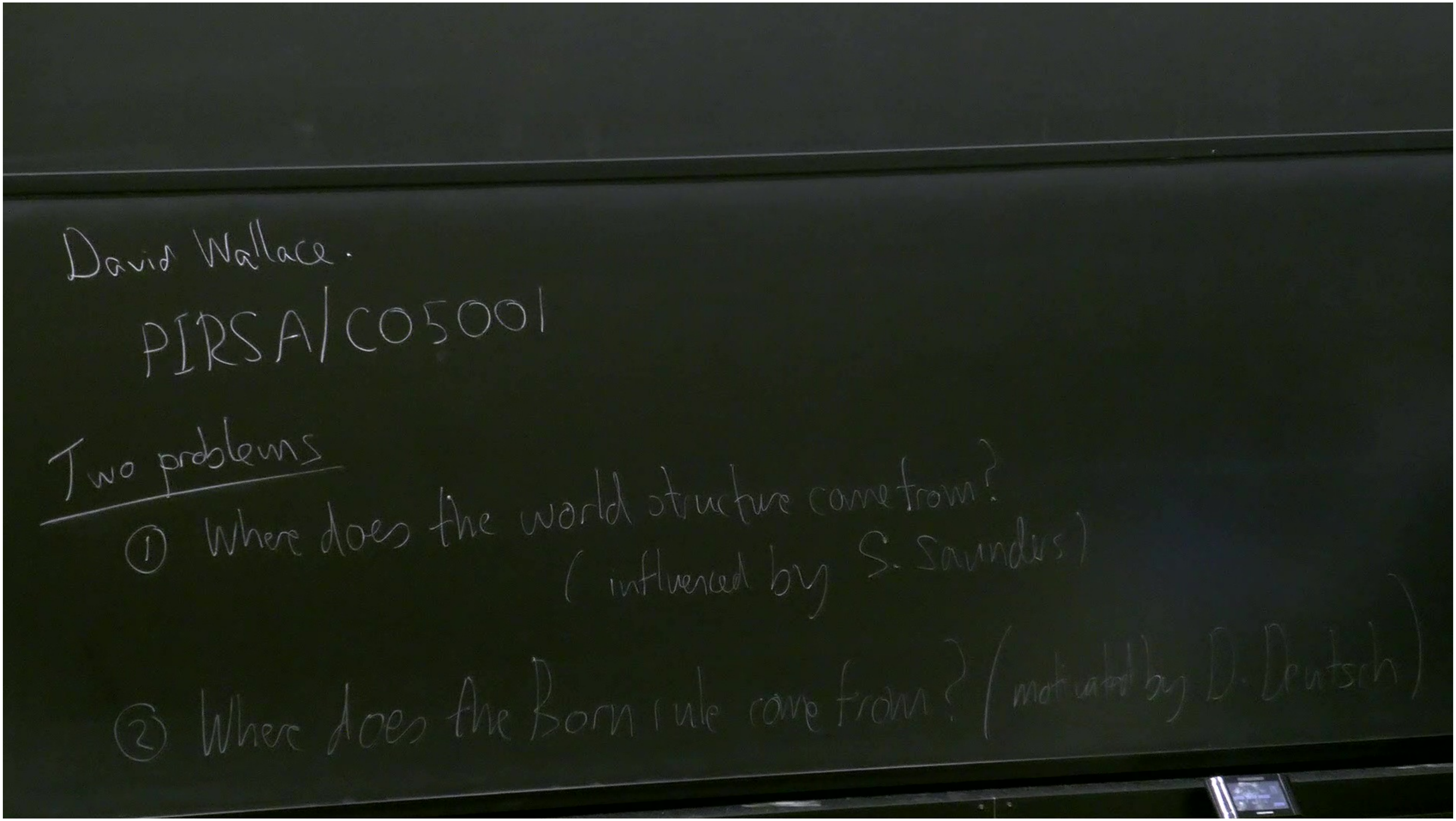
Two problems
① Where does the world structure come from?
(influenced by S. Saunders)
② Where does the Born rule come from?


David Wallace.
PIRSA/C05001
Two problems
① Where does the world structure come from?
(influenced by S. Saunders)
② Where does the Born rule come from? (motivated by D. Deutsch)