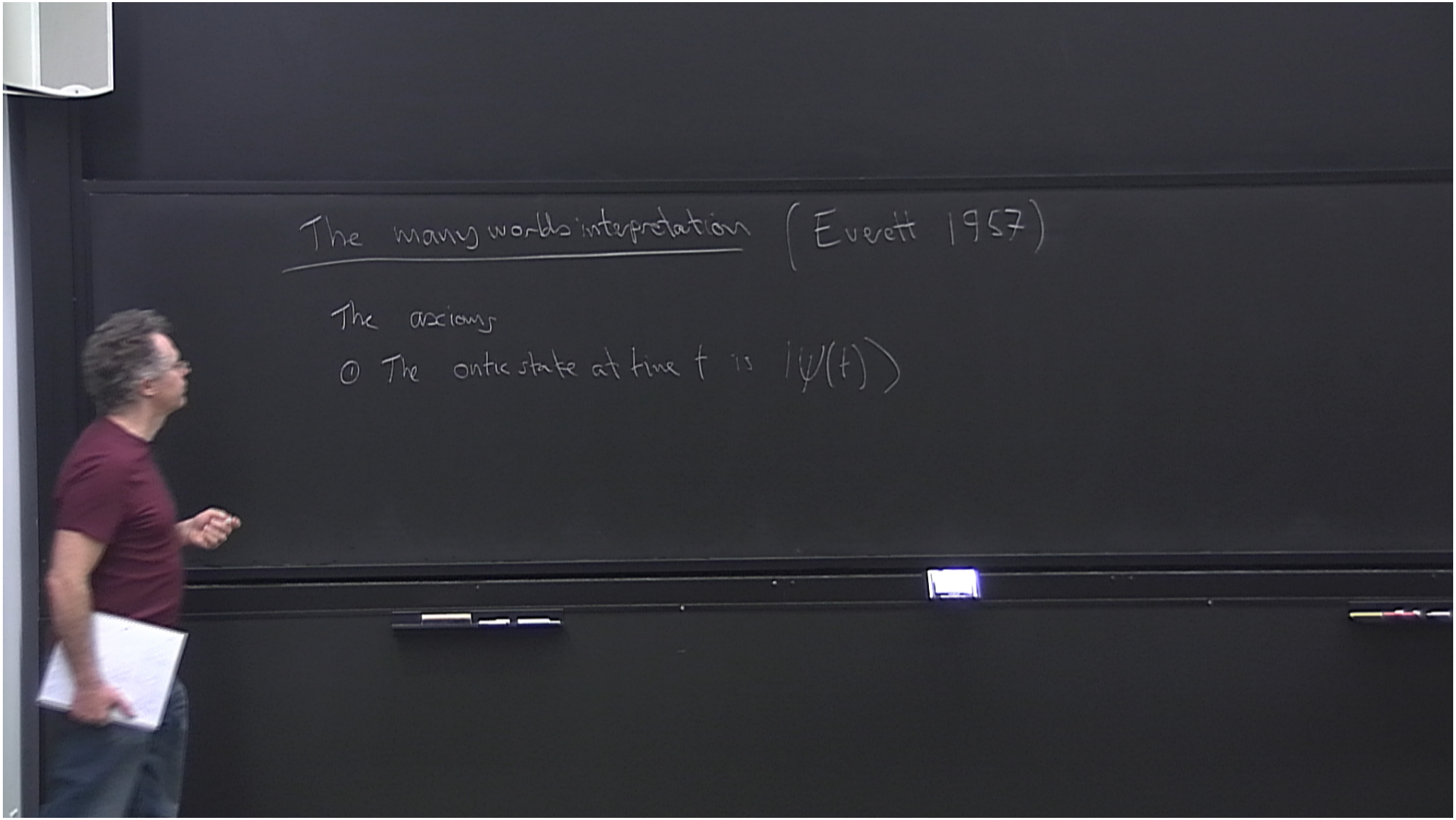
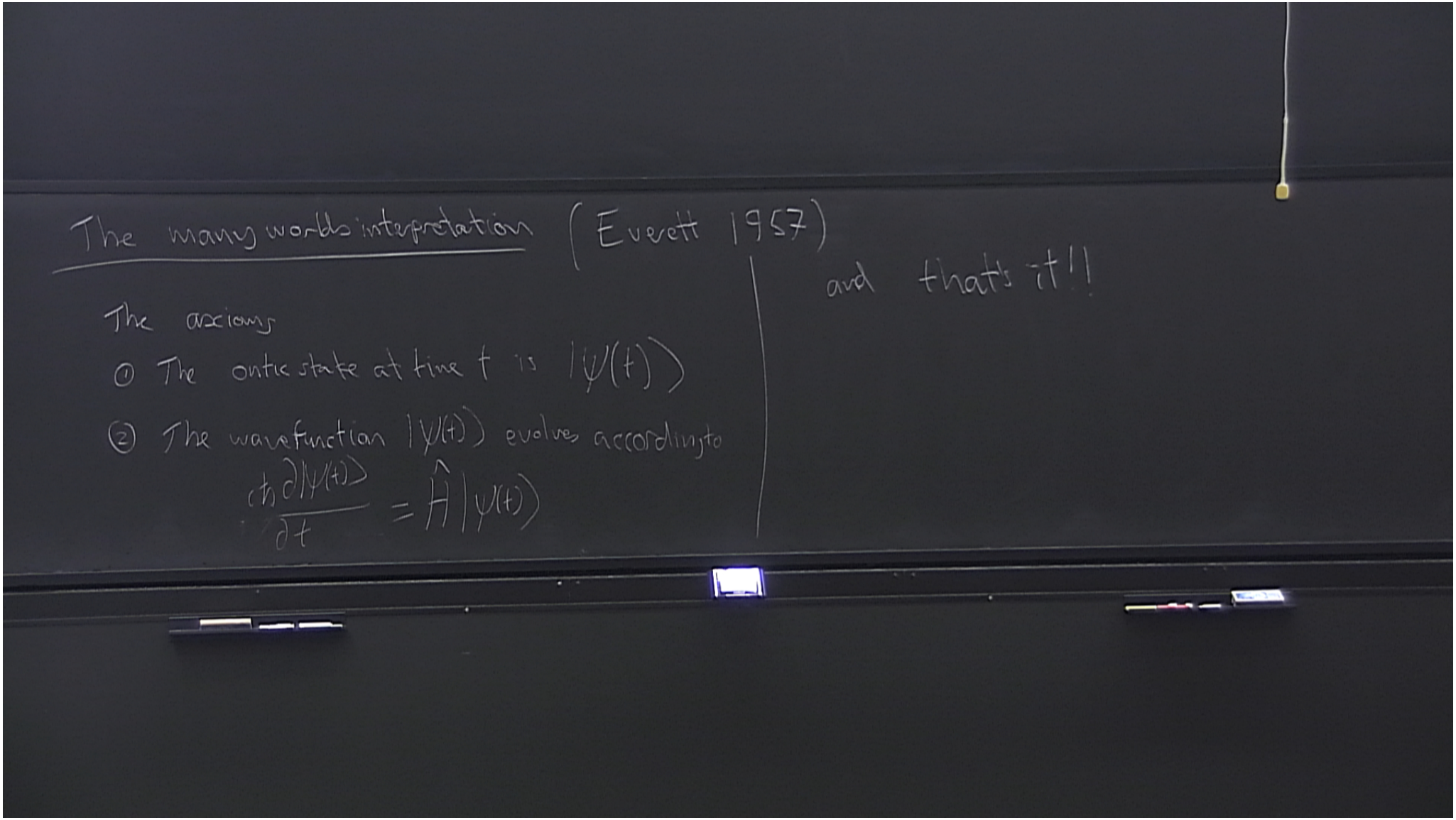
Title: Foundations of Quantum Mechanics-7

Date: Jan 13, 2015 11:30 AM

URL: http://pirsa.org/15010046

Abstract:


The many worlds interpretation (Everett 1957)
The axioms
① The ontic state at time t is $|\psi(t)\rangle$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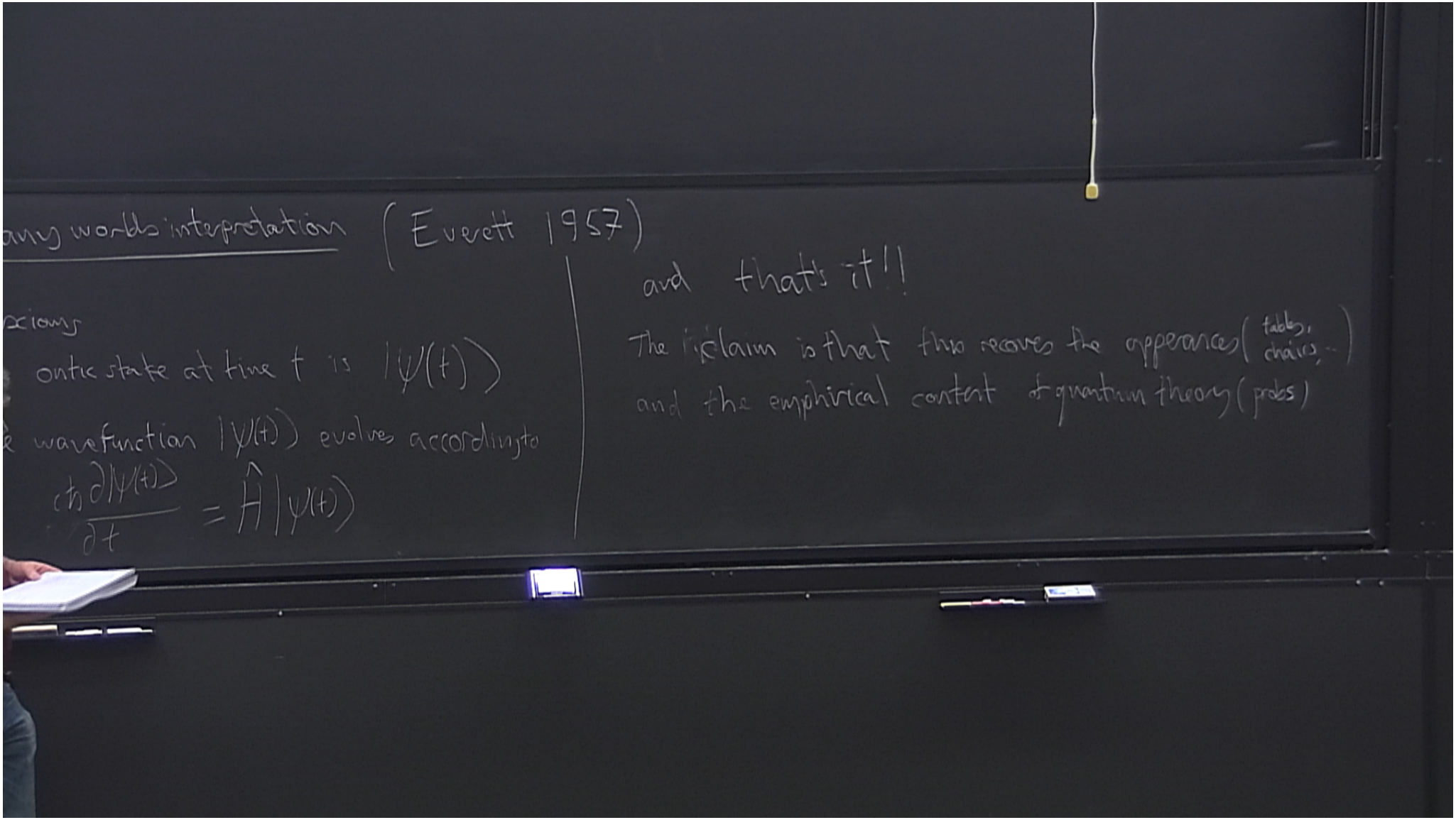
① The ontic state at time t is $|\psi(t)\rangle$
② The wavefunction $|\psi(t)\rangle$ evolves according to
$$i\hbar \frac{\partial |\psi(t)\rangle}{\partial t} = \hat{H}|\psi(t)\rangle$$
and that's it!!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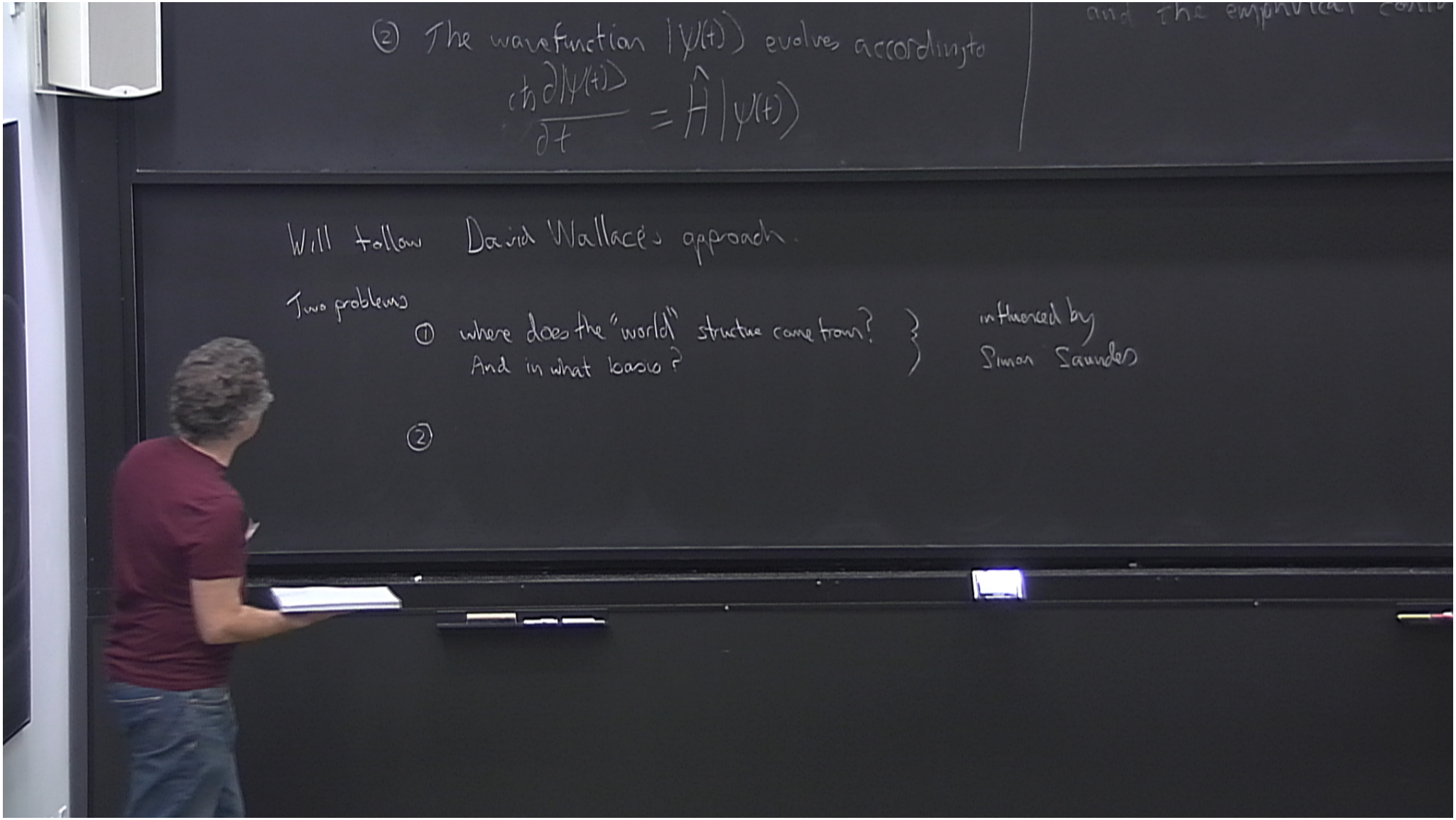
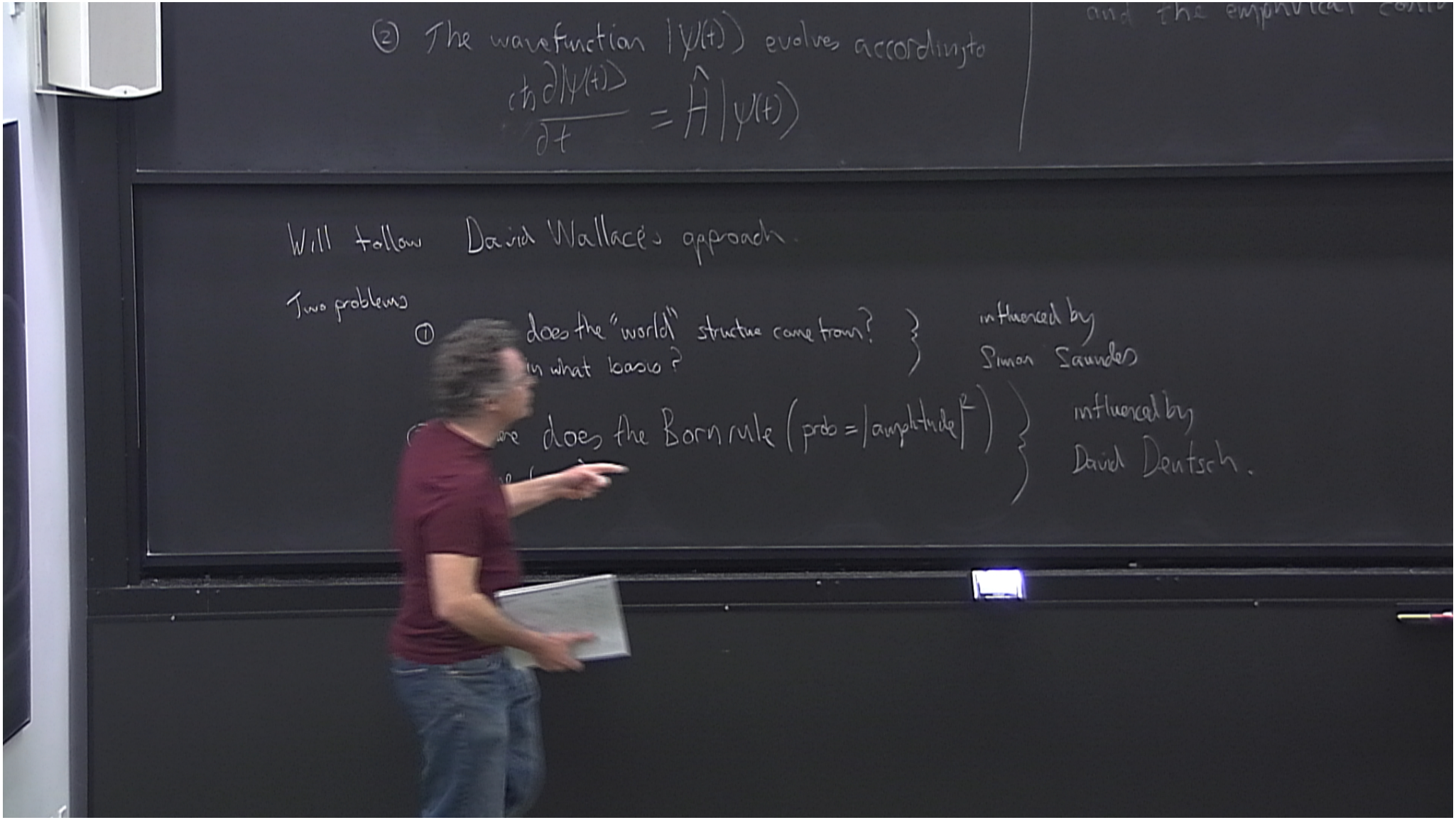
The claim is that this recovers the appearances (tables, chairs, ...)
and the empirical content of quantum theory (probs)


② The wavefunction $|\psi(t)\rangle$ evolves according to $\frac{ih\partial|\psi(t)\rangle}{\partial t} = \hat{H}|\psi(t)\rangle$
Will follow David Wallace's approach.
Two problems
① where does the "world" structure come from? And in what basis?
② }
influenced by Simon Saunders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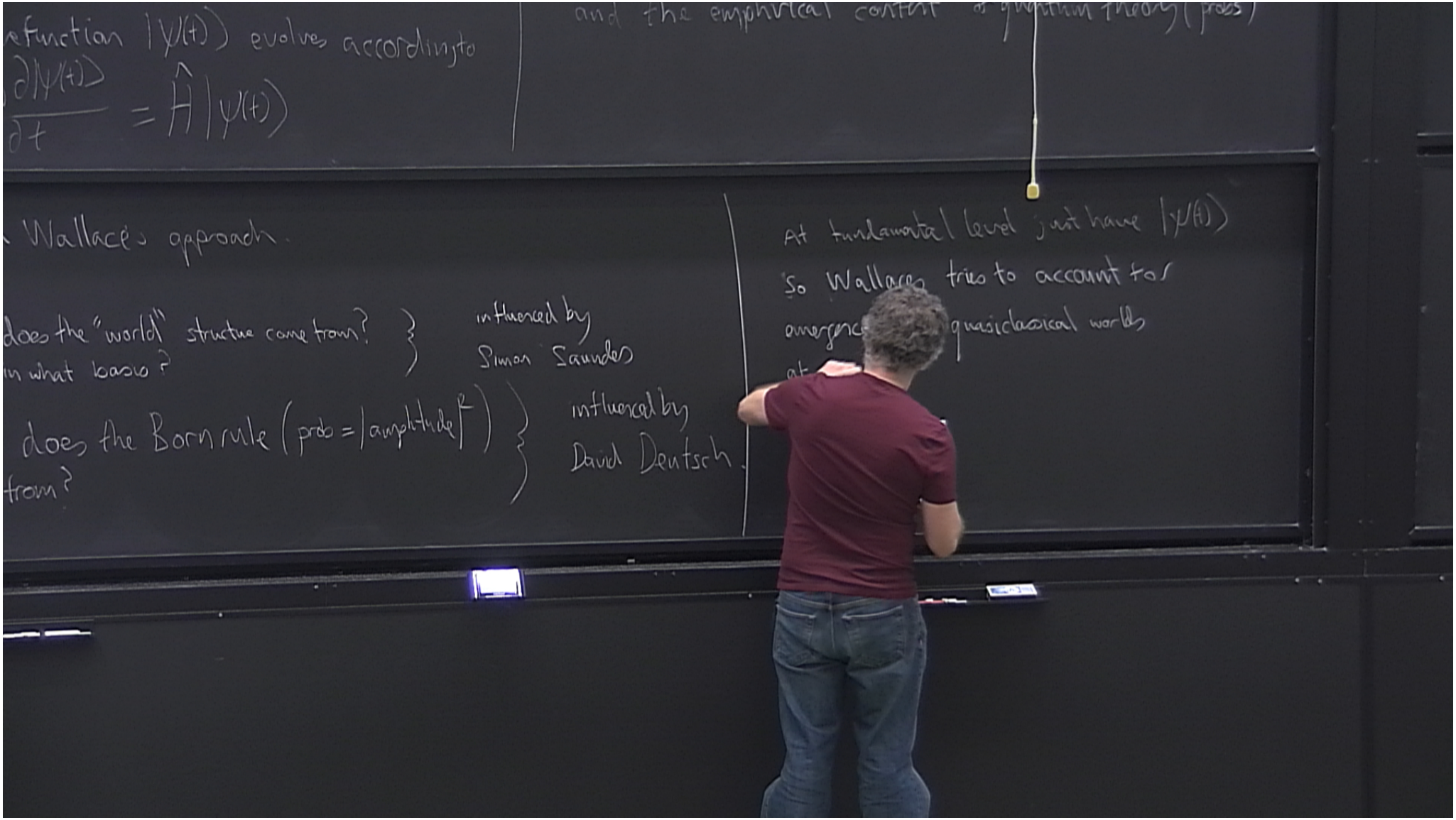
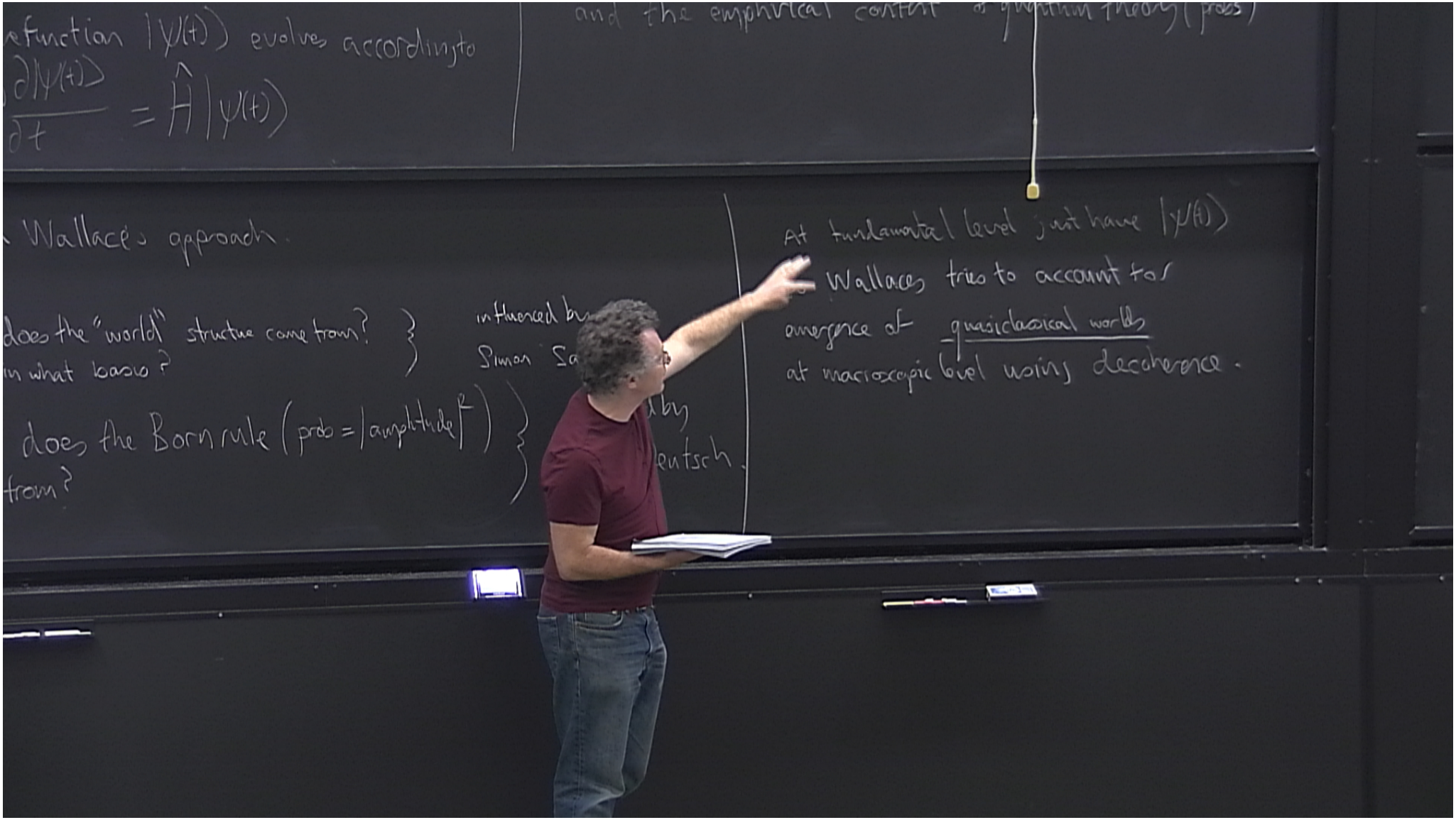
① does the "world" structure come from? in what basis?
influenced by Simon Saunders
does the Born rule (prob = |amplitude|²)
influenced by David Deutsch.


function $|\psi(t)\rangle$ evolves according to
$\frac{\partial|\psi(t)\rangle}{\partial t} = \hat{H}|\psi(t)\rangle$
and the emphirical content
Wallace's approach
does the "world" structure come from?
in what basis?
} influenced by Simon Saunders
does the Born rule (prob = |amplitude|^2)
from?
} influenced by David Deutsch.
At fundamental level just have $|\psi(t)\rangle$
So Wallace tries to account for
emergence quasiclassical worlds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At fundamental level just have $|\psi(t)\rangle$
Wallace tries to account for
emergence of quasiclassical worlds
at macroscopic level using decoherence.

② Where does the Born rule (prob = |amplitude|²) come from?

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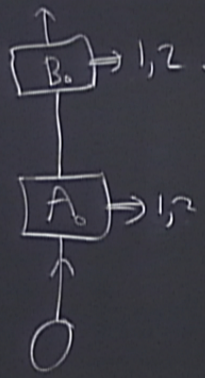

$$|\psi\rangle_S |A_0\rangle_A |B_0\rangle_B \rightarrow \alpha |a_1\rangle_S |A_1\rangle |B_0\rangle + \beta |a_2\rangle |A_2\rangle |B_0\rangle$$

② Where does the Born rule (prob = |amplitude|²) come from?

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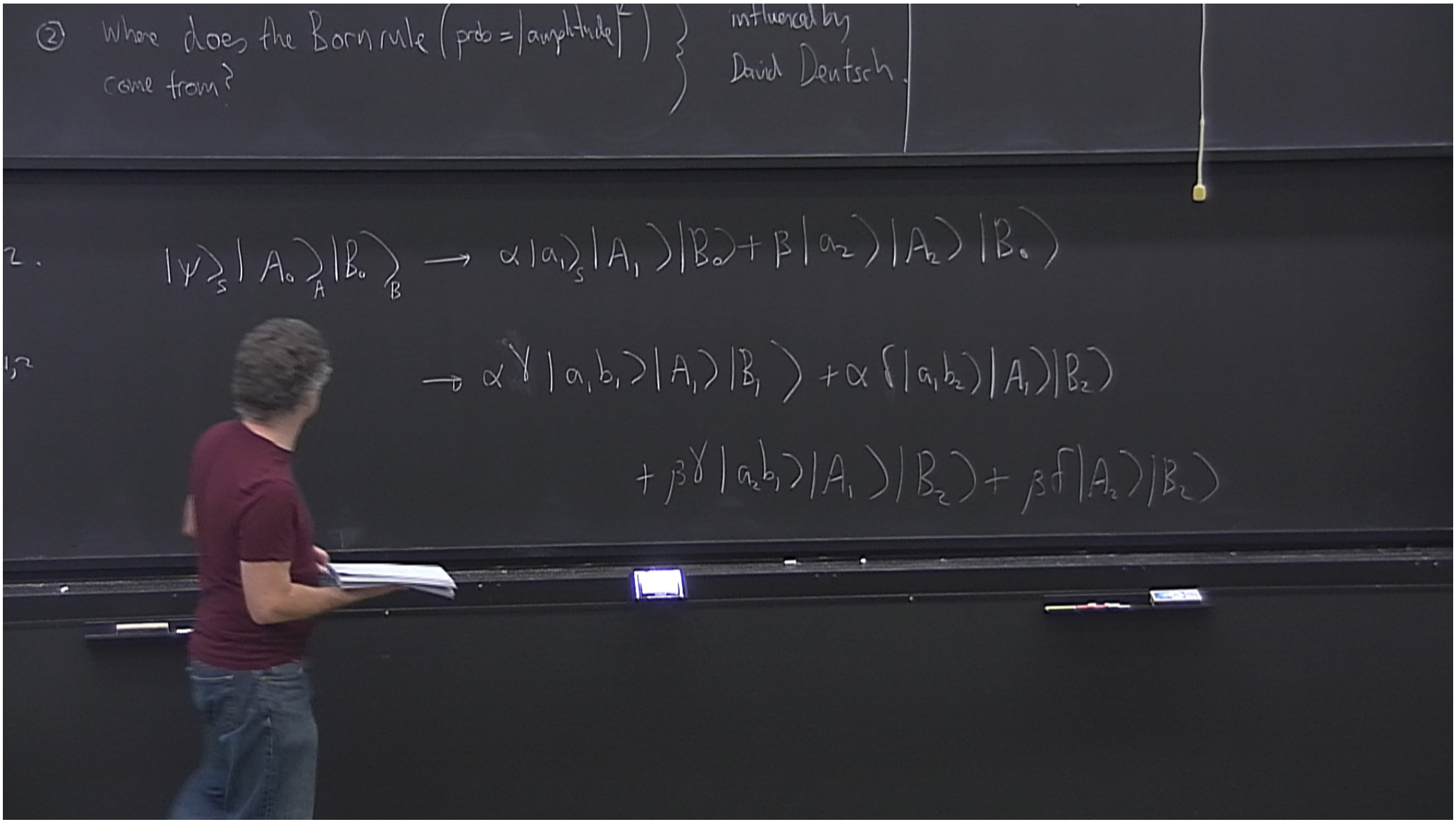

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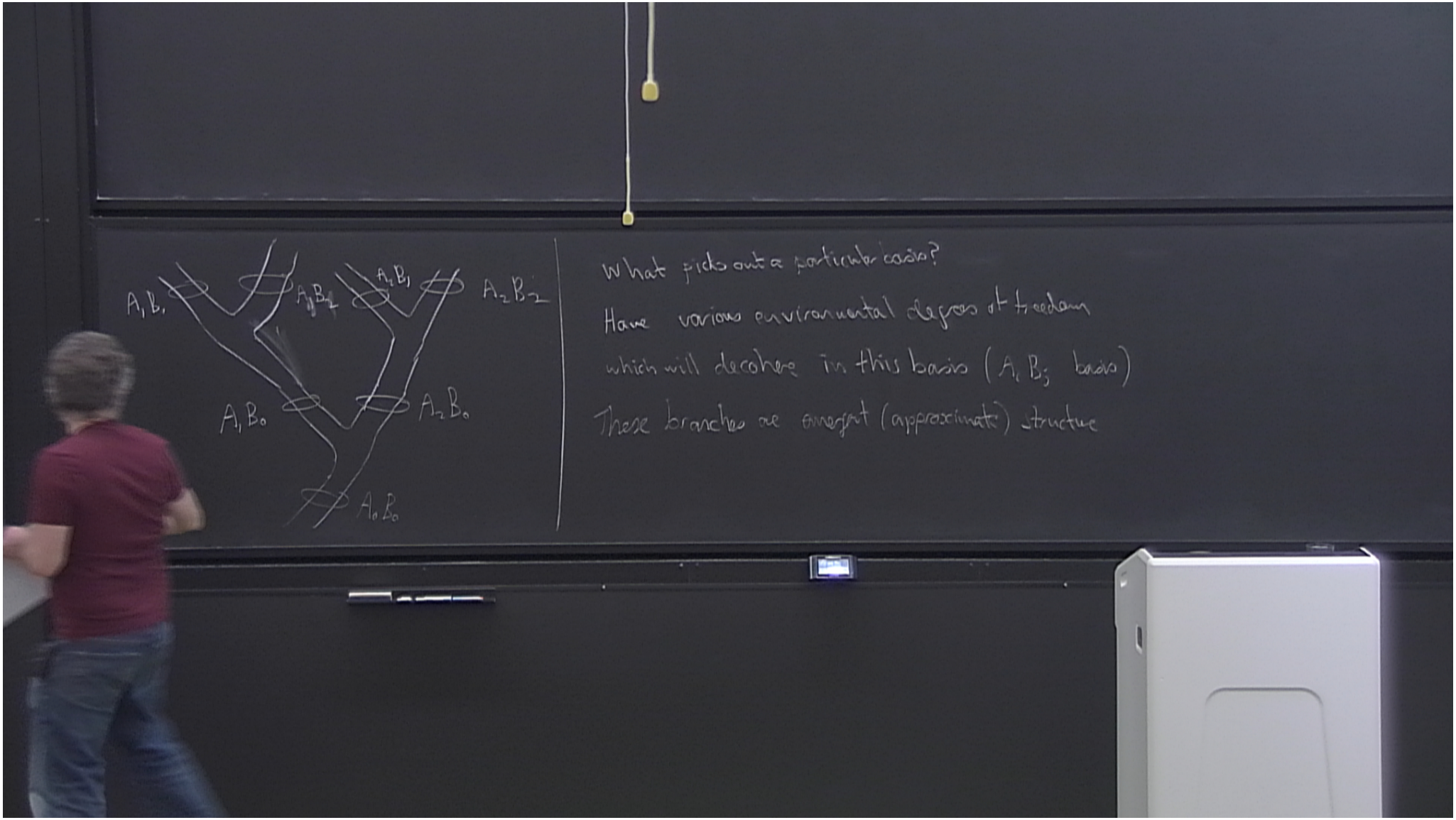
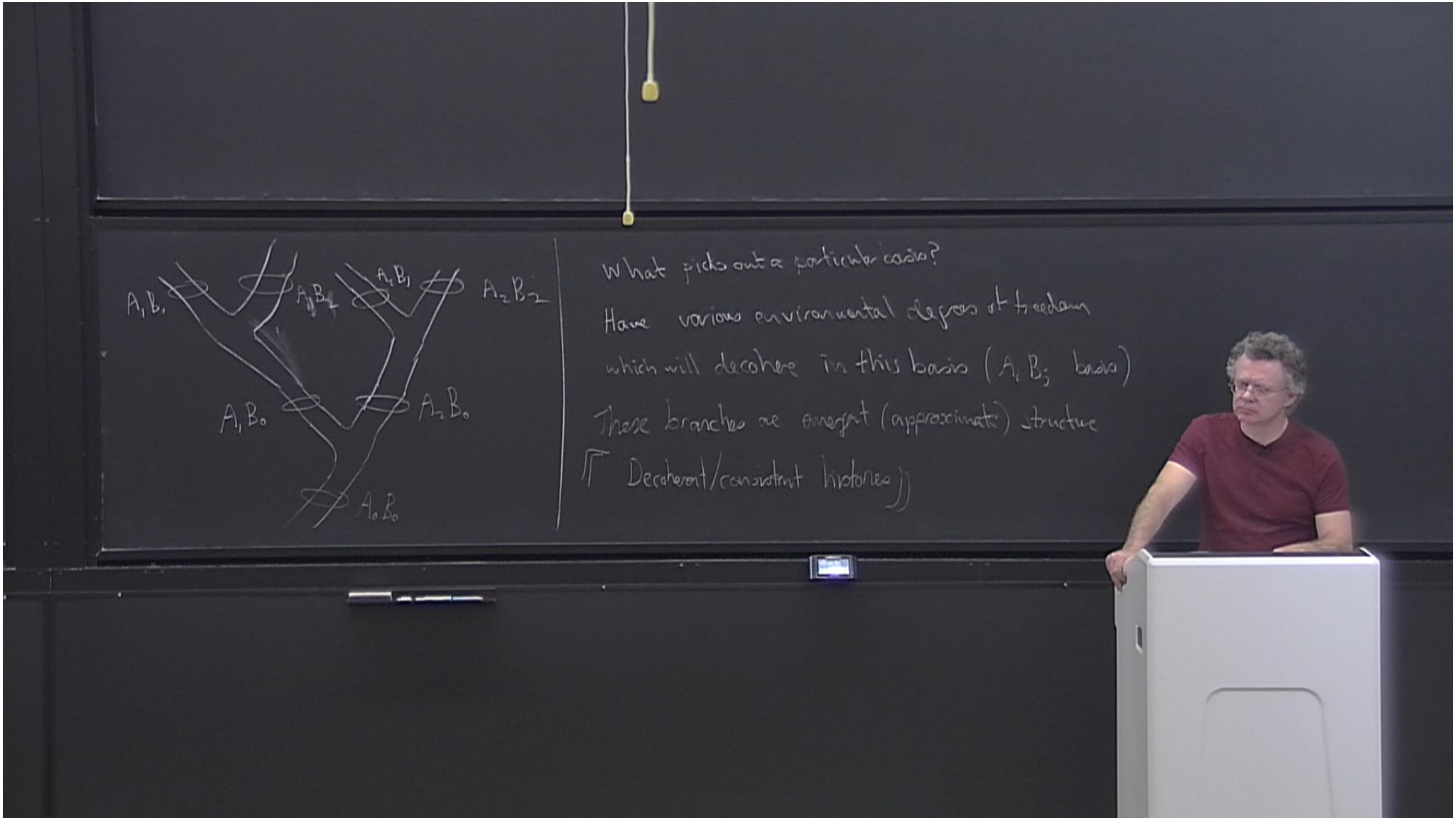
2. $|\psi\rangle_S |A_0\rangle_A |B_0\rangle_B \rightarrow \alpha |a_1\rangle_S |A_1\rangle |B_0\rangle + \beta |a_2\rangle |A_2\rangle |B_0\rangle$

$\rightarrow \alpha\gamma |a_1 b_1\rangle |A_1\rangle |B_1\rangle + \alpha\delta |a_1 b_2\rangle |A_1\rangle |B_2\rangle$

$+ \beta\gamma |a_2 b_1\rangle |A_1\rangle |B_2\rangle + \beta\delta |A_2\rangle |B_2\rangle$

$\gamma |a_1 b_1\rangle + \delta |a_1 b_2\rangle$


A_1B_1
A_1B_2
A_2B_1
A_2B_2
A_1B_0
A_2B_0
A_0B_0
What picks out a particular basis?
Have various environmental degrees of freedom
which will decohere in this basis (A_iB_j basis)
These branches are emergent (approximate) structure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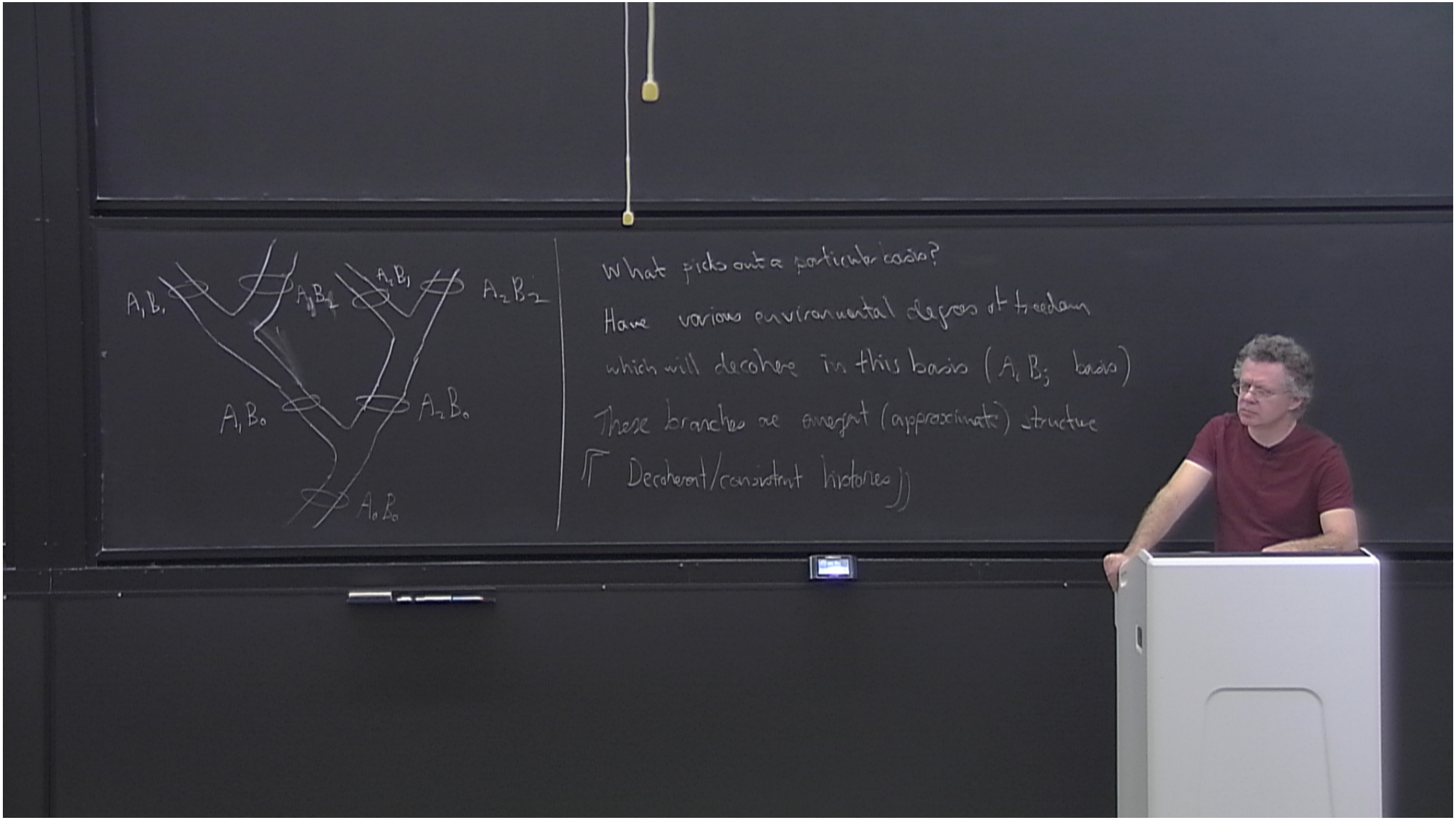
A_1B_1
A_1B_2
A_2B_1
A_2B_2
A_1B_0
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What picks out a particular basis?
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certainly happens.

$|\psi\rangle|A\rangle \rightarrow \alpha|a_1\rangle|A_1\rangle + \beta|a_2\rangle|A_2\rangle$

and $\beta = 10^{-100}$

but this world is just as real (colours just as bright, ...)

but in MW it definitely happens

why don't we get

$prob_2 = 1$

even if we have a probability

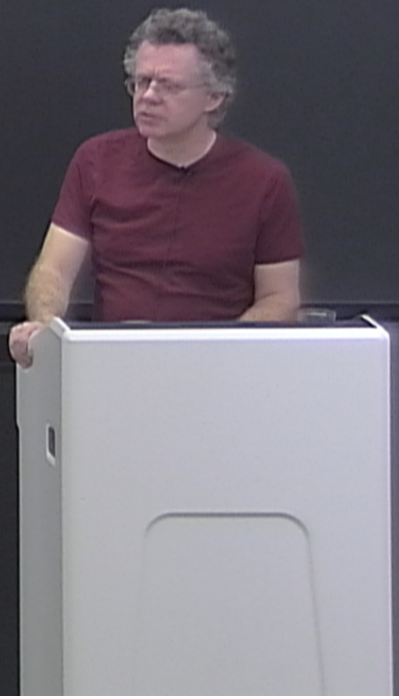
why not

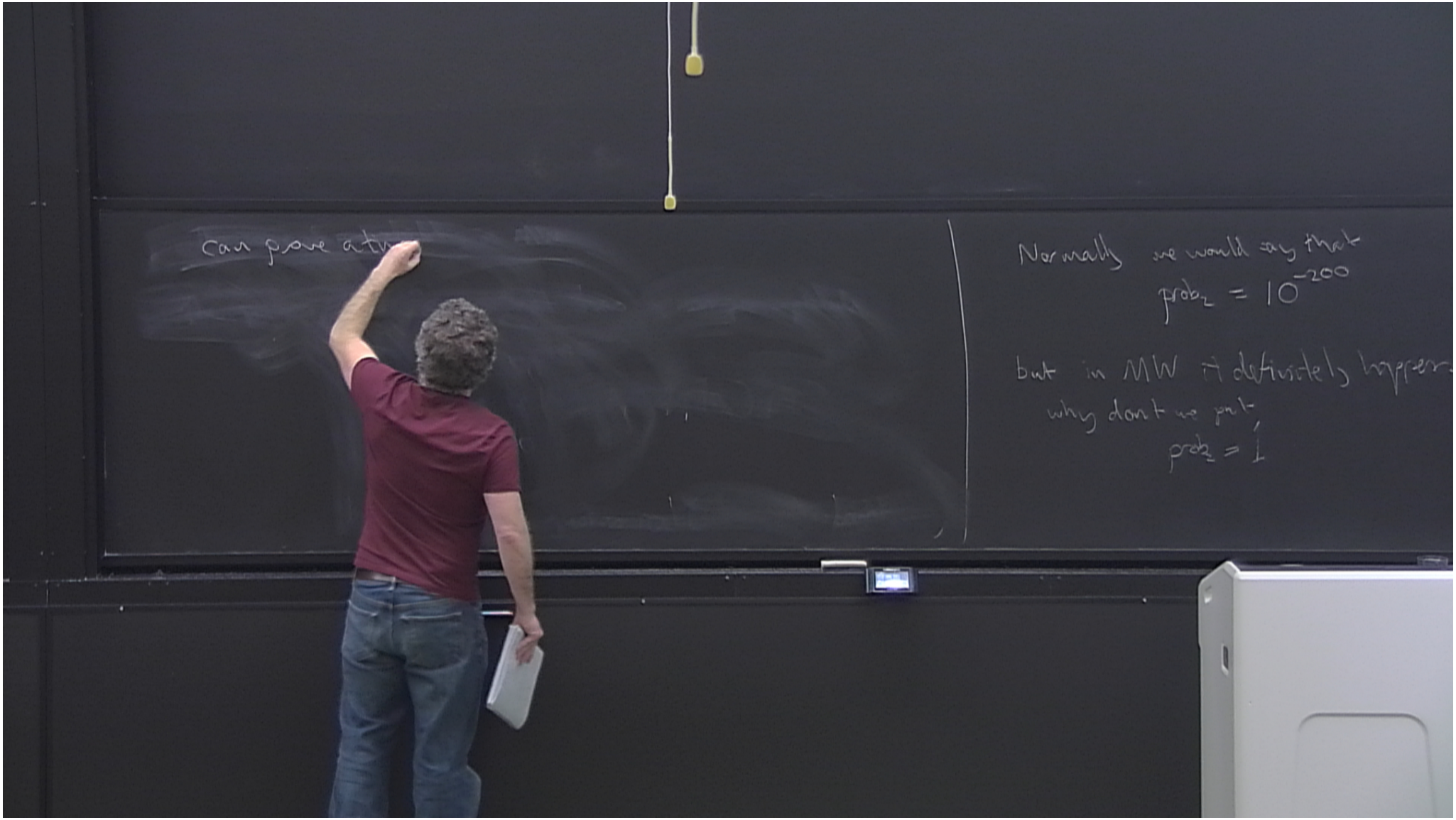
$$prob_2 = \frac{1}{2}$$

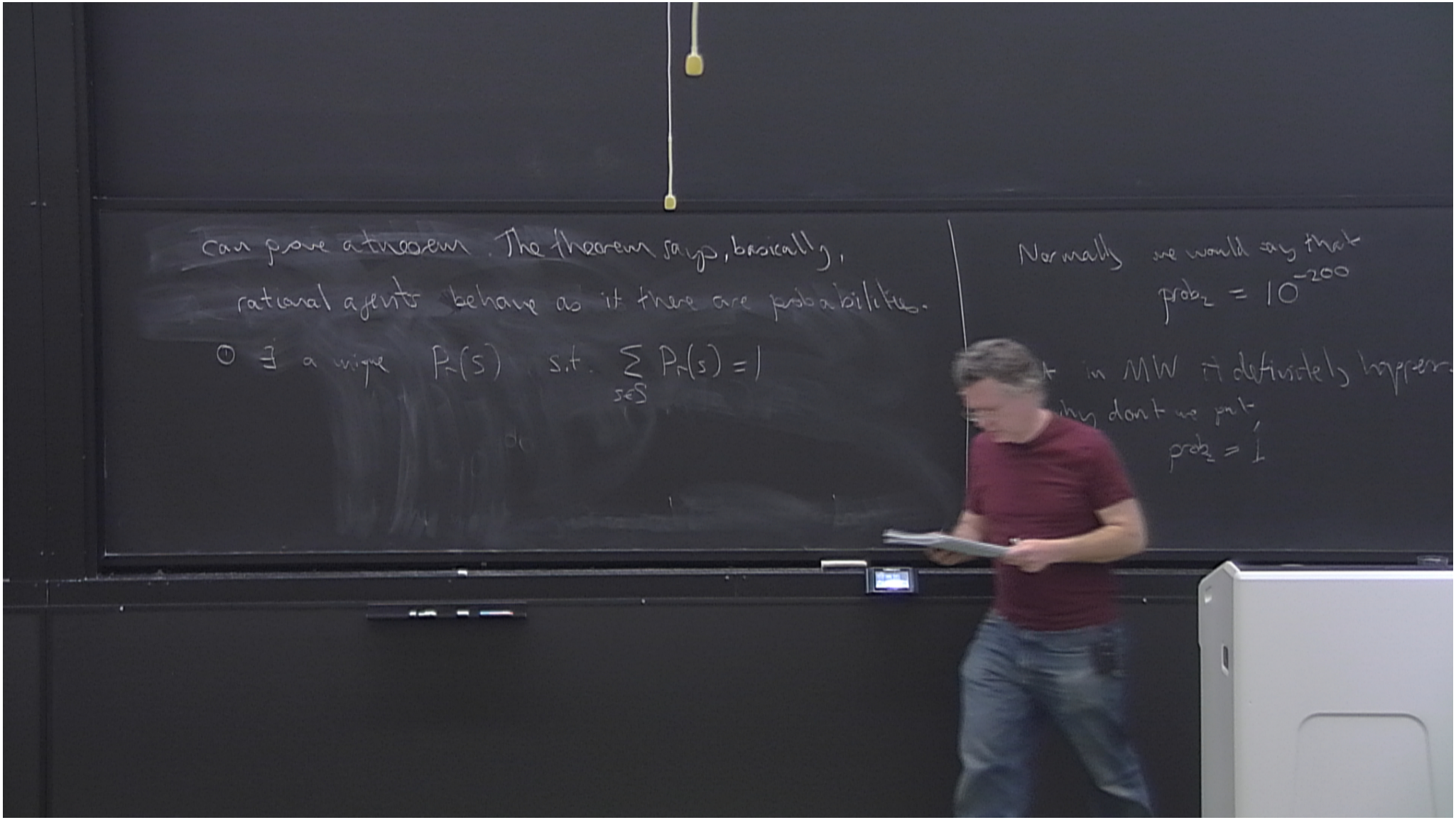
The idea

Probability is a measure of agents subjective belief and so influences how agents act

$\Rightarrow$ Decision theory




Can prove at
Normally we would say that
$prob_2 = 10^{-200}$
but in MW it definitely happens
why don't we put
$prob_2 = 1$


can prove a theorem. The theorem says, basically,
rational agents behave as if there are probabilities.
① ∃ a unique $P_A(s)$ s.t. $\sum_{s \in S} P_A(s) = 1$
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$prob_2 = 10^{-200}$
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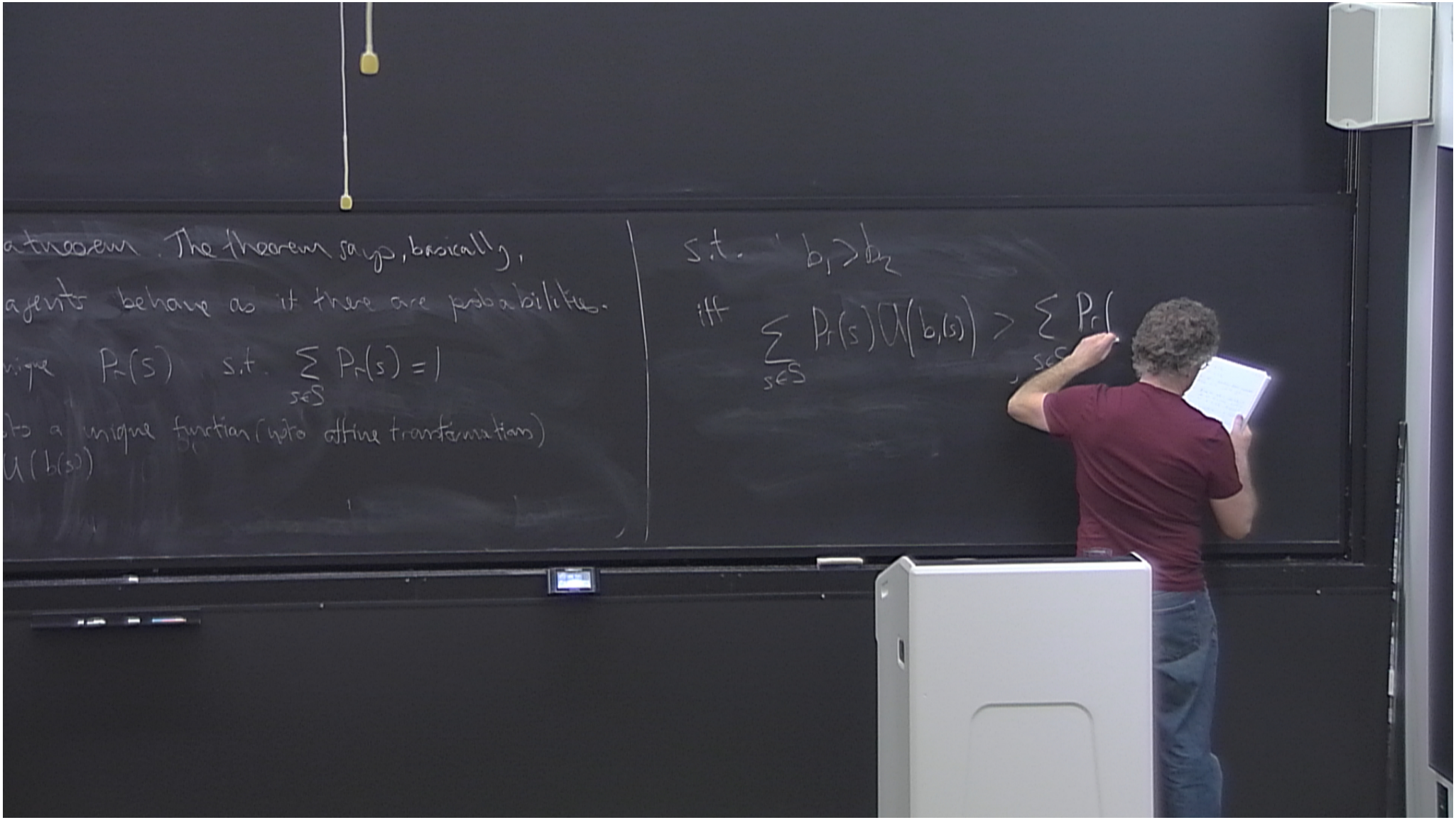
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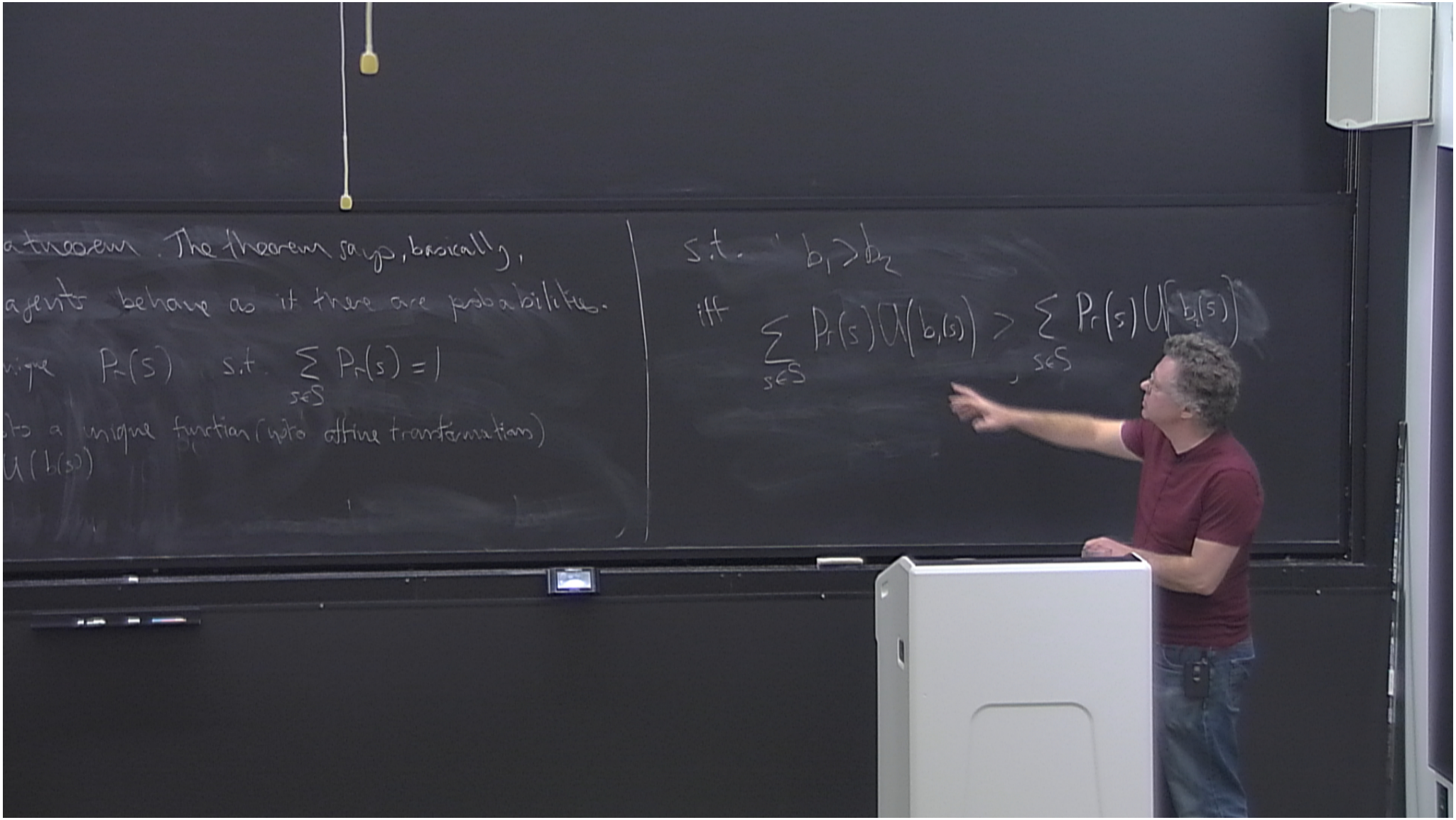
$P_i(s)$ s.t. $\sum_{s \in S} P_i(s) = 1$
$U(b(s))$
s.t. $b_1 > b_2$
iff
$\sum_{s \in S} P_i(s) U(b_1(s)) > \sum_{s \in S} P_i($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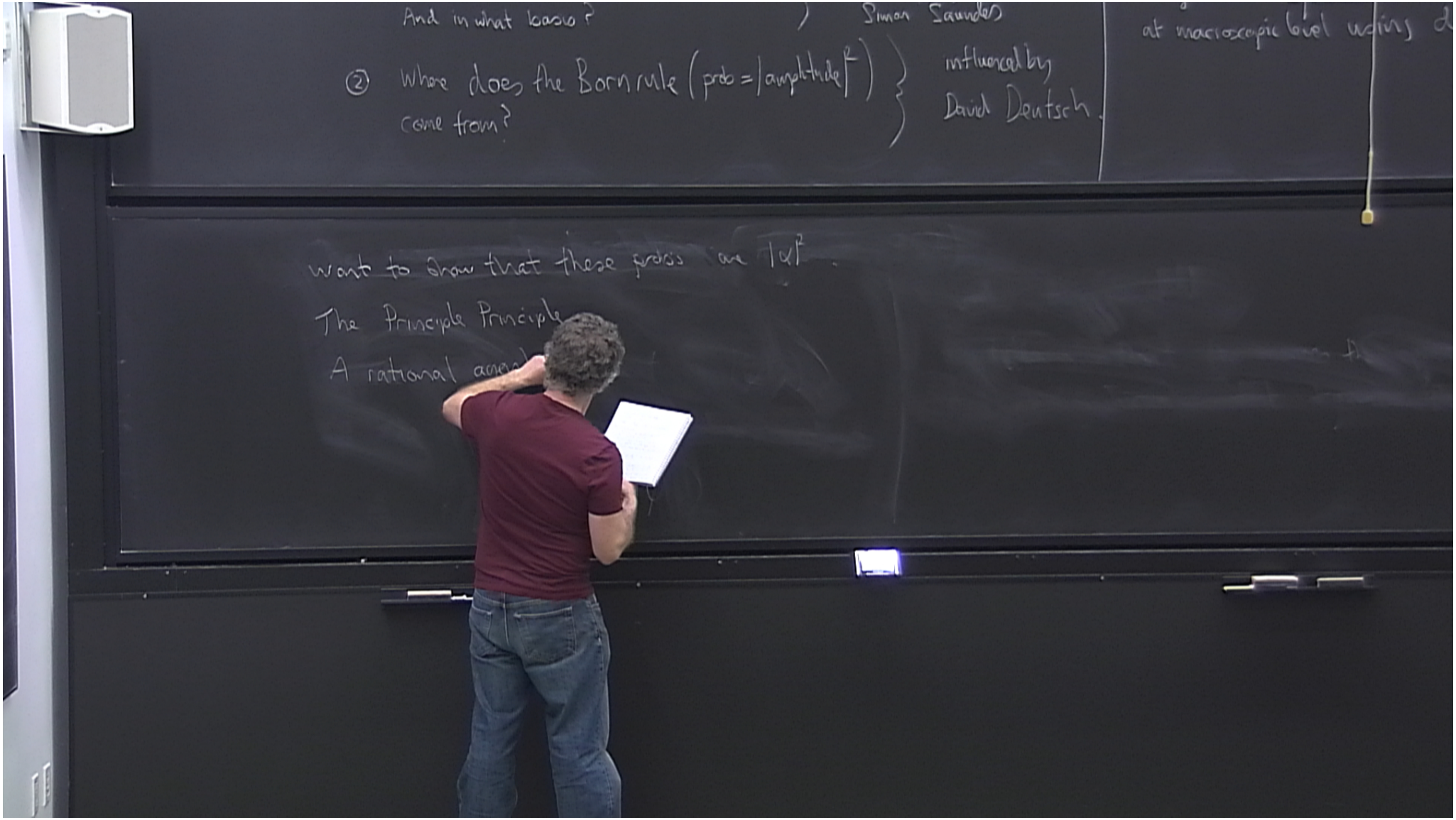
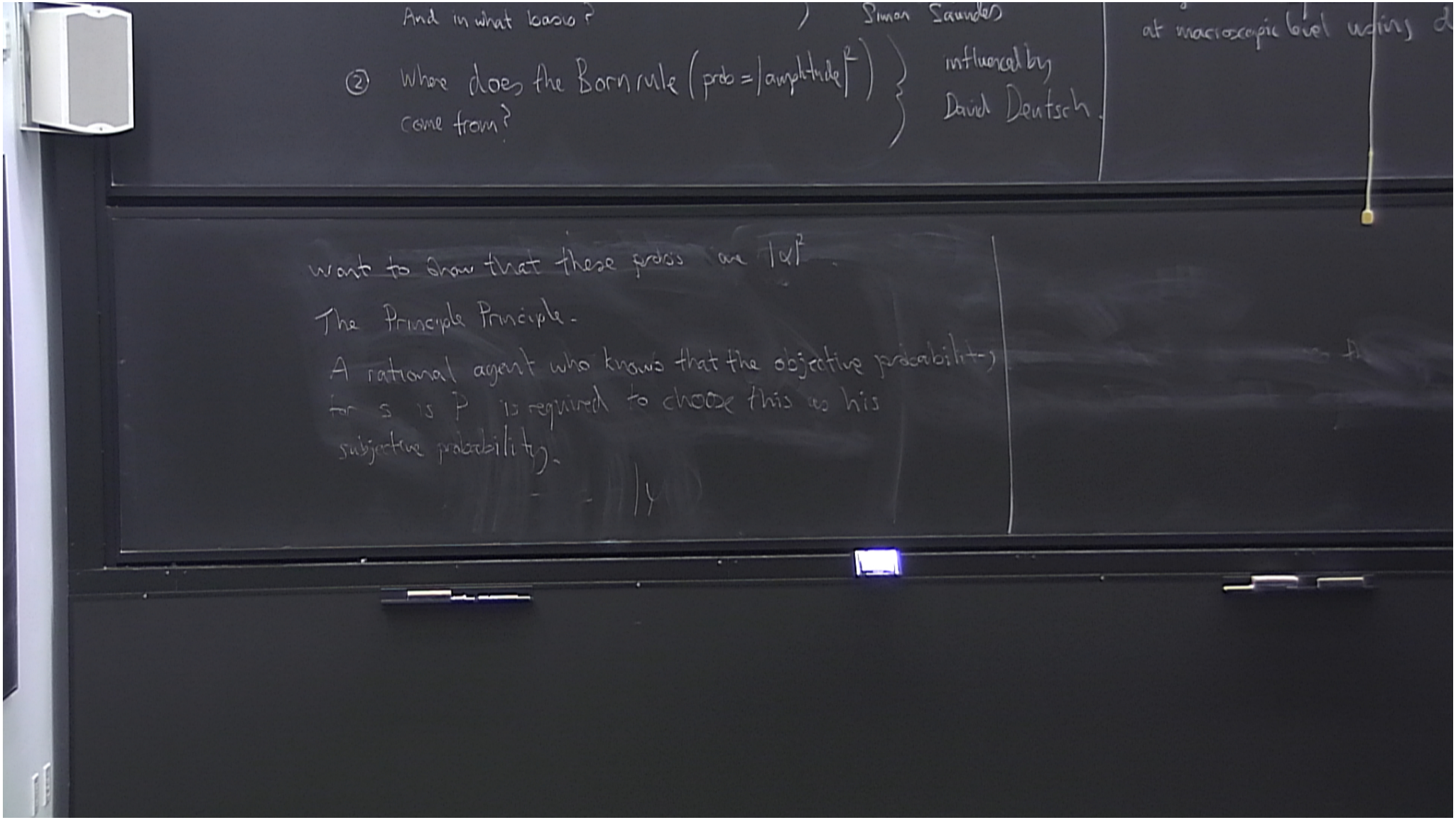
agents behave as if there are probabilities.
nique $P_r(s)$ s.t. $\sum_{s \in S} P_r(s) = 1$
to a unique function (up to affine transformations)
$U(b(s))$
s.t. $b_1 > b_2$
iff $\sum_{s \in S} P_r(s) U(b_1(s)) > \sum_{s \in S} P_r(s) U(b_2(s))$


And in what basis?
② Where does the Born rule (prob = |amplitude|²) come from?
Simon Saunders
influenced by
David Deutsch
at macroscopic level using
want to show that these probs are |α|².
The Principle Principle
A rational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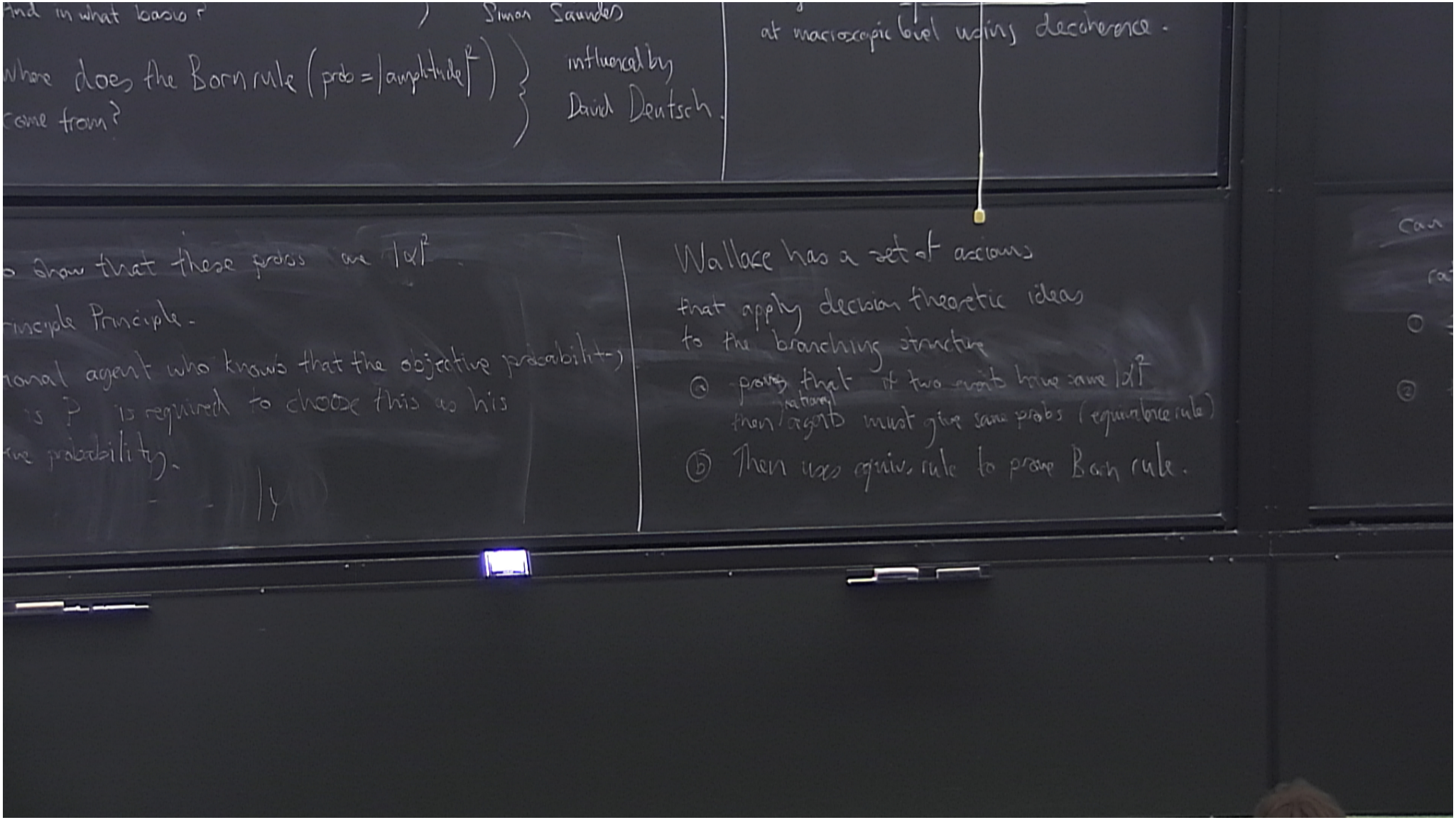
The Principle Principle.
A rational agent who knows that the objective probability for S is P is required to choose this as his subjective probability.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Principle Principle.
rational agent who knows that the objective probability is p is required to choose this as his subjective probability.
Wallace has a set of axioms that apply decision theoretic ideas to the branching structure
(a) prove that if two events have same |α|² then rational agents must give same probs (equivalence rule)
(b) Then uses equiv. rule to prove Born rule.