Title: Quantum Foundations Lecture - 230123

Speakers: Lucien Hardy

Collection: Quantum Foundations (2022/2023)

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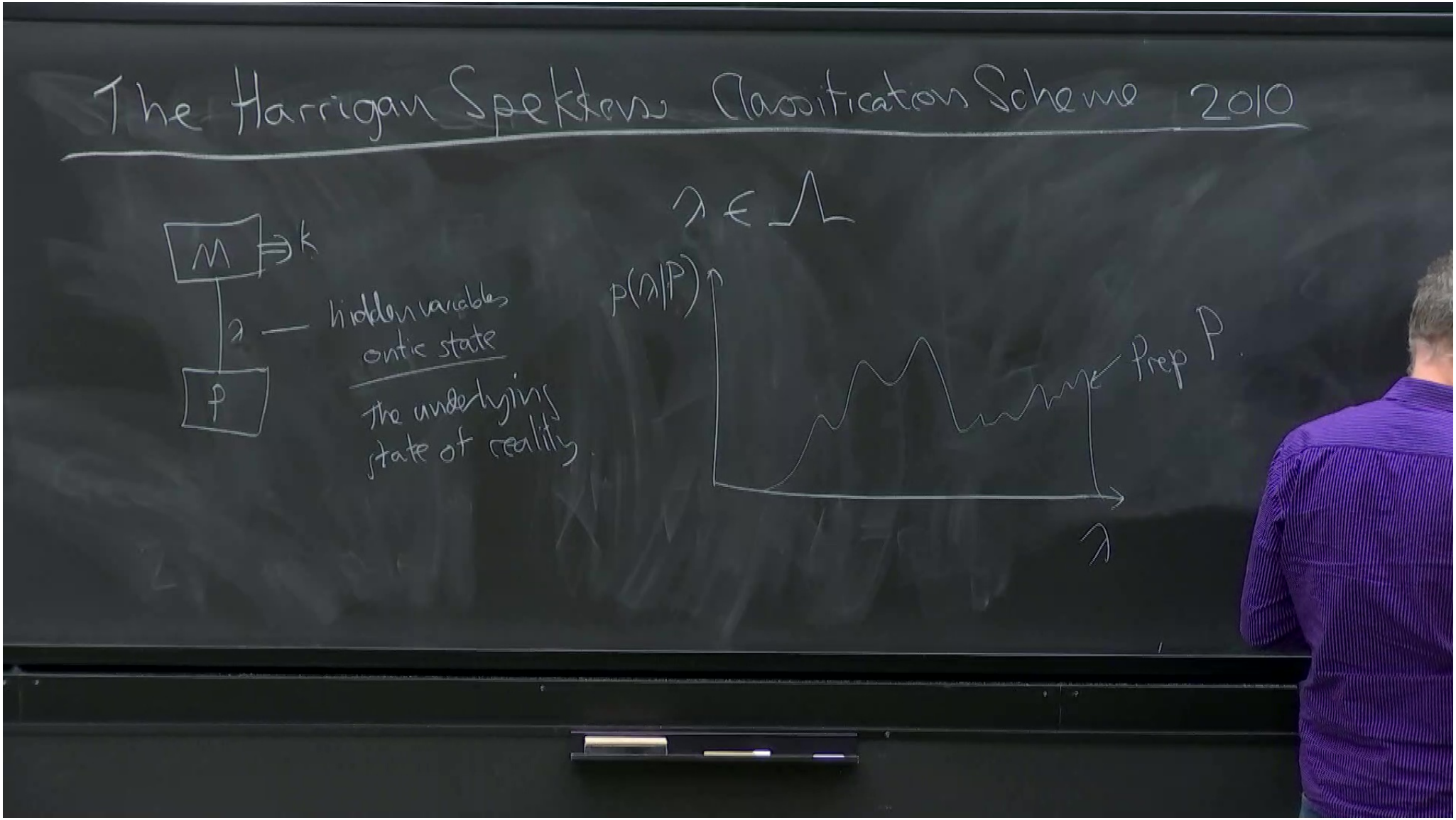
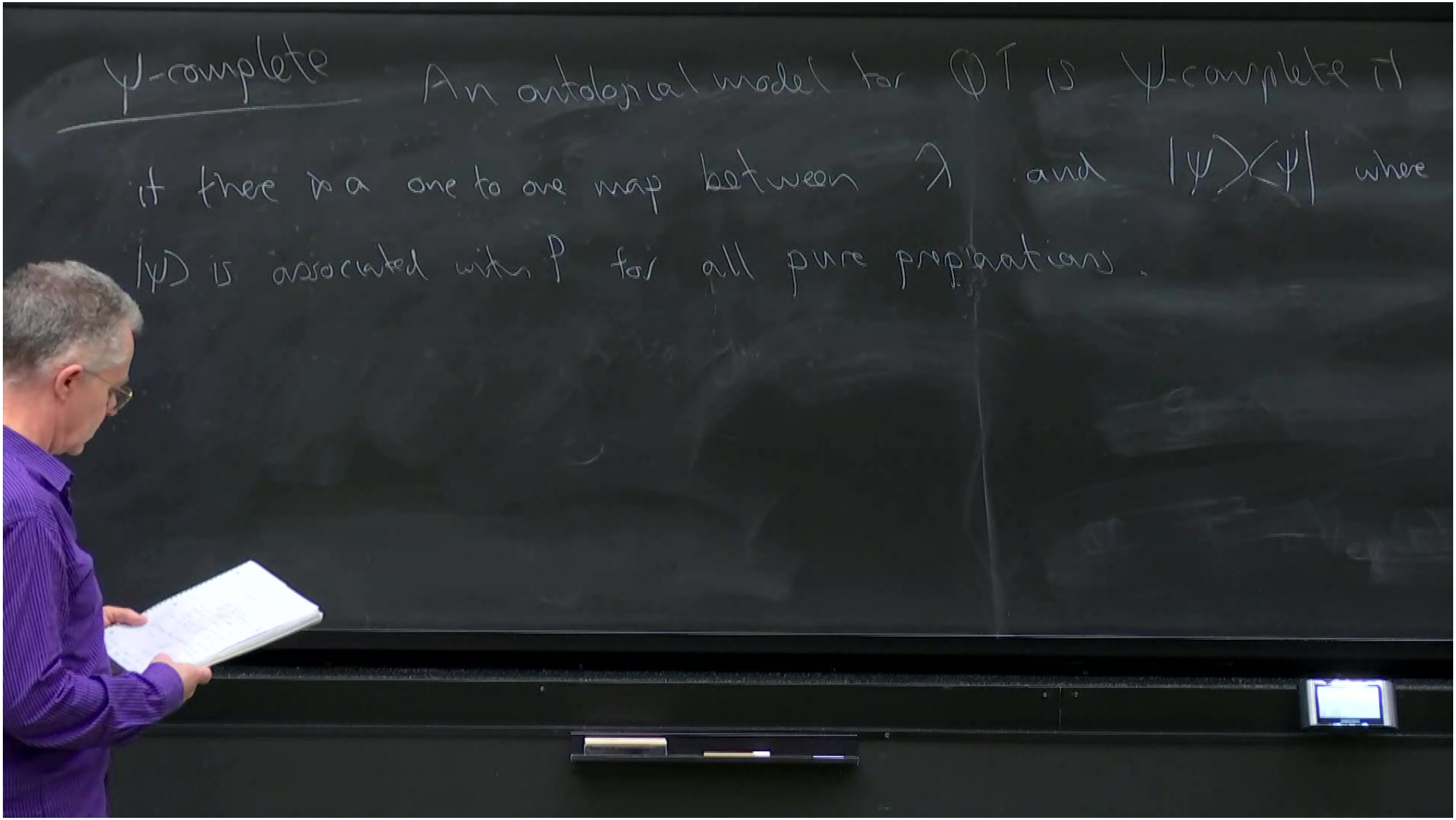

The Harrigan Spekkens Classification Scheme 2010
M
k
λ — hidden variables
ontic state
The underlying
state of reality
P
λ ∈ Λ
p(λ|P)
Prep P.
λ

$$\text{prob}(k|P,M) = \int_\Lambda d\lambda\, p(k|M,\lambda)\, p(\lambda|P)$$

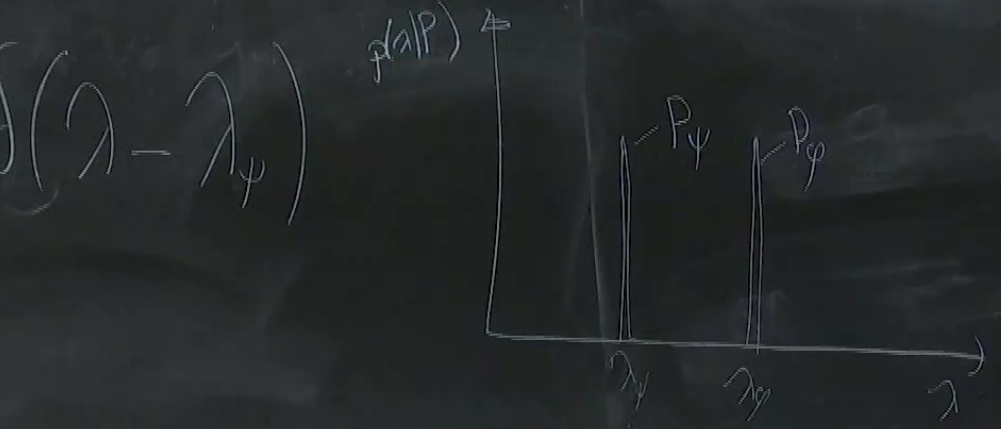
This is the ontological model framework.


ψ-complete
An ontological model for QT is ψ-complete if
it there is a one to one map between λ and |ψ⟩⟨ψ| where
|ψ⟩ is associated with P for all pure preparations.

ψ-complete An ontological model for QT is ψ-complete if it there is a one to one map between λ and $|\psi\rangle\langle\psi|$ where $|\psi\rangle$ is associated with P for all pure preparations.

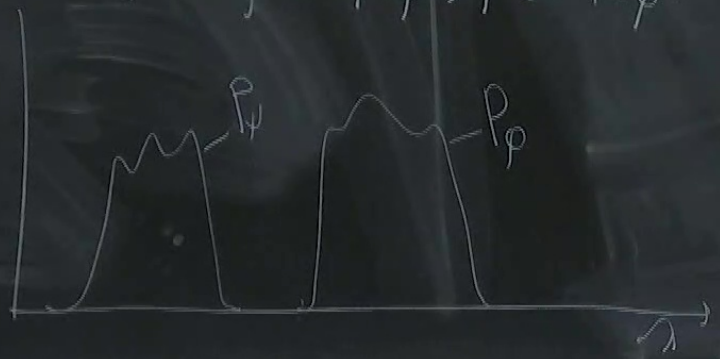
This means that

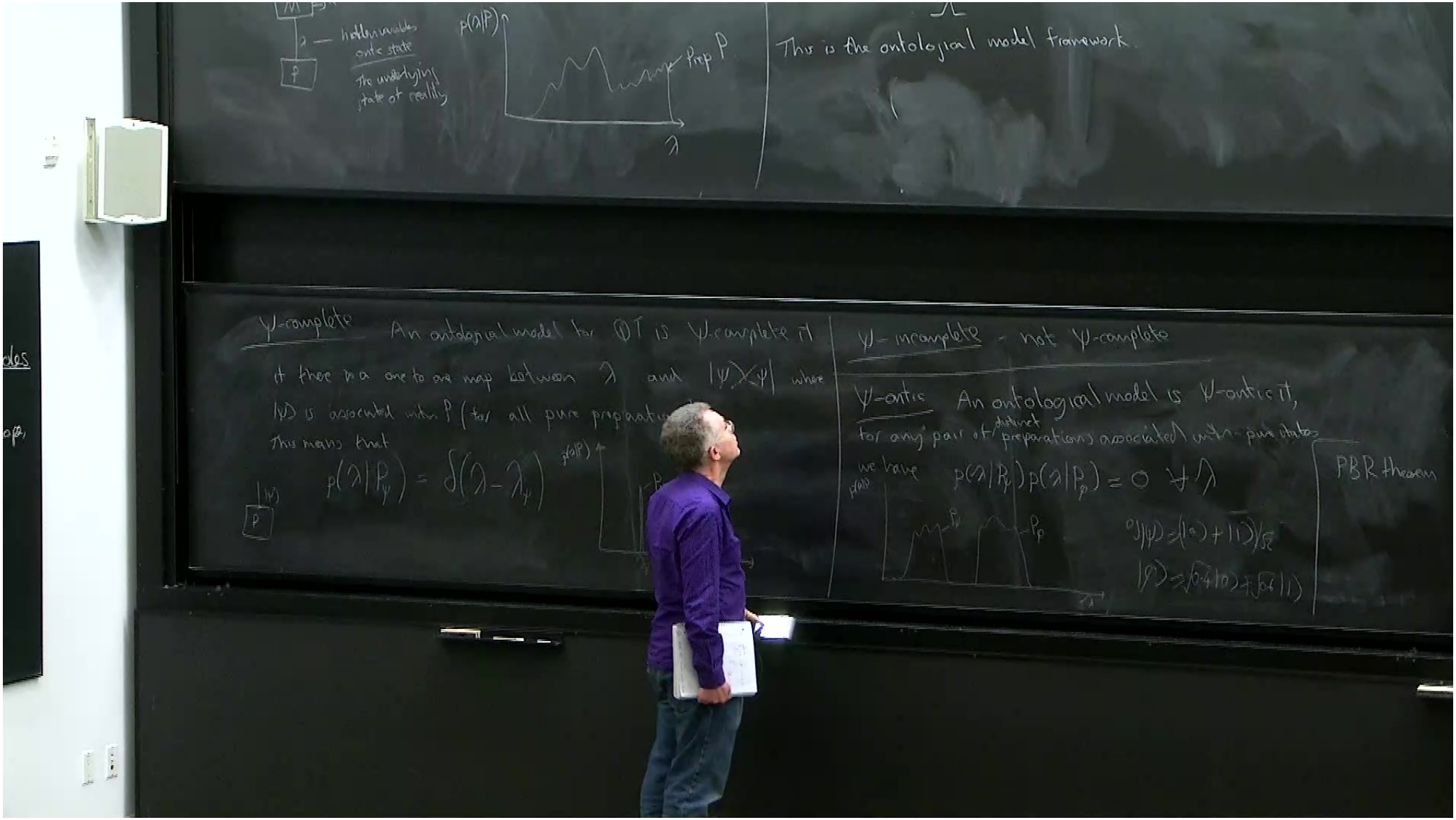
$$p(\lambda|P_\psi) = \delta(\lambda - \lambda_\psi)$$



ψ-incomplete - not ψ-complete

ψ-ontic An ontological model is ψ-ontic if, for any pair of (distinct preparations) associated with pure states we have $p(\lambda|P_\psi)\,p(\lambda|P_\phi) = 0 \;\forall\,\lambda$

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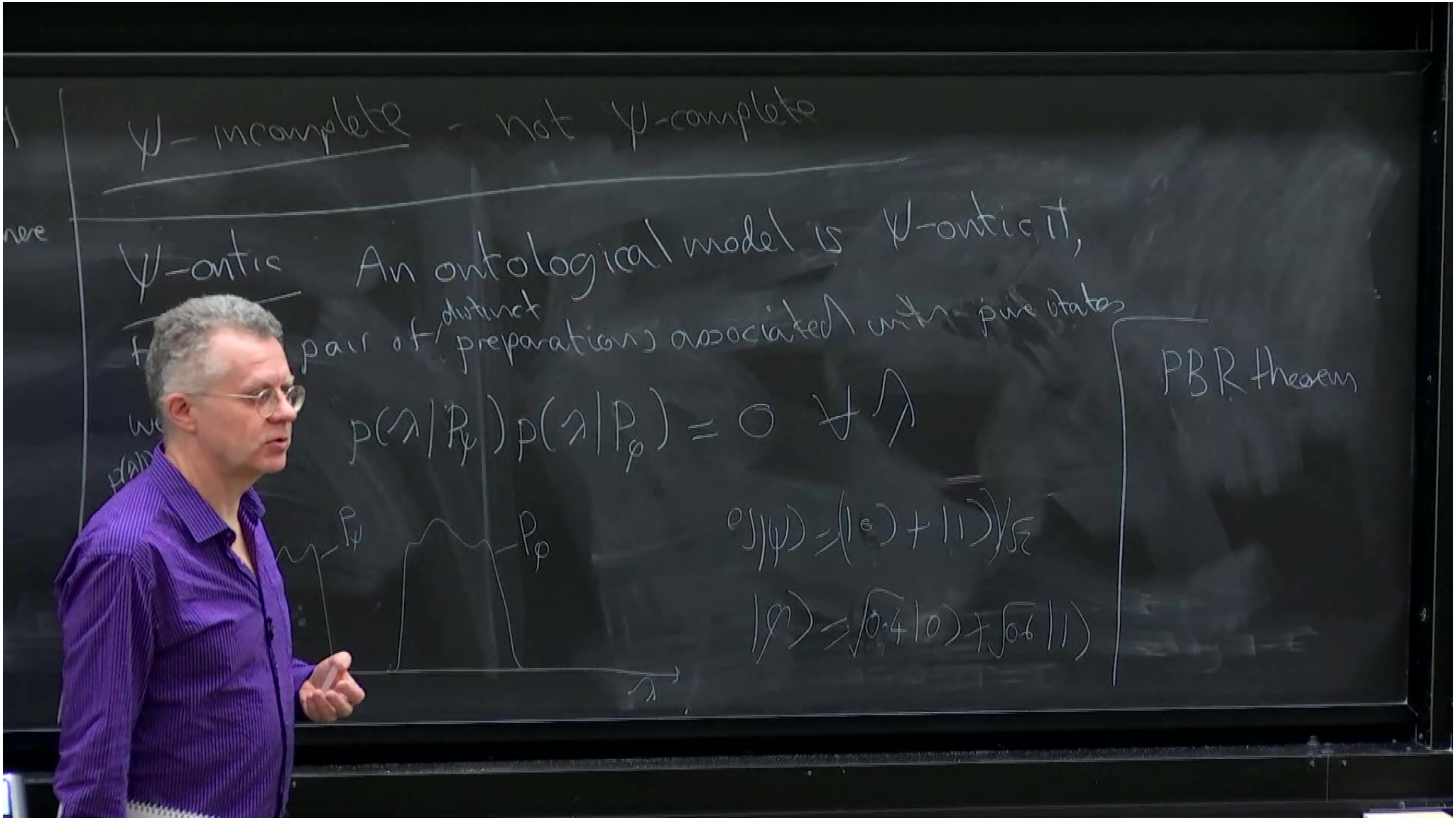
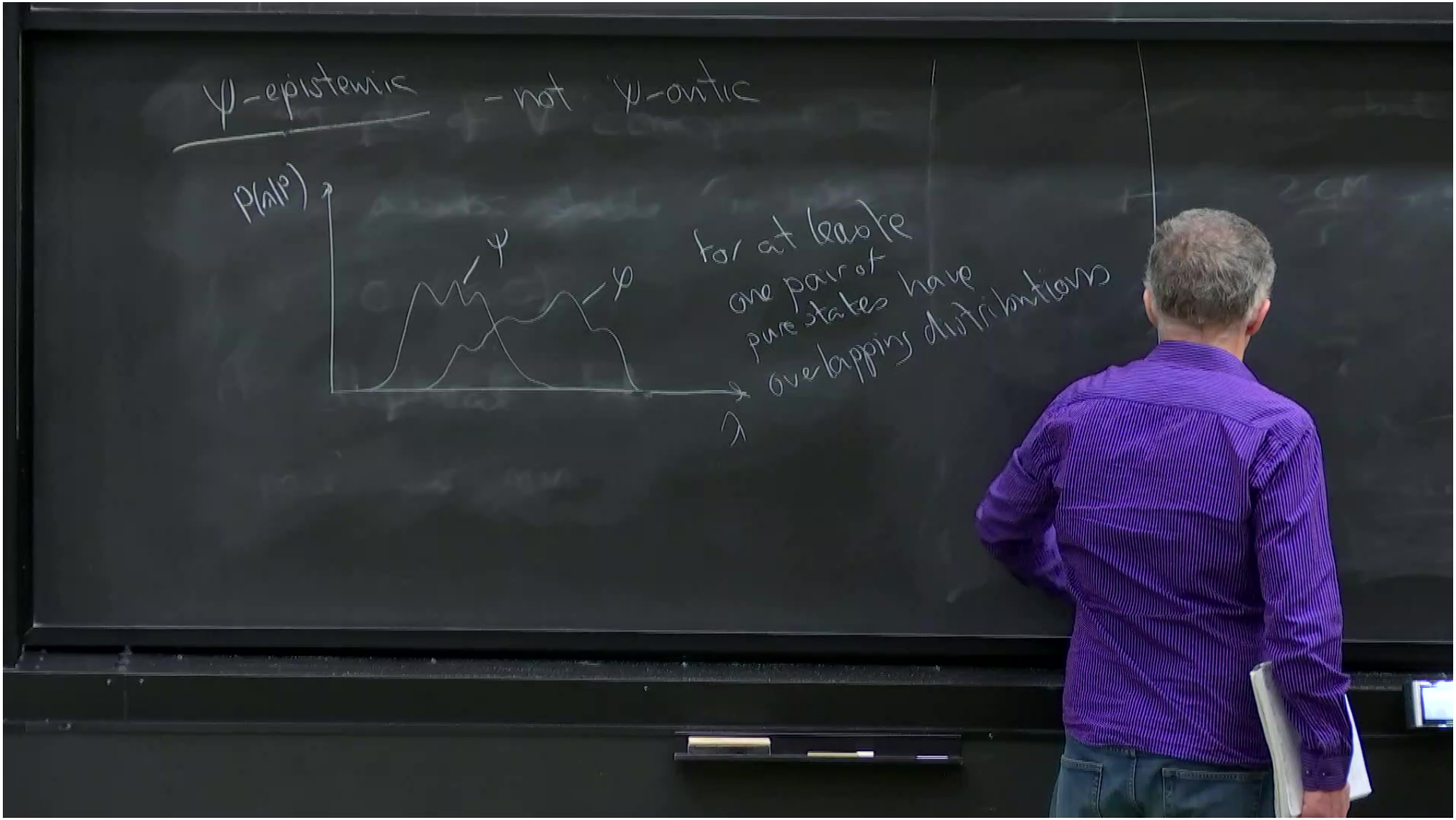
ψ-incomplete - not ψ-complete
ψ-ontic
An ontological model is ψ-ontic if,
PBR theorem

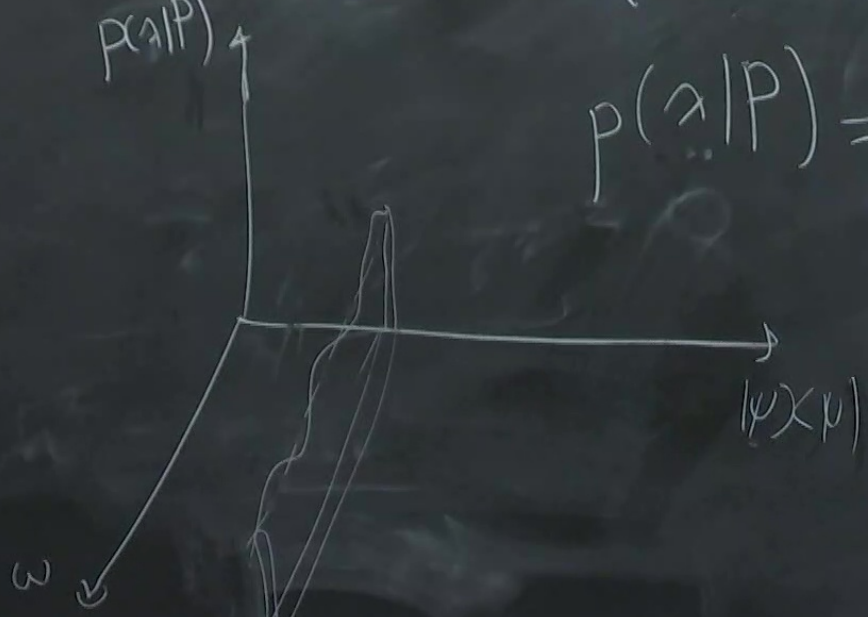

ψ-incomplete - not ψ-complete
ψ-ontic An ontological model is ψ-ontic if,
pair of distinct preparations associated with pure states
$p(\lambda|P_k)\,p(\lambda|P_\ell) = 0 \;\forall\,\lambda$
$|\psi\rangle = (|0\rangle + |1\rangle)/\sqrt{2}$
$|\varphi\rangle = \sqrt{0.4}\,|0\rangle + \sqrt{0.6}\,|1\rangle$
PBR theorem

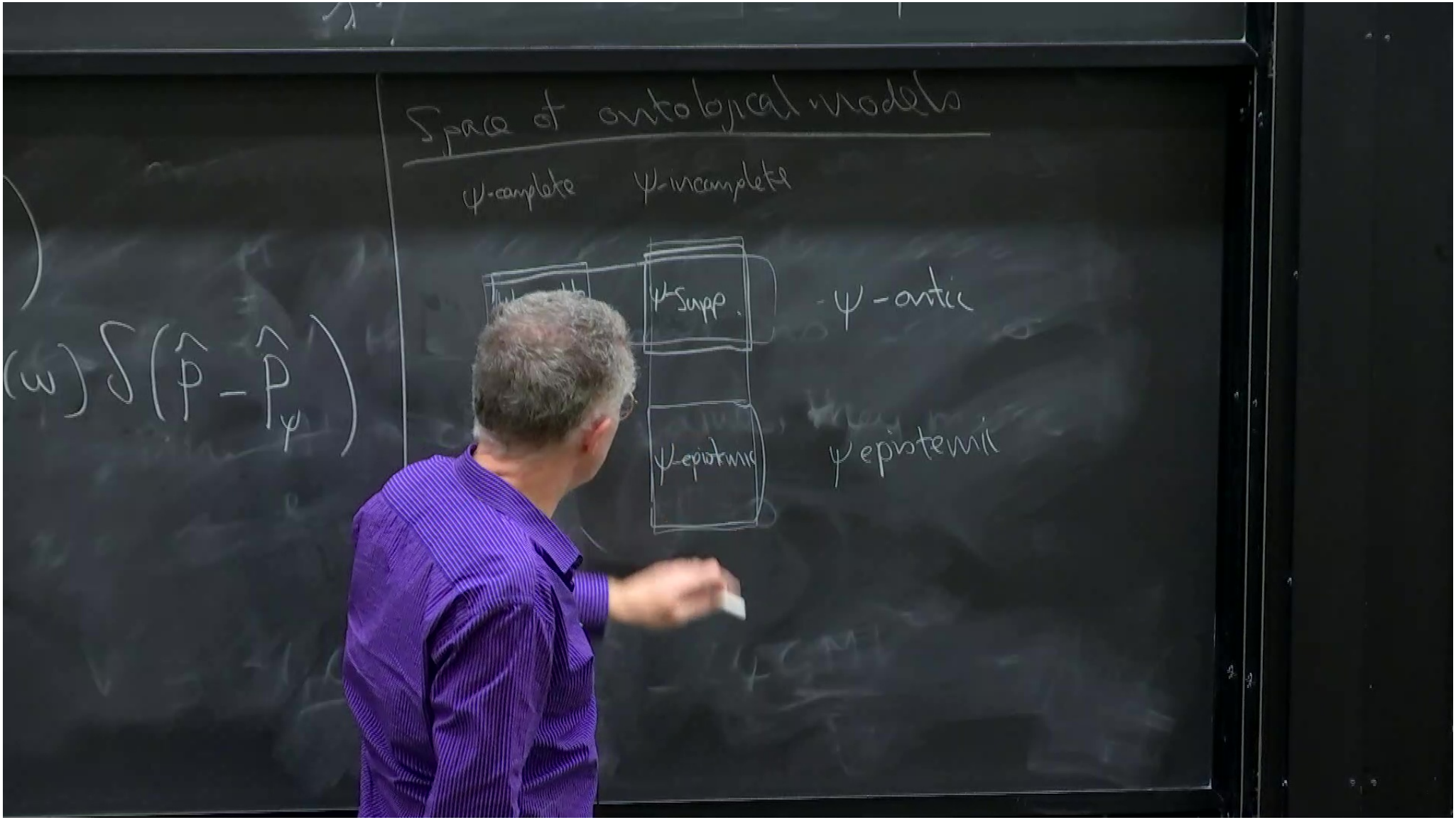

ψ-epistemic - not ψ-ontic
P(λ|P)
ψ
φ
λ
for at least one pair of pure states have overlapping distributions

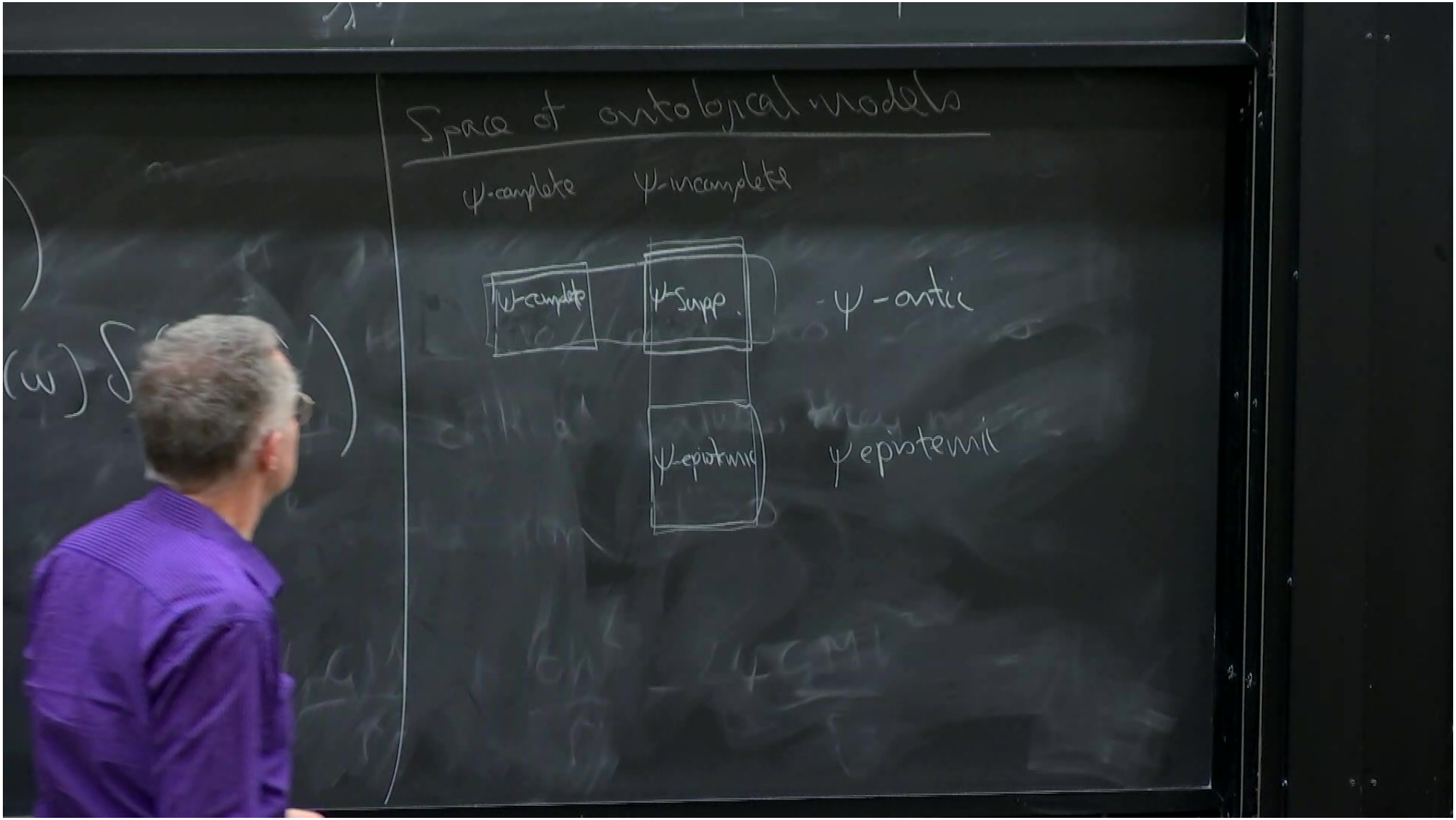
Def: ψ-supplemented

This is when $\lambda_\psi = (|\psi\rangle\langle\psi|, \omega)$

$$p(\lambda|P) = f(\omega)\,\delta(\hat{P} - \hat{P}_\psi)$$




Space of ontological models
ψ-complete
ψ-incomplete
ψ-Supp.
ψ-epistemic
ψ-ontic
ψ epistemic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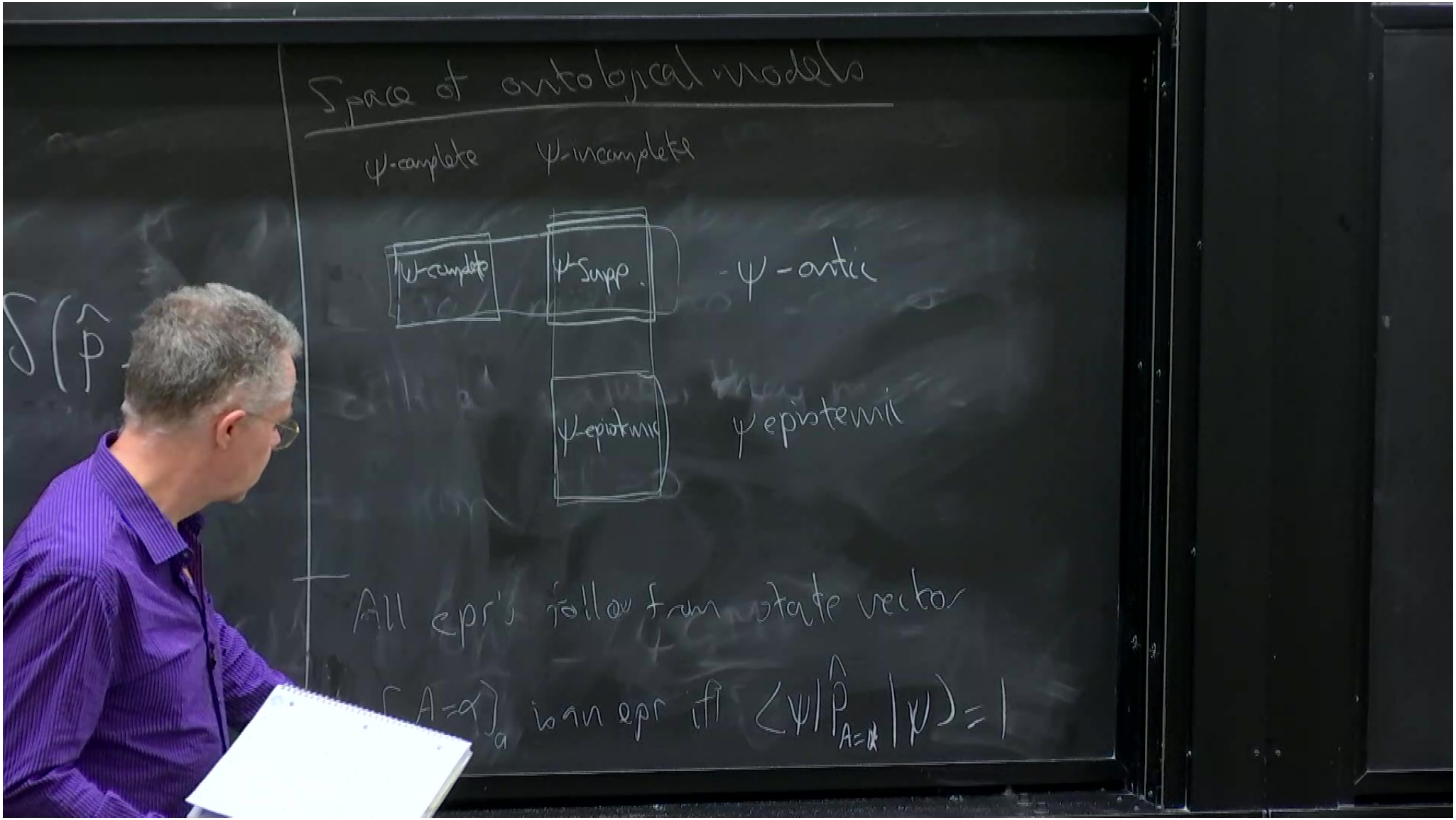
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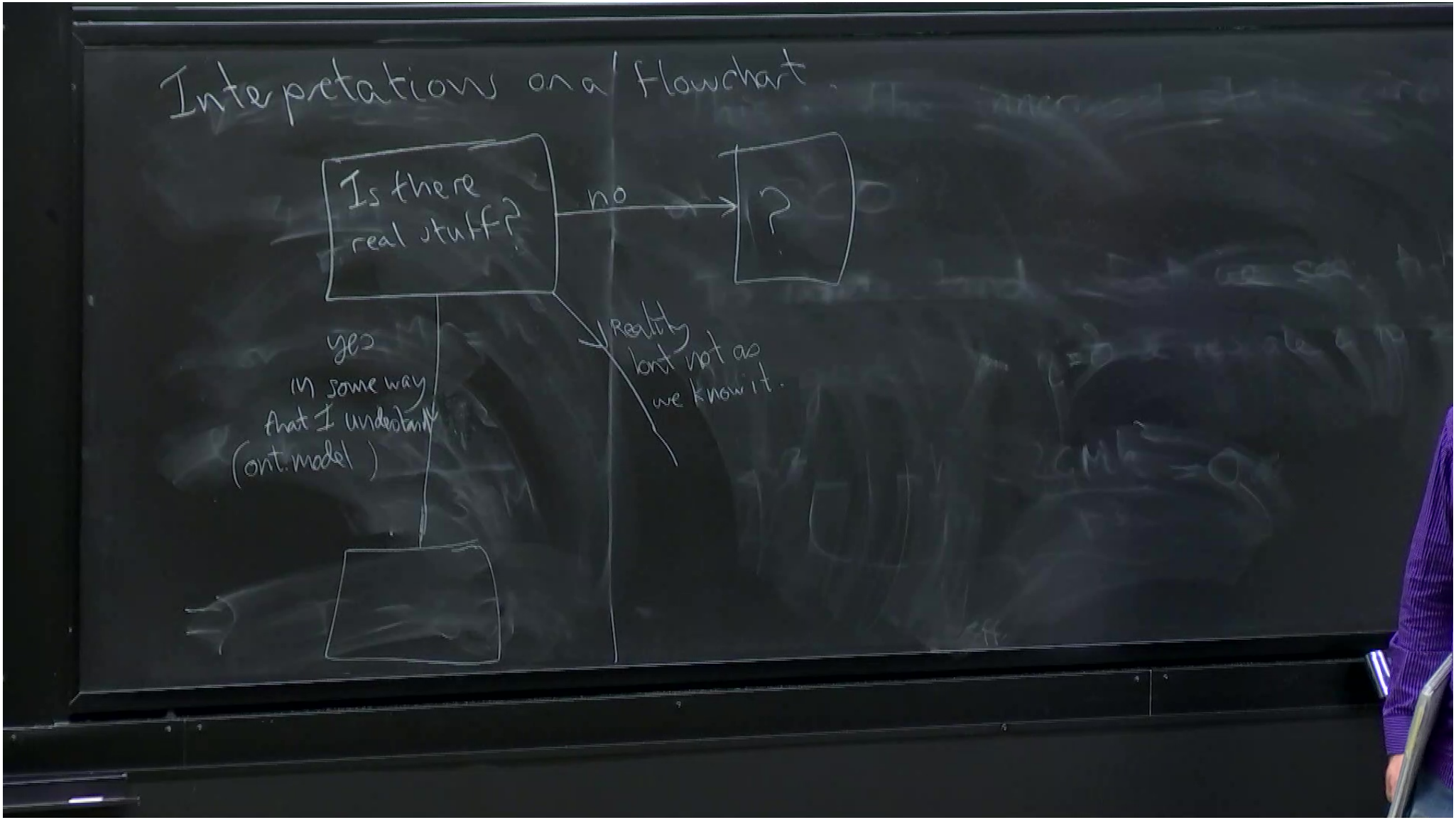
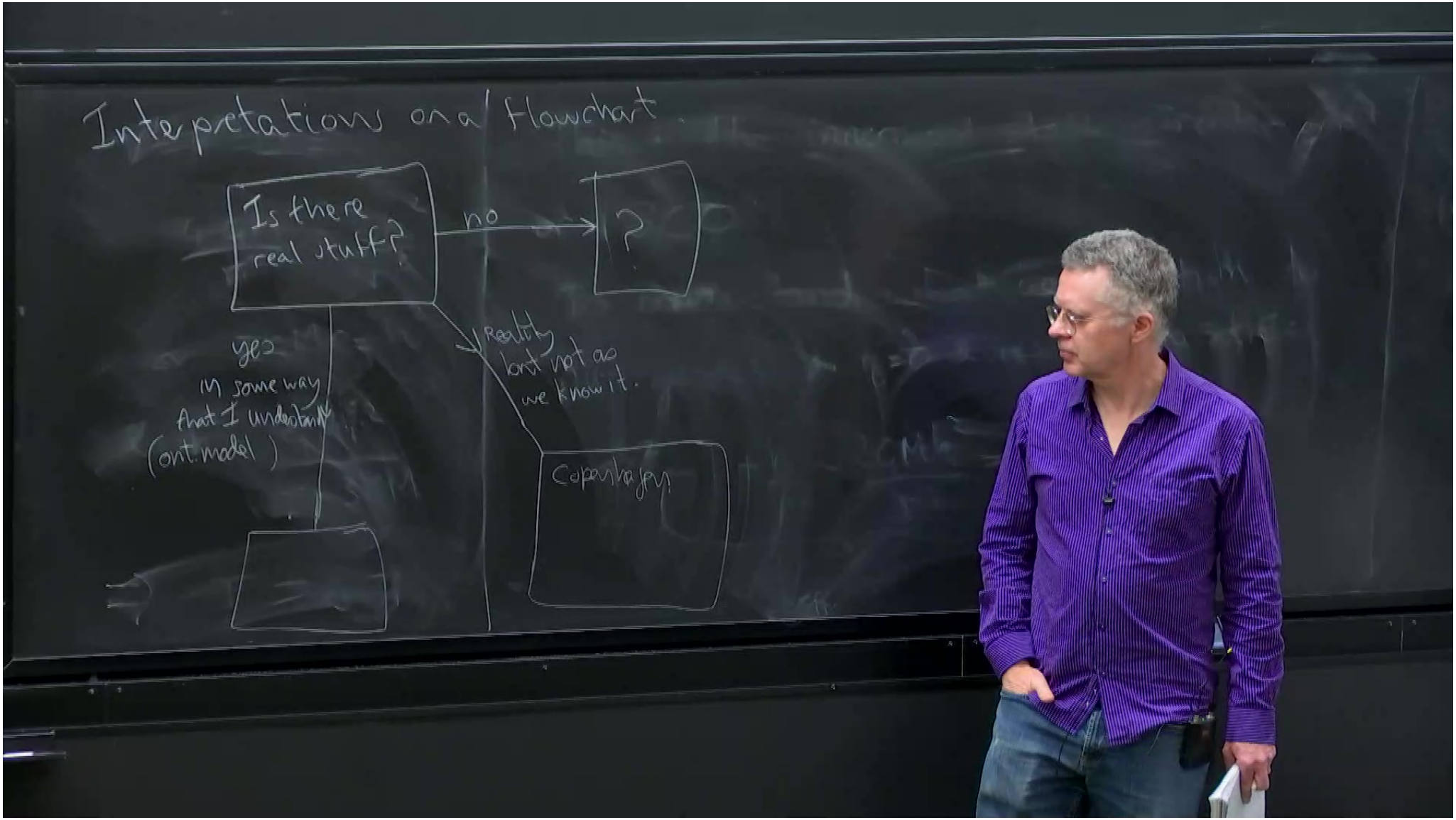
ψ epistemic
All epr's follow from state vector
is an epr iff


Interpretations on a flowchart
Is there real stuff?
no
?
yes
in some way that I understand
(ont. model)
Reality but not as we know it.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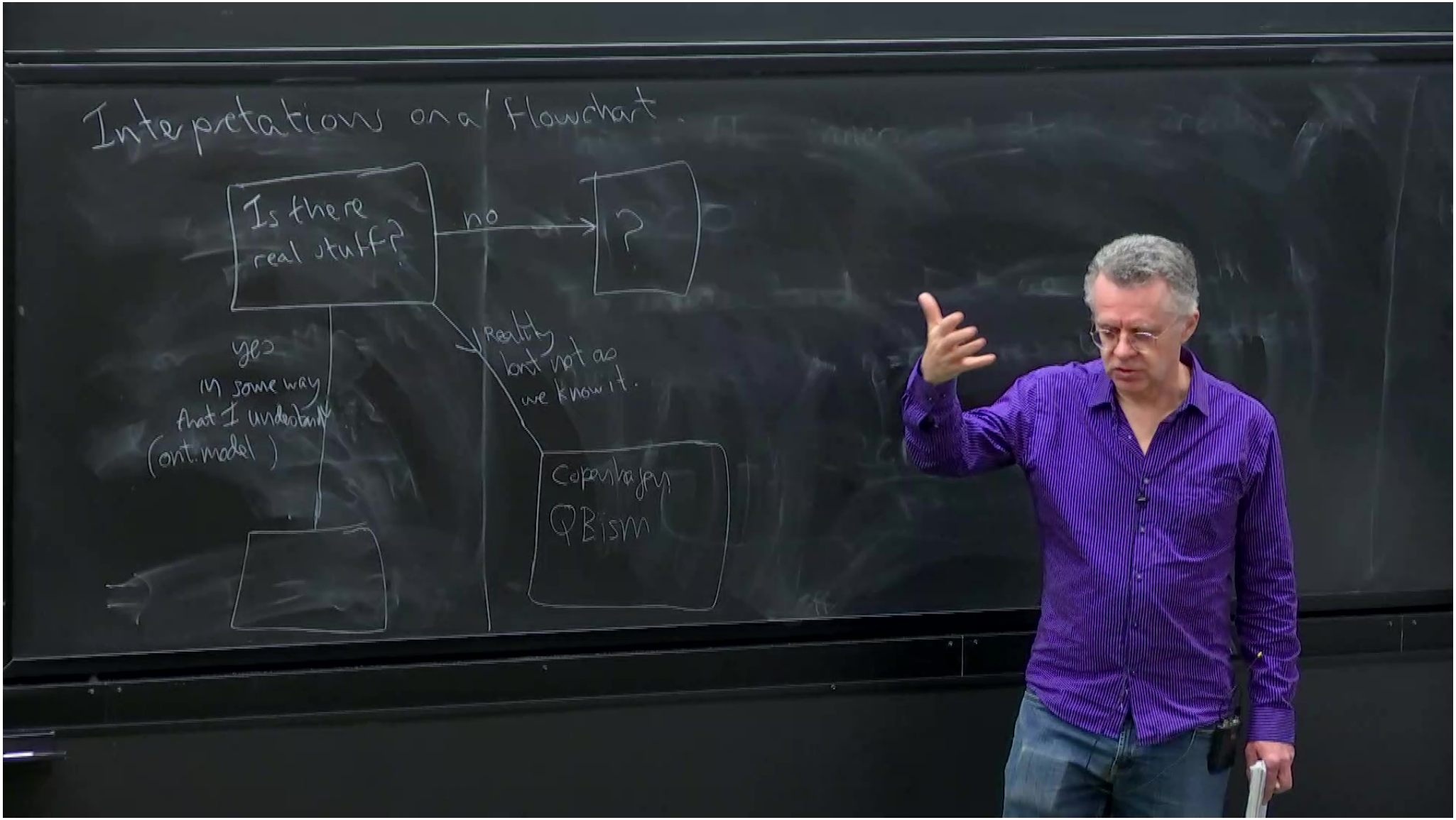
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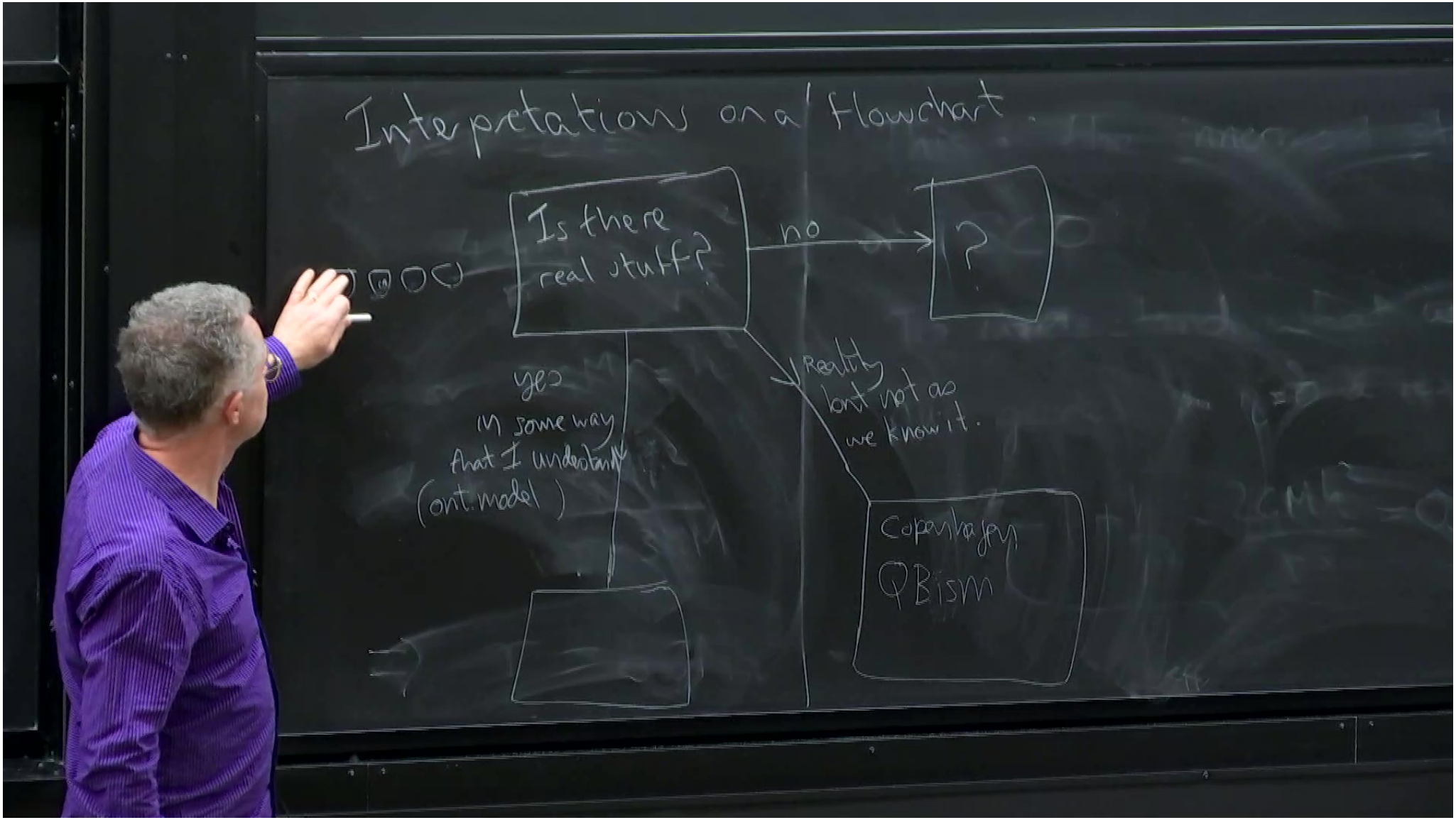
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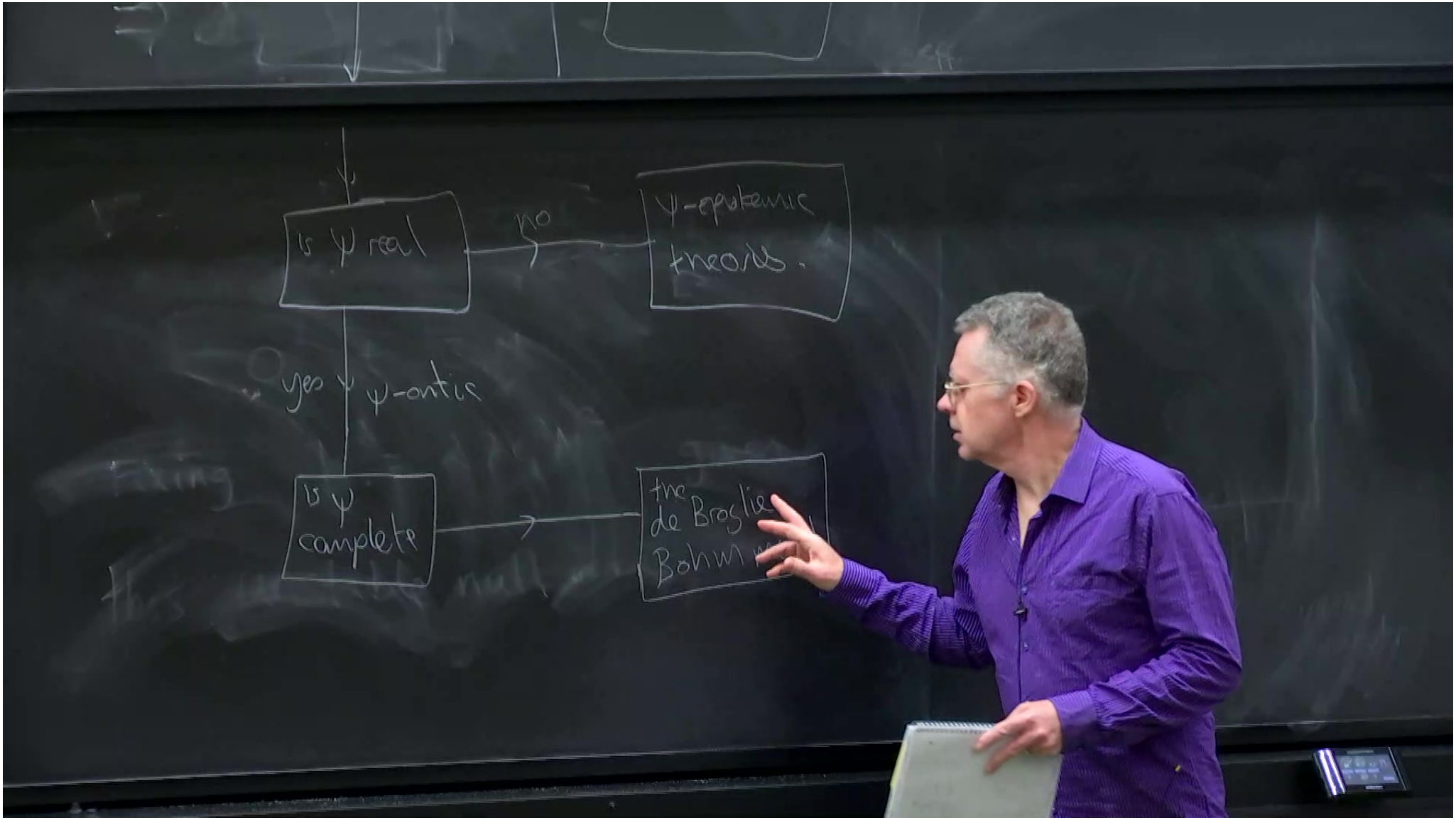
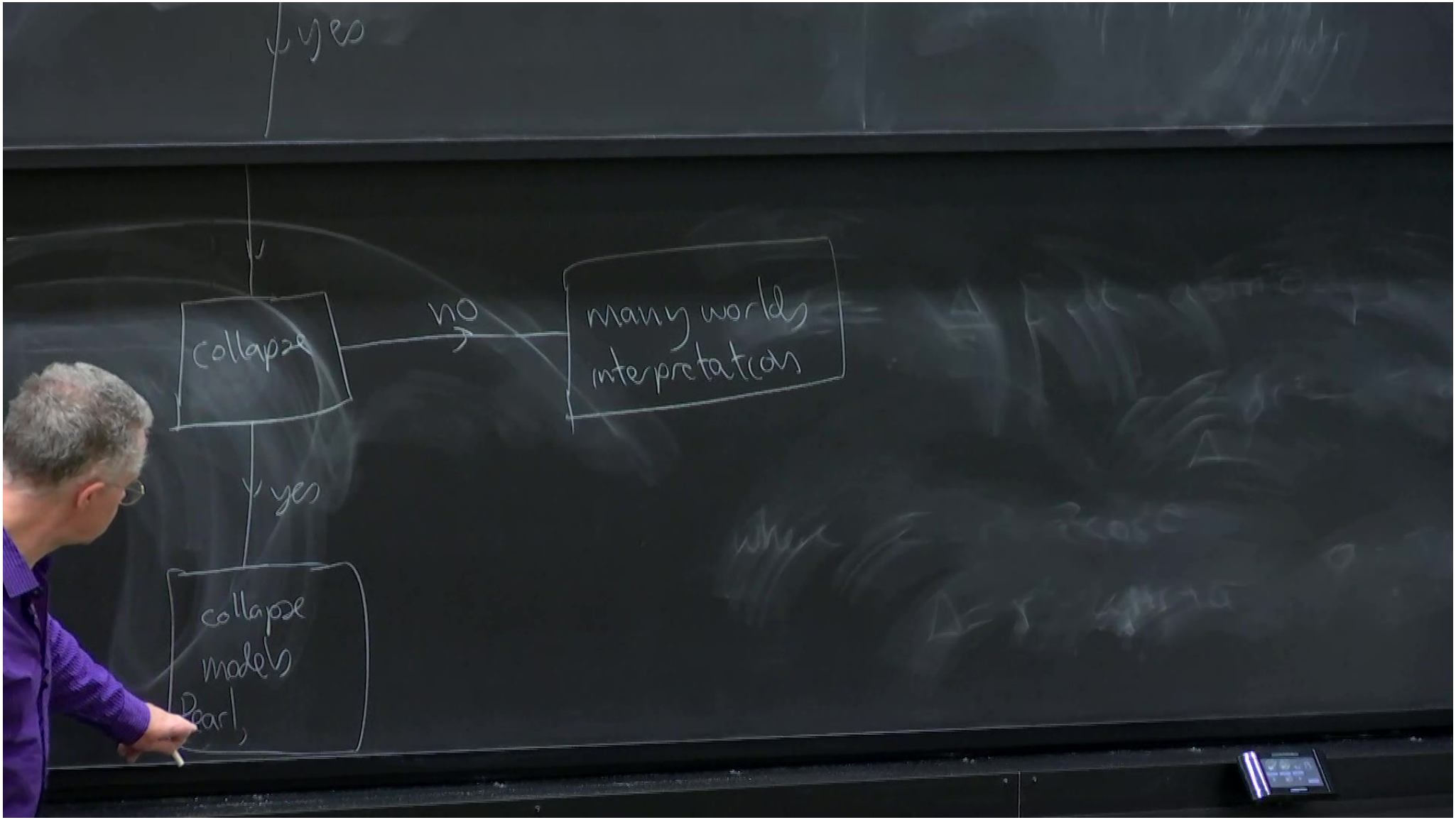

ψ
Is ψ real
no
ψ-epistemic
theories.
yes
ψ-ontic
Is ψ
complete
the
de Broglie
Bohm


yes
collapse
no
many worlds interpretation
yes
collapse models
Pearl