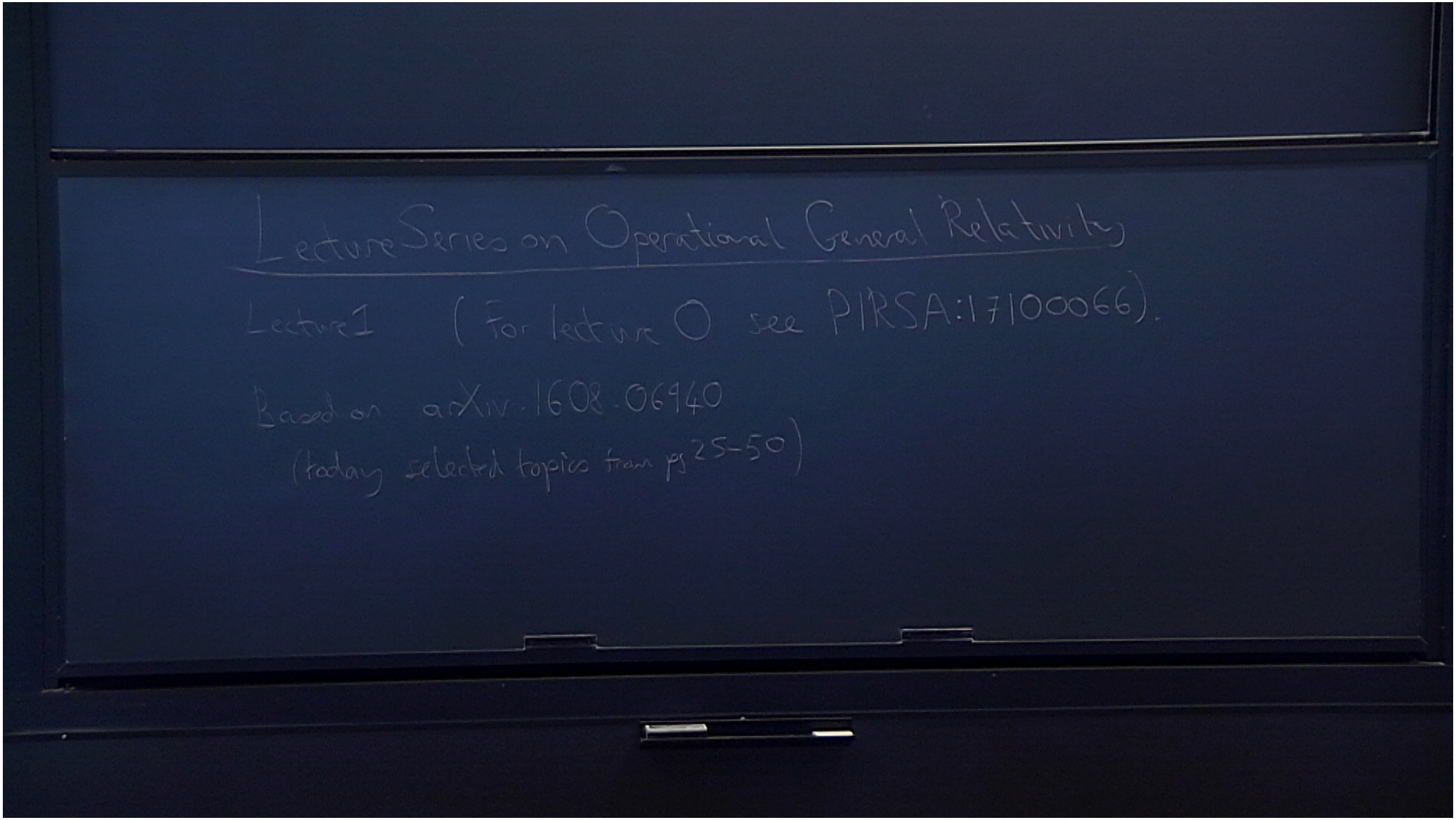
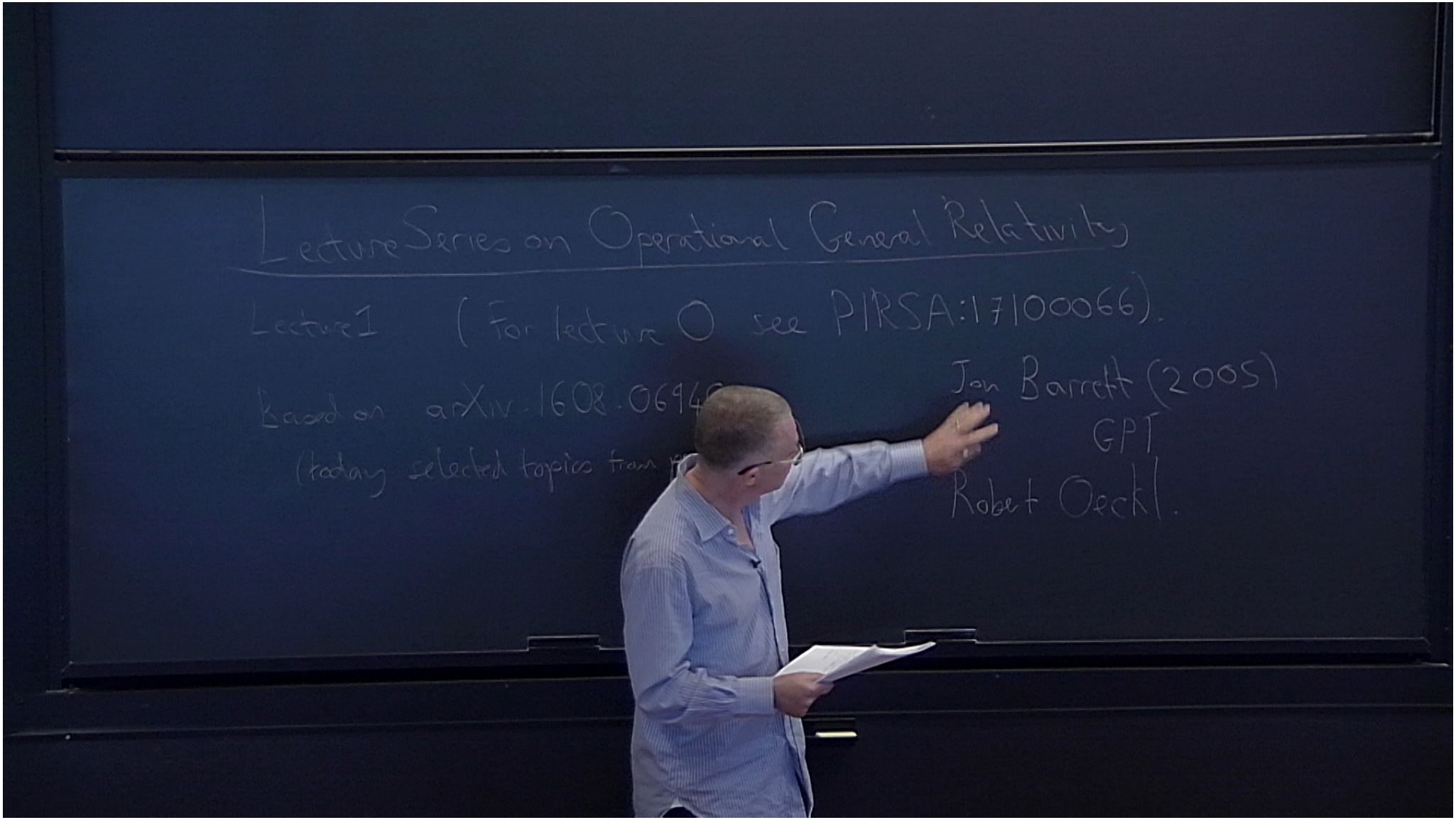
Title: Operational General Relativity - Lecture 1

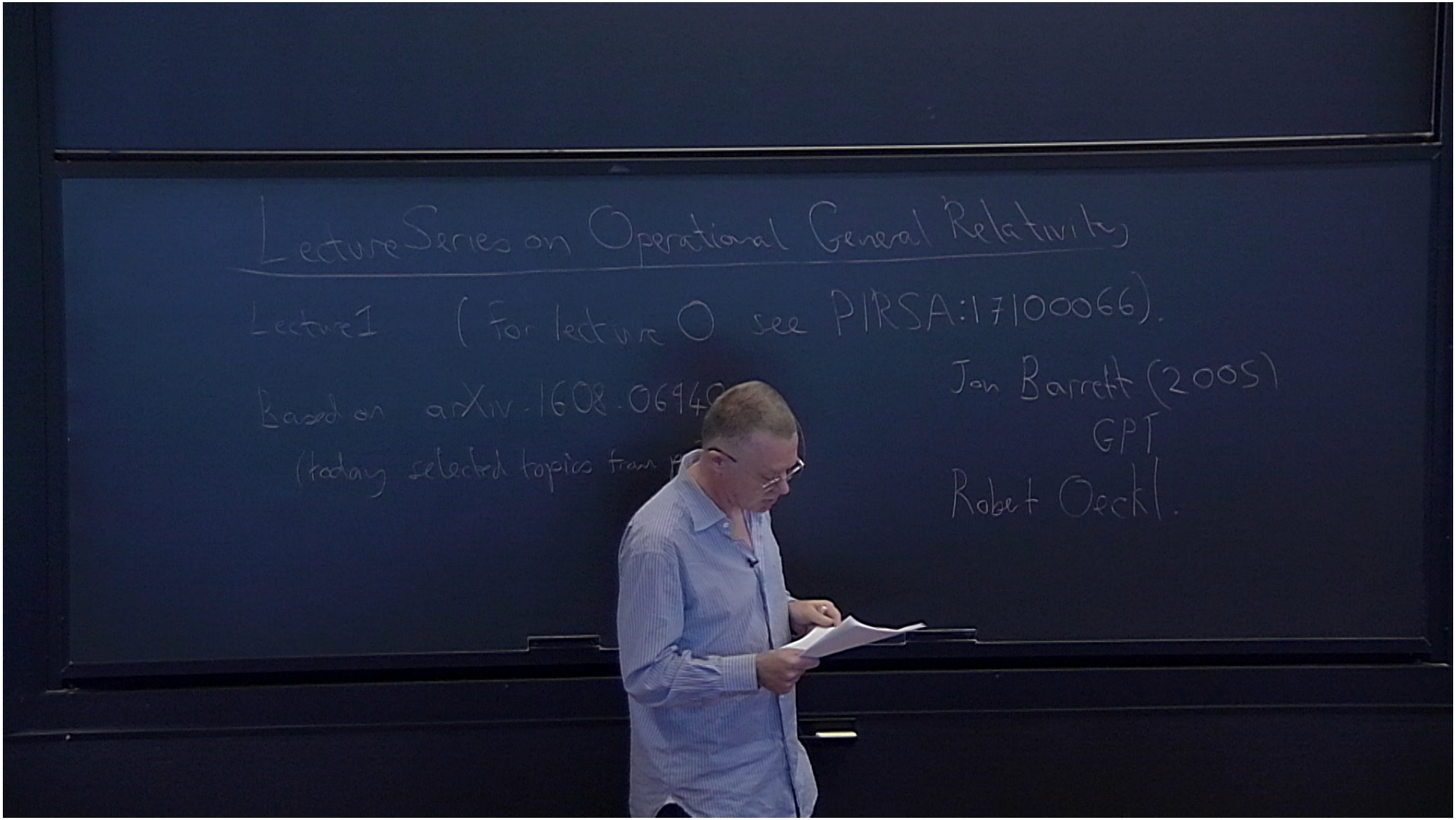
Date: Oct 16, 2017 02:00 PM

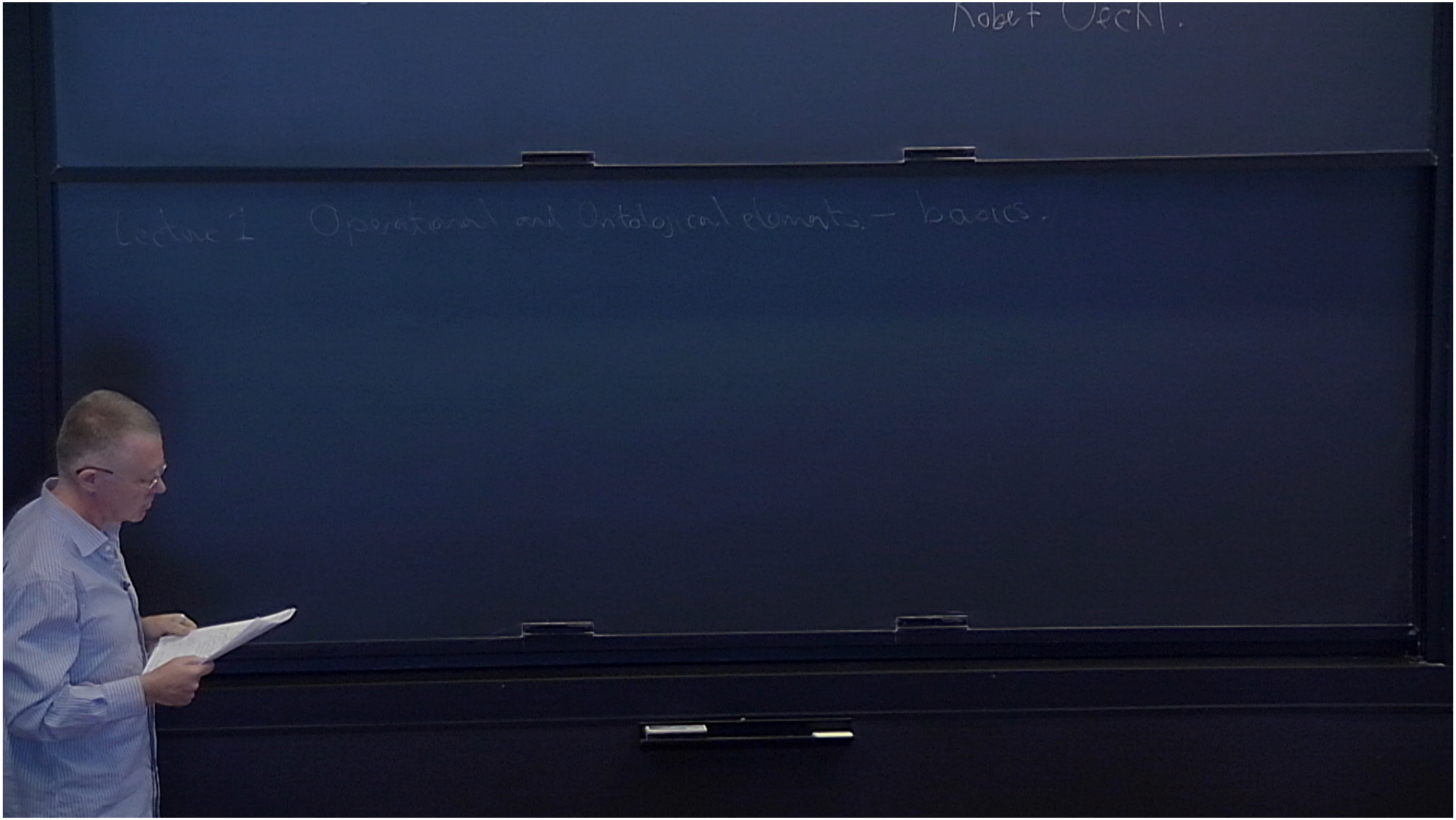
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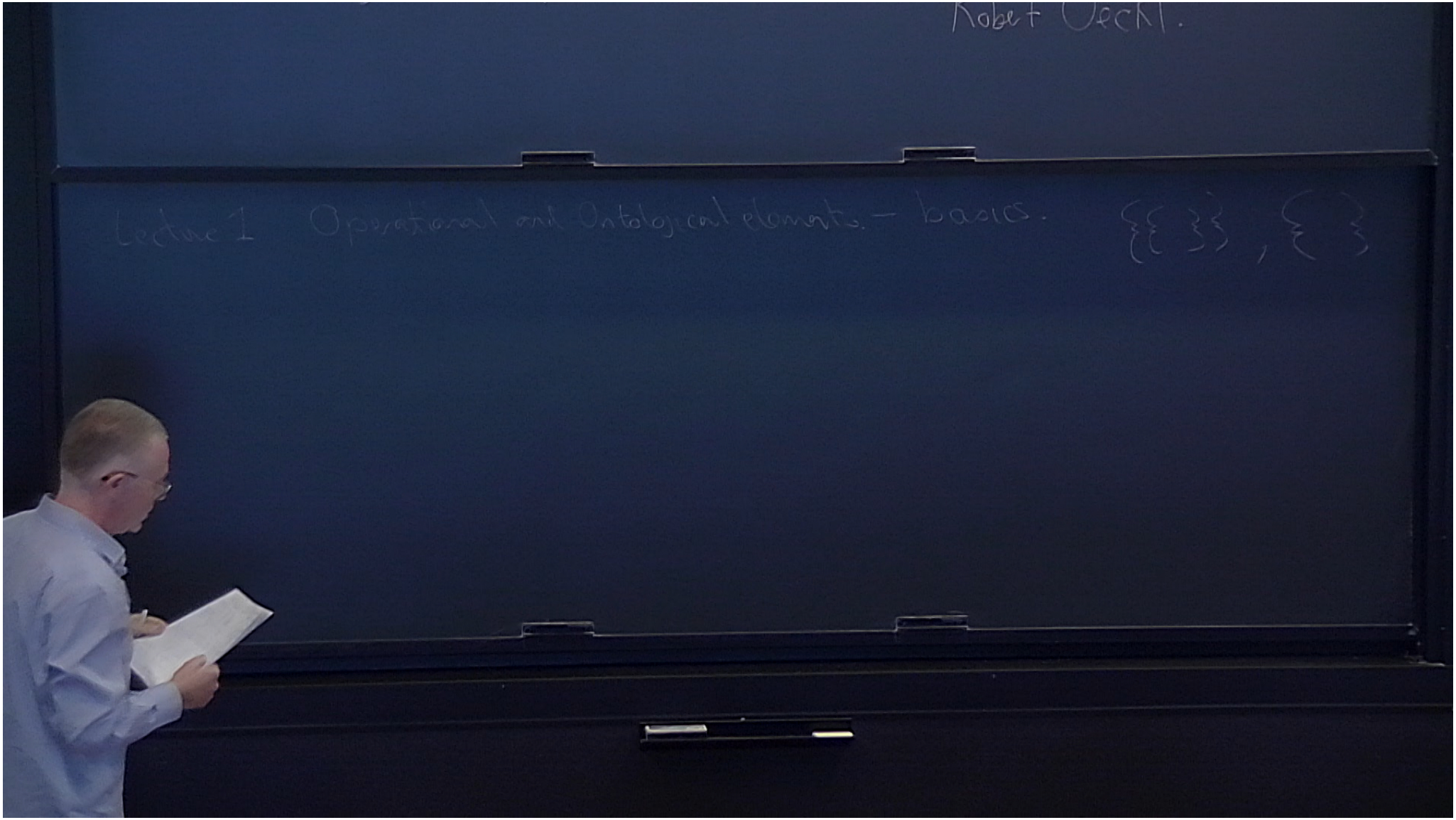
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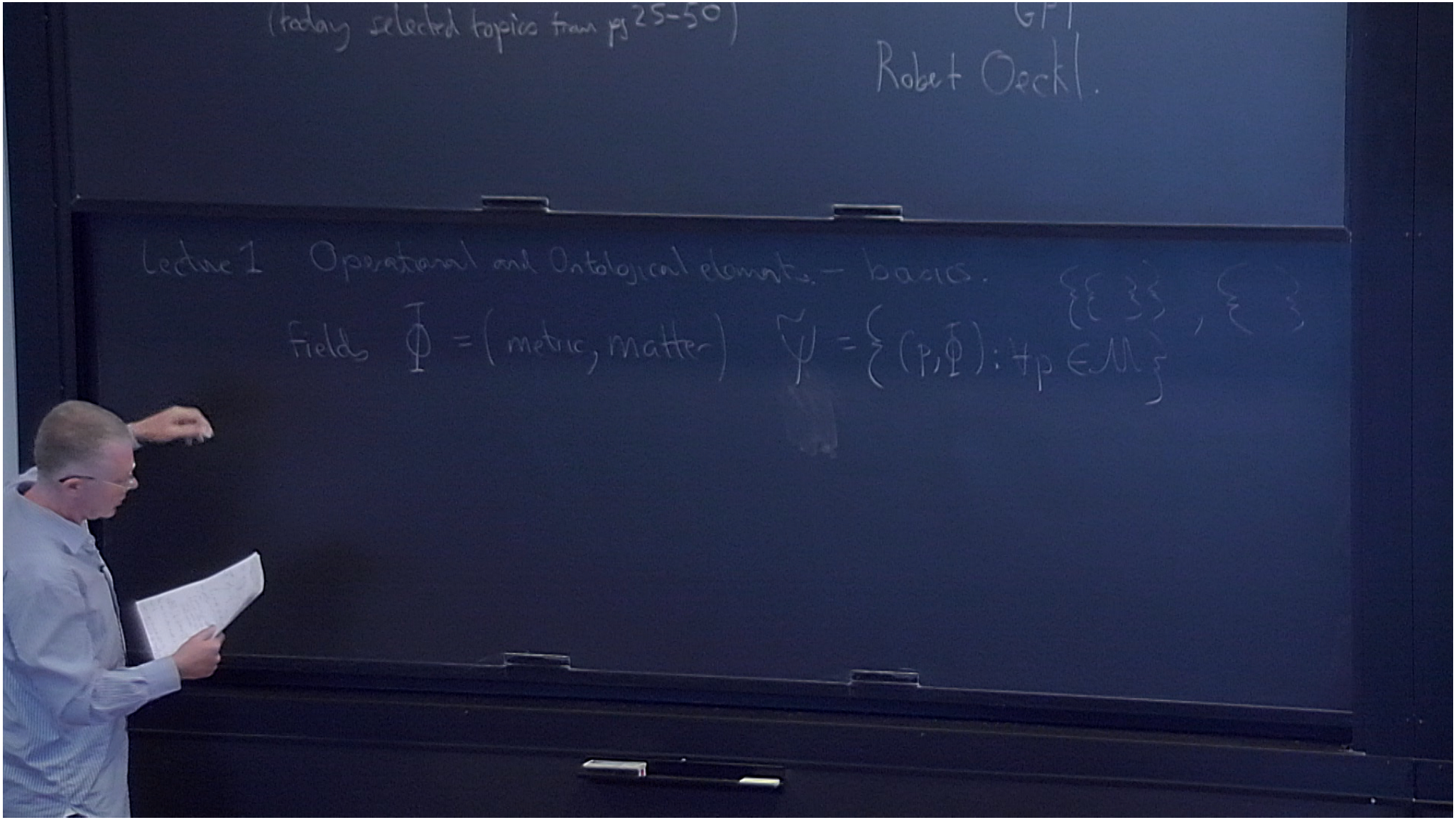

Lecture Series on Operational General Relativity
Lecture 1 (For lecture 0 see PIRSA:17100066).
Based on arXiv:1608.06940
(today selected topics from pg 25-50)


Lecture Series on Operational General Relativity
Lecture 1 (For lecture 0 see PIRSA:17100066).
Based on arXiv:1608.06948
(today selected topics from
Jon Barrett (2005)
GPT
Robert Oeckl.


Lecture Series on Operational General Relativity
Lecture 1 (For lecture 0 see PIRSA:17100066).
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GPT
Robert Oeckl.


Robert Oeckl.
Lecture 1 Operational and Ontological elements. – basics.


Robert Oeckl.
Lecture 1 Operational and Ontological elements. – basics.


(today selected topics from pg 25-50)
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Lecture 1 Operational and Ontological elements - basics.
Fields Φ = (metric, matter) $\tilde{\psi} = \{(p, \Phi) : \forall p \in \mathcal{M}\}$

(today selected topics from pg 25-50)

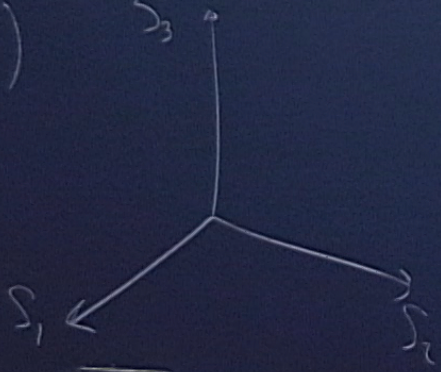
GPT

Robert Oeckl.

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$\underline{\Sigma} = (\Sigma_1, \Sigma_2, \cdots \Sigma_k)$



(today selected topics from pg 25-50)

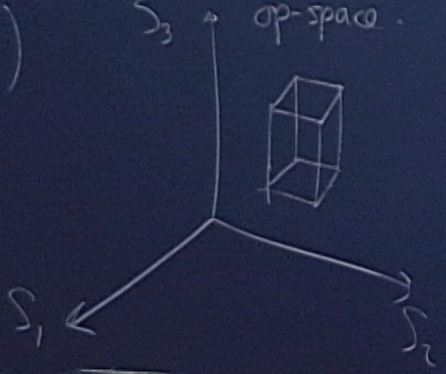
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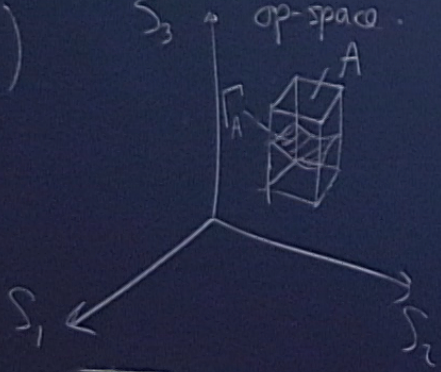
GPT

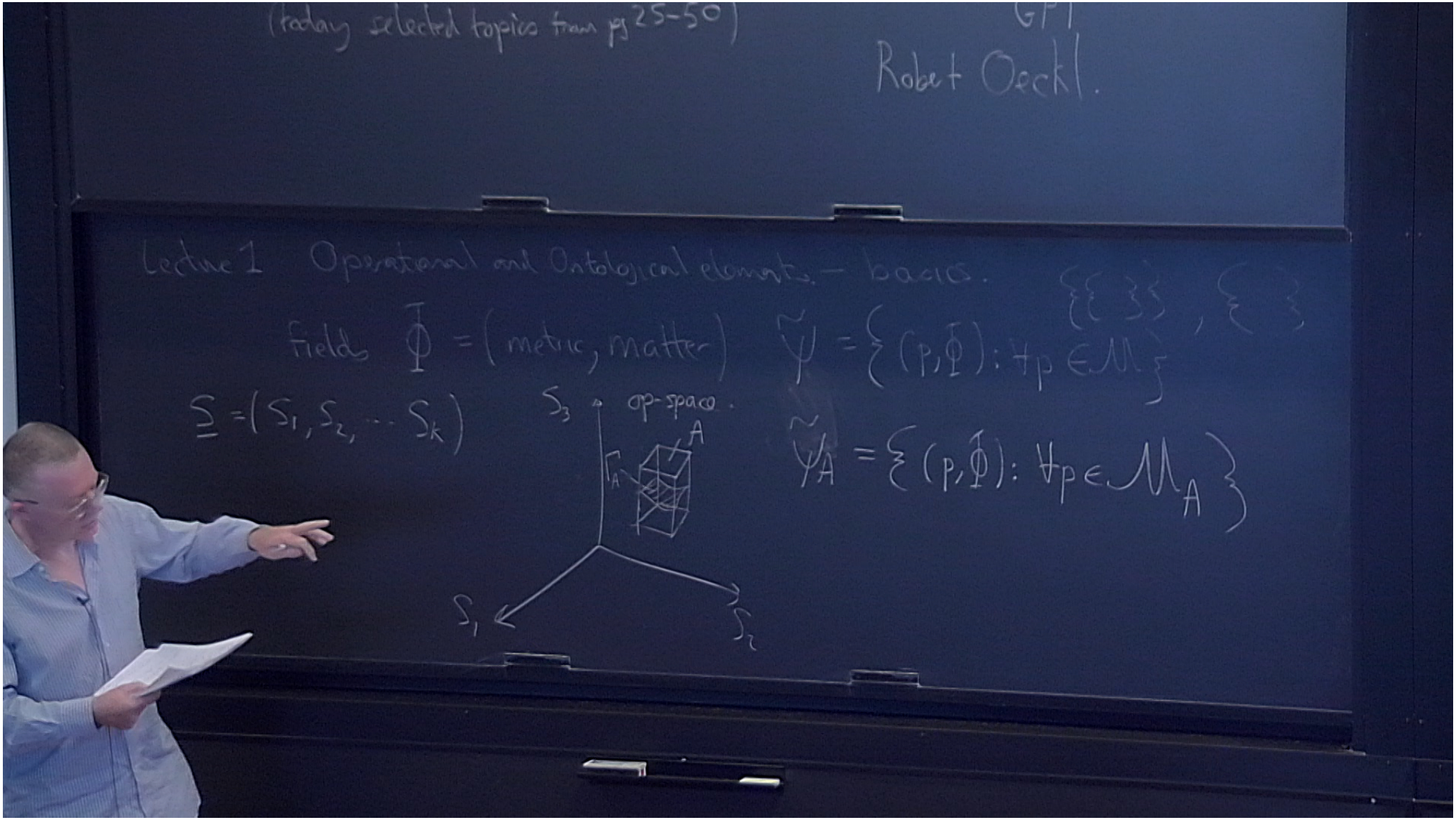
Robert Oeckl.

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(today selected topics from pg 25-50)
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Lecture 1 Operational and Ontological elements – basics.
Fields $\Phi = (\text{metric}, \text{matter})$
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Σ_3
op-space.
A
Γ_A
Σ_1
Σ_2
$\tilde{\psi} = \{(p, \Phi) : \forall p \in \mathcal{M}\}$
$\tilde{\psi}_A = \{(p, \Phi) : \forall p \in \mathcal{M}_A\}$

(today selected topics from pg 25-50)

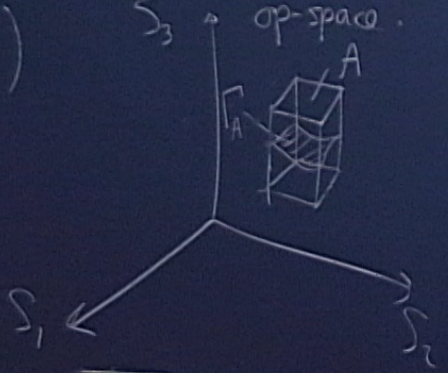
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$\tilde{\psi}_A = \{(p, \Phi) : \forall p \in \mathcal{M}_A\}$

$S(p) \in A$ for $p \in \mathcal{M}_A$

(today selected topics from pg 25-50)

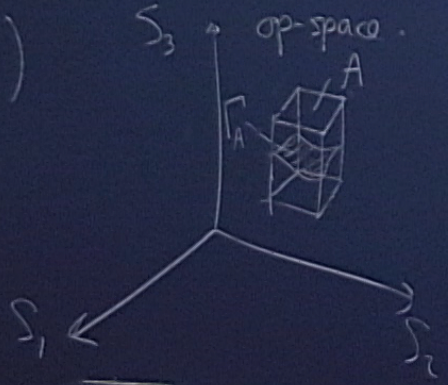
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Lecture 1 Operational and Ontological elements – basics.

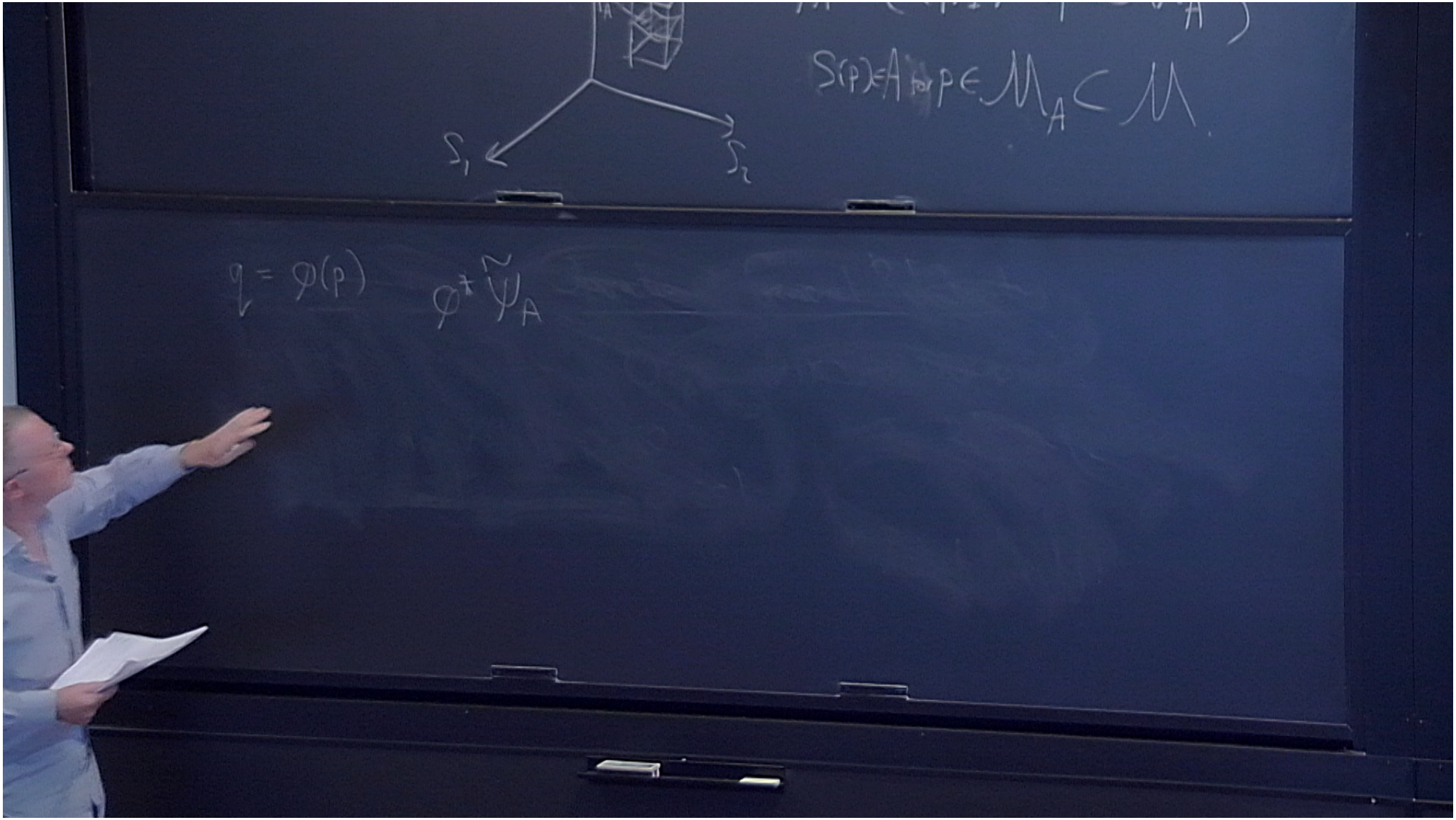
Fields $\Phi = (\text{metric}, \text{matter})$ $\psi = \{(p, \Phi) : \forall p \in \mathcal{M}\}$

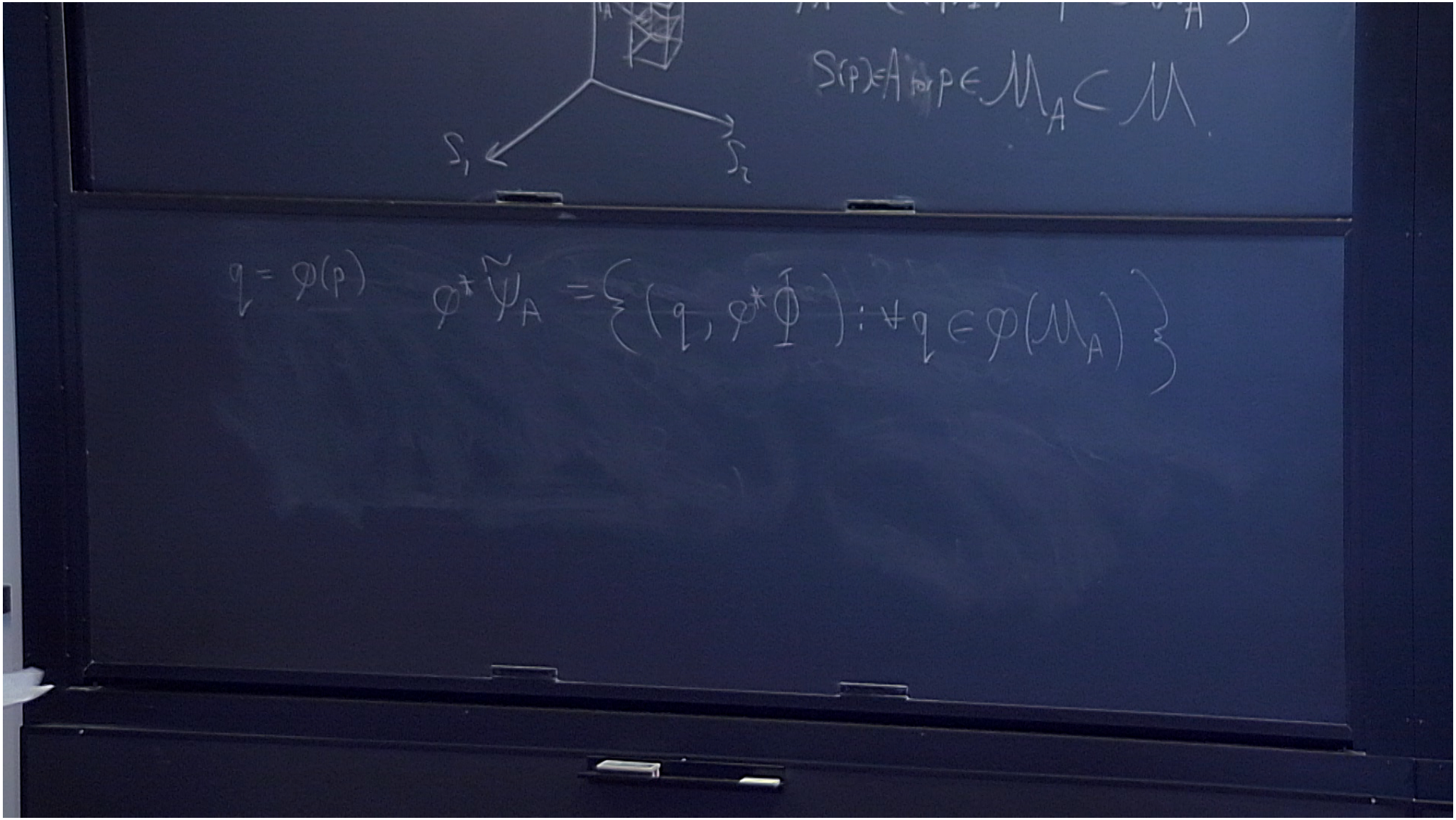
$\Sigma = (\Sigma_1, \Sigma_2, \dots \Sigma_k)$

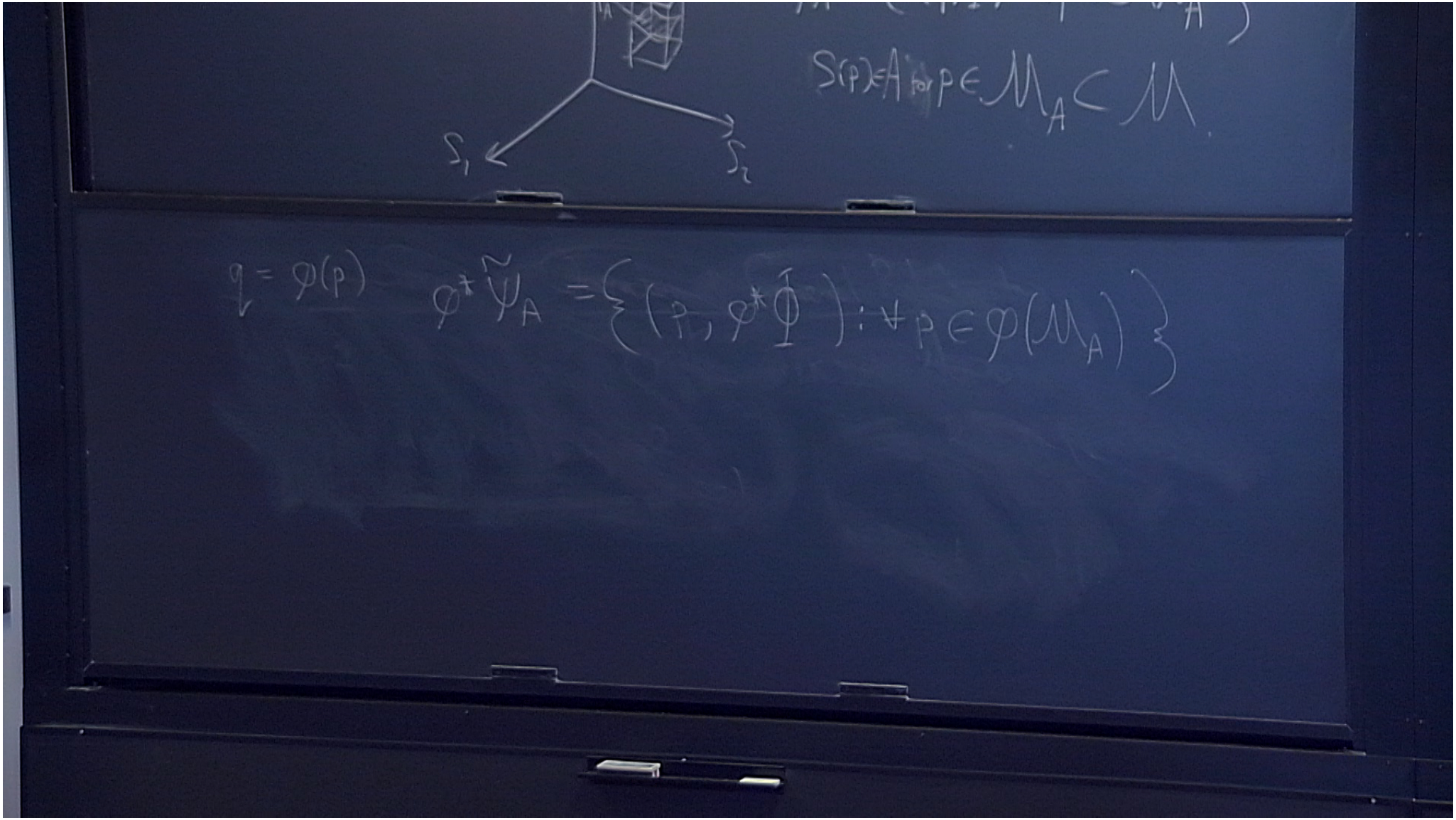


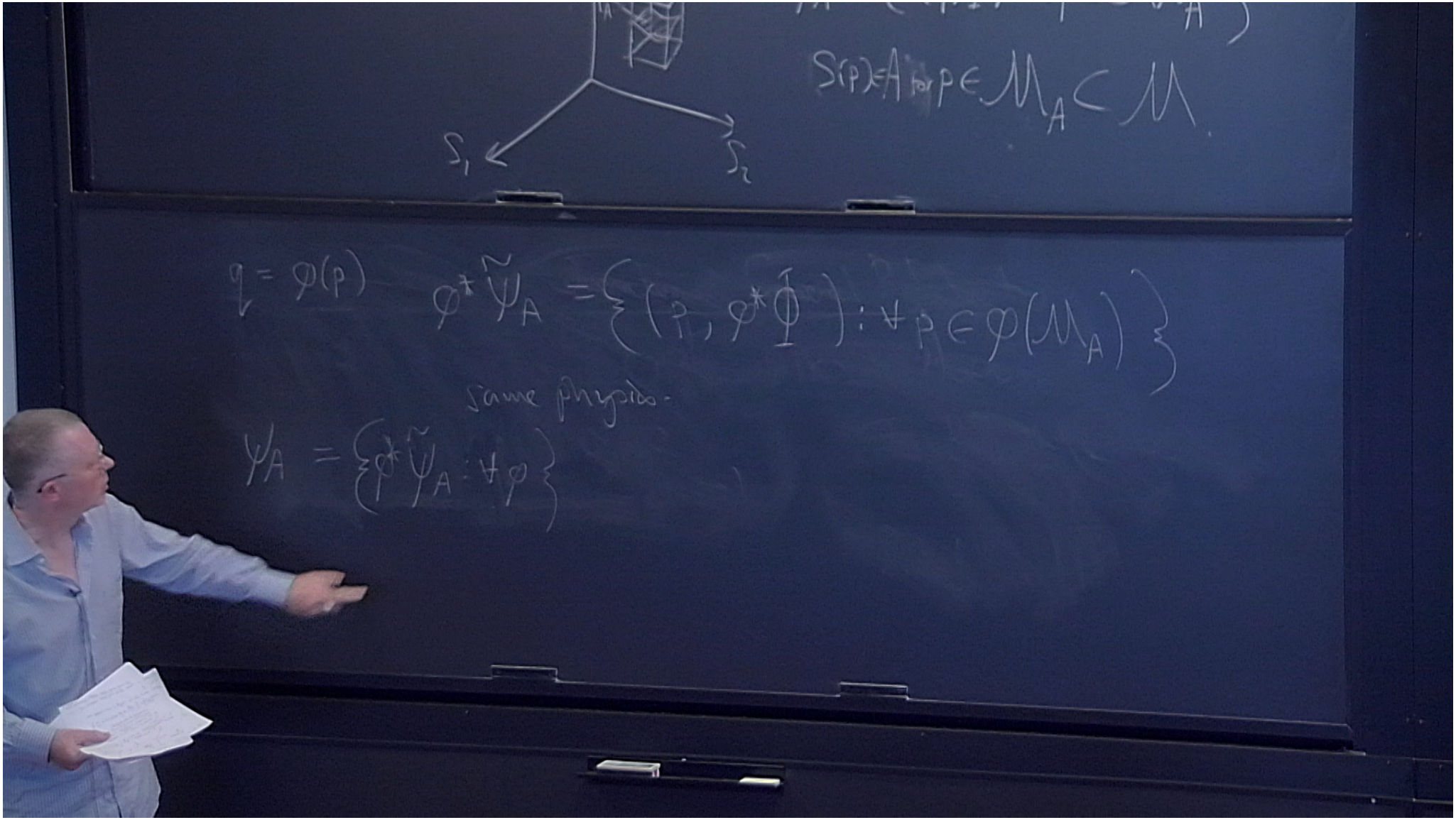
$\psi_A = \{(p, \Phi) : \forall p \in \mathcal{M}_A\}$

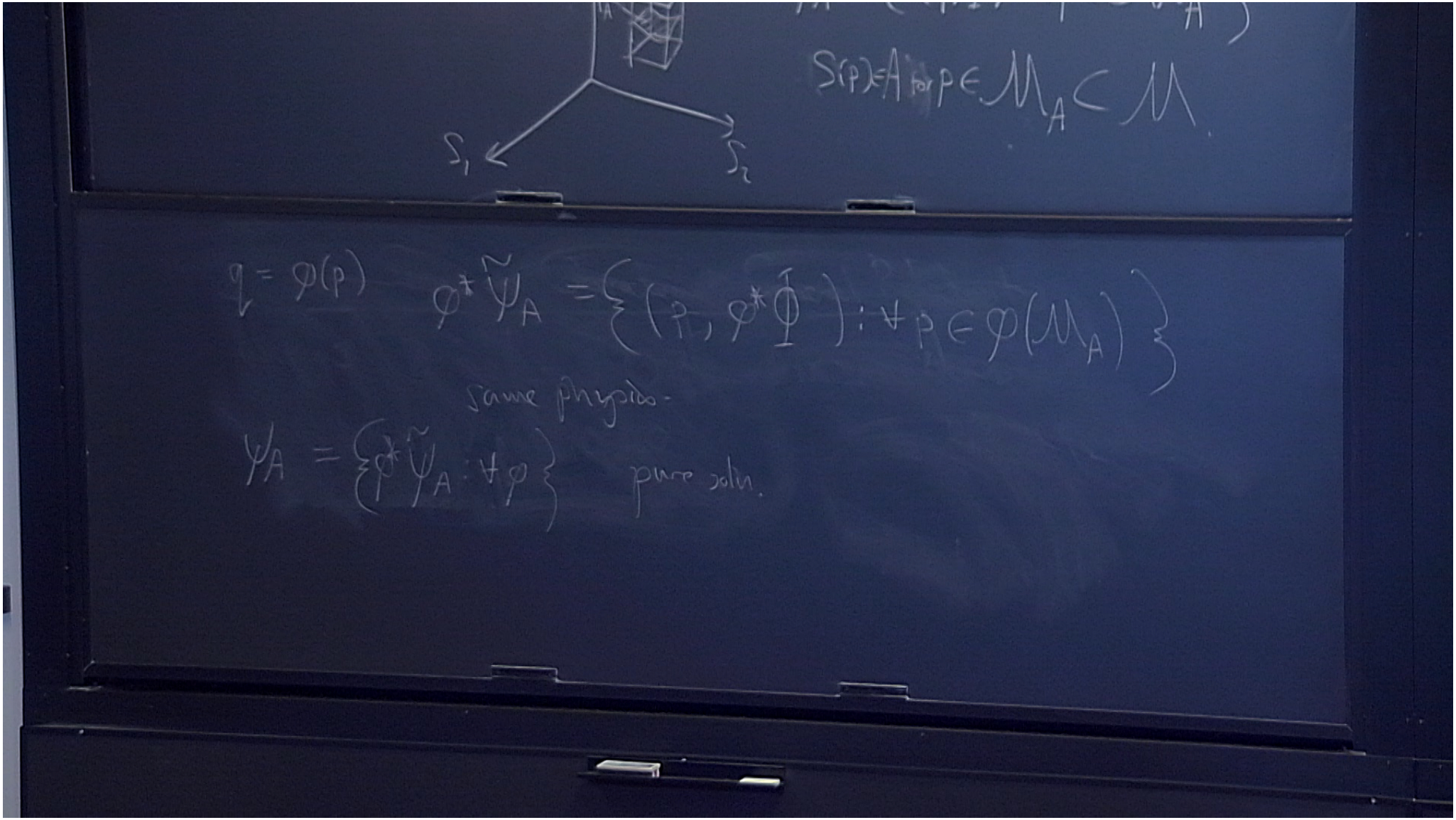
$S(p) \in A$ for $p \in \mathcal{M}_A \subset \mathcal{M}$

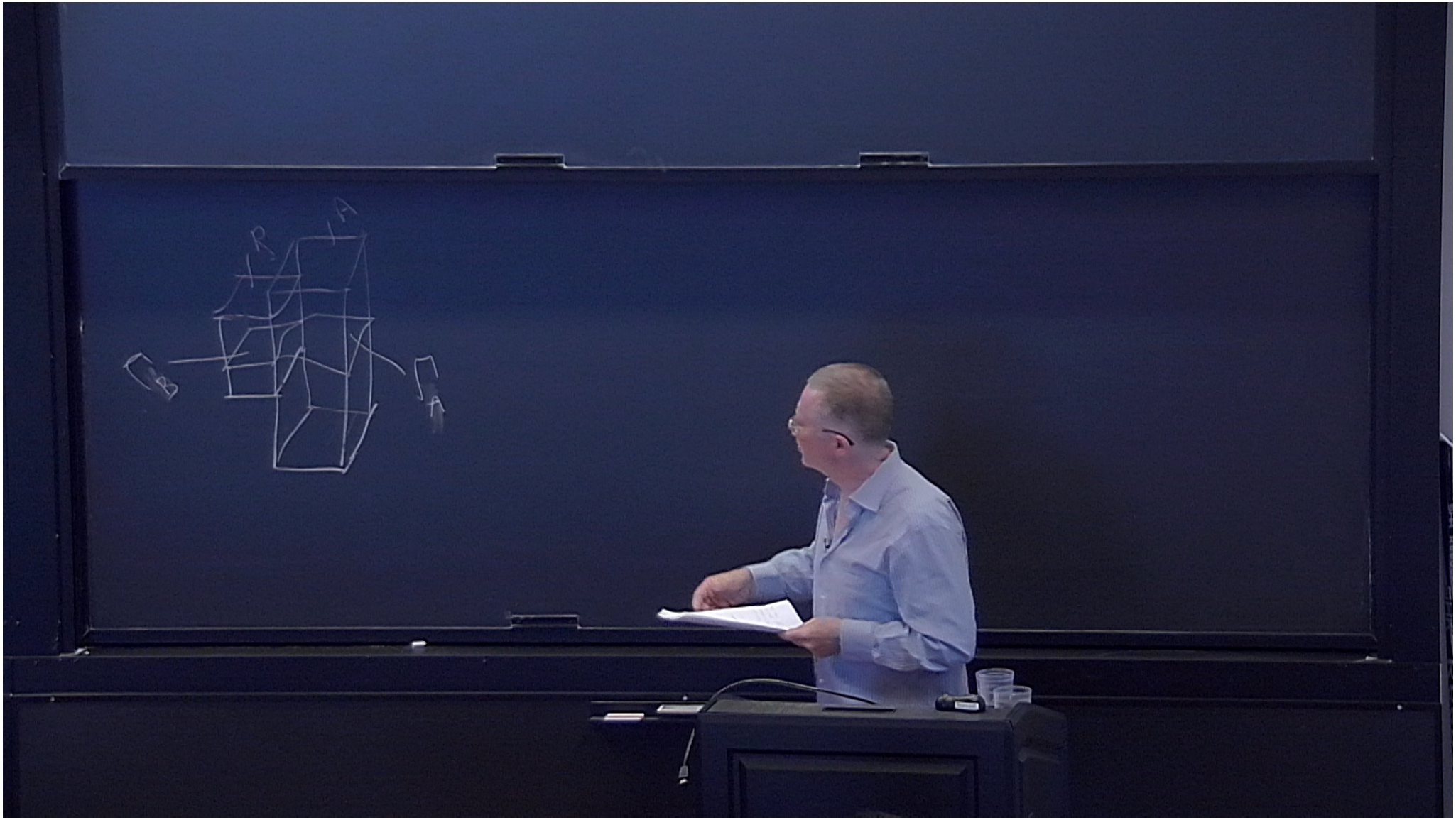

$S(p)=A$ for $p \in M_A \subset M$
S_1
S_2
$q = \varphi(p)$
$\varphi^* \tilde{\psi}_A$

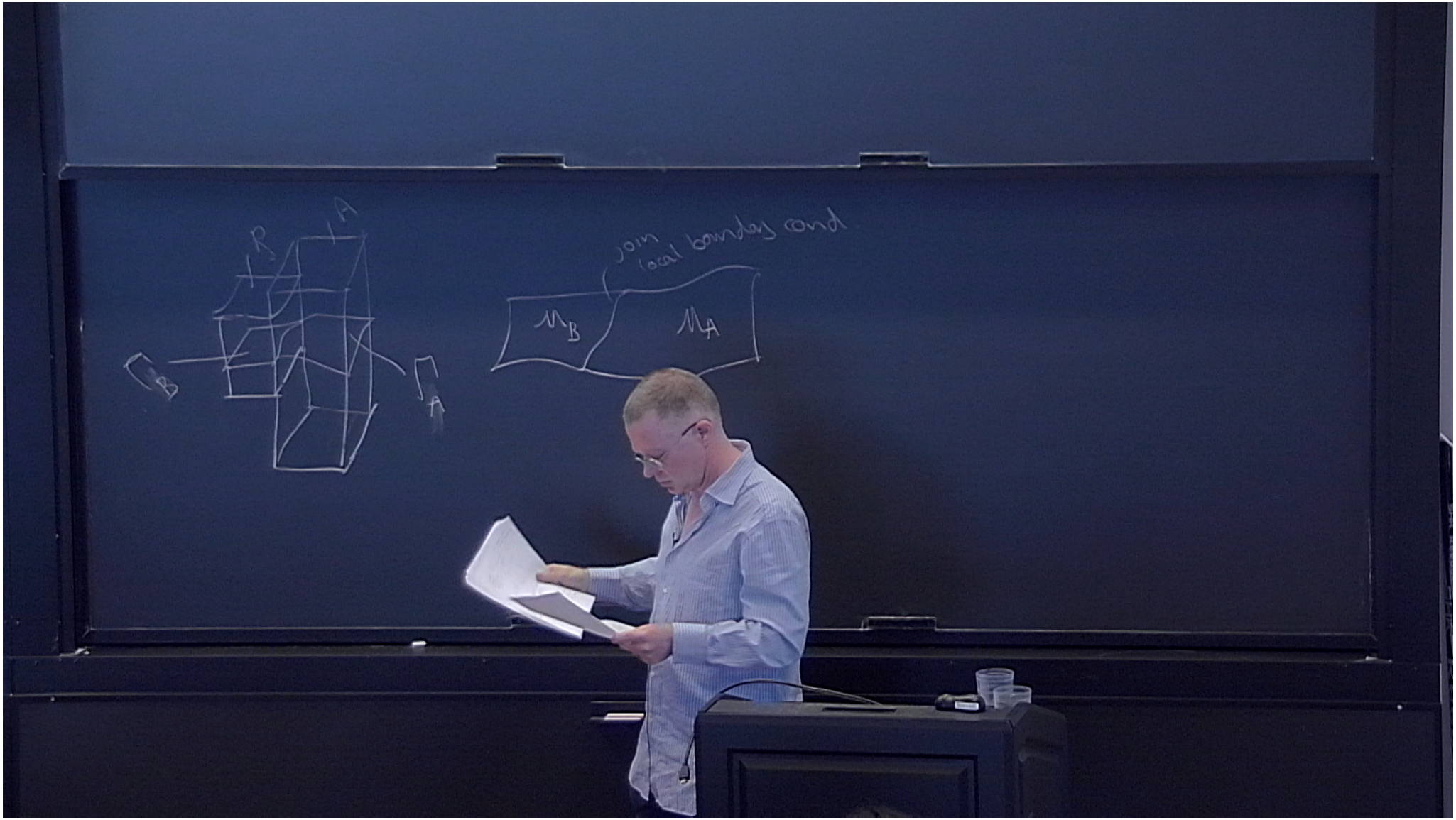

S_1
S_2
$S(p) \in A$ for $p \in \mathcal{M}_A \subset \mathcal{M}$
$q = \varphi(p)$
$\varphi^* \tilde{\psi}_A = \{ (q, \varphi^* \underline{\phi}) : \forall q \in \varphi(\mathcal{M}_A) \}$

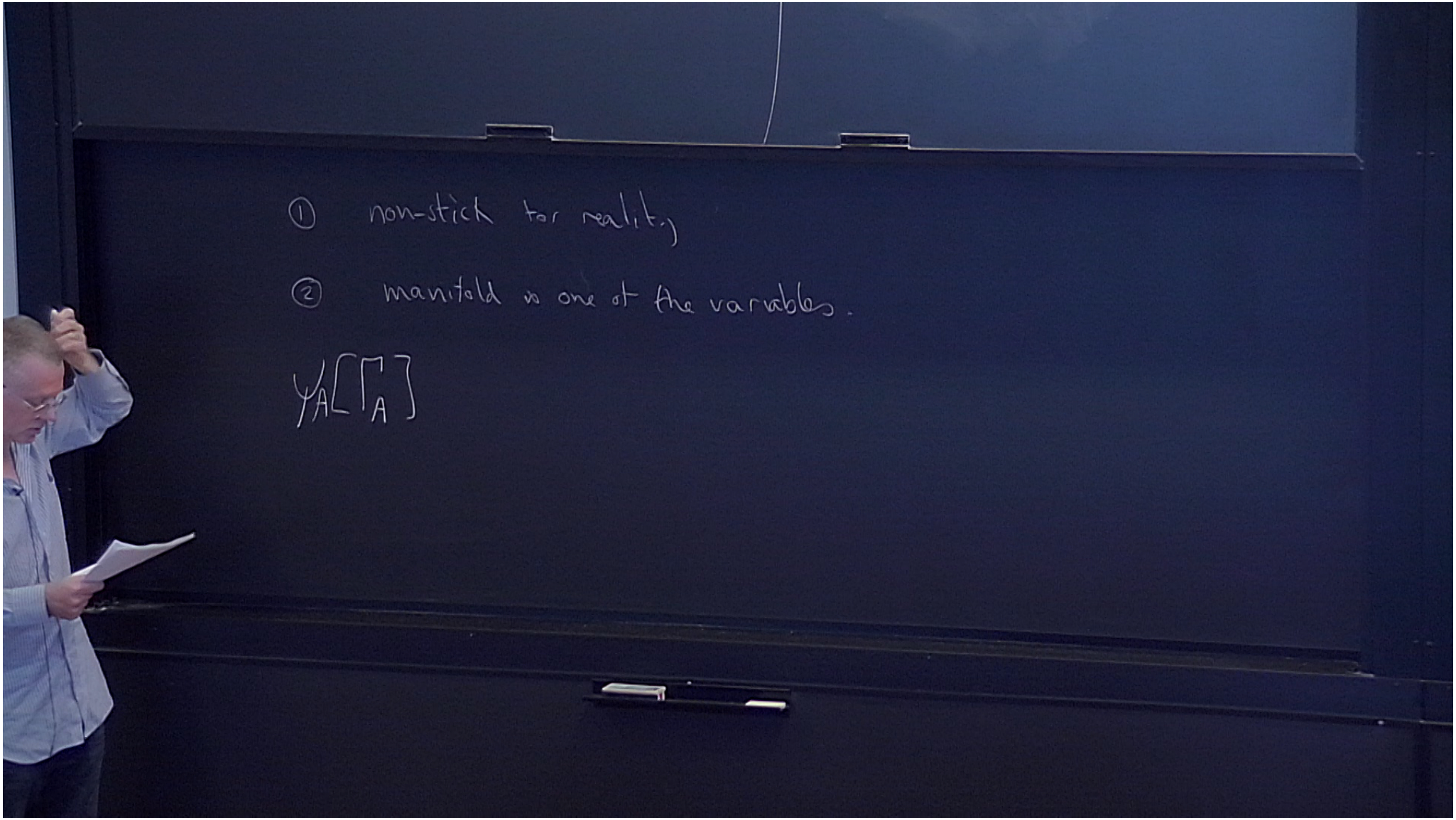

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S_1
S_2
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$\varphi^* \tilde{\psi}_A = \{ (p, \varphi^* \Phi) : \forall p \in \varphi(M_A) \}$

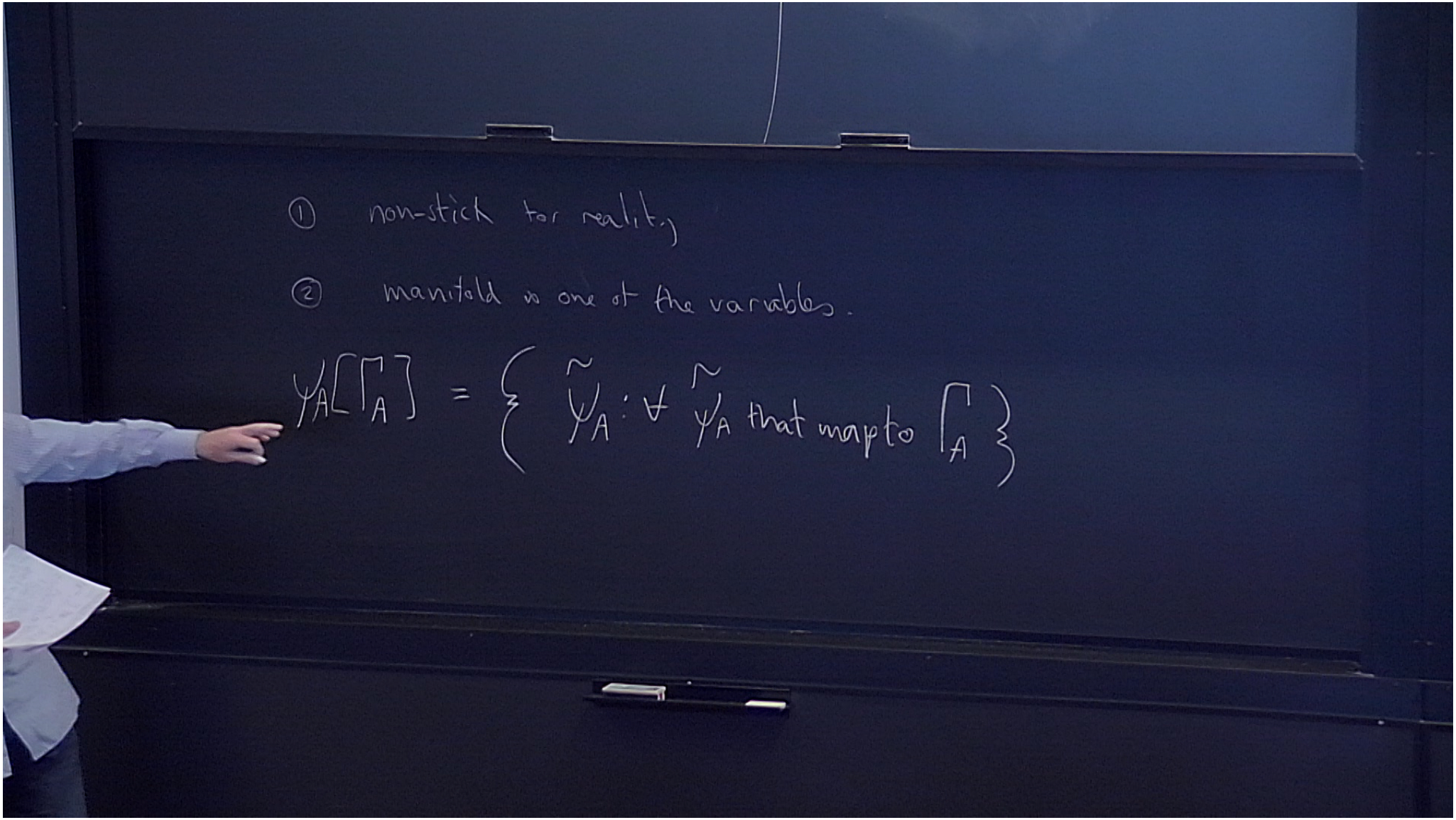

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S_1
S_2
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$\varphi^* \tilde{\psi}_A = \{(p, \varphi^* \Phi) : \forall p \in \varphi(M_A)\}$
same physics
$\psi_A = \{\varphi^* \tilde{\psi}_A : \forall \varphi\}$

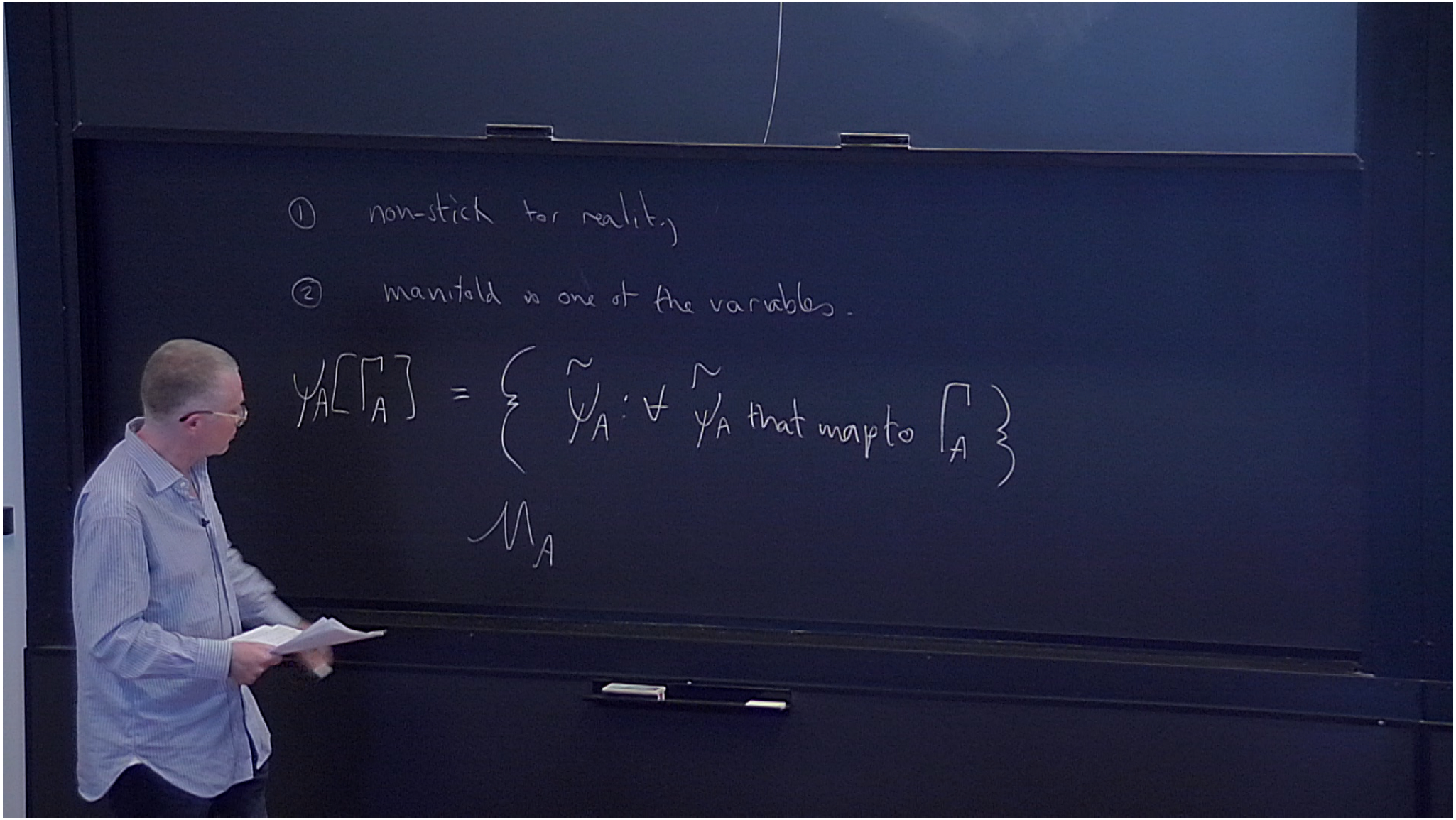

$S(p)=A$ for $p \in M_A \subset M$
S_1
S_2
$q = \varphi(p)$
$\varphi^* \tilde{\psi}_A = \{(p, \varphi^* \tilde{\Phi}) : \forall p \in \varphi(M_A)\}$
same physics
$\psi_A = \{\varphi^* \tilde{\psi}_A : \forall \varphi\}$
pure solns.

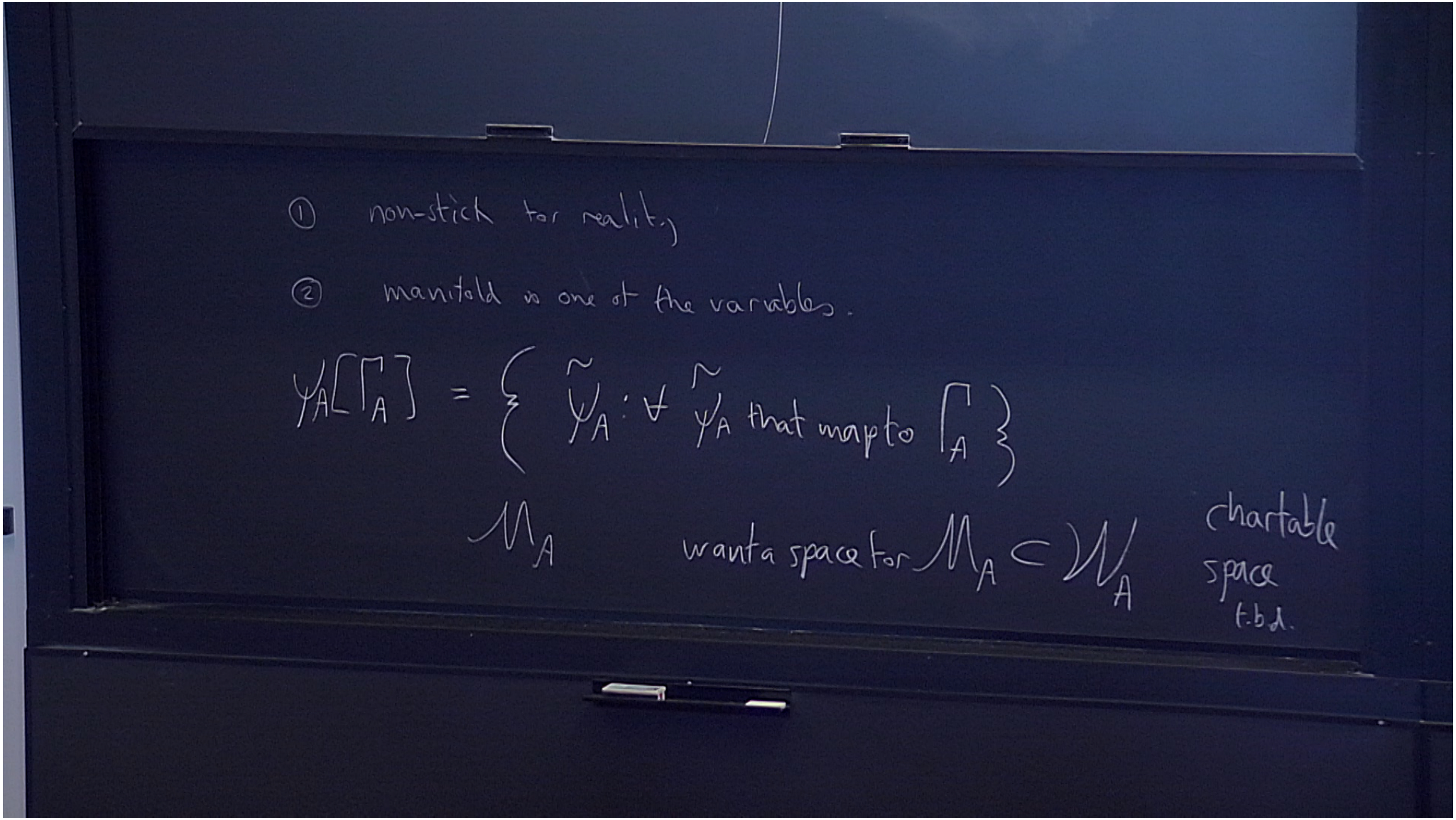

R
A
B

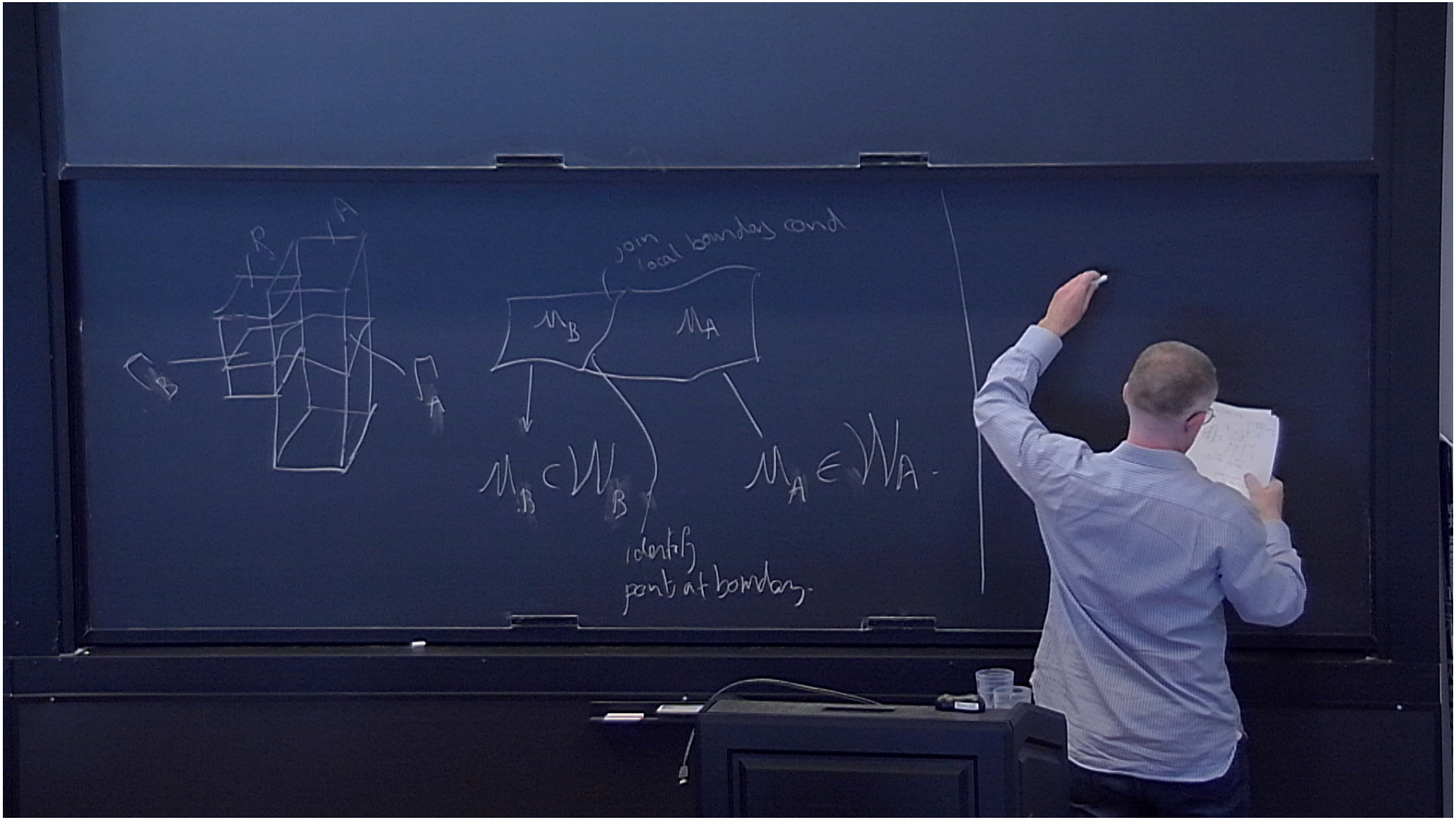

B
A
joint
local boundary cond
M_B
M_A

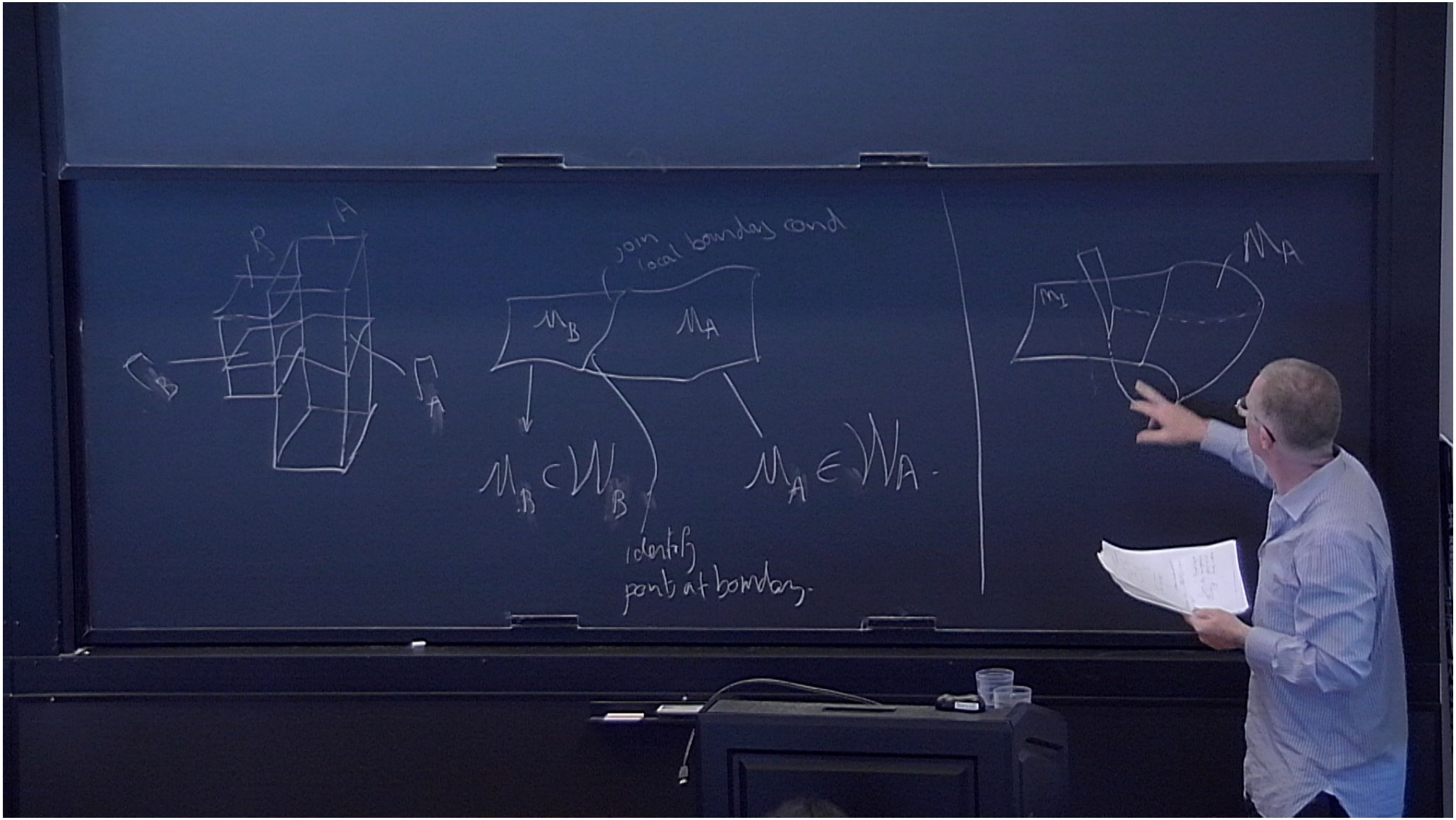

① non-stick for reality
② manifold is one of the variables.
$\Psi_A[\Gamma_A]$

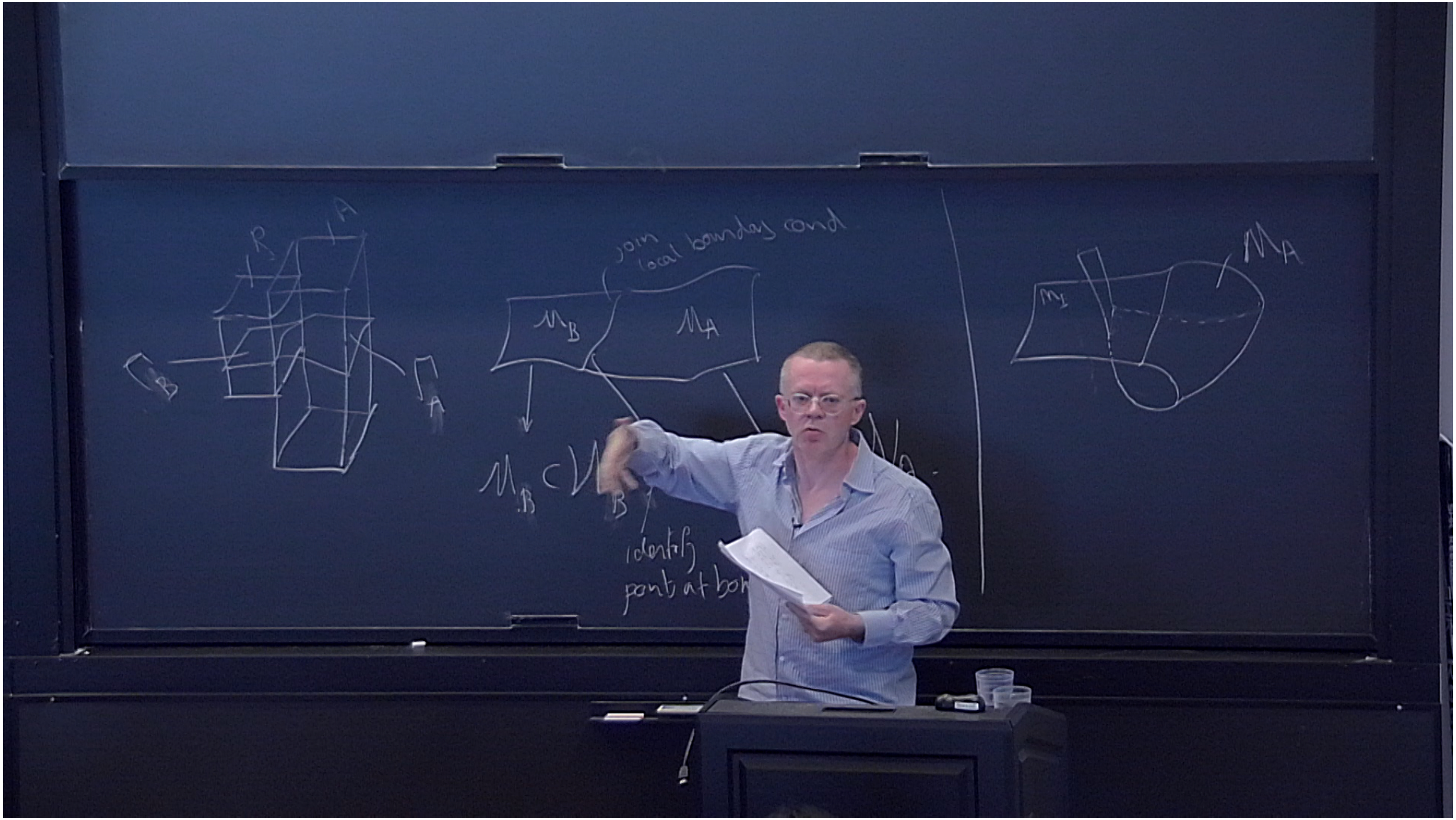

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$\psi_A[\Gamma_A] = \{ \tilde{\psi}_A : \forall\ \tilde{\psi}_A$ that map to $\Gamma_A \}$


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$\mathcal{M}_A$


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$\Psi_A[\Gamma_A] = \{ \tilde{\Psi}_A : \forall\ \tilde{\Psi}_A$ that map to $\Gamma_A \}$
$\mathcal{M}_A$ want a space for $\mathcal{M}_A \subset \mathcal{N}_A$ chartable space t.b.d.


R
A
B
Γ_A
join
local boundary cond
M_B
M_A
M_B ⊂ W_B
M_A ∈ W_A
identify
points at boundary.


B
A
B
A
join
local boundary cond
$\mathcal{M}_B$
$\mathcal{M}_A$
$\mathcal{M}_B \subset \mathcal{W}_B$
$\mathcal{M}_A \in \mathcal{W}_A$.
identify
points at boundary.
$\mathcal{M}_I$
$\mathcal{M}_A$


B
A
join
local boundary cond
identify
points at bou

identify
points at boundary.

A manifold

A set of points is a manifold if

① It can be covered by open subsets $\mathcal{O}_i$ s.t.

$$\bigcup_i \mathcal{O}_i = \mathcal{M}$$

②

identify
points at boundary.

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$$\bigcup_i \mathcal{O}_i = \mathcal{M}$$

② For each i $\exists$ a one-to-one map $\chi_i(p)$ between $\mathcal{O}_i$ and an open subset V_i of $\mathbb{R}^N$

identify
points at boundary.

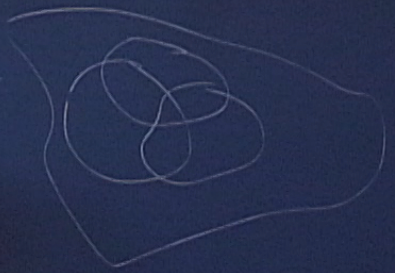
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identify
points at boundary.

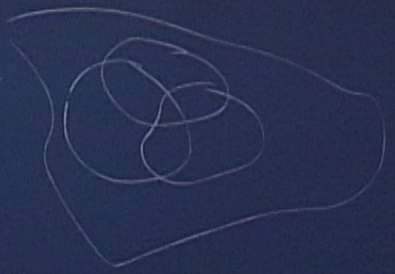
A manifold

A set of points is a manifold if

1. It can be covered by open subsets $\mathcal{O}_i$ s.t.
$$\bigcup_i \mathcal{O}_i = \mathcal{M}$$

2. For each i $\exists$ a one-to-one map $\chi_i(p)$ between $\mathcal{O}_i$ and an open subset V_i of $\mathbb{R}^N$

3. Technical cond.



identify
points at boundary.

A manifold

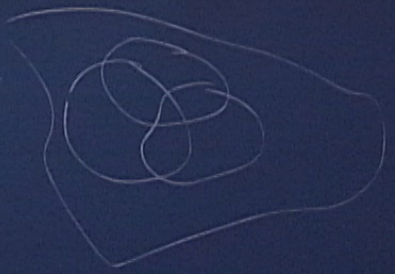
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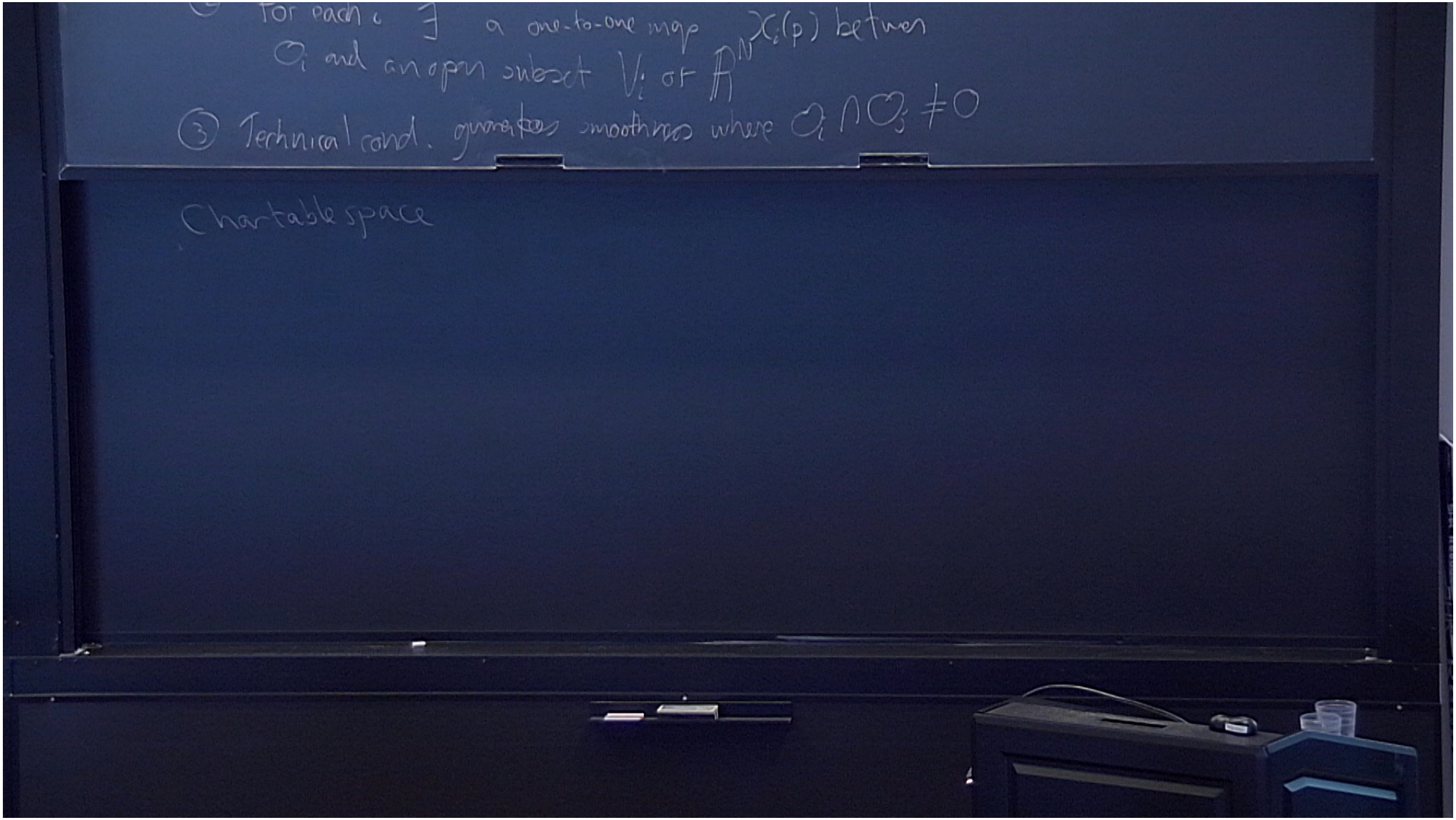
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③ Technical cond. guarantees smoothness where $\mathcal{O}_i \cap \mathcal{O}_j \neq 0$



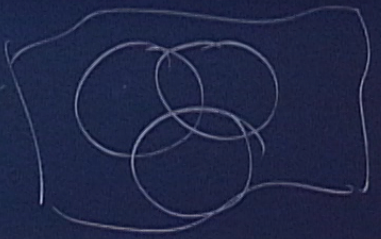

for each i $\exists$ a one-to-one map $\chi_i(p)$ between
$\mathcal{O}_i$ and an open subset V_i of $\mathbb{R}^N$
(3) Technical cond. guarantees smoothness where $\mathcal{O}_i \cap \mathcal{O}_j \neq 0$
Chartable space

For each i $\exists$ a one-to-one map $\chi_i(p)$ between $\mathcal{O}_i$ and an open subset V_i of $\mathbb{R}^N$

(3) Technical cond. guarantees smoothness where $\mathcal{O}_i \cap \mathcal{O}_j \neq 0$

Chartable space —

$x_i \in \mathbb{R}^N \cup \{-\}$



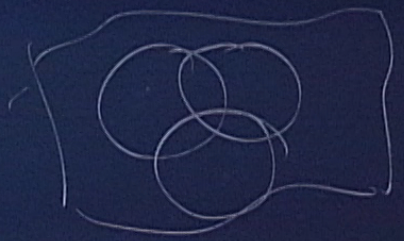
$\vec{x} = (x_1, x_2, \cdots x_i, \cdots)$

for each i $\exists$ a one-to-one map $\chi_i(p)$ between $\mathcal{O}_i$ and an open subset V_i of $\mathbb{R}^N$

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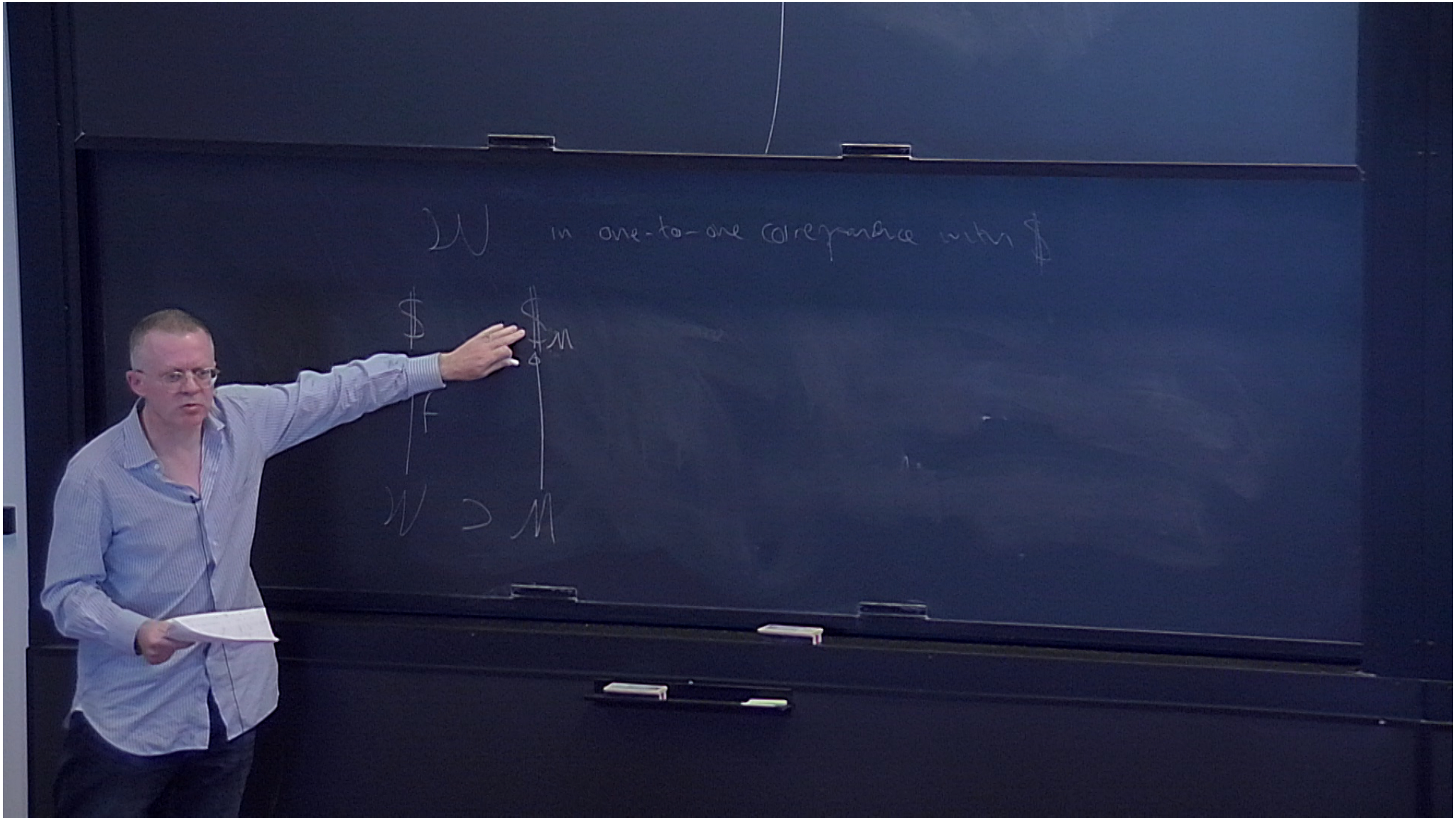
Chartable space —

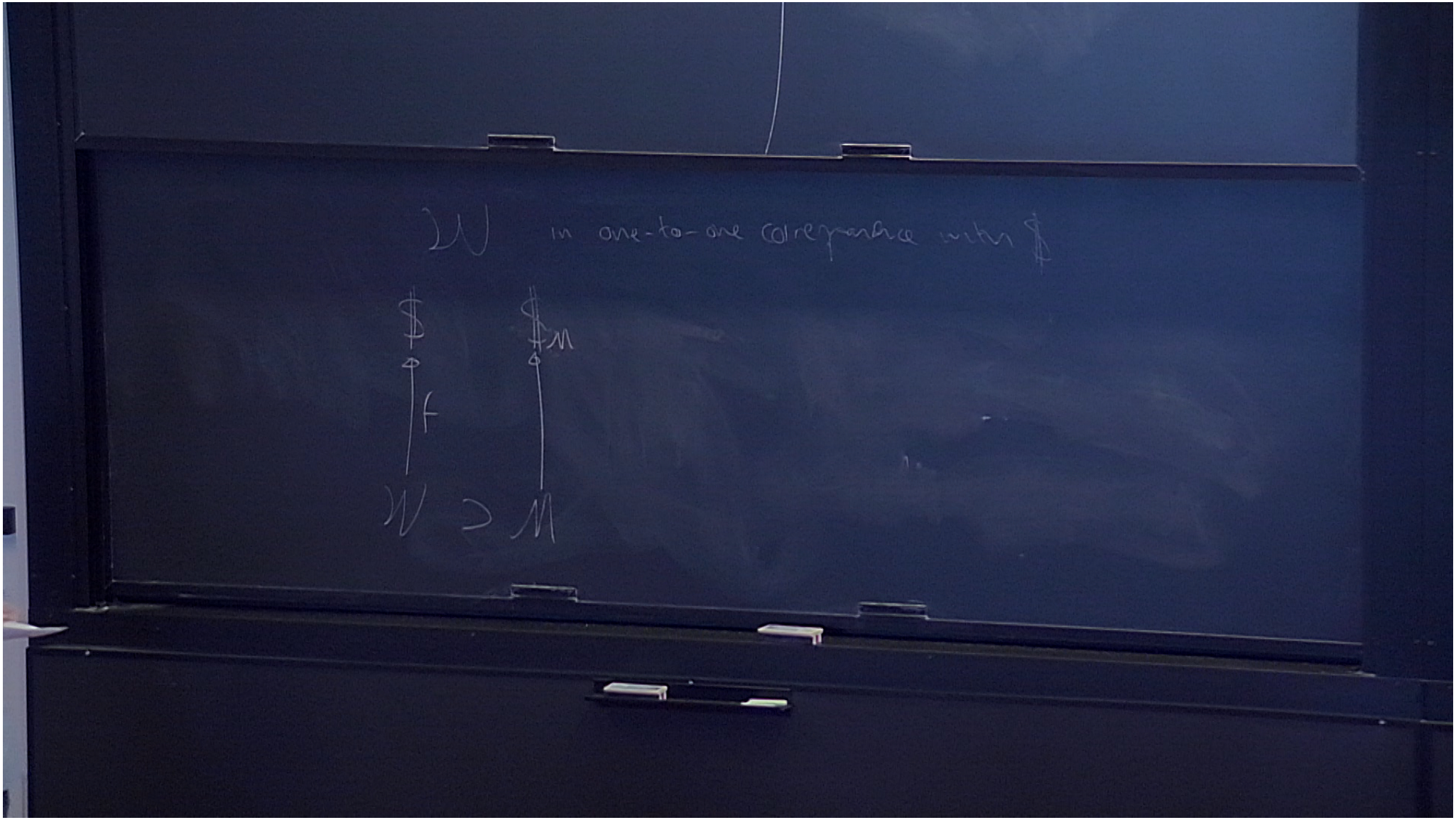
$x_i \in \mathbb{R}^N \cup \{-\}$

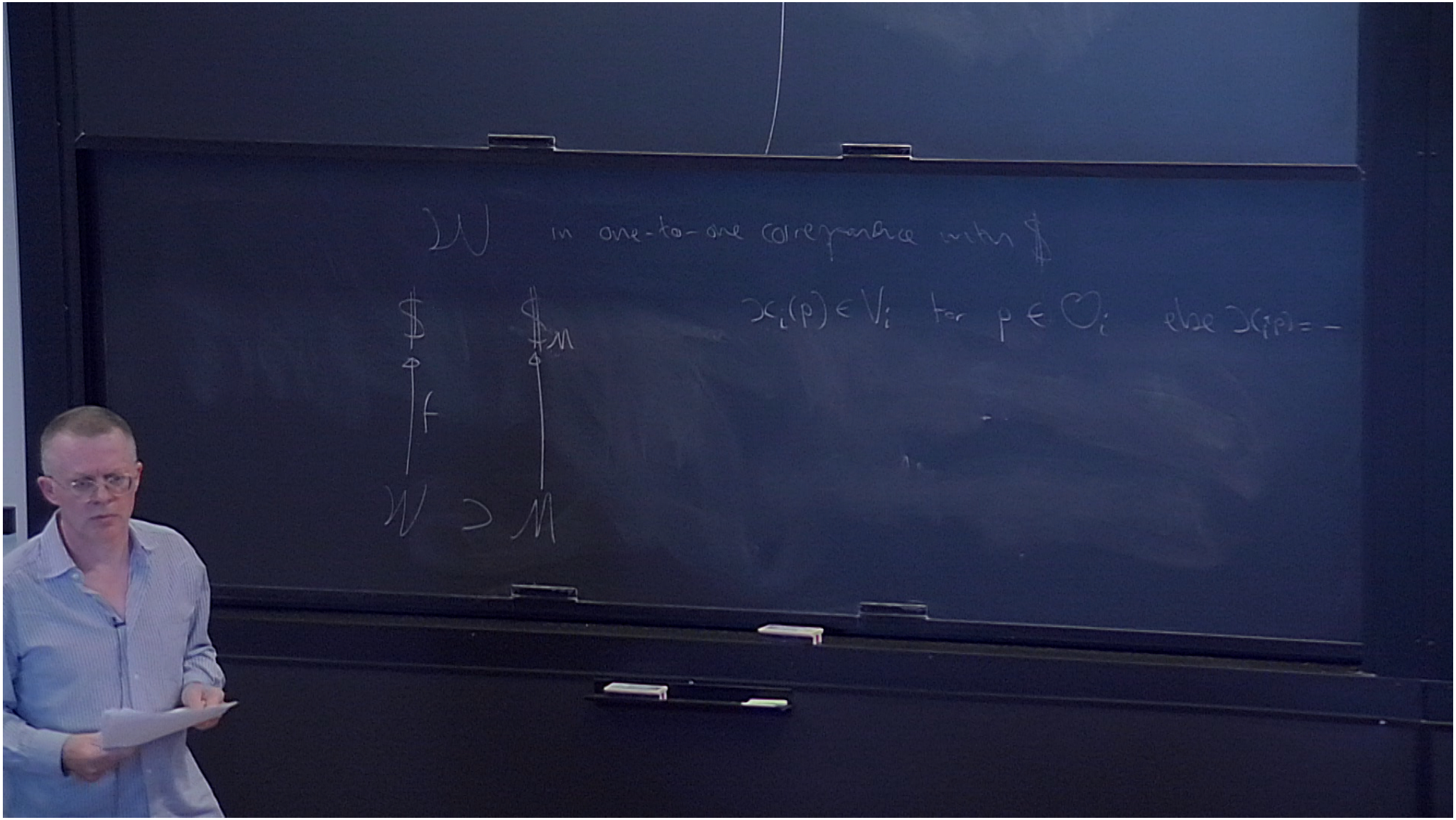


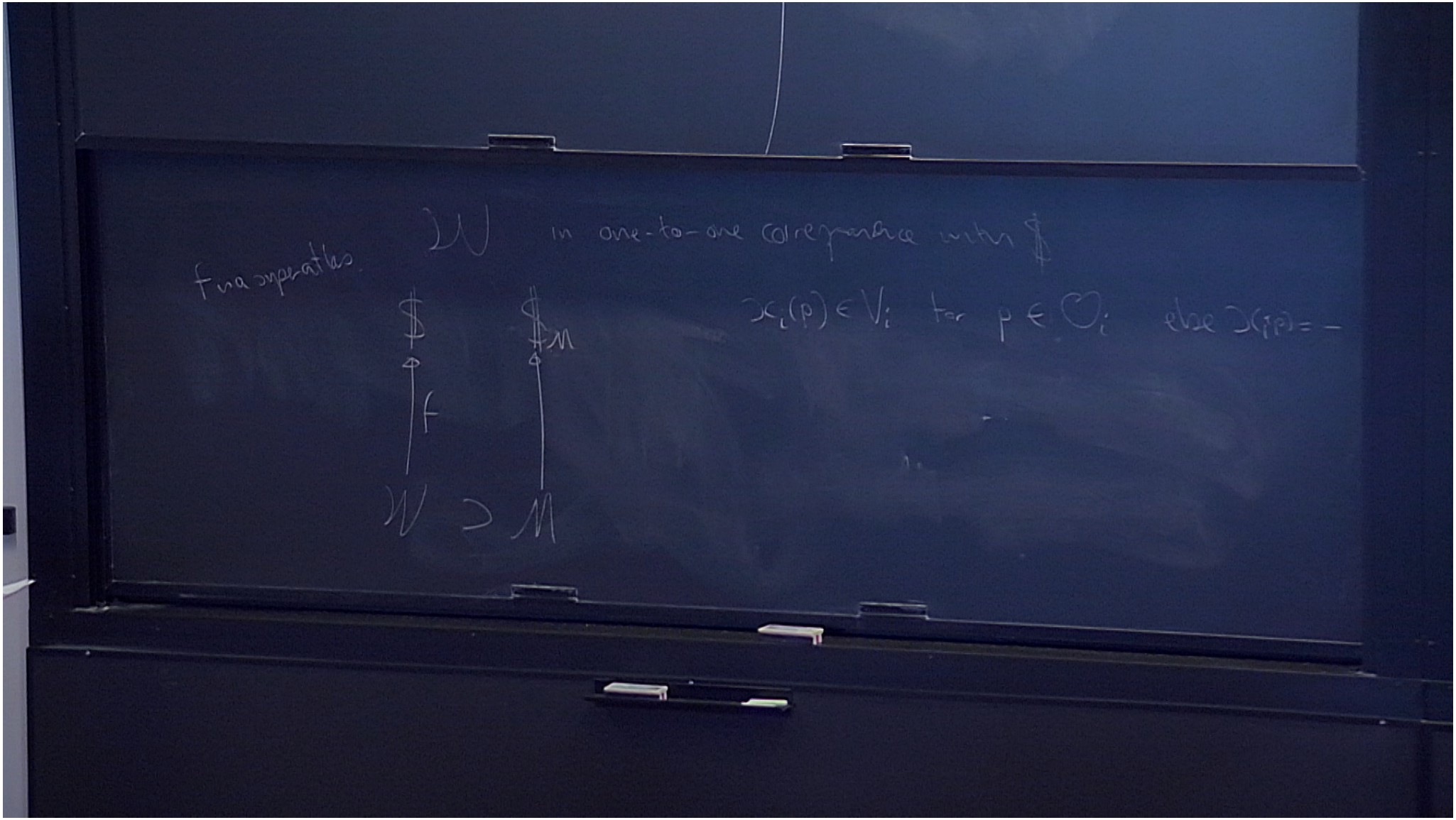
$\check{x} = (x_1, x_2, \cdots x_i, \cdots)$

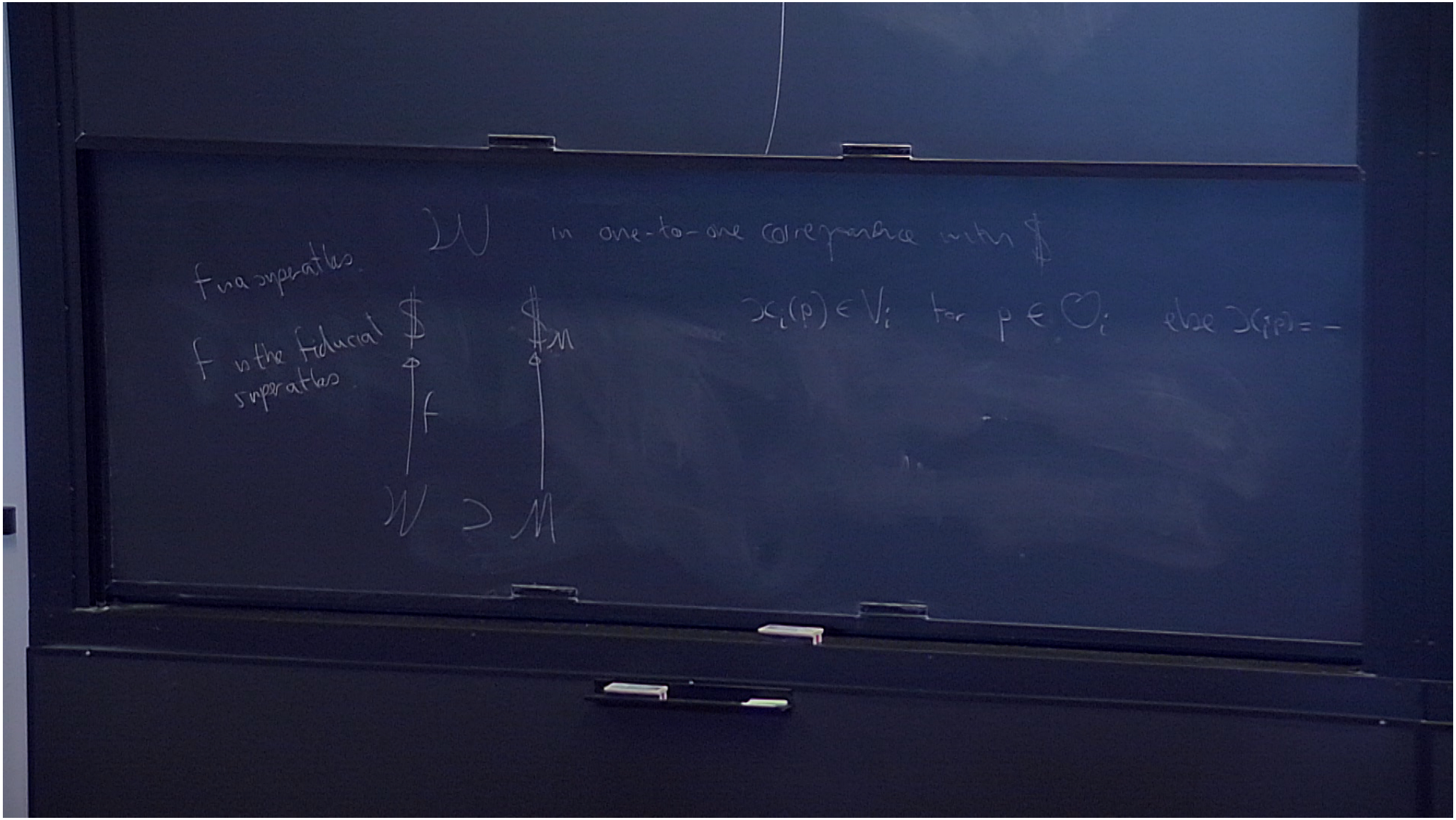
$\nexists = \{ \check{x} : \forall \check{x} \}$

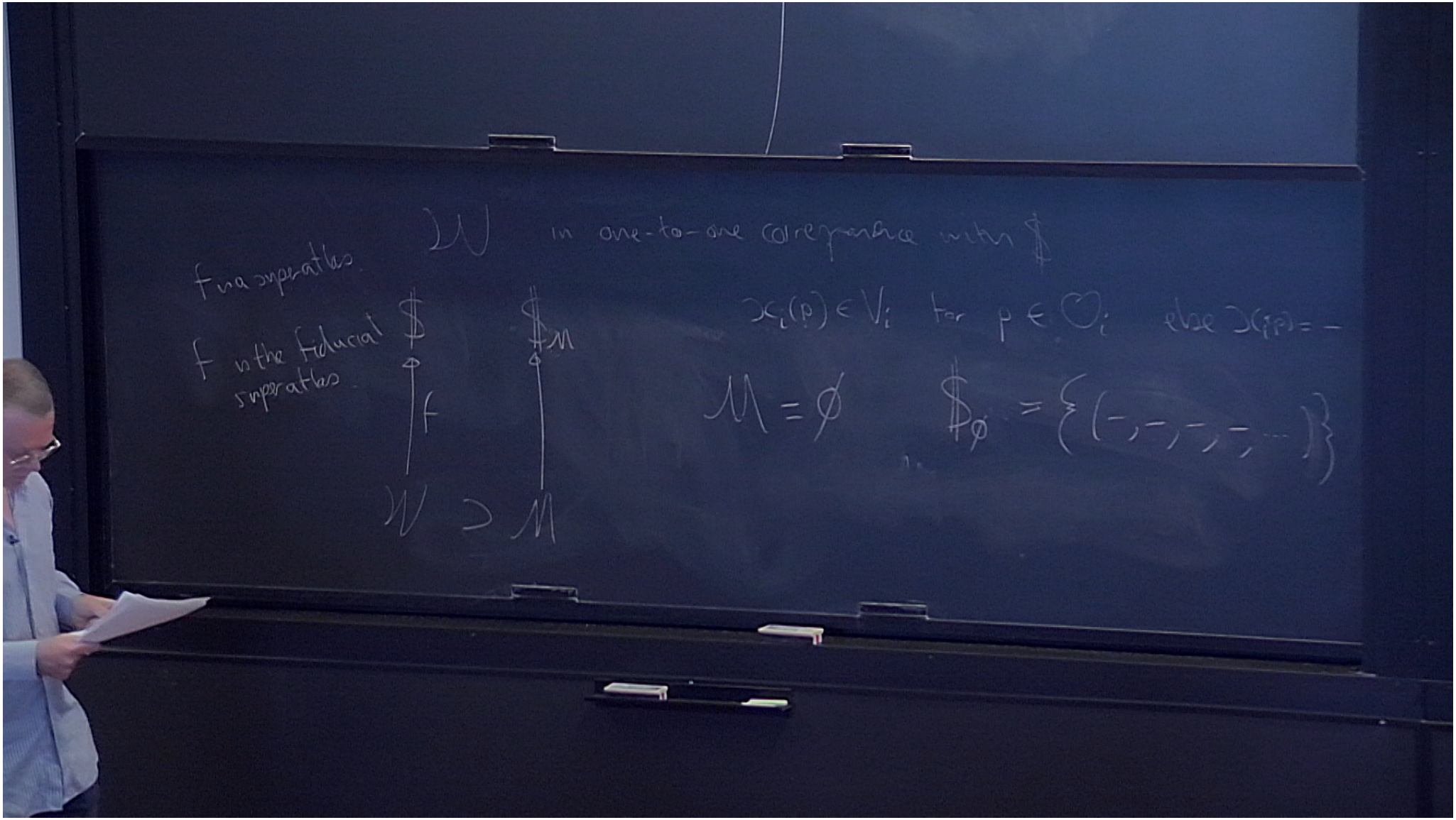

$
$
F
N ≥ M

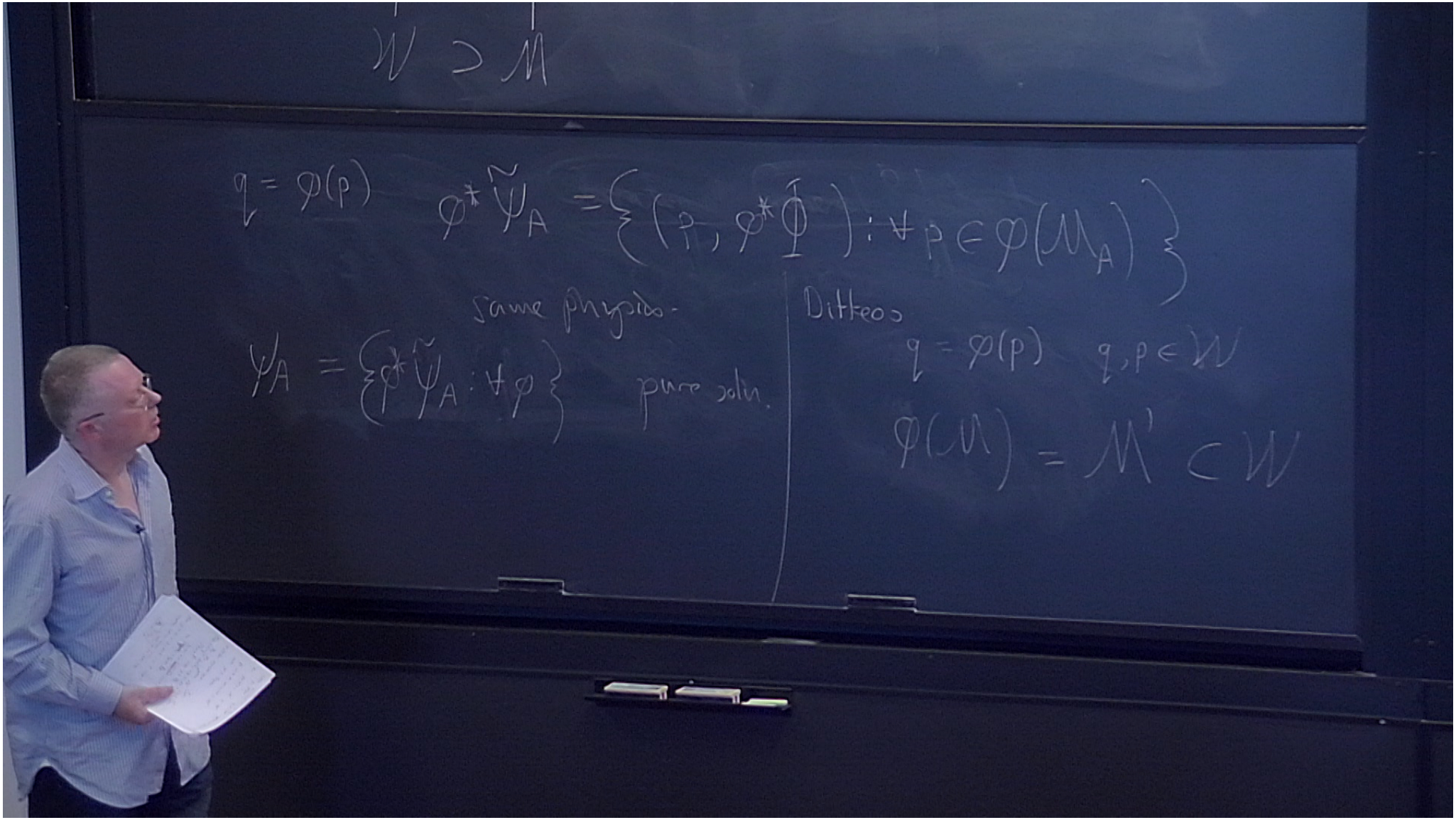

$\mathbb{N}$ in one-to-one correspondence with $\{$
$\{$
$\{1, \ldots, M\}$
f
$\mathbb{N} \geq M$

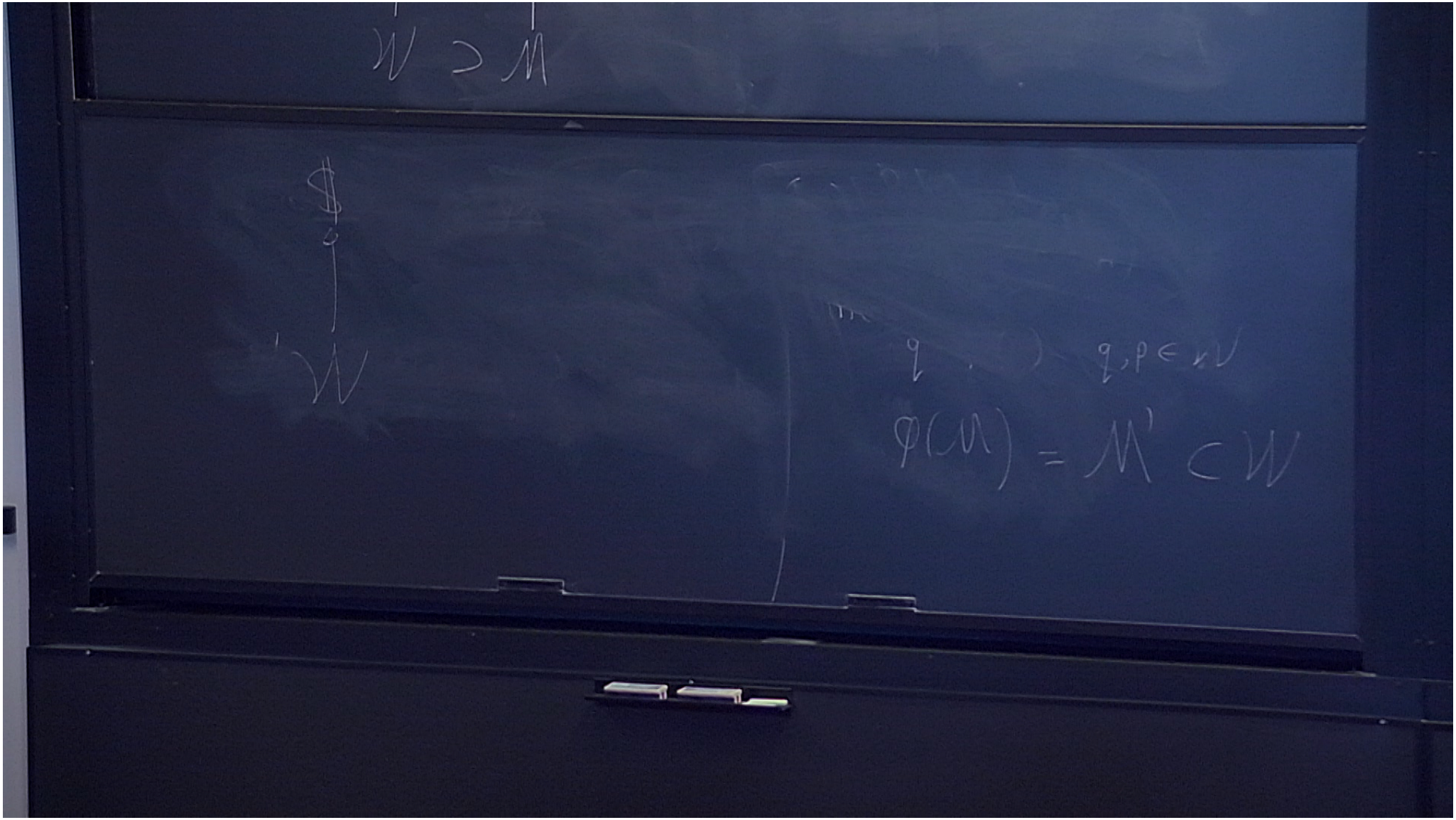

$
$
f
N ≥ M

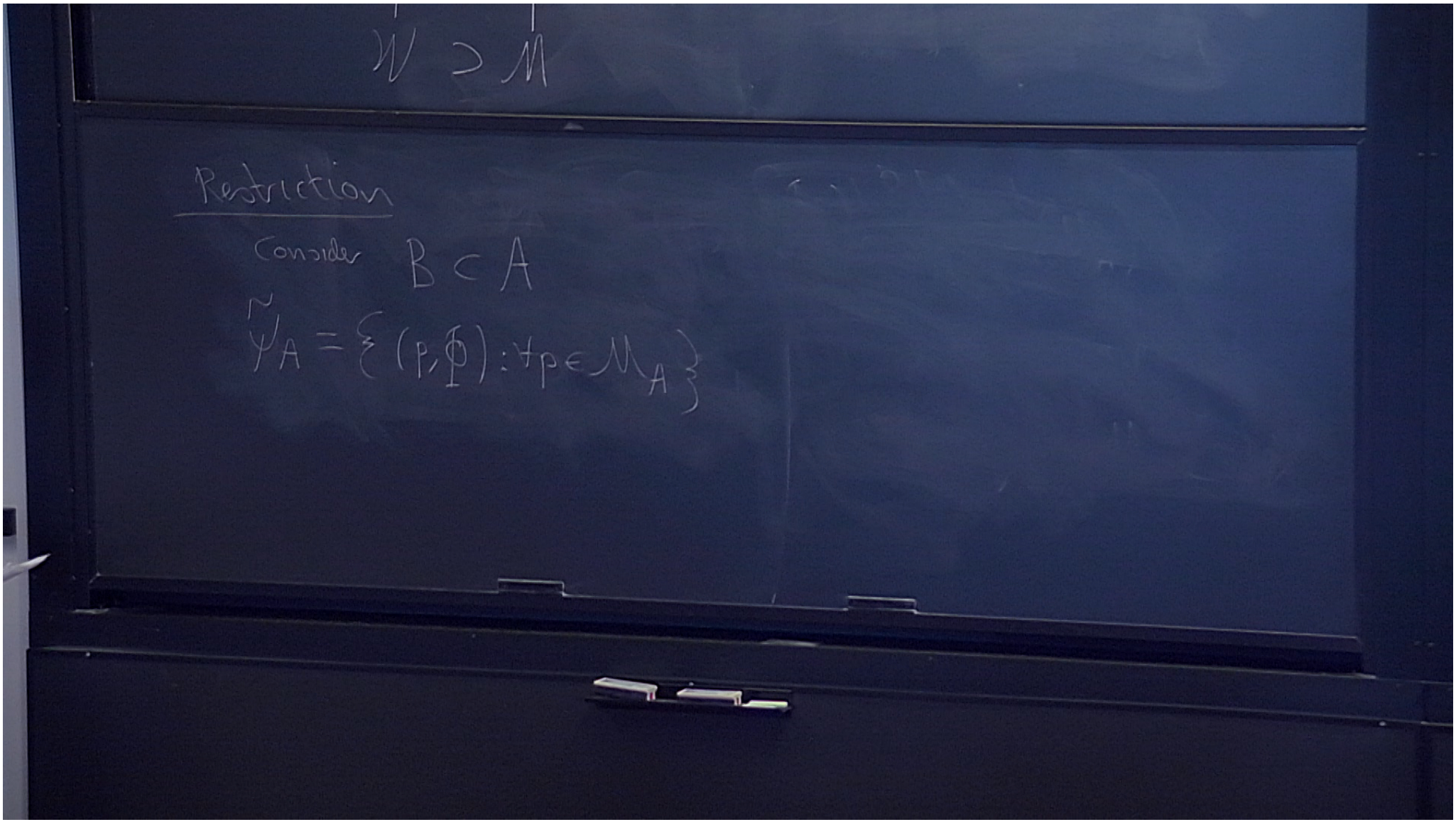

in one-to-one correspondence with
$\chi_i(p) \in V_i$ for $p \in \mathcal{O}_i$ else $\chi_i(p) = -$
$\mathcal{N} \geq M$

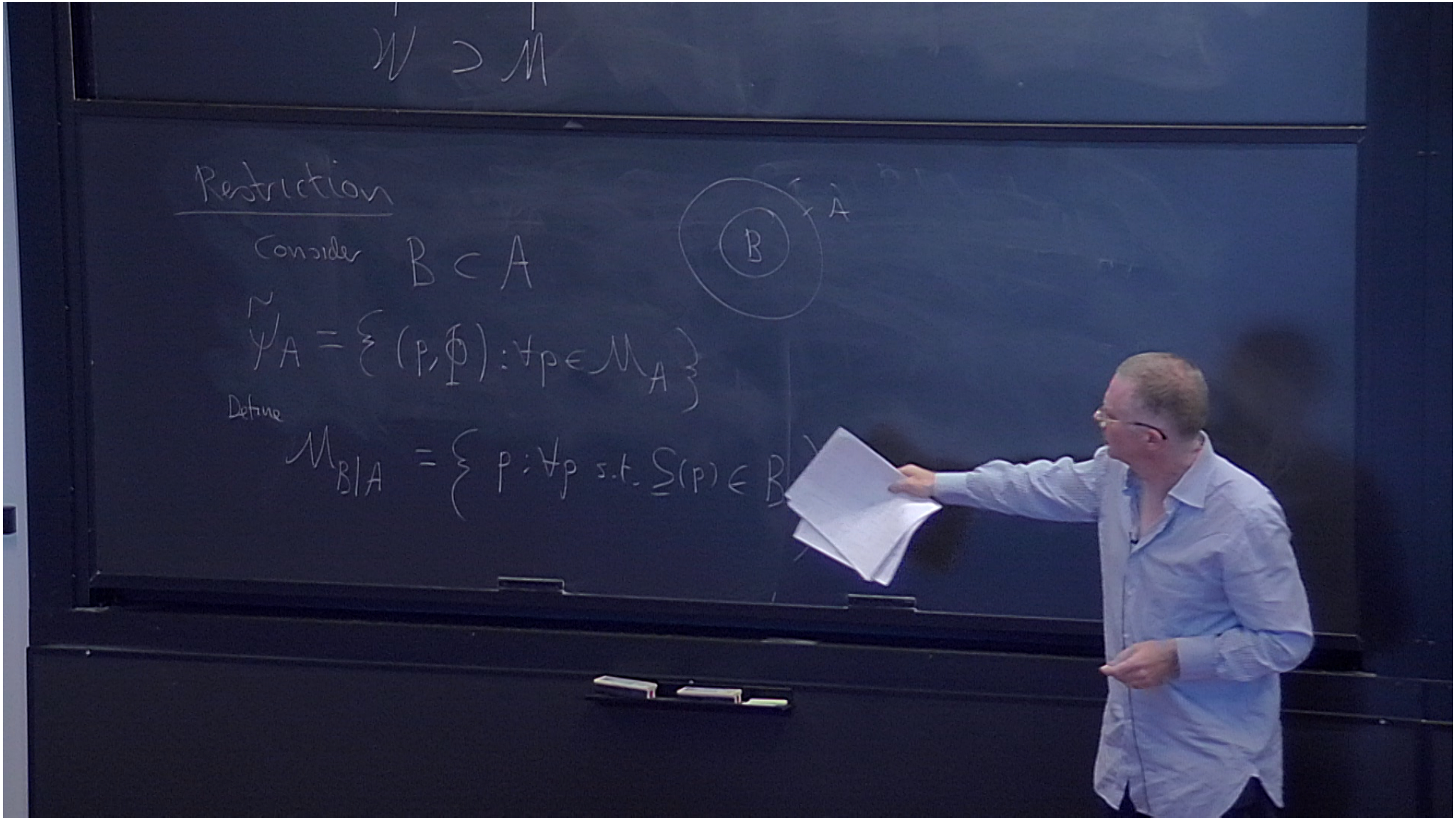

$\mathcal{U}$ in one-to-one correspondence with $\mathcal{F}$
f is a superatlas
f is the fiducial superatlas
$\mathcal{F}$
$\mathcal{F}_M$
f
$\mathcal{U} \supset M$
$x_i(p) \in V_i$ for $p \in \mathcal{O}_i$ else $x_i(p) = -$

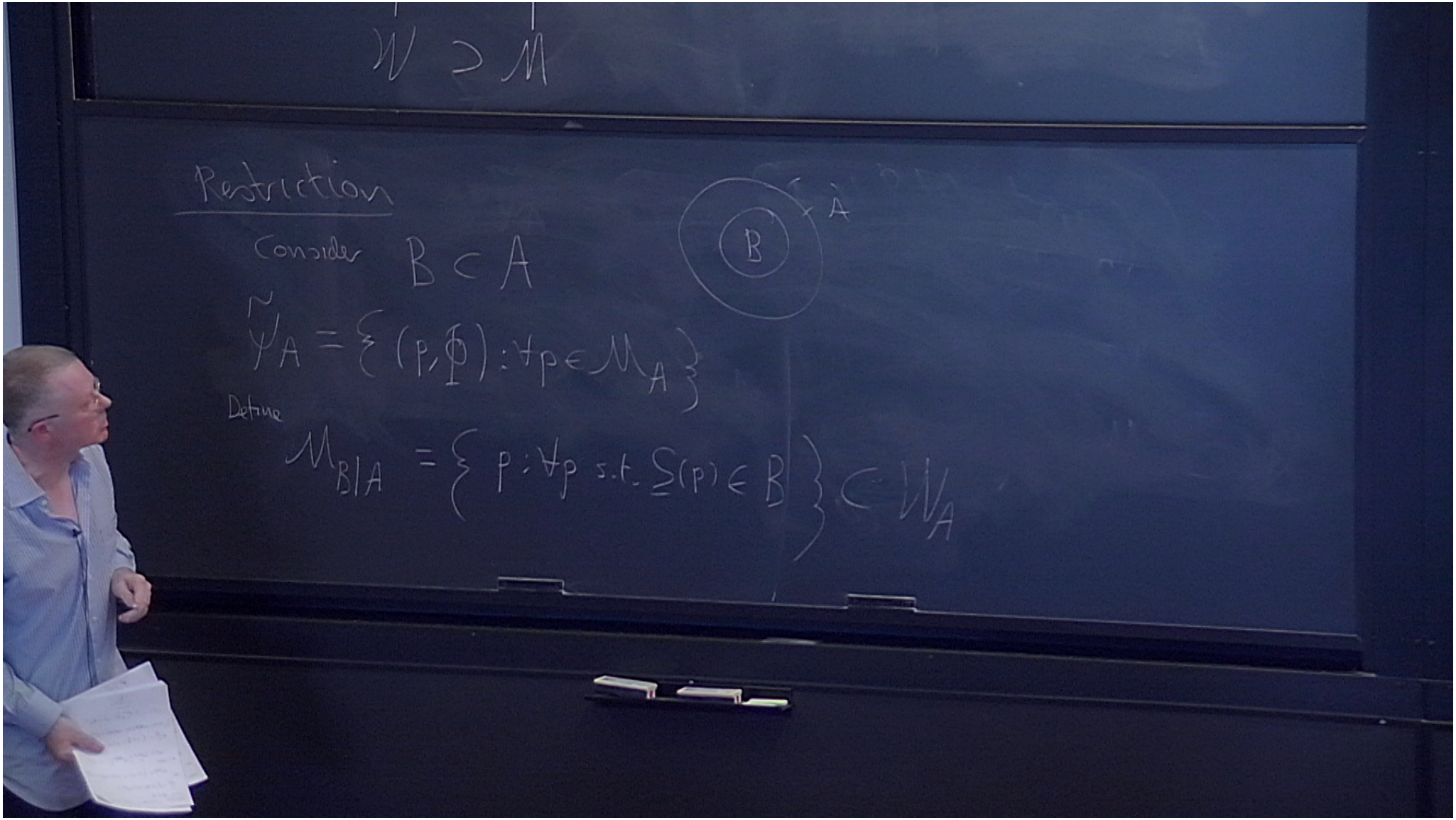

f is a superatlas
$\mathcal{U}$ in one-to-one correspondence with $
f is the fiducial superatlas
$
$_M
f
$\mathcal{U}$ ⊃ $\mathcal{M}$
$\chi_i(p) \in V_i$ for $p \in \mathcal{O}_i$ else $\chi_i(p) = -$
$\mathcal{M} = \emptyset$
$_\emptyset = {(-,-,-,-,\dots)}$

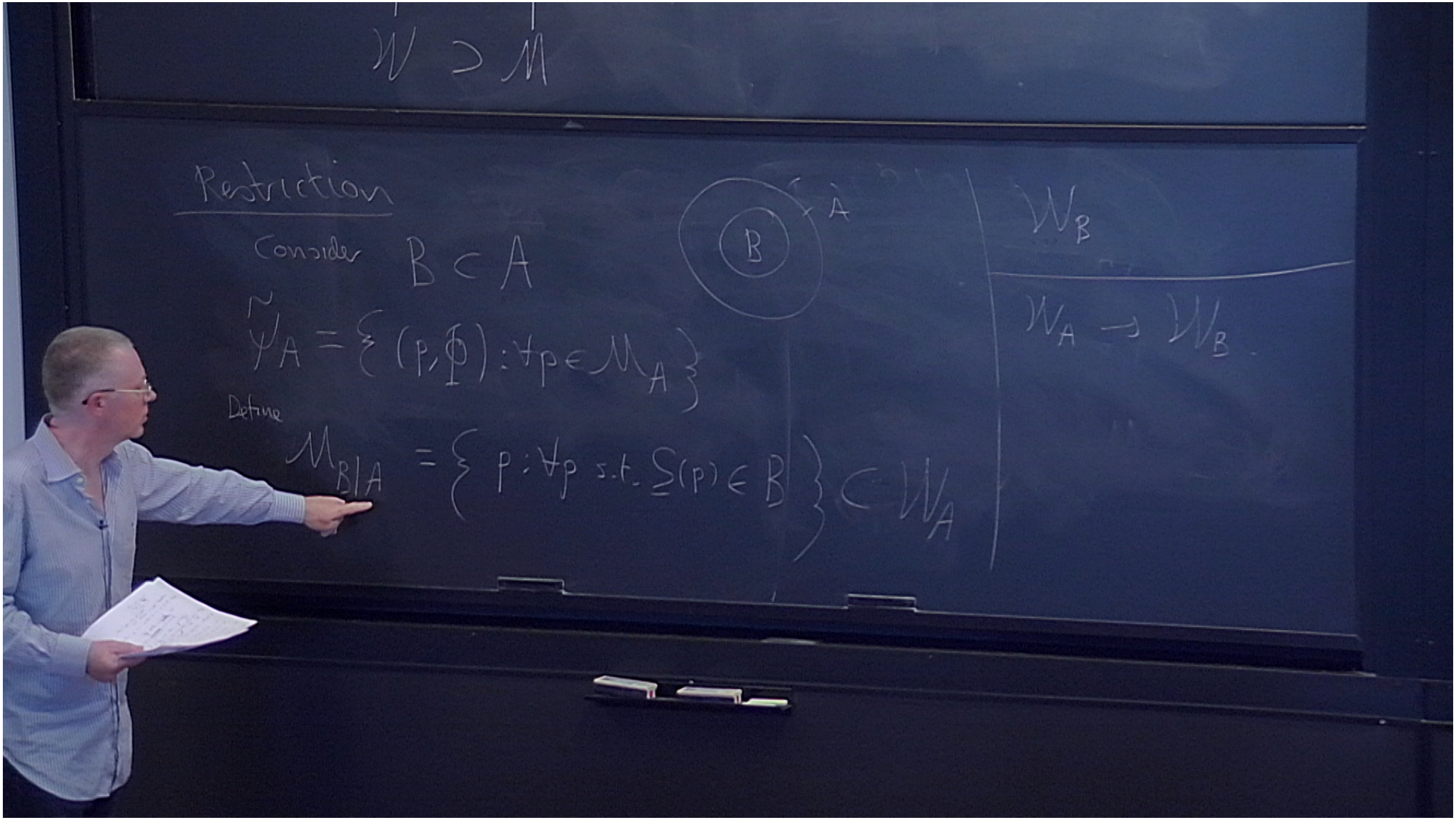

$\mathcal{N} \supset \mathcal{M}$
$q = \varphi(p)$
$\varphi^* \tilde{\psi}_A = \{(?, \varphi^* \tilde{\phi}) : \forall p \in \varphi(\mathcal{M}_A)\}$
same physics.
$\psi_A = \{\varphi^* \tilde{\psi}_A : \forall \varphi\}$
pure solin.
Diffeos
$q = \varphi(p)$ $q, p \in \mathcal{N}$
$\varphi(\mathcal{M}) = \mathcal{M}' \subset \mathcal{N}$

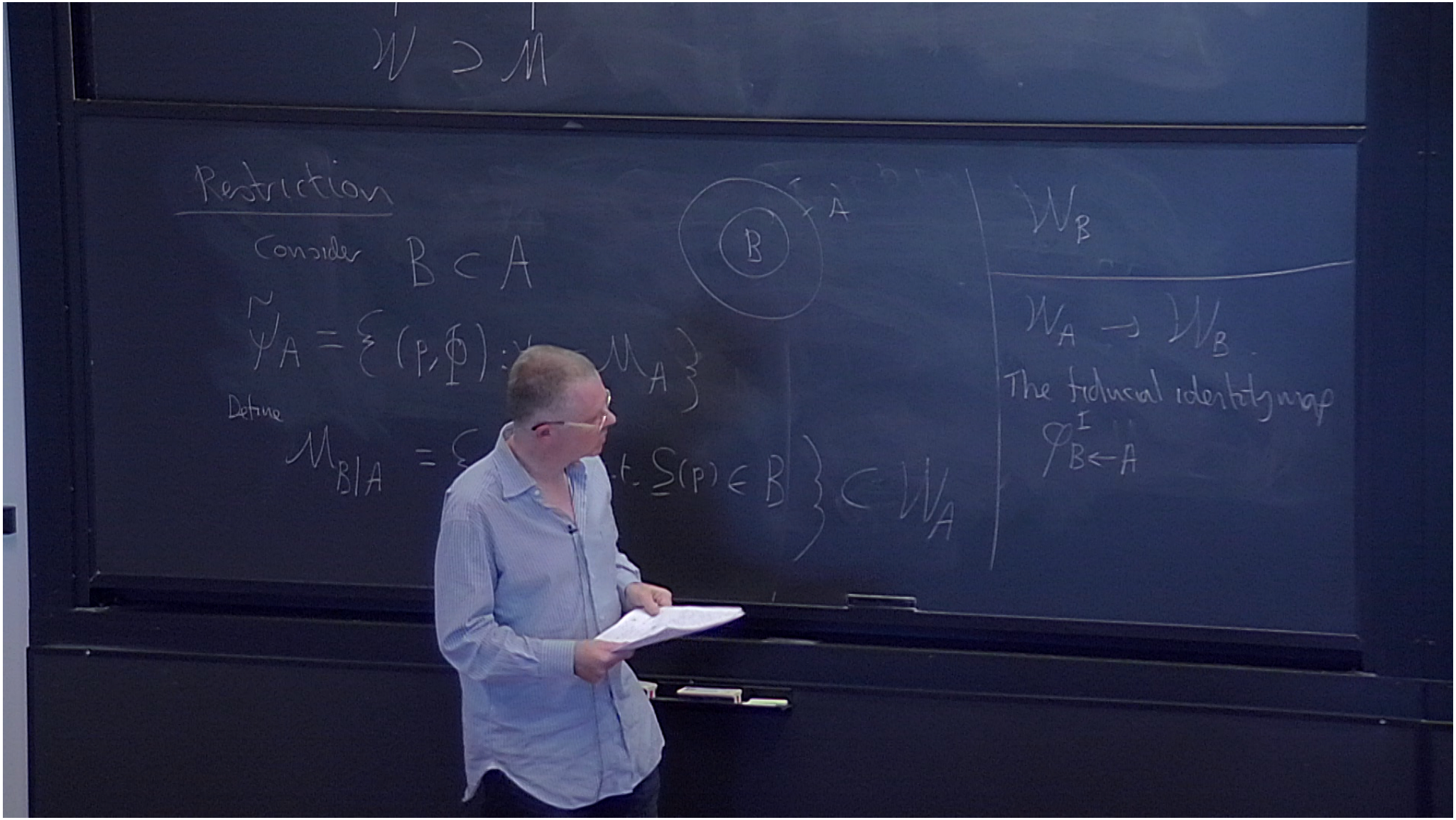

$W \supset M$
φ
W
$q, p \in \mathbb{N}$
$\varphi(M) = M' \subset W$

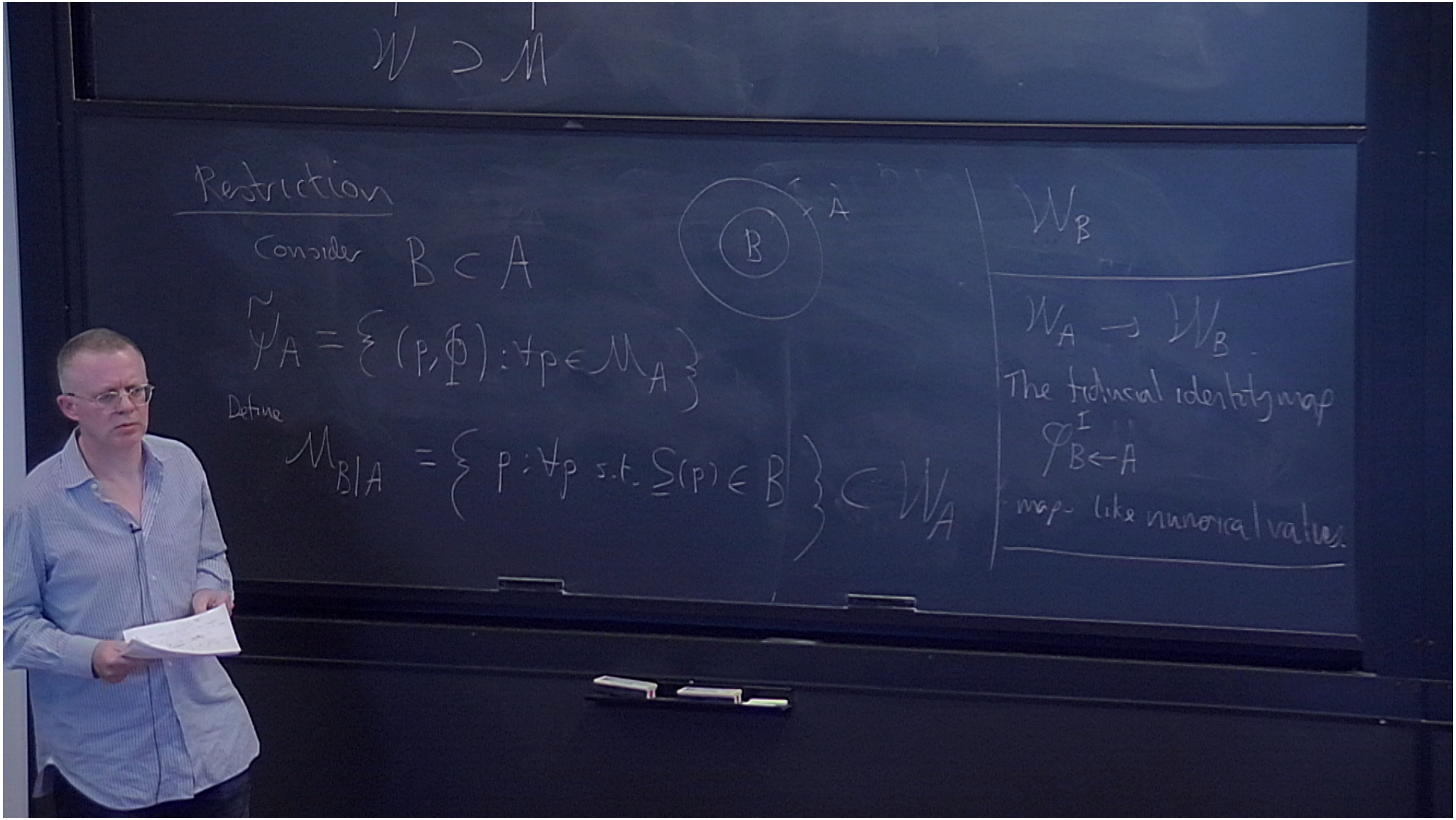

$\mathcal{N} \supset \mathcal{M}$
Restriction
Consider $B \subset A$
$\tilde{\psi}_A = \{(p, \phi) : \forall p \in \mathcal{M}_A\}$

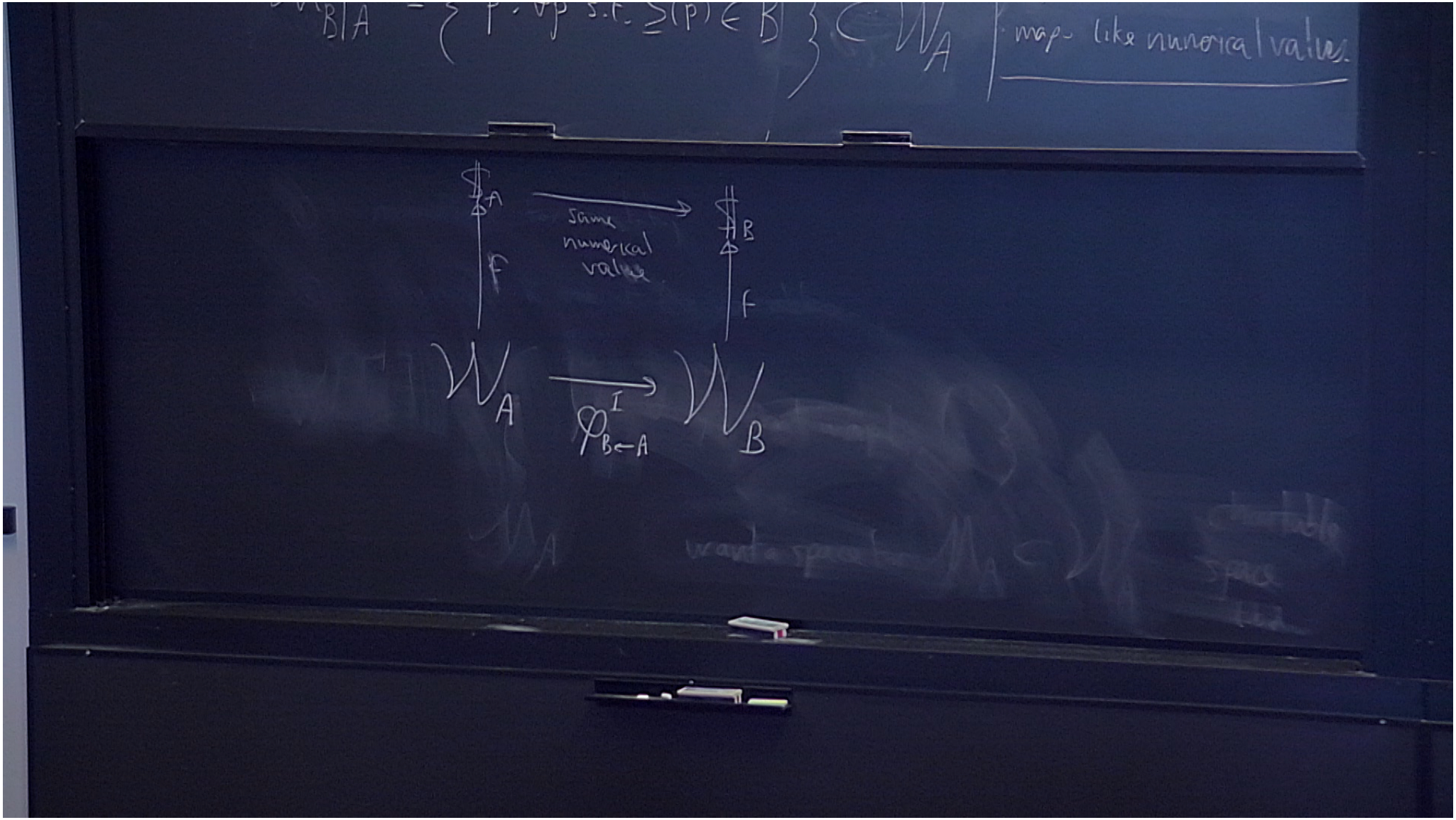

Restriction
Consider $B \subset A$
$\tilde{\psi}_A = \{(p, \Phi) : \forall p \in \mathcal{M}_A\}$
Define
$\mathcal{M}_{B|A} = \{p : \forall p \text{ s.t. } \Sigma(p) \in B$
B
A

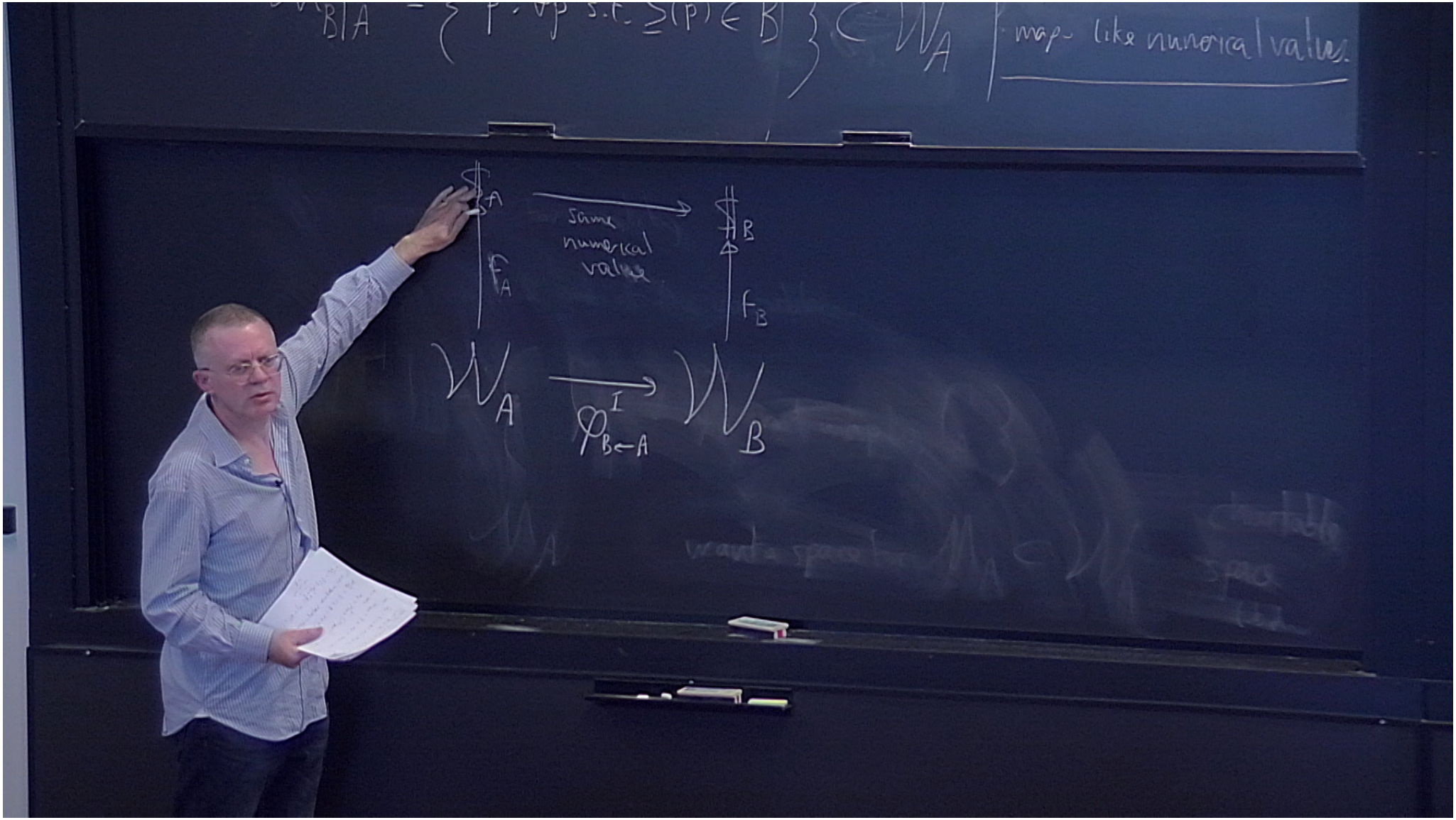

$\mathcal{W} \supset \mathcal{M}$
Restriction
Consider $B \subset A$
$\tilde{\mathcal{W}}_A = \{(p, \Phi) : \forall p \in \mathcal{M}_A\}$
Define
$\mathcal{M}_{B|A} = \{p : \forall p \text{ s.t. } \Sigma(p) \in B\} \subset \mathcal{W}_A$
A
B

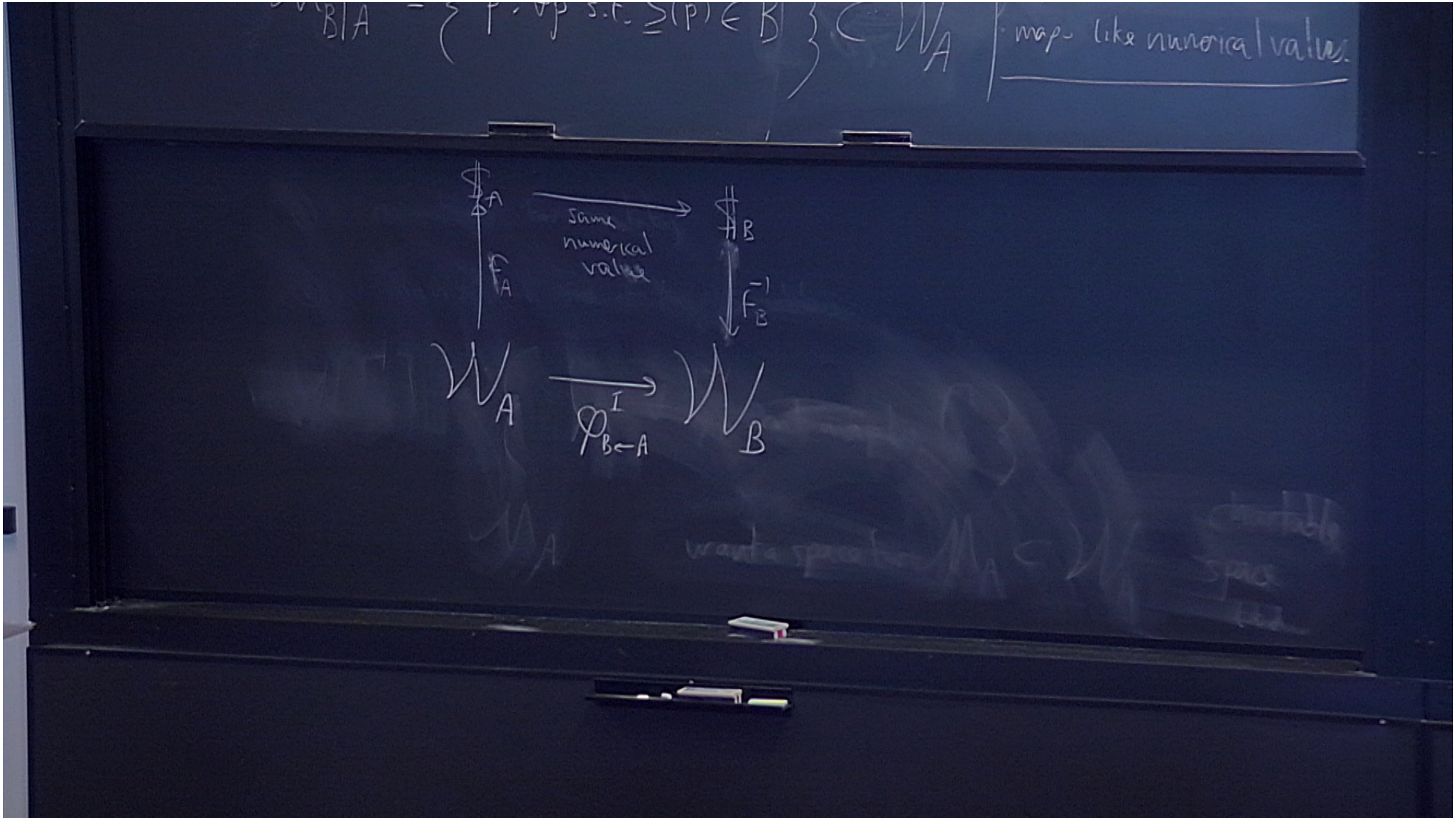

Restriction
Consider $B \subset A$
$\tilde{\mathcal{W}}_A = \{(p, \Phi) : \forall p \in \mathcal{M}_A\}$
Define
$\mathcal{M}_{B|A} = \{p : \forall p \text{ s.t. } \Sigma(p) \in B\} \subset \mathcal{M}_A$
A
B
$\mathcal{W}_B$
$\mathcal{W}_A \to \mathcal{W}_B$

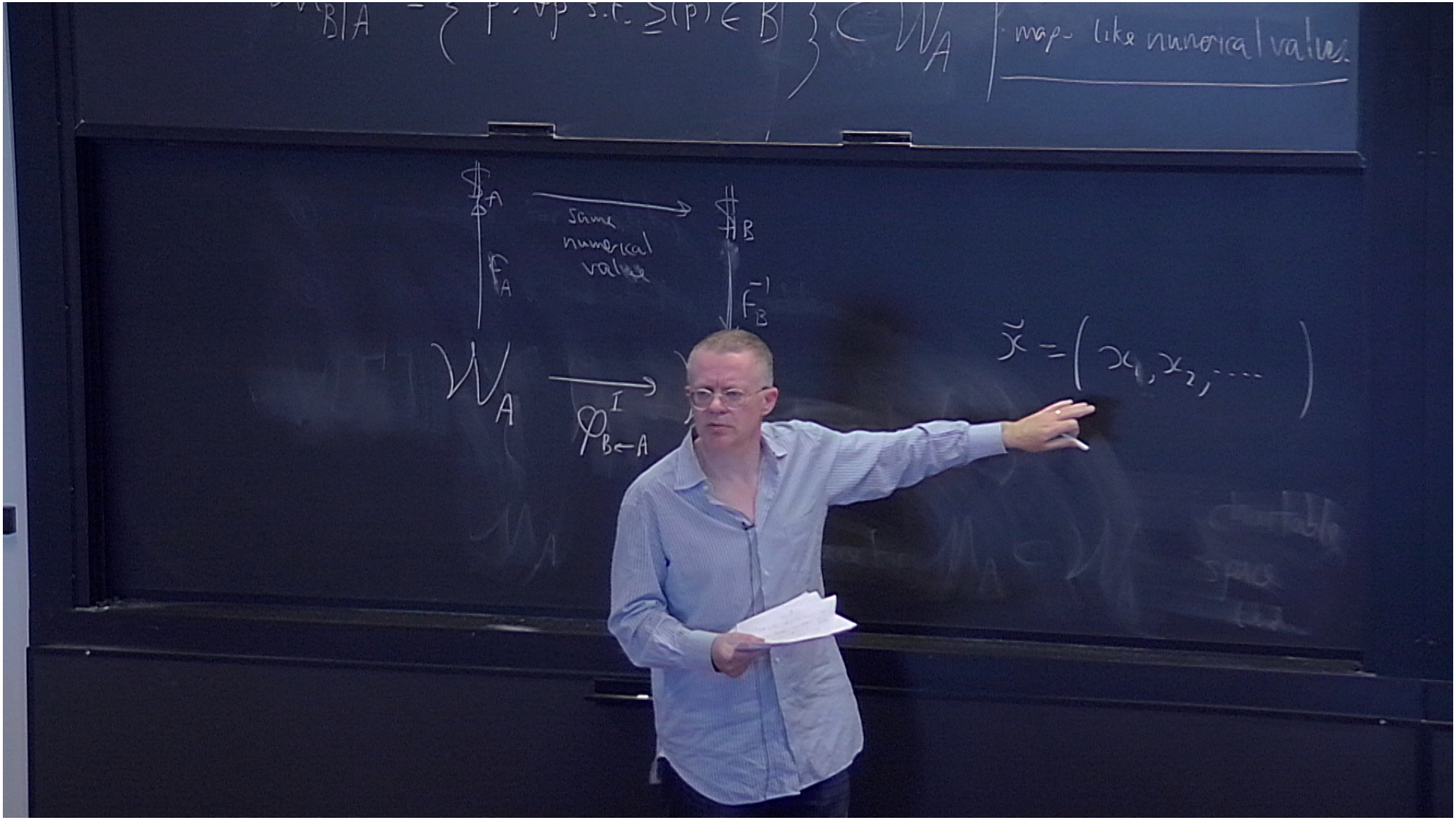

Restriction
Consider $B \subset A$
$\tilde{\psi}_A = \{(p, \phi) : \mathcal{M} \to \mathcal{M}_A\}$
Define
$\mathcal{M}_{B|A} = \{ \text{s.t. } \Sigma(p) \in B \} \subset \mathcal{M}_A$
A
B
$\mathcal{M}_B$
$\mathcal{M}_A \to \mathcal{M}_B$
The fiducial identity map
$\mathcal{I}_{B \leftarrow A}$


Restriction
Consider $B \subset A$
$\tilde{\psi}_A = \{(p, \phi) : \forall p \in \mathcal{M}_A\}$
Define
$\mathcal{M}_{B|A} = \{p : \forall p \text{ s.t. } \Sigma(p) \in B\} \subset \mathcal{W}_A$
A
B
$\mathcal{W}_B$
$\mathcal{W}_A \to \mathcal{W}_B$
The tridirectional identity map
$\mathcal{I}_{B \leftarrow A}$
map-like numerical values.


map-like numerical values
same numerical value
F
F


map-like numerical values
same numerical value
F_A
F_B
W_A
W_B
$\varphi^I_{B\leftarrow A}$


map-like numerical values
same numerical value
F_A
F_B^{-1}
$\mathcal{W}_A$
$\varphi^I_{B\leftarrow A}$
$\mathcal{W}_B$


map-like numerical values
same numerical value
$\mathcal{W}_A$
$\mathcal{W}_B$
F_A
F_B^{-1}
$\varphi^I_{B\leftarrow A}$
$\tilde{x} = (x_1, x_2, \cdots)$