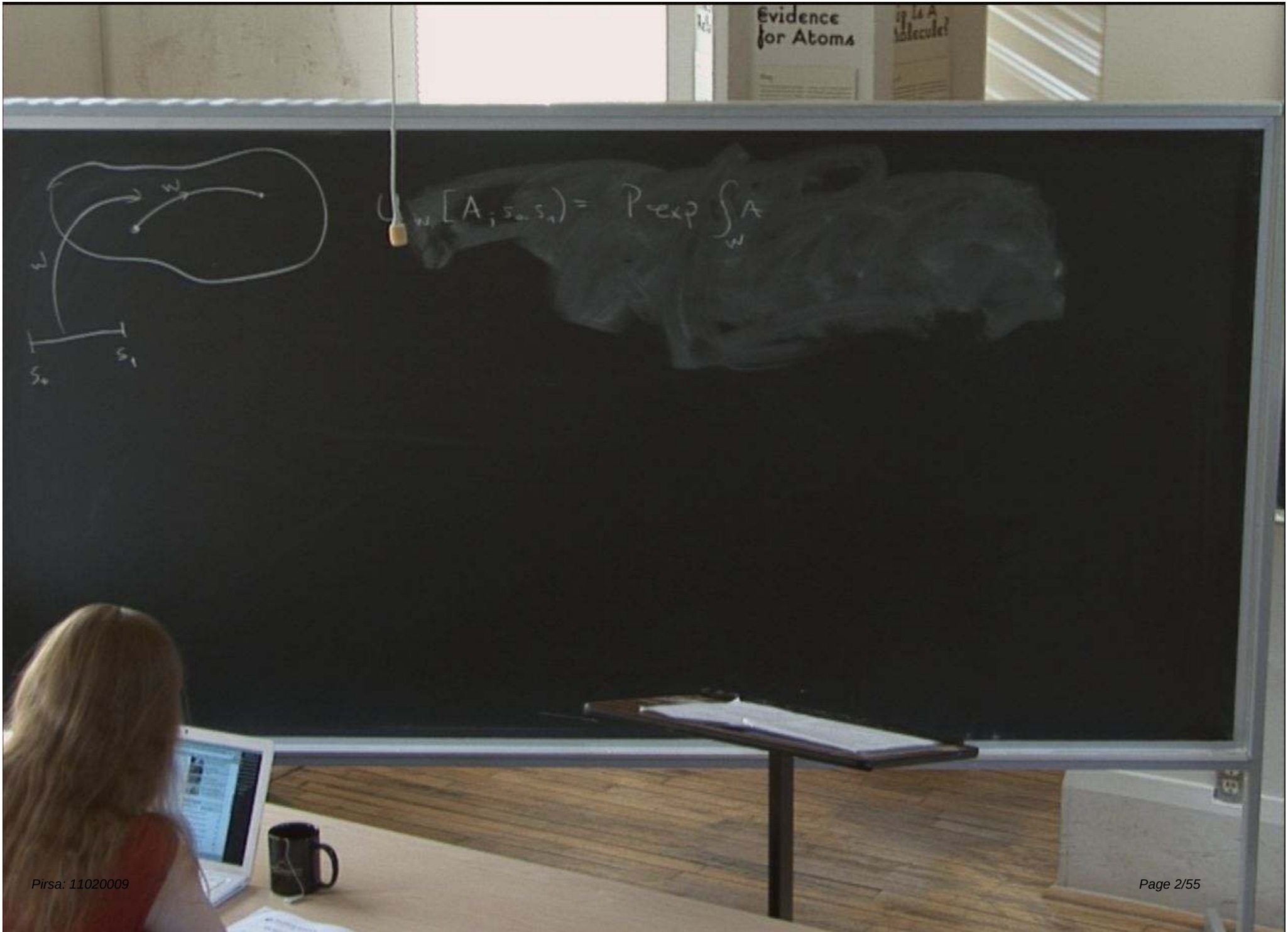
Title: Quantum Gravity Review - Lecture 12

Date: Feb 08, 2011 10:15 AM

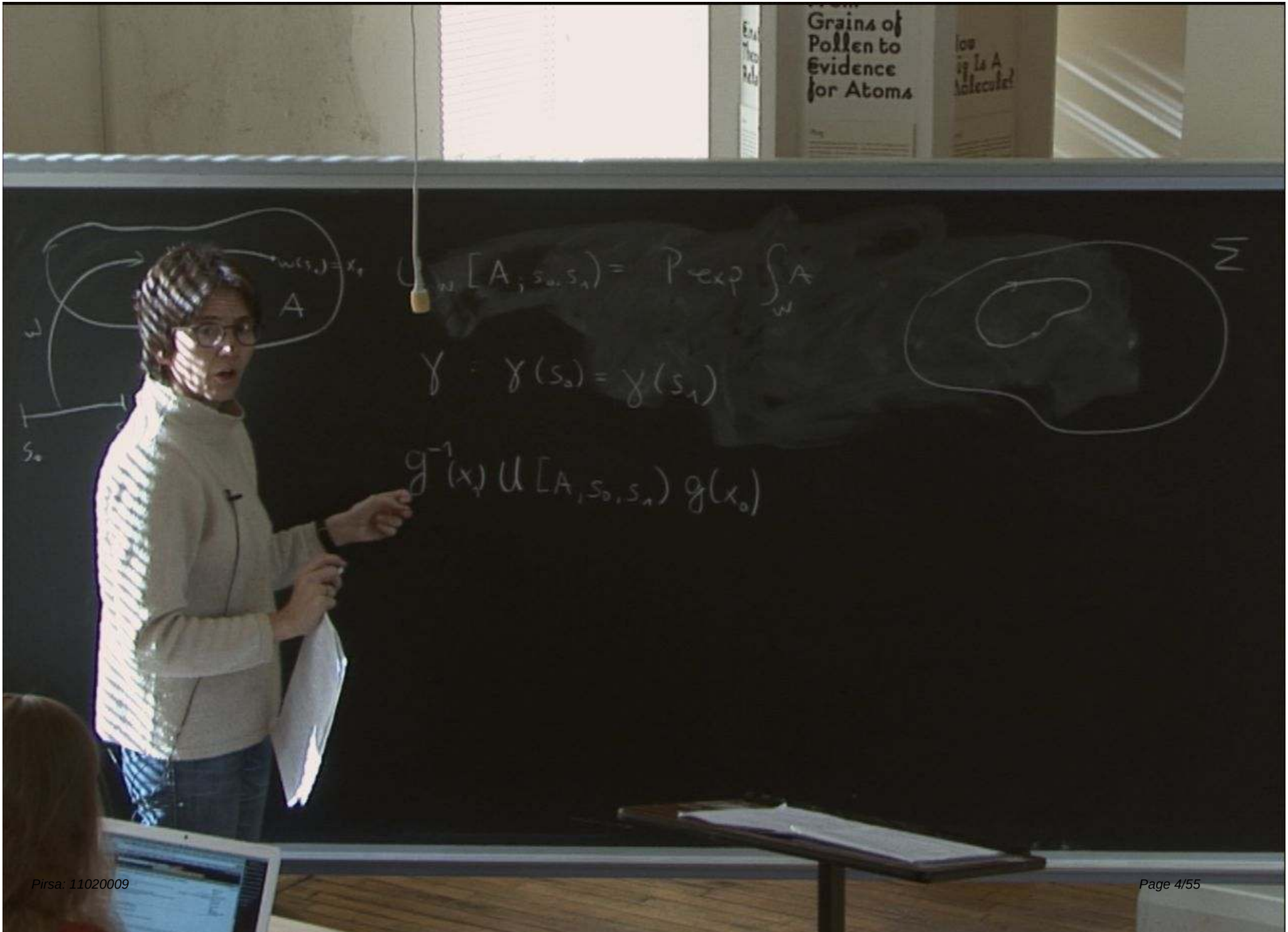
URL: http://pirsa.org/11020009

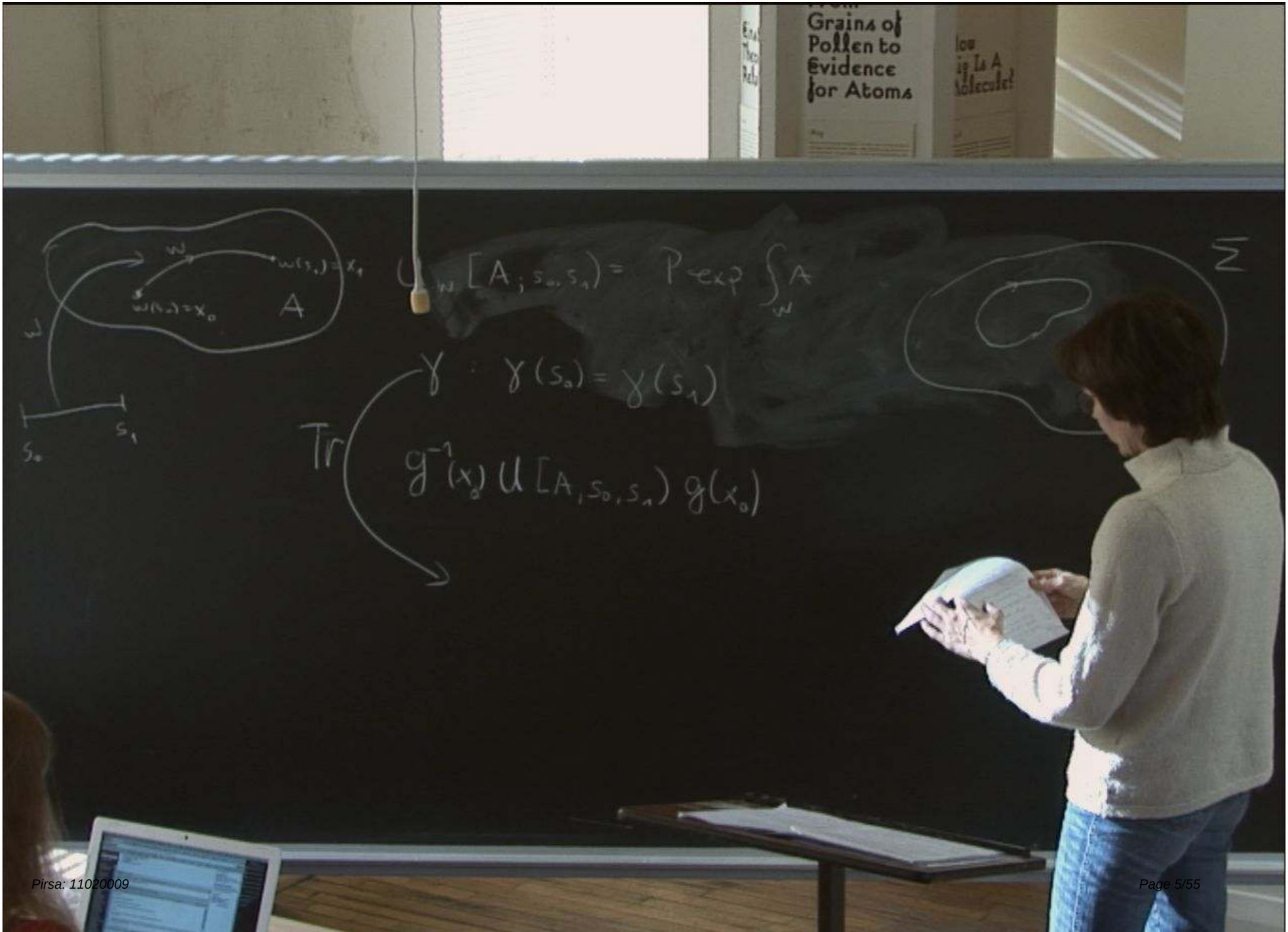
Abstract:

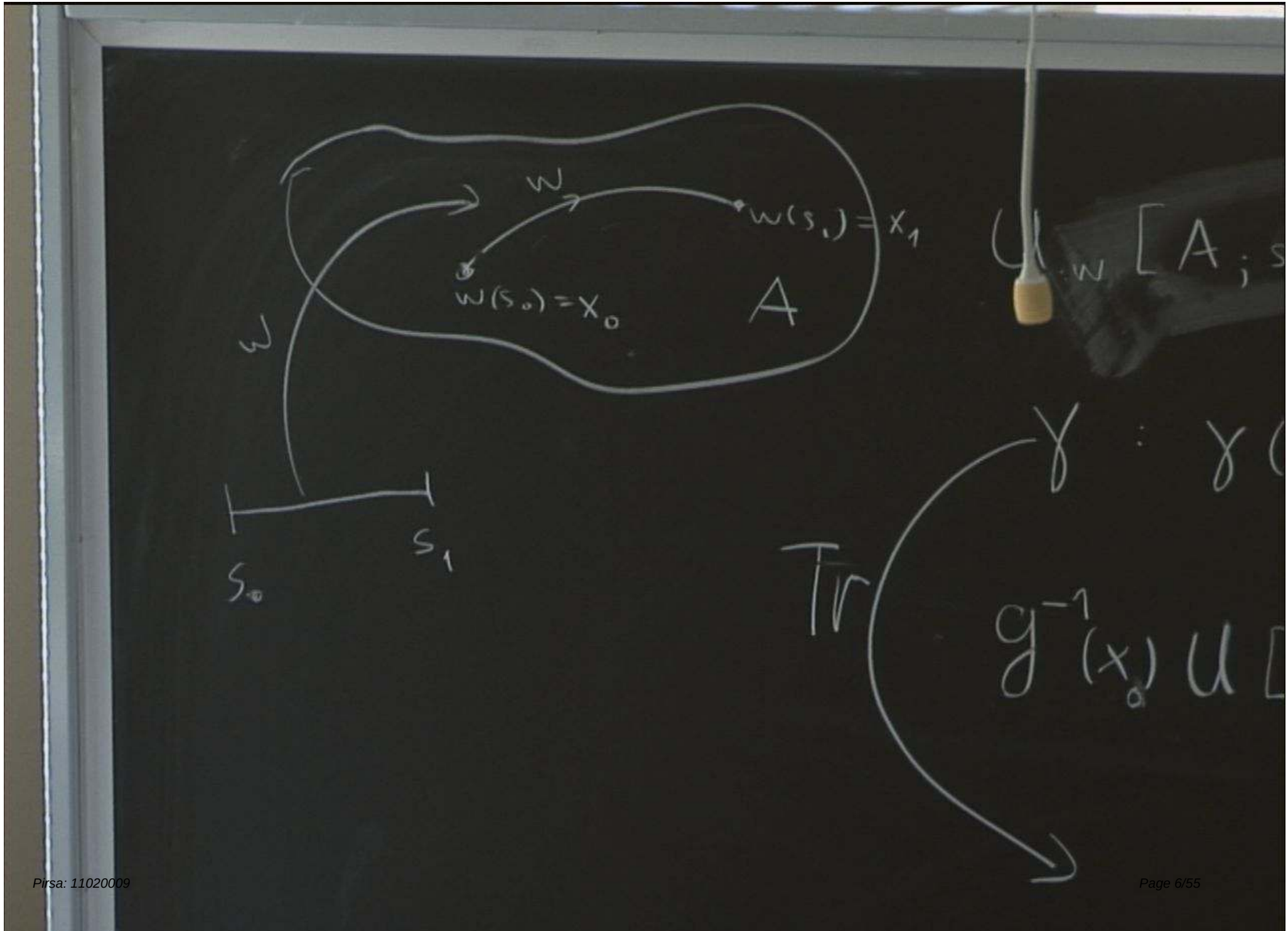

Evidence
for Atoms
w
w
s_0
s_1
$U_w[A; s_0, s_1) = P \exp \int_w A$

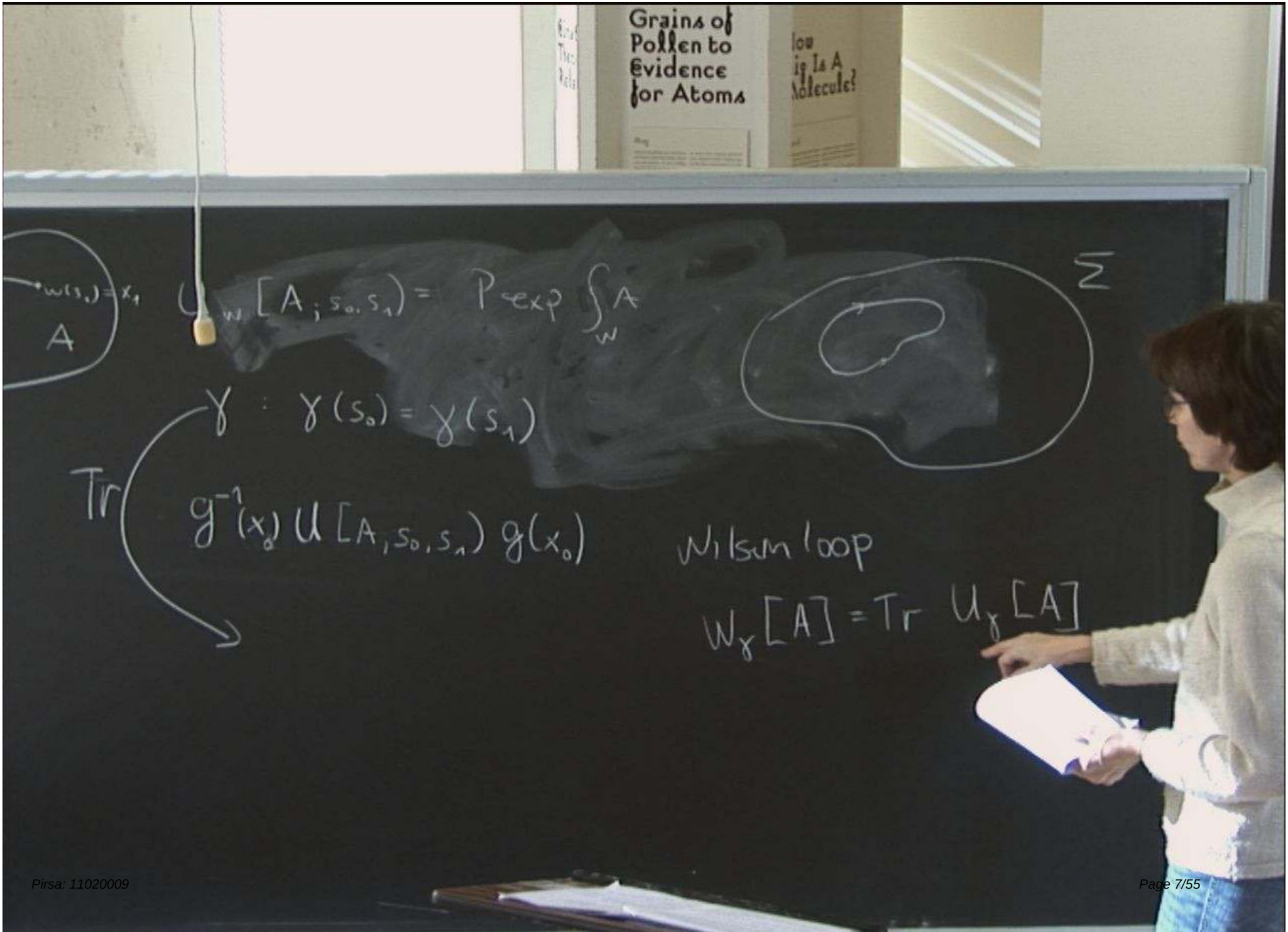
YM. variables $(A_i^a(\vec{x}), E_b^j(\vec{x}))$

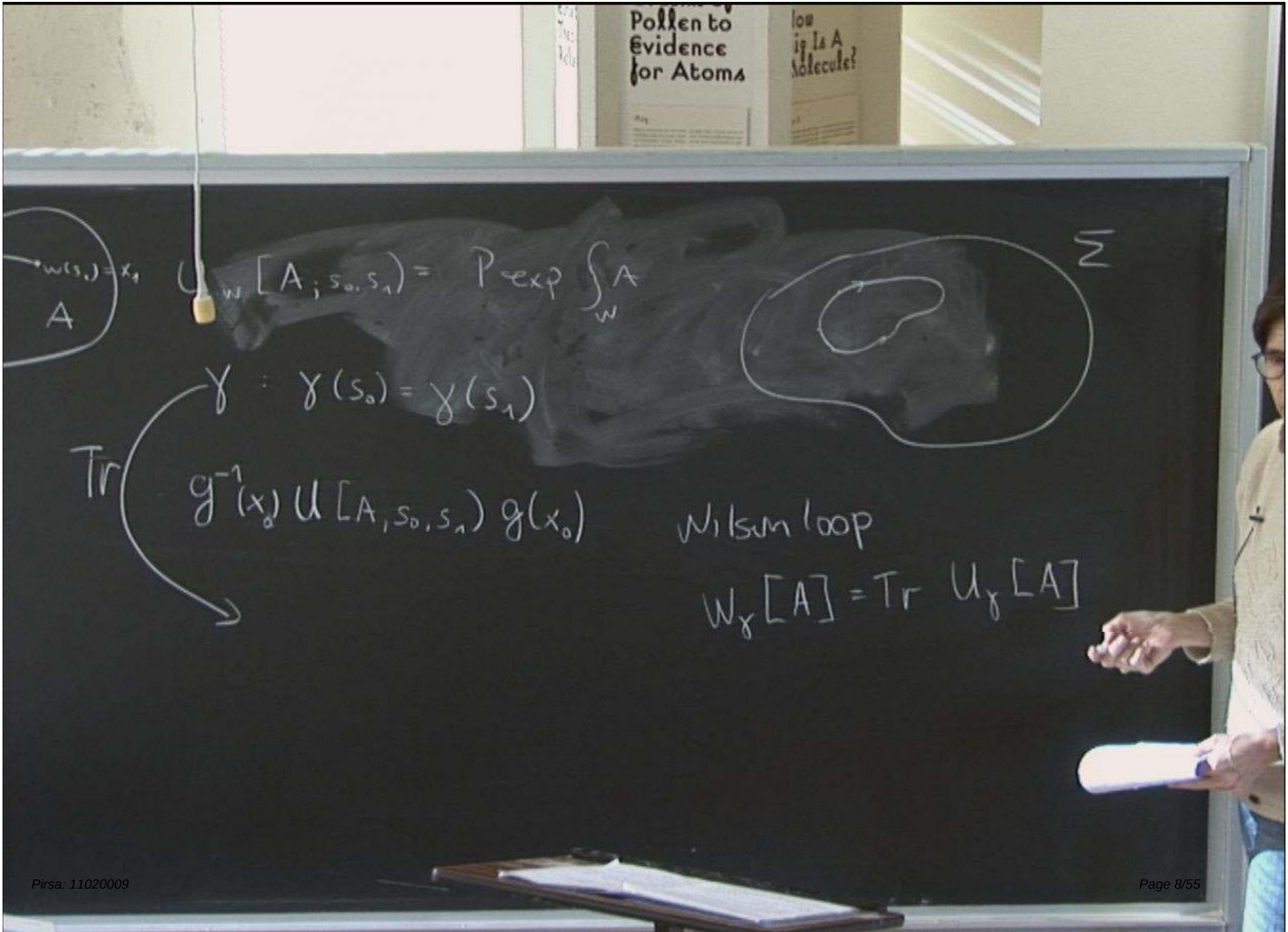
$A_i^a(x)\, X_a$

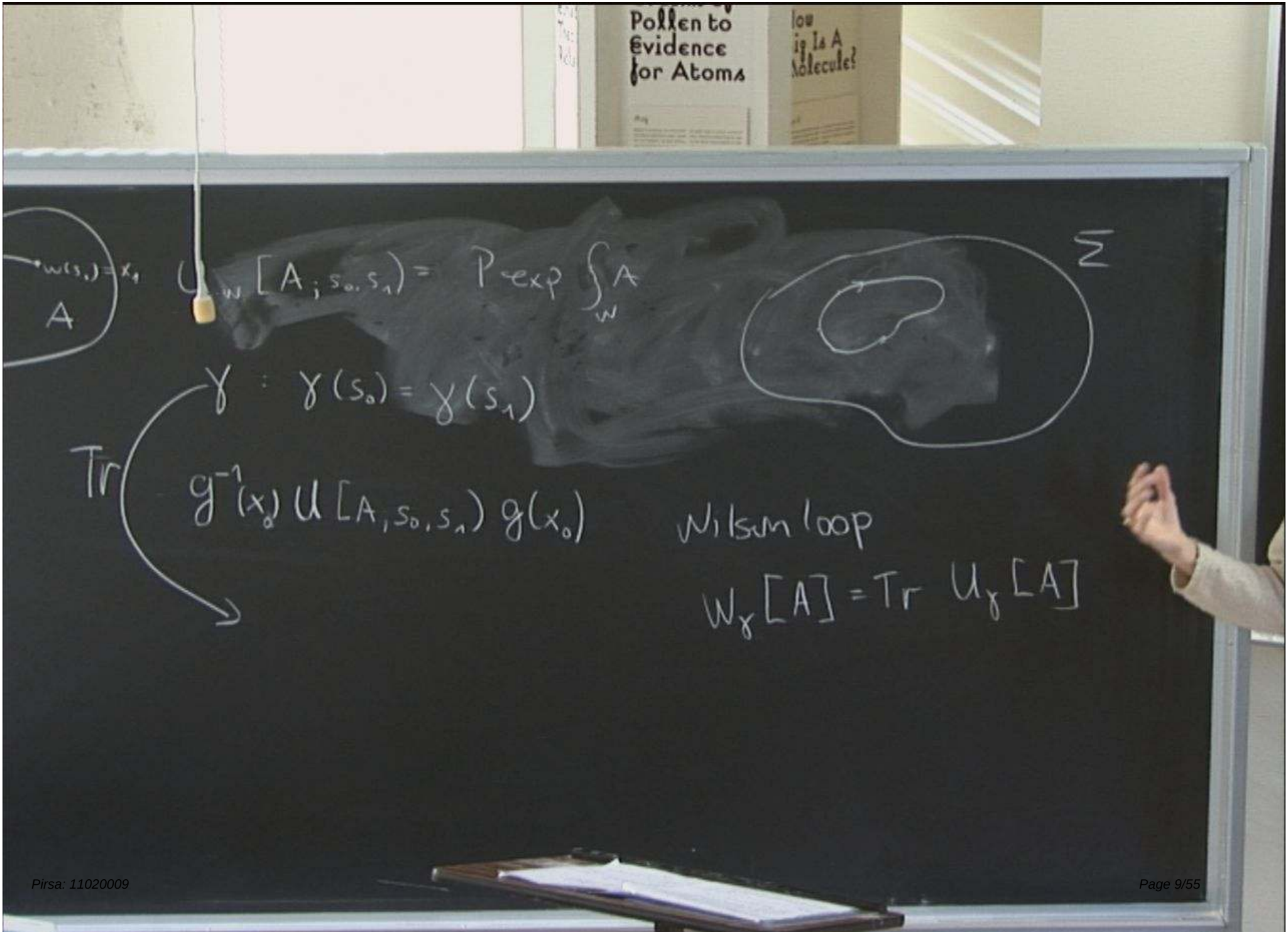

Grains of
Pollen to
Evidence
for Atoms
A
$U_w[A; s_0, s_1) = P\exp\int_w A$
$\gamma : \gamma(s_0) = \gamma(s_1)$
$g^{-1}(x_1)\, U[A, s_0, s_1)\, g(x_0)$


Grains of Pollen to Evidence for Atoms
How is A Molecule?
$U_w[A; s_0, s_1) = P\text{-}exp \int_w A$
$\gamma : \gamma(s_0) = \gamma(s_1)$
$Tr\left(g^{-1}(x_1)\, U[A, s_0, s_1)\, g(x_0) \right)$
$w(s_1) = x_1$
$w(s_0) = x_0$
A
w
s_0
s_1
Σ


w
w(s1) = x1
w(s0) = x0
A
w
s0
s1
γ
Tr
g⁻¹(x0)


Grains of Pollen to Evidence for Atoms
How Big Is A Molecule?
A
$U_w[A; s_0, s_1) = P \exp \oint_w A$
$\gamma : \gamma(s_0) = \gamma(s_1)$
Tr
$g^{-1}(x_0)\, U[A, s_0, s_1)\, g(x_0)$
Wilson loop
$W_\gamma[A] = \mathrm{Tr}\, U_\gamma[A]$


Pollen to
Evidence
for Atoms
Is A
Molecule?
A
Σ
γ : γ(s₀) = γ(s₁)
Tr
Wilson loop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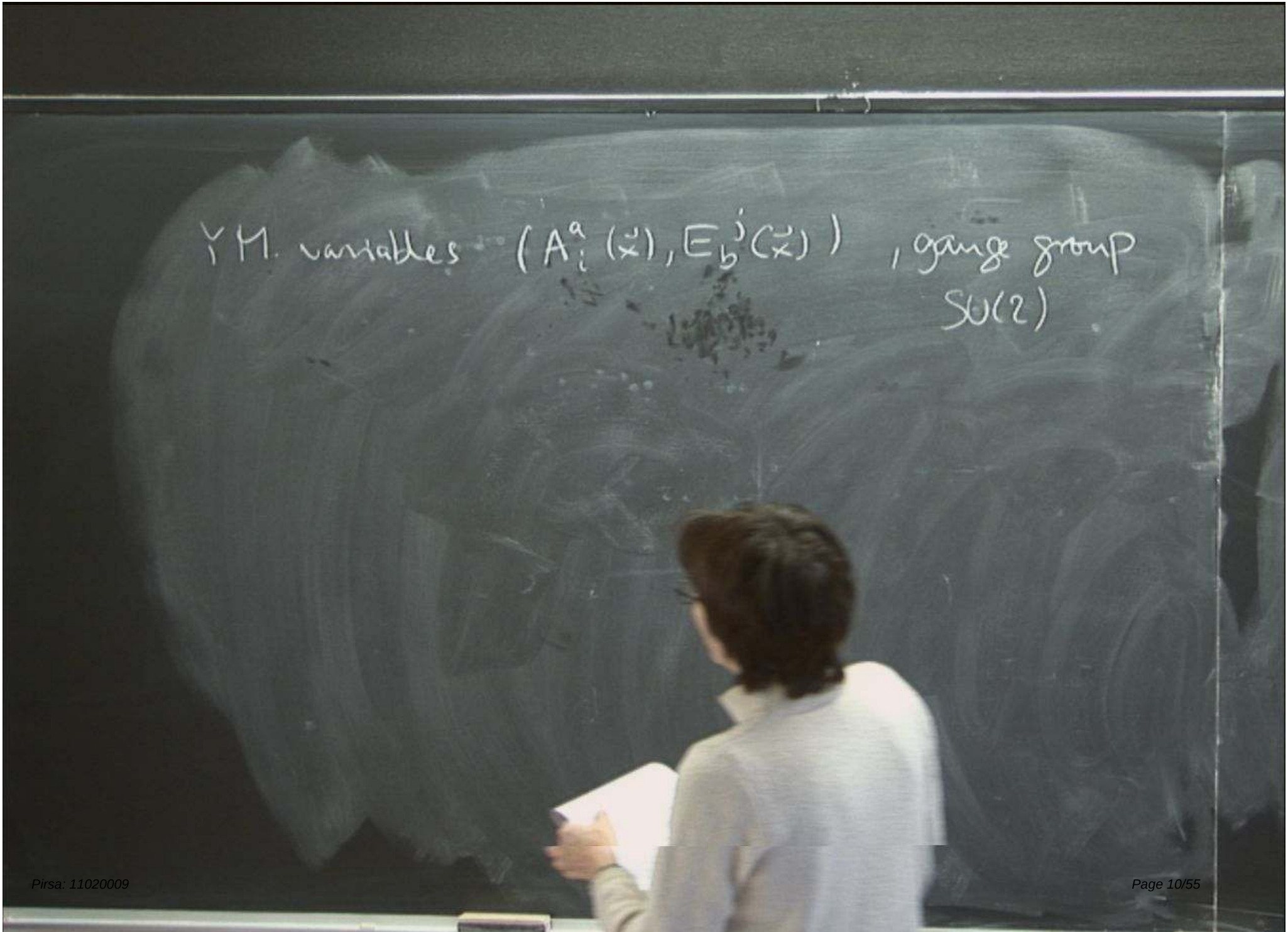
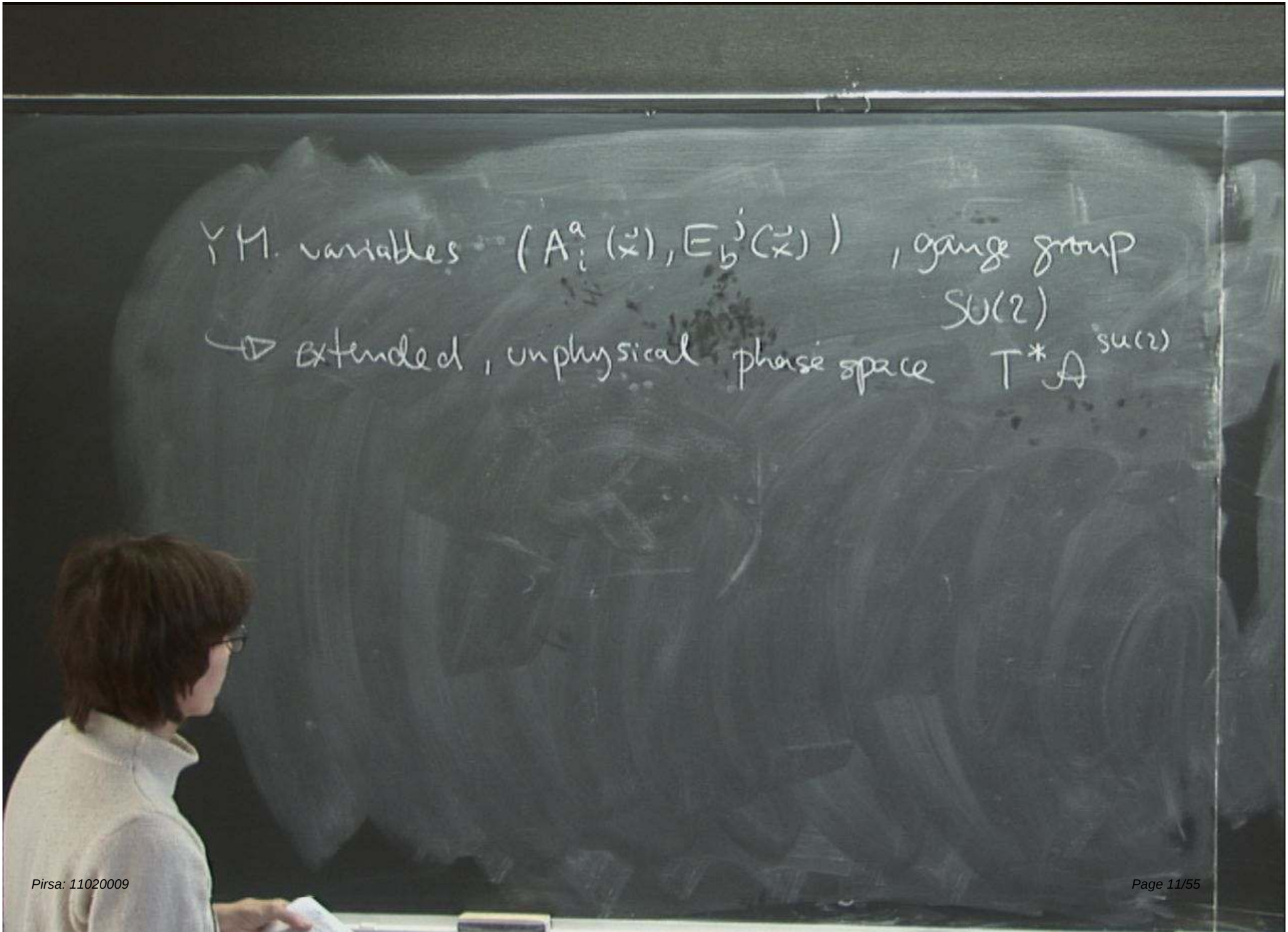

YM. variables $(A_i^a(\vec{x}), E_b^j(\vec{x}))$, gauge group
SU(2)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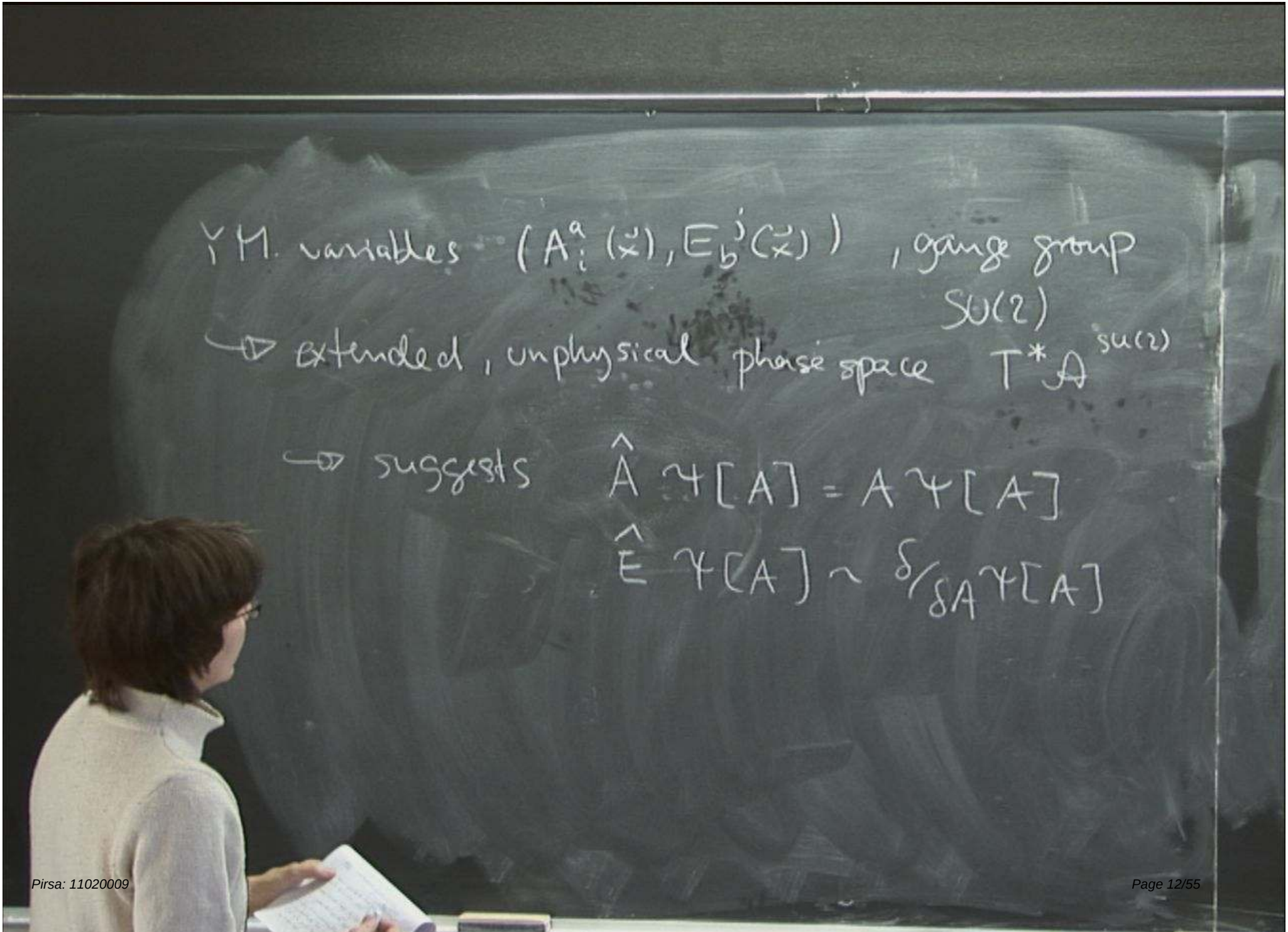
↳ extended, unphysical phase space $T^*A^{su(2)}$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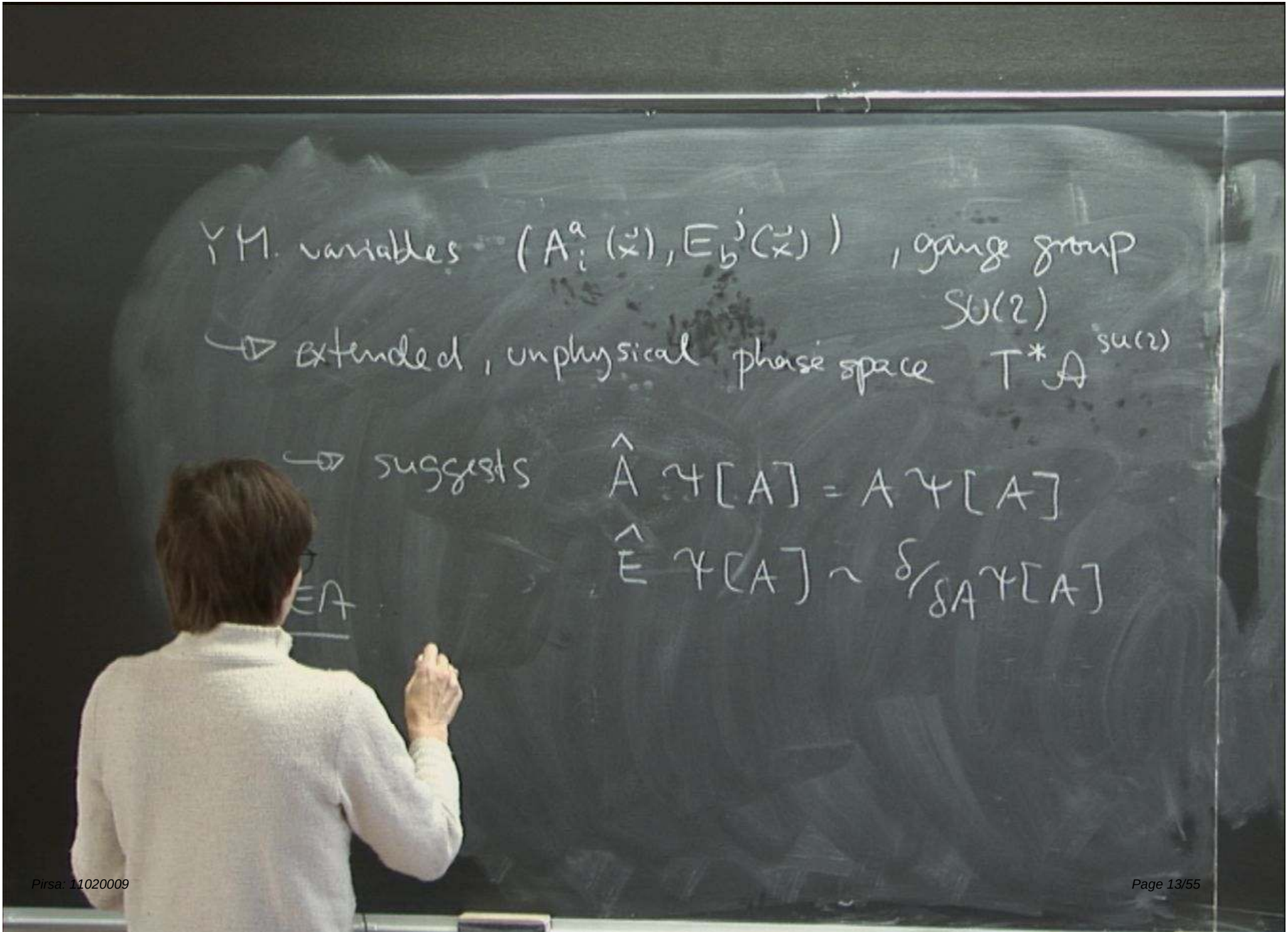
$\hat{E}\,\Psi[A] \sim \delta/\delta A\,\Psi[A]$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LQA: choose Wilson loops as "coordinates" on $\mathcal{A}^{su(2)}/\mathcal{G}^{su(2)}$

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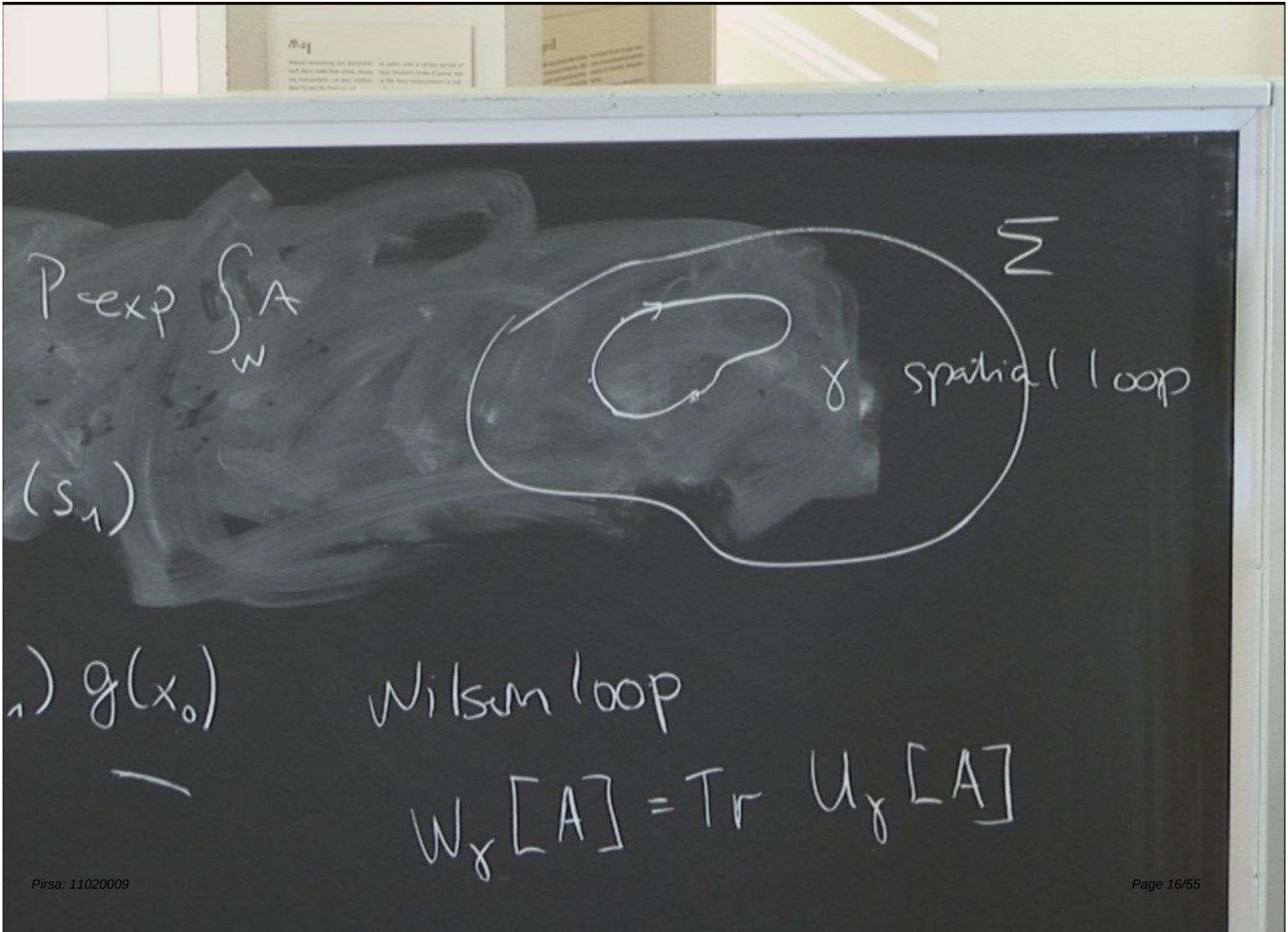
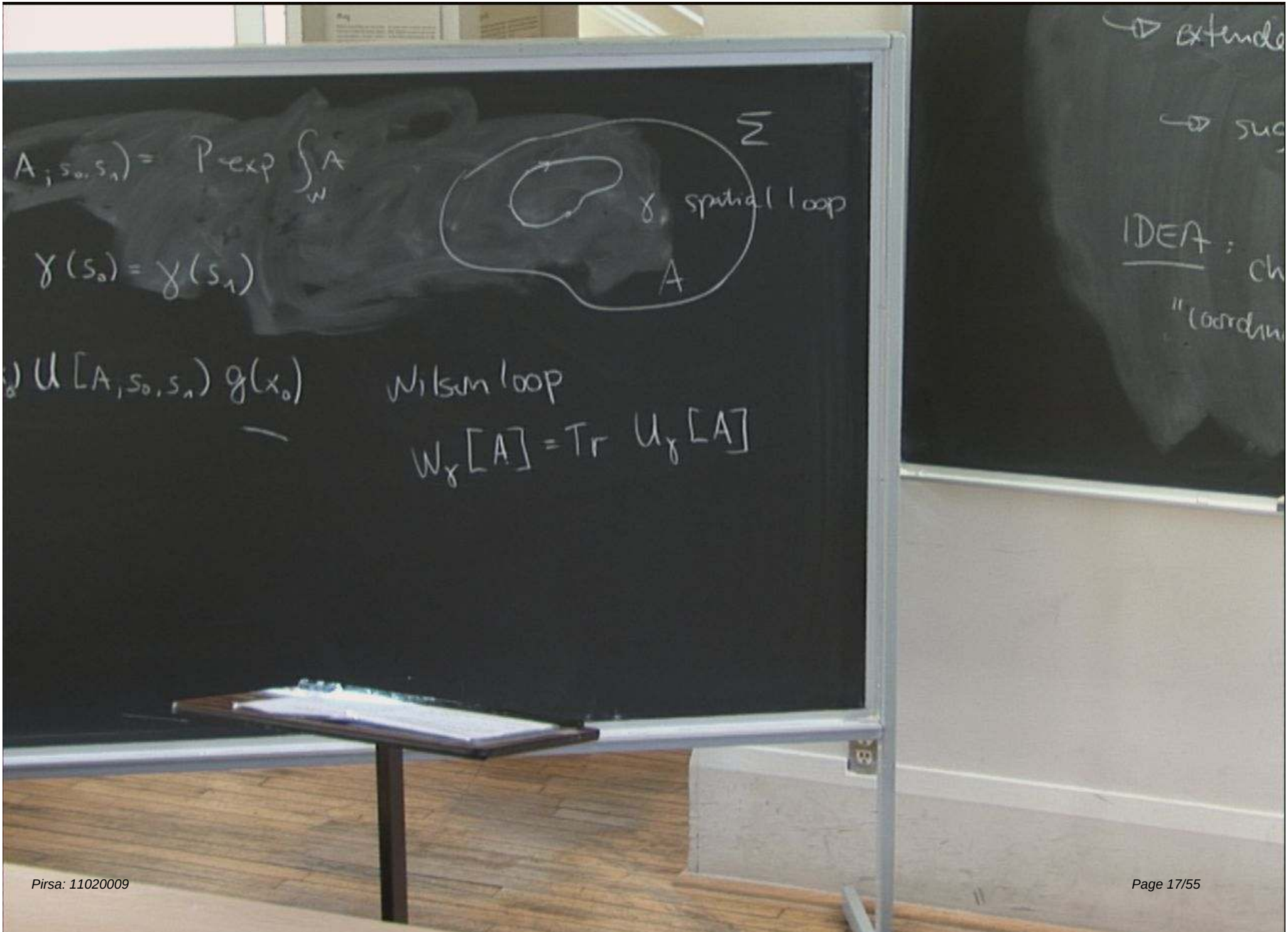

$P\exp\oint_w A$
Σ
γ spatial loop
(s_1)
$g(x_0)$
Wilson loop
$W_\gamma[A] = \mathrm{Tr}\ U_\gamma[A]$


$A, s_0, s_1) = P \exp \int_w A$
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γ, spatial loop
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$U[A, s_0, s_1)\, g(x_0)$
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IDEA:

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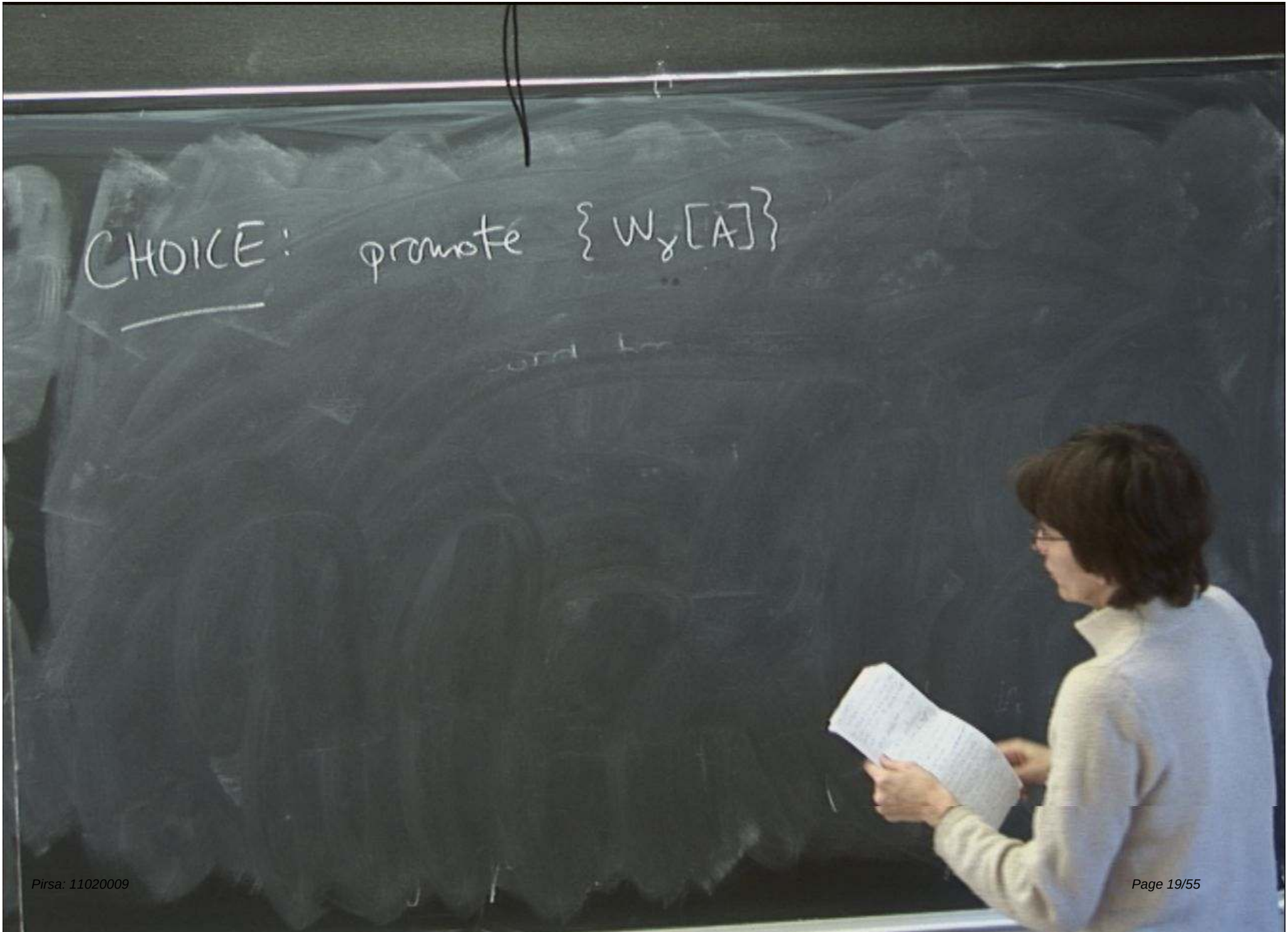
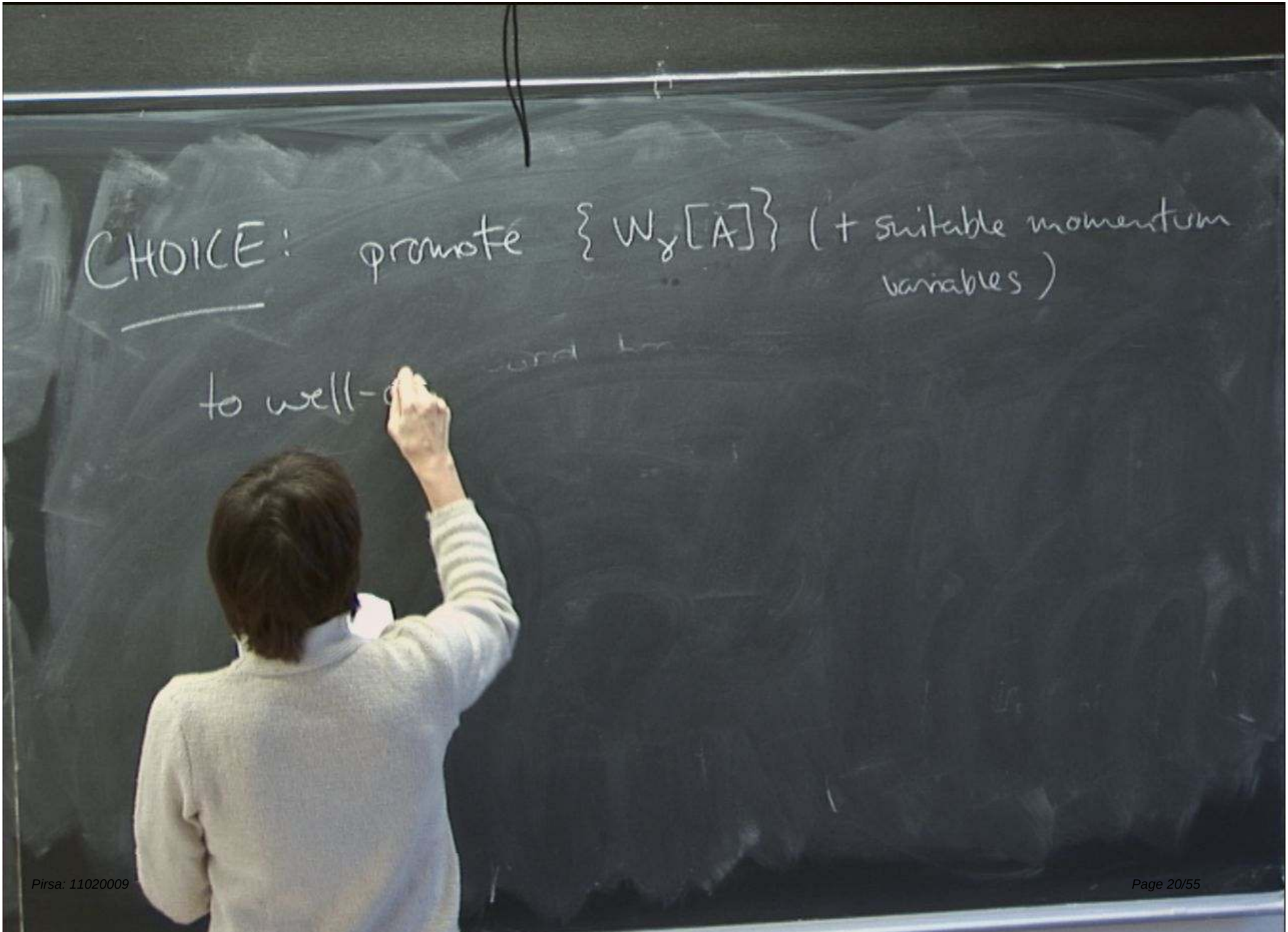
IDEA: choose Wilson loops as "coordinates" on $\mathcal{A}^{su(2)}/\mathcal{G}^{su(2)}$ (Rovelli, Smolin 1990)


CHOICE: promote {W_y[A]}


CHOICE: promote $\{W_\gamma[A]\}$ (+ suitable momentum variables)
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QT: metric is excited along one-dimensional curves / graphs in Σ

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to well-defined operators in the quantum theory.

(nontrivial)

QT: metric is excited along one-dimensional curves / graphs in Σ ... "spin network states"

$\{W_\gamma[A]\}$ (+ suitable [illegible]
variables)

d operators in the quantum theory.

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" spin network states "

CHOICE: promote $\{W_\gamma[A]\}$ (+ suitable momentum variables)

to well-defined operators in the quantum theory.

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QT: metric is excited along one-dimensional graphs in Σ ... "spin network states" ...

well-defined Hilbert $\longrightarrow \mathcal{H}^{aux} = L^2(\bar{A}/\mathcal{G})$

well-defined operators in the quantum theory.

al)

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graphs in Σ " spin network states "

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Ashtekar, Lewandowski

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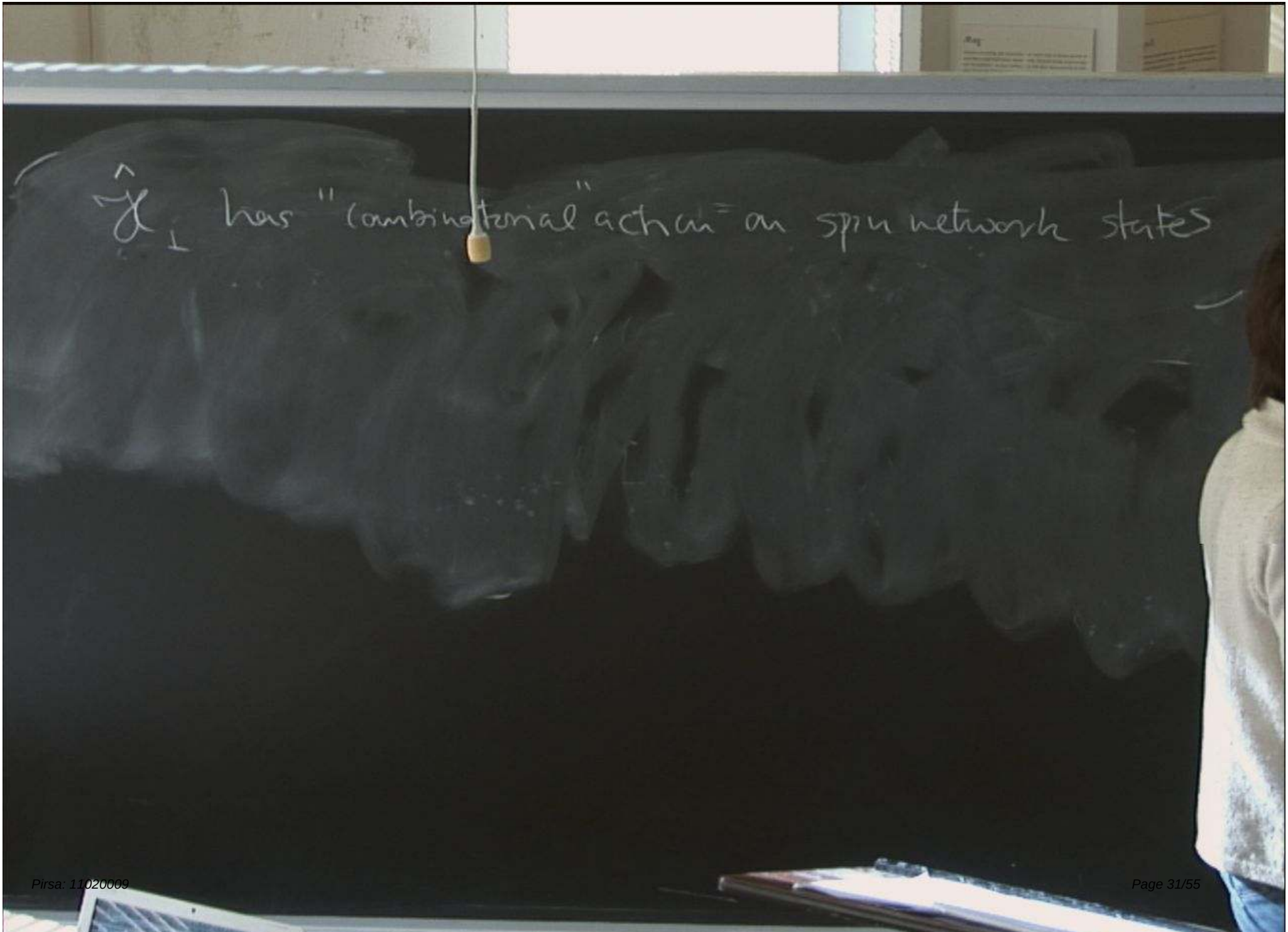
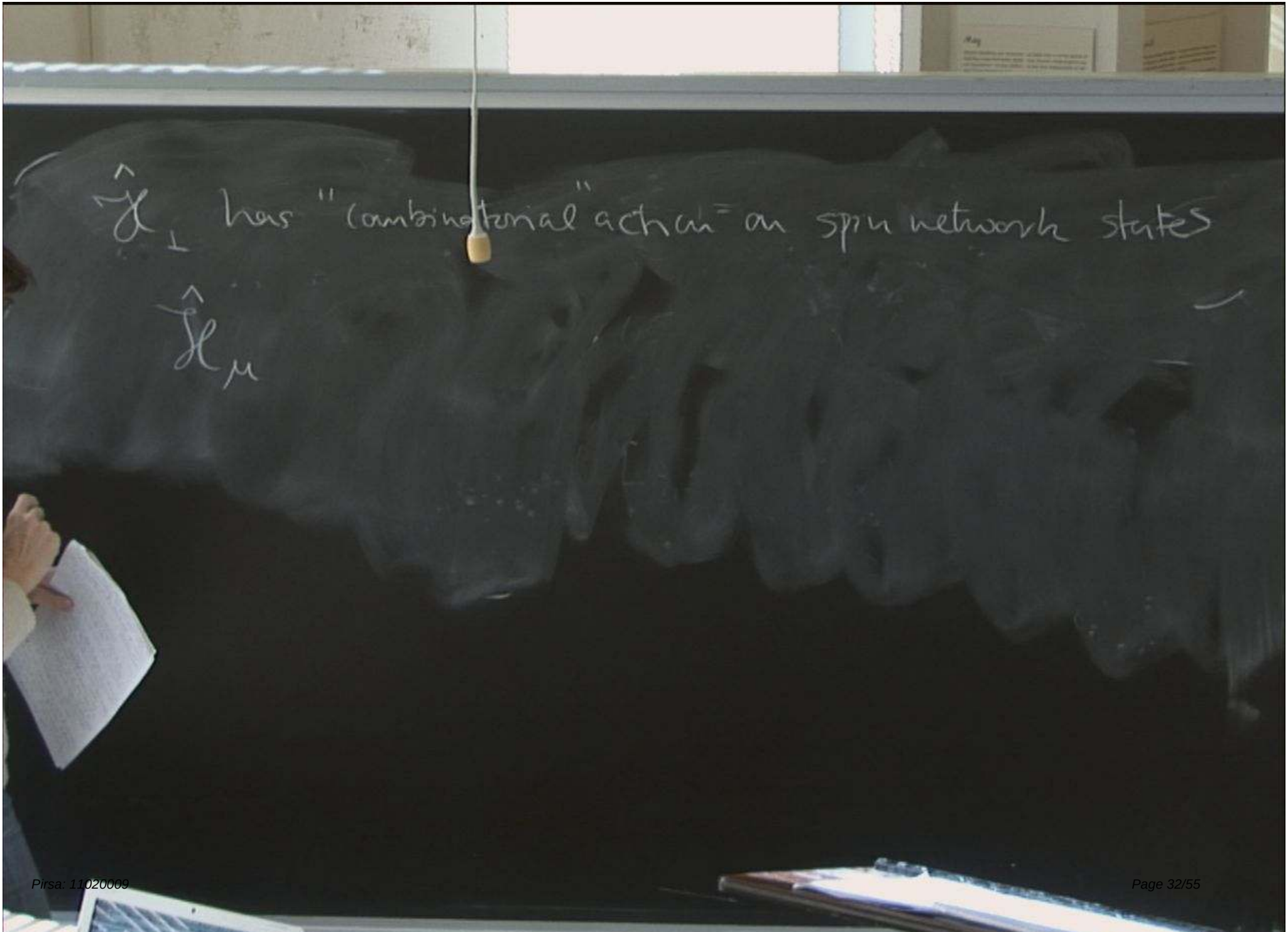
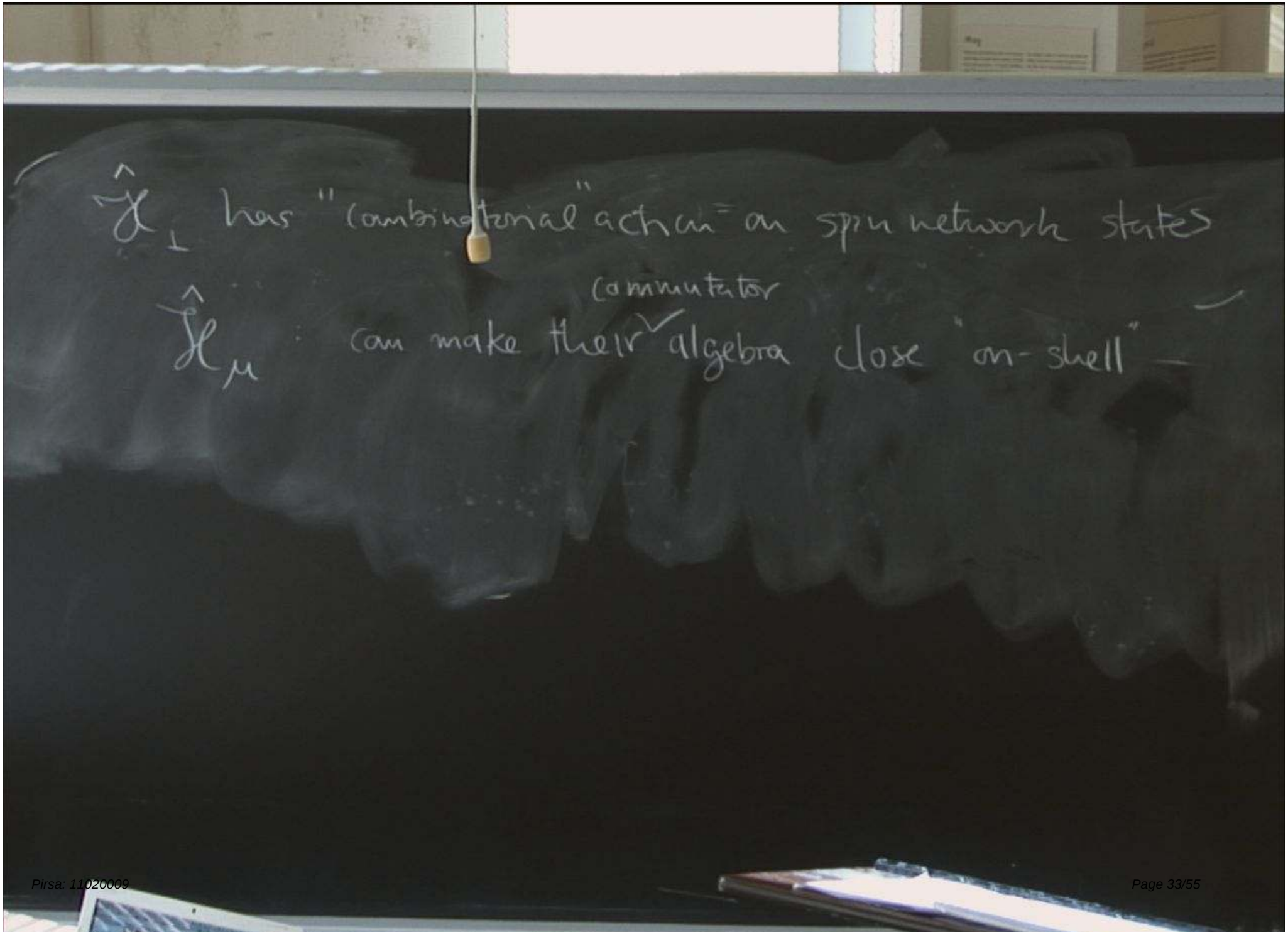
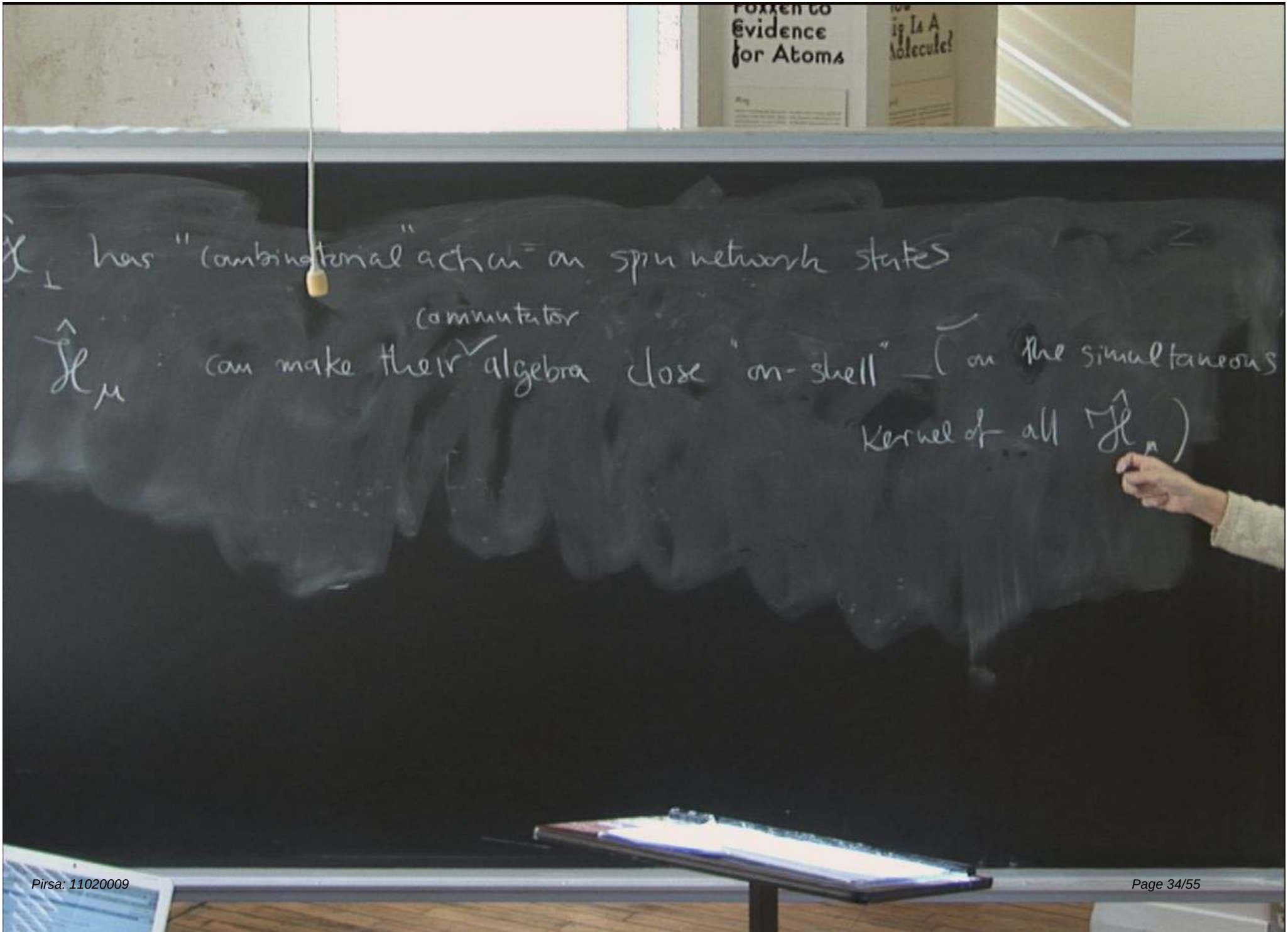
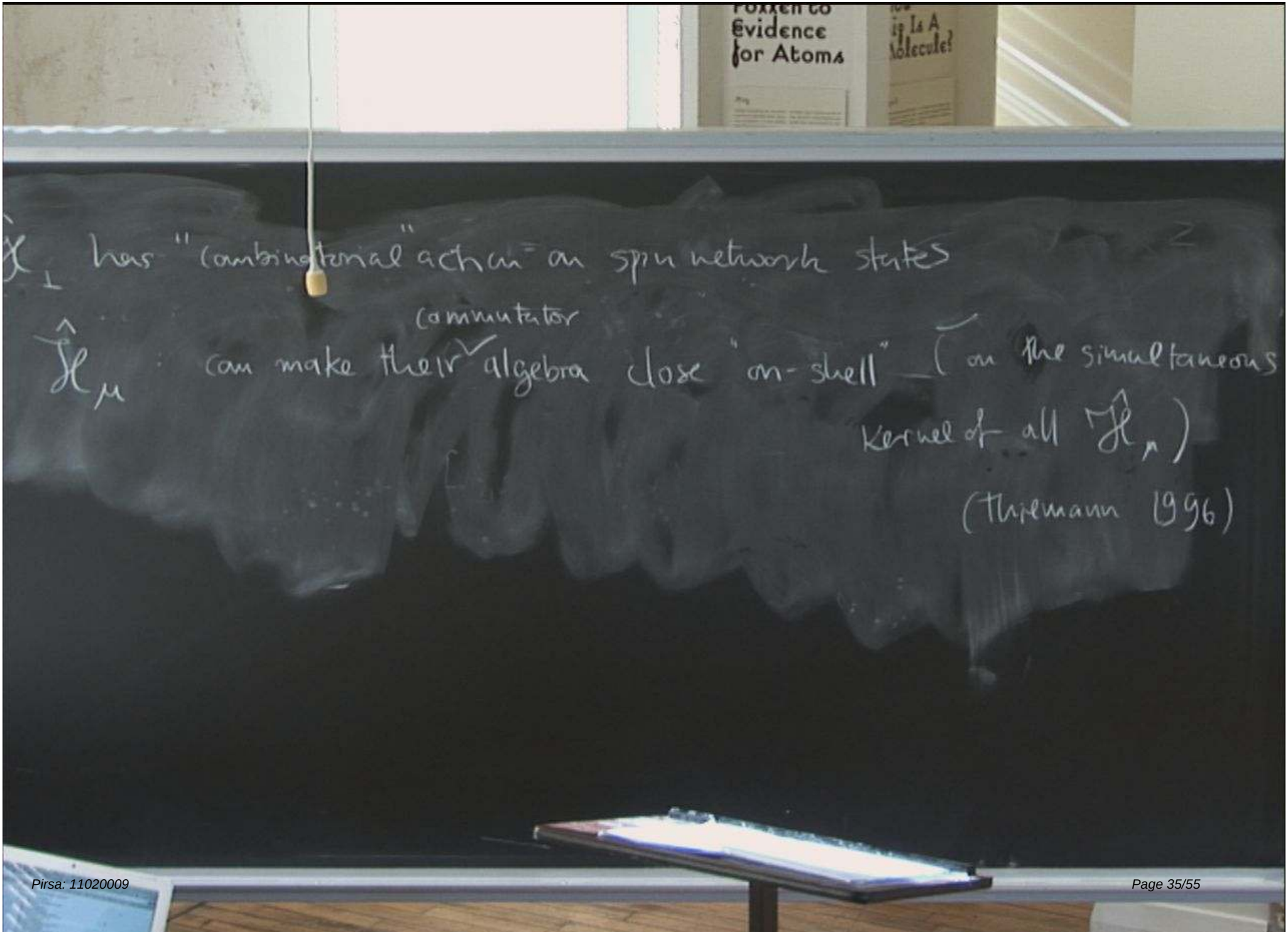

$\hat{\mathcal{H}}_1$ has "combinatorial" action on spin network states


$\hat{\mathcal{H}}_\perp$ has "combinatorial" action on spin network states
$\hat{\mathcal{H}}_\mu$


$\hat{\mathcal{H}}_\perp$ has "combinatorial" action on spin network states
commutator
$\hat{\mathcal{H}}_\mu$ can make their algebra close "on-shell"


Evidence
for Atoms
$\hat{\mathcal{H}}_\perp$ has "combinatorial" action on spin network states
commutator
$\hat{\mathcal{H}}_\mu$ can make their algebra close "on-shell" (on the simultaneous
Kernel of all $\hat{\mathcal{H}}_n$)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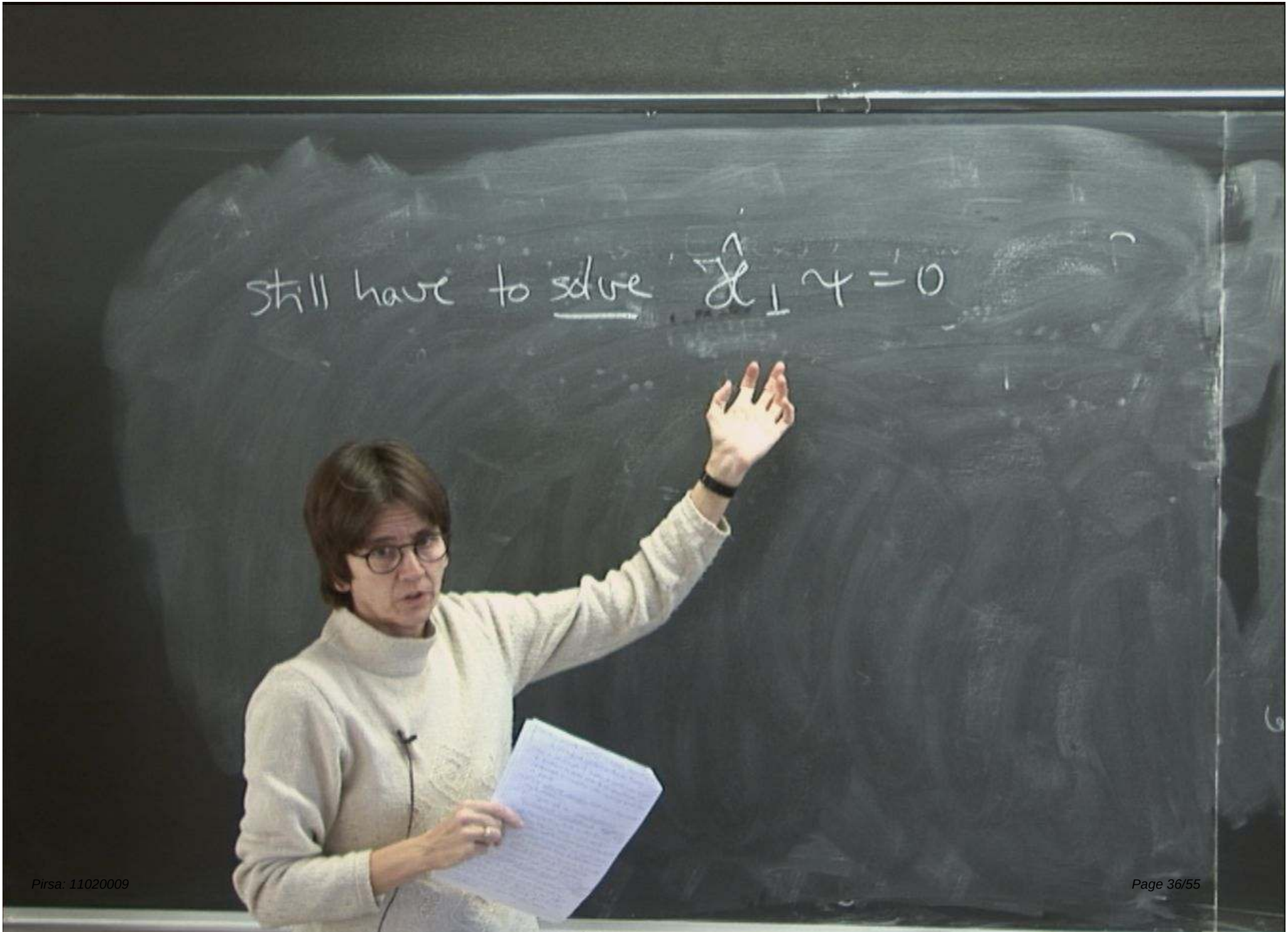
(Thiemann 1996)


still have to solve $\not{\partial}_\perp \psi = 0$

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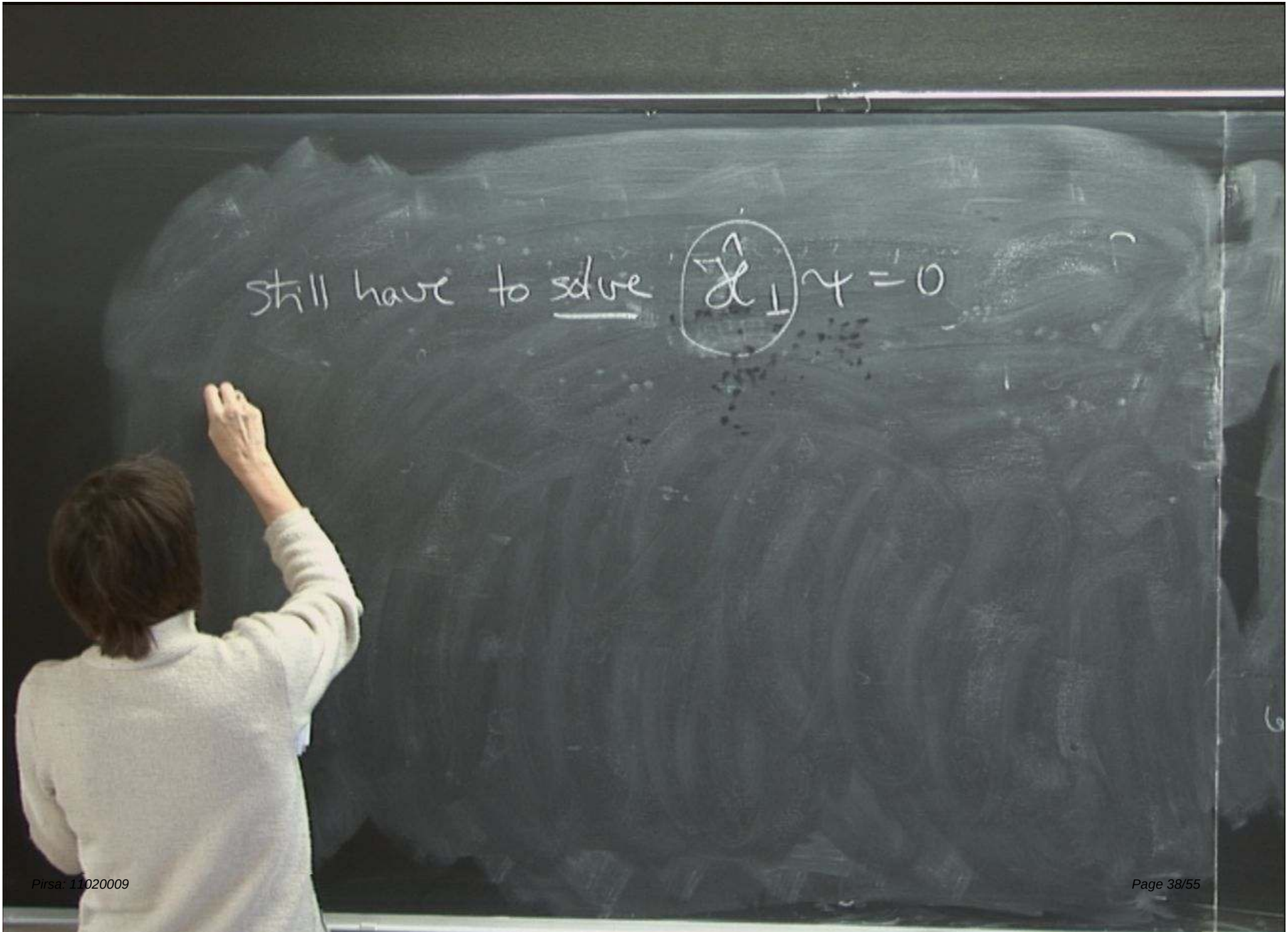
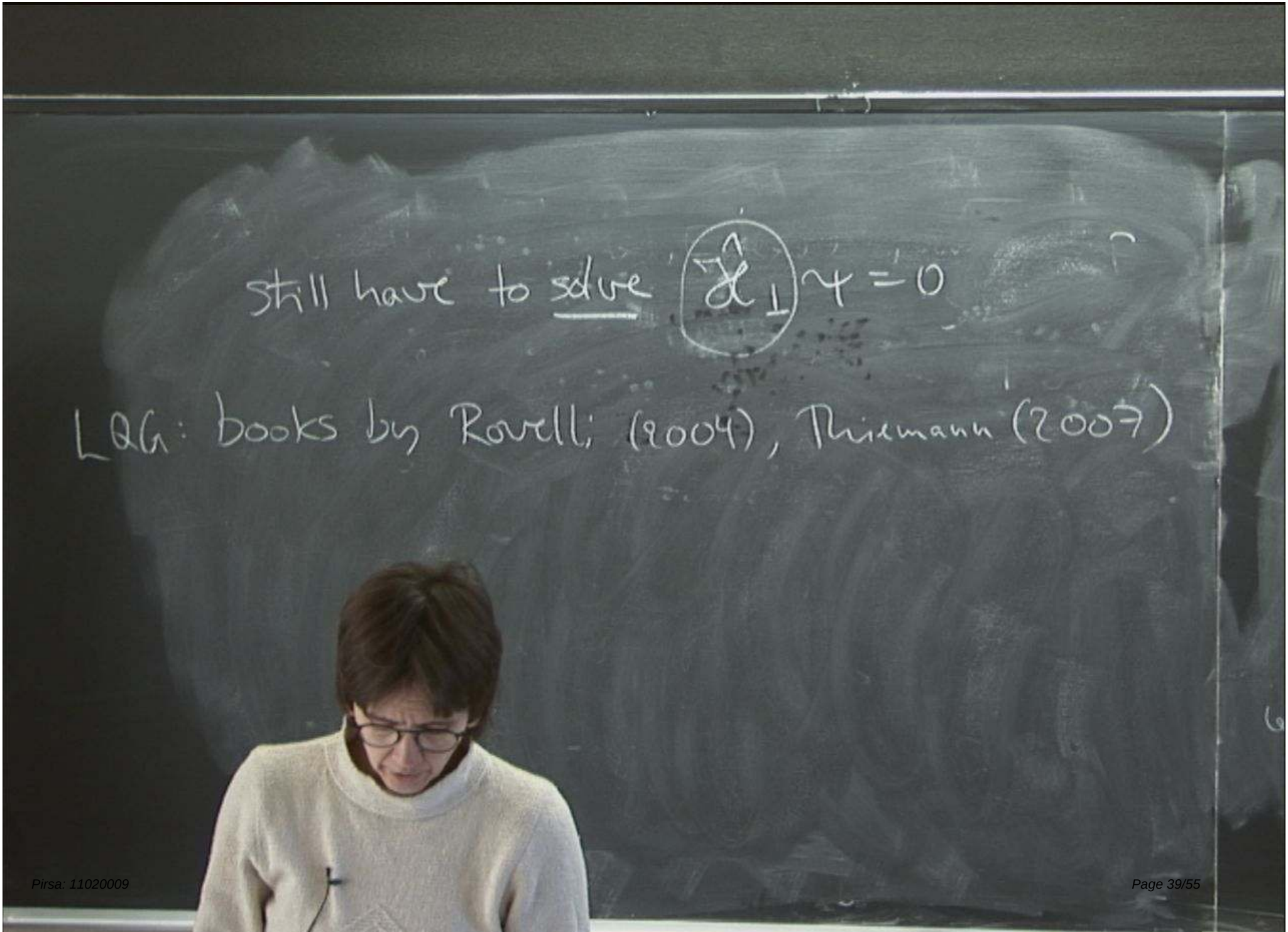
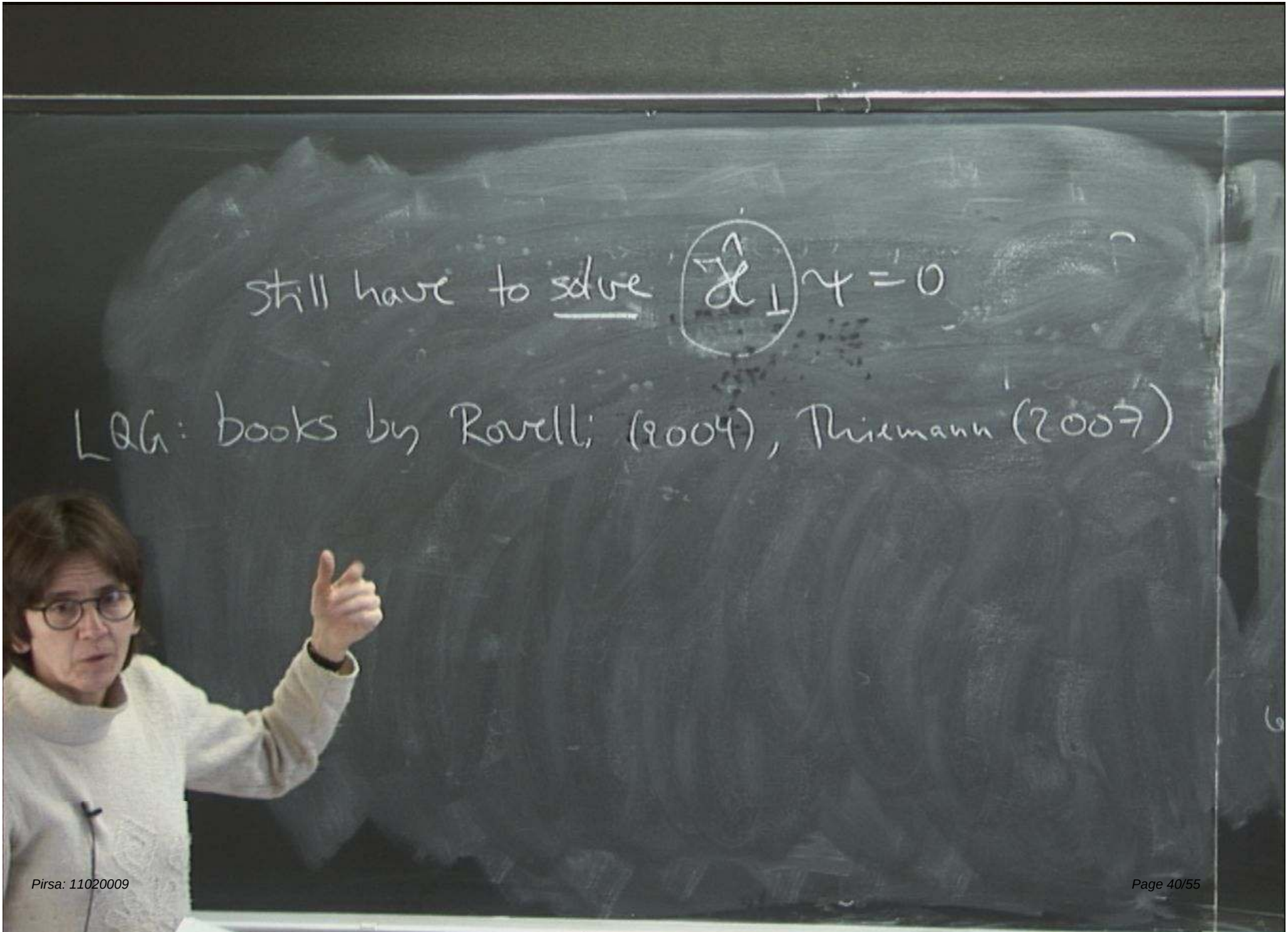

Still have to solve $\hat{\mathcal{L}}_\perp \psi = 0$


Still have to solve $\hat{\mathcal{H}}_1 \psi = 0$
LQG: books by Rovelli (2004), Thiemann (2007)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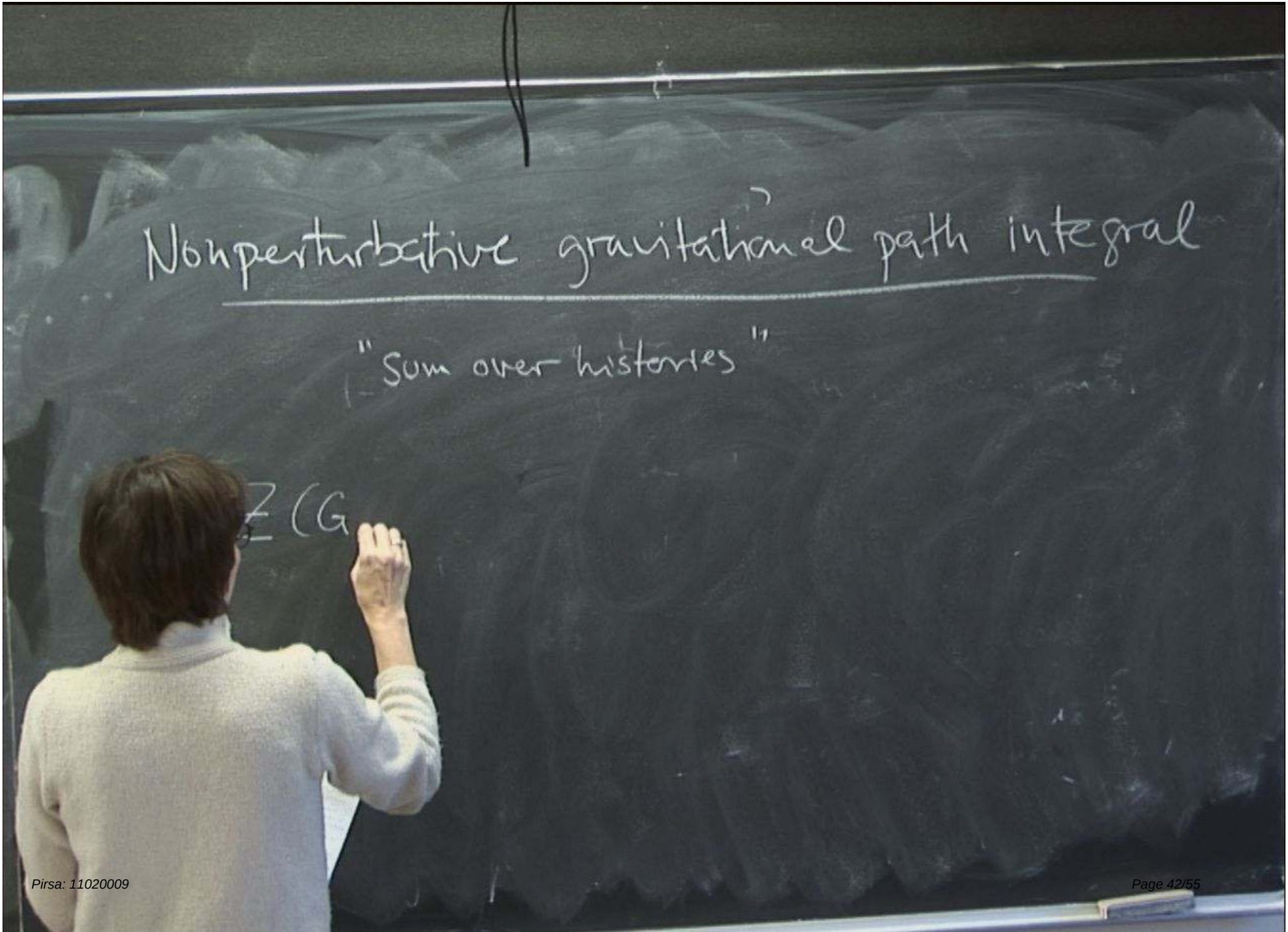
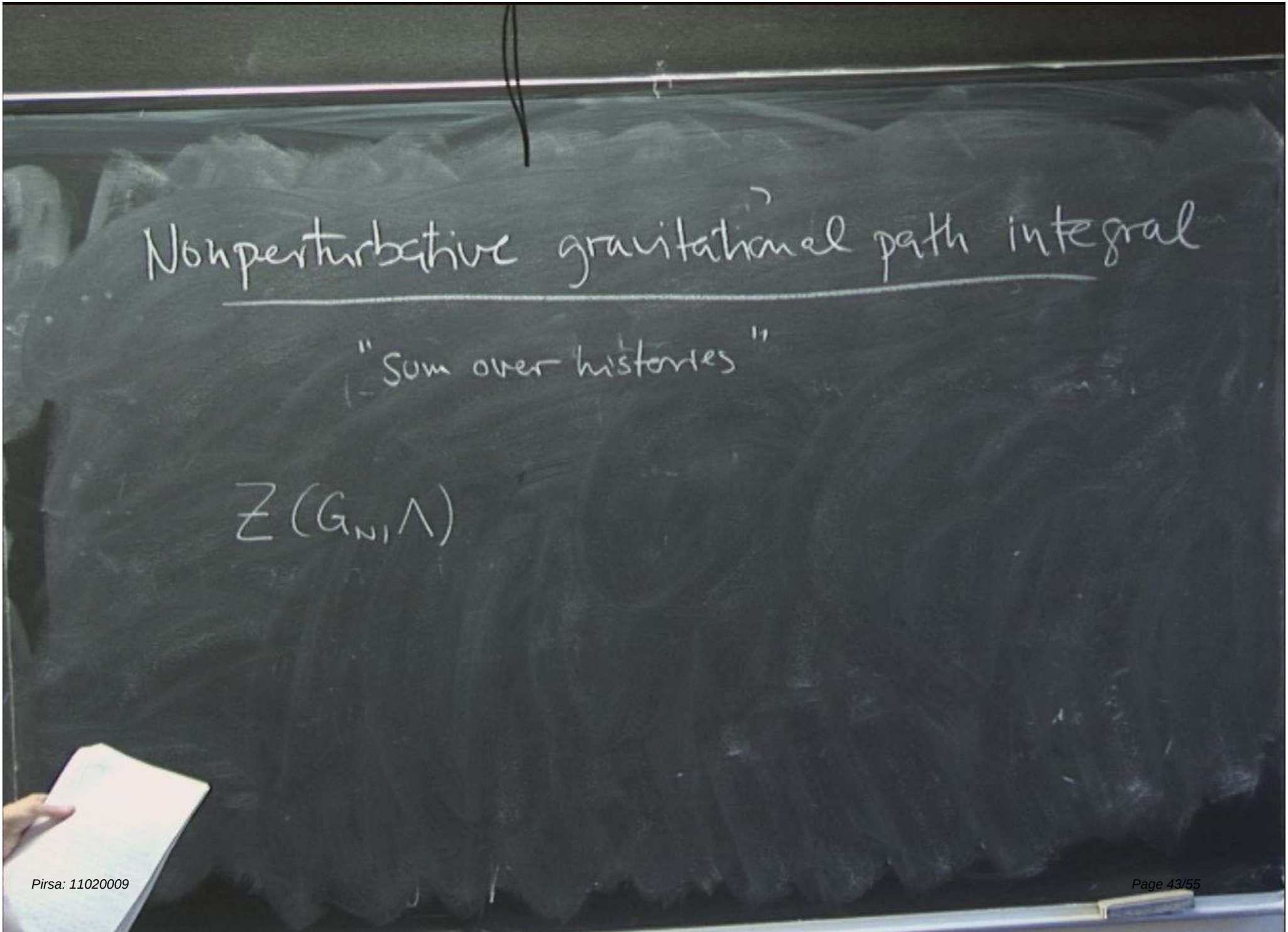
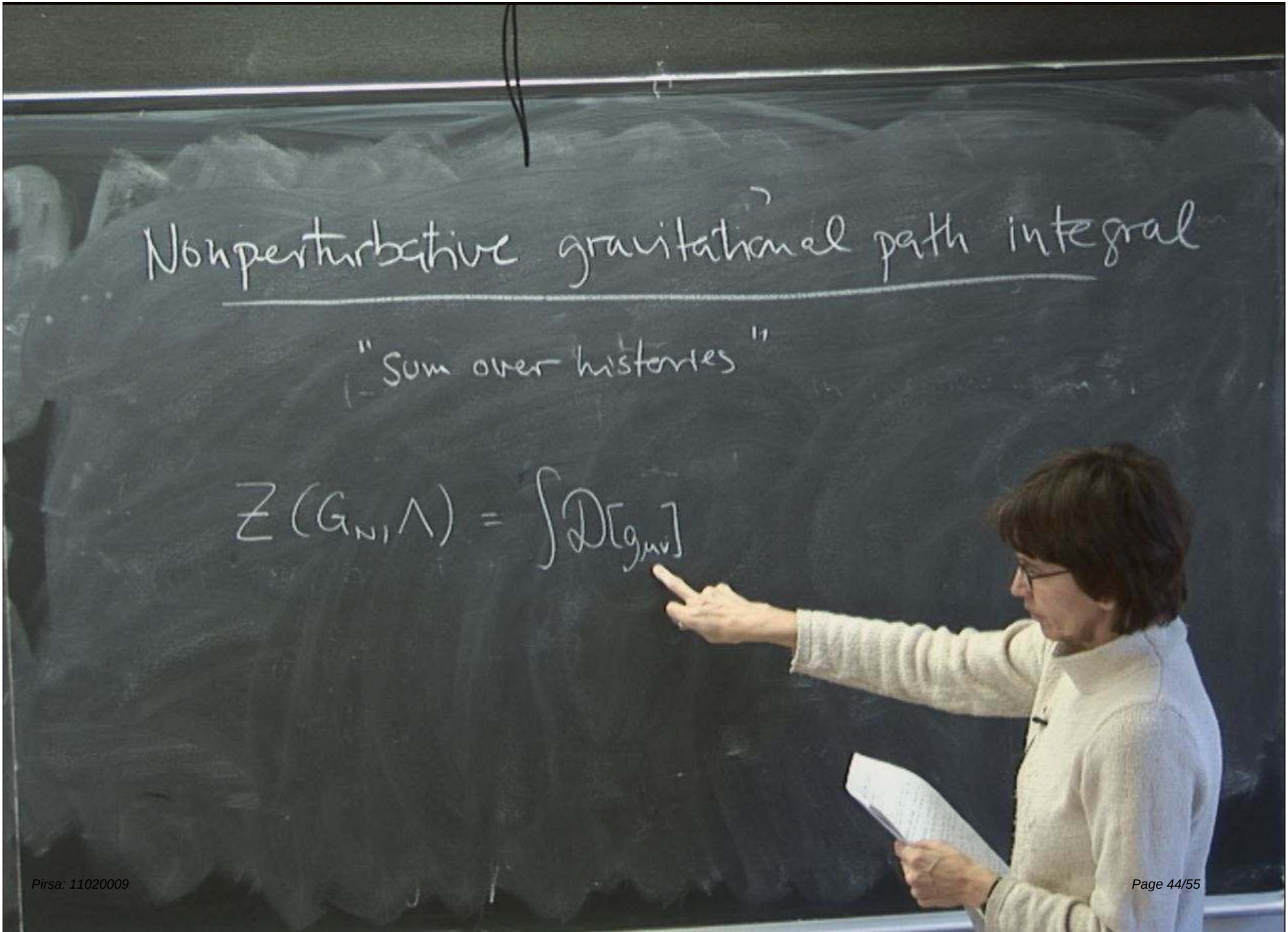
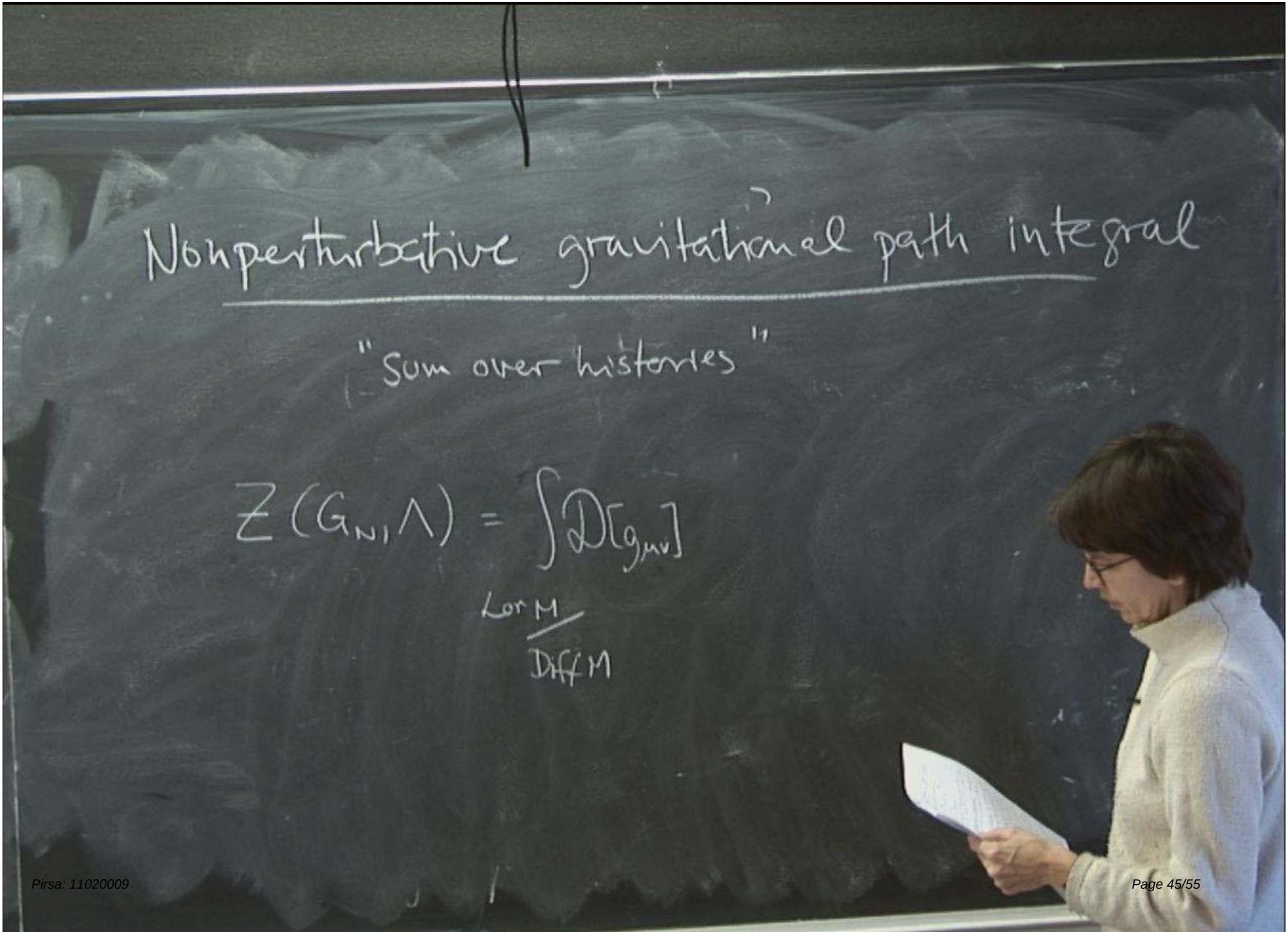

Nonperturbative gravitational path integral
"Sum over histories"
Z(G


Nonperturbative gravitational path integral
"Sum over histories"
$Z(G_N, \Lambda)$


Nonperturbative gravitational path integral
"Sum over histories"
$Z(G_N, \Lambda) = \int \mathcal{D}[g_{\mu\nu}]$


Nonperturbative gravitational path integral
"Sum over histories"
$Z(G_N, \Lambda) = \int \frac{\mathcal{D}[g_{\mu\nu}]}{\text{Lor M} / \text{Diff M}}$

Nonperturbative gravitational path integral

"Sum over histories"

$$Z(G_N, \Lambda) = \int \frac{\mathcal{D}[g_{\mu\nu}]}{\text{Lor M} \,/\, \text{Diff M}} \, e^{iS^{EH}[g_{\mu\nu}]}$$

Nonperturbative gravitational path integral

"Sum over histories"

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G_N, Λ: cosmol. const.

Lor M / Diff M

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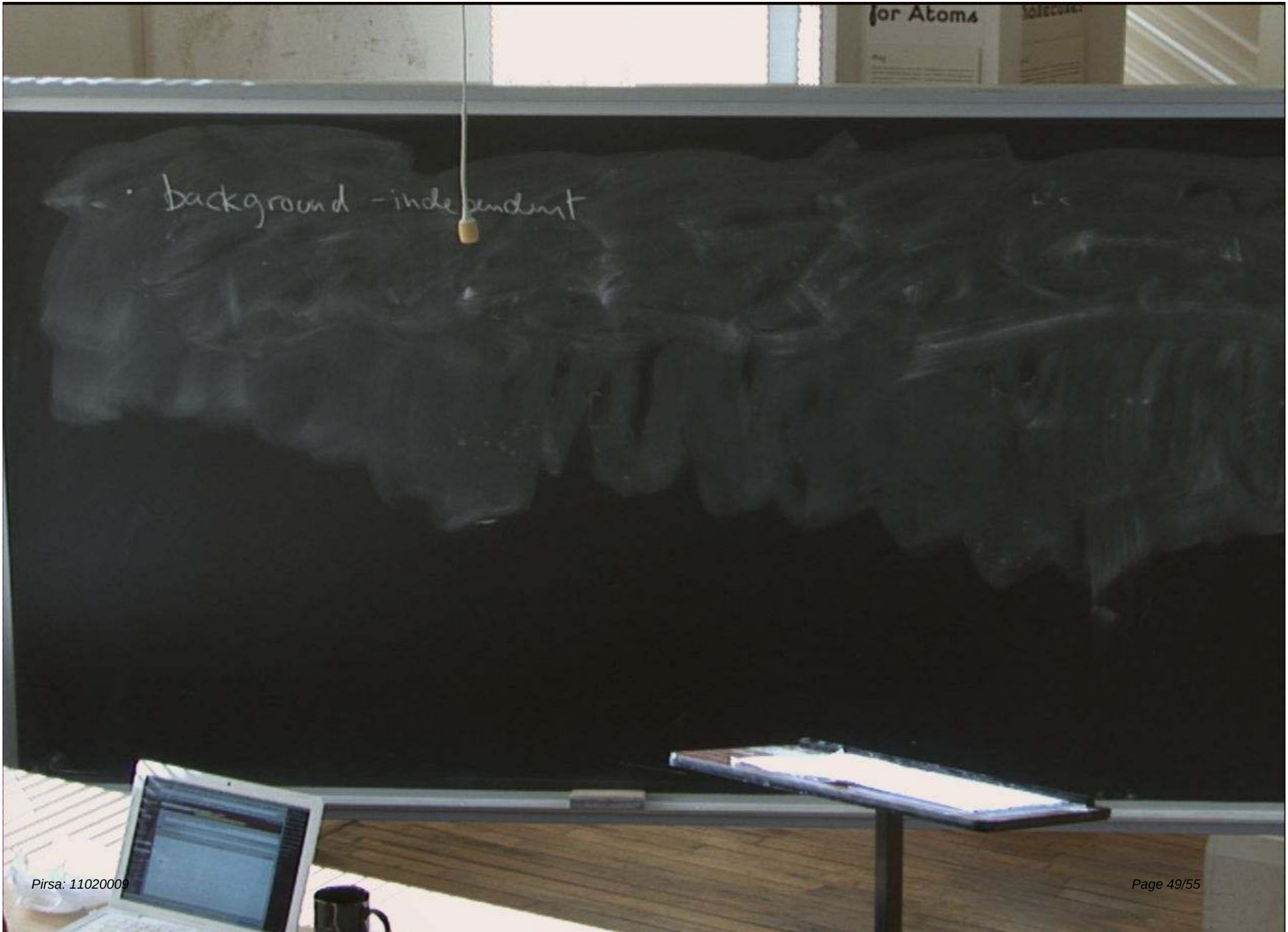
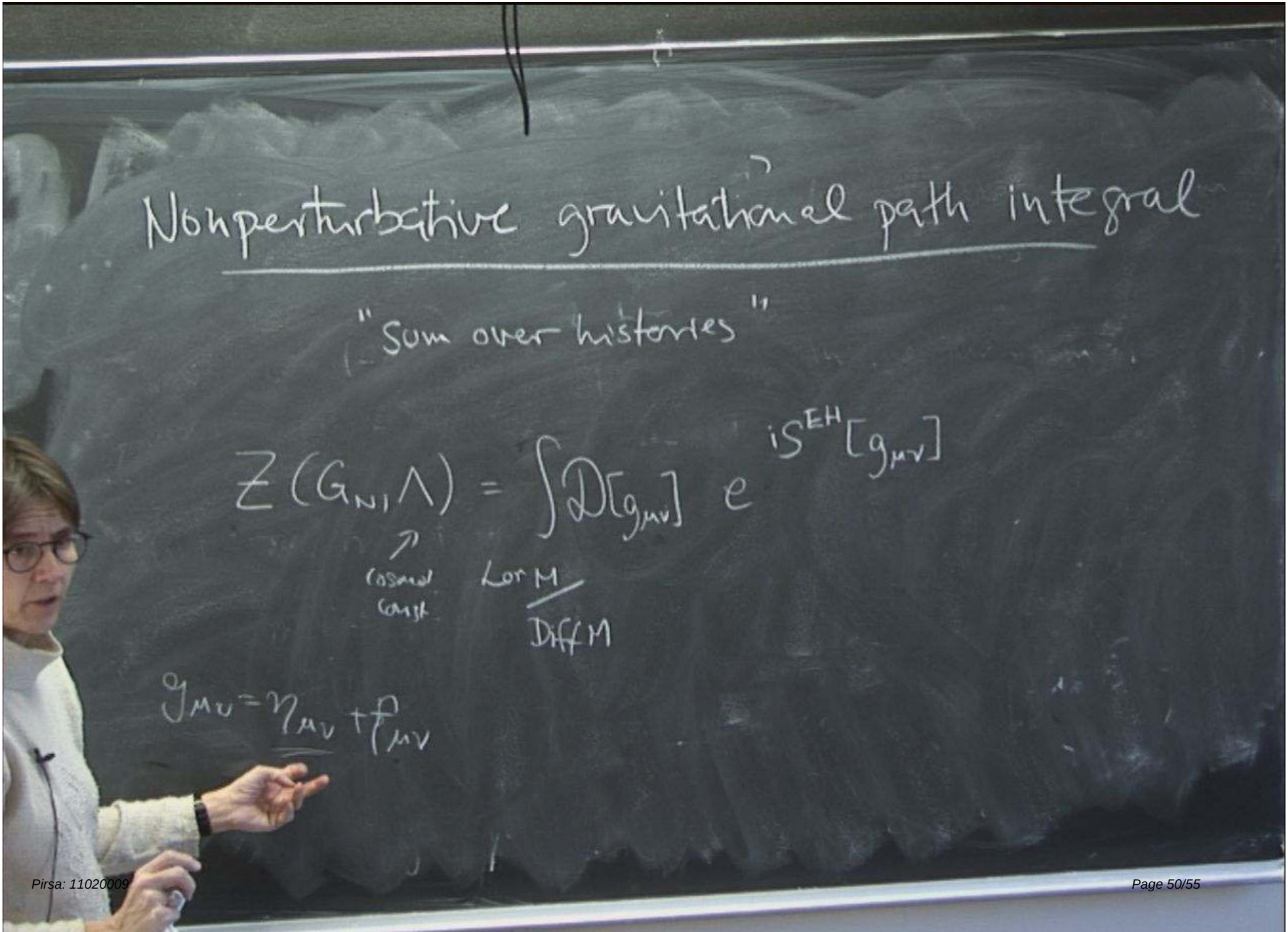

for Atoms
background - independent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cosmol const
Lor M
Diff M
$g_{\mu\nu} = \eta_{\mu\nu} + f_{\mu\nu}$

Nonperturbative gravitational path integral

"Sum over histories"

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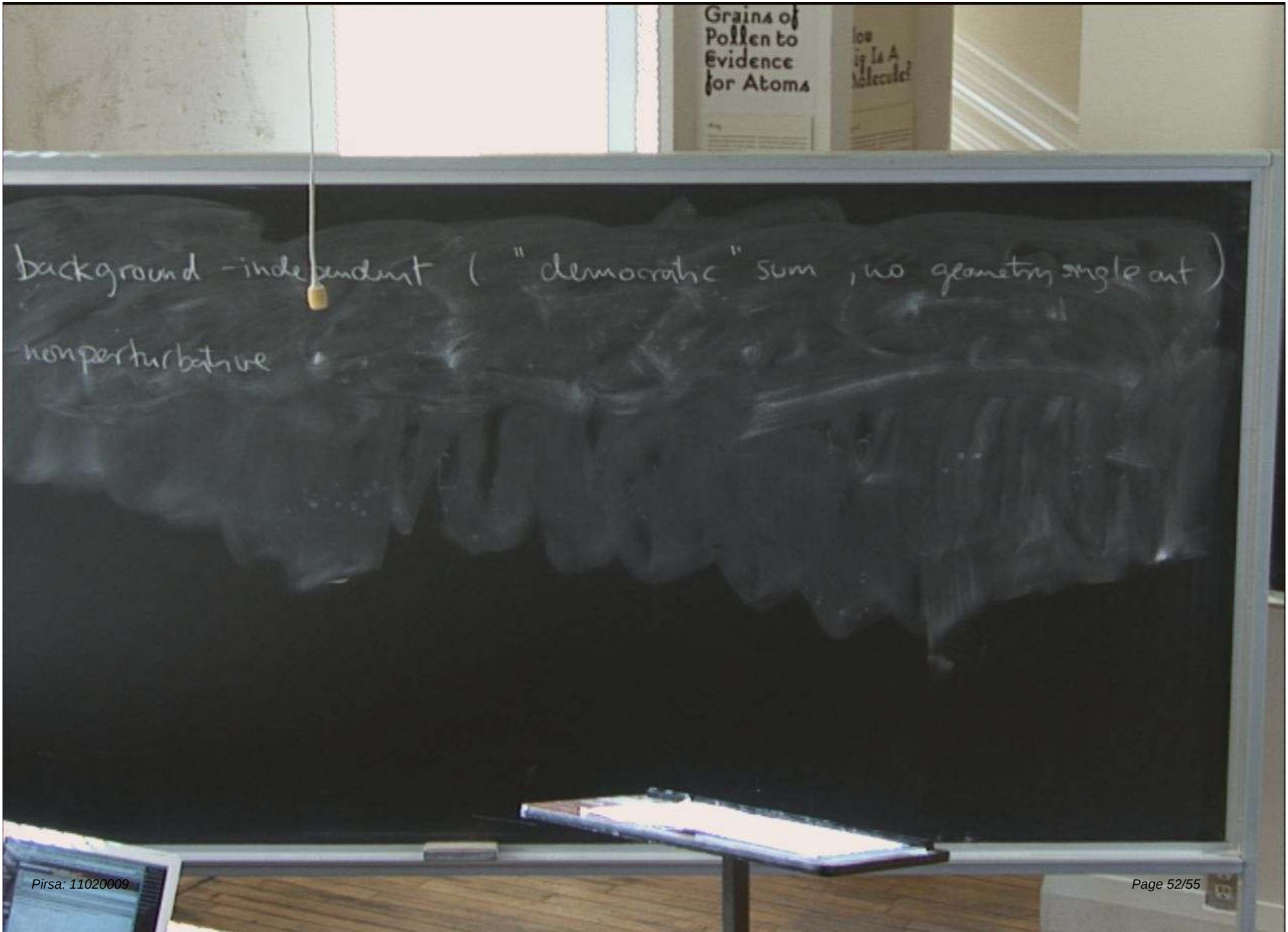
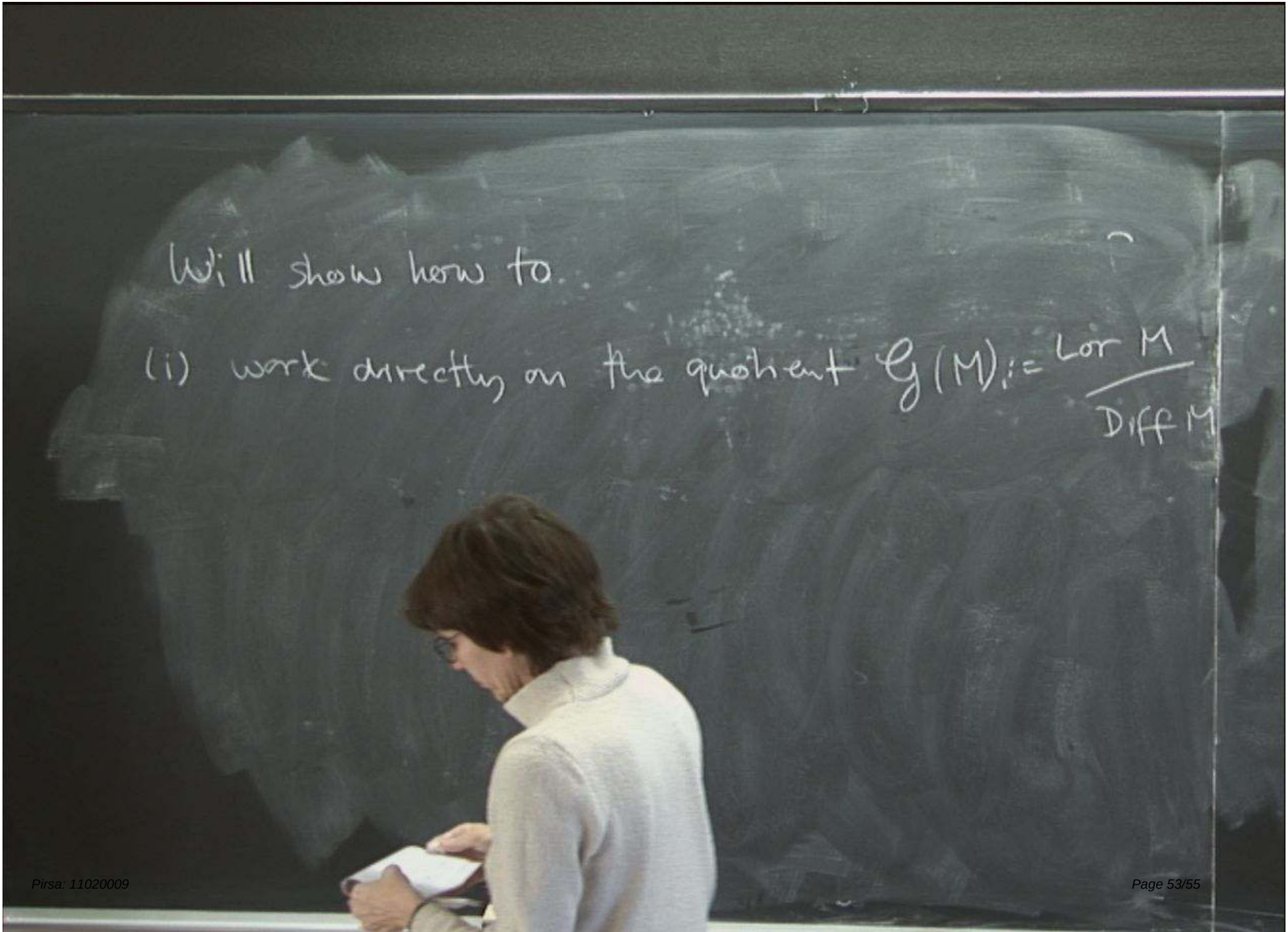
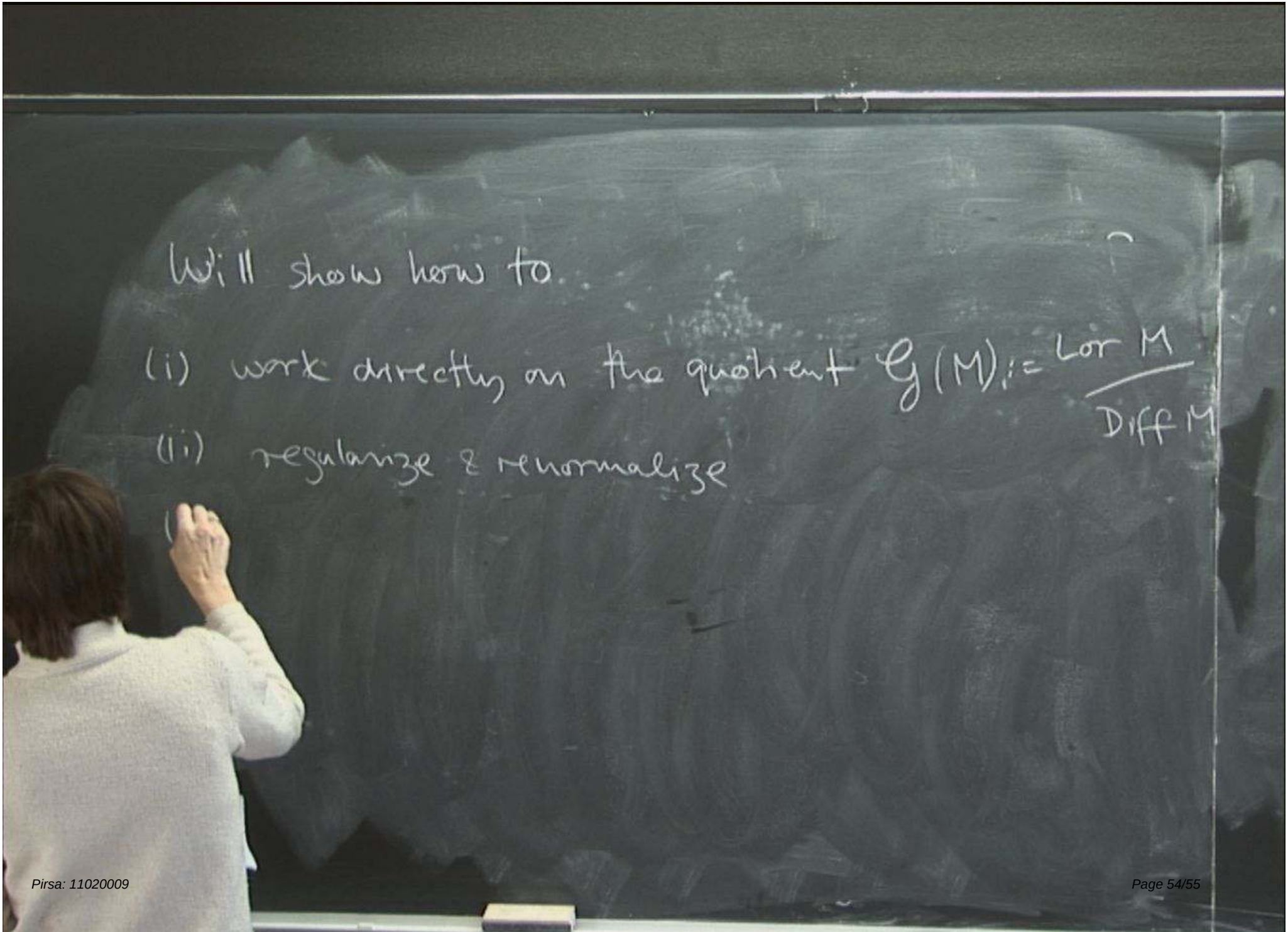
G_N, Λ: cosmol. const.

Lor M / Diff M

$g_{\mu\nu} = \eta_{\mu\nu} + f_{\mu\nu}$


Grains of
Pollen to
Evidence
for Atoms
background - independent ("democratic" sum , no geometry angle cut)
nonperturbative


Will show how to.
(i) work directly on the quotient $\mathcal{G}(M) := \frac{\mathrm{Lor}\, M}{\mathrm{Diff}\, M}$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(ii) regularize & renormalize

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(ii) regularize & renormalize

(iii) deal with the "i"

(iv) deal with the boundedness of S^{EH}