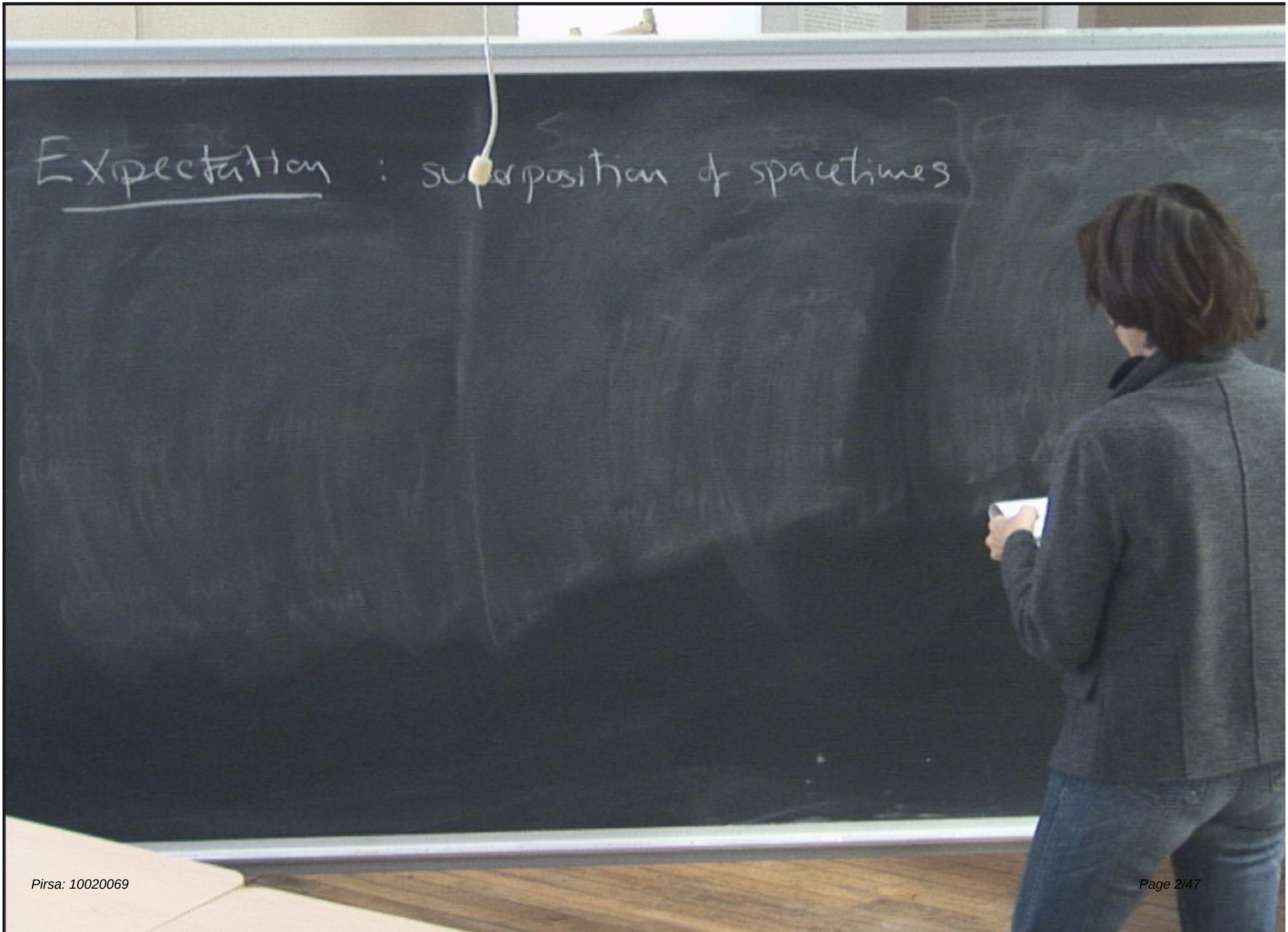
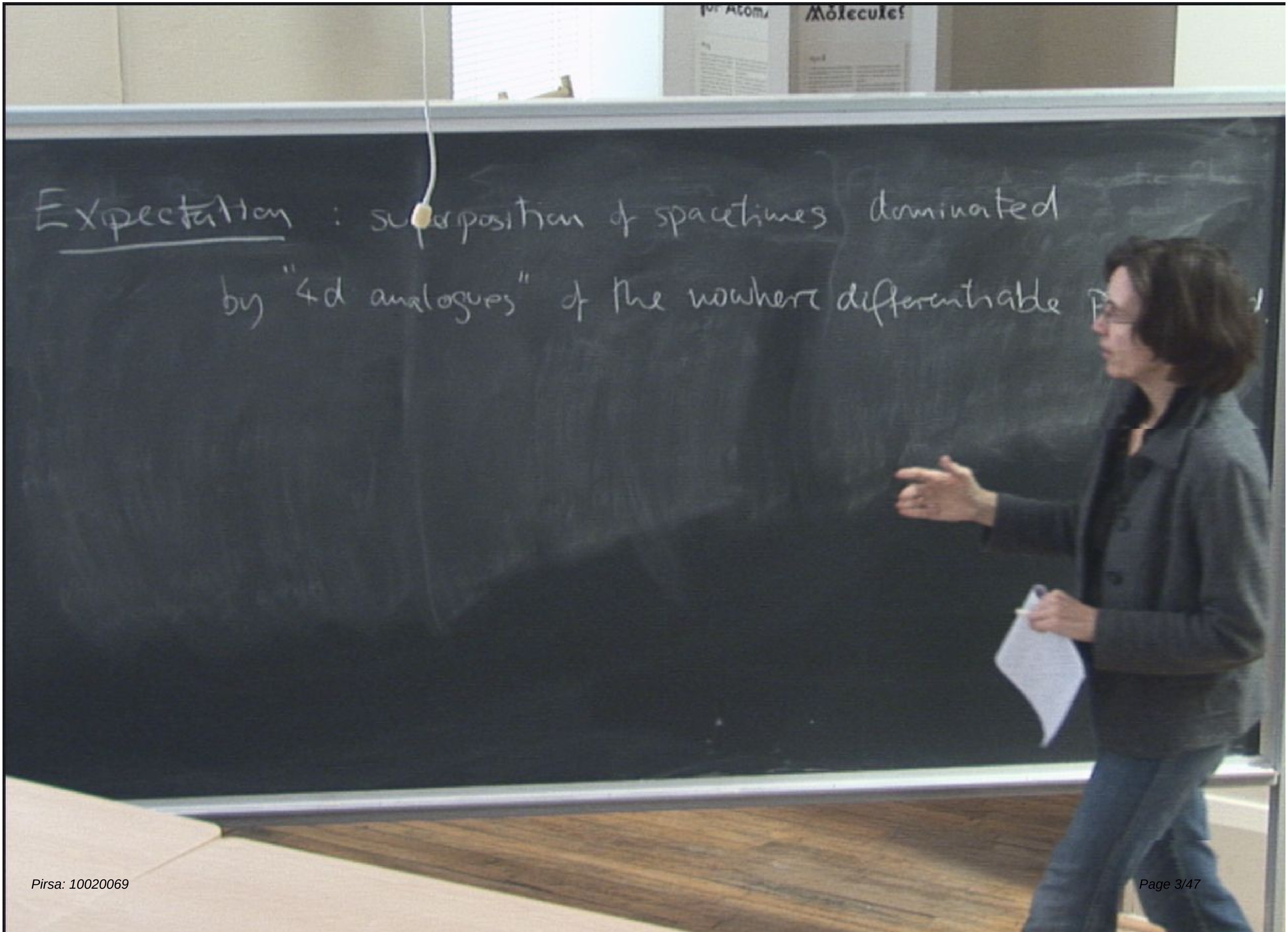
Title: Quantum Gravity - Review (PHYS 638) - Lecture 15

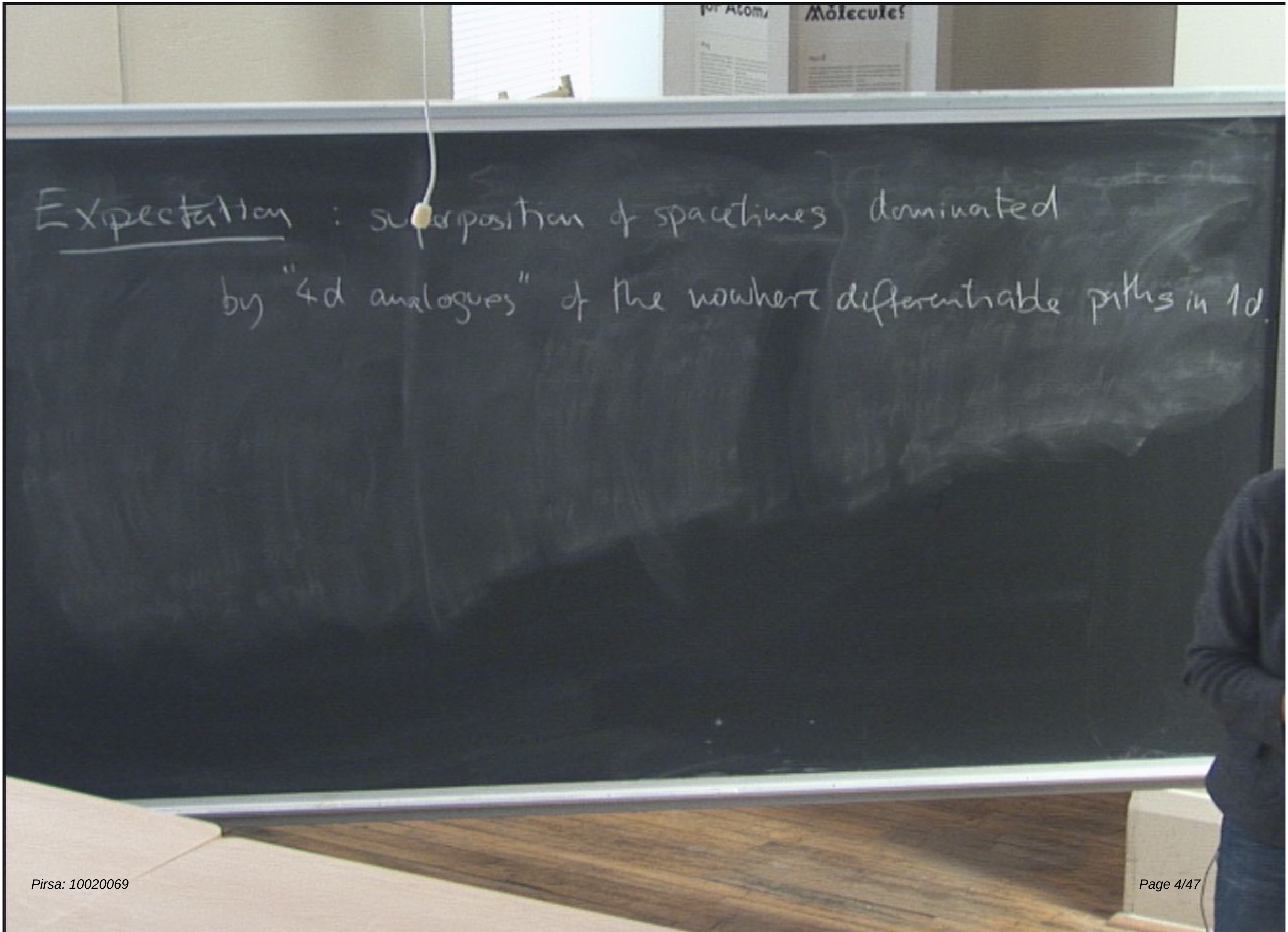
Date: Feb 12, 2010 10:00 AM

URL: http://pirsa.org/10020069

Abstract:


Expectation : superposition of spacetimes


Expectation : superposition of spacetimes dominated
by "4d analogues" of the nowhere differentiable
Molecules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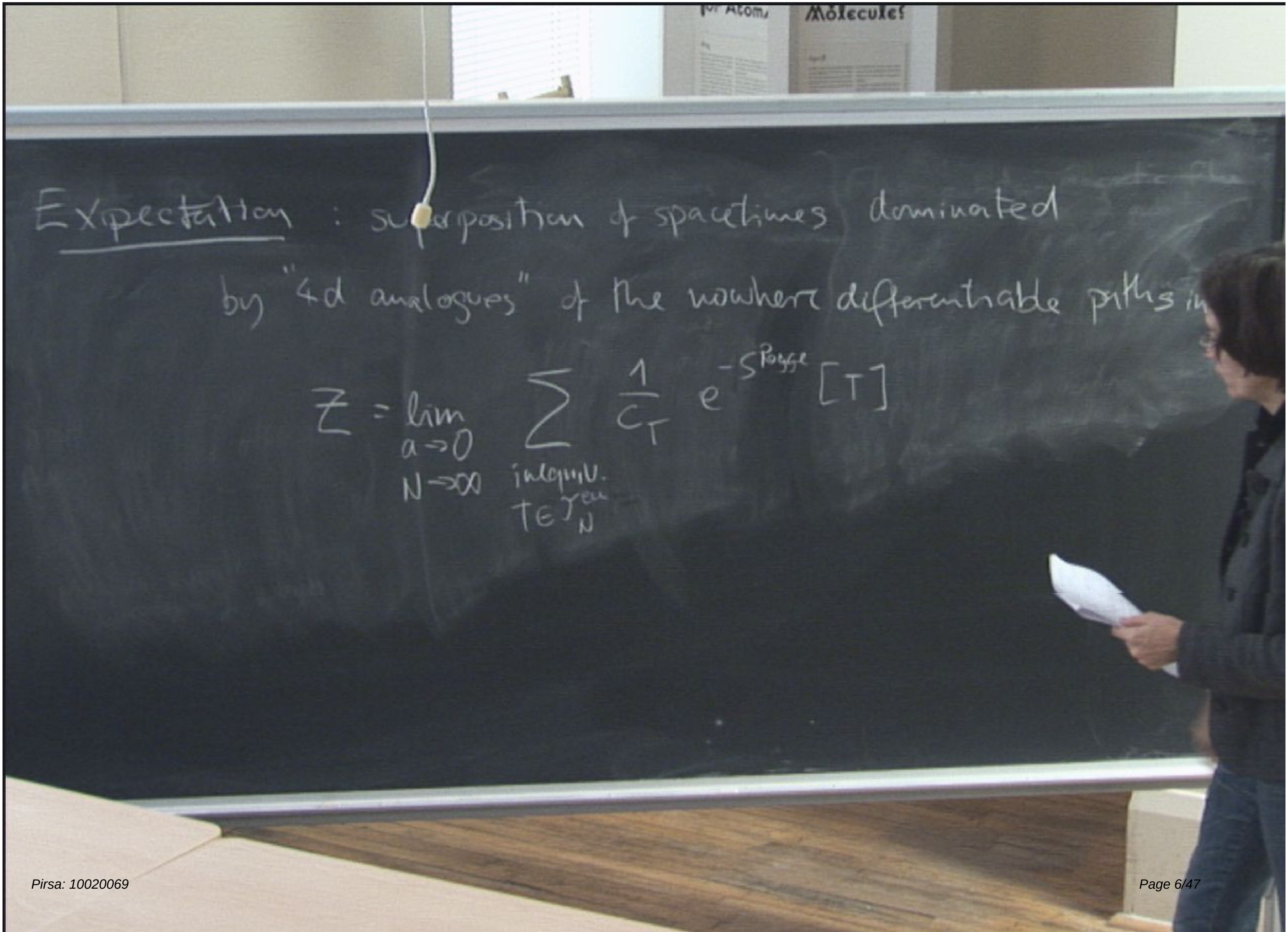
$$Z = \lim_{\substack{a \to 0 \\ N \to \infty}} \sum_{\substack{\text{inequiv.} \\ T \in \mathcal{T}_N}} \frac{1}{C_T} \, e^{i S^{\text{Regge}}[T]}$$


Molecules
Expectation : superposition of spacetimes dominated
by "4d analogues" of the nowhere differentiable paths in
$Z = \lim_{\substack{a \to 0 \\ N \to \infty}} \sum_{\substack{\text{inequiv.} \\ T \in \mathcal{T}_N^{reg}}} \frac{1}{C_T} e^{-S^{Regge}[T]}$

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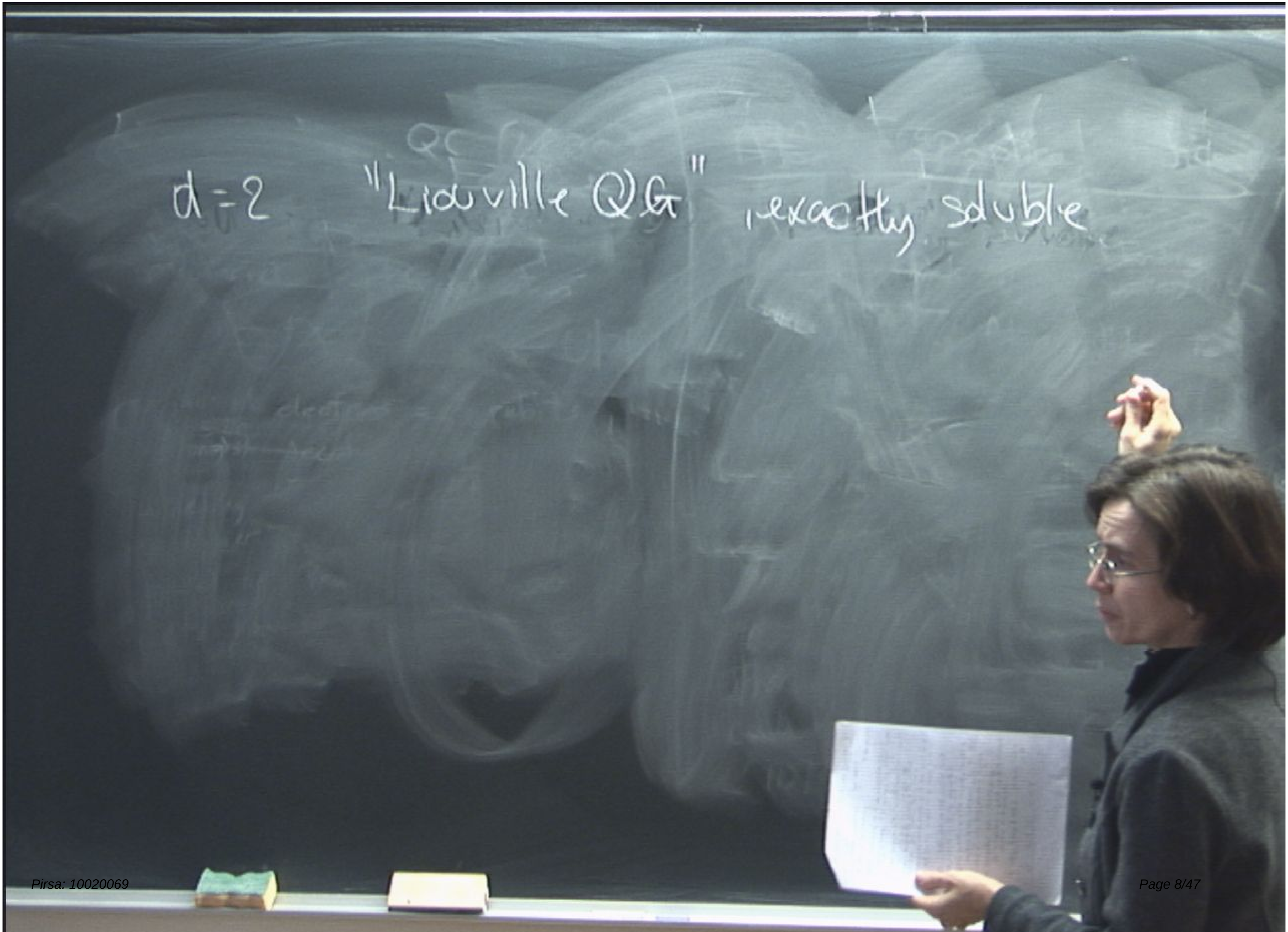
d = 2 "Liouville QG", exactly soluble

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$d>2$ EDT (Euclidean DT) has no good class. limit.

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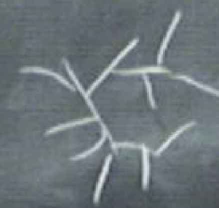
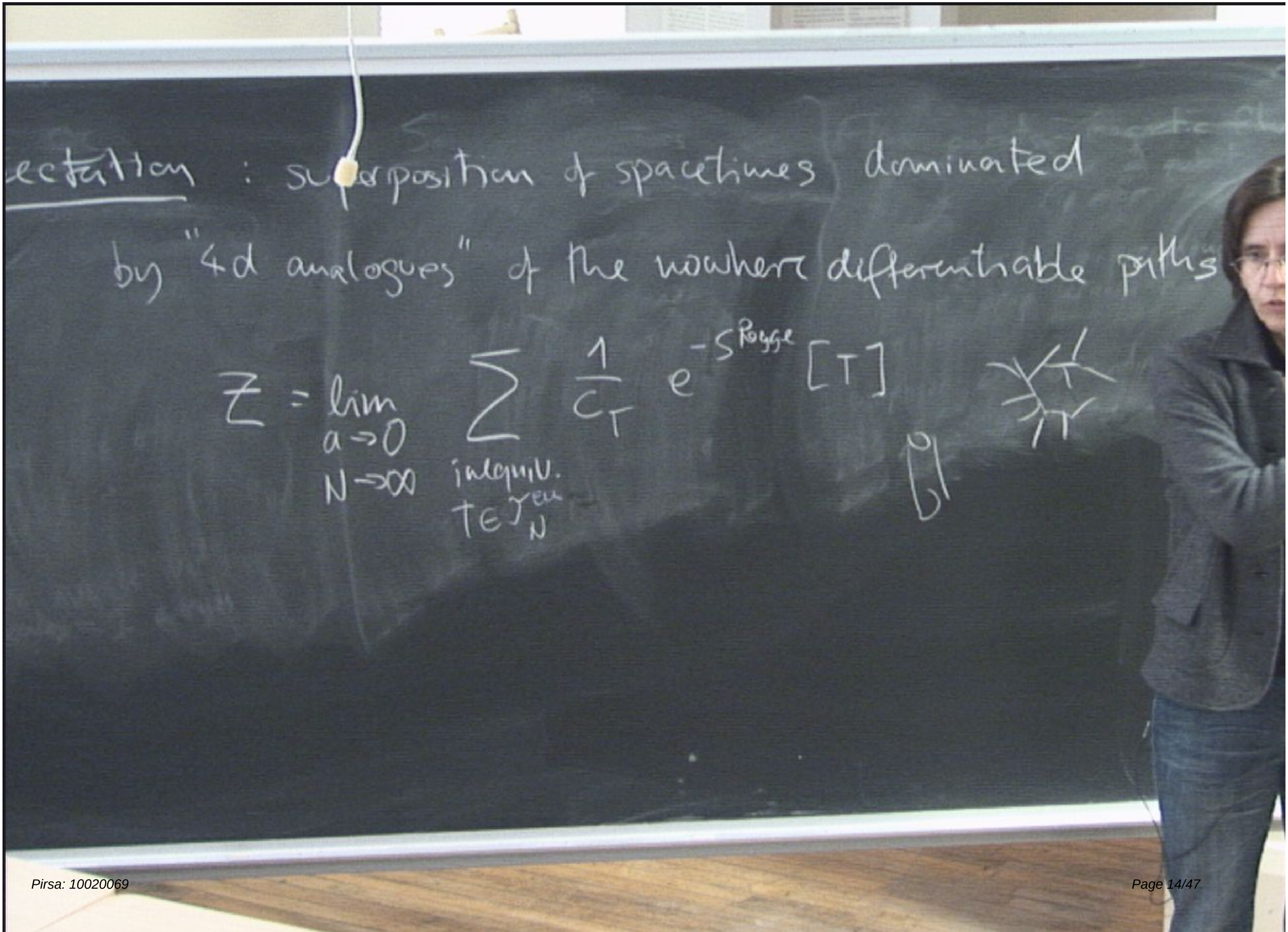


$d_H = 2$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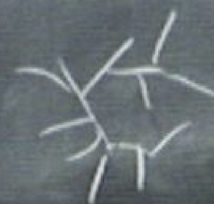

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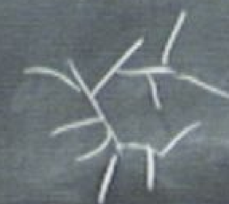

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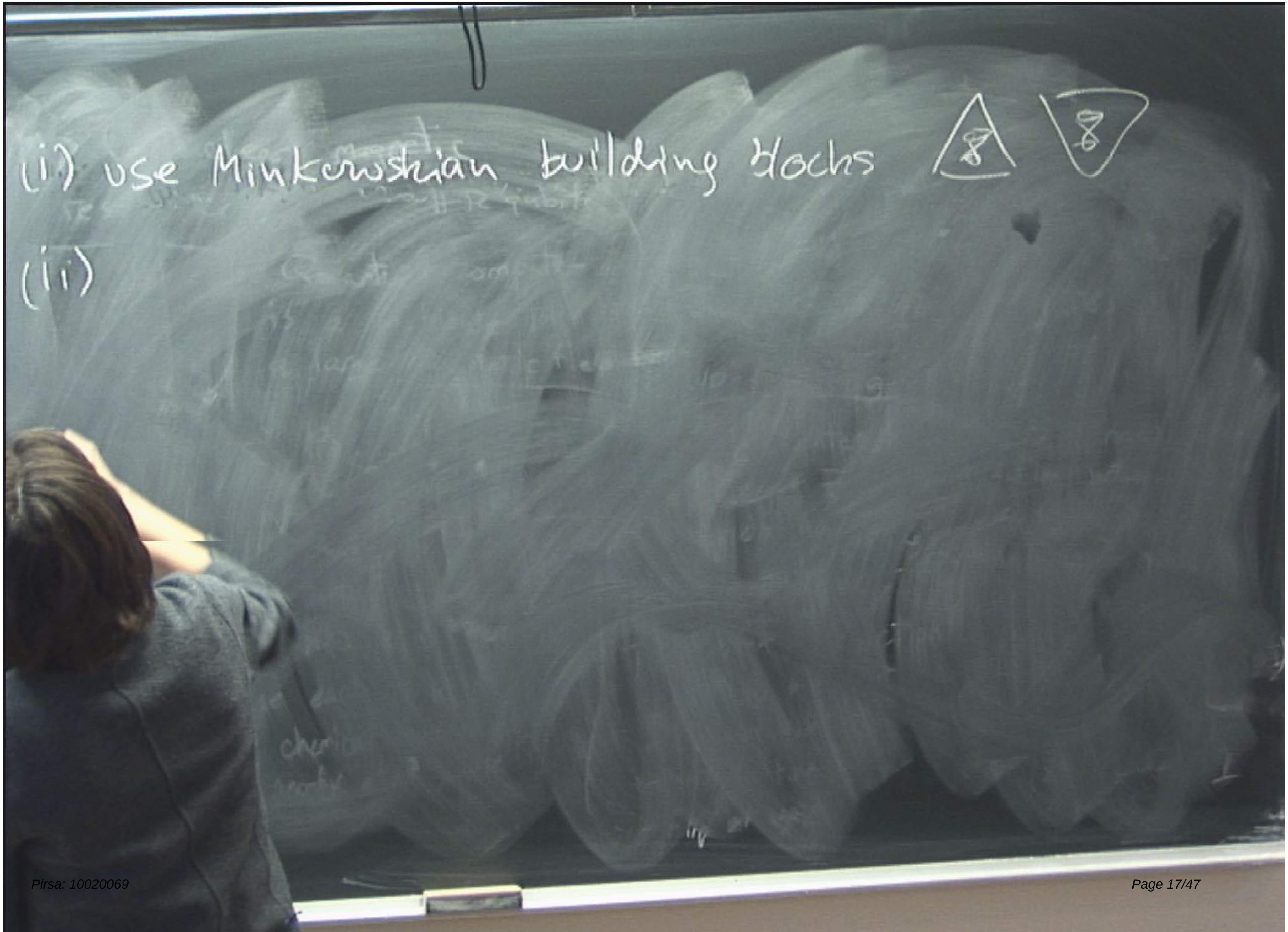
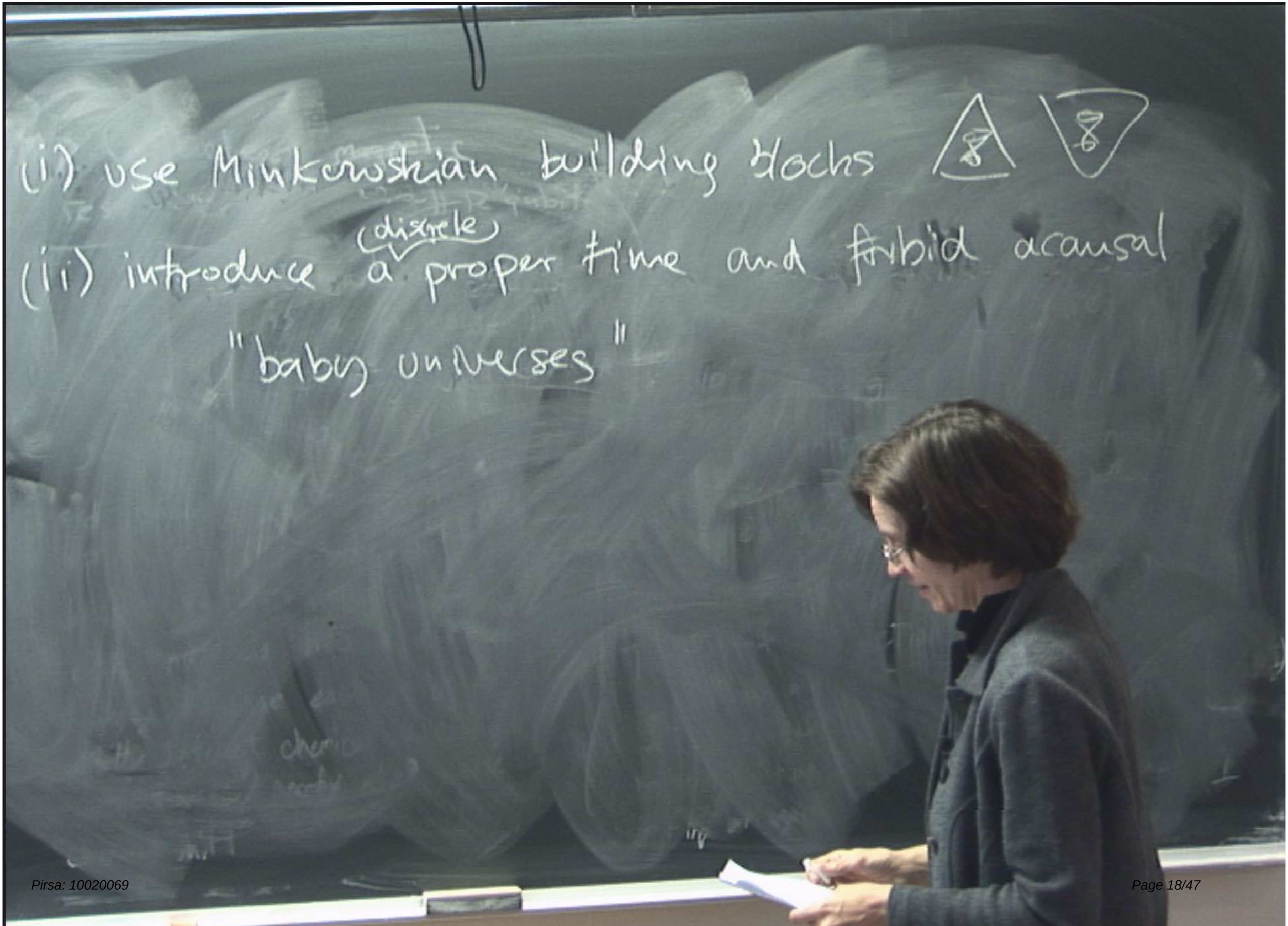
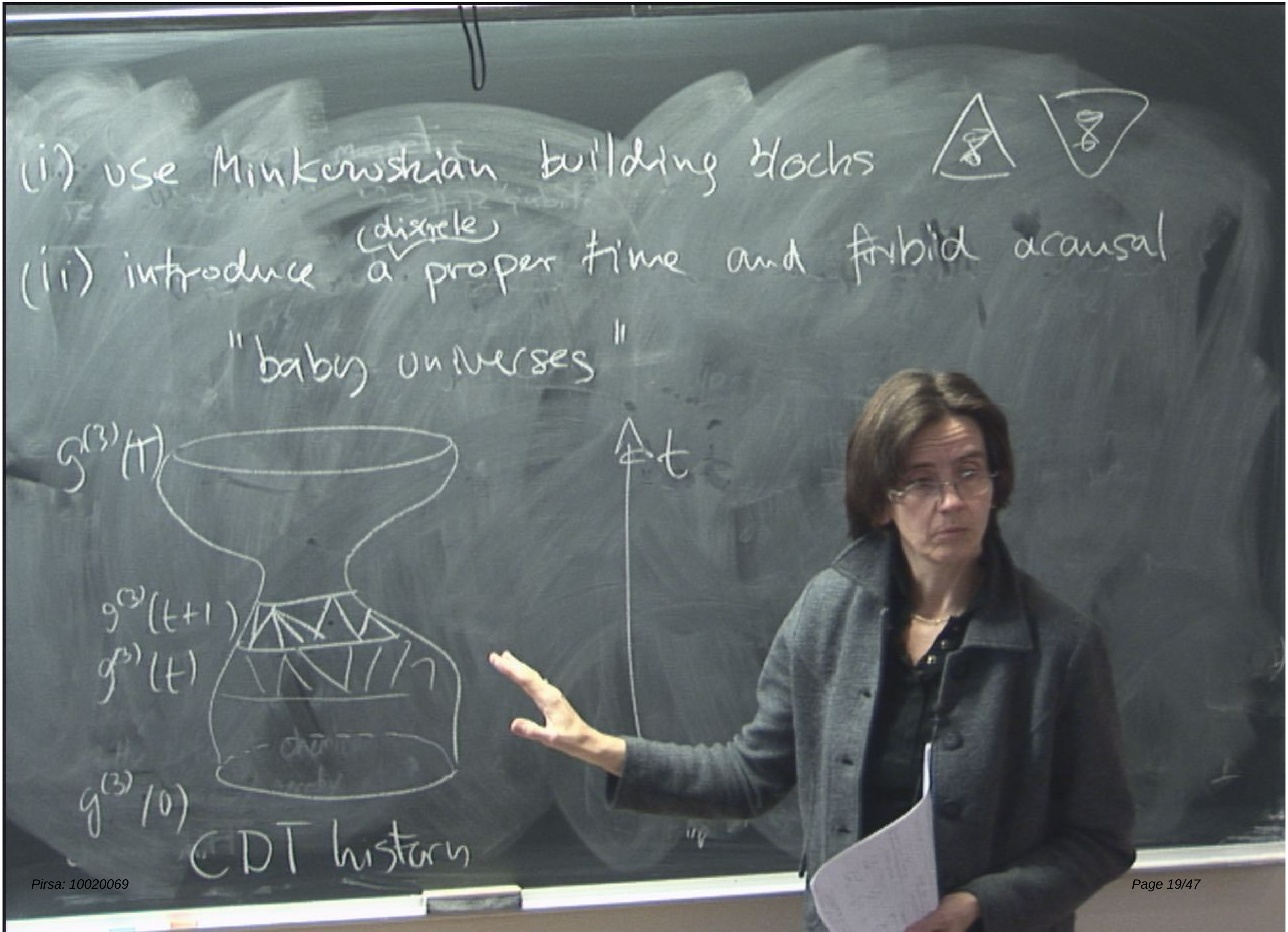

(i) use Minkowskian building blocks
(ii)

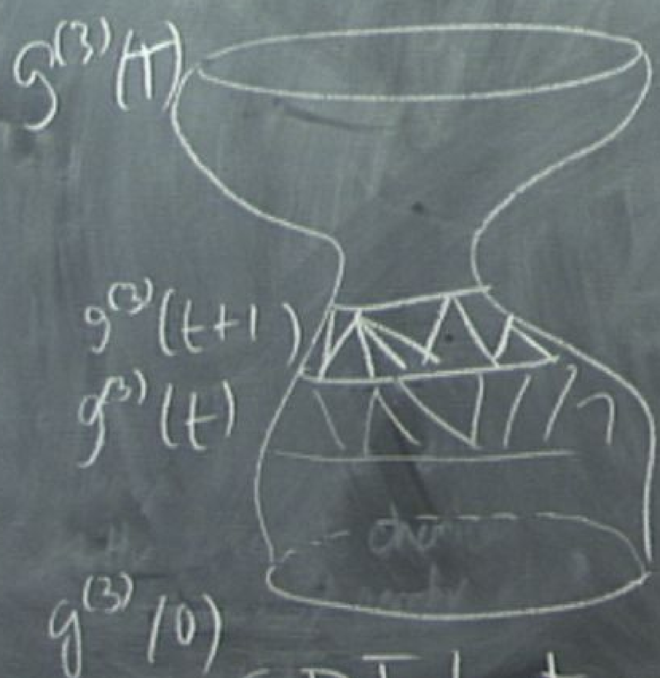

(i) use Minkowskian building blocks
(ii) introduce a (discrete) proper time and forbid acausal
"baby universes"


(i) use Minkowskian building blocks
(discrete)
(ii) introduce a proper time and forbid acausal
"baby universes"
$g^{(3)}(t)$
$g^{(3)}(t+1)$
$g^{(3)}(t)$
$g^{(3)}(0)$
t
CDT history

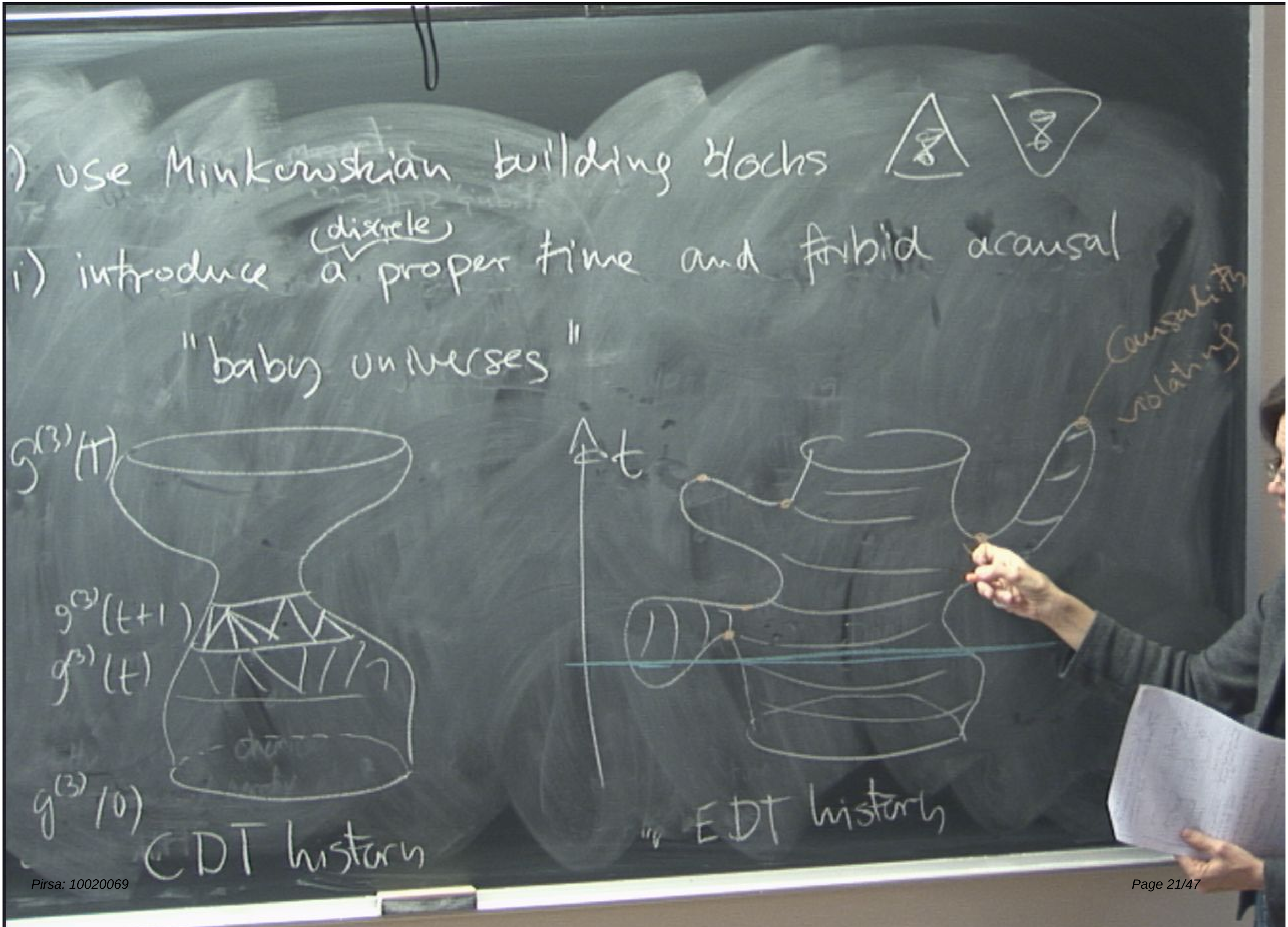
(i) use Minkowskian building blocks

(ii) introduce a (discrete) proper time and forbid acausal

"baby universes"



CDT history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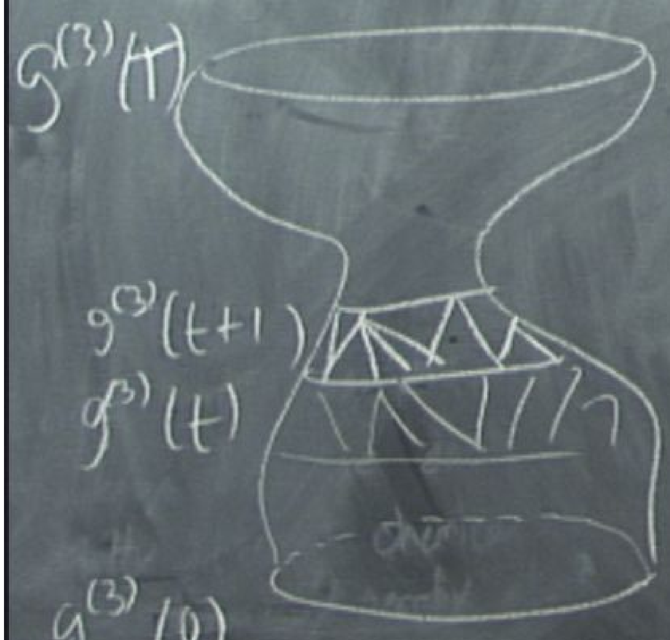
i) introduce a (discrete) proper time and forbid acausal
"baby universes"
causality violating
$g^{(3)}(T)$
$g^{(3)}(t+1)$
$g^{(3)}(t)$
$g^{(3)}(0)$
t
CDT history
"EDT history"

) use Minkowskian building blocks 

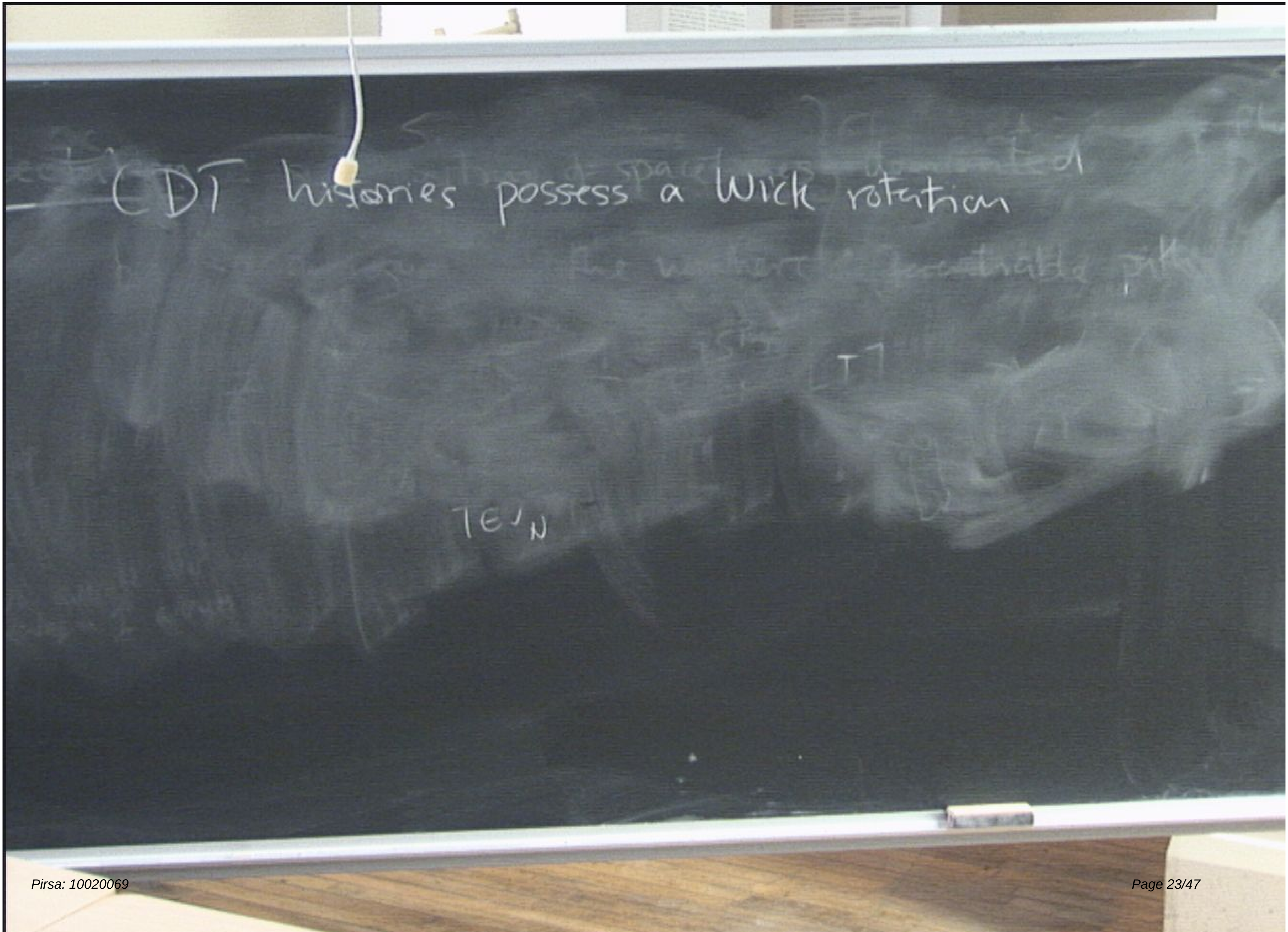
i) introduce a (discrete) proper time and forbid acausal

"baby universes"



CDT history

"EDT history


CDT histories possess a Wick rotation

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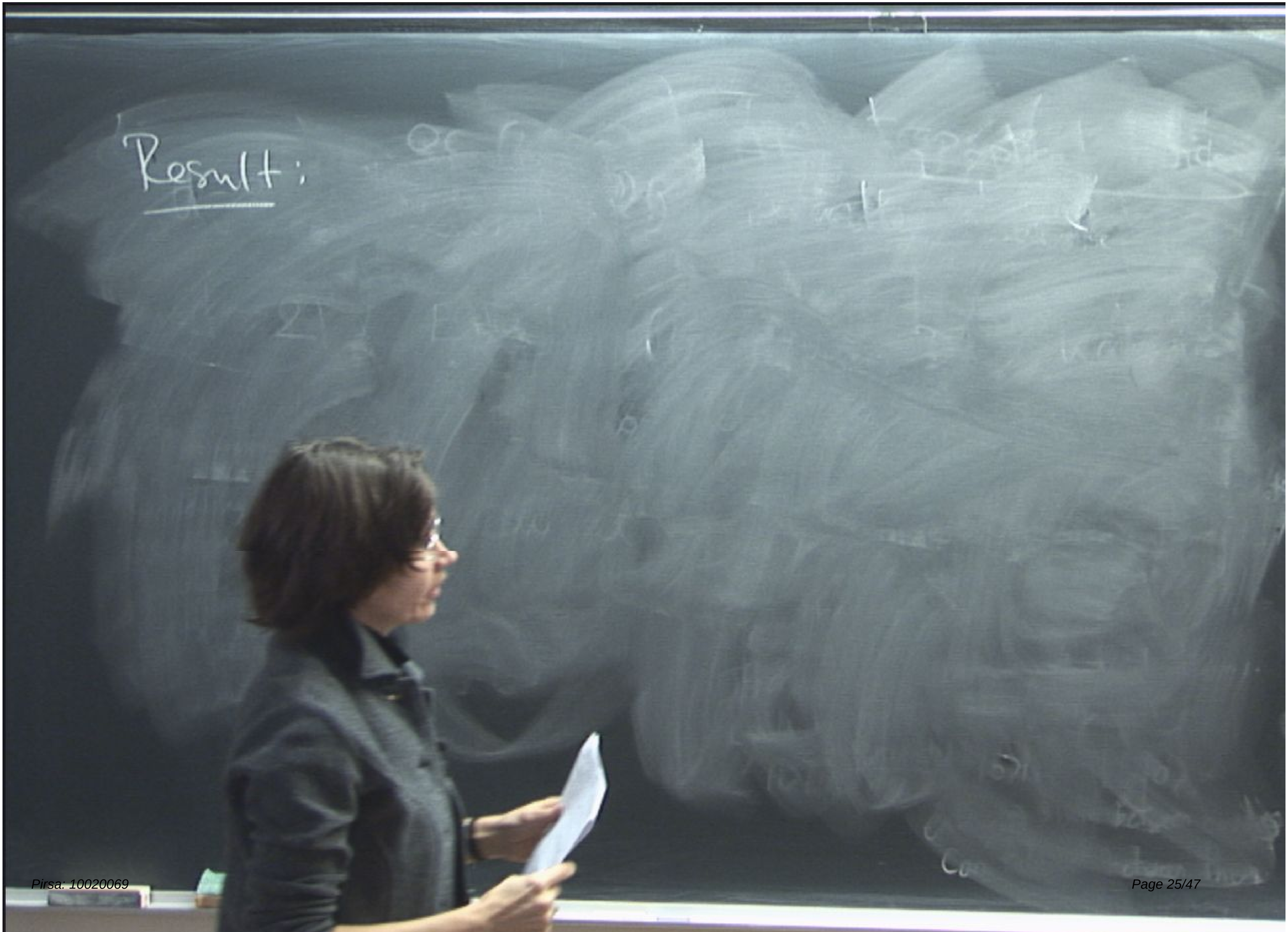
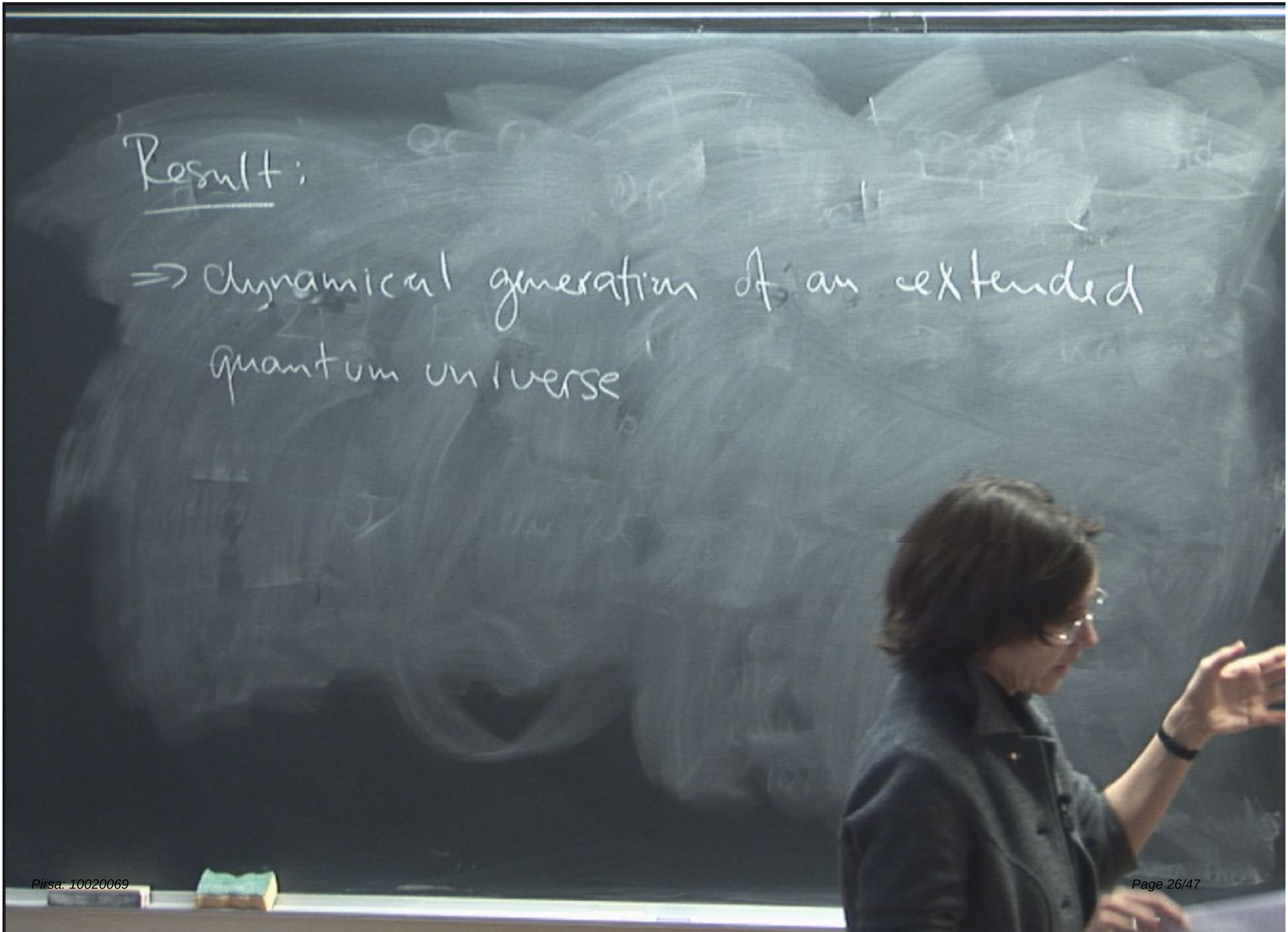
Wick (Lorentzian DT) $\subsetneq$ Euclidean DT


Result:


Result:
⇒ dynamical generation of an extended
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on large scales: de Sitter space!

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$$\langle V_3(t) \rangle = \frac{1}{Z} \sum_T \frac{1}{C_T} \, V_3(t) \, e^{-S^{Regge}[T]}$$

3-volume

Result:

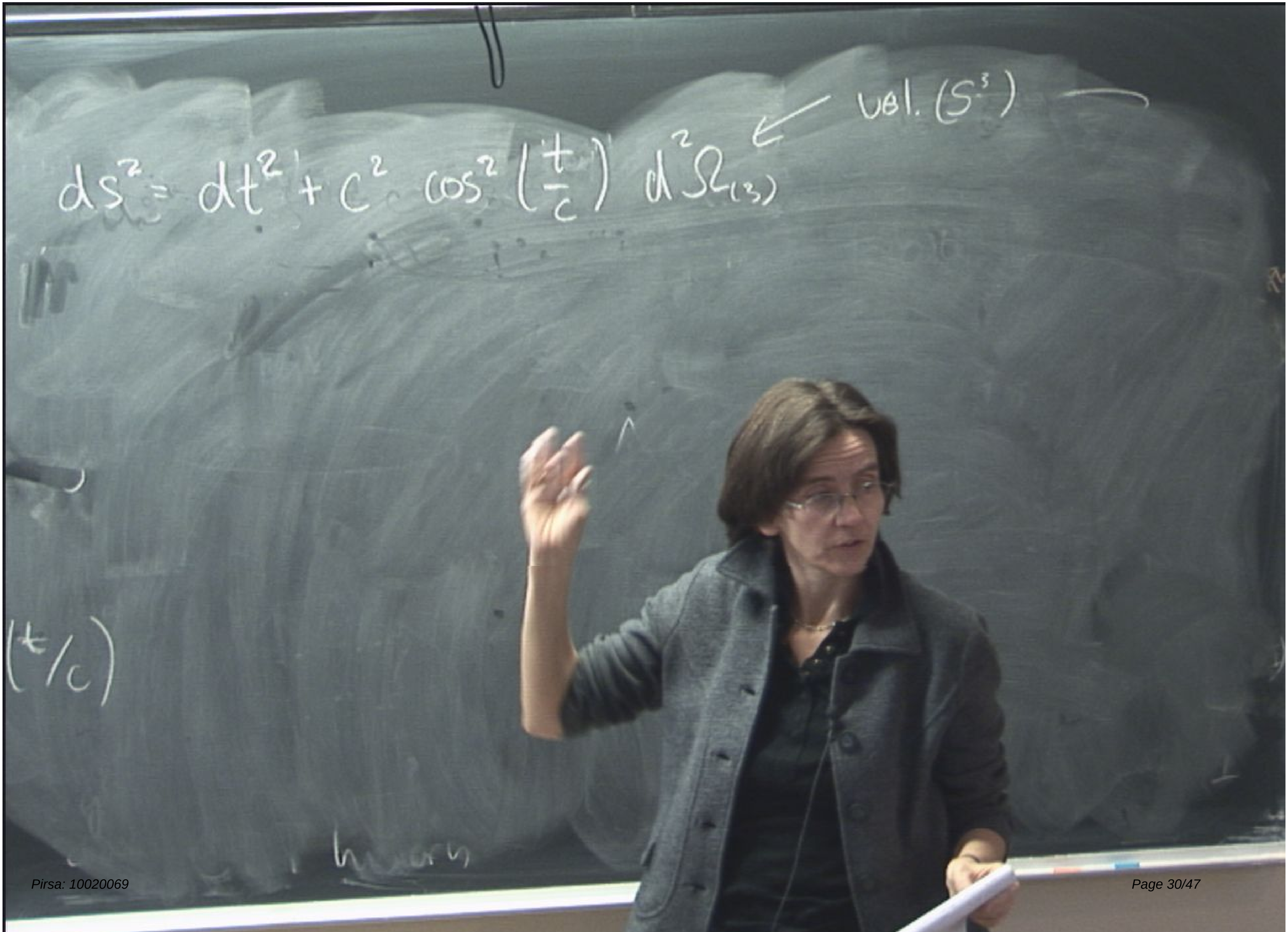
$\Rightarrow$ dynamical generation of an extended quantum universe

on large scales: de Sitter space!

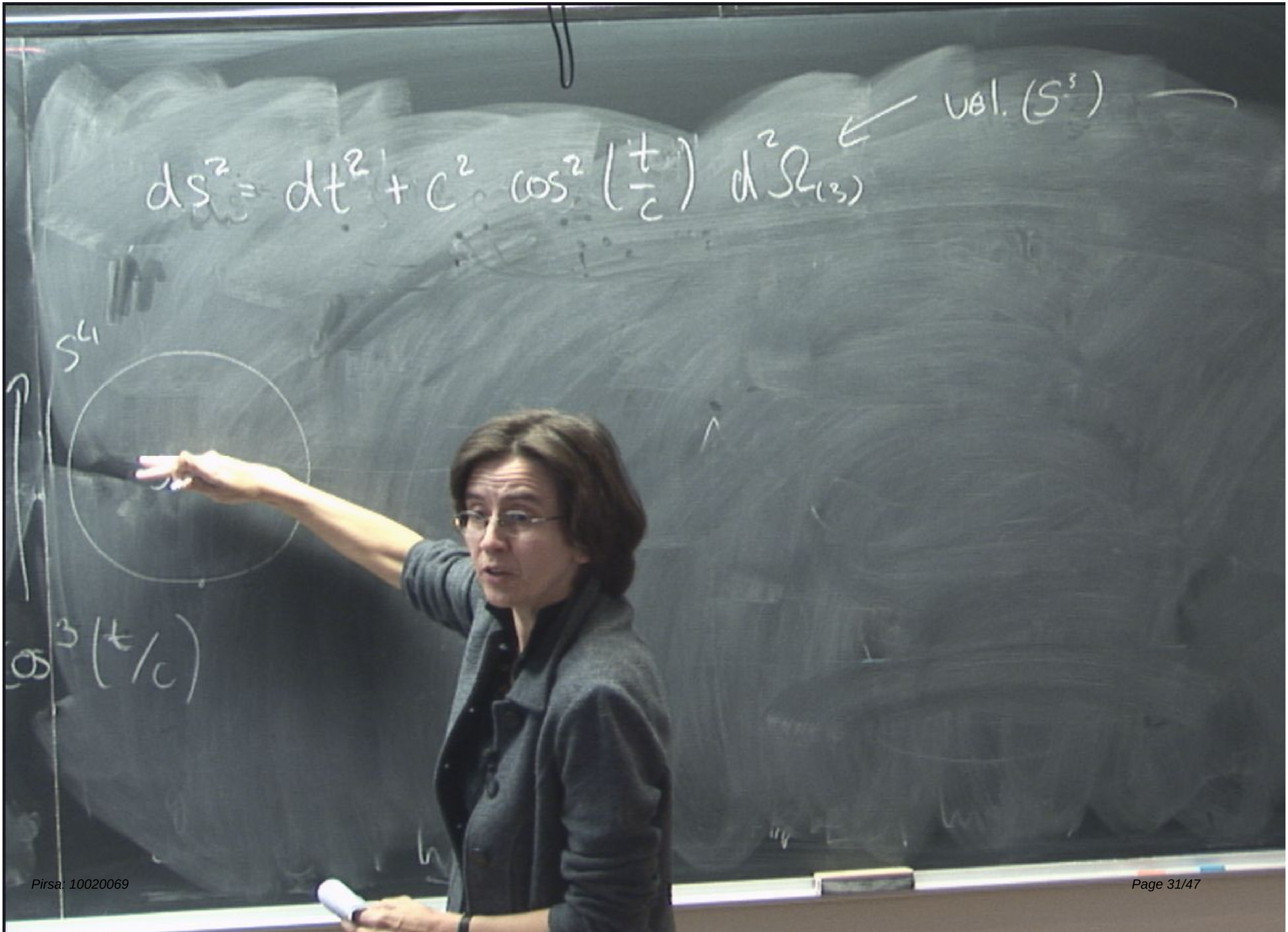
$$\langle V_3(t) \rangle = \frac{1}{Z} \sum_T \frac{1}{C_T} V_3(t)\, e^{-S^{Regge}[T]} \propto \cos^3(t/c)$$

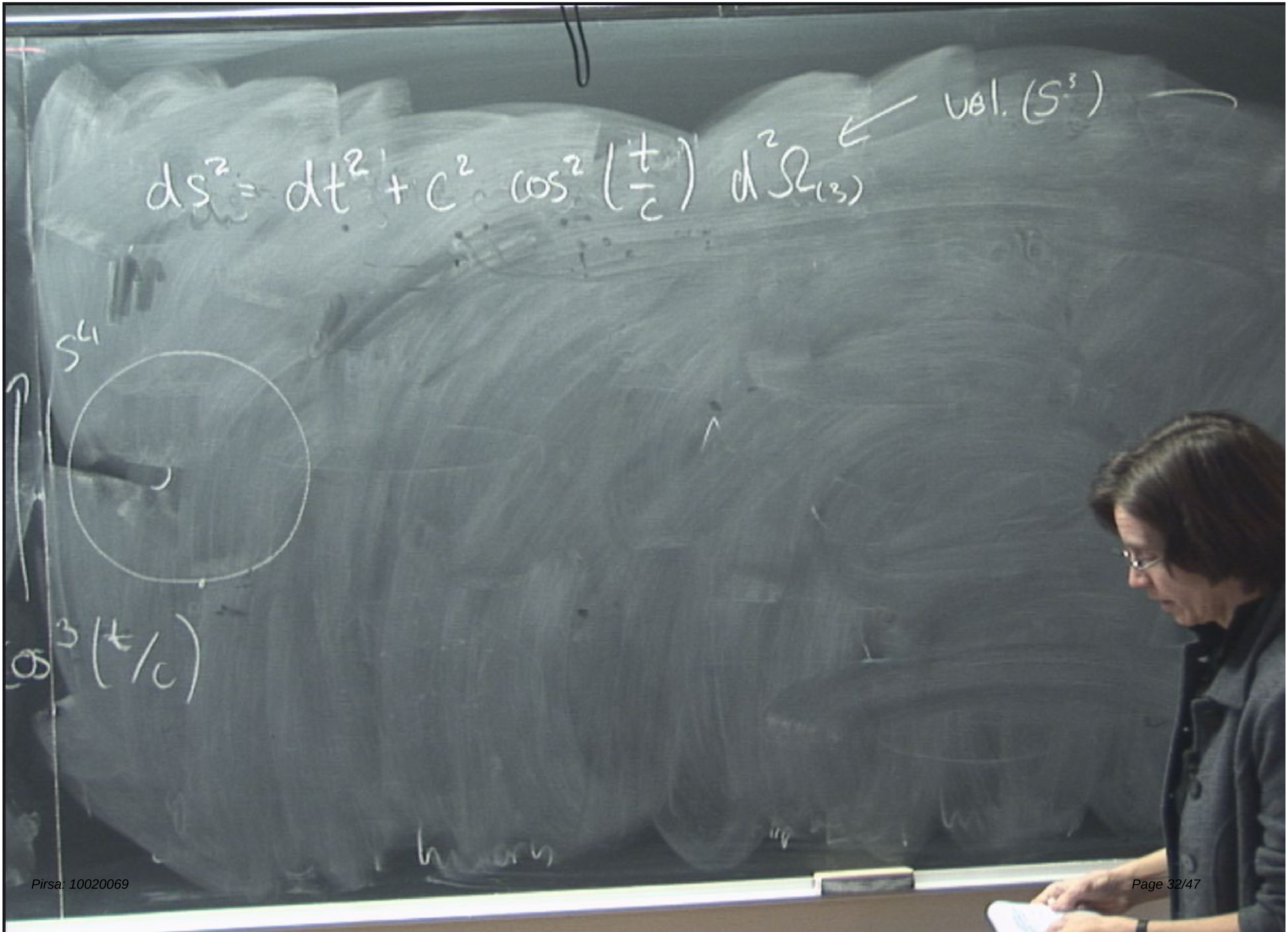
3-volume

$ds^2 =$



$ds^2 = dt^2 + c^2 \cos^2\left(\frac{t}{c}\right) d^2\Omega_{(3)}$
vol. (S^3)
(t/c)


vol. (S³)
ds² = dt² + c² cos² (t/c) d²Ω(3)
S⁴
cos³ (t/c)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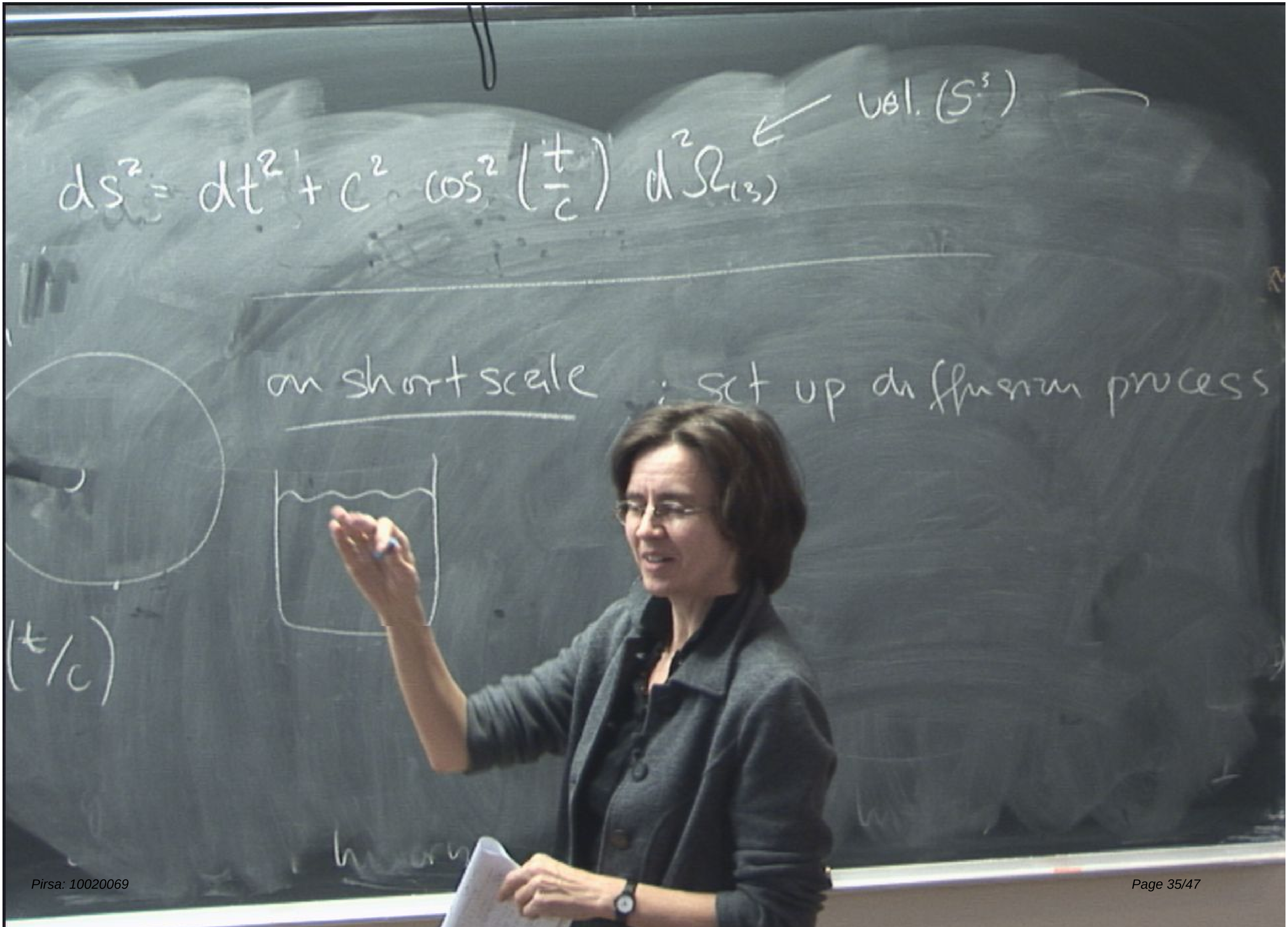
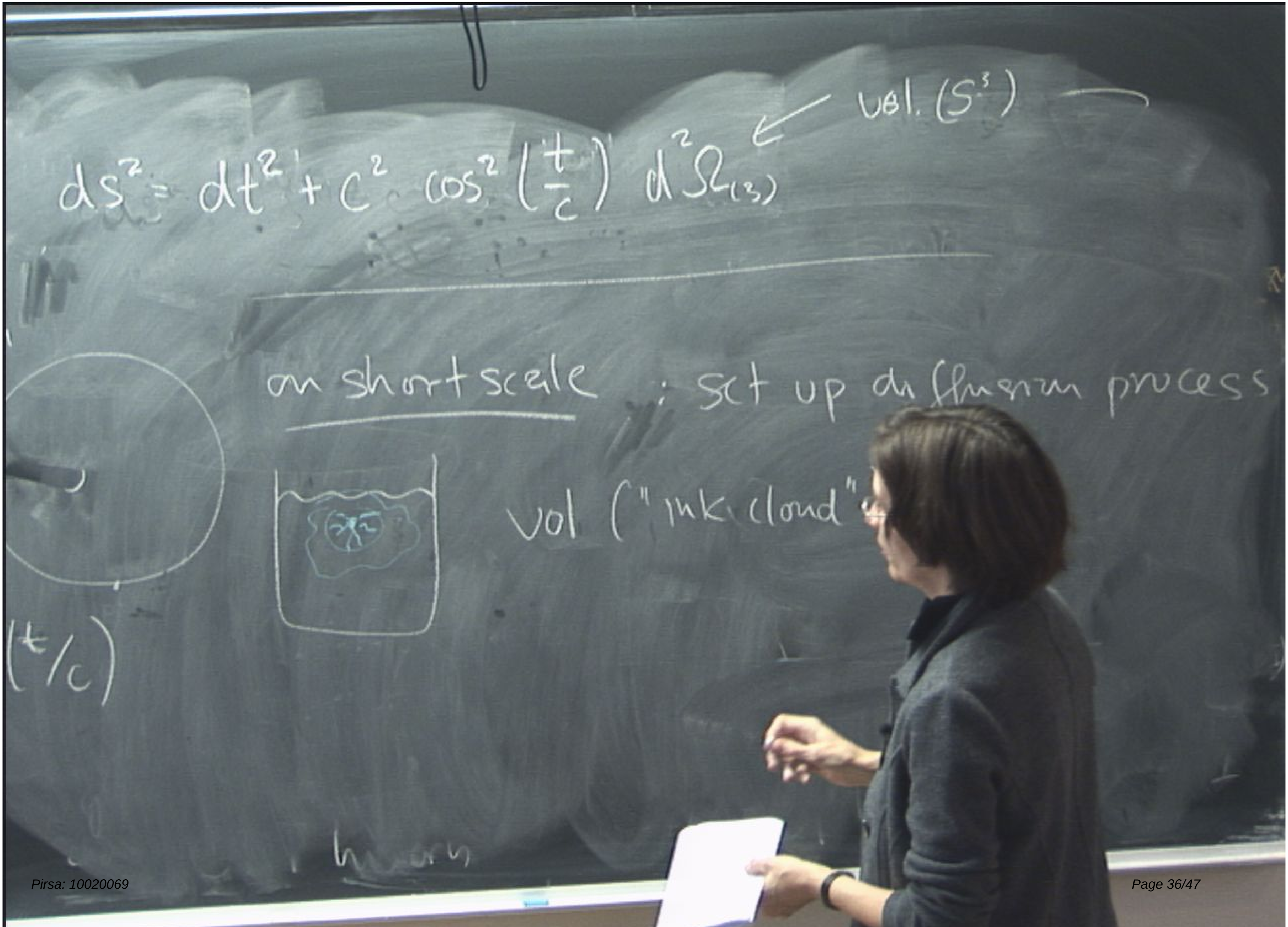
S^4

on short scale

$\cos^3(t/c)$


$ds^2 = dt^2 + c^2 \cos^2\left(\frac{t}{c}\right) d^2\Omega_{(3)}$
vol. (S^3)
on short scale
; set up diffusion process
(t/c)


vol. (S^3)
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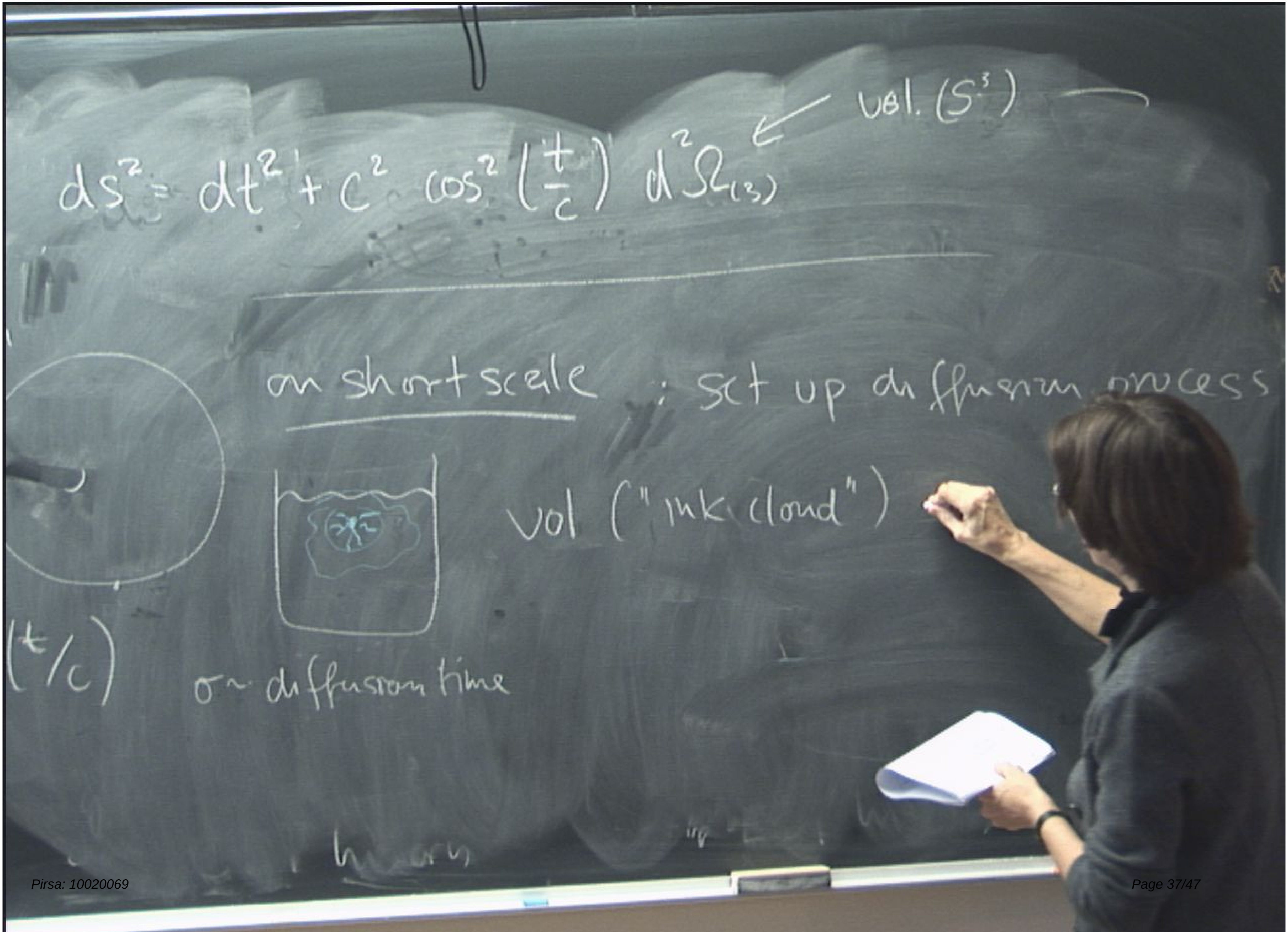
vol ("ink cloud"
(t/c)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σ ~ diffusion time

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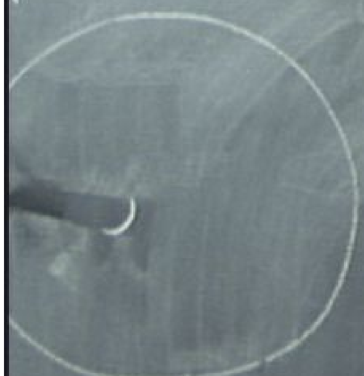

(t/c)

on short scale ; set up diffusion process

$$\text{vol}\,(\text{"ink cloud"}) \sim \sigma^{d_s/2}$$

$\sigma \sim$ diffusion time

vol. (S^3)

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on short scale : set up diffusion process

vol ("ink cloud") $\sim \sigma$

$d_S \sim$ spectral dimension

(t/c)

$\sigma \sim$ diffusion time

$$ds^2 = dt^2 + c^2 \cos^2\left(\frac{t}{c}\right) d^2\Omega_{(3)}$$ ← vol. (S^3)

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(t/c)

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(t/c)

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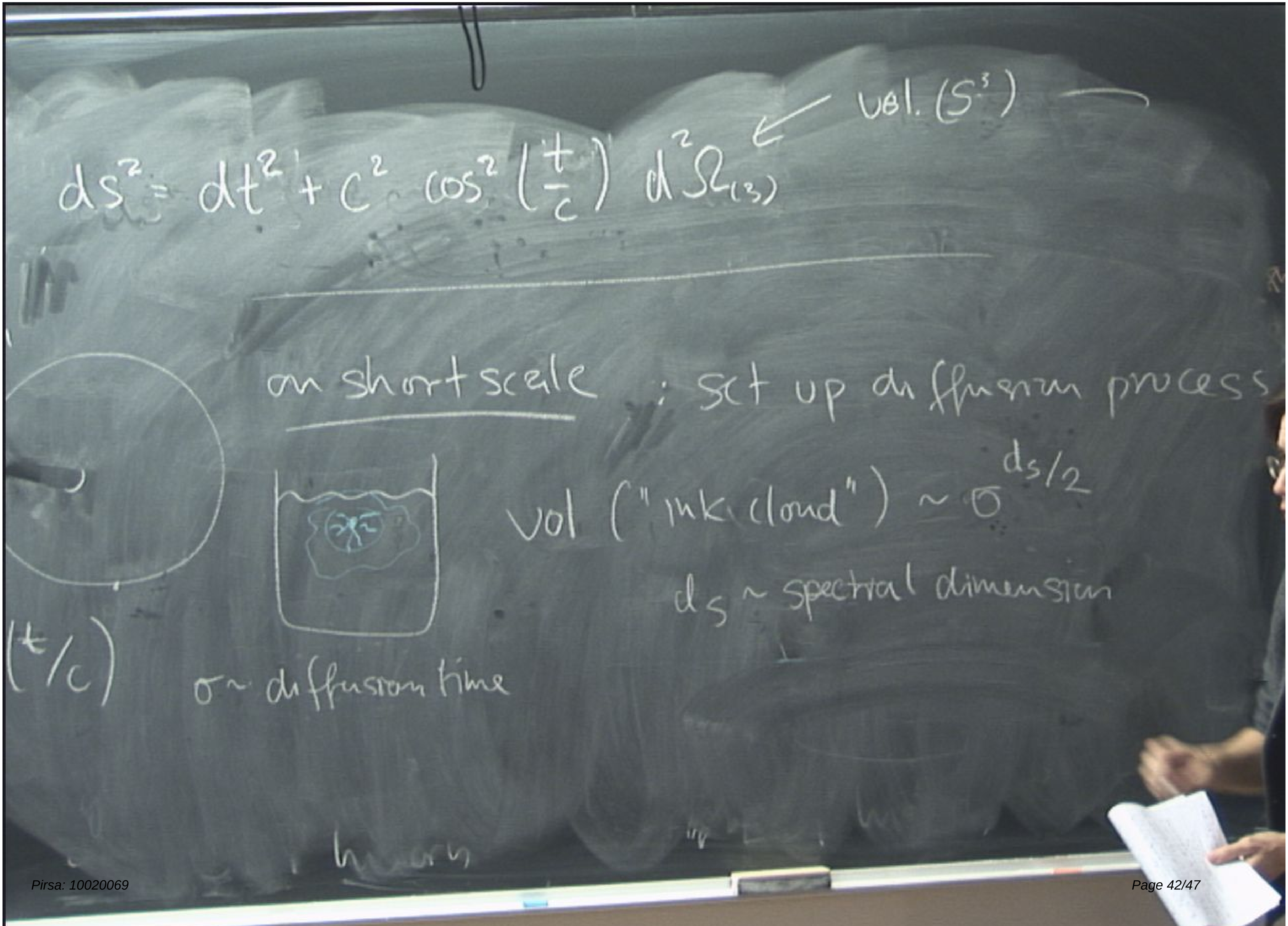
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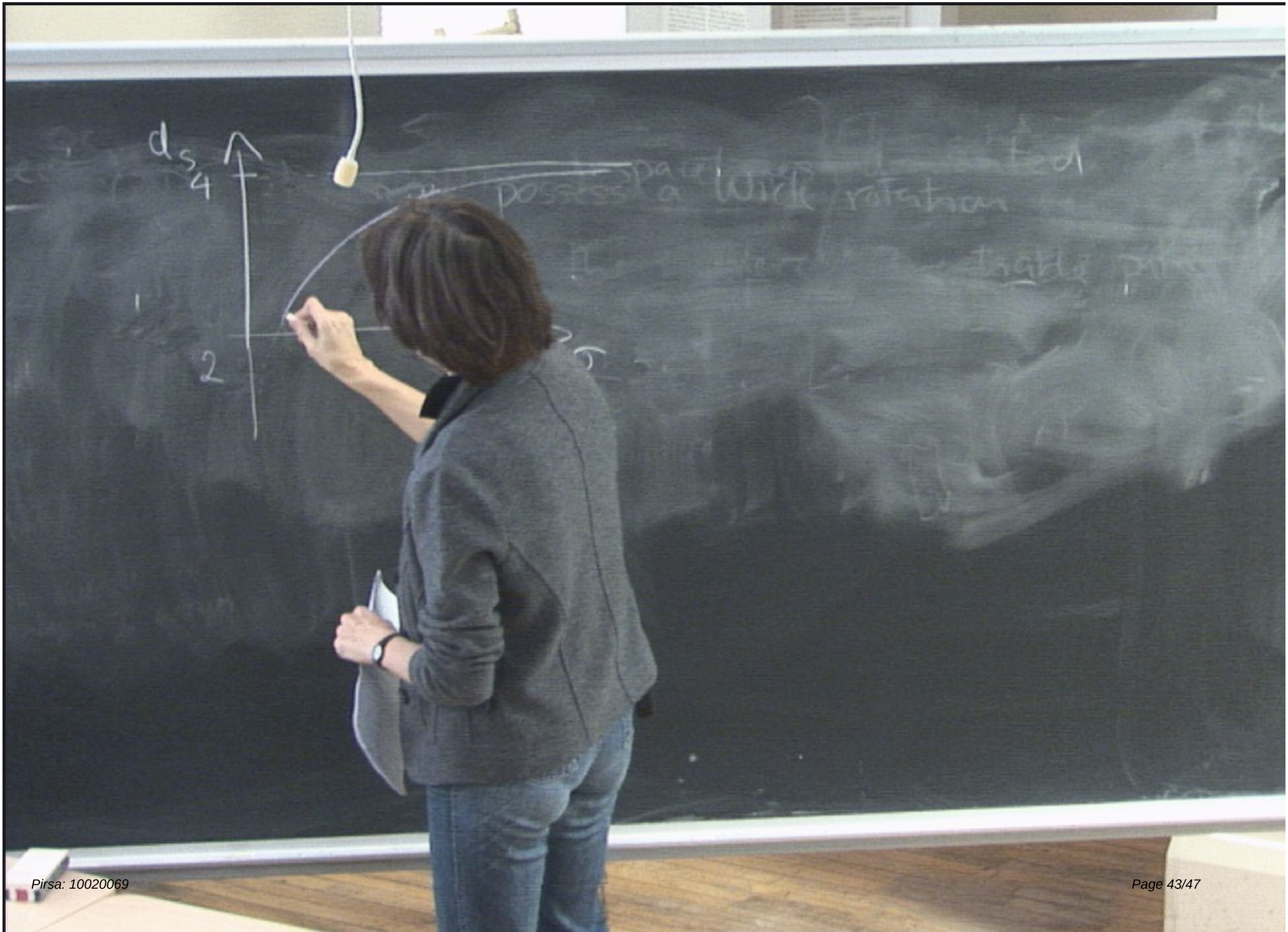
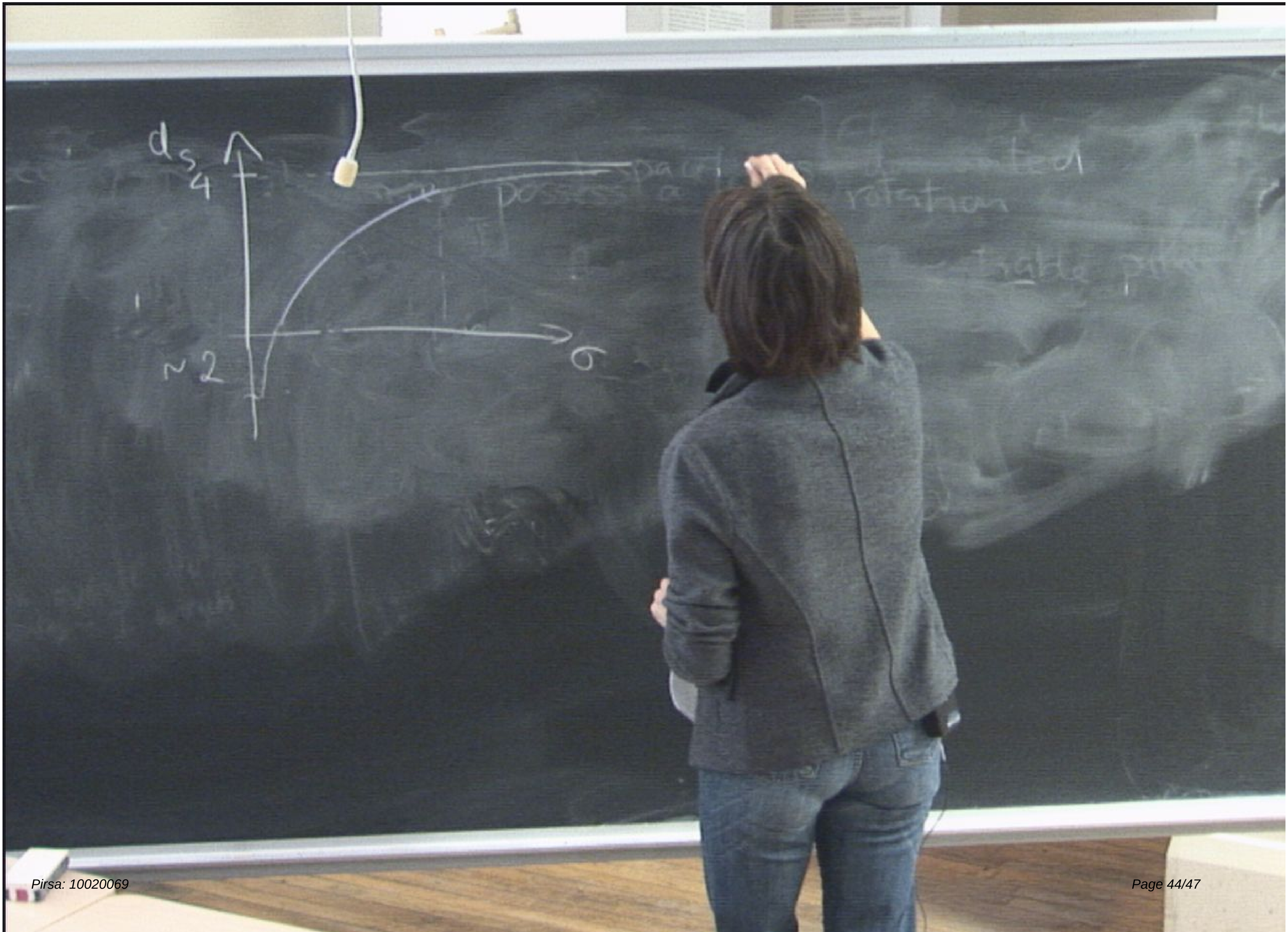
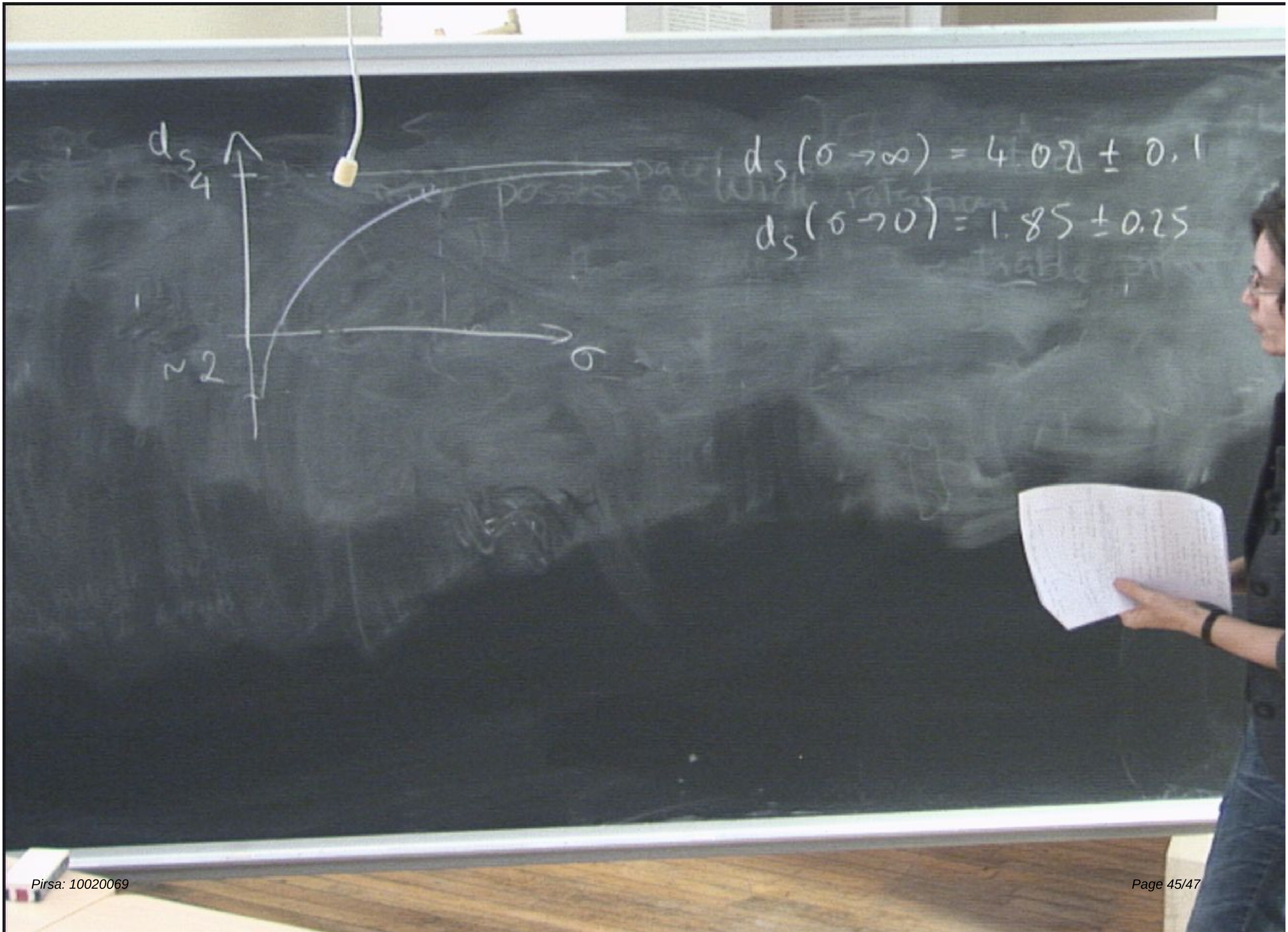
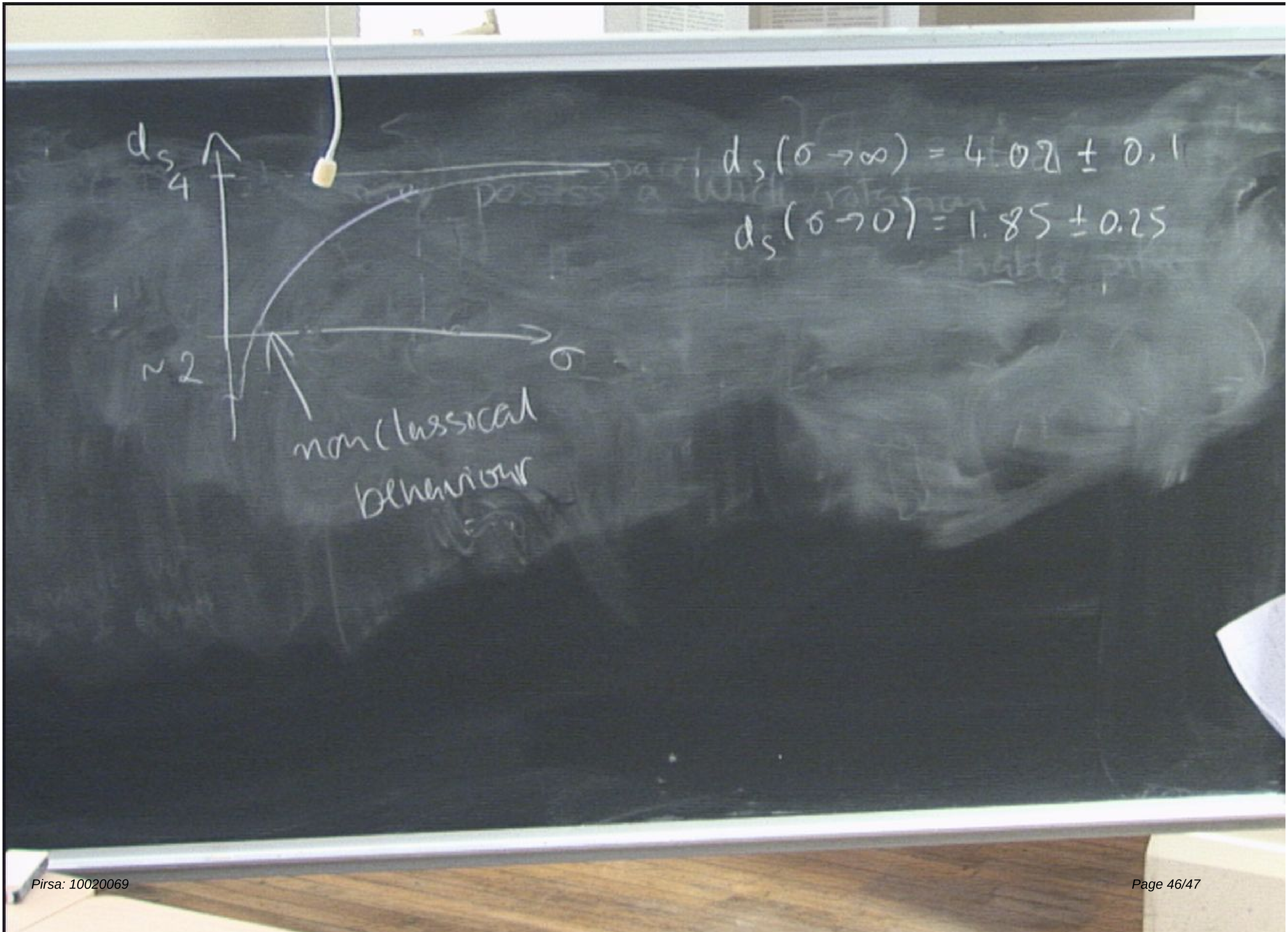


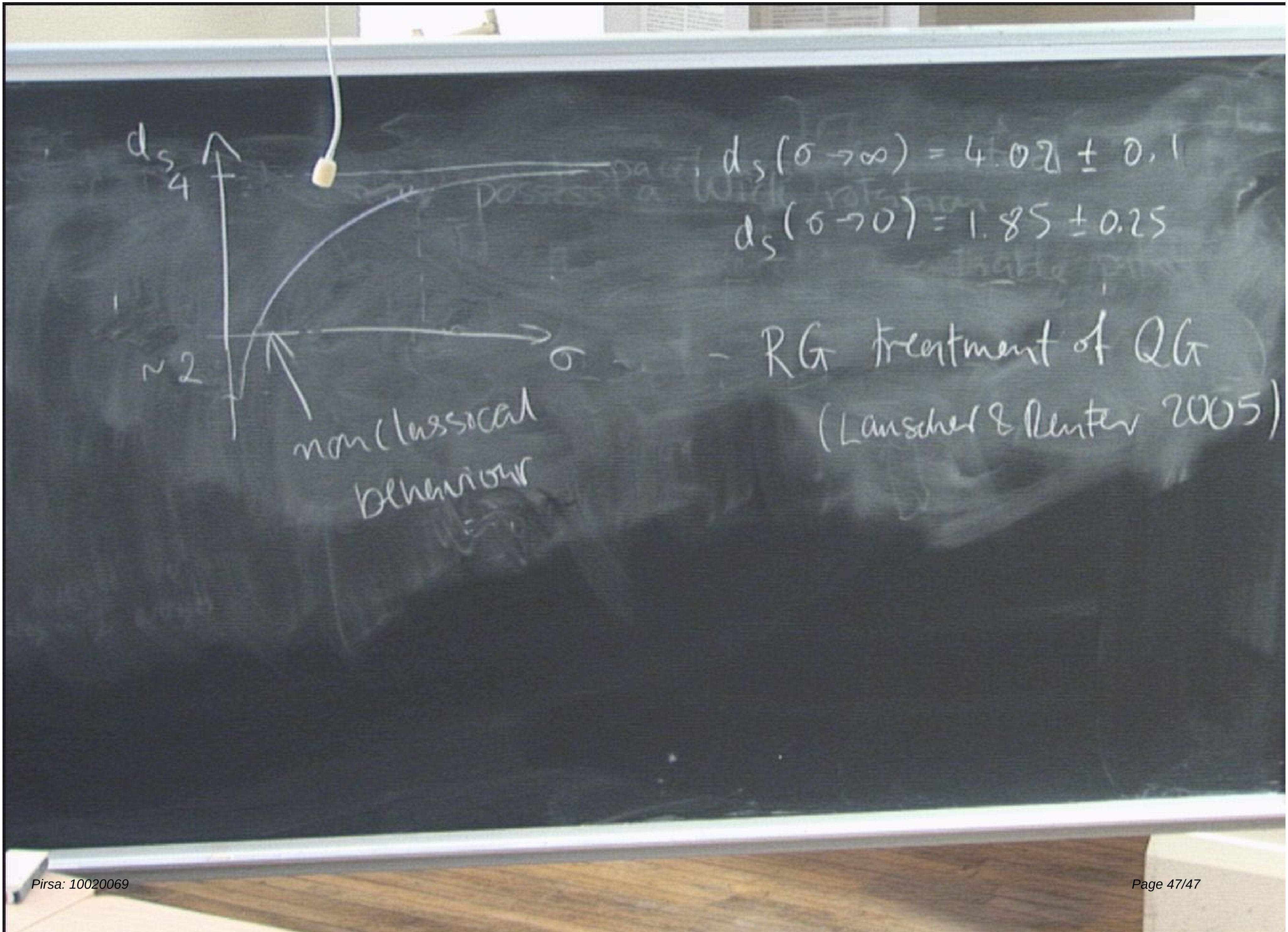
possess a Wick rotation


ds4
~2
σ
possess
rotation


$d_s(\sigma \to \infty) = 4.02 \pm 0.1$
$d_s(\sigma \to 0) = 1.85 \pm 0.25$
d_s
4
~2
σ



d_s
4
~2
σ
non classical behaviour
$d_s(\sigma \to \infty) = 4.02 \pm 0.1$
$d_s(\sigma \to 0) = 1.85 \pm 0.25$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- RG treatment of QG
(Lauscher & Reuter 2005)