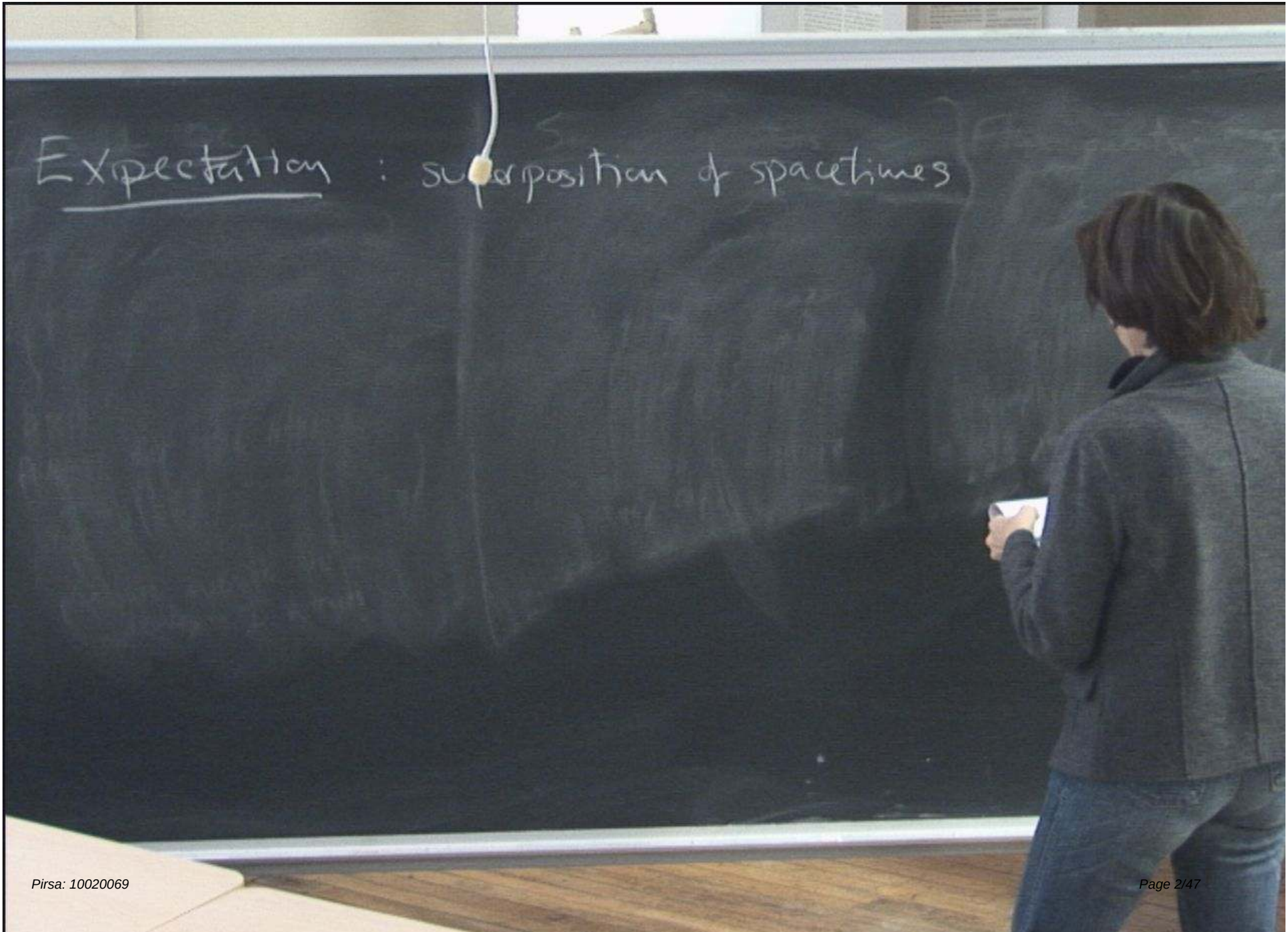
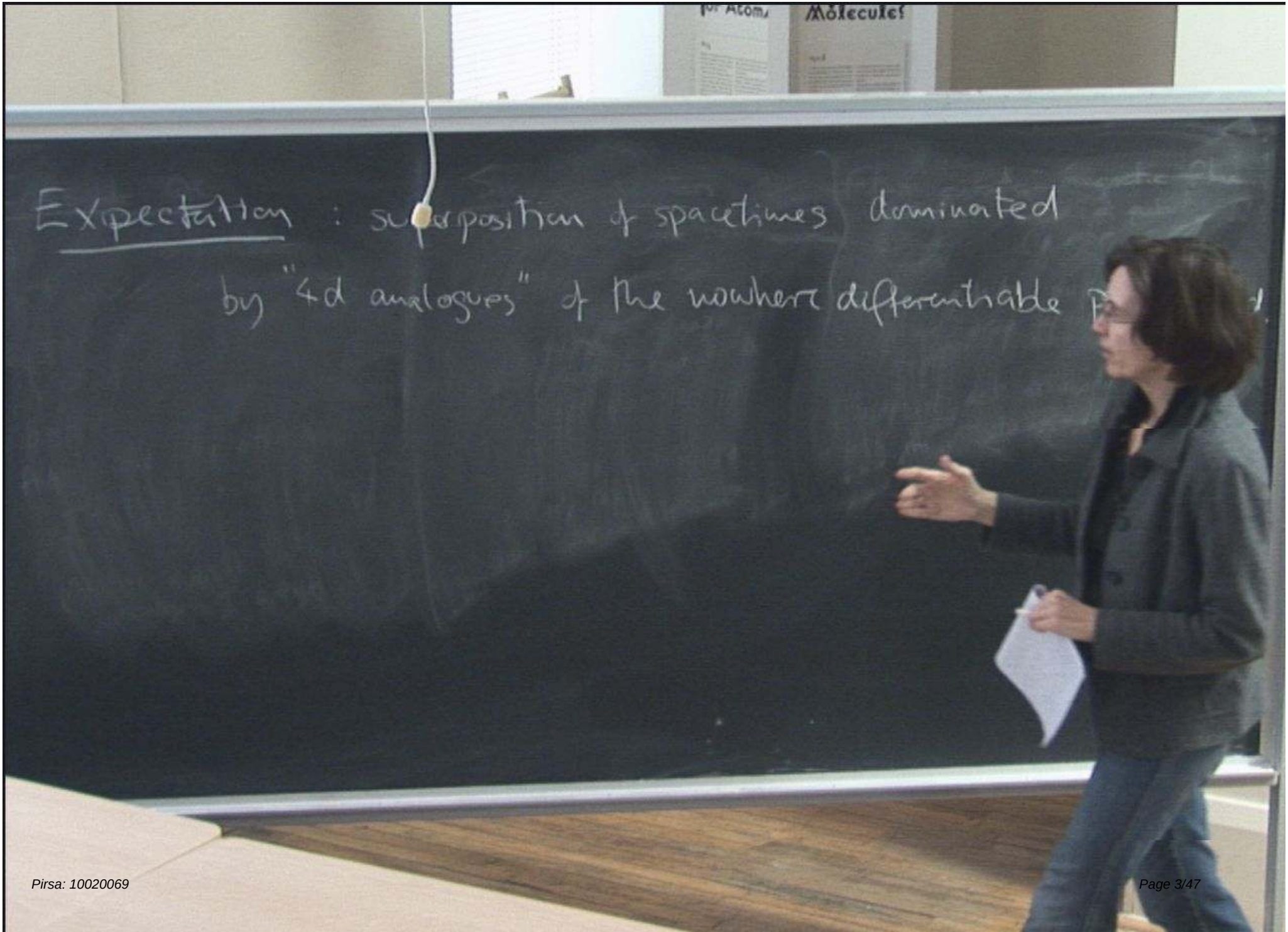
Title: Quantum Gravity - Review (PHYS 638) - Lecture 15

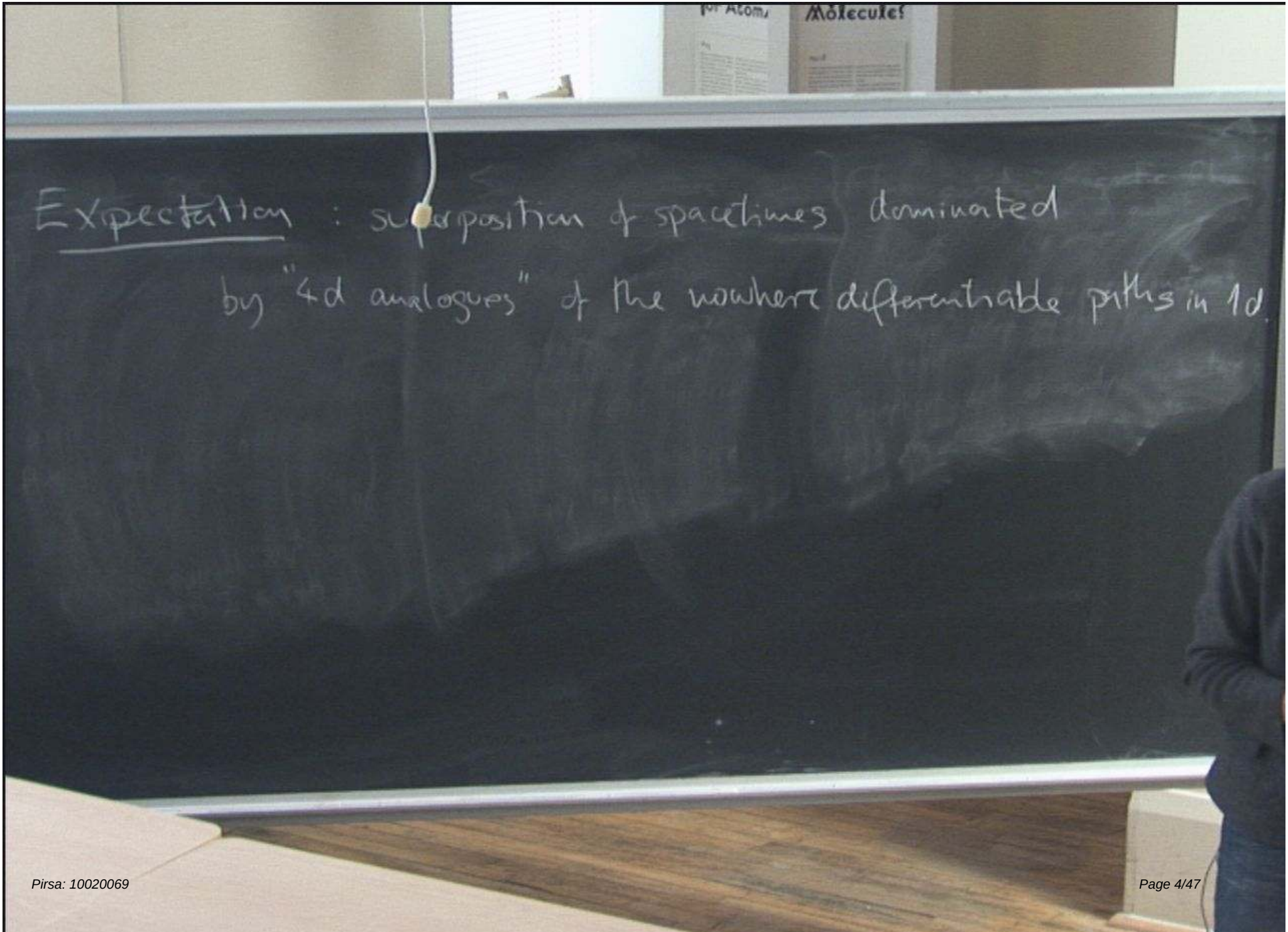
Date: Feb 12, 2010 10:00 AM

URL: http://pirsa.org/10020069

Abstract:


Expectation : superposition of spacetimes


Expectation : superposition of spacetimes dominated
by "4d analogues" of the nowhere differentiable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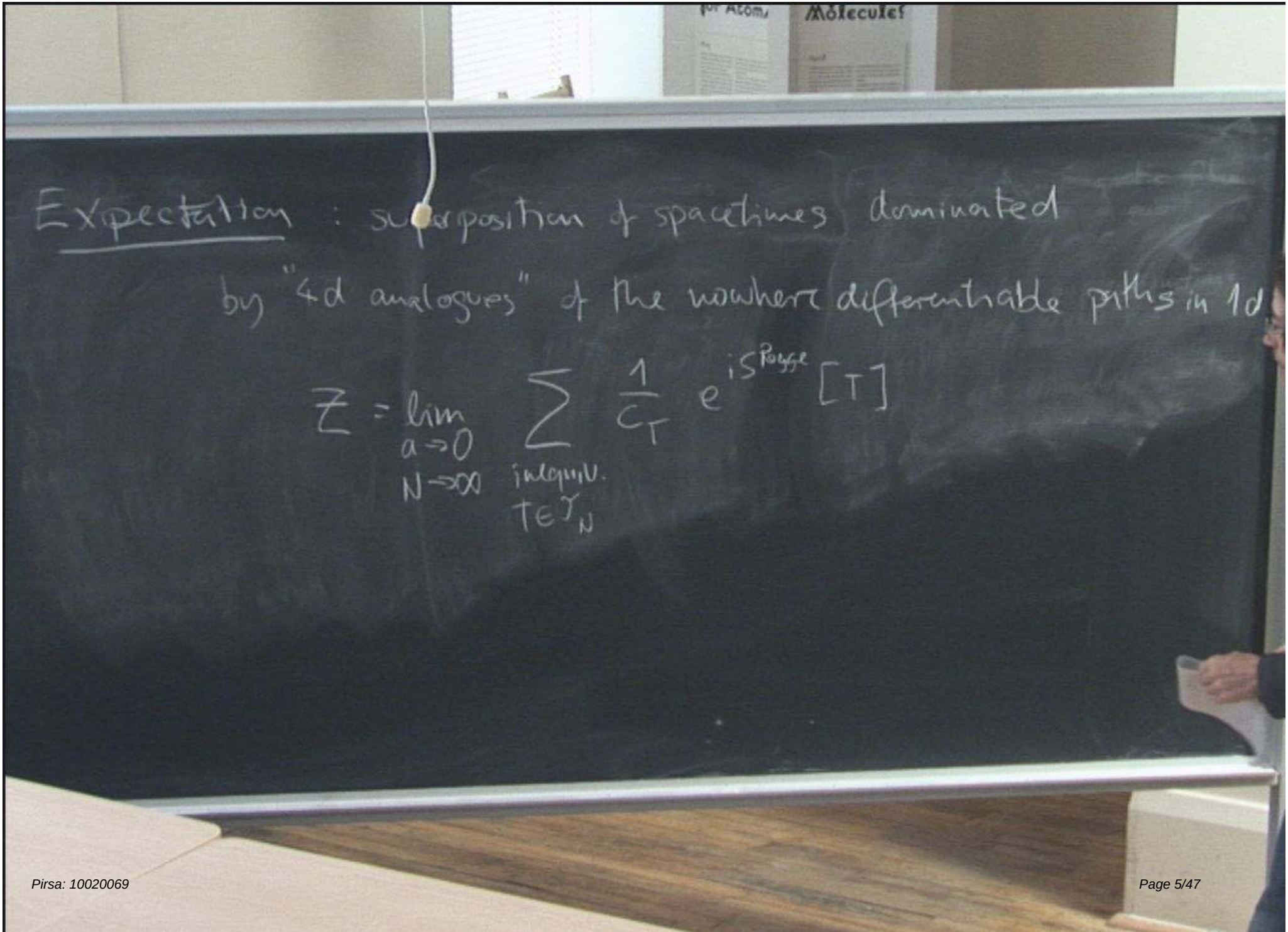
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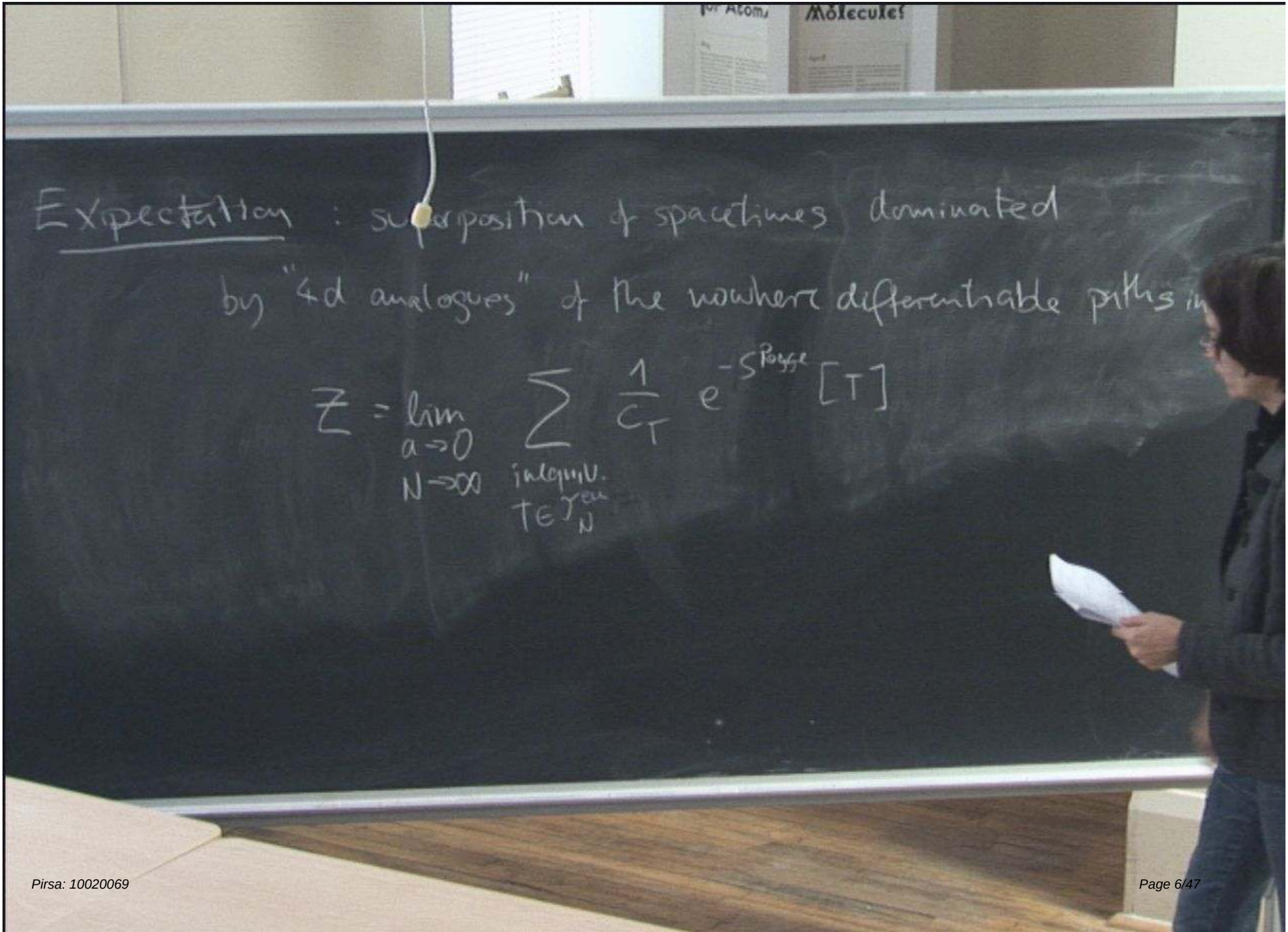
Molecule?
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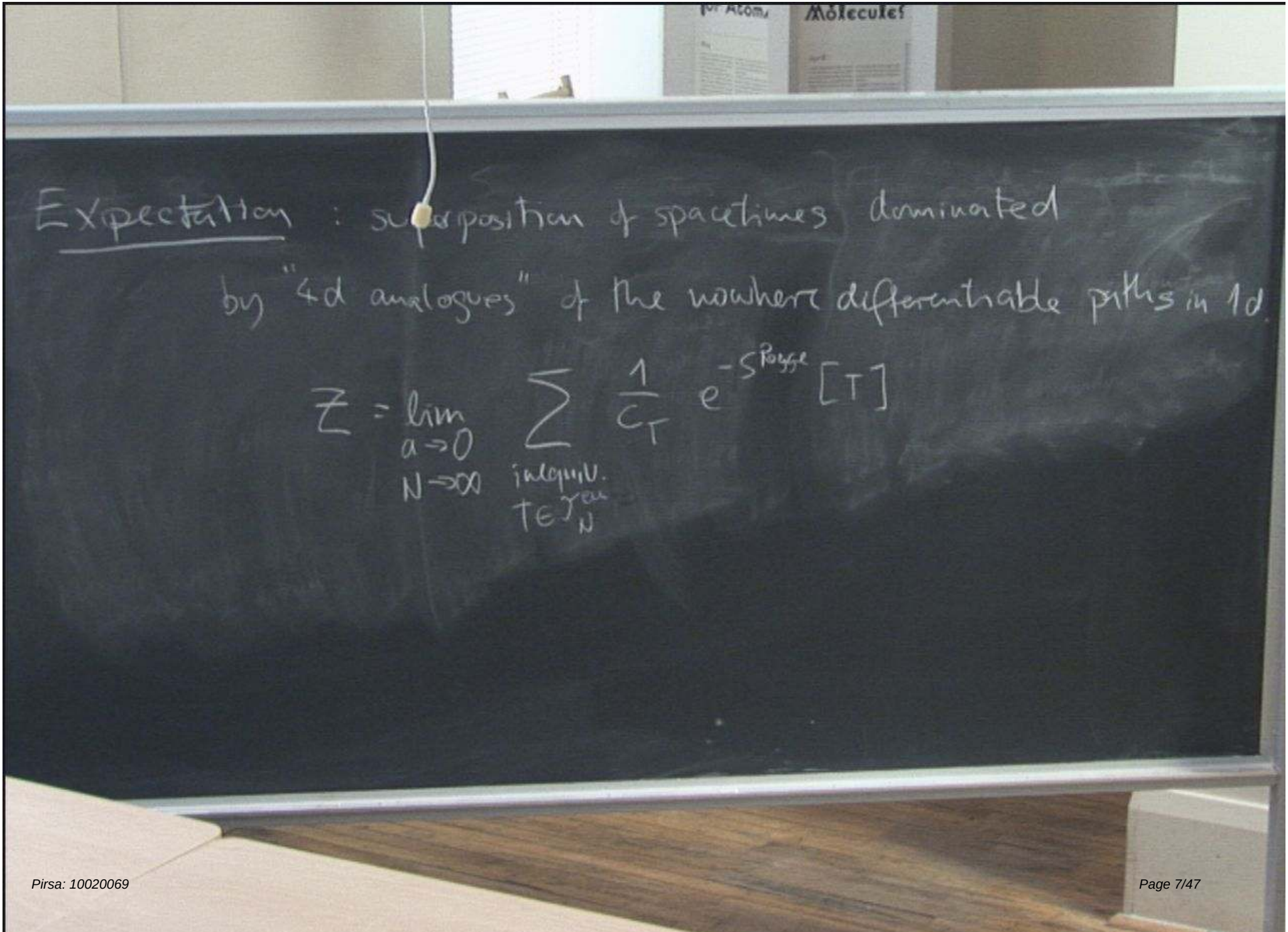
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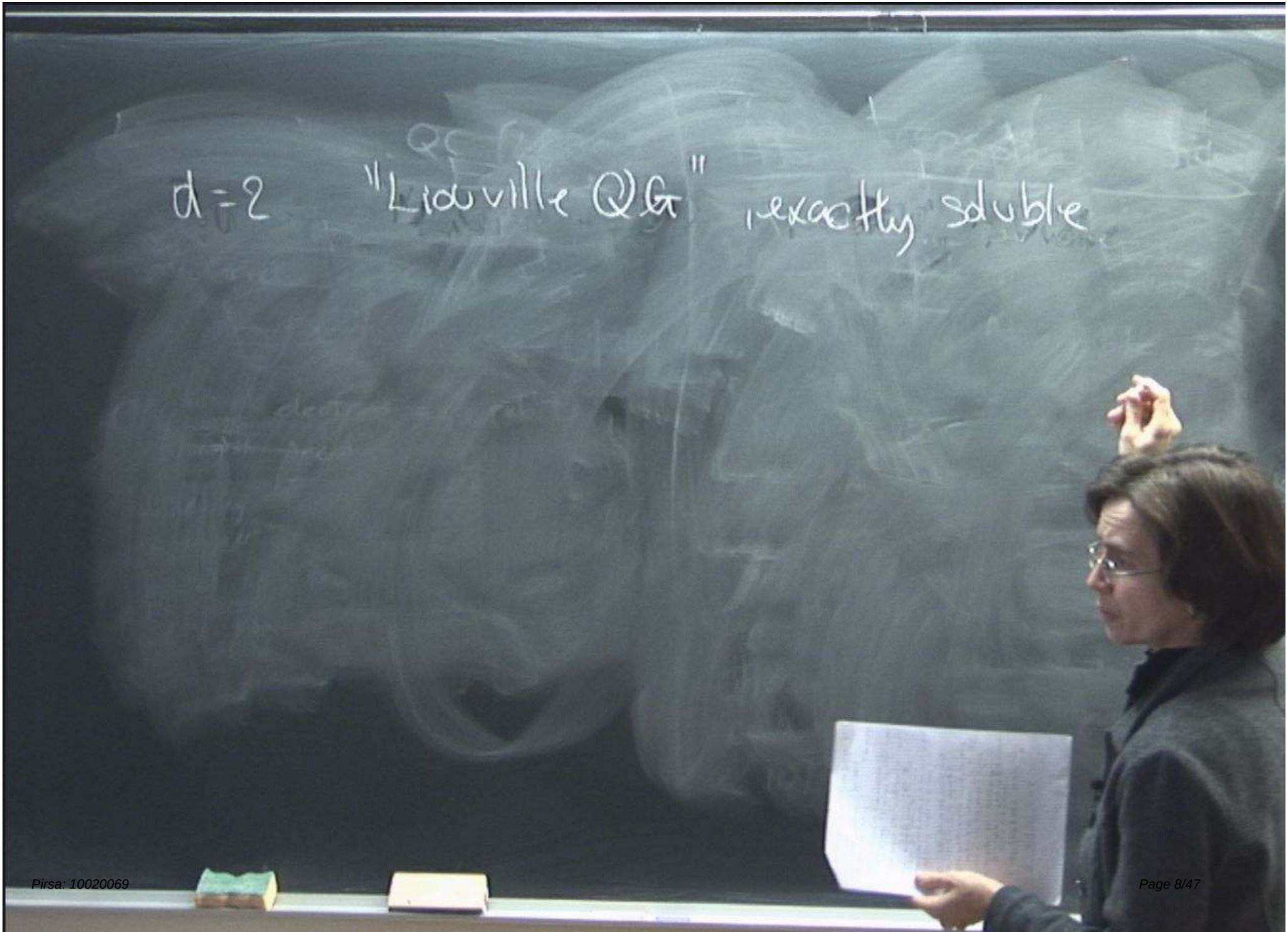
d = 2 "Liouville QG" exactly soluble

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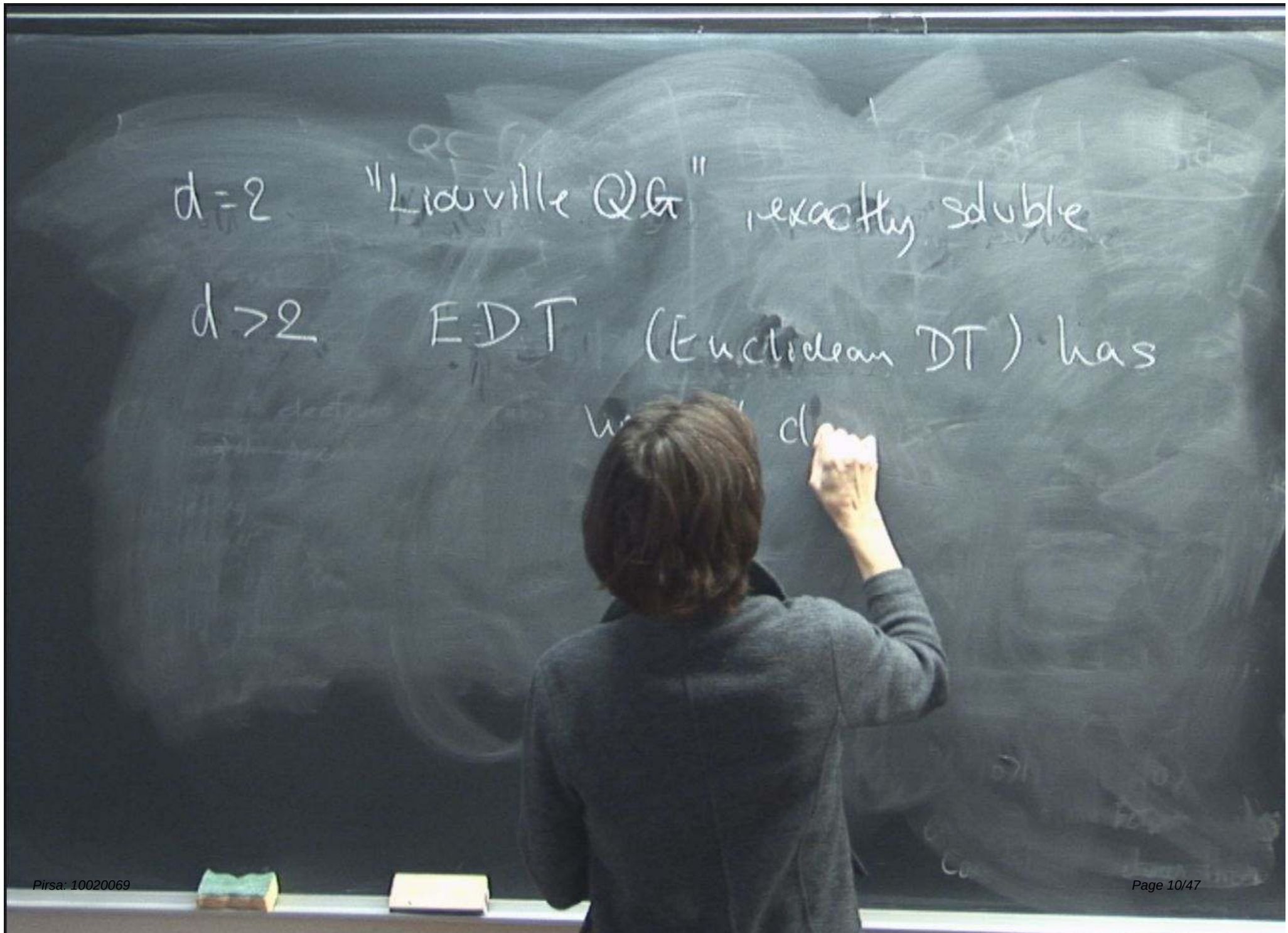
$d > 2$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d>2 EDT (Euclidean DT) has

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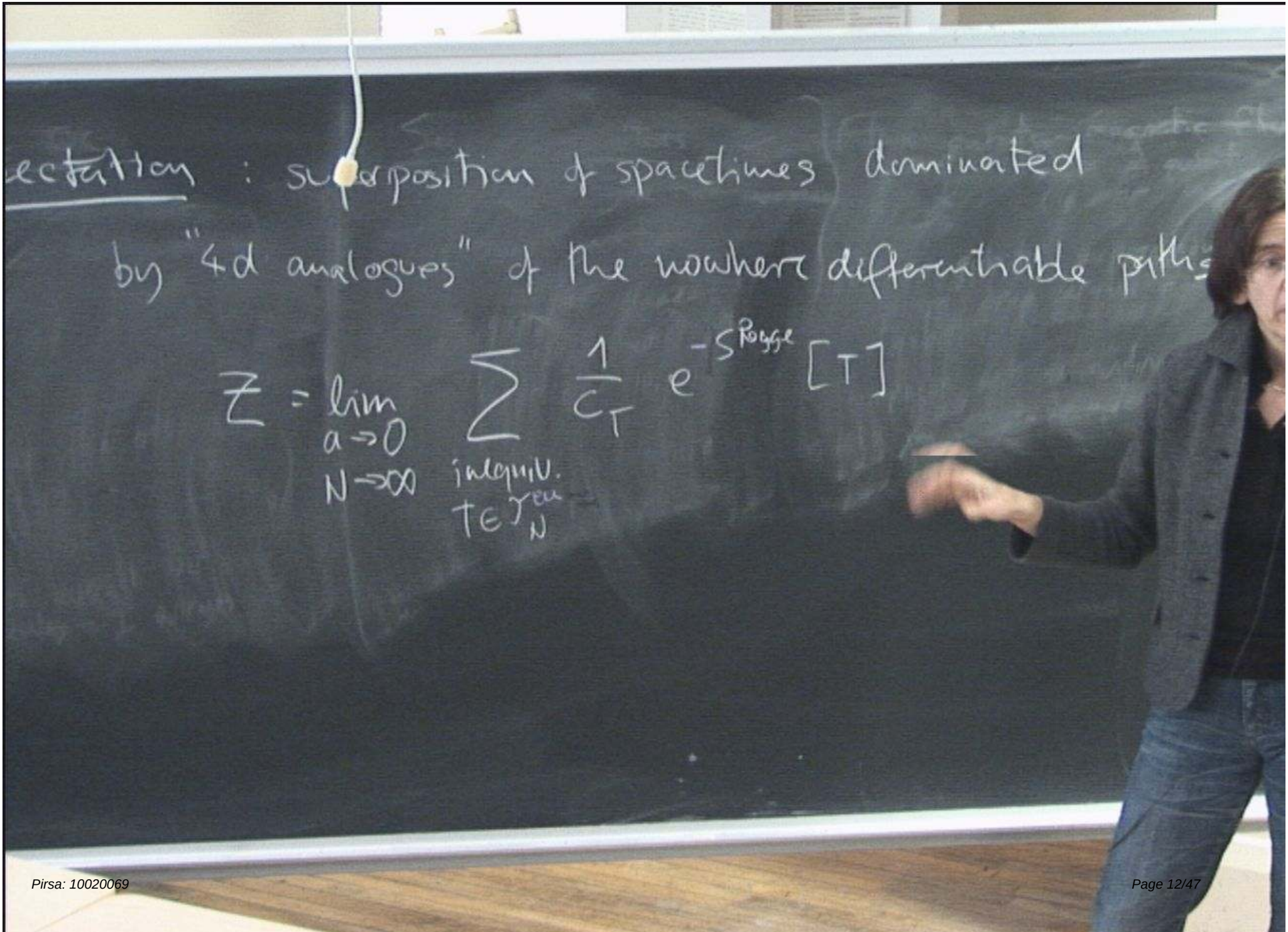
$d > 2$ EDT (Euclidean DT) has no good class. limit.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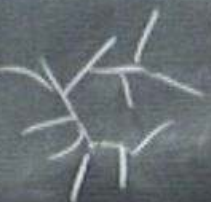

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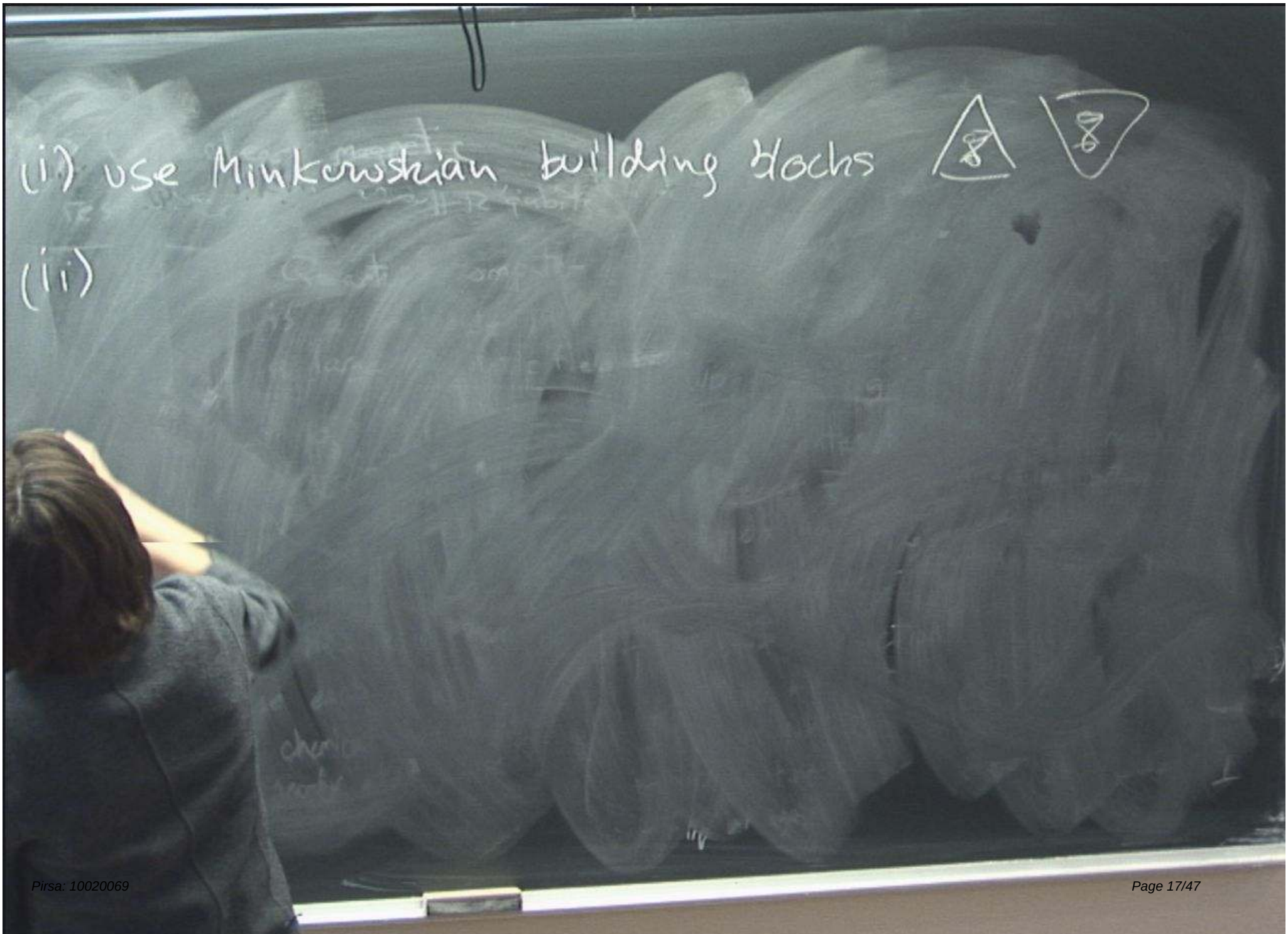
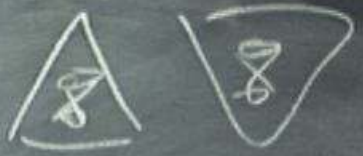
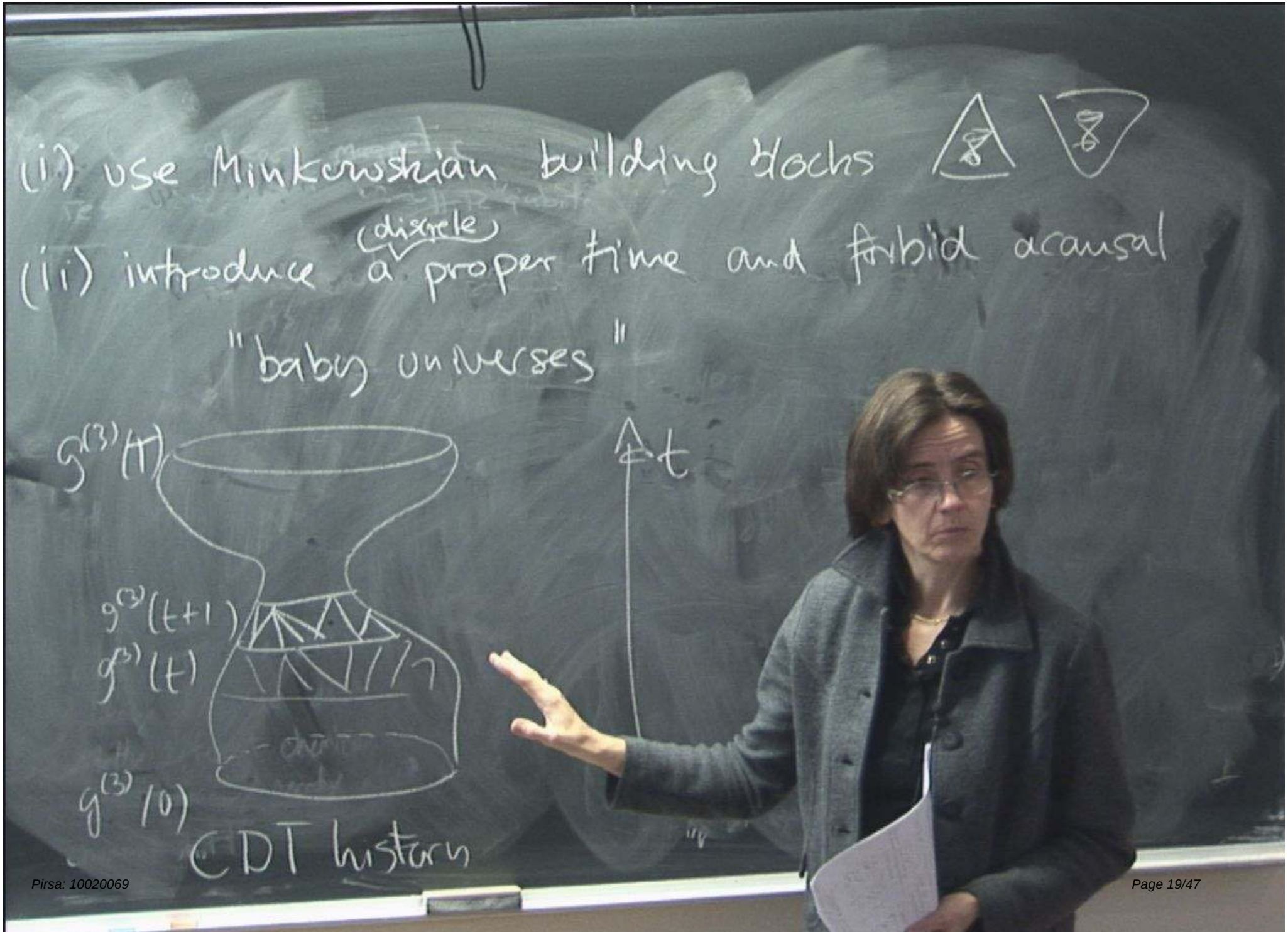

(i) use Minkowskian building blocks
(ii)

(i) use Minkowskian building blocks 

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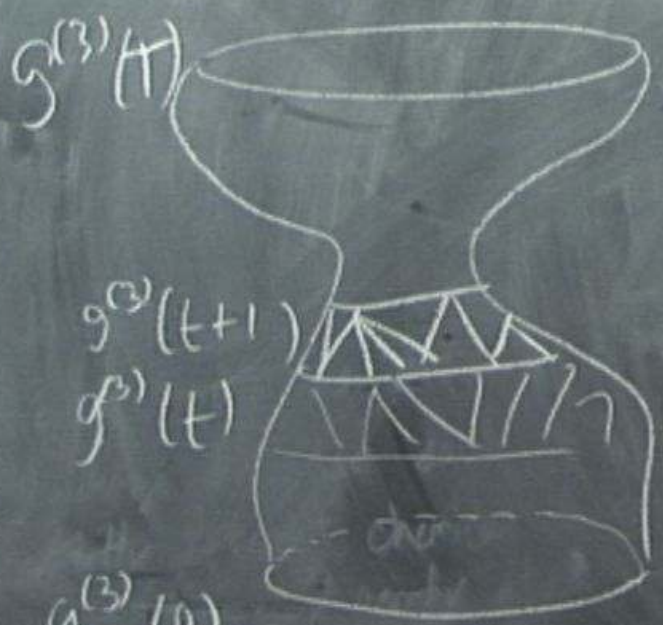
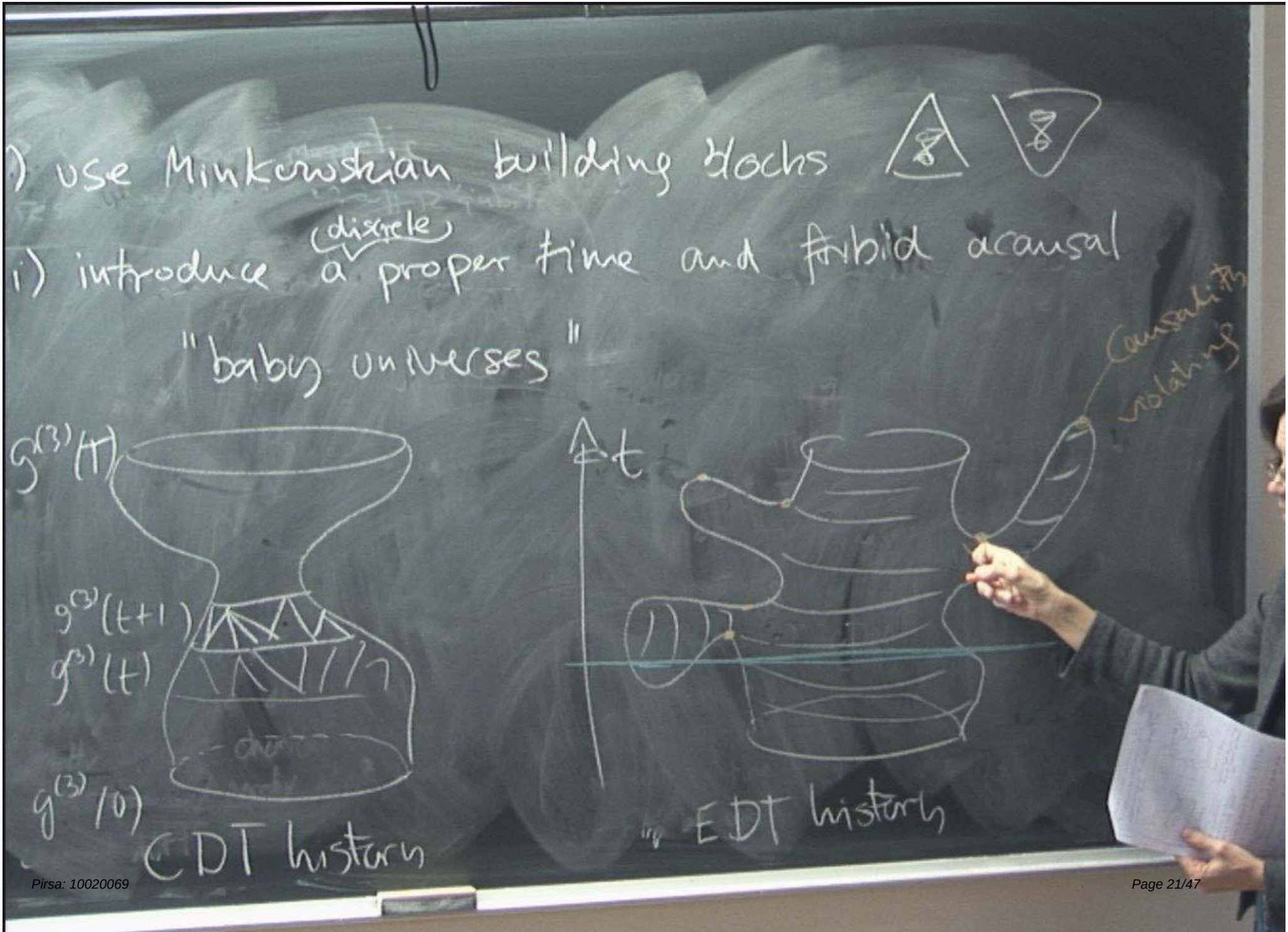


CDT history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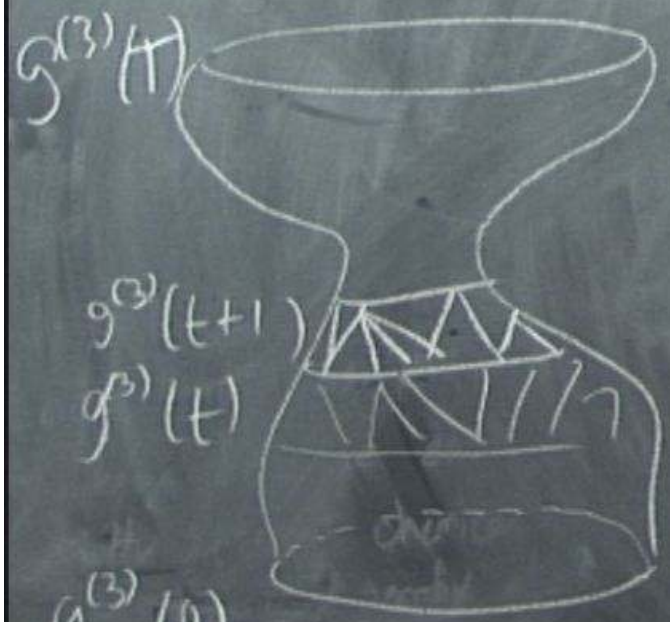

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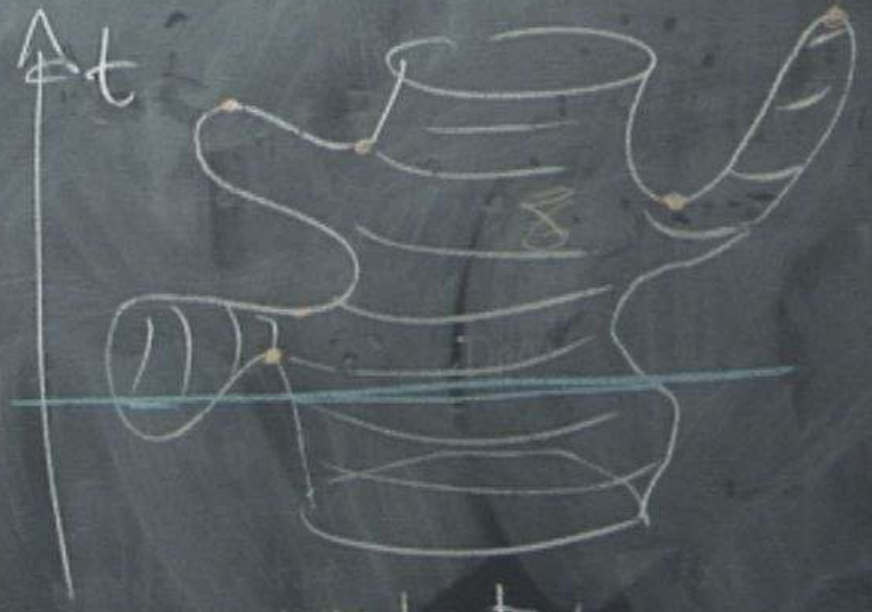

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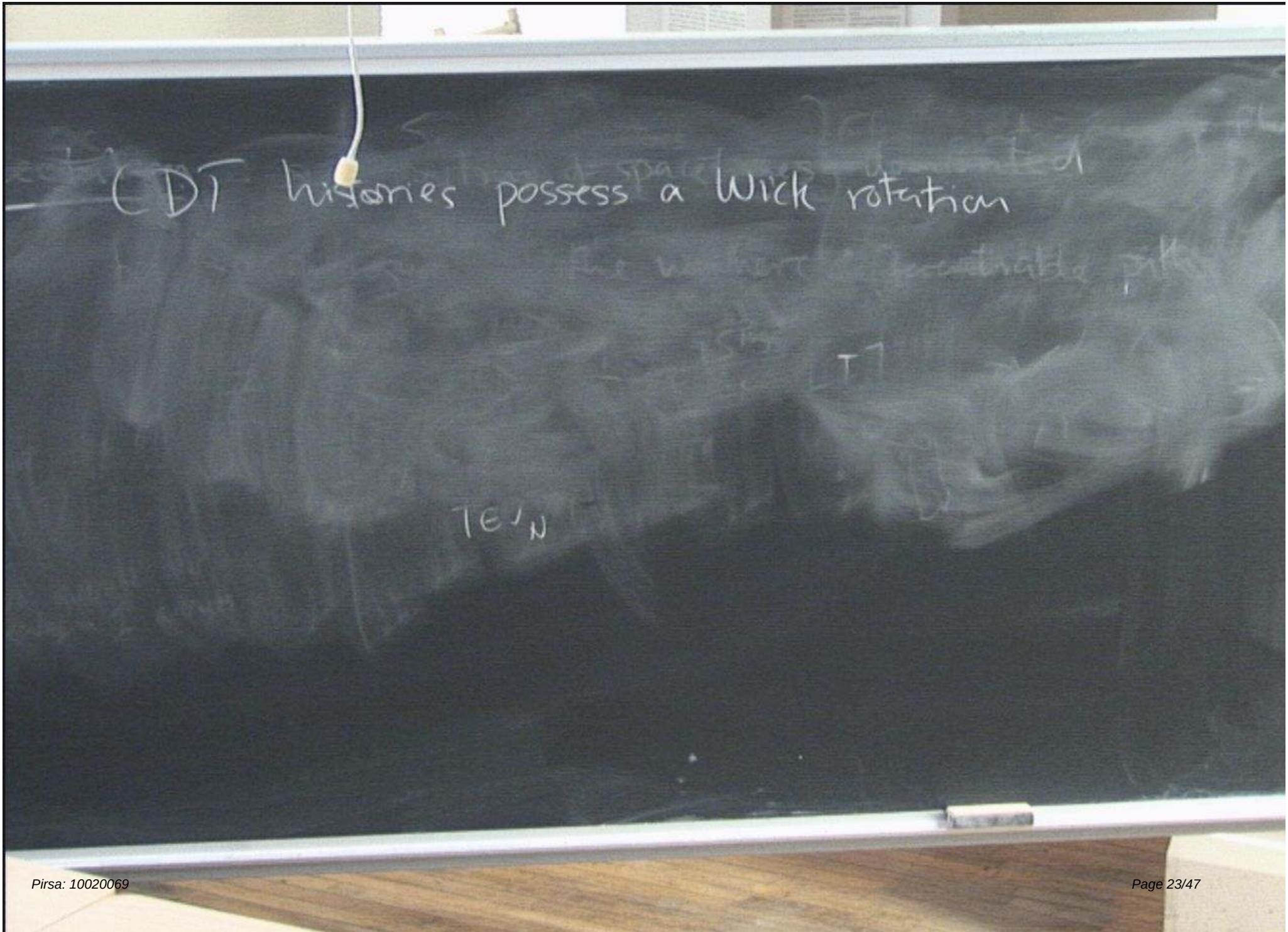
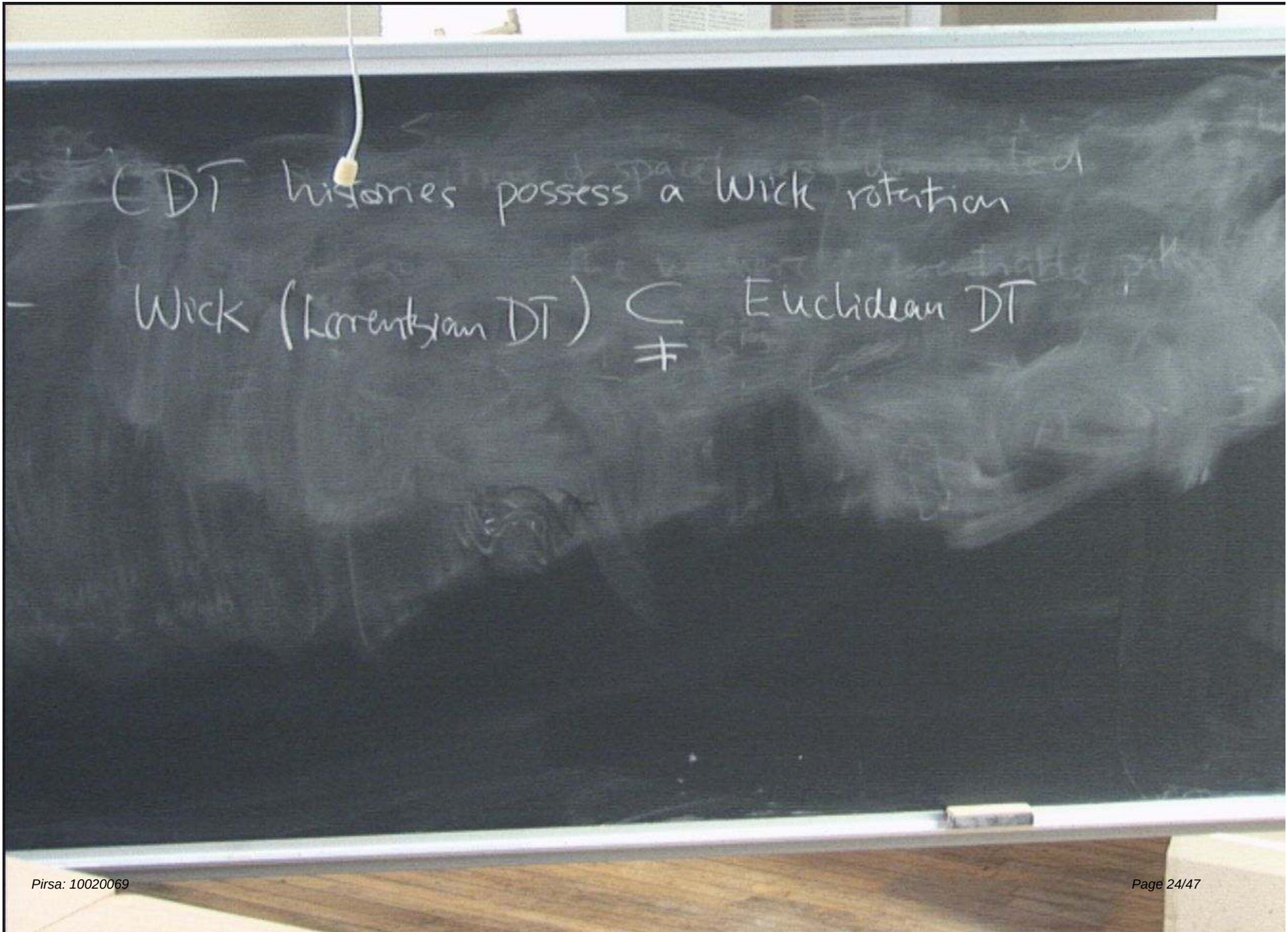
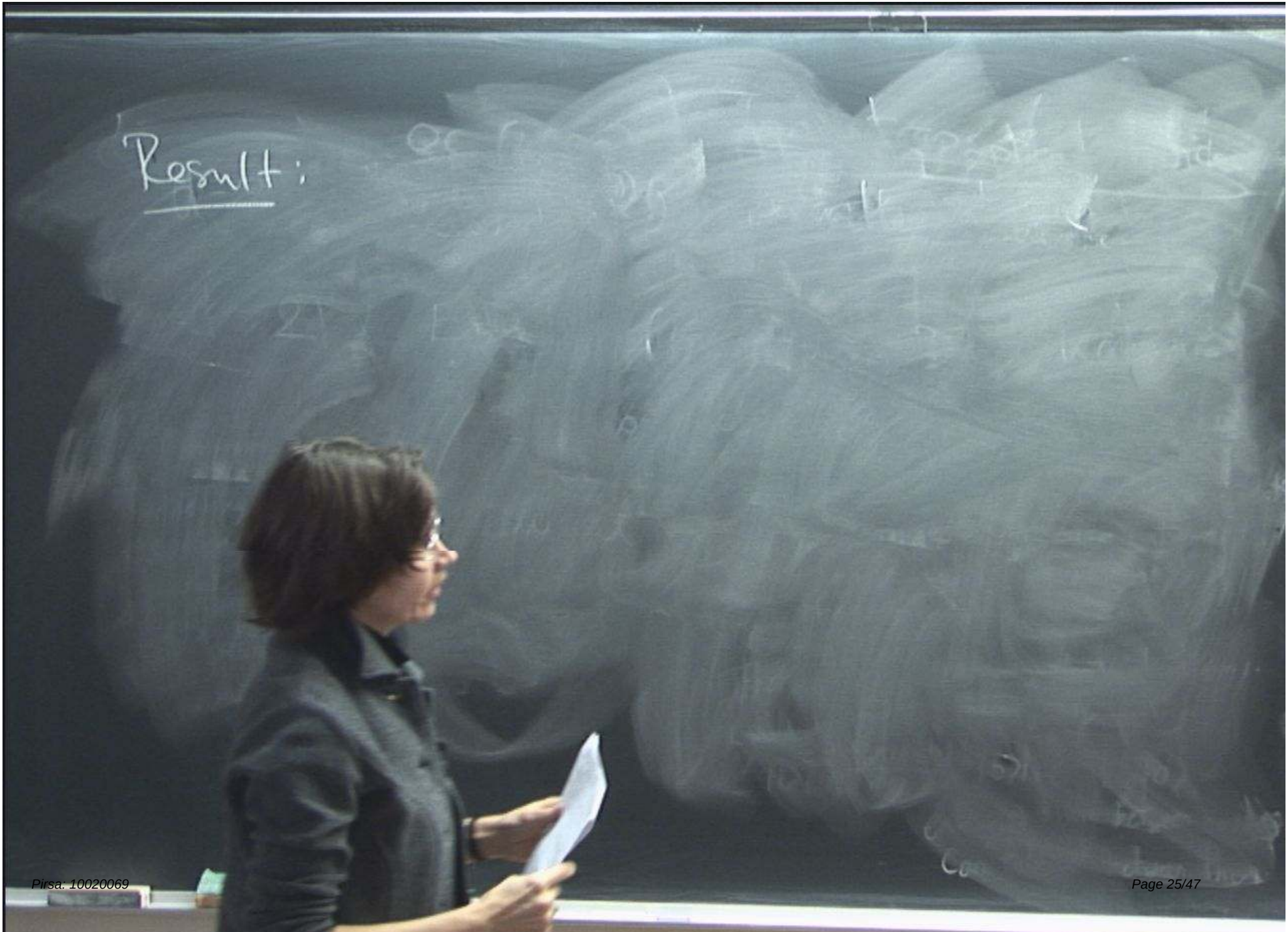
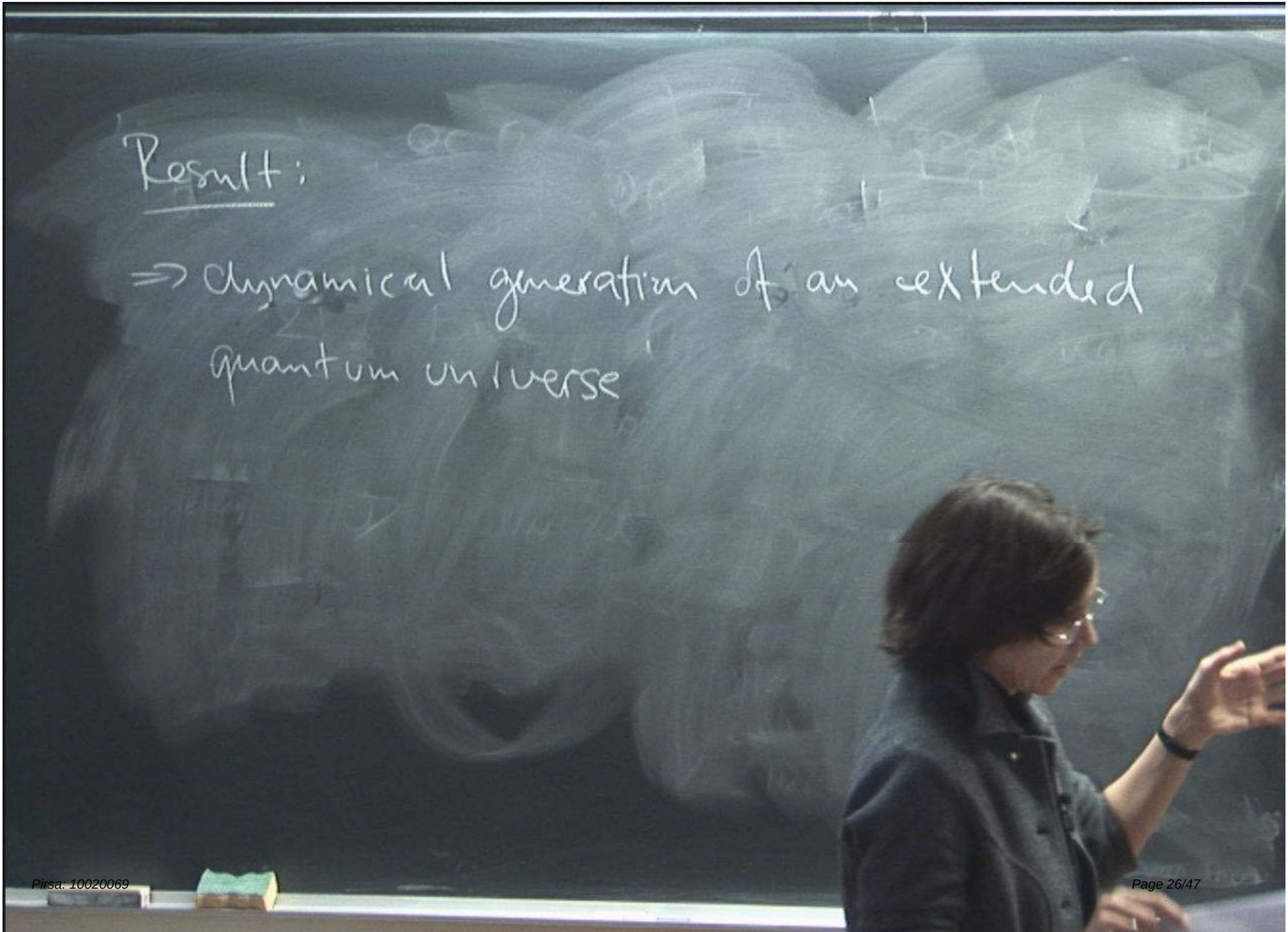

CDT histories possess a Wick rotation


CDT histories possess a Wick rotation
Wick (Lorentzian DT) ⊆ Euclidean DT


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

↑ 3-volume

Result:

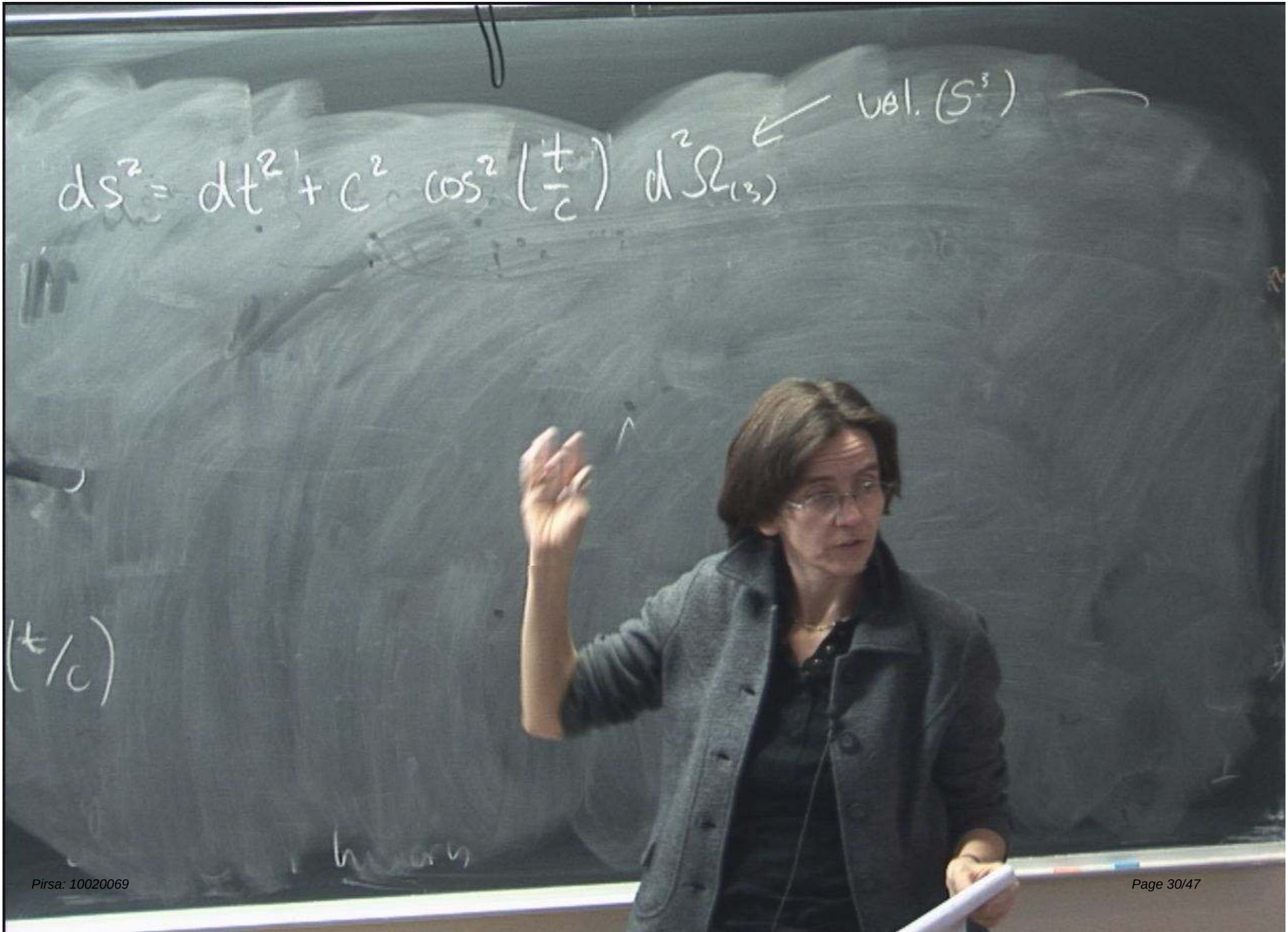
$ds^2 =$

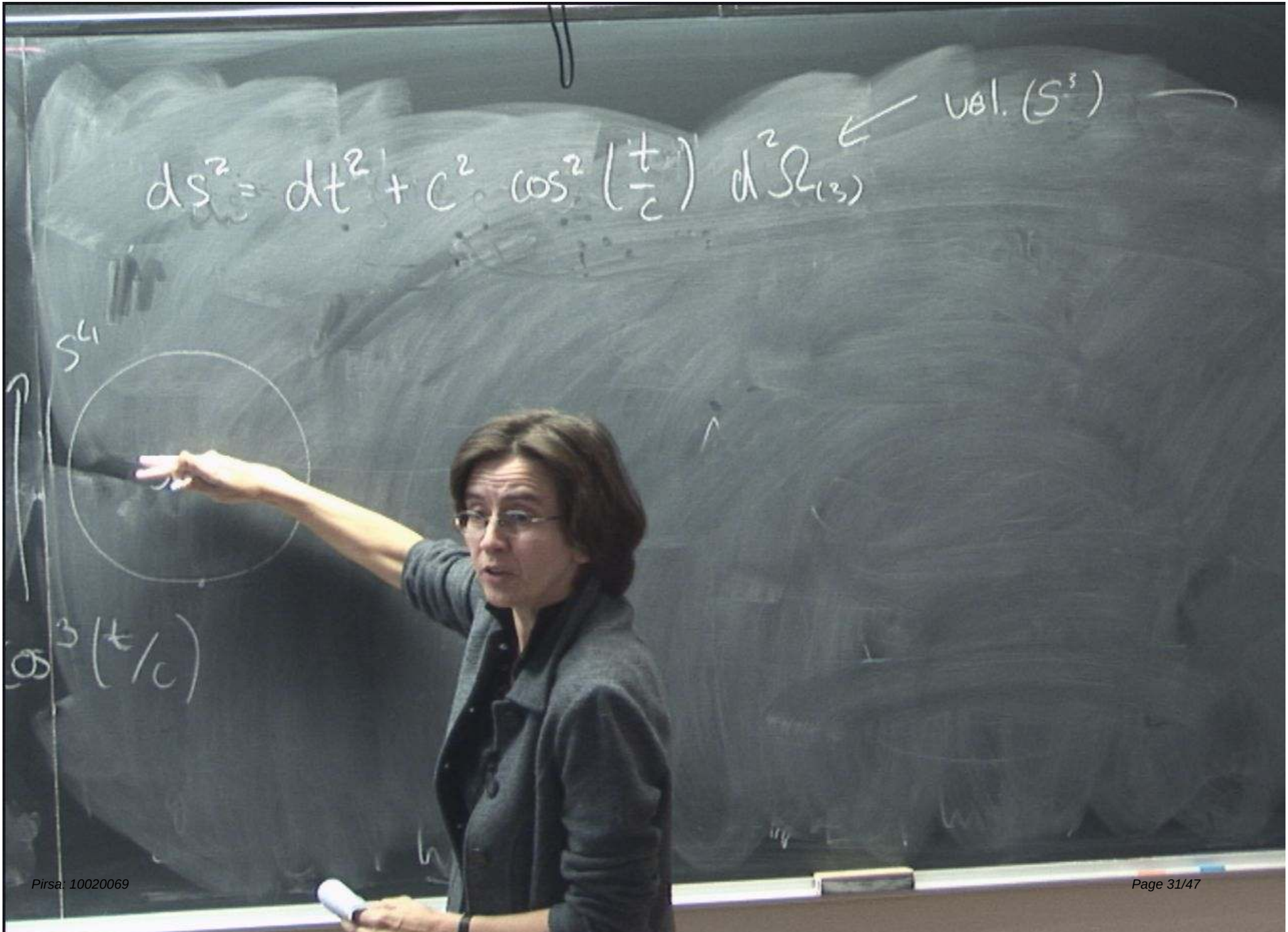
⇒ dynamical generation of an extended quantum universe

on large scales : de Sitter space !

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

$\langle V_3(t) \rangle$ ↑ 3-volume


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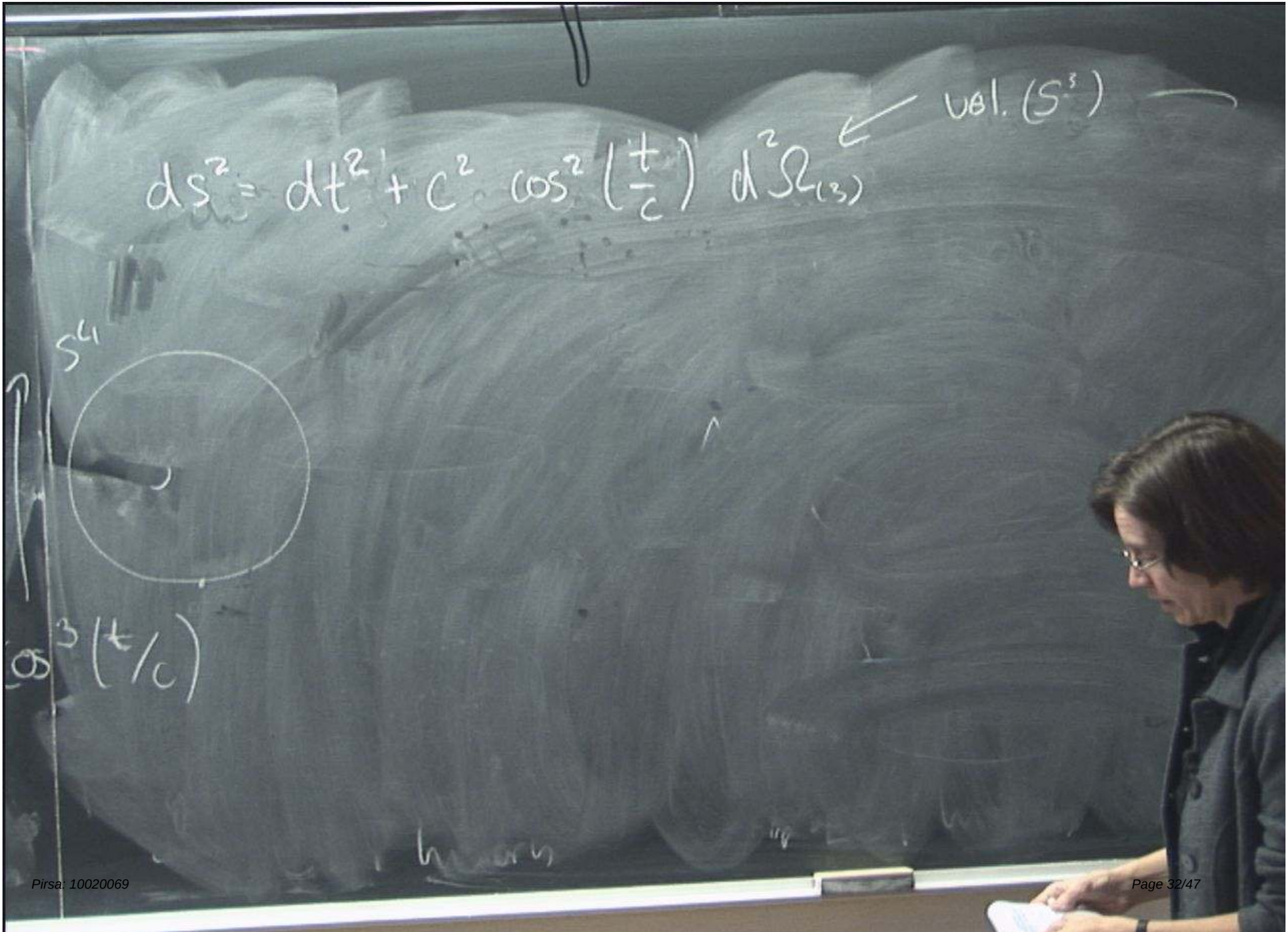
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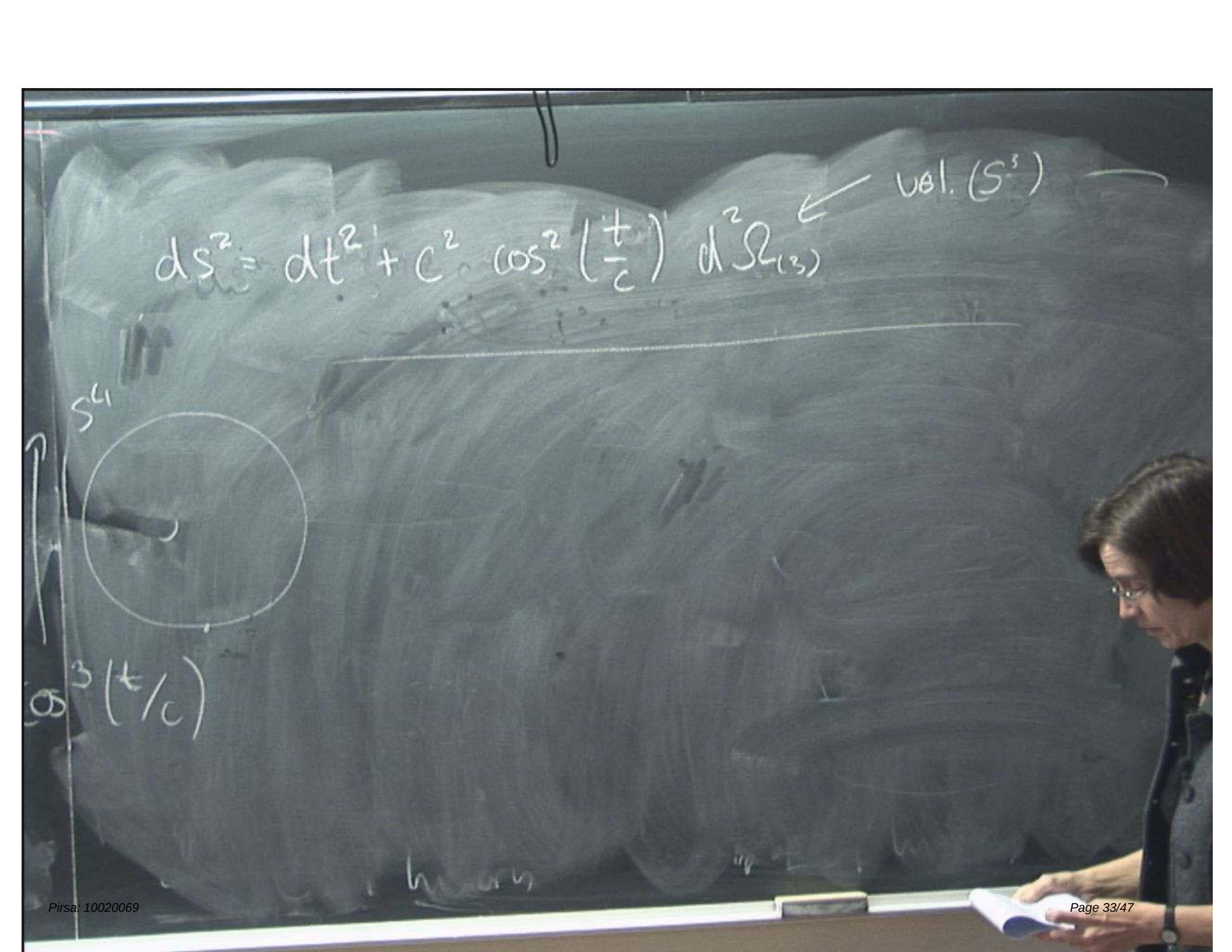
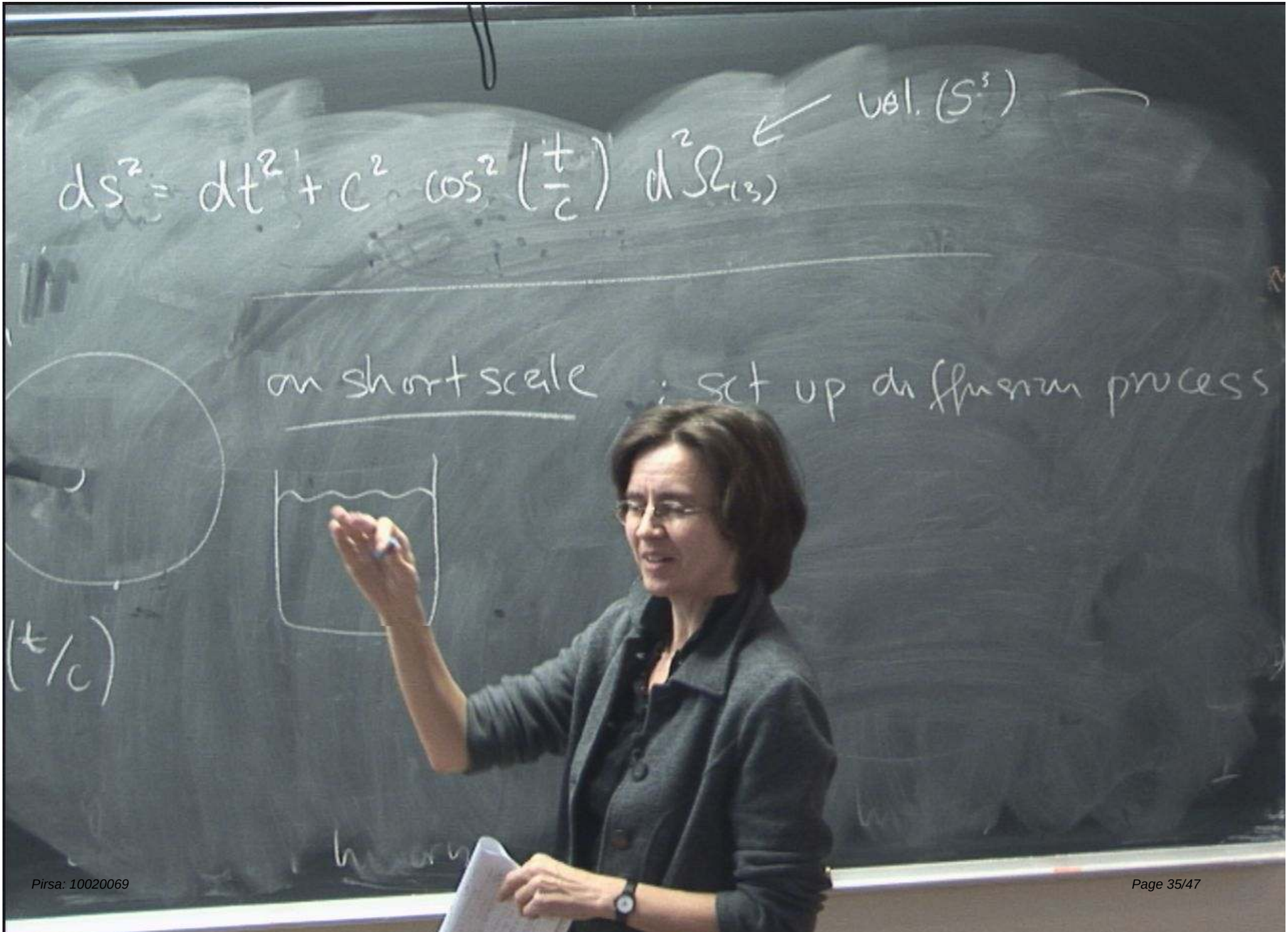


$ds^2 = dt^2 + c^2 \cos^2\left(\frac{t}{c}\right) d^2\Omega_{(3)}$ ← vol. (S^3)

S^4

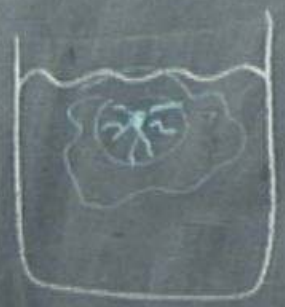
on short scale

$\cos^3(t/c)$


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

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

on short scale ; set up an ensemble process

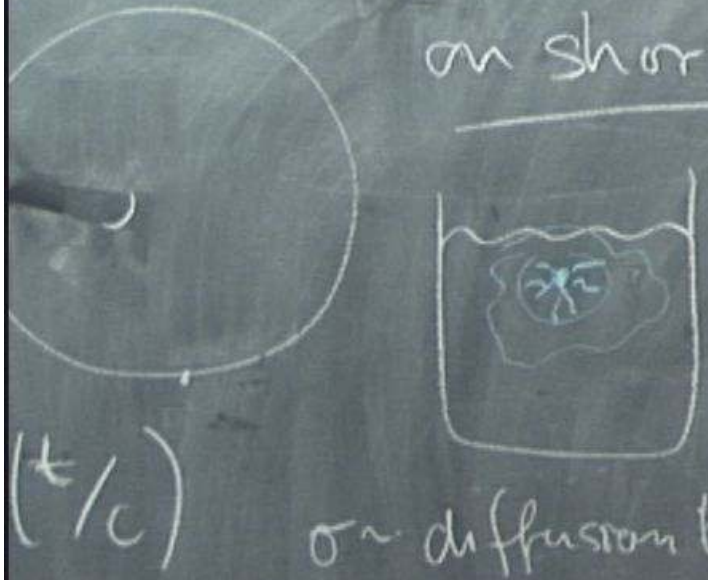


vol ("ink cloud"

(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



vol ("ink cloud")

(t/c) ~ diffusion time

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

← vol. (S^3)

on short scale ; set up diffusion process

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

(t/c)

$\sigma \sim$ diffusion time

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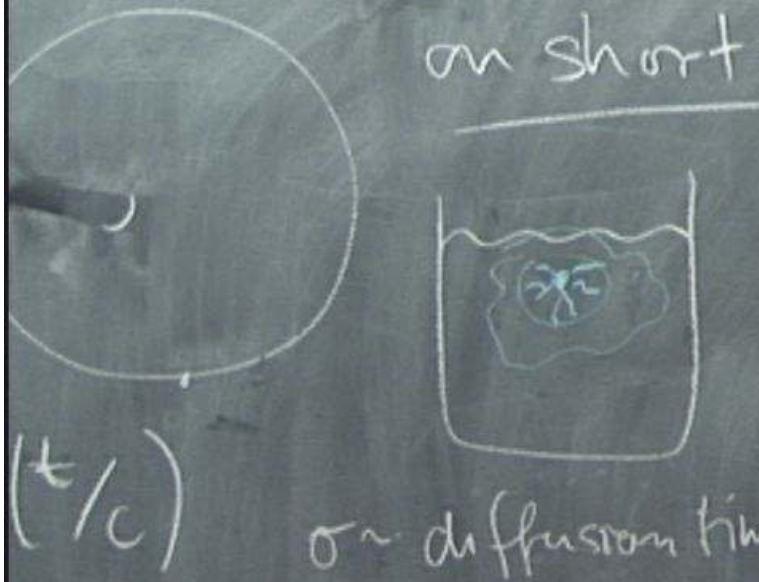

vol ("ink cloud") ~

d_S ~ spectral dimension

(t/c)

σ ~ diffusion time

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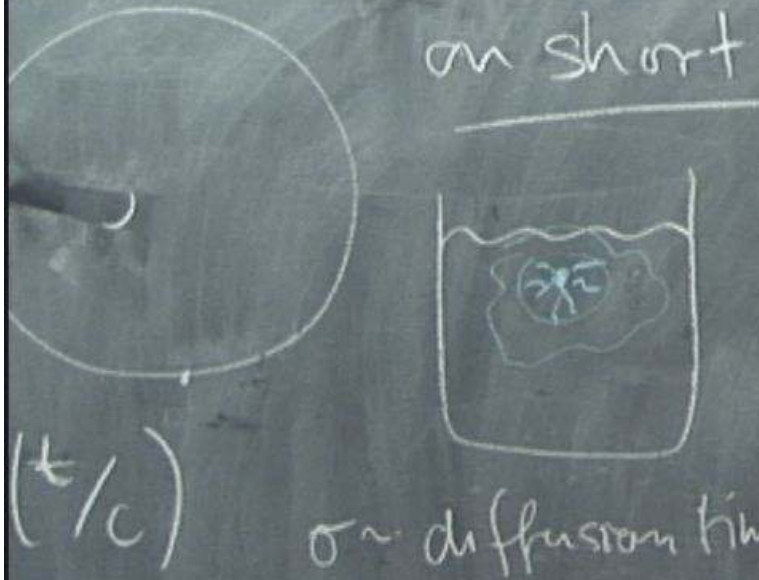

vol ("ink cloud") $\sim \sigma^{d_s/2}$

$d_s \sim$ spectral dimension

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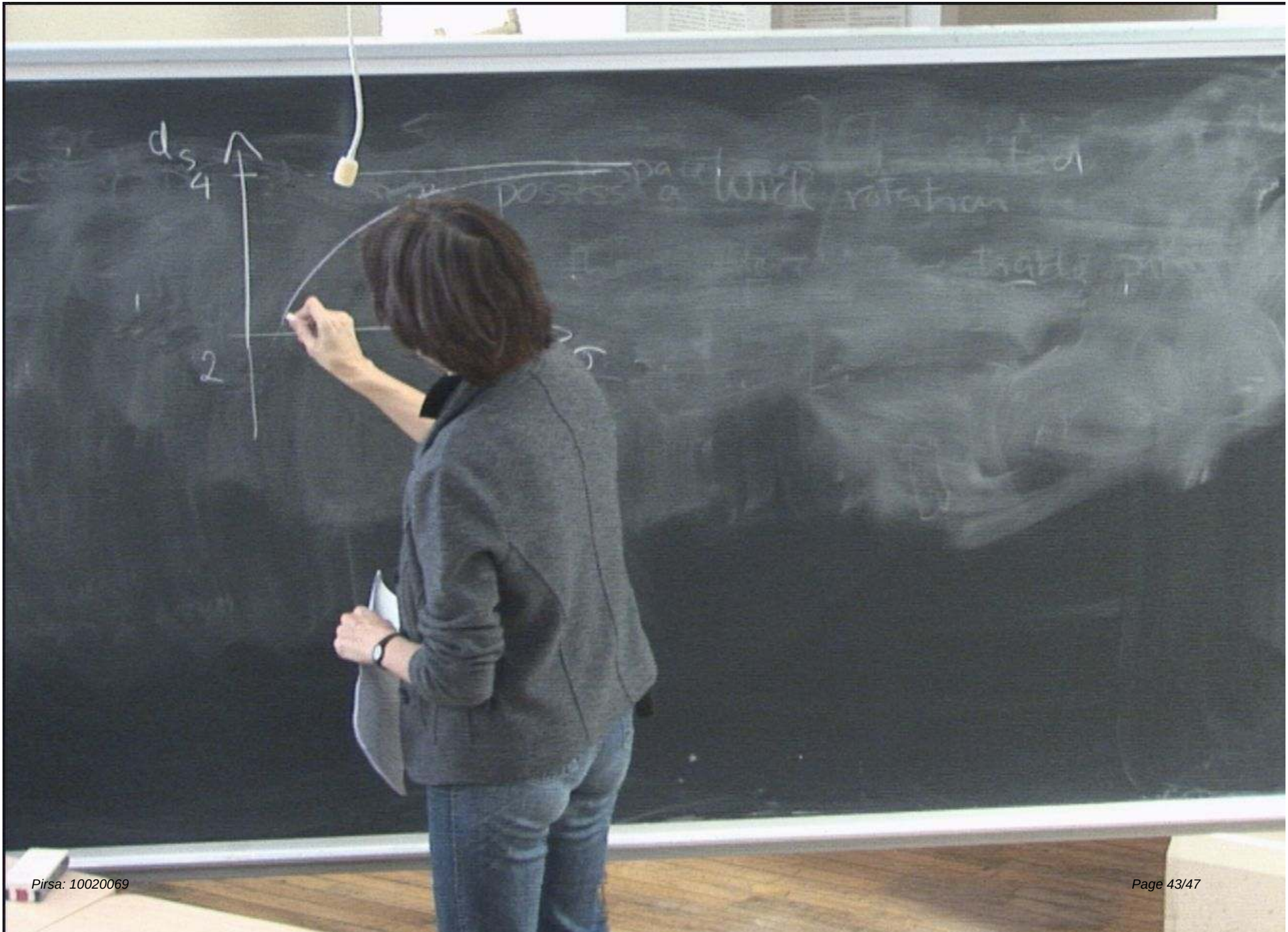
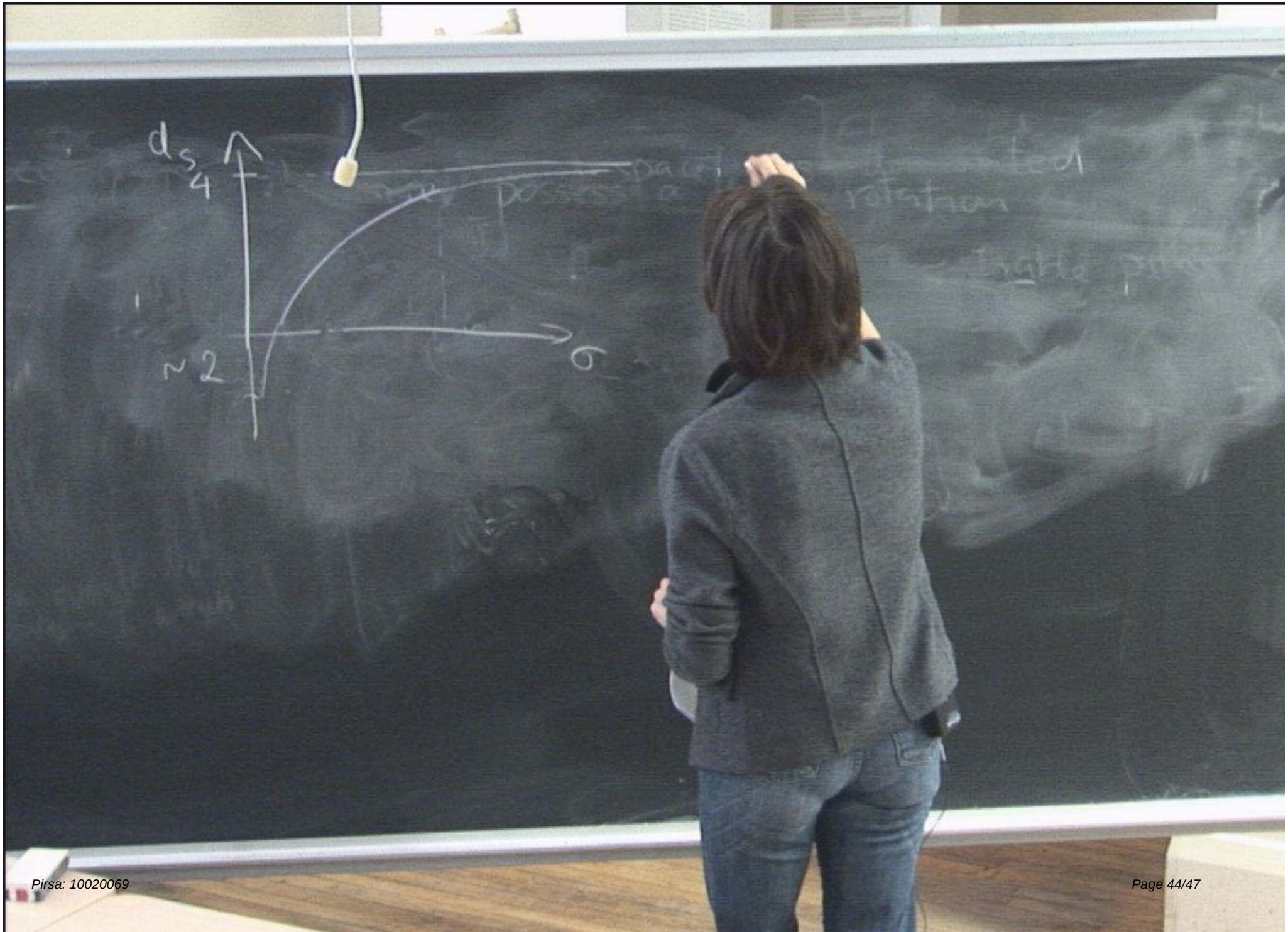
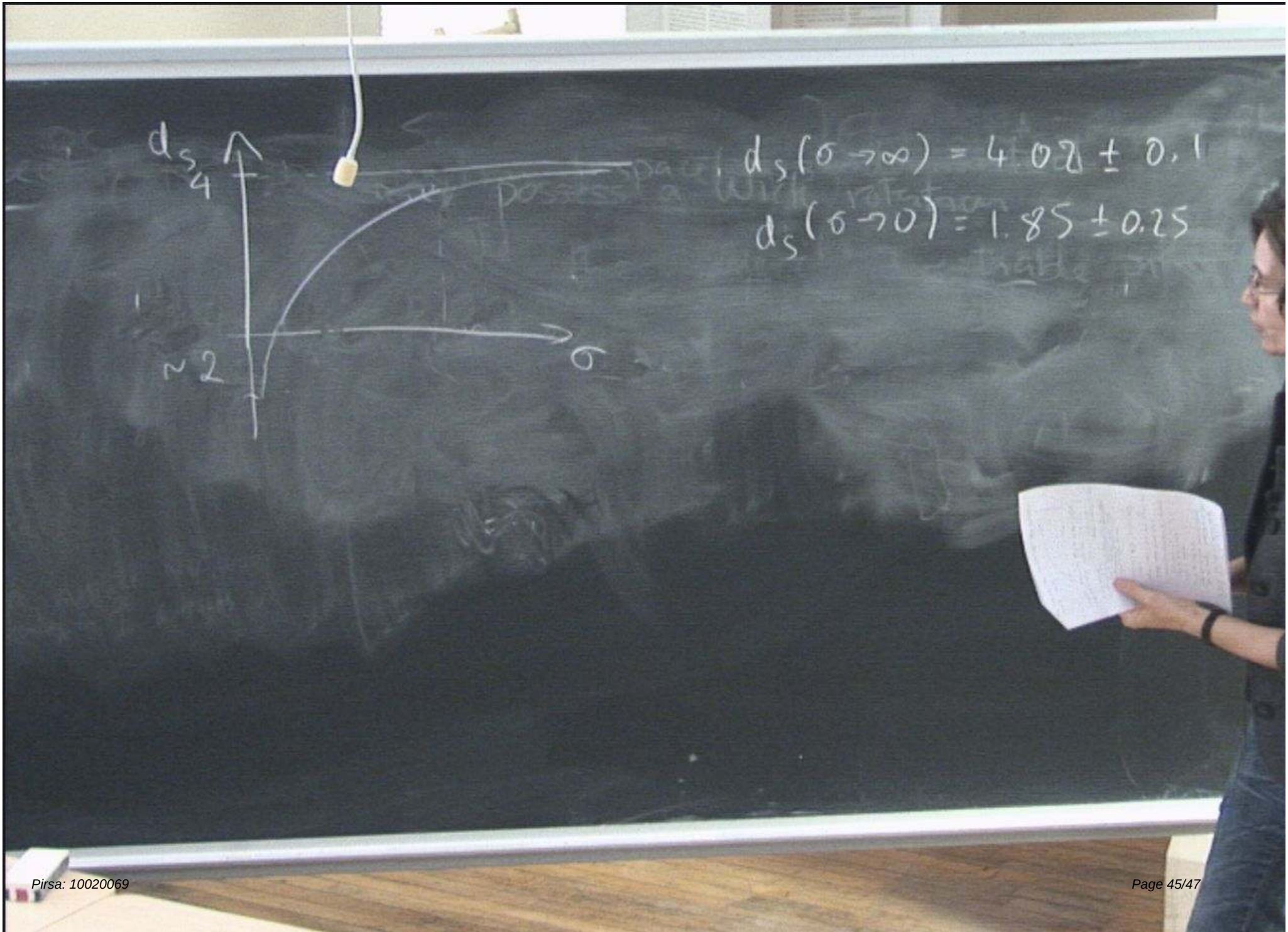
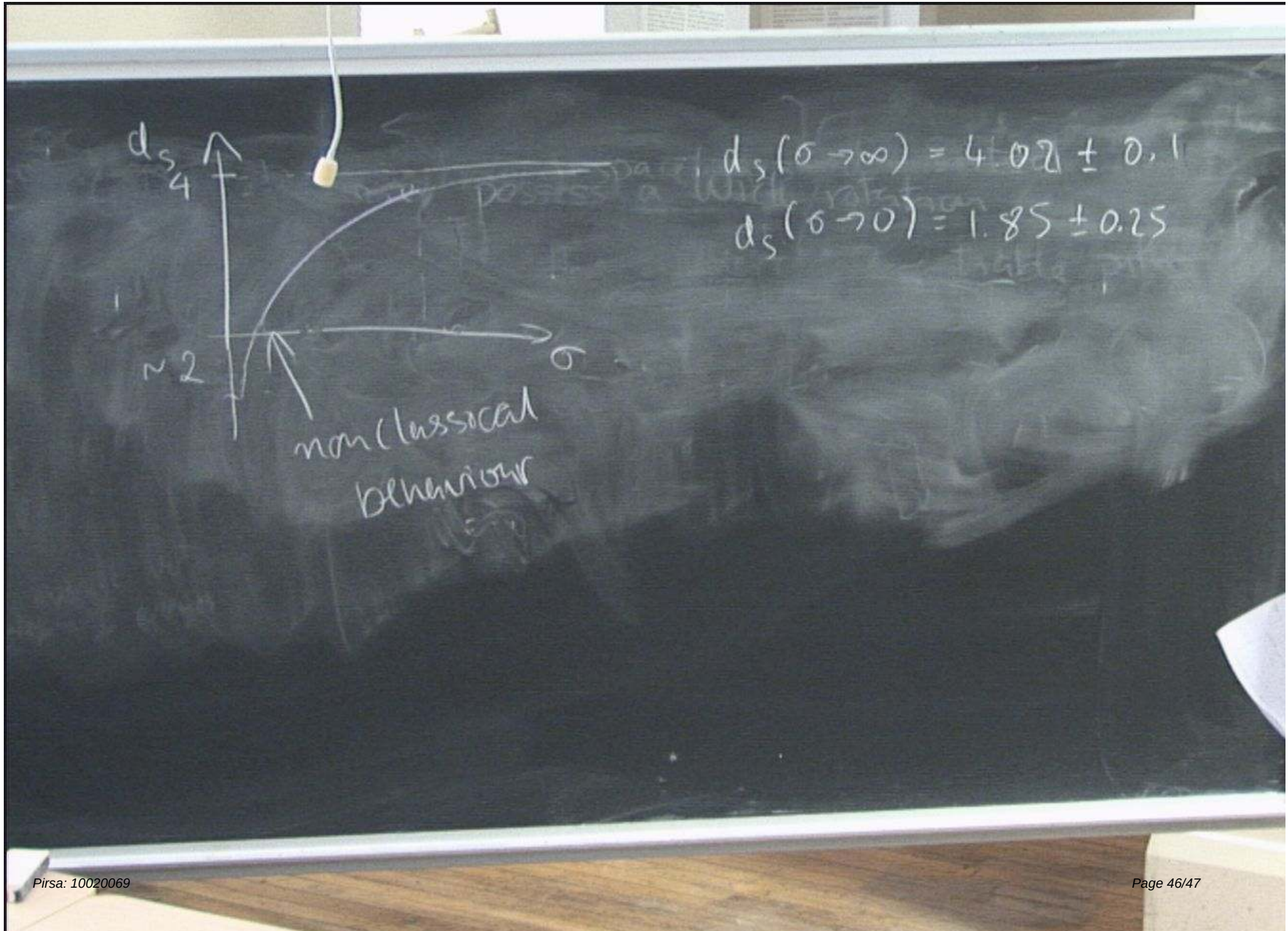

ds_4
2


d_{S_4}
N 2
σ


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


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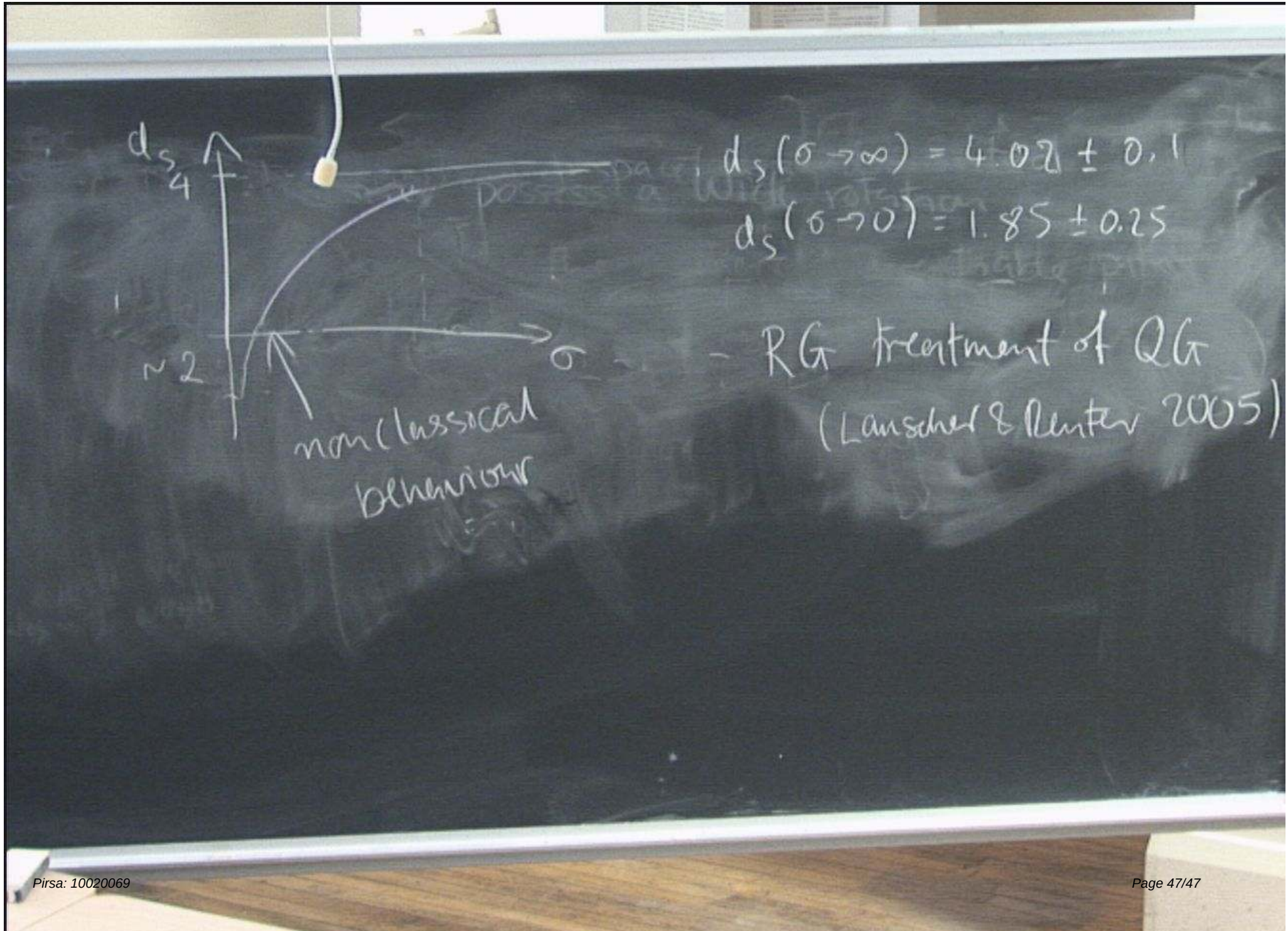
d_s
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~ 2
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non classical behaviour
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RG treatment of QG
(Lauscher & Reuter 2005)