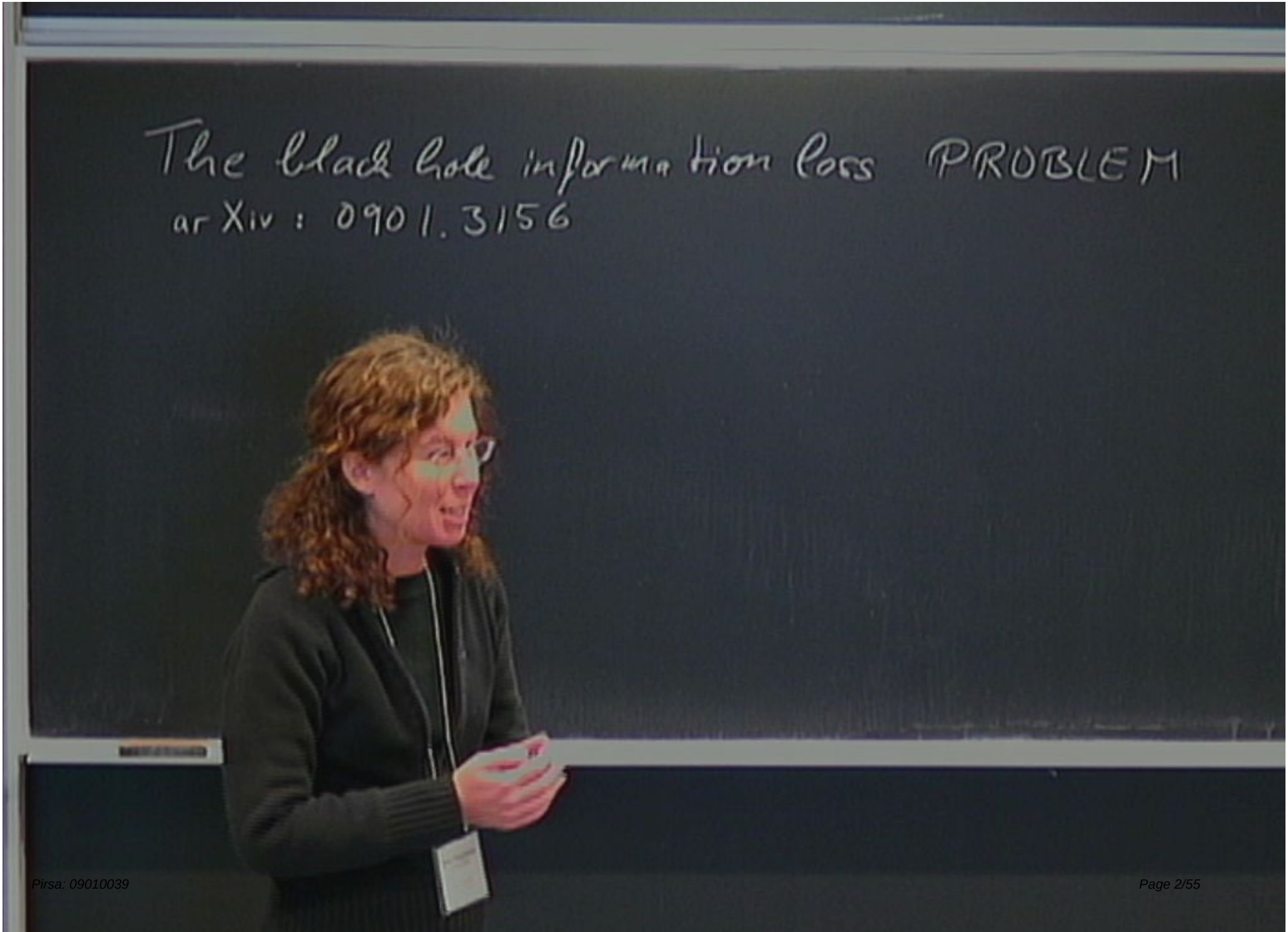
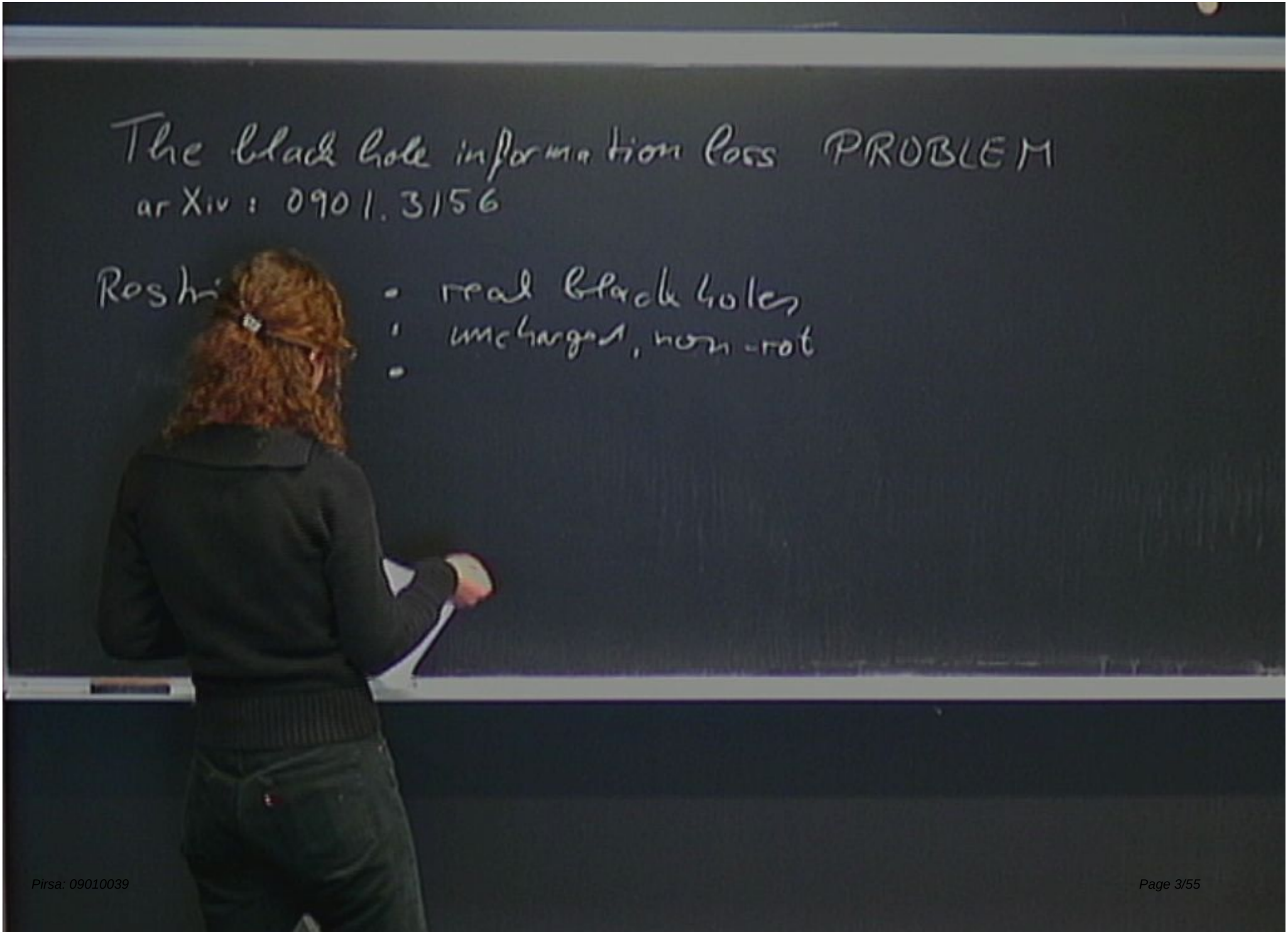
Title: Black Hole Information - What's the Problem?

Date: Jan 24, 2009 09:00 AM

URL: http://pirsa.org/09010039

Abstract: I will classify the options to solve the black hole information loss problem by how radical a departure from semi-classical gravity they require outside the quantum gravitational regime. I will argue that the most plausible and conservative conclusion is that the problem of information loss originates in the presence of the singularity and that thus effort should be focused on understanding its avoidance. A consequence of accepting the accuracy of the semi-classical approximation is the surface interpretation of black hole entropy. I will summarize the arguments that have been raised for and against such scenarios. Reference: http://arxiv.org/abs/0901.3156


The black hole information loss PROBLEM
arXiv : 0901.3156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Roshi
: real black holes
: uncharged, non-rot
:

The black hole information loss PROBLEM

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Roshicd :
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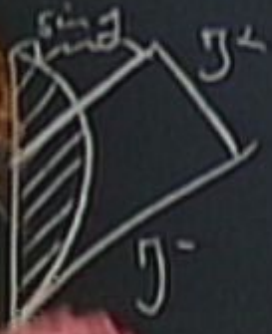
- uncharged, non-rot
- asympt. flat



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Hawking ra

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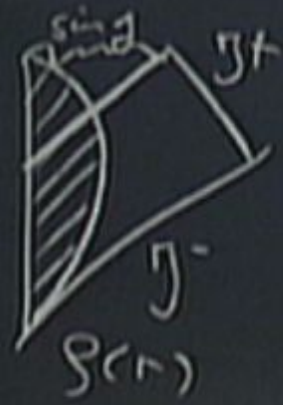

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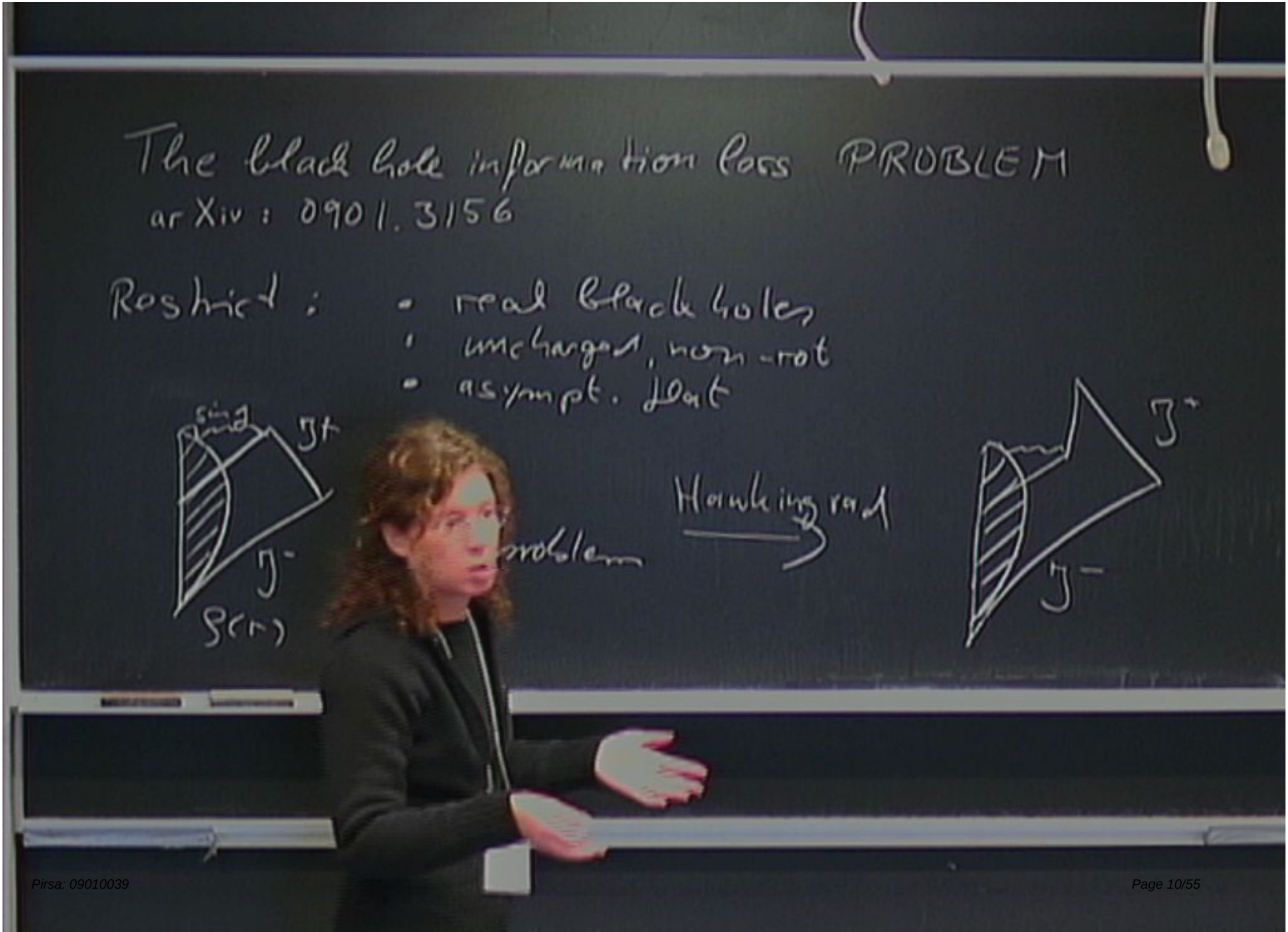
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problem
J+
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J+
J-

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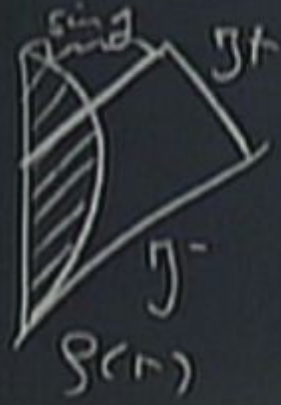

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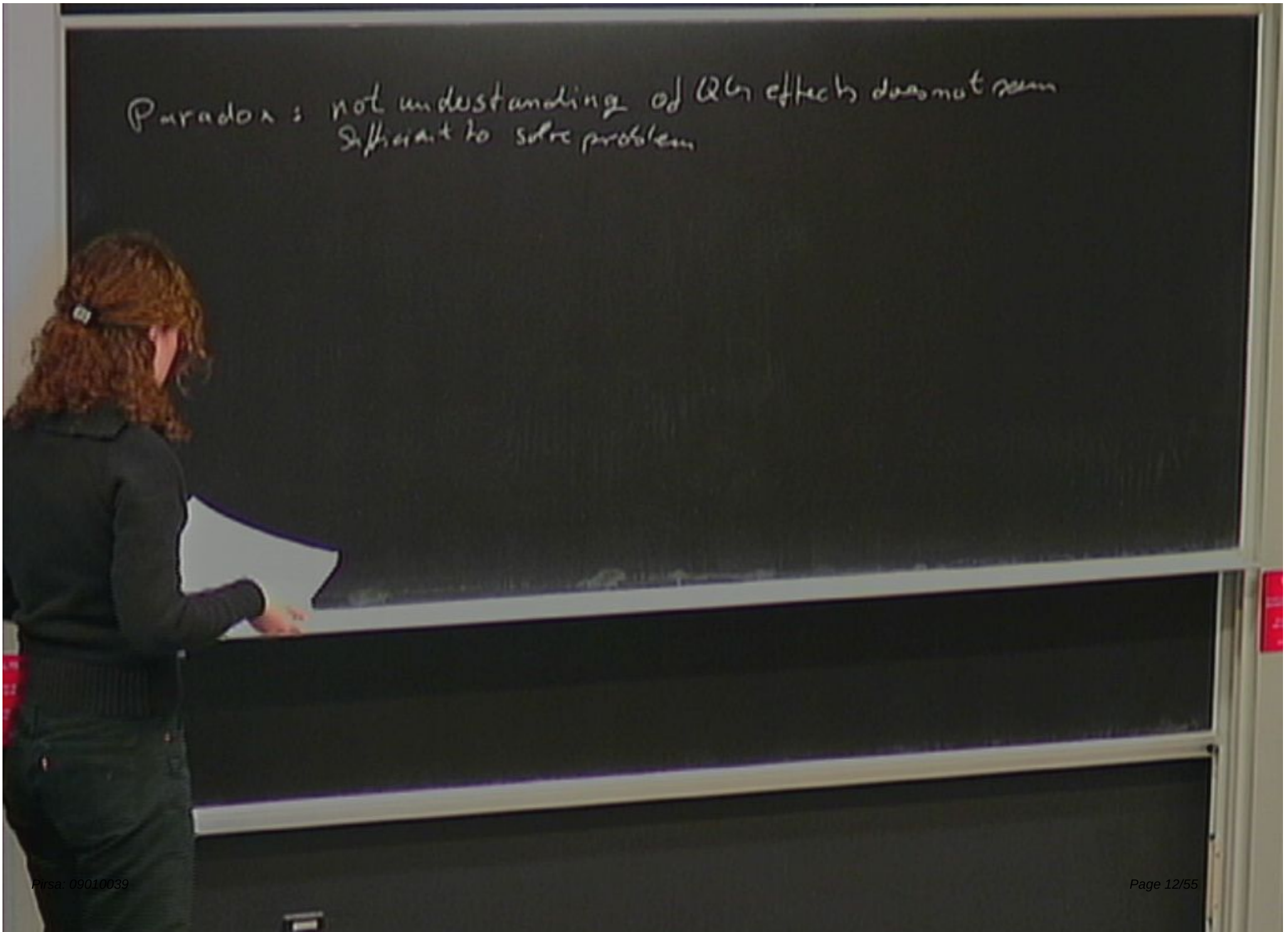
Paradox : not understanding of QG effects does not seem
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$R^2 \sim m_p^4$

Possible options : ① Non unitary

②

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Possible options :

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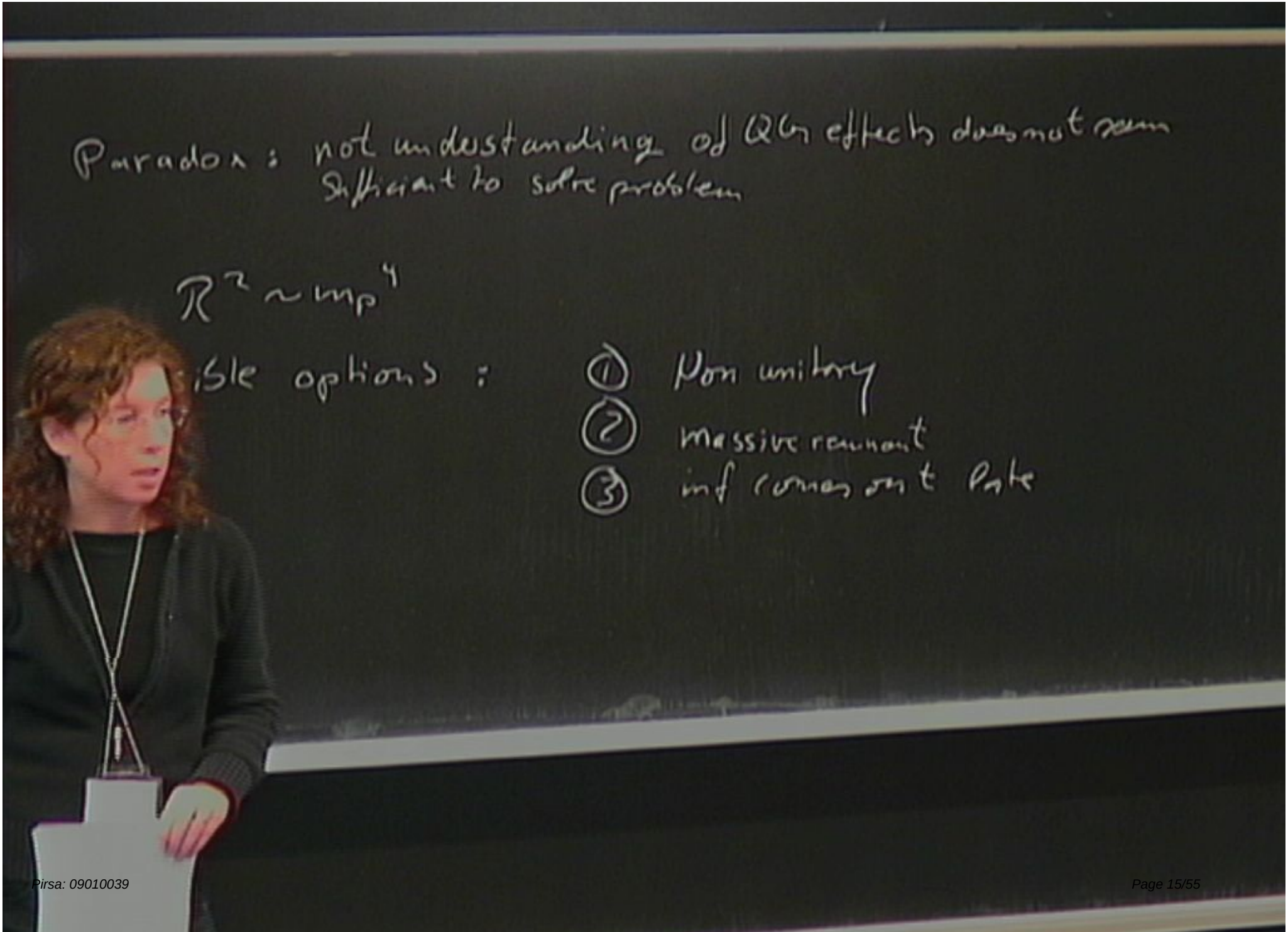
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Possible options:

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4. " early

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Horizon — Singularity

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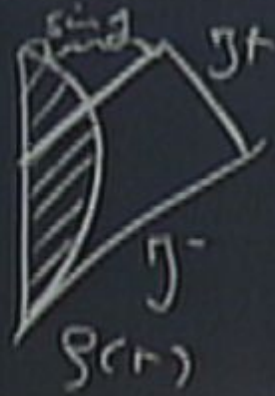

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Horizon

Singularity

Paradox: not understanding of QG effects does not seem sufficient to solve problem

$R^2 \sim m_p^4$

Possible options:

1. Non unitary
2. massive remnant
3. inf remnants or too late
4. ||

Space-time: would classically evolve into black hole

Horizon: space-time has asympt. future & middle region

Horizon: space-time has asympt. future & hidden region

singularity:

Horizon: space-time has asympt. future & hidden region

quantum non-singular: Evolution from Σ_1 to Σ_2 is reversible $\forall \Sigma_1, \Sigma_2$

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classify solutions :- "radical" departure from semi-classical limit where unexpected

Horizon: space-time has asympt. future & middle region

quantum non-singular: Evolution from Σ_1 to Σ_2 is reversible $\not\Leftrightarrow$ $\Sigma_1 \not\Leftarrow \Sigma_2$

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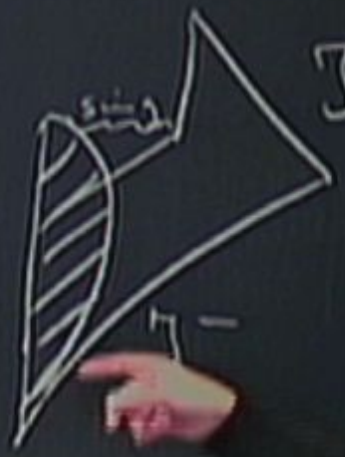
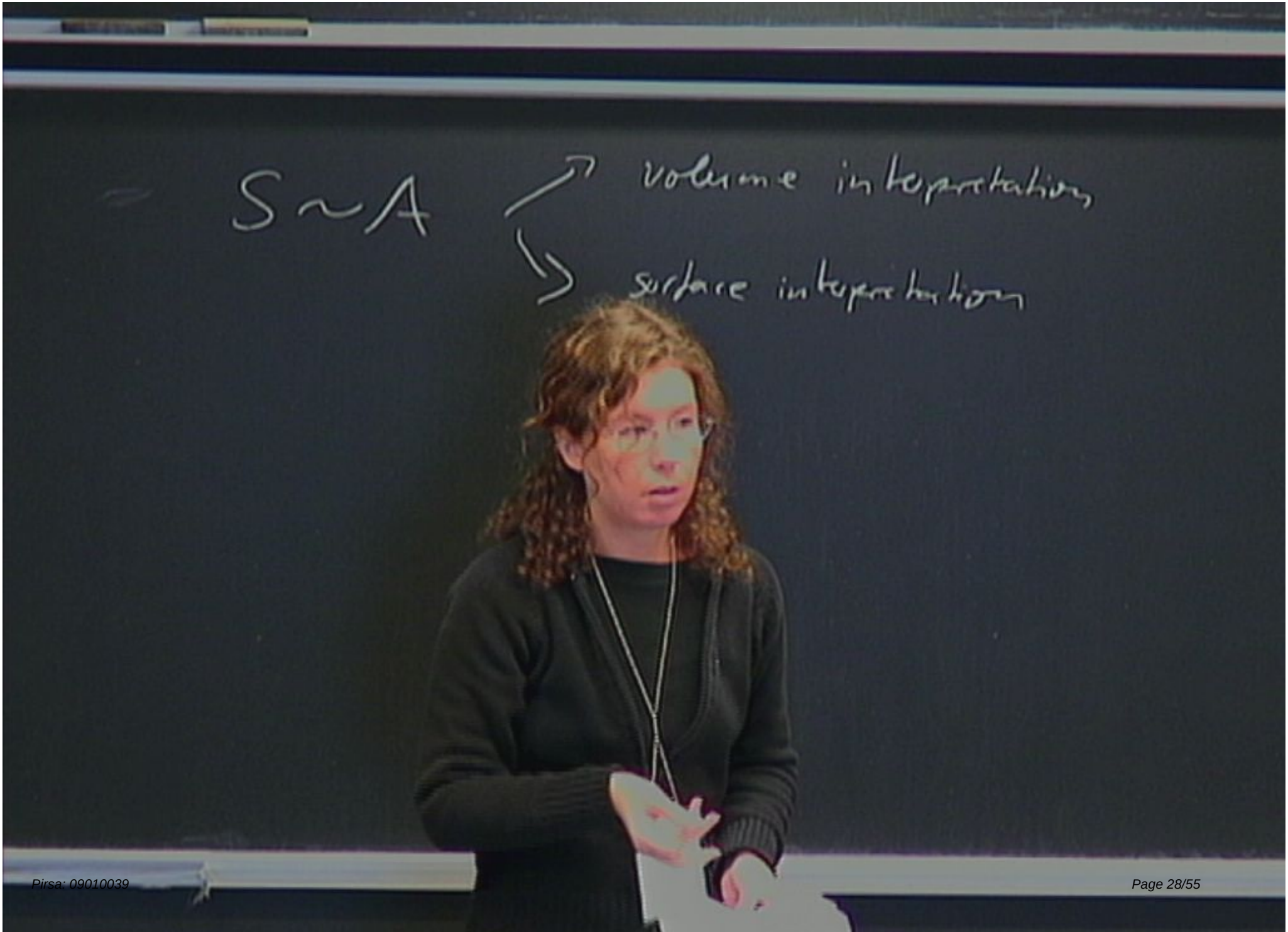
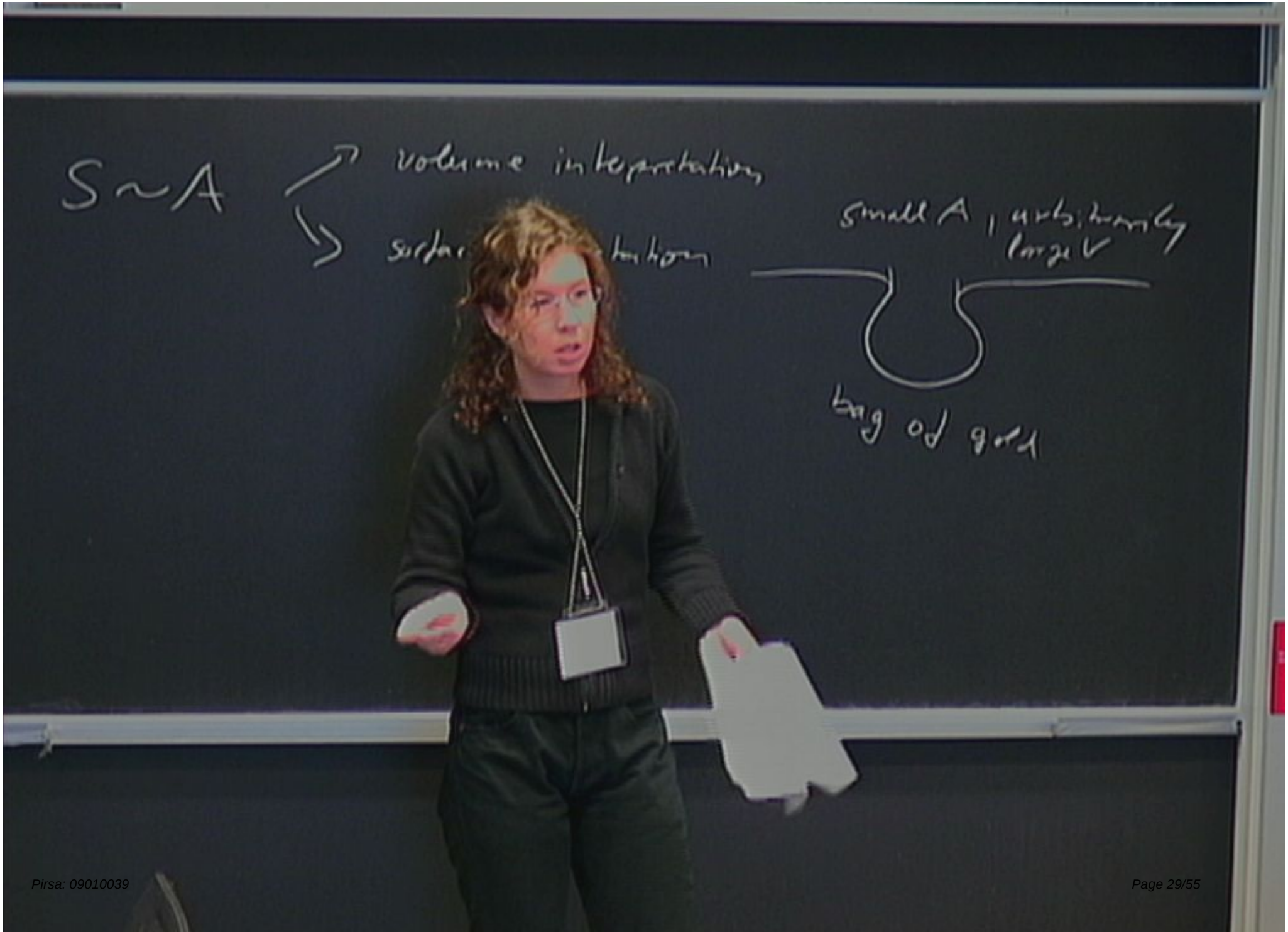
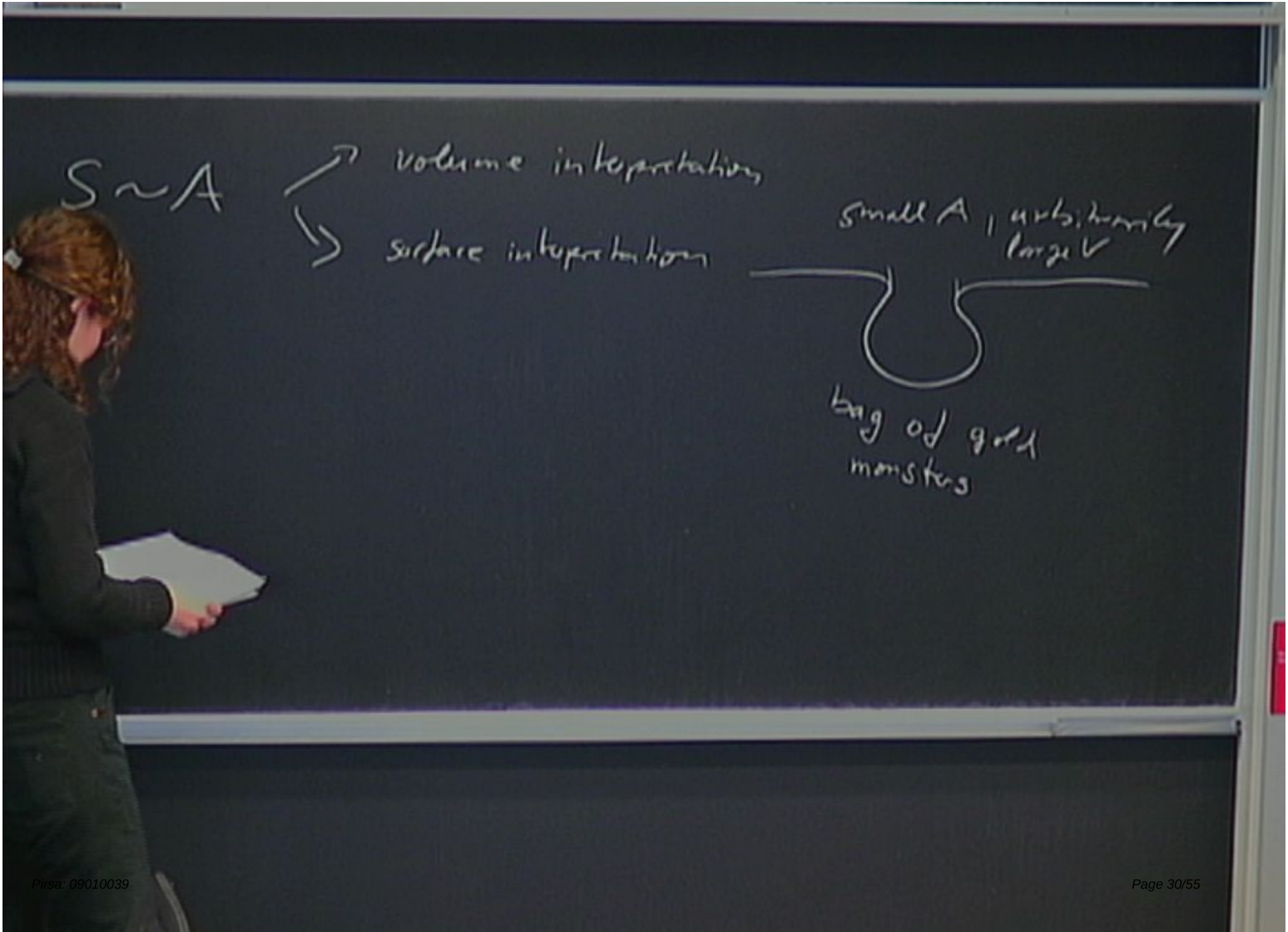


Horizon

Singularity


S~A
volume interpretation
surface interpretation


S~A
volume interpretation
small A
bag of gold


S~A
volume interpretation
surface interpretation
small A, arbitrarily large V
bag of gold
monsters

$S \sim A$

volume interpretation

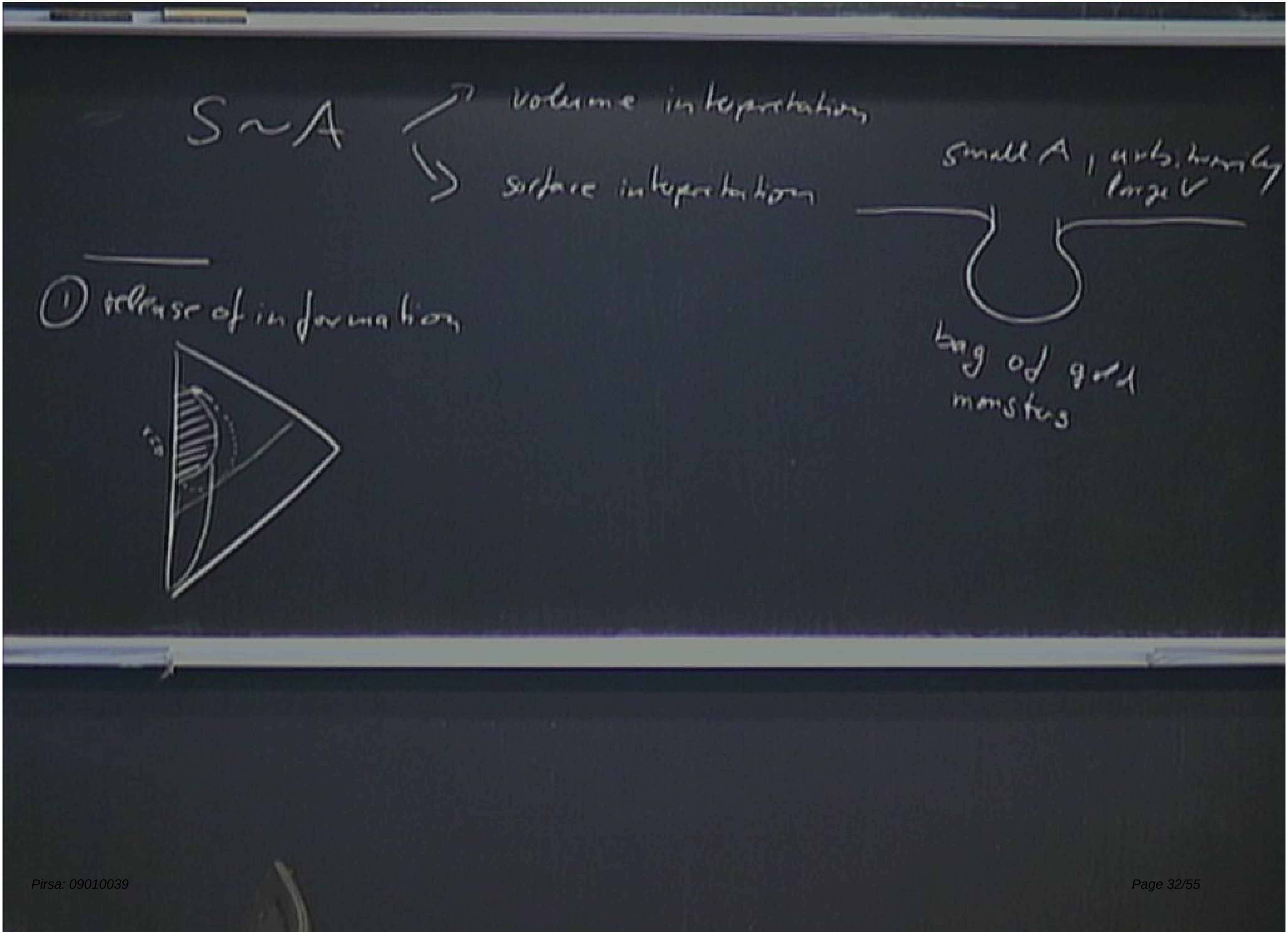
surface interpretation

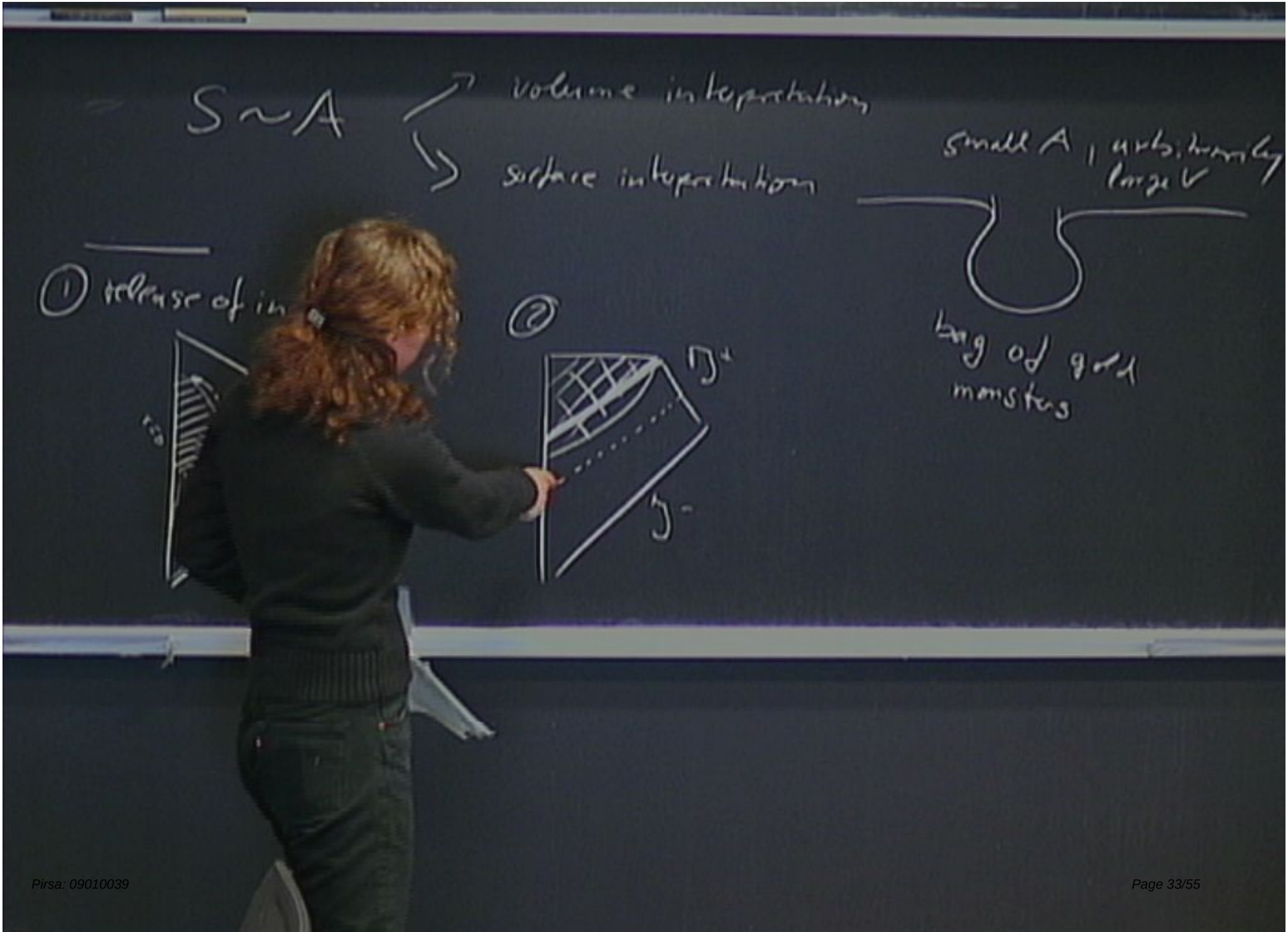
small A, arbitrarily large V

bag of gold

monsters

Phase of information


S ~ A
volume interpretation
surface interpretation
small A, arbitrarily large V
① release of information
bag of gold
monsters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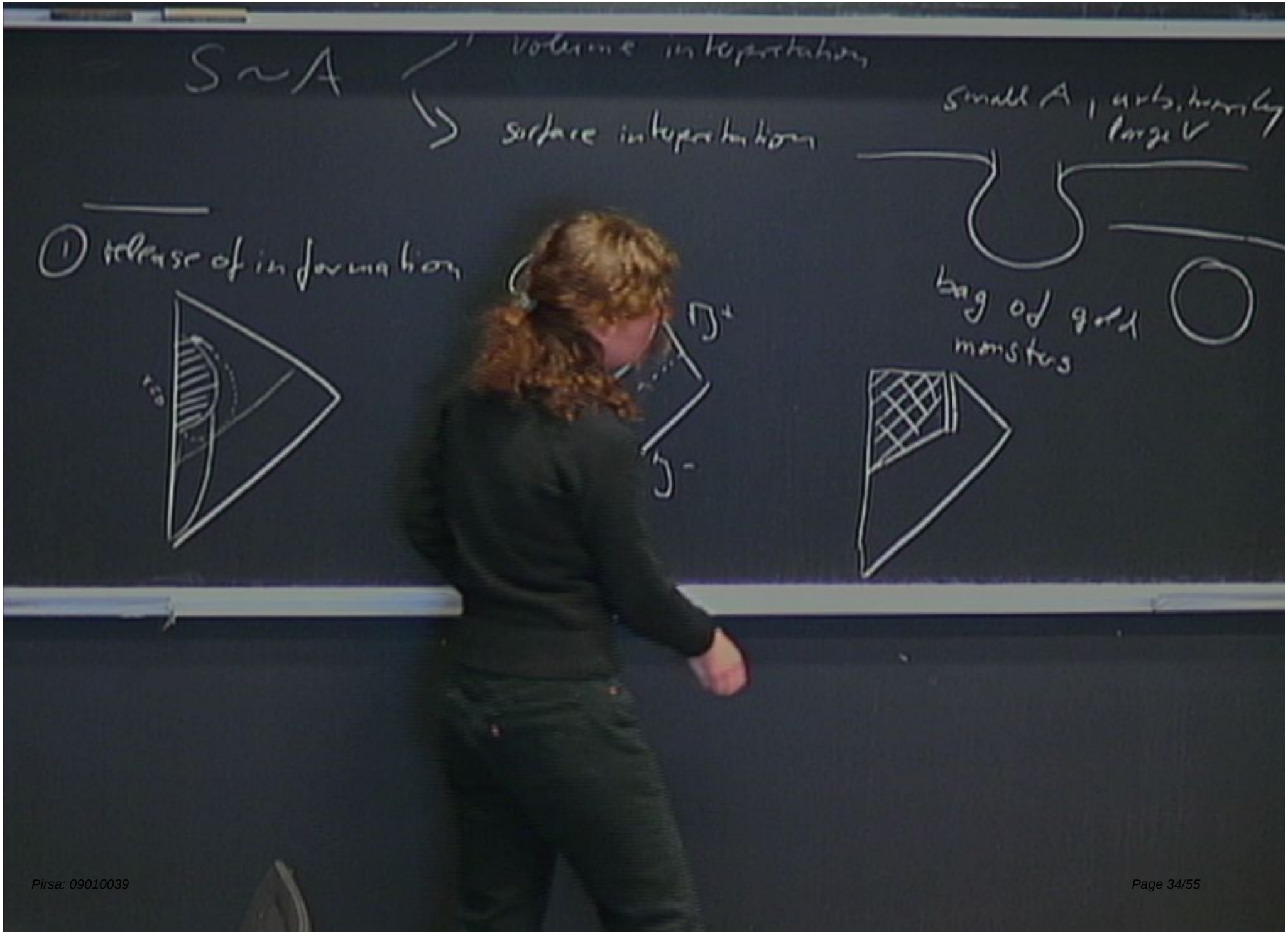
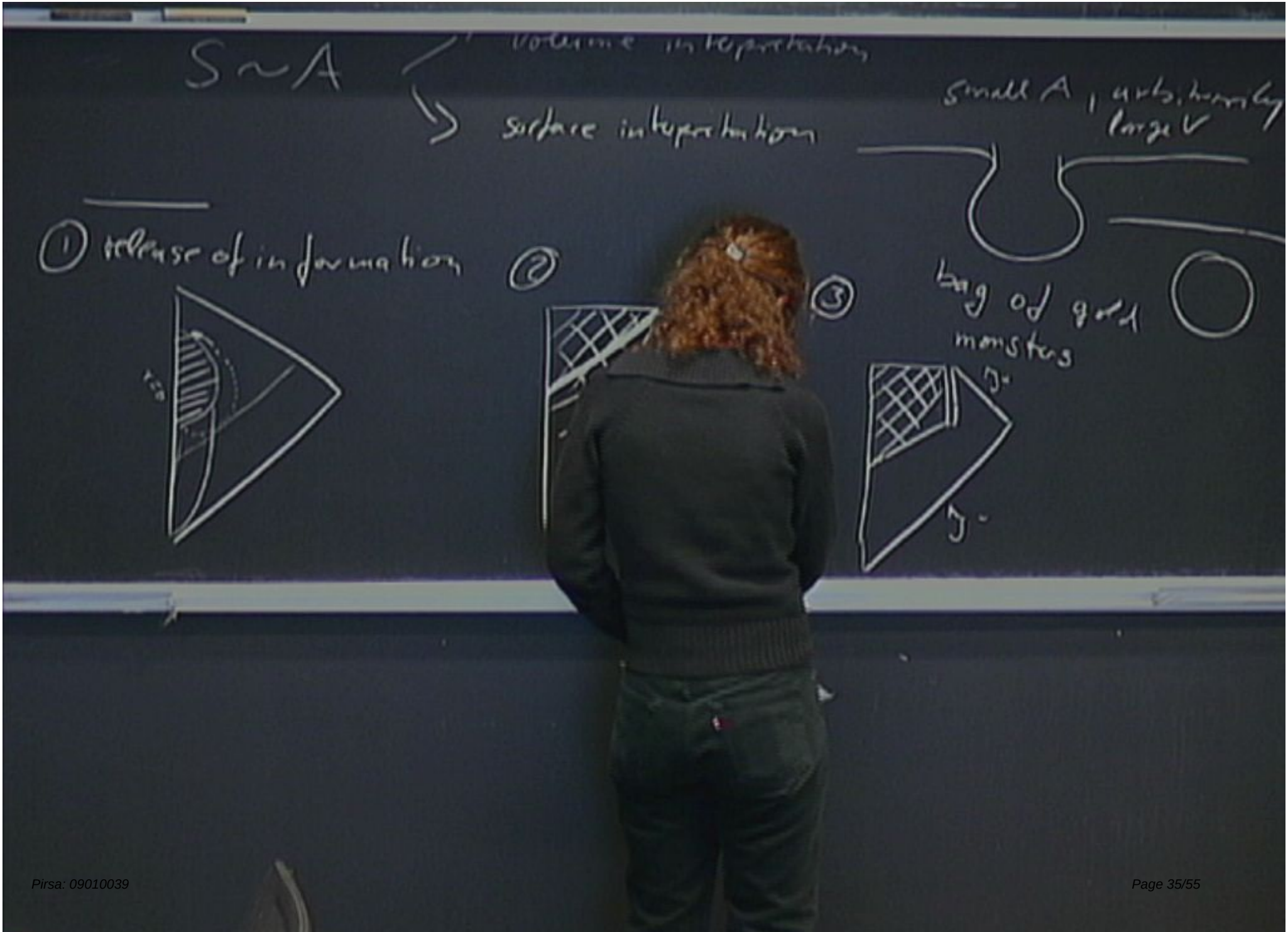

S~A
volume interpretation
surface interpretation
small A, curls, hairy
large V
① release of information
bag of gold
monsters


S~A
surface interpretation
small A, curvy, horrocky
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②
③
bag of gold
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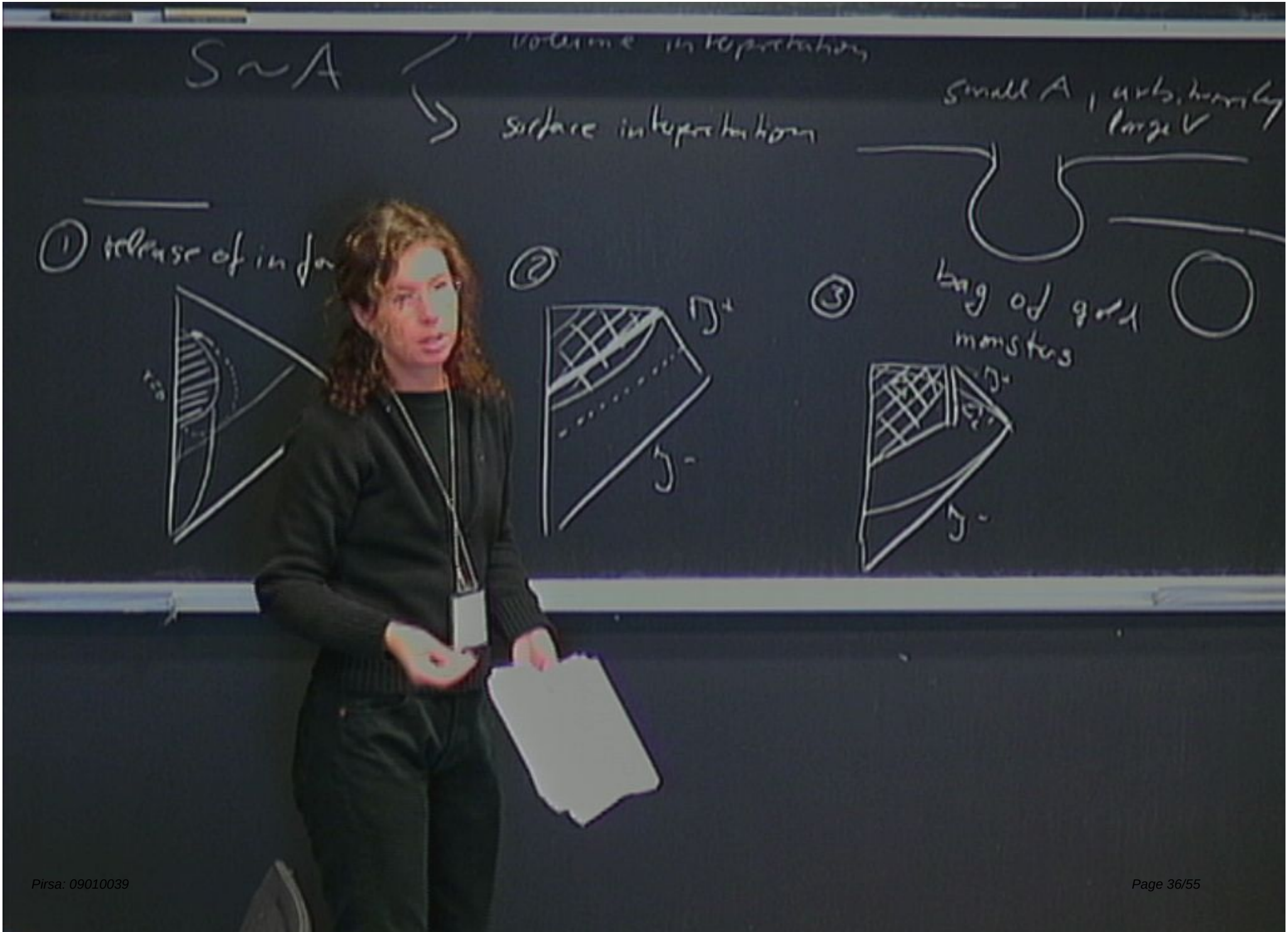
S~A
surface interpretations
small A, curvy, horrible
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① release of in
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③
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- pair production problem

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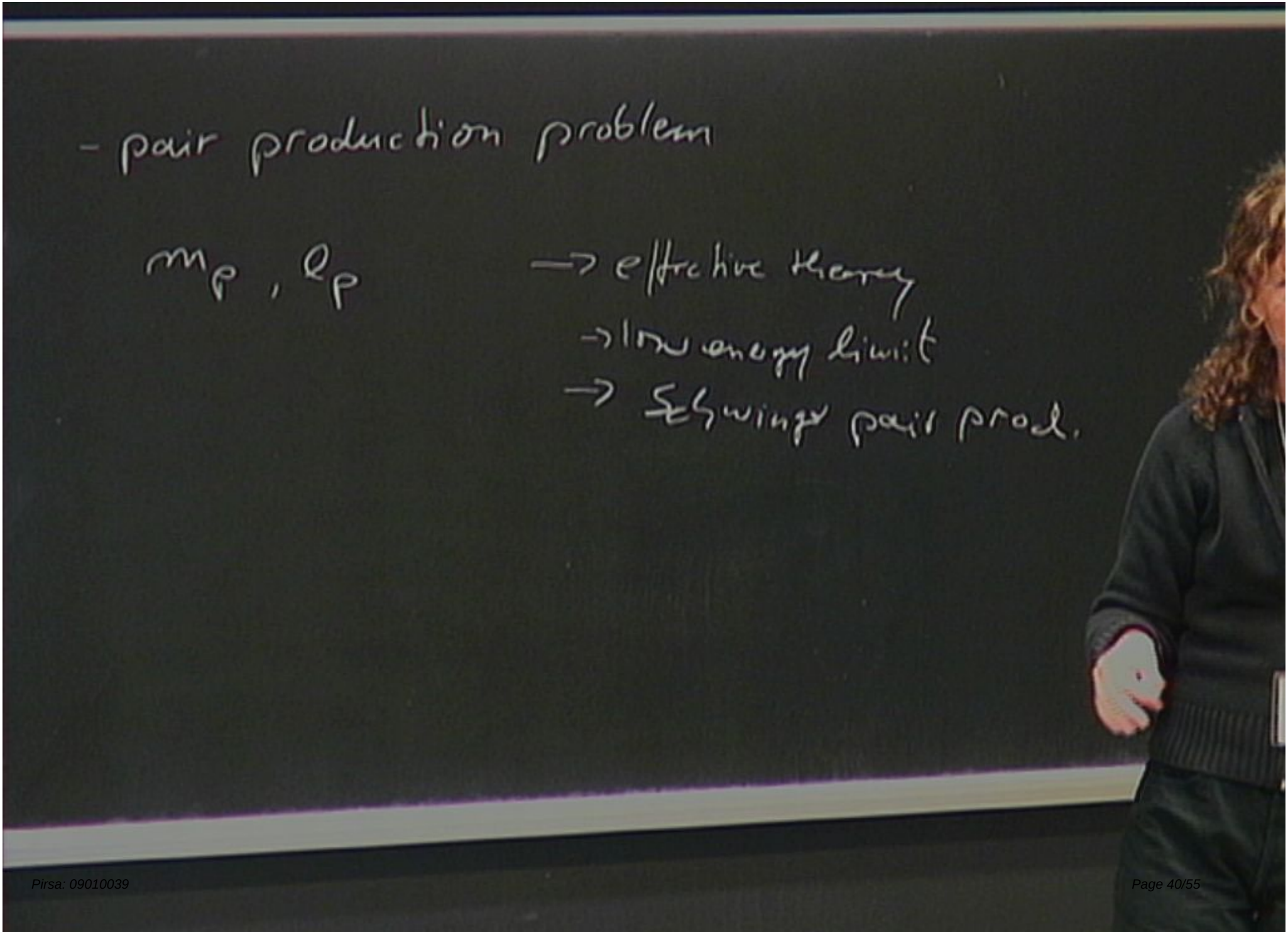
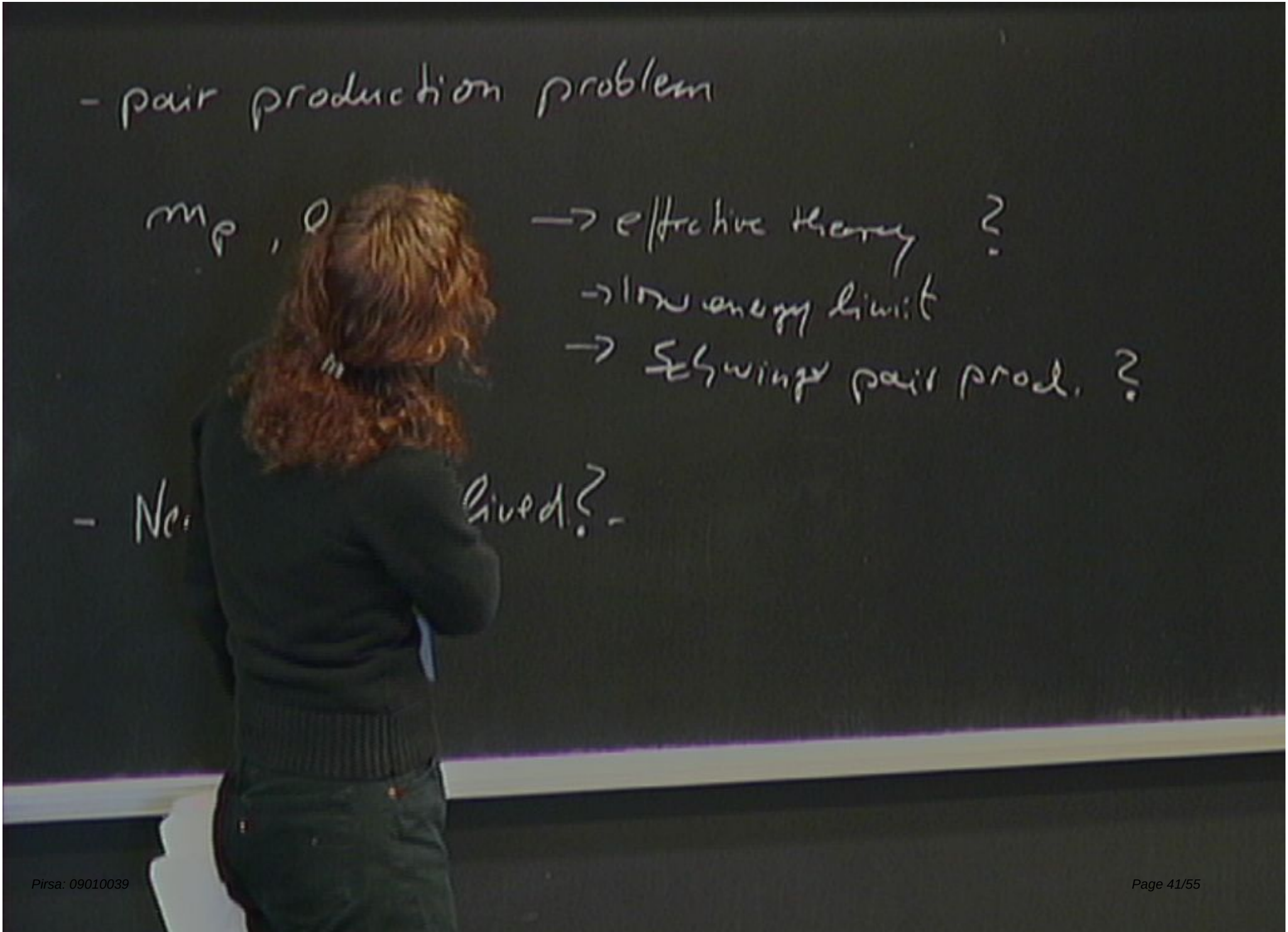
m_p , Q_p

- pair production problem

m_ρ , g_ρ → effective theory

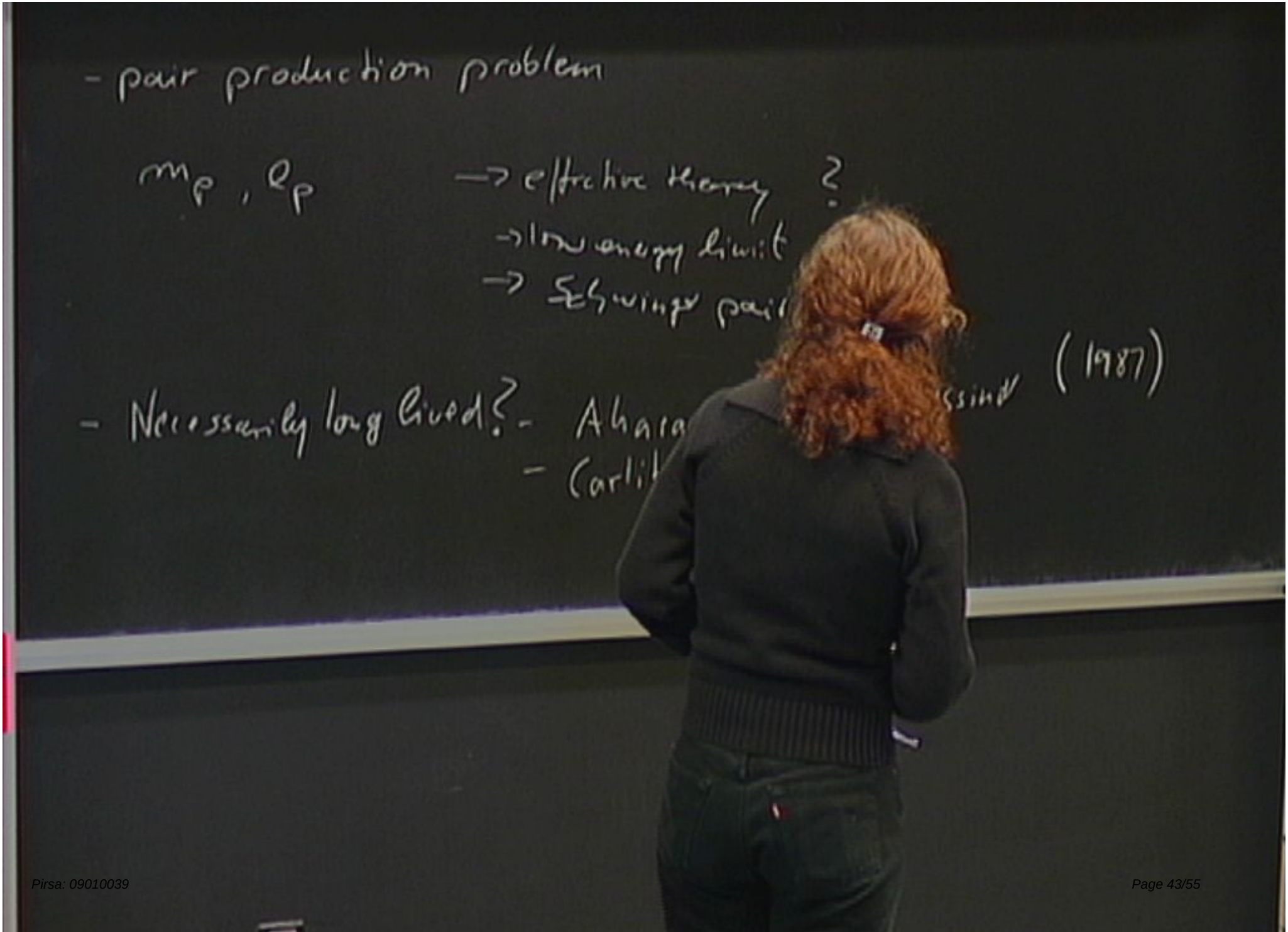

- pair production problem
m_ρ , g_ρ
→ effective theory
→ low energy limit
→ Schwinger pair prod.


- pair production problem
m_p , 0
→ effective theory ?
→ low energy limit
→ Schwinger pair prod. ?
- Ne
Sived ?-

- pair production problem

m_ρ, ℓ_ρ → effective theory ?
→ low energy limit
→ Schwinger pair prod. ?

- Necessarily long lived? -


- pair production problem
m_p , e_p
→ effective theory ?
→ low energy limit
→ Schwinger pair
- Necessarily long lived? - Ahara
- Carli
(1987)

- pair production problem

m_p, e_p → effective theory ?
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- Necessarily long lived? - Aharanov, Casher, Nussinov (1987)
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Possible options : ① Non unitary
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③ inf coming out late
④ " early

Space-times : would classically evolve into black hole

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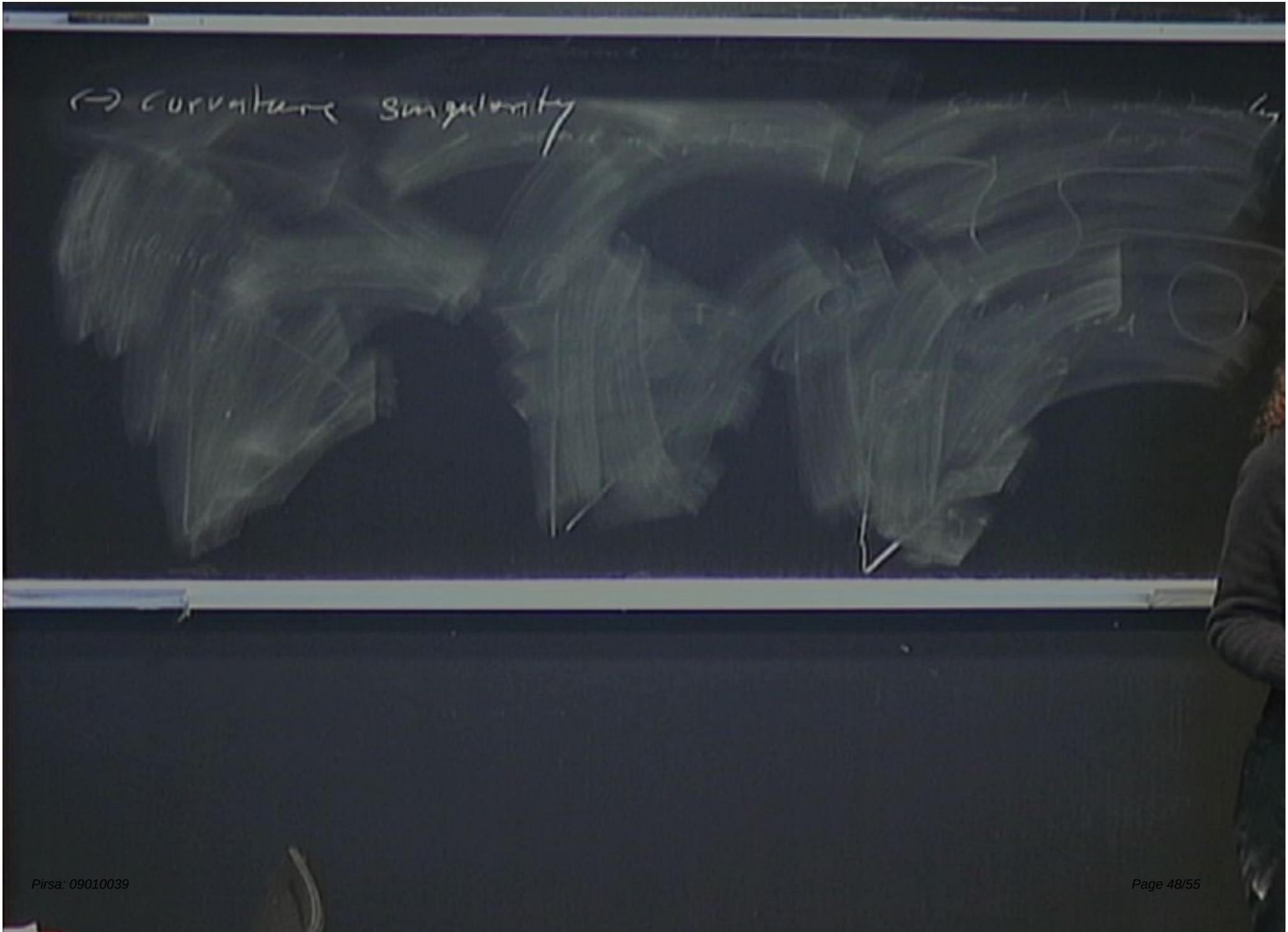
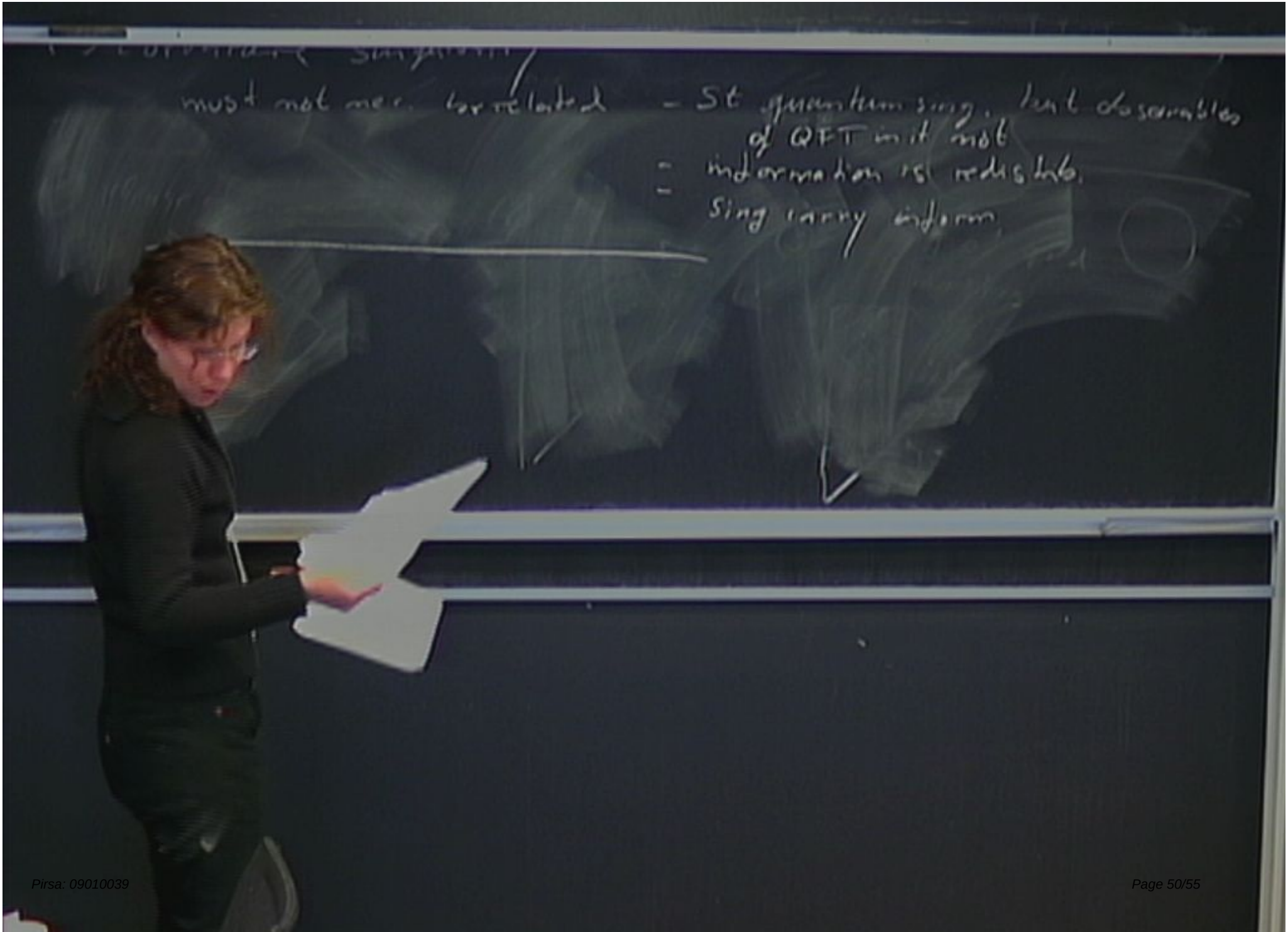

↪ curvature singularity

(−) curvature singularity

must not nec. be related – St quantum sing.


must not mea. be related
- St quantum sing. but observables
of QFT in it not
= information is redistrib.
= Sing carry inform.

must not occ. be related

- St quantum sing. but observables of QFT in it not
- information is redundant.
- Sing carry inform.

Conclusion: Need better understanding of highly entropic quantum grav. Planck-scale objects

Paradox : not understanding of QG effects does not seem sufficient to solve problem

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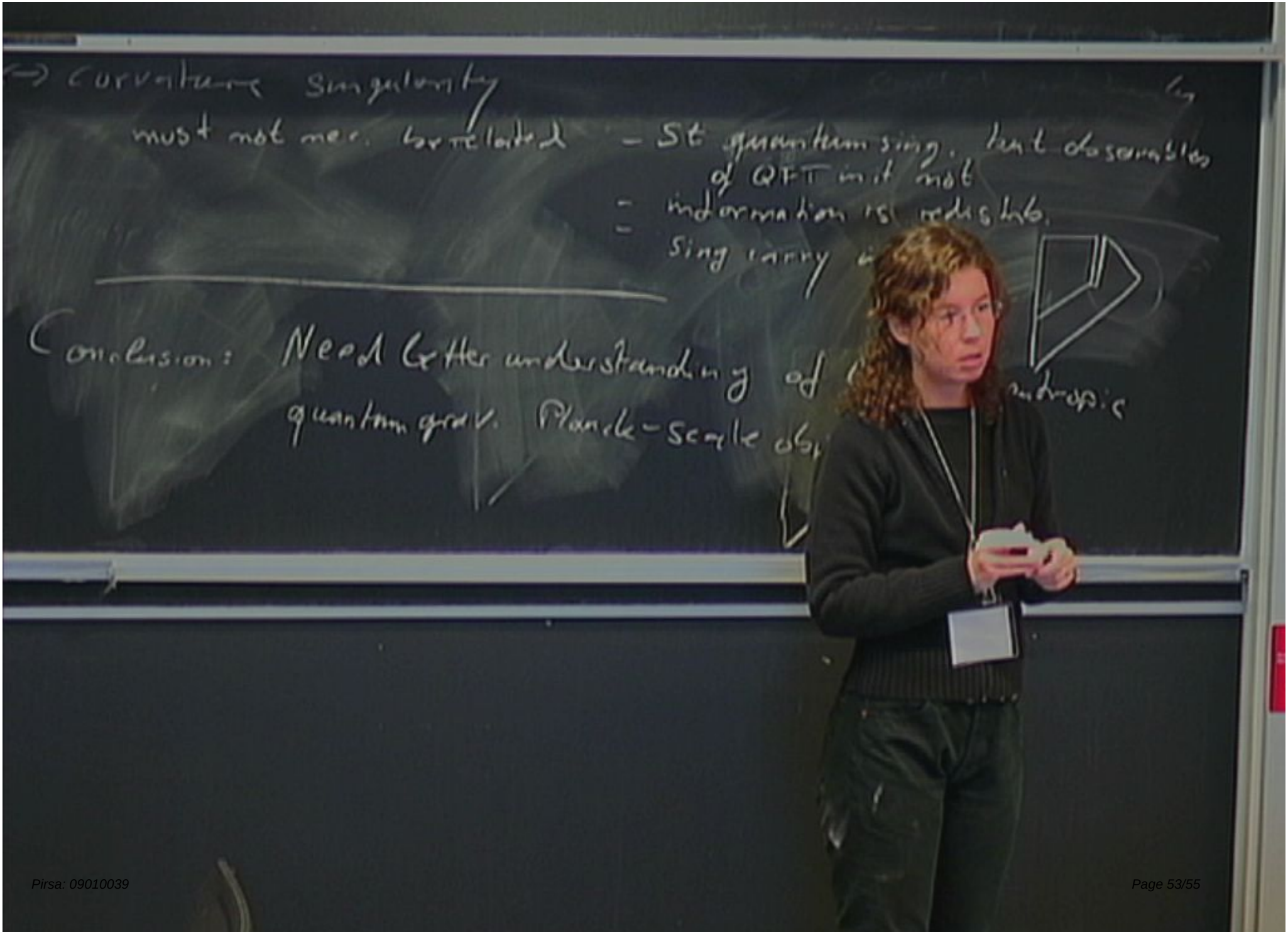
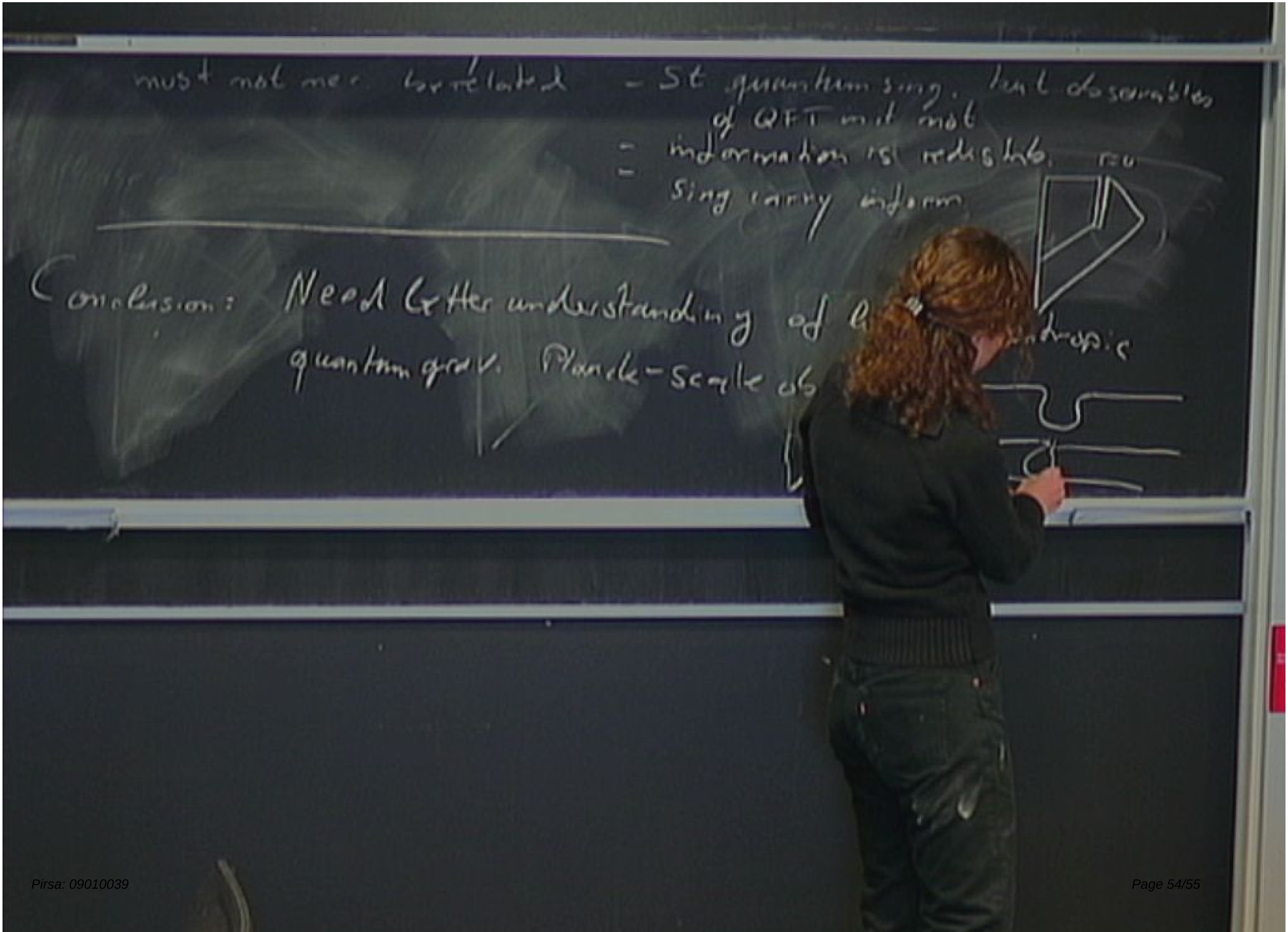
Space-time : would classically evolve into Black hole

- Carlip, Willay (1987)


Curvature Singularity
must not occur
Conclusion:
Need better understanding of
quantum grav.
anthropic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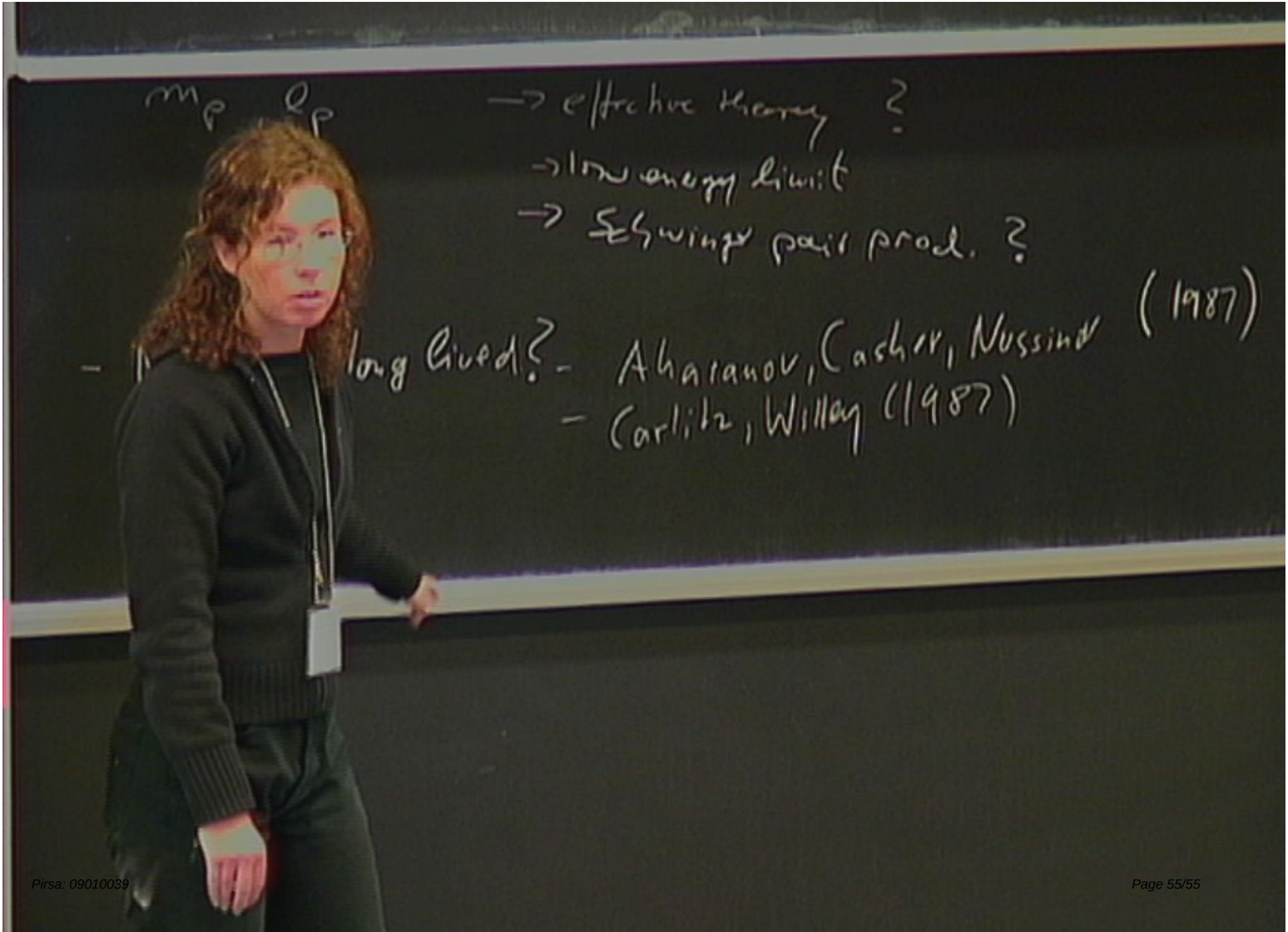
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