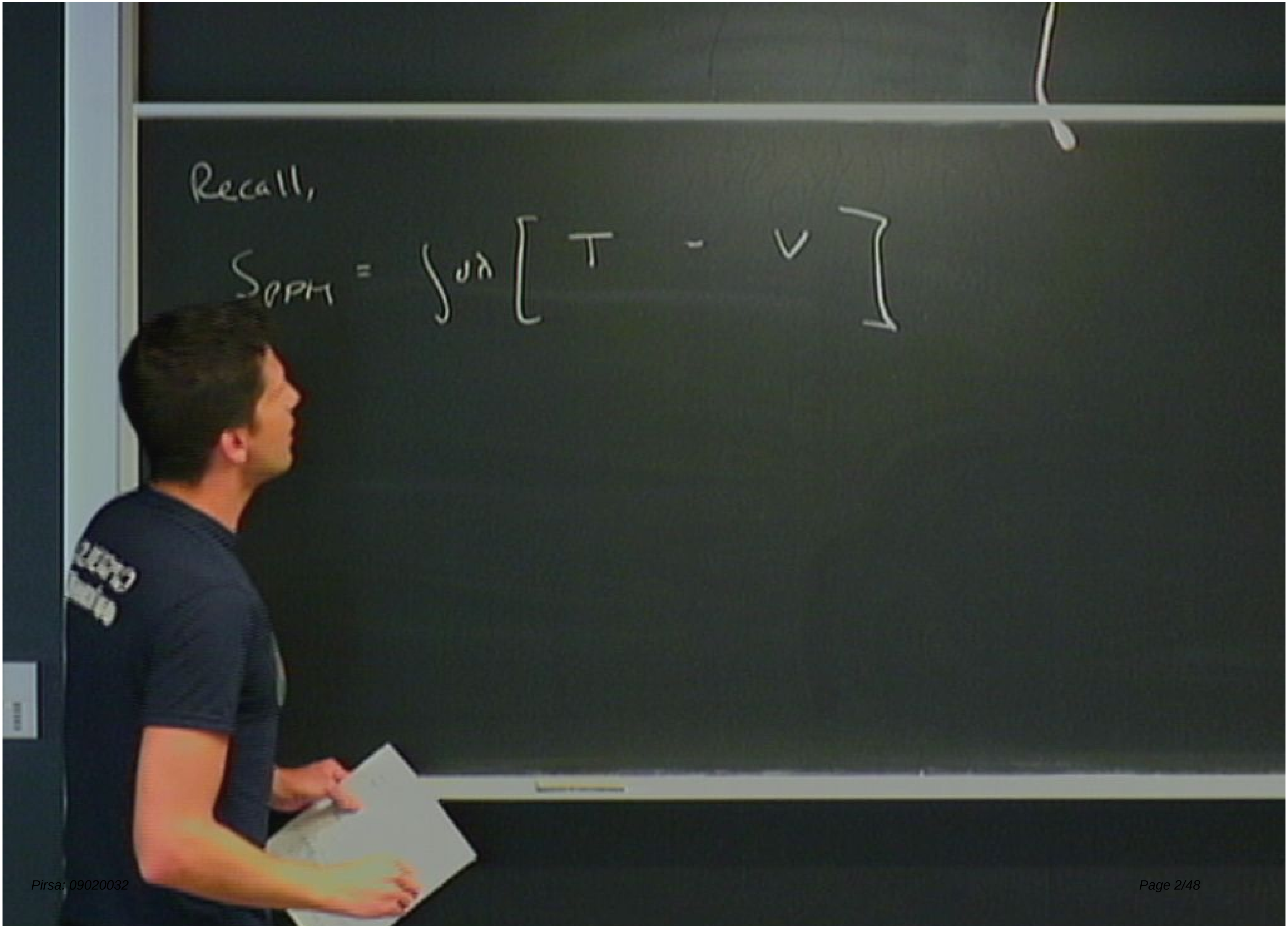
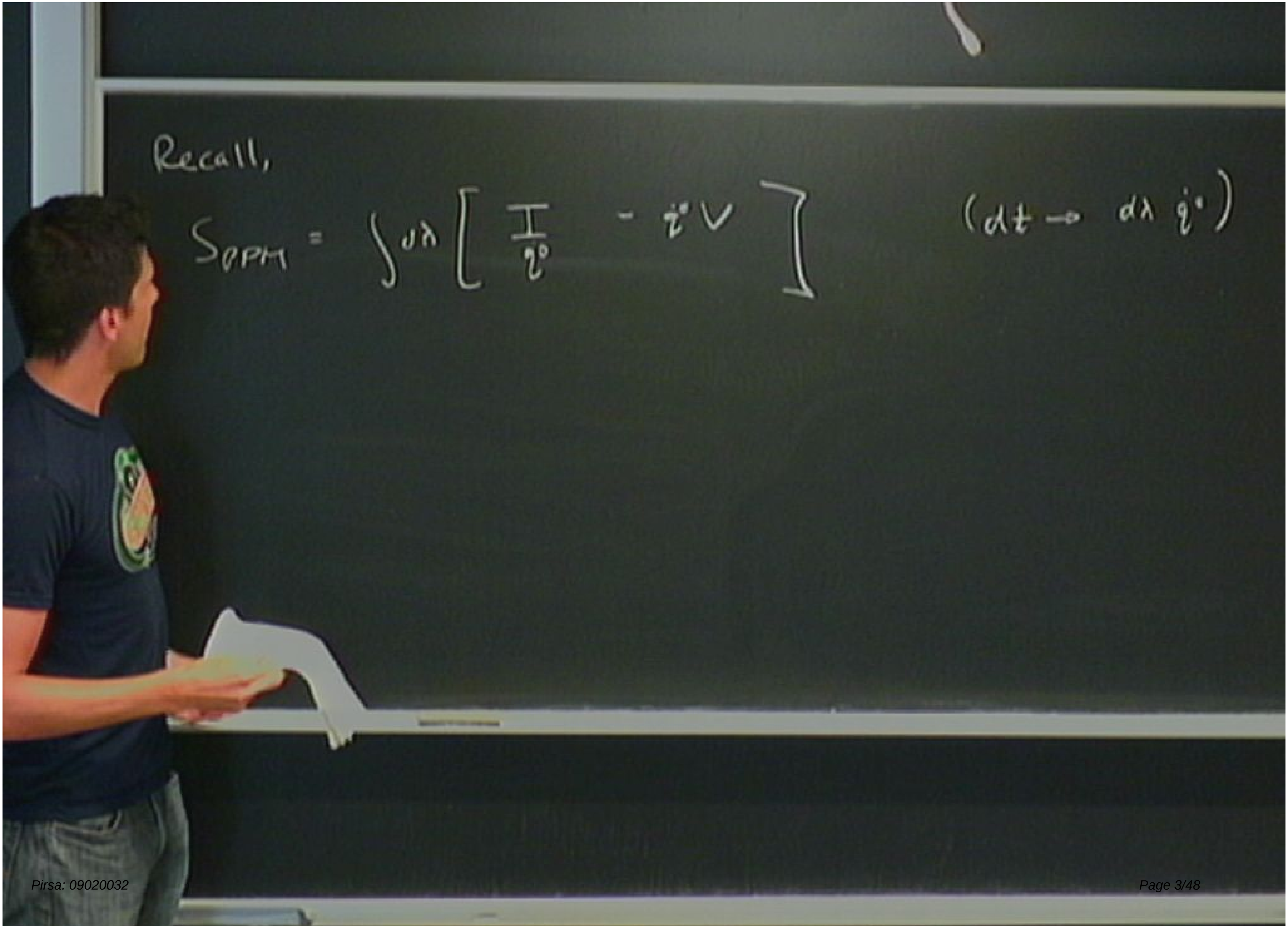
Title: Mini-Course on Mach's Principle - Lecture 3

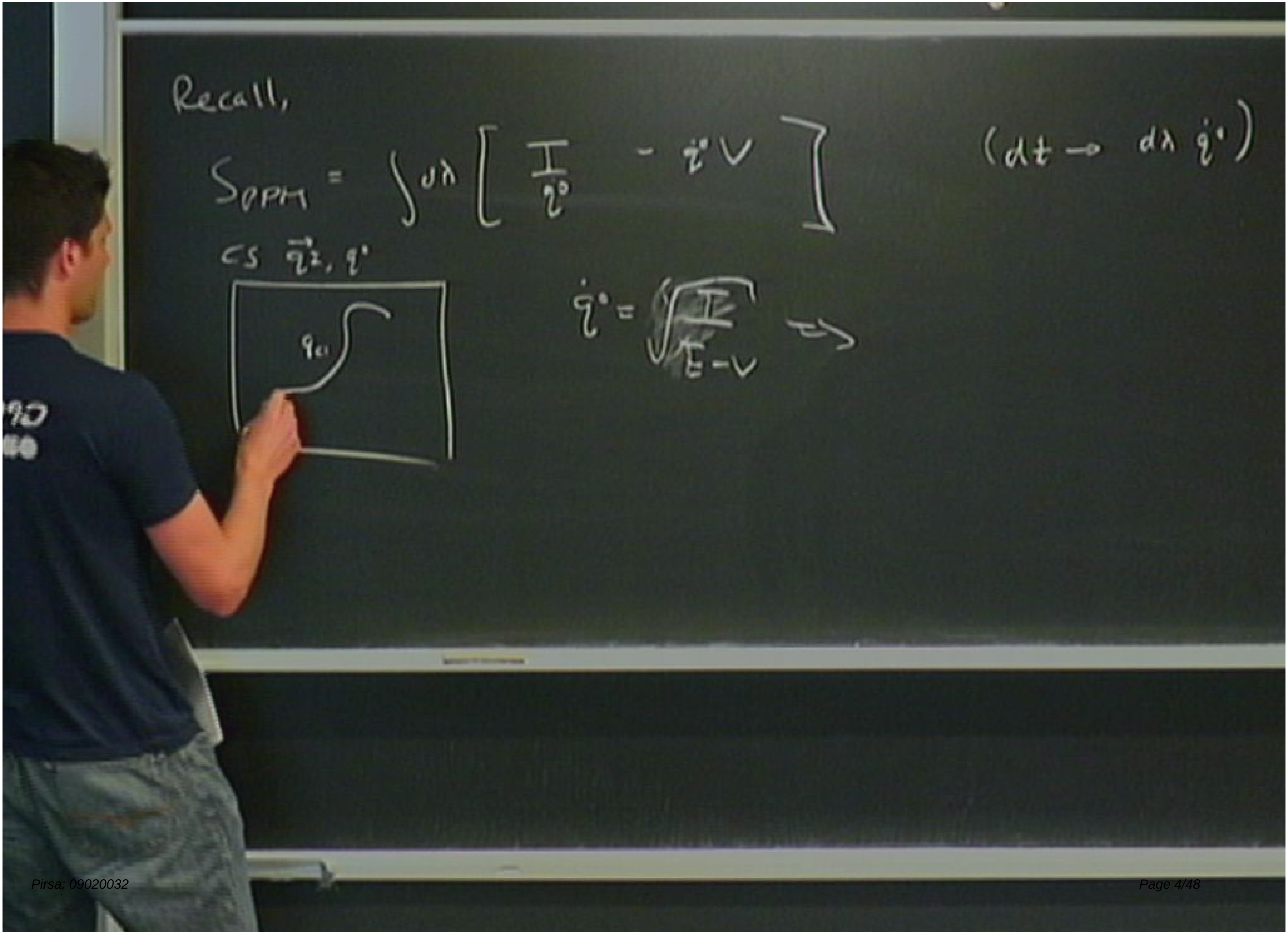
Date: Feb 25, 2009 10:30 AM

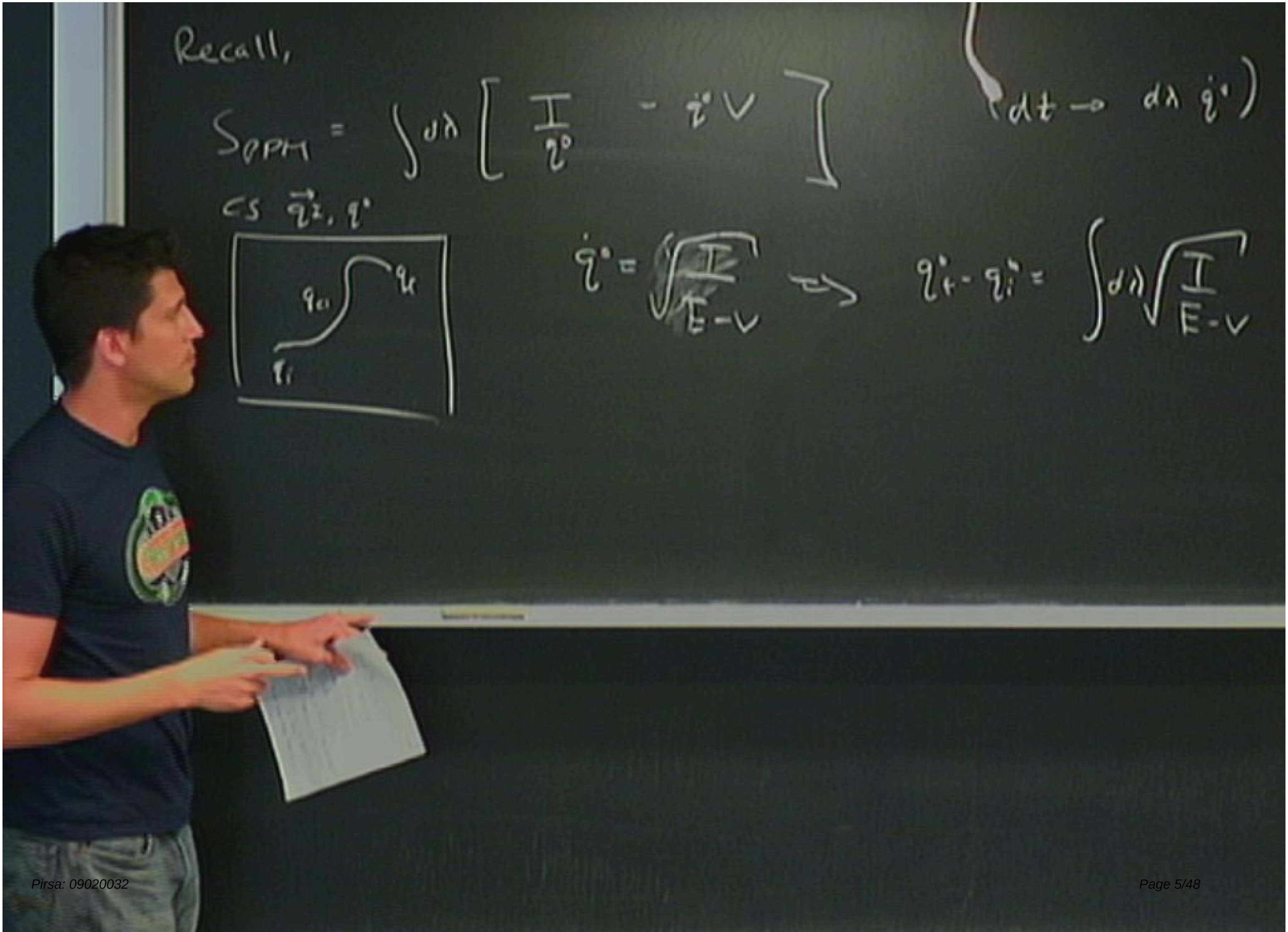
URL: http://pirsa.org/09020032

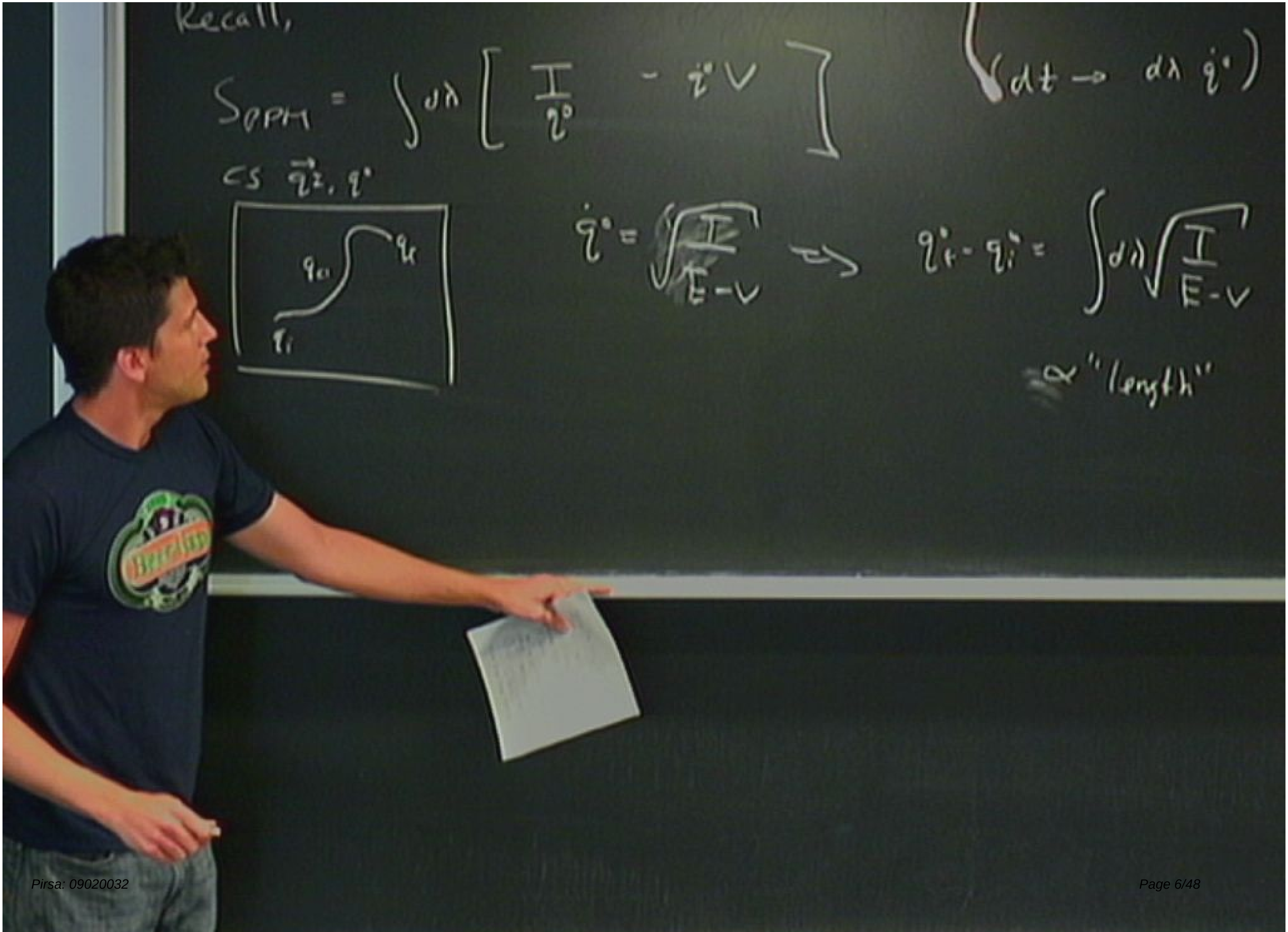
Abstract:

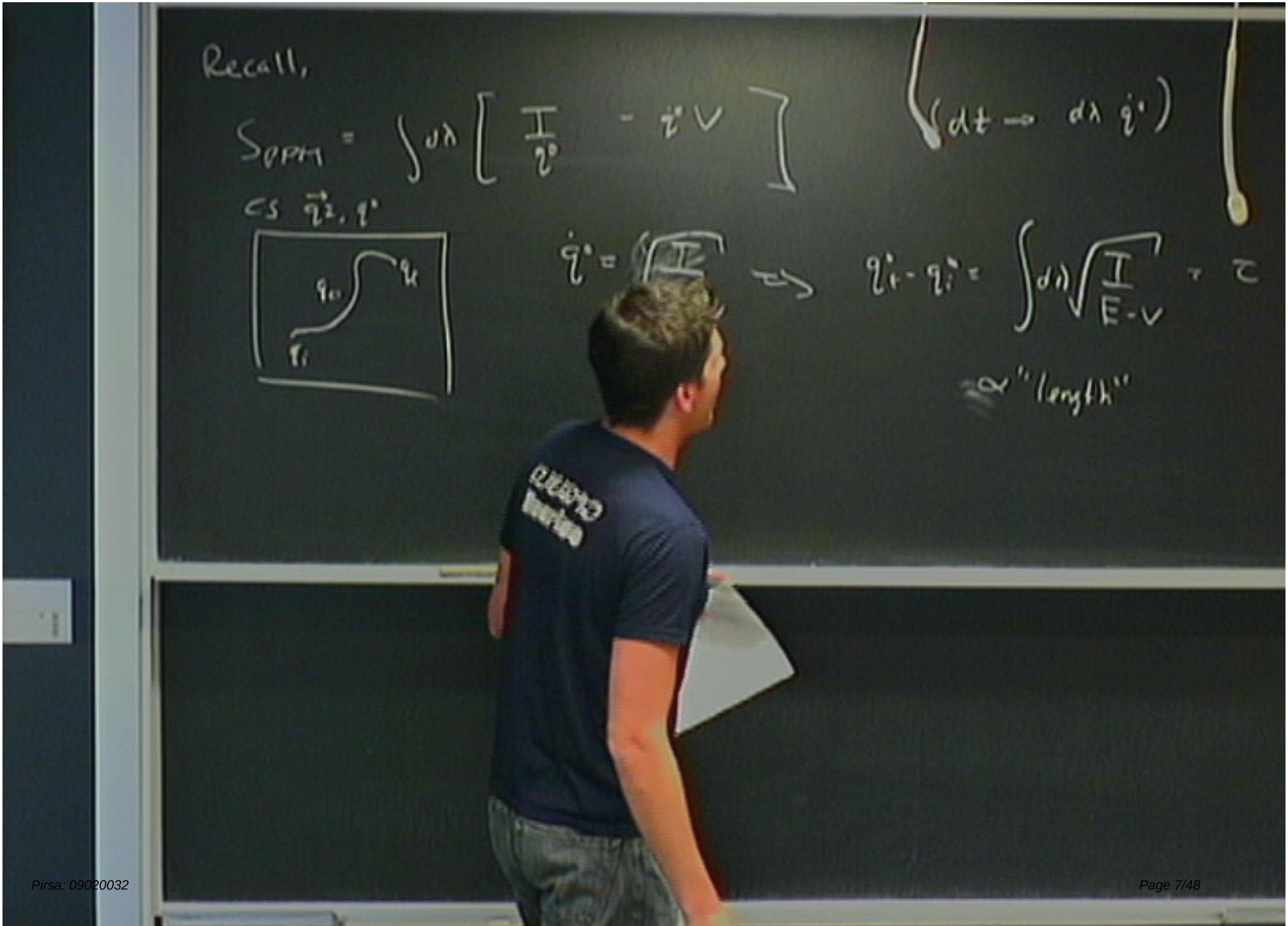

Recall,
S_ppm = ∫dλ [T - V]

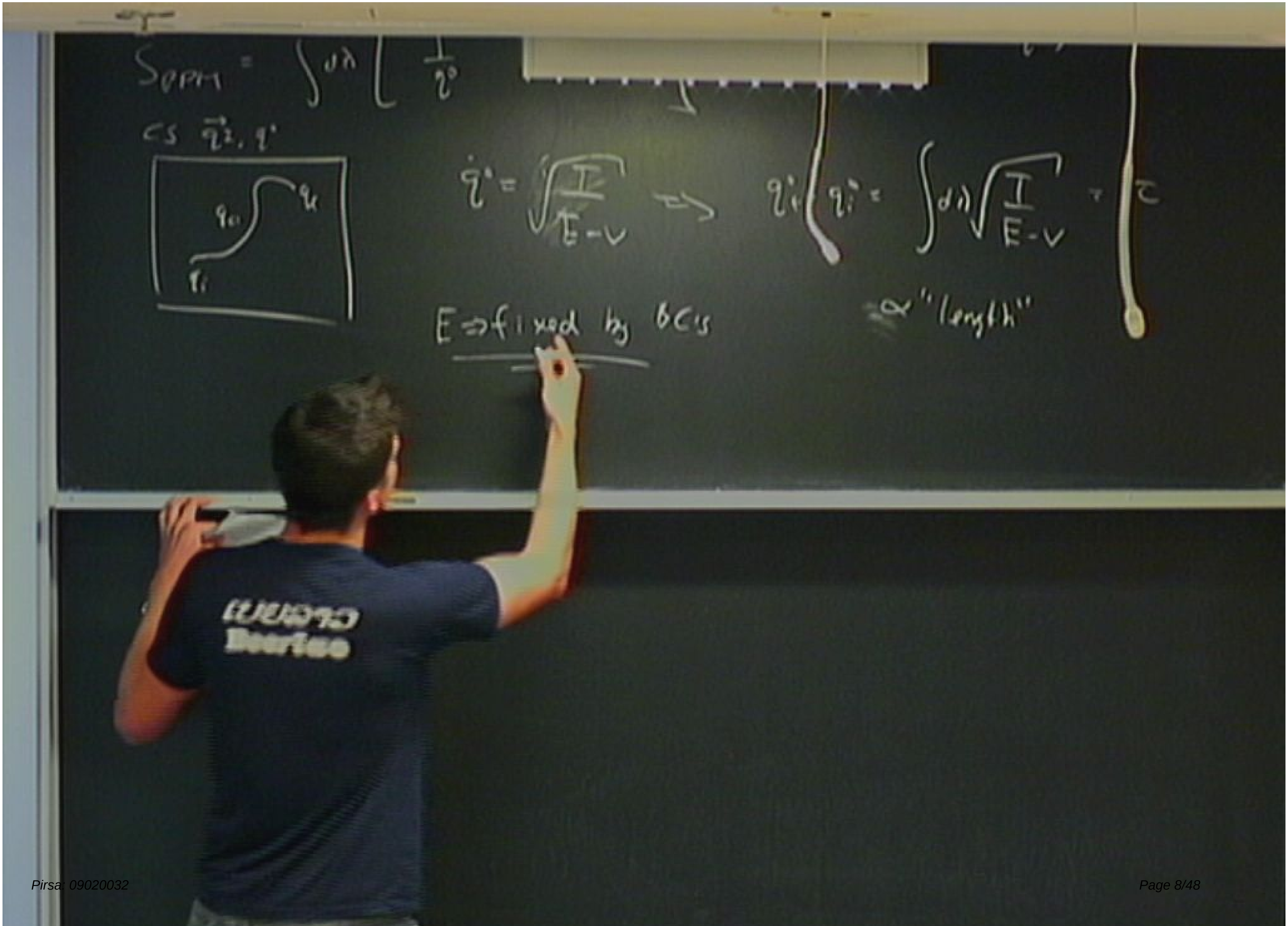

Recall,
$S_{PPM} = \int d\lambda \left[\frac{I}{\dot{q}^0} - \dot{q}^0 V \right]$
$(dt \to d\lambda\, \dot{q}^0)$


Recall,
S_QPM = ∫ dλ [I / q'^0 − q'^0 V]
(dt → dλ q'^0)
cs q⃗², q^0
q_cl
q'^0 = √(I / (E−V)) =>


Recall,
$S_{BPM} = \int d\lambda \left[\frac{I}{\dot{q}^0} - \dot{q}^0 V \right]$
$(dt \to d\lambda\, \dot{q}^0)$
q_i
q_{cl}
q_f
$\dot{q}^0 = \sqrt{\frac{I}{E-V}} \Rightarrow q^0_f - q^0_i = \int d\lambda \sqrt{\frac{I}{E-V}}$

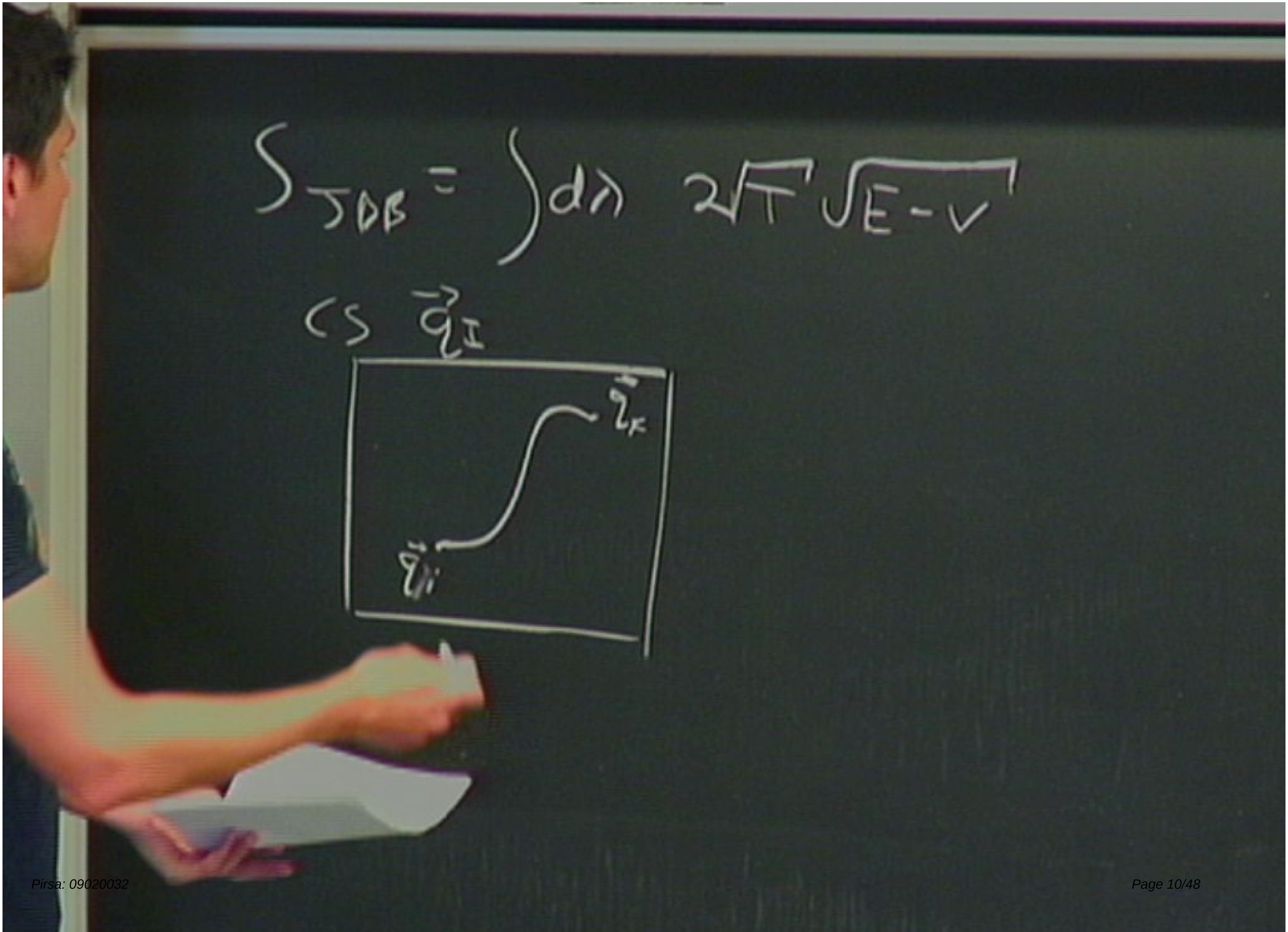

Recall,
$S_{DPM} = \int d\lambda \left[\frac{I}{\dot{q}^0} - \dot{q}^0 V \right]$
$(dt \to d\lambda \, \dot{q}^0)$
CS $\vec{q}^2, q^0$
q_i
q_{c1}
q_f
$\dot{q}^0 = \sqrt{\frac{I}{E-V}} \Rightarrow q^0_f - q^0_i = \int d\lambda \sqrt{\frac{I}{E-V}}$
$\propto$ "length"

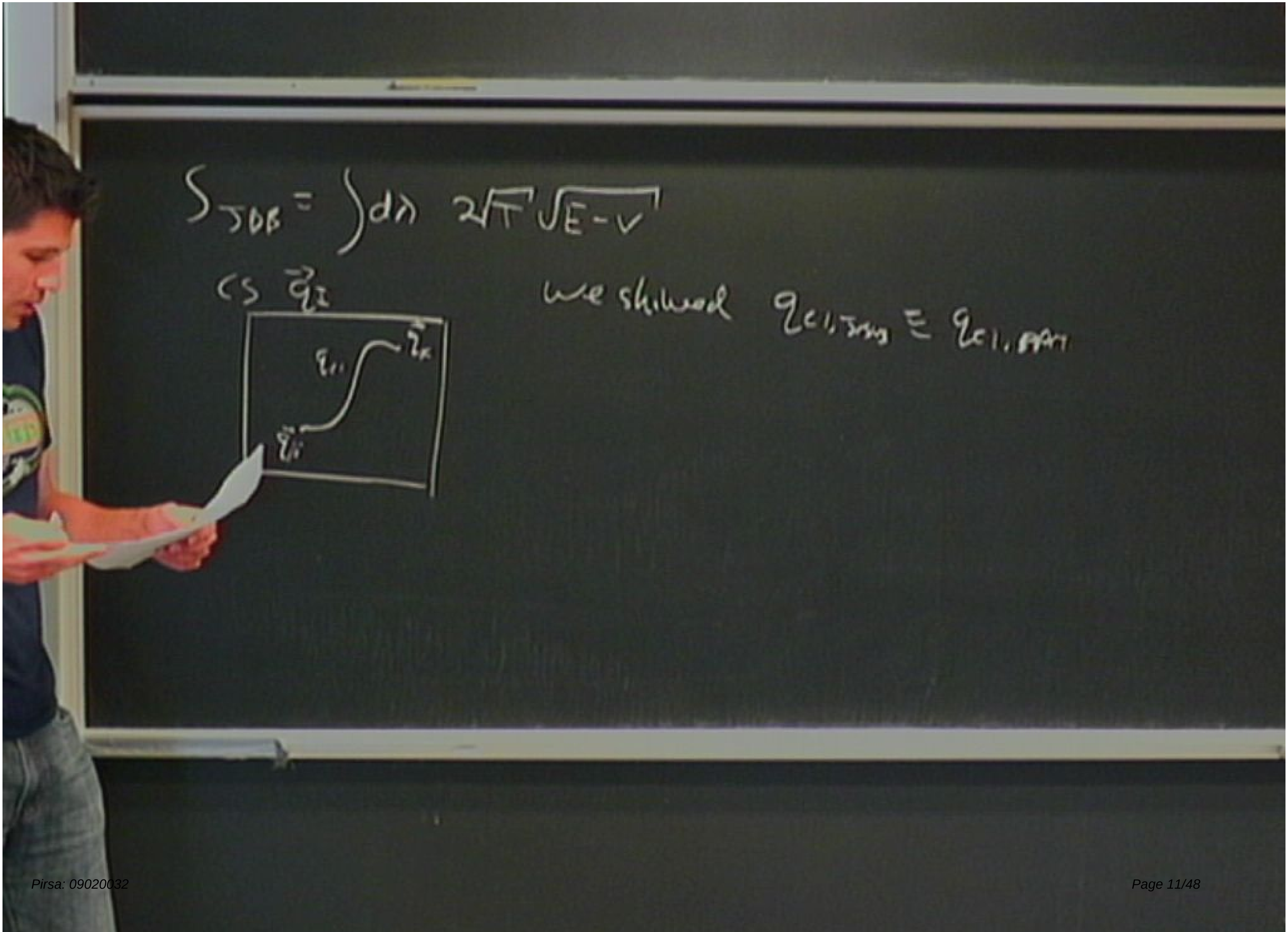

Recall,
$S_{QPM} = \int d\lambda \left[\frac{I}{\dot{q}^0} - \dot{q}^0 V \right]$
$(dt \to d\lambda\, \dot{q}^0)$
CS $\vec{q}^{\,i}, q^0$
q_i
q_f
$\dot{q}^0 = \sqrt{\frac{I}{E-V}} \Rightarrow q^0_f - q^0_i = \int d\lambda \sqrt{\frac{I}{E-V}} = \tau$
$\propto$ "length"

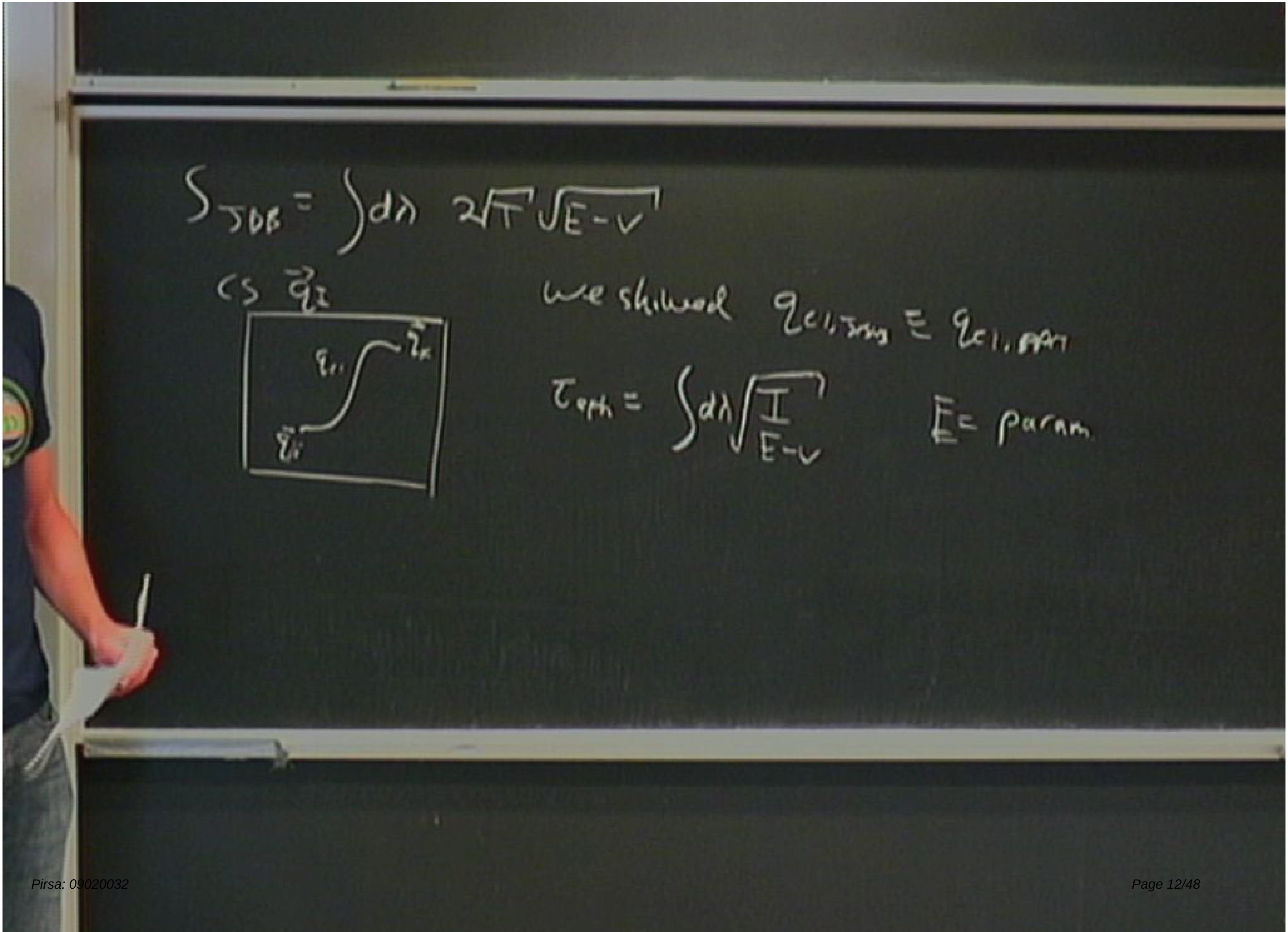

E ⇒ fixed by BC's
∝ "length"

$$S_{JDB} = \int d\lambda \; 2\sqrt{T}\sqrt{E-V}$$

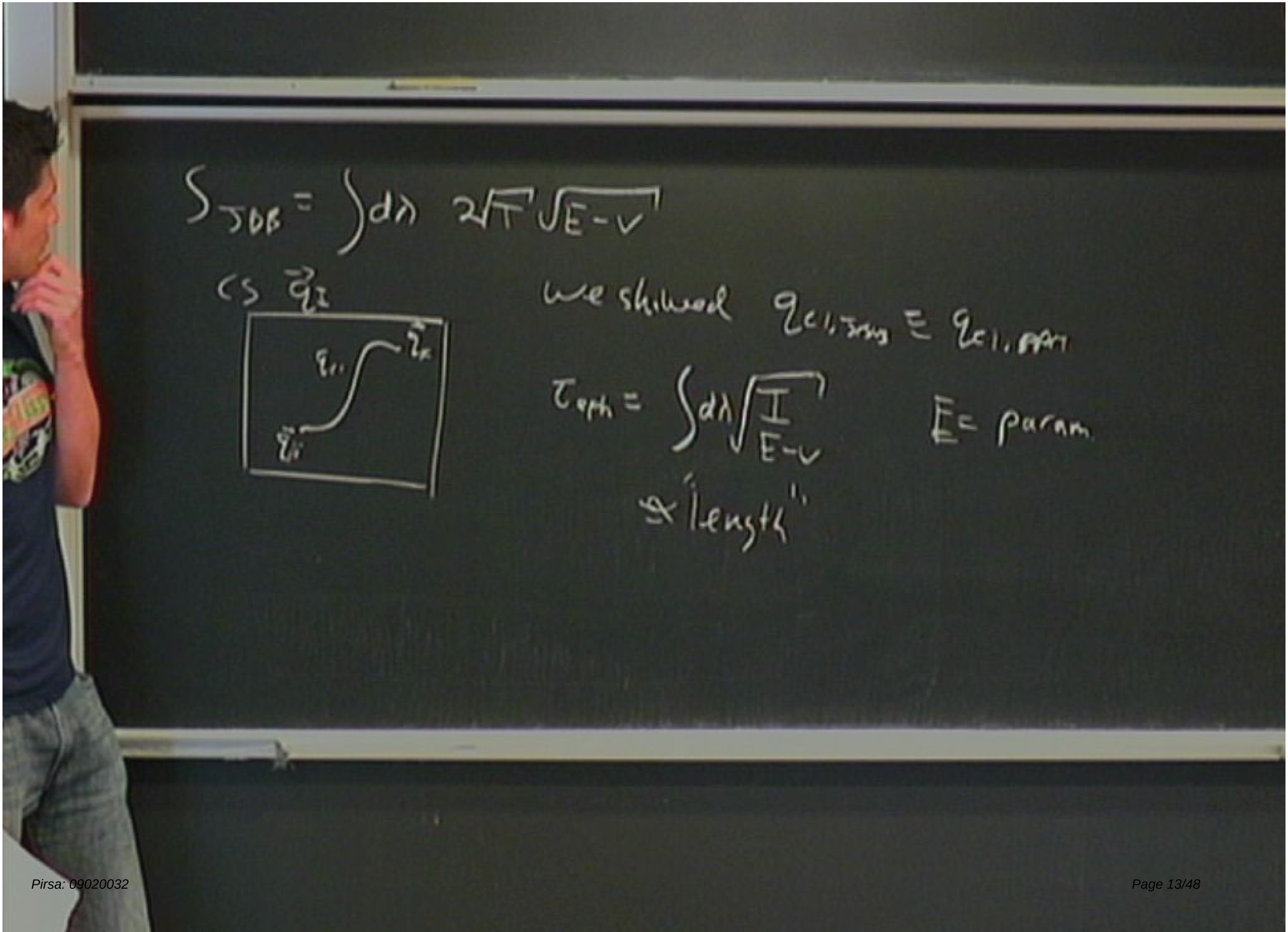
CS $\vec{q}_I$

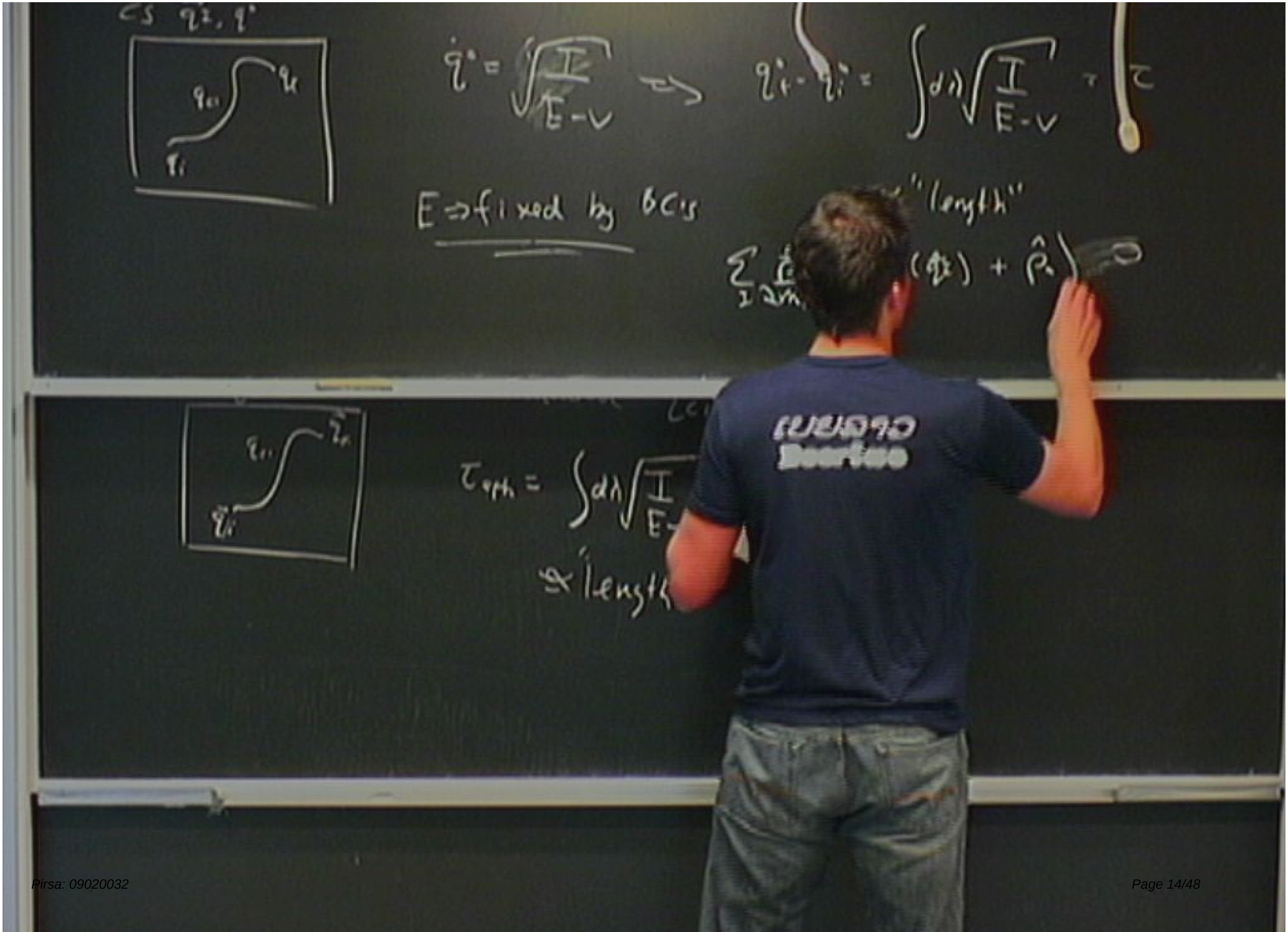

S_JDB = ∫dλ 2√T √(E − V)
cs q⃗_I
q⃗_f
q⃗_i

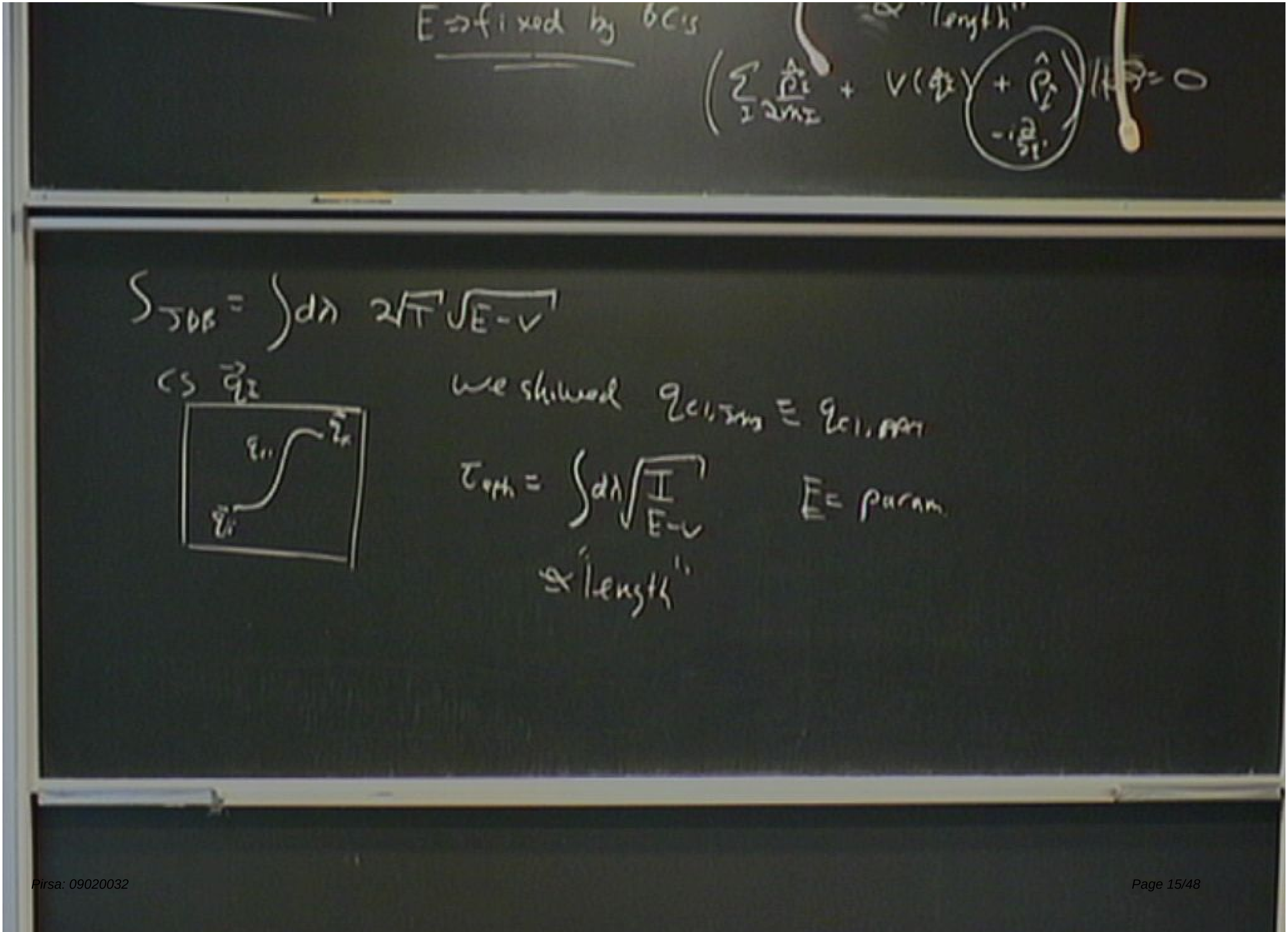

S_JDB = ∫dλ 2√T √E−V
we showed



$S_{JDB} = \int d\lambda \, 2\sqrt{T}\sqrt{E-V}$
we should
$\tau_{eph} = \int d\lambda \sqrt{\frac{I}{E-V}}$
E = param


$S_{JDB} = \int d\lambda \, 2\sqrt{T}\sqrt{E-V}$
we showed
$\tau_{eph} = \int d\lambda \sqrt{\frac{I}{E-V}}$
E= param
"length"


E ⇒ fixed by BC's
"length"
≈ "length"

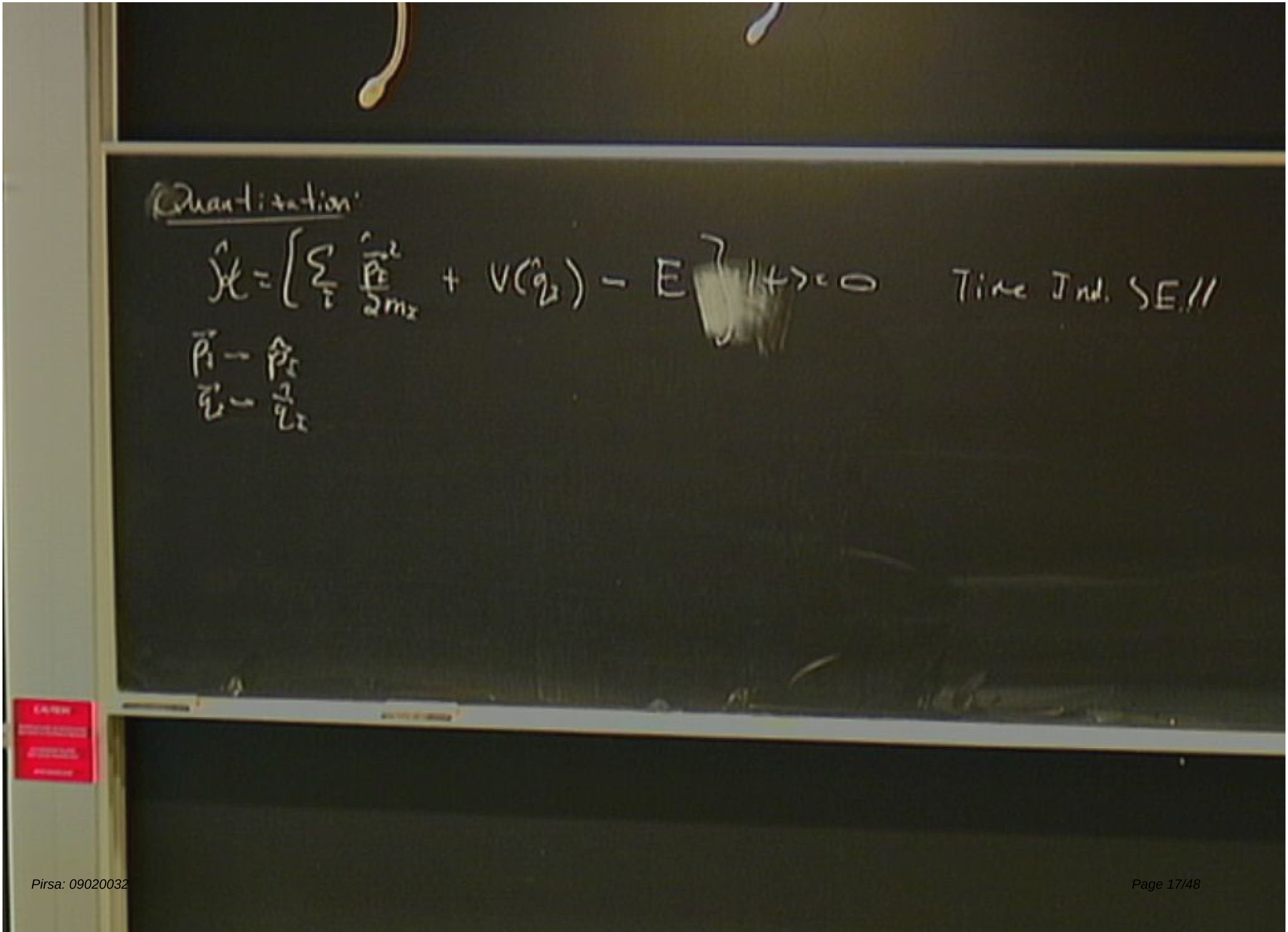

E ⇒ fixed by BC's
"length"
$\left(\sum_I \frac{\hat{p}_I^2}{2m_I} + V(\hat{q}_I) + \hat{p}_I\right)|\psi\rangle = 0$
$-i\frac{\partial}{\partial q_I}$
$S_{JOB} = \int d\lambda\, 2\sqrt{T}\sqrt{E-V}$
CS $\vec{q}_I$
q_{i}
q_{f}
we showed $q_{cl,Jam} = q_{cl,apm}$
$\tau_{eph} = \int d\lambda \sqrt{\frac{I}{E-V}}$
E = param
∝ "length"

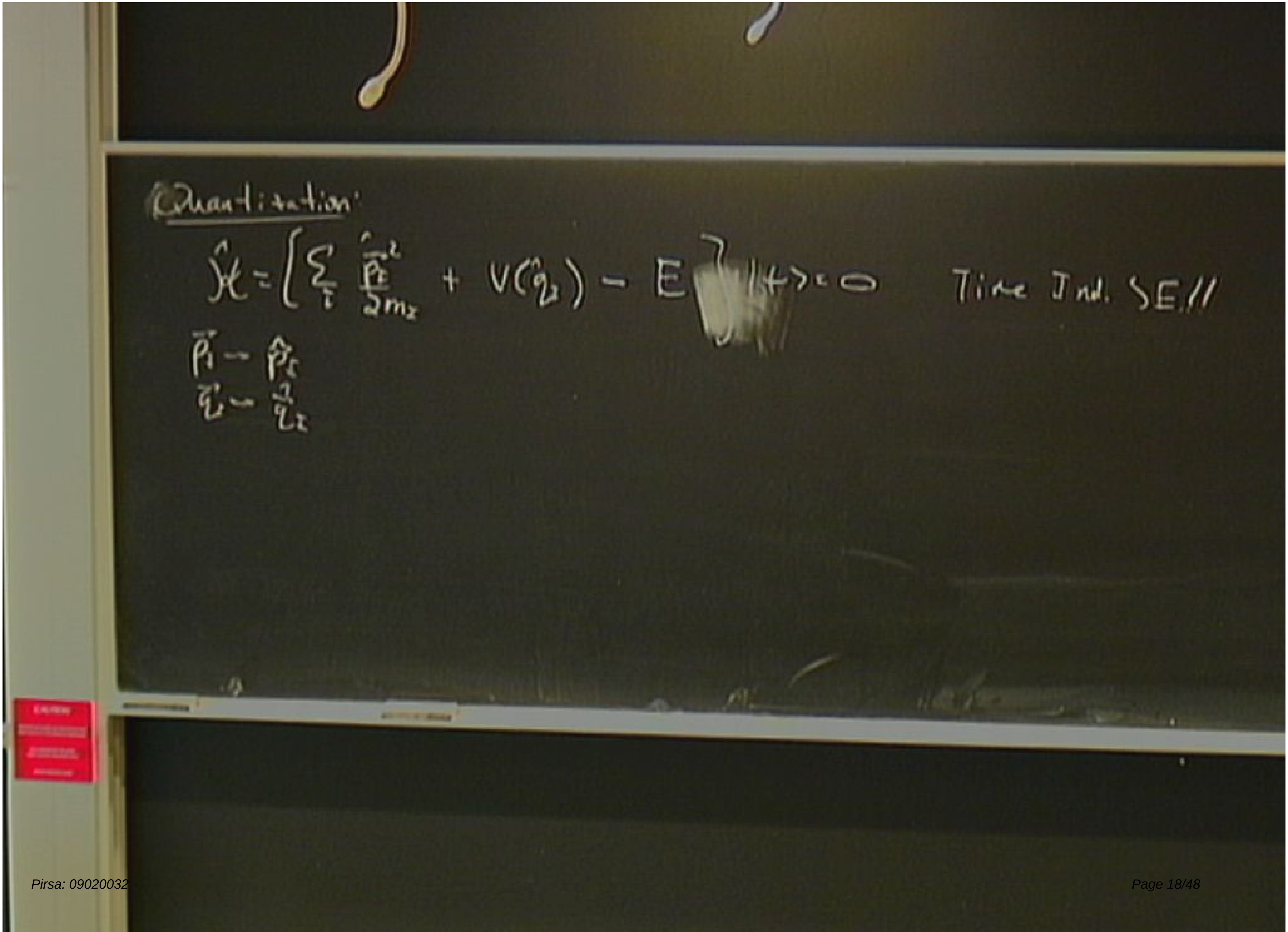
Quantization:

$$\mathcal{H} = \sum_i \frac{\vec{p}_i^{\,2}}{2m_i} + V(q_i) - E = 0$$

$\vec{p}_i \to \hat{p}_i$

$\vec{q}_i \to \hat{q}_i$


Quantitation:
$\hat{H} = \left\{ \sum_i \frac{\hat{\vec{p}}_i^{\,2}}{2m_i} + V(\hat{q}_i) - E \right\} |\psi\rangle = 0$
Time Ind. SE.//
$\vec{p}_i \to \hat{\vec{p}}_i$
$\vec{q}_i \to \hat{\vec{q}}_i$


Quantization:
$\hat{\mathcal{H}} = \{ \sum_i \frac{\hat{\vec{p}}_i^{\,2}}{2m_i} + V(\hat{q}_i) - E \} |\psi\rangle = 0$ Time Ind. SE.//
$\vec{p}_i \to \hat{p}_i$
$\vec{q}_i \to \hat{q}_i$

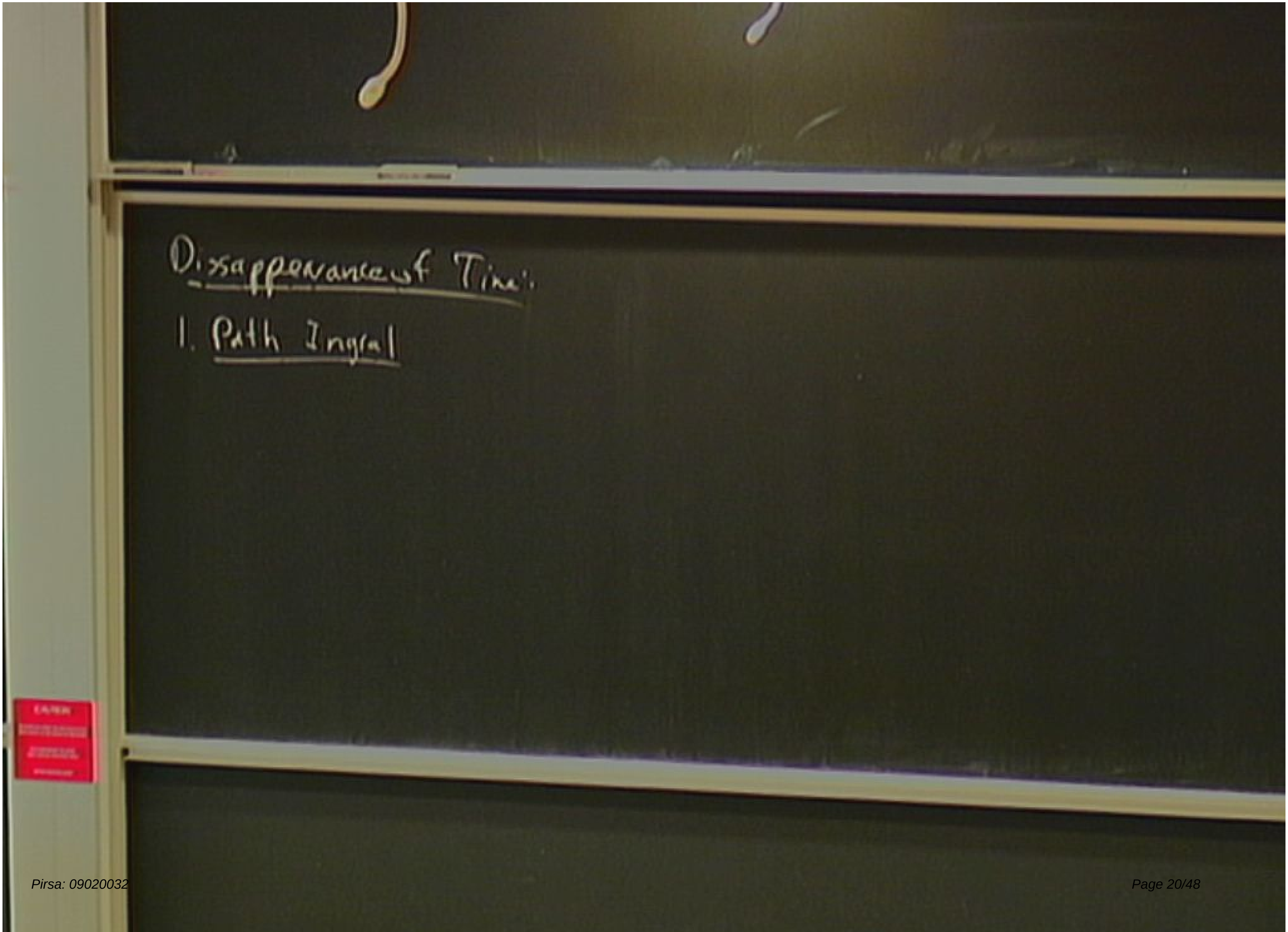
Quantisation:

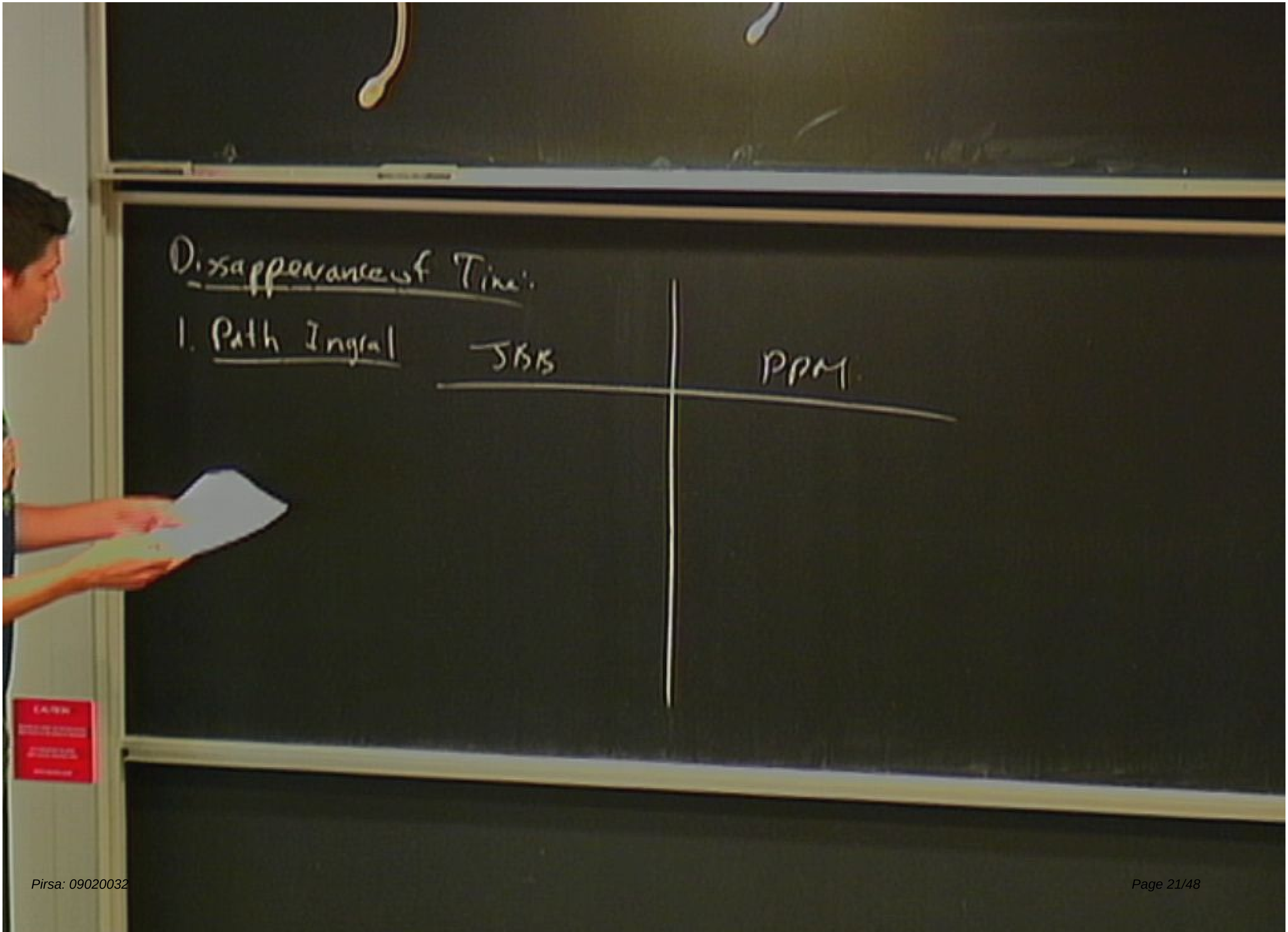
$$\hat{\mathcal{H}} = \left[\sum_i \frac{\hat{\vec{p}}_i^{\,2}}{2m_i} + V(\hat{q}_i) - E\right]|\psi\rangle = 0$$ Time Ind. SE.!!

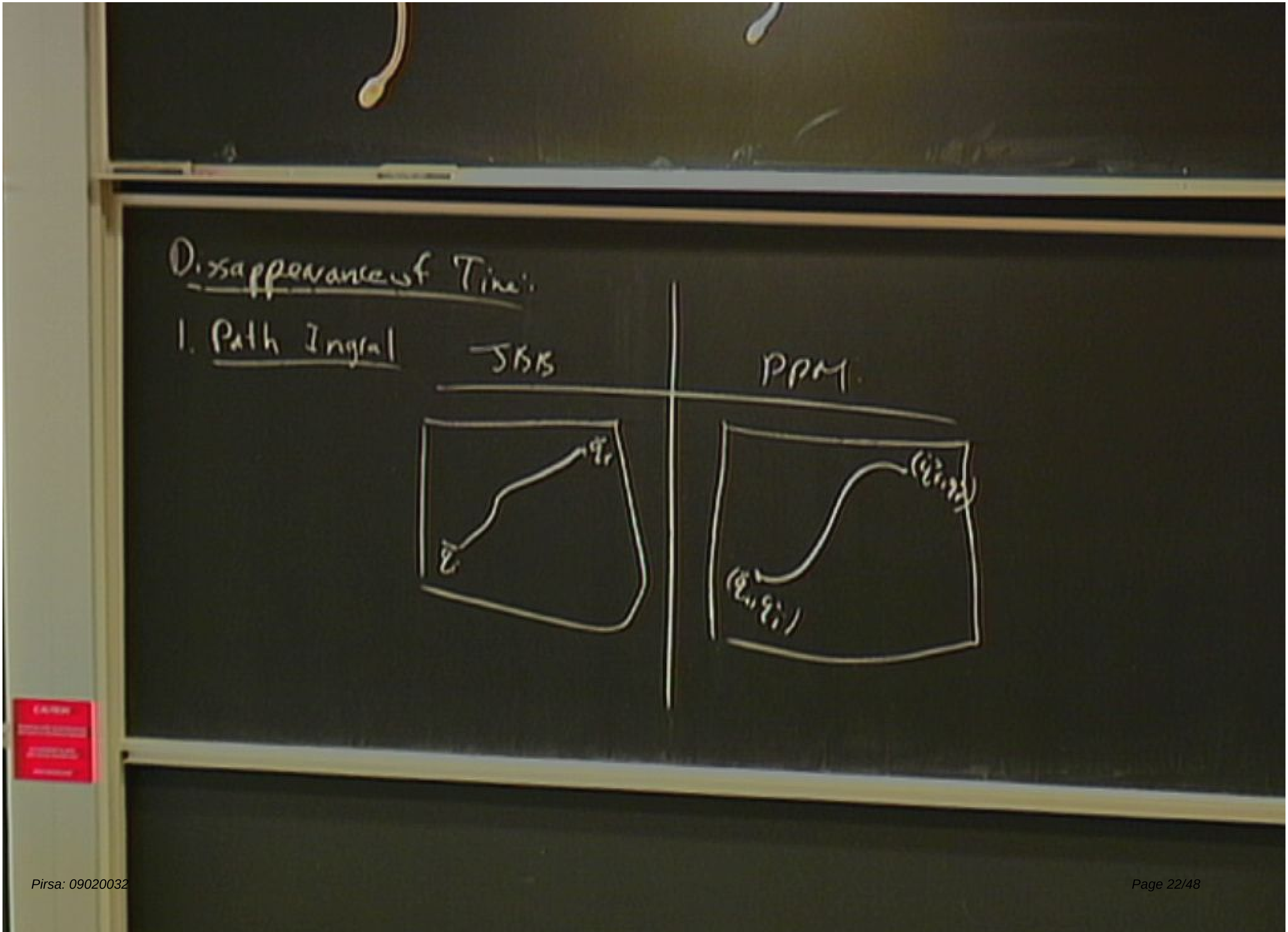
$\vec{p}_i \to \hat{p}_i$

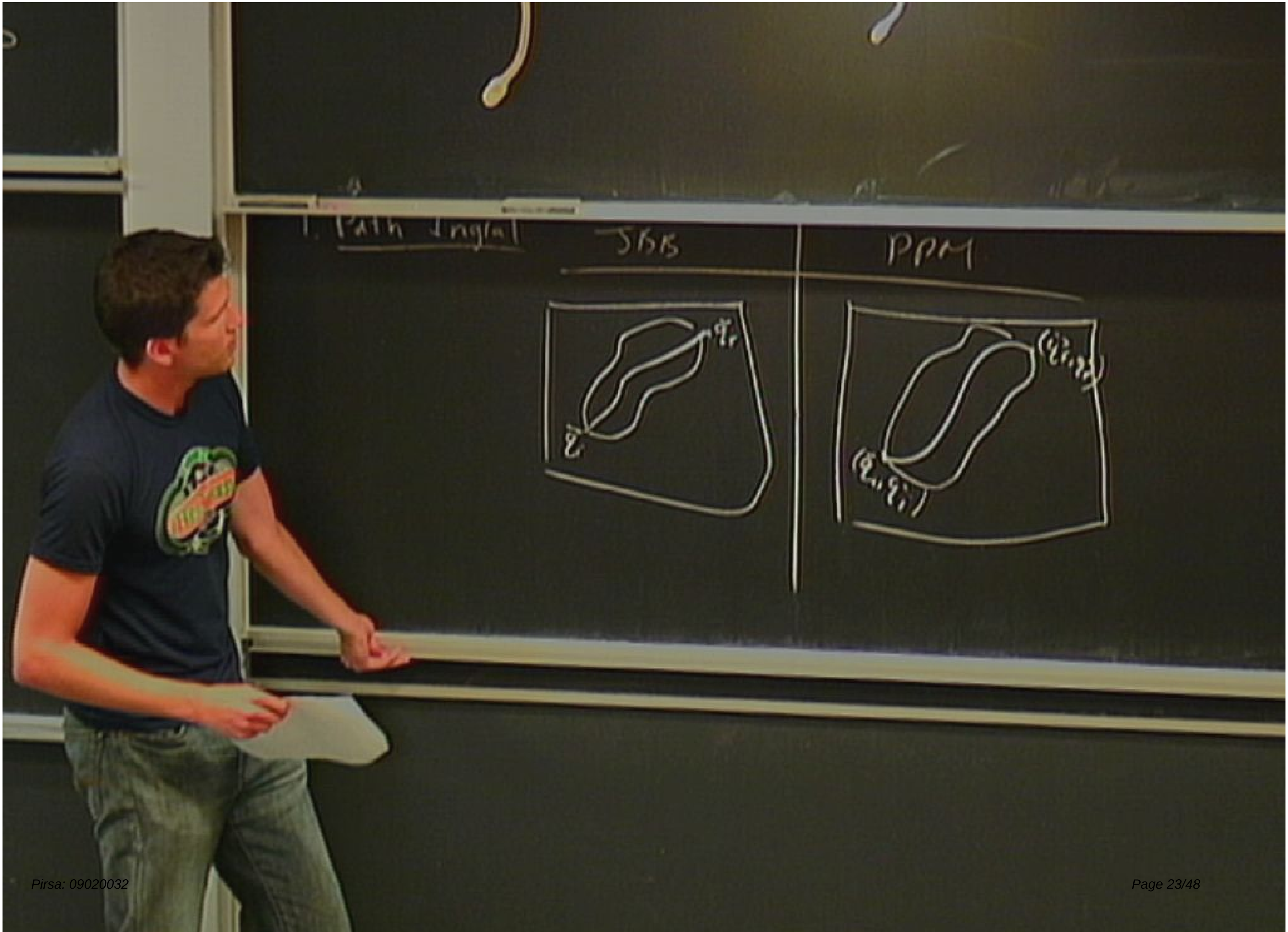
$\vec{q}_i \to \hat{q}_i$

Problem of time!

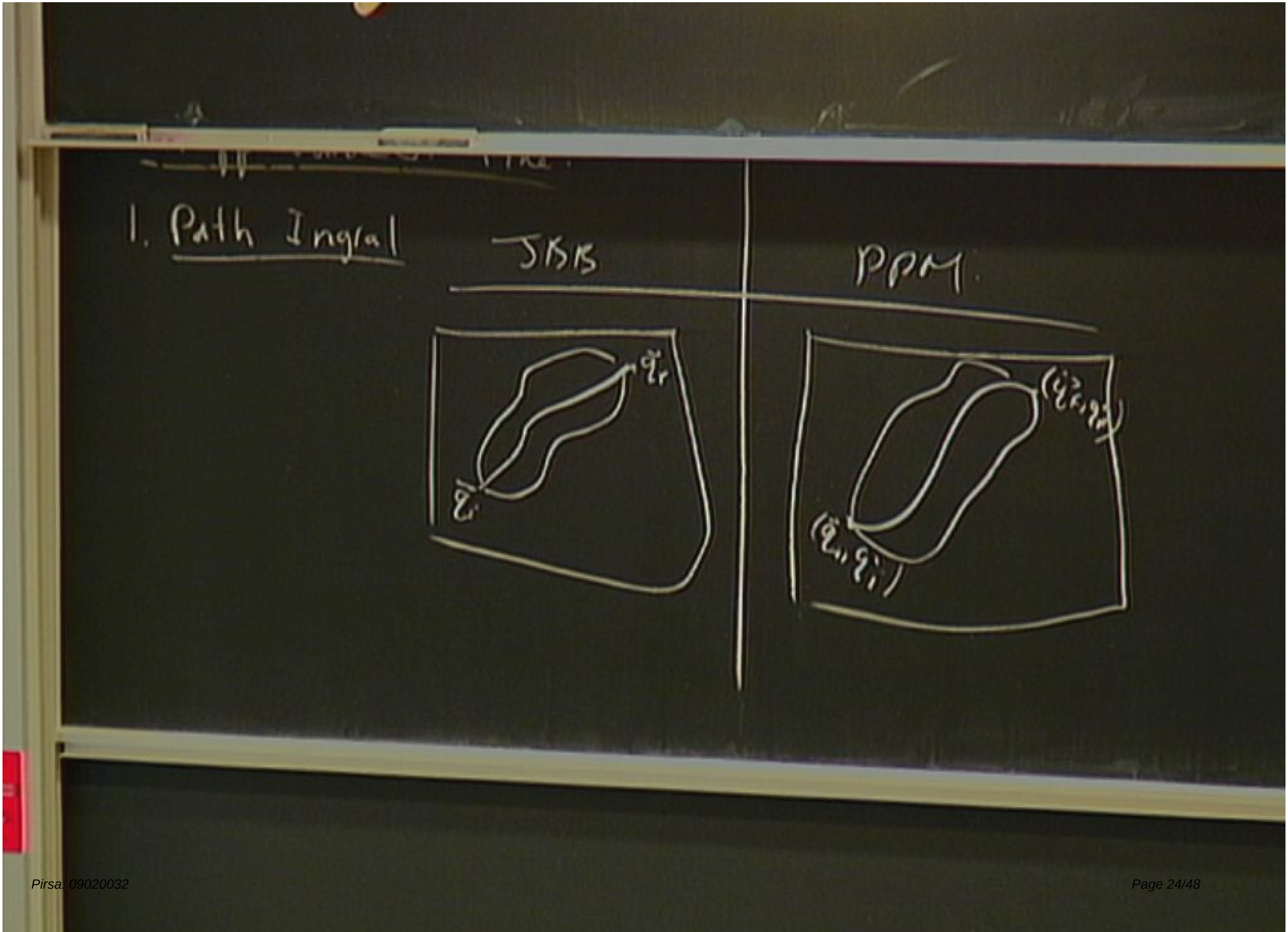

Disappearance of Time:
1. Path Integral


Dissapperance of Time:
1. Path Ingral
JBB
PPM

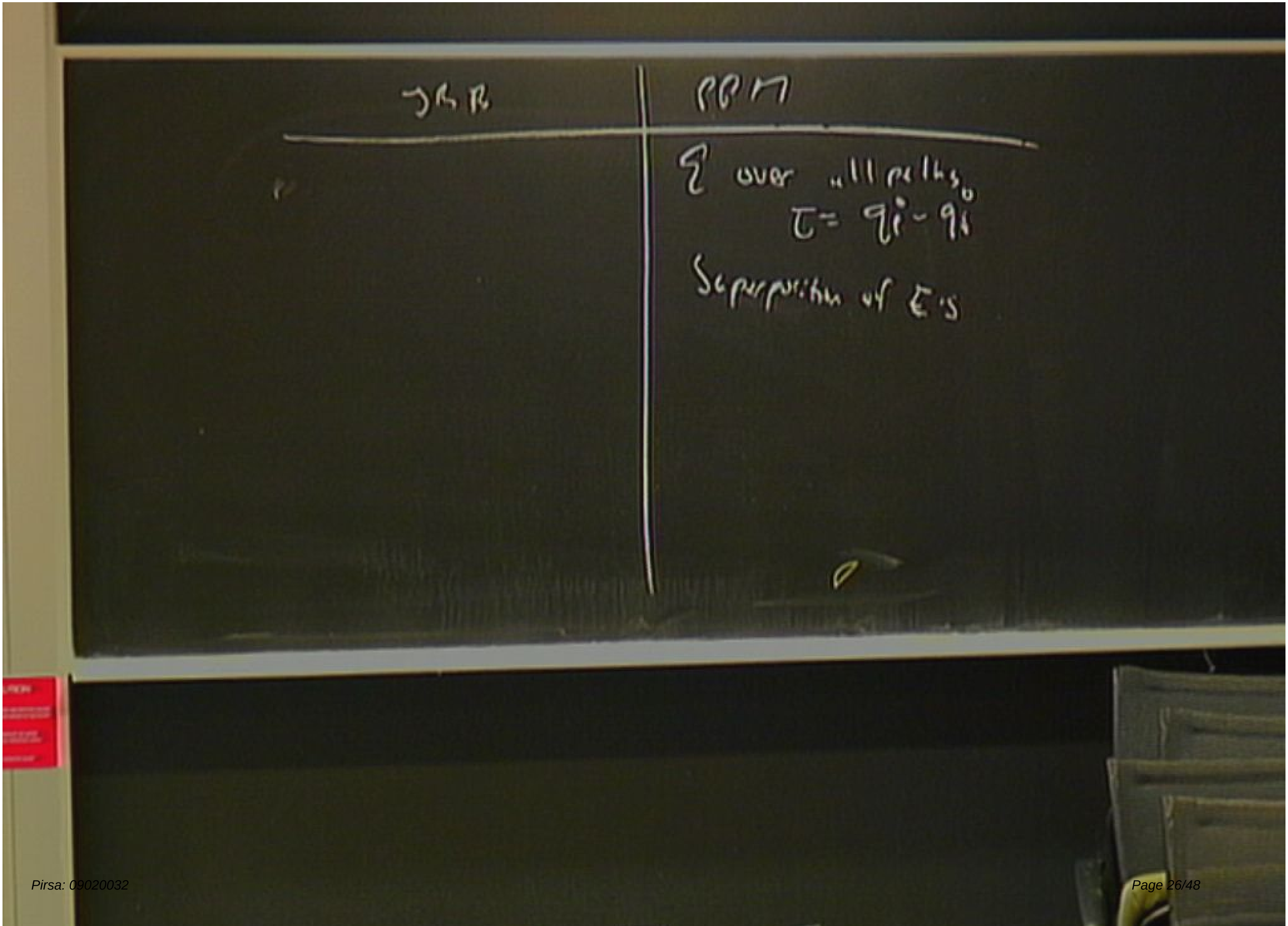

D. Dissappearance of Time:
1. Path Ingral
JBB
PPM
q_i
q_f
$(q_i, \dot{q}_i)$
$(q_f, \dot{q}_f)$



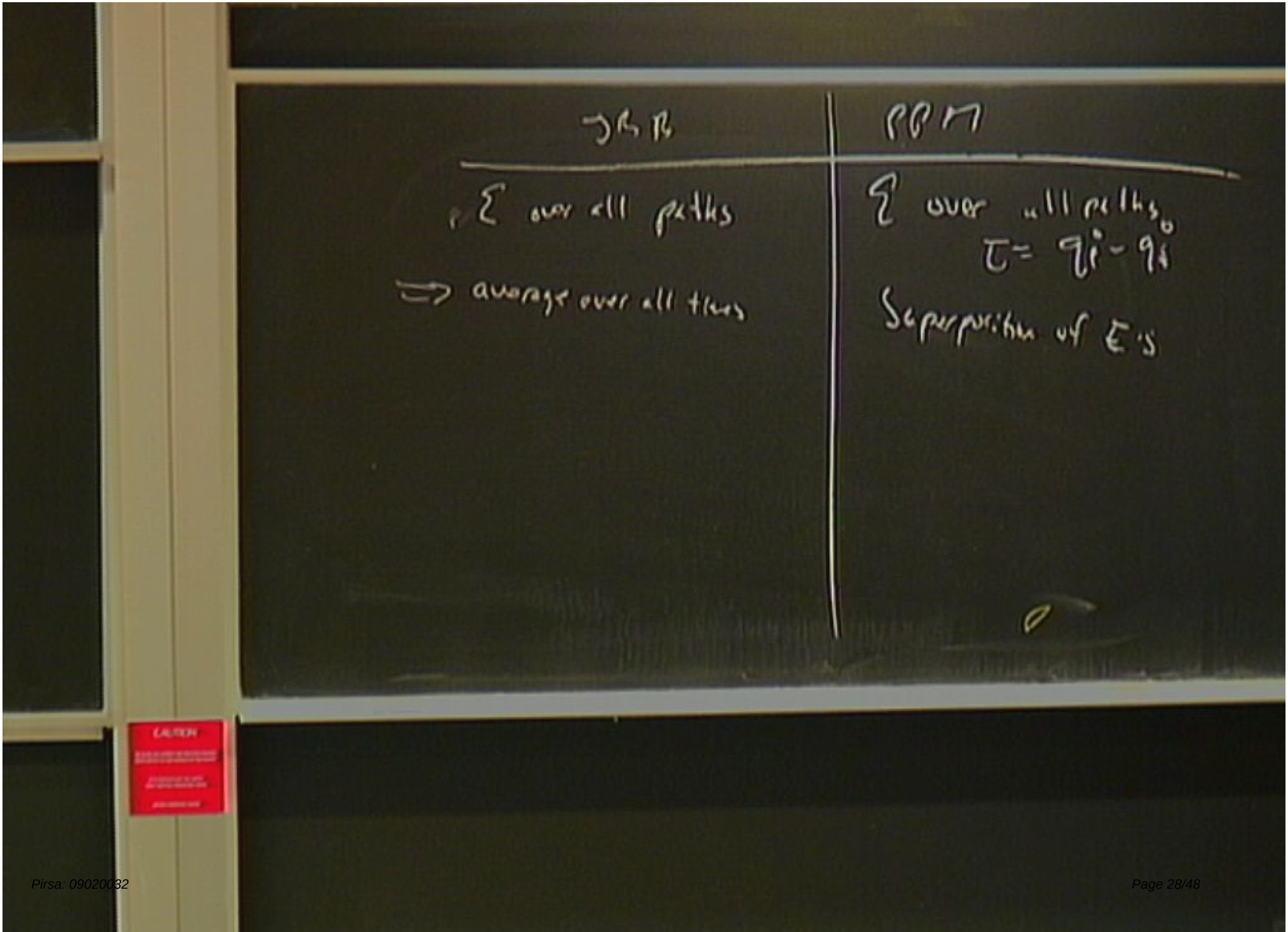
1. Path Integral
JBB
PPM

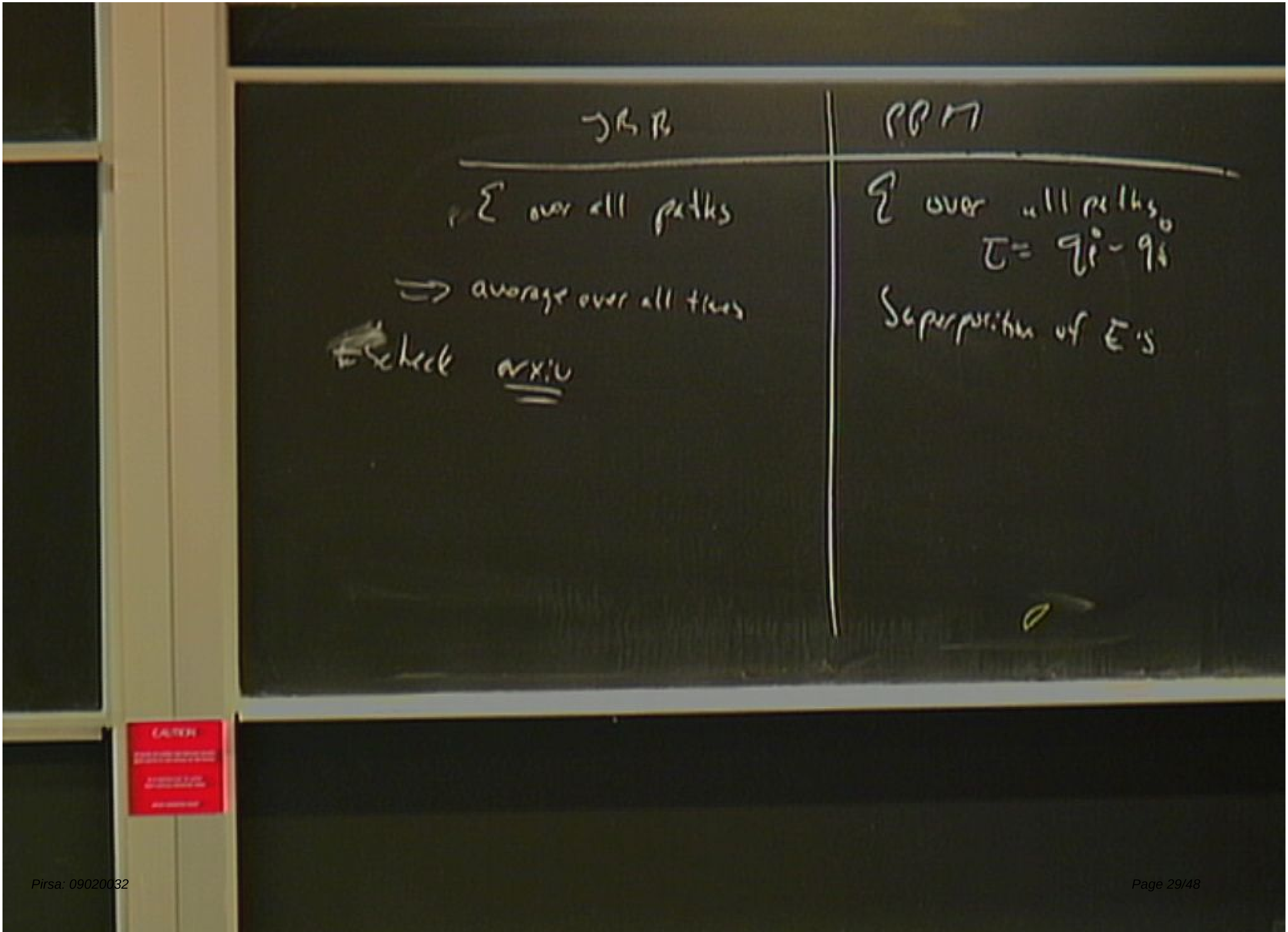

1. Path Ingral
JBB
PPM.

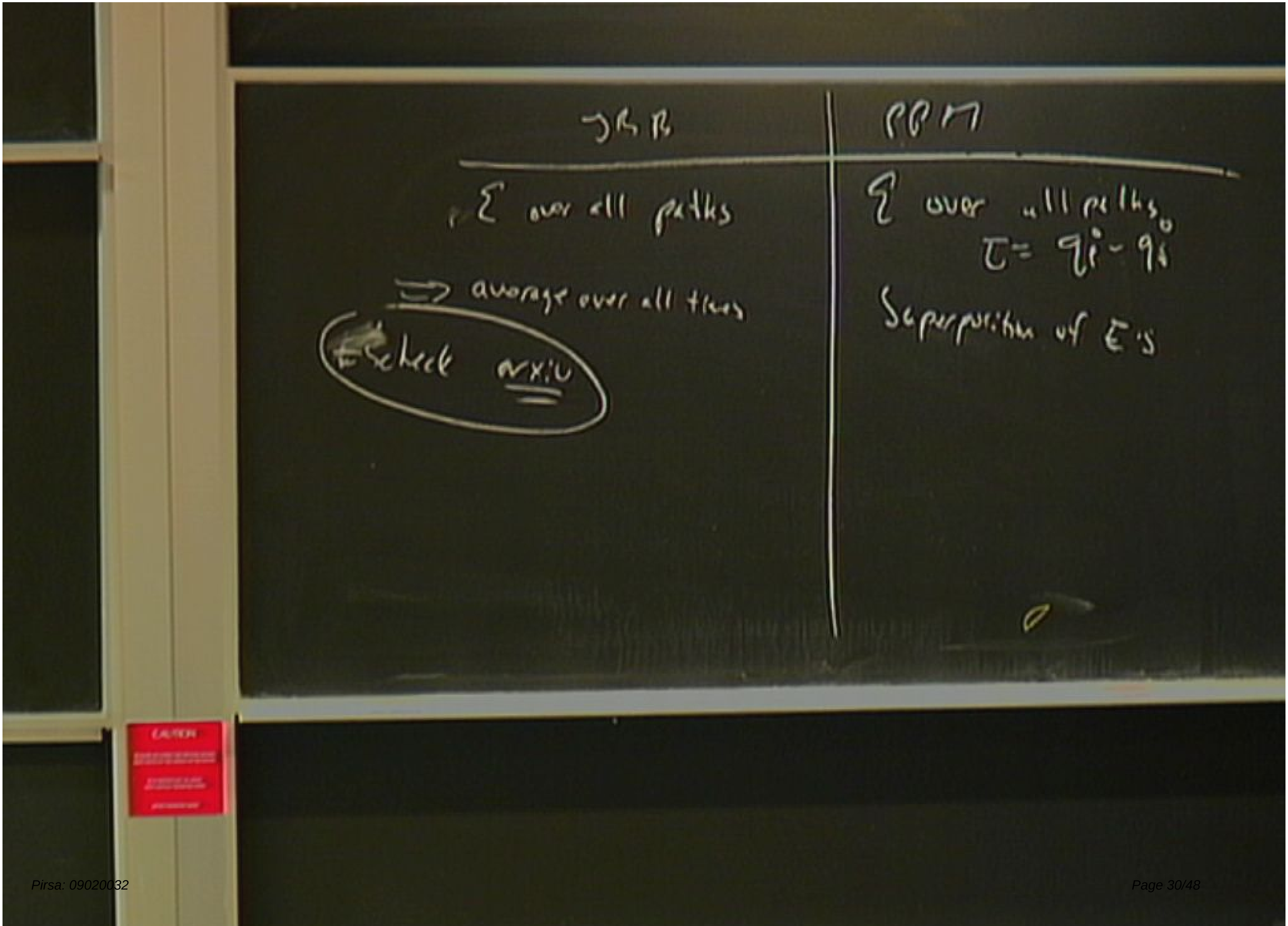
JBB	RPM
	Σ over all paths, $\tau = q_f - q_i$

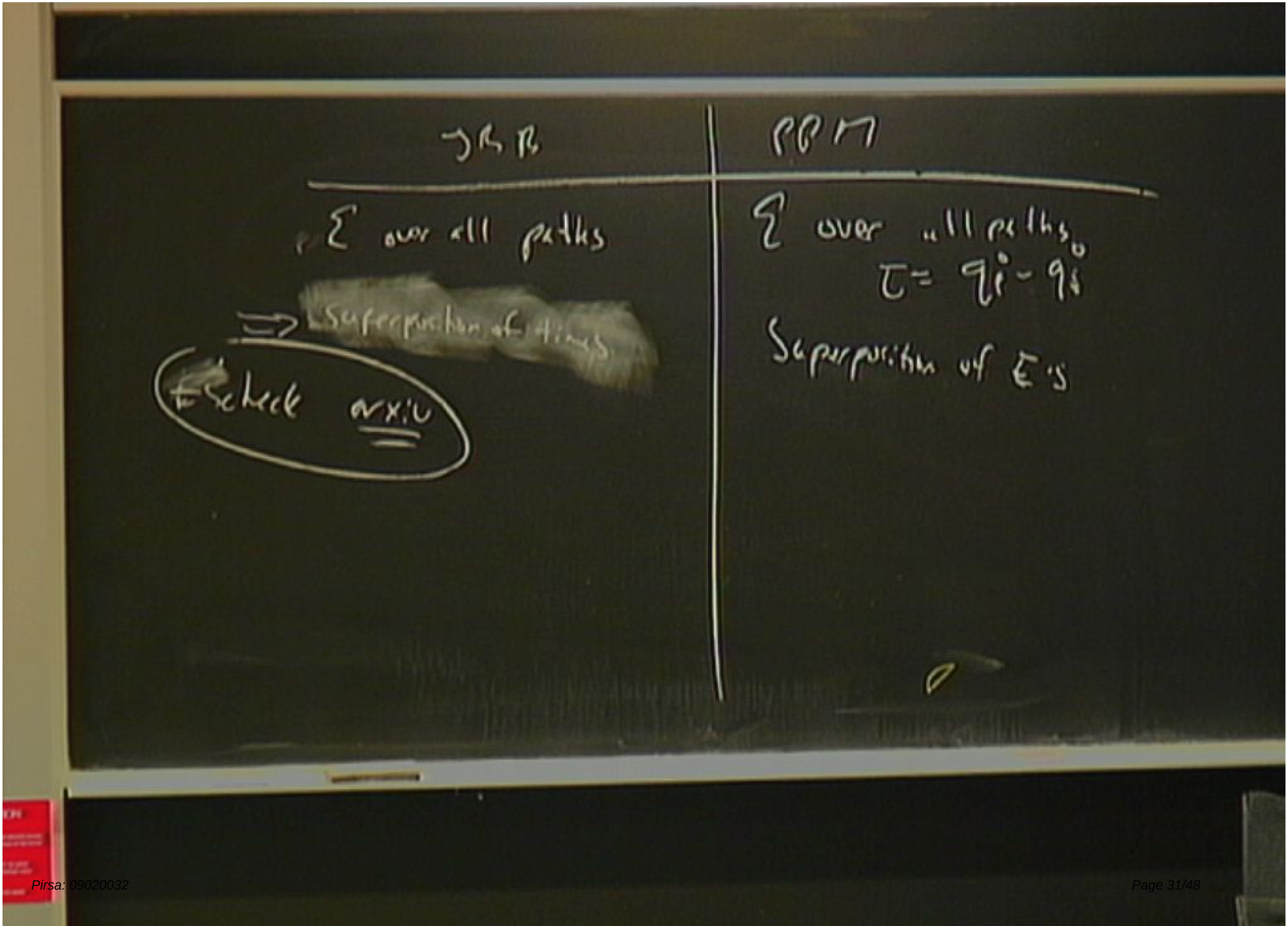

JBB
PBM
Σ over all paths
τ = $q_f - q_i$
Superposition of Ψ's

JBB	RPM
Σ over all paths	Σ over all paths, $\tau = q_i^0 - q_f^0$
	Superposition of $\mathcal{E}$'s

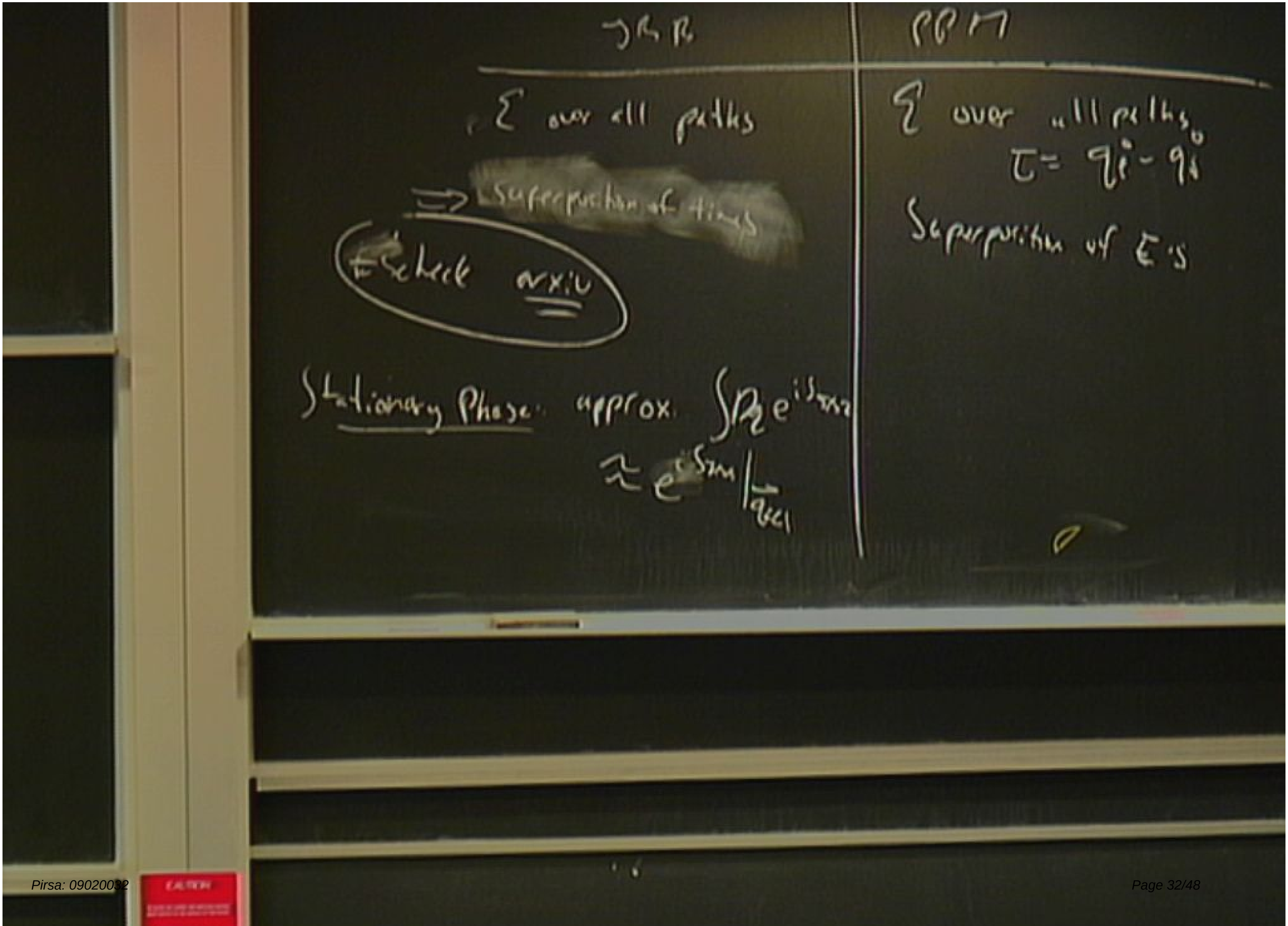

JBB
RPM
Σ over all paths
Σ over all paths
τ = qi - qf
⇒ average over all times
Superposition of E's

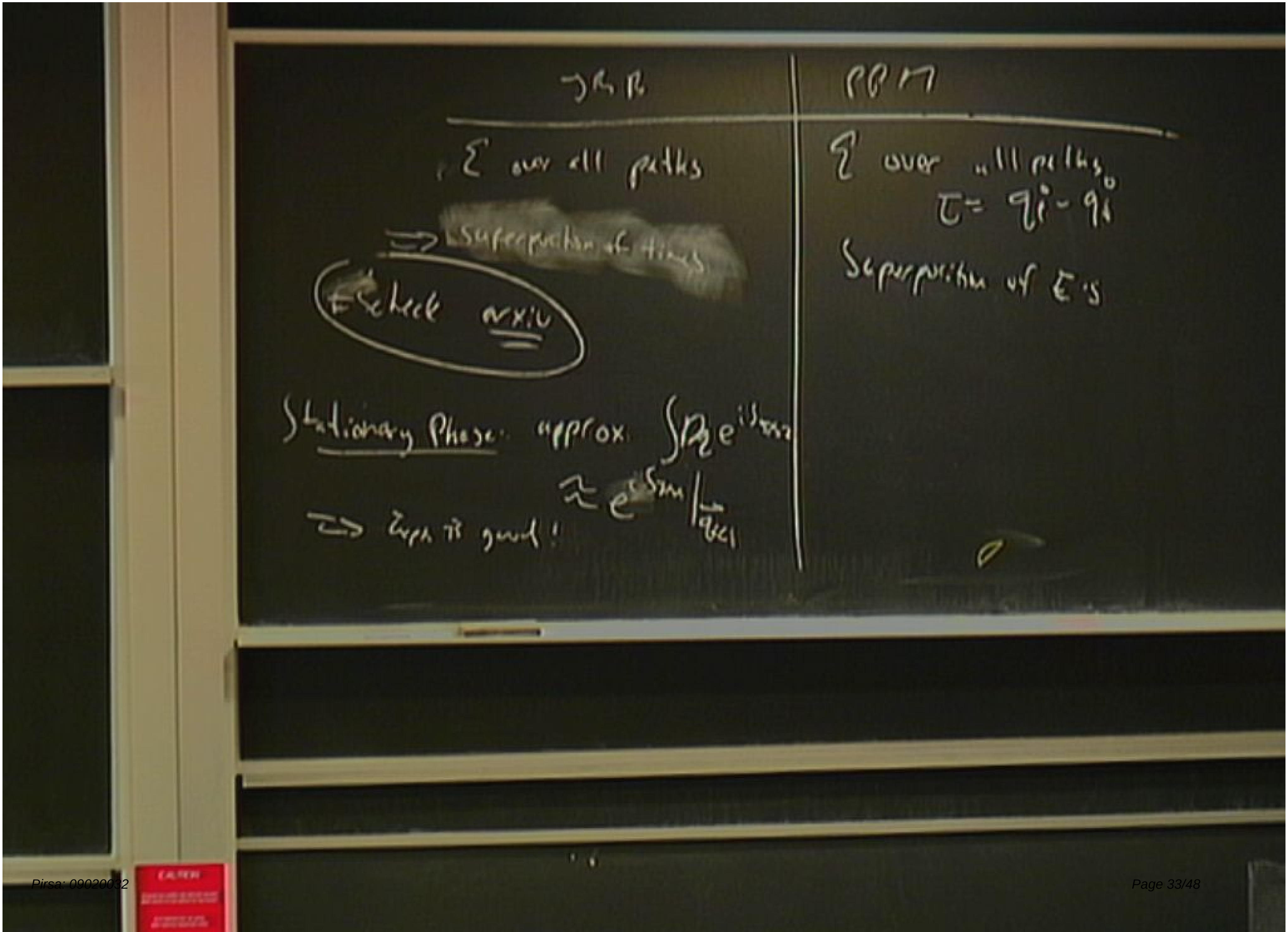

JBB
PBM
Σ over all paths
Σ over all paths
⇒ average over all times
Superposition of E's
check arXiv

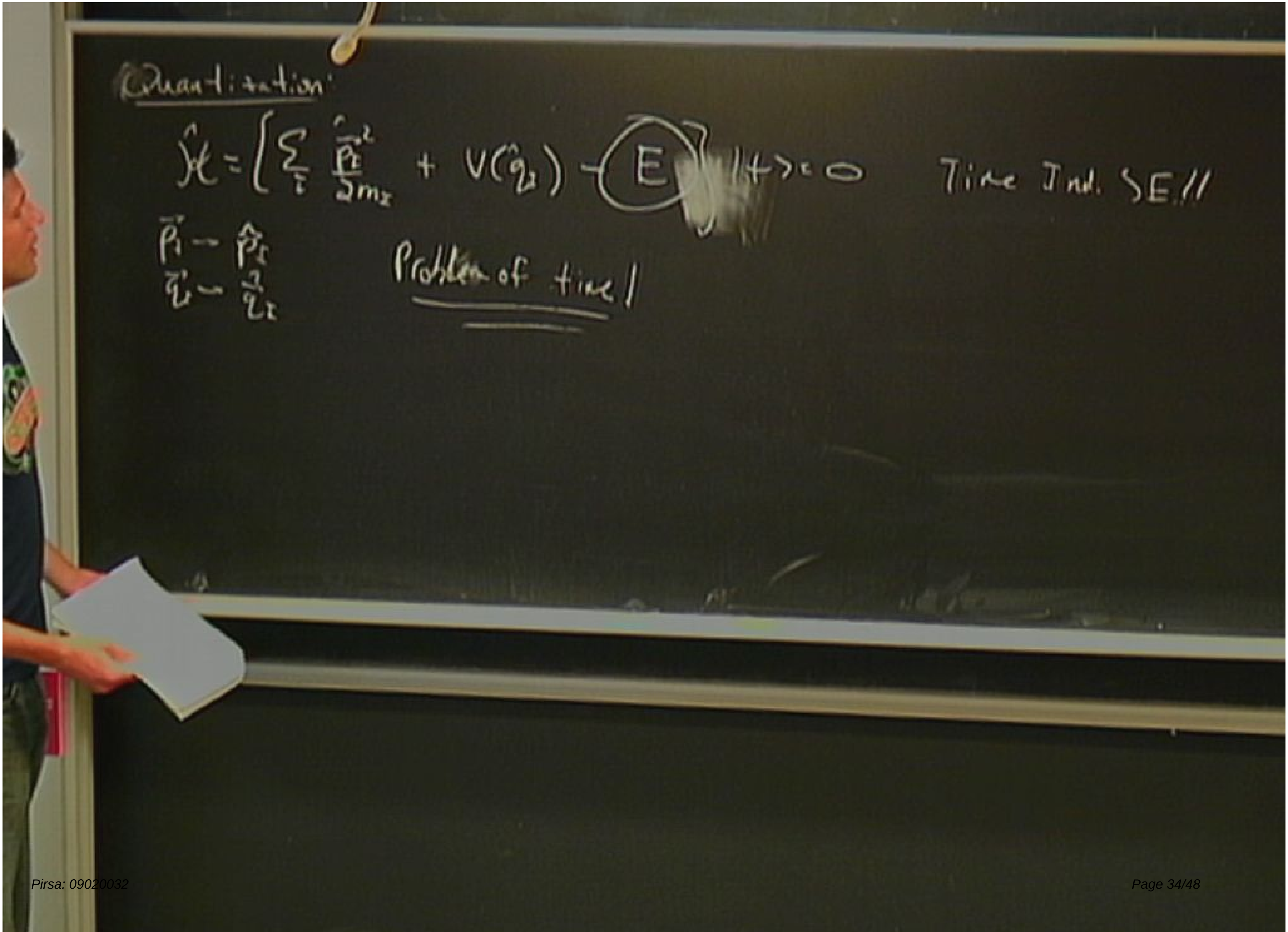

JBB
PBM
Σ over all paths
⇒ average over all times
check arXiv
Σ over all paths
Superposition of E's



Σ over all paths
Superposition of times
check arXiv
Σ over all paths
Superposition of E's


Σ over all paths
Superposition of times
check arXiv
Stationary Phase approx.
Σ over all paths
Superposition of E's


Σ over all paths
Σ over all paths
Superposition of E's
Stationary Phase approx


Quantization:
$\hat{\mathcal{H}} = \left[\sum_i \frac{\hat{\vec{p}}_i^{\,2}}{2m_i} + V(\hat{q}_i) - E \right] |\psi\rangle = 0$
Time Ind. SE!!
$\vec{p}_i \to \hat{p}_i$
$\vec{q}_i \to \hat{q}_i$
Problem of time!

Quantization:

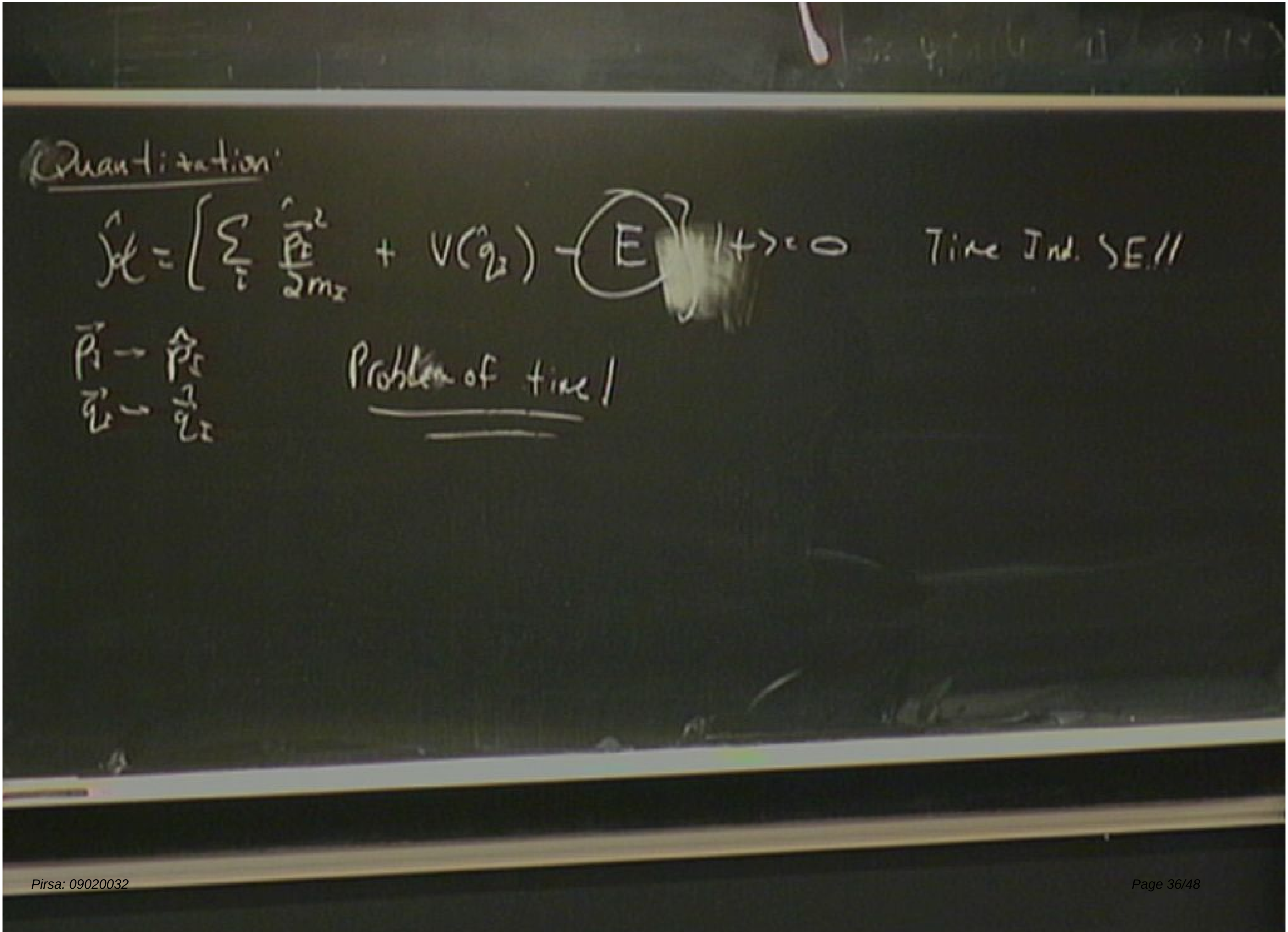
$$\hat{\mathcal{H}} = \left[\sum_i \frac{\hat{\vec{p}}_i^{\,2}}{2m_i} + V(\hat{q}_i) - E\right]|\psi\rangle = 0$$

Time Ind. SE!!

$\vec{p}_i \to \hat{p}_i$

$\vec{q}_i \to \hat{q}_i$

Problem of time!


Quantization:
$\hat{\mathcal{H}} = \left[\sum_i \frac{\hat{\vec{p}}_i^{\,2}}{2m_i} + V(\hat{q}_i) - E \right] |\psi\rangle = 0$
Time Ind. SE!!
$\vec{p}_i \to \hat{p}_i$
$\vec{q}_i \to \hat{q}_i$
Problem of time!

Eschek arXiv

Stationary Phase "approx" $\int \mathcal{D}q\, e^{iS_{[q]}}$

$\approx e^{iS_{[q]}}\big|_{q_{cl}}$

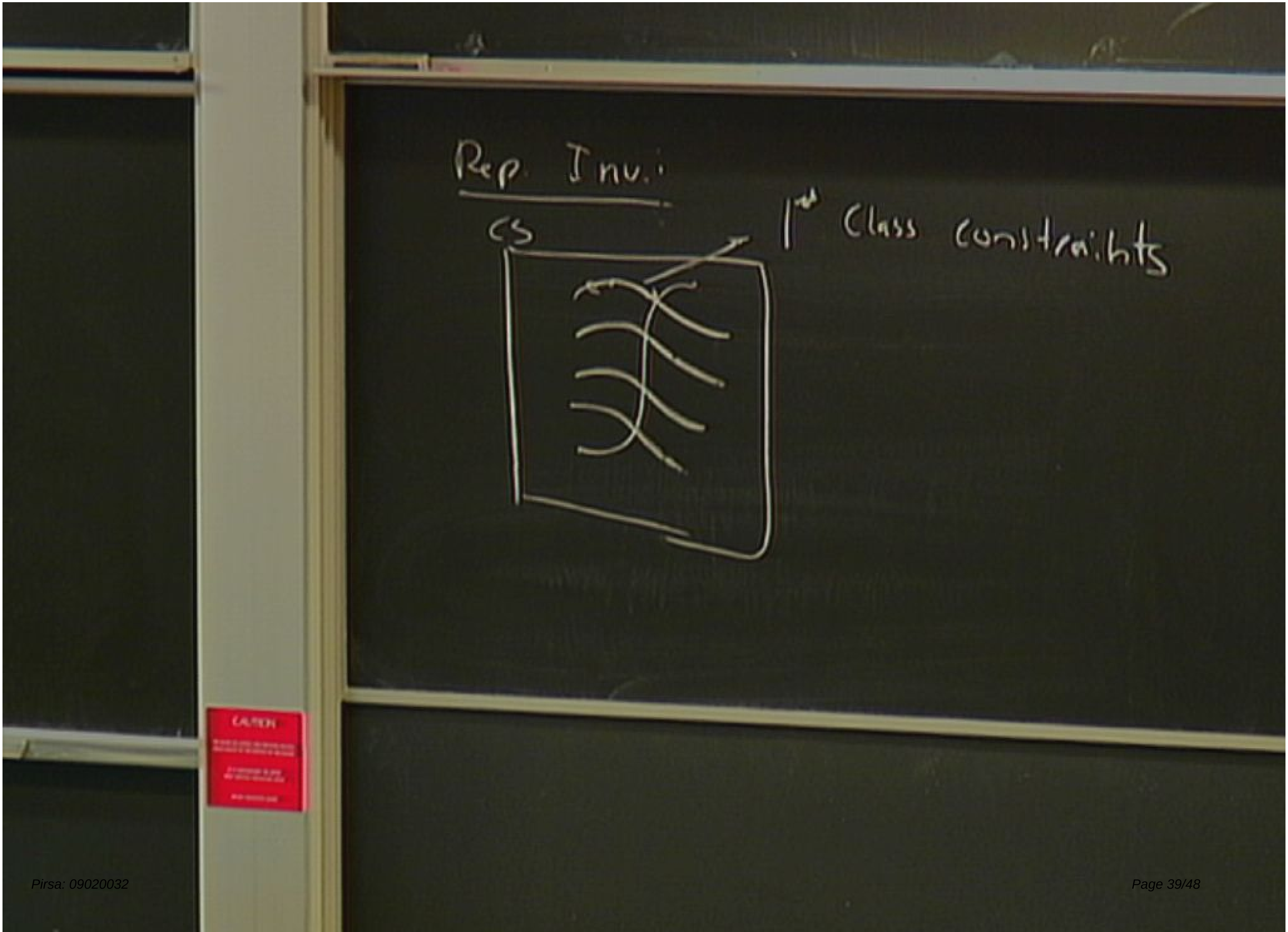
$\Rightarrow$ Expn is good!

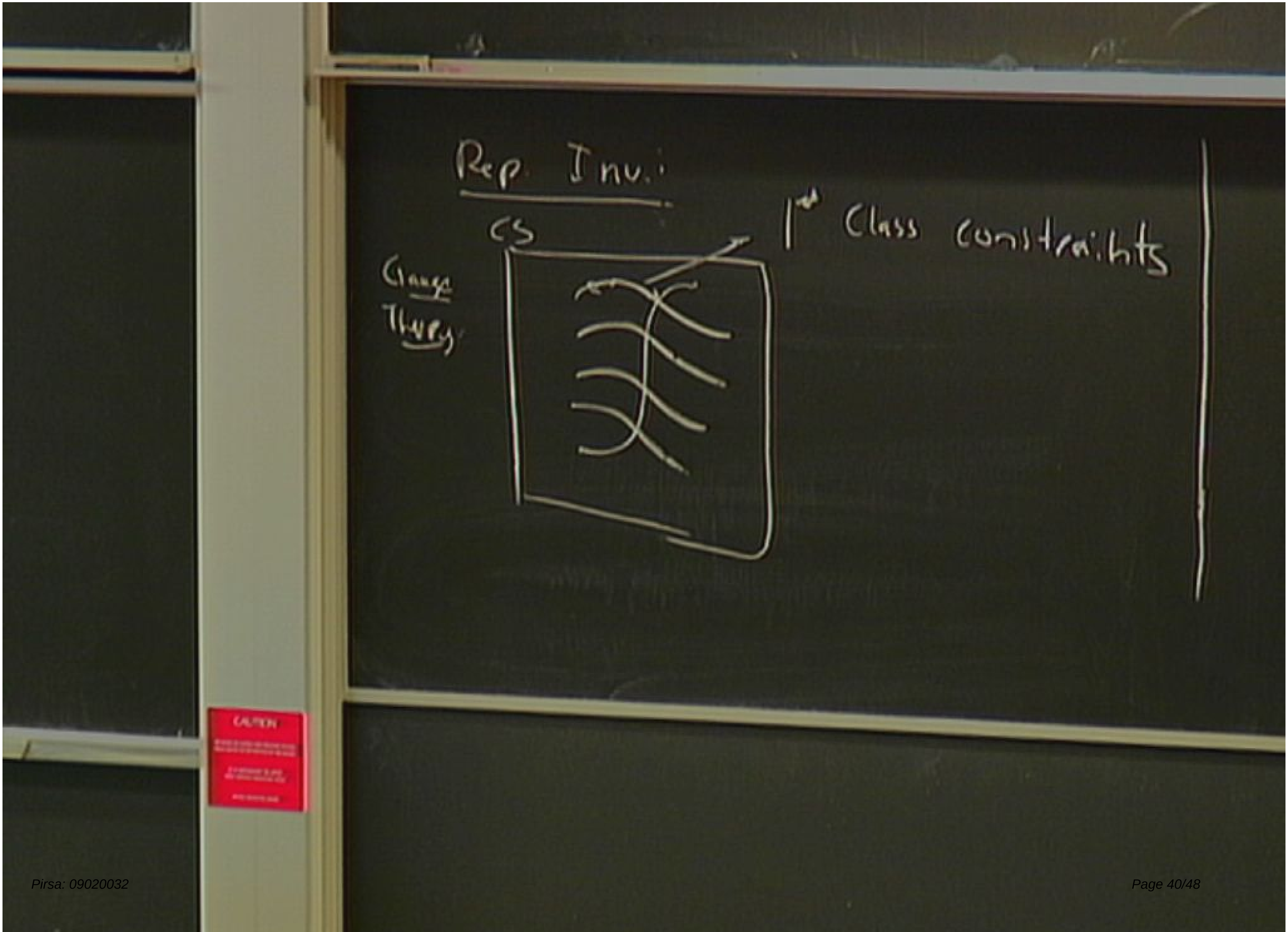
K.K. { "heavy" dof $\Rightarrow$ give a time
"light" dof $\Rightarrow$ evolve qm according to this time.

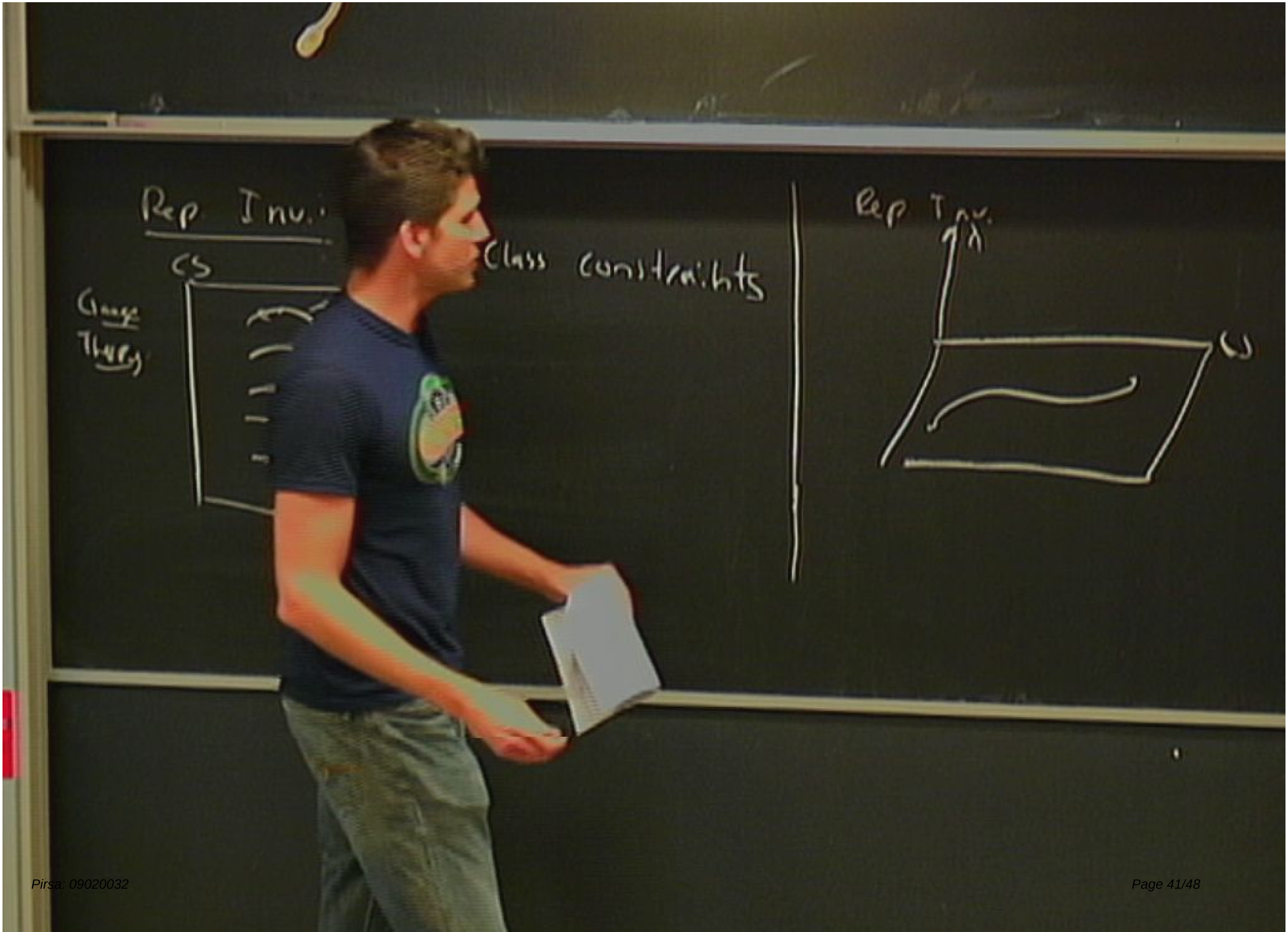
⟹ Expn is good!

K.K. { "heavy" dof ⟹ give a time
"light" dof ⟹ evolve qm according to this time.

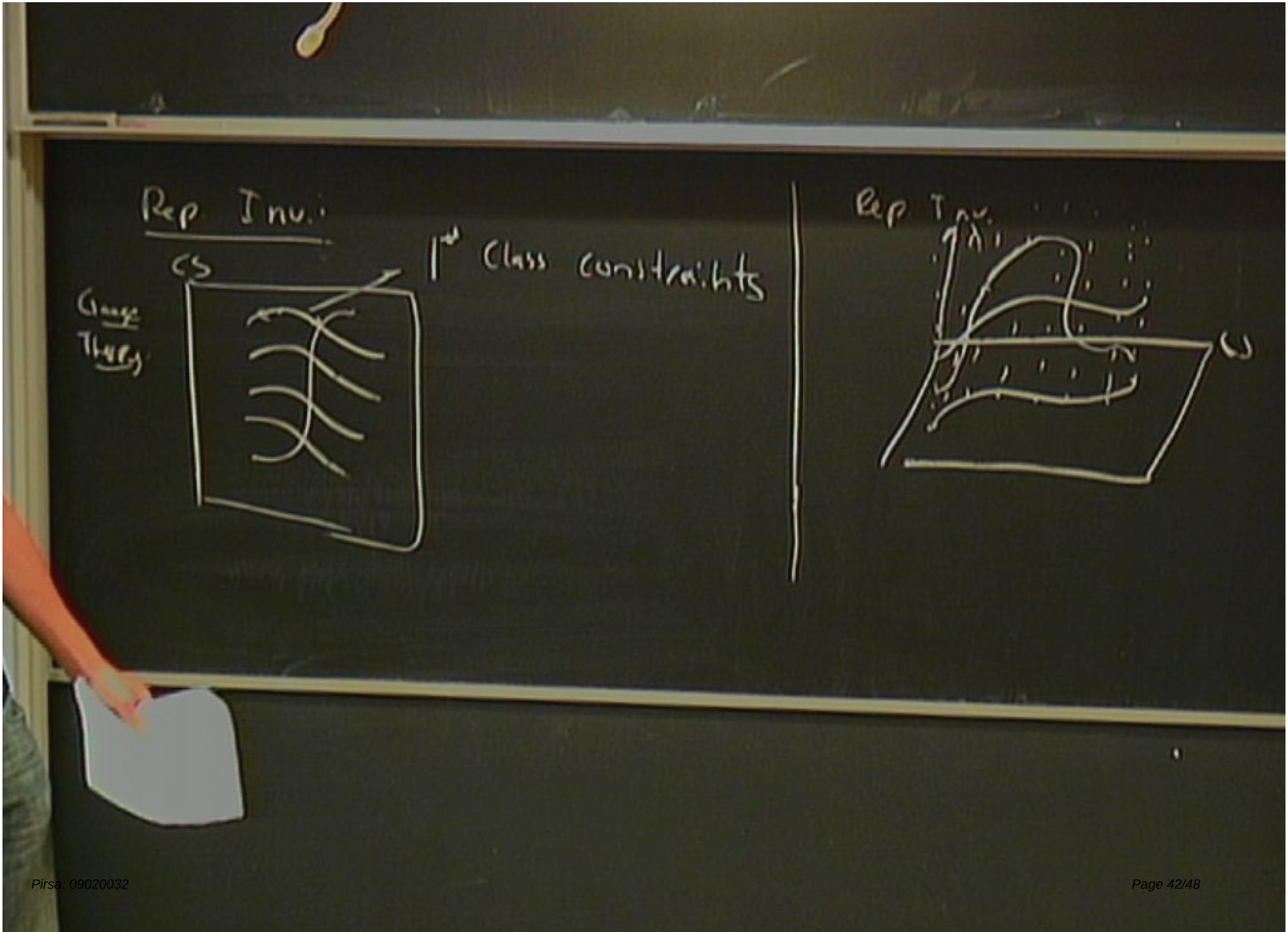
Robert Brout a

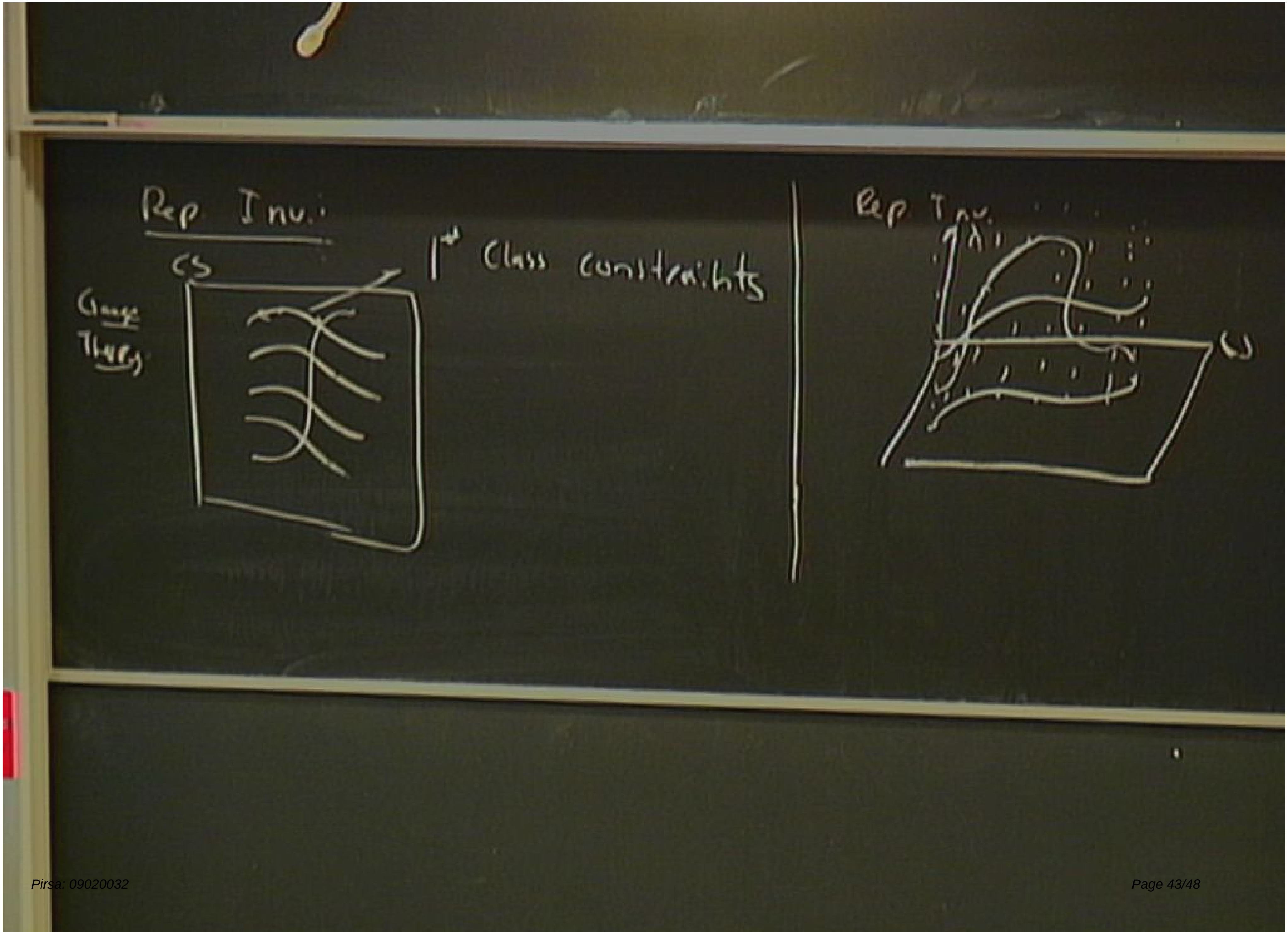

Rep. Inv.:
CS
1st Class constraints
CAUTION

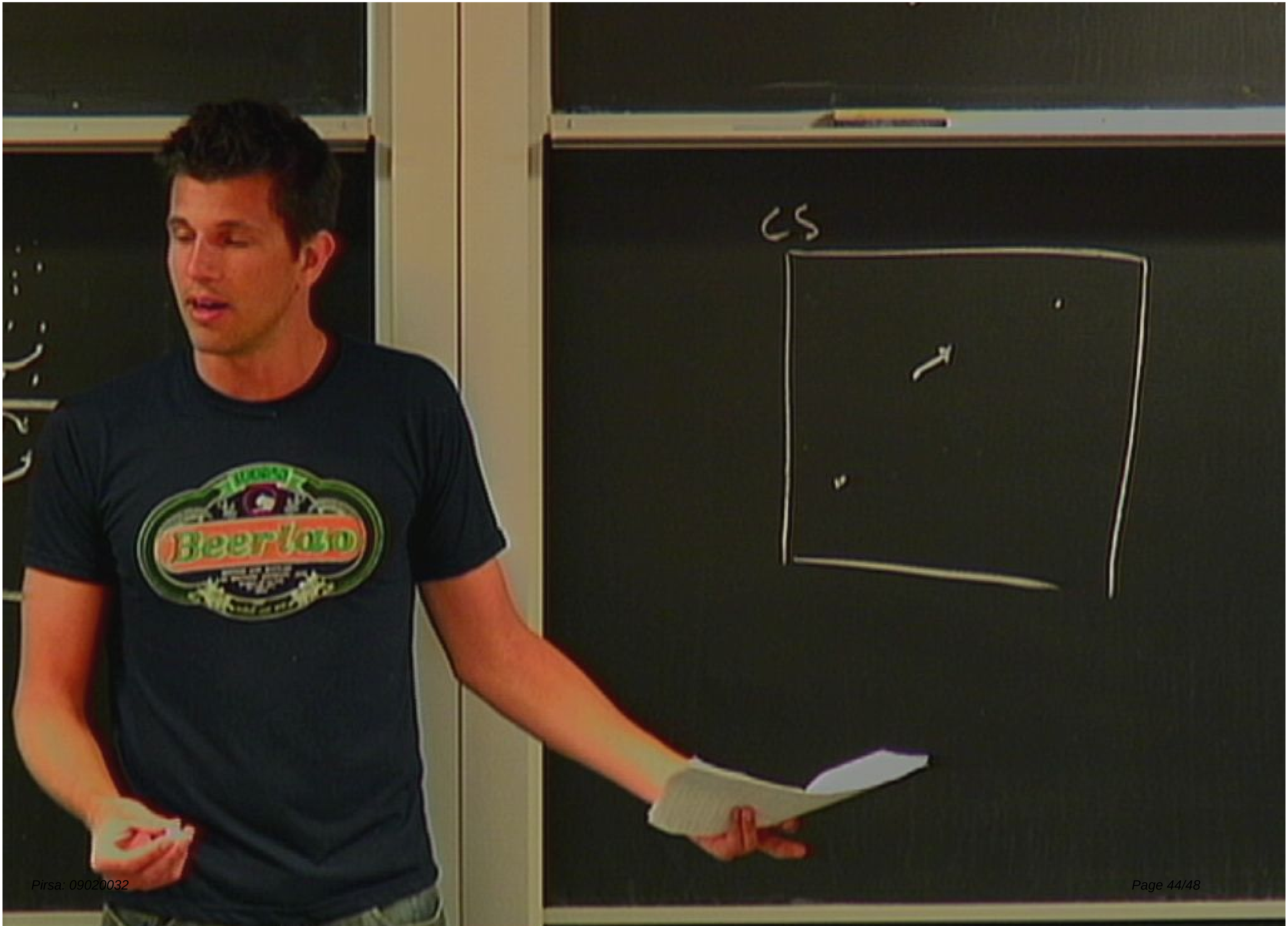

Rep. Inv.:
CS
Gauge Theory
1st Class constraints
CAUTION

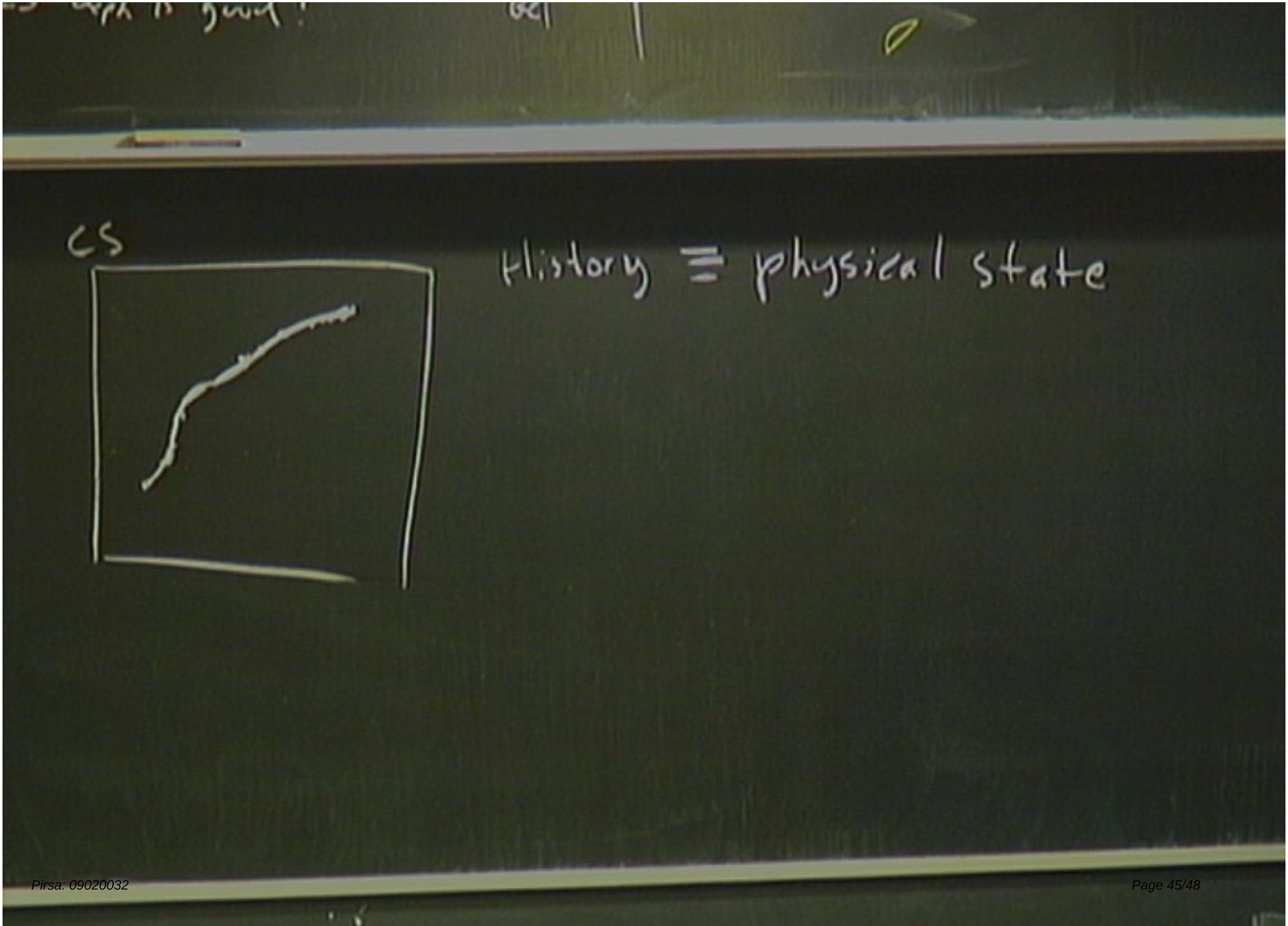


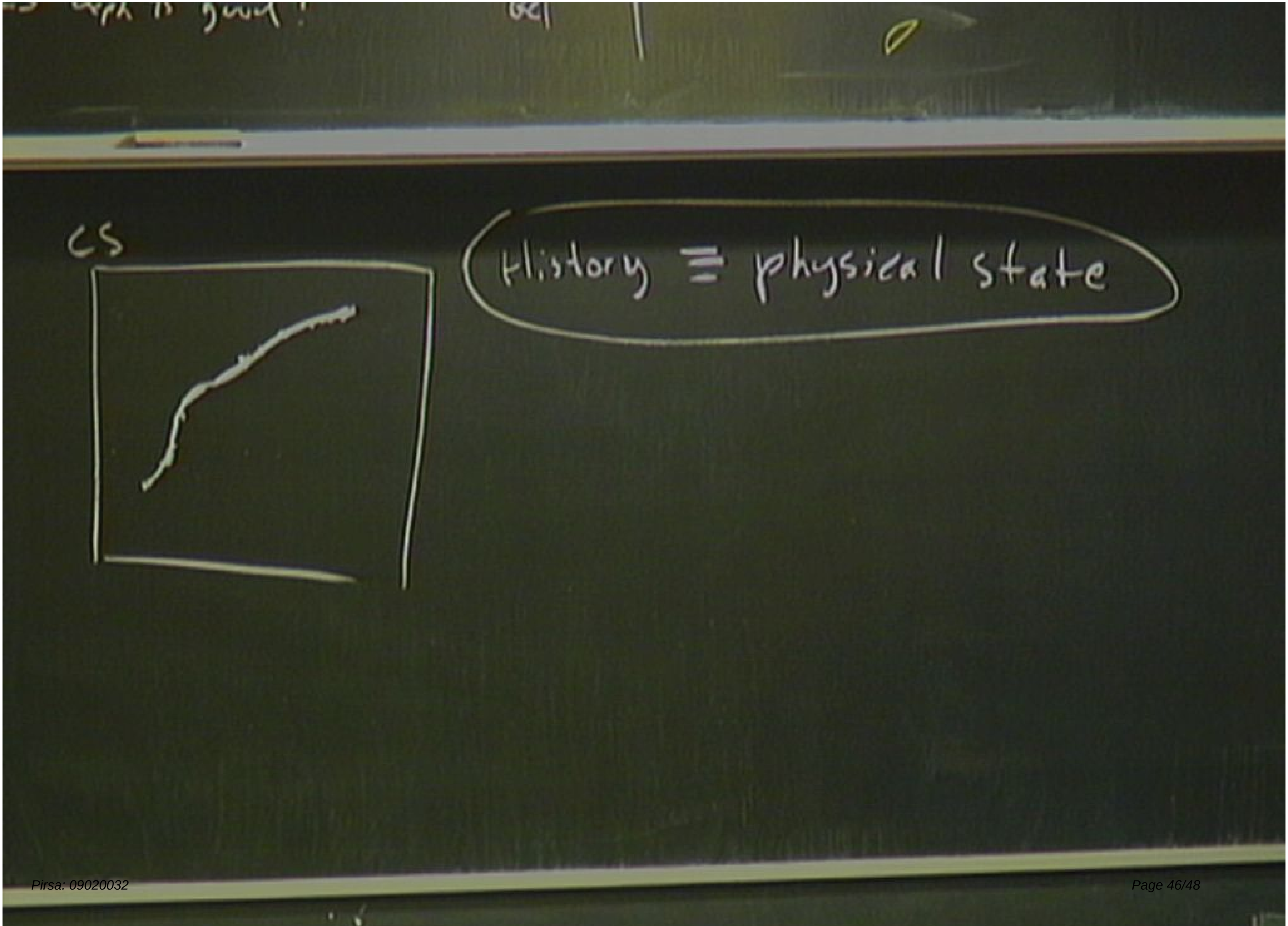
Rep Inv.
CS
Gauge Theory
Class constraints
Rep Inv.
λ
ω


Rep Inv:
CS
Gauge Theory
1st Class constraints
Rep Inv.
CS


Rep Inv.:
Gauge Theory
1st Class constraints
Rep Inv.


CS
Beerlao


CS
History ≡ physical state


CS
History ≡ physical state

CS

History ≡ physical state

Barbour & Foster

CS

History ≡ physical state

Barbour & Foster

Kuchař