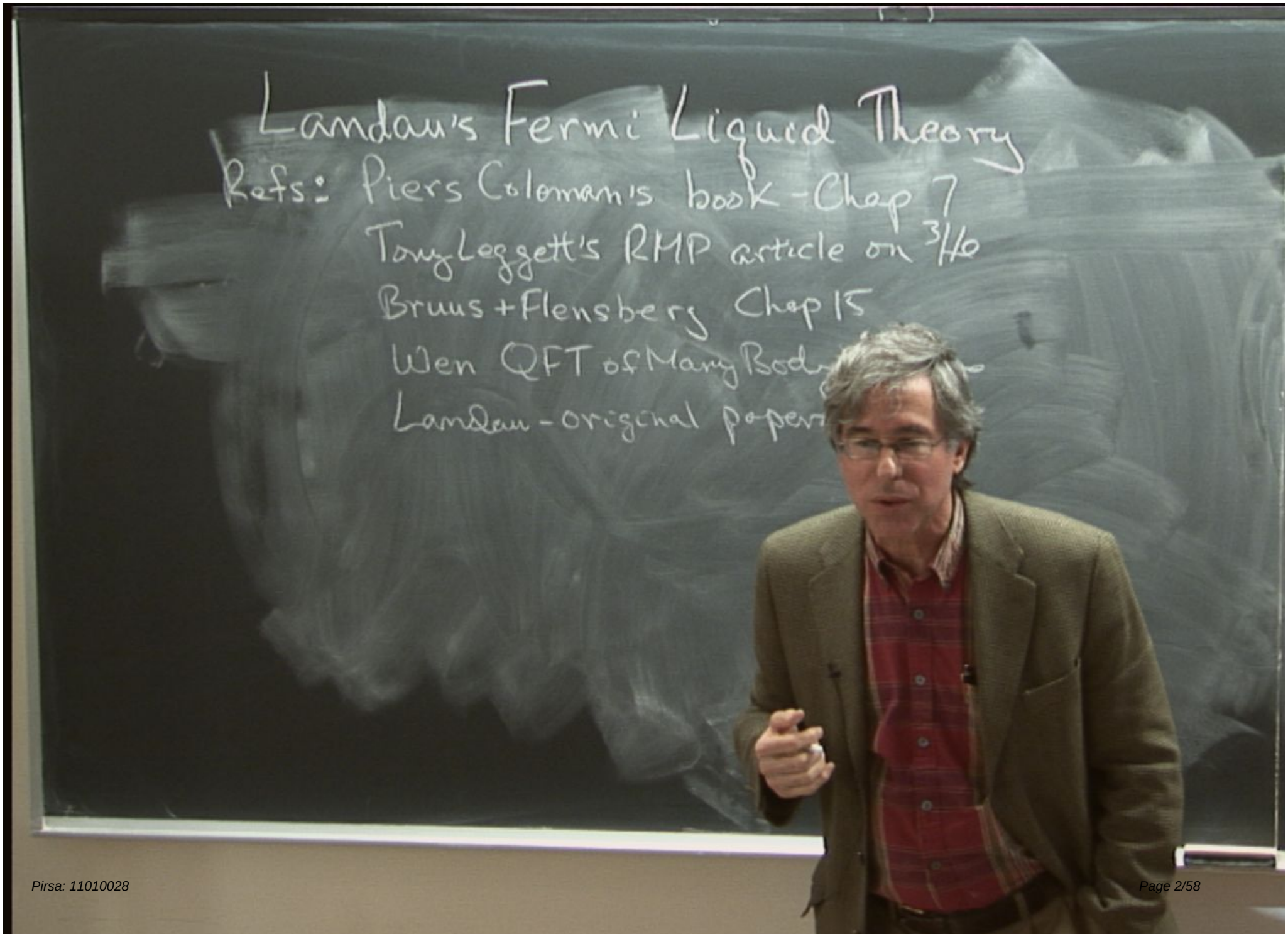
Title: Condensed Matter Review - Lecture 6

Date: Jan 10, 2011 10:15 AM

URL: http://pirsa.org/11010028

Abstract:


Landau's Fermi Liquid Theory
Refs: Piers Coleman's book - Chap 7
Tony Leggett's RMP article on 3He
Bruus + Flensberg Chap 15
Wen QFT of Many Body
Landau - original paper

Landau's Fermi Liquid Theory

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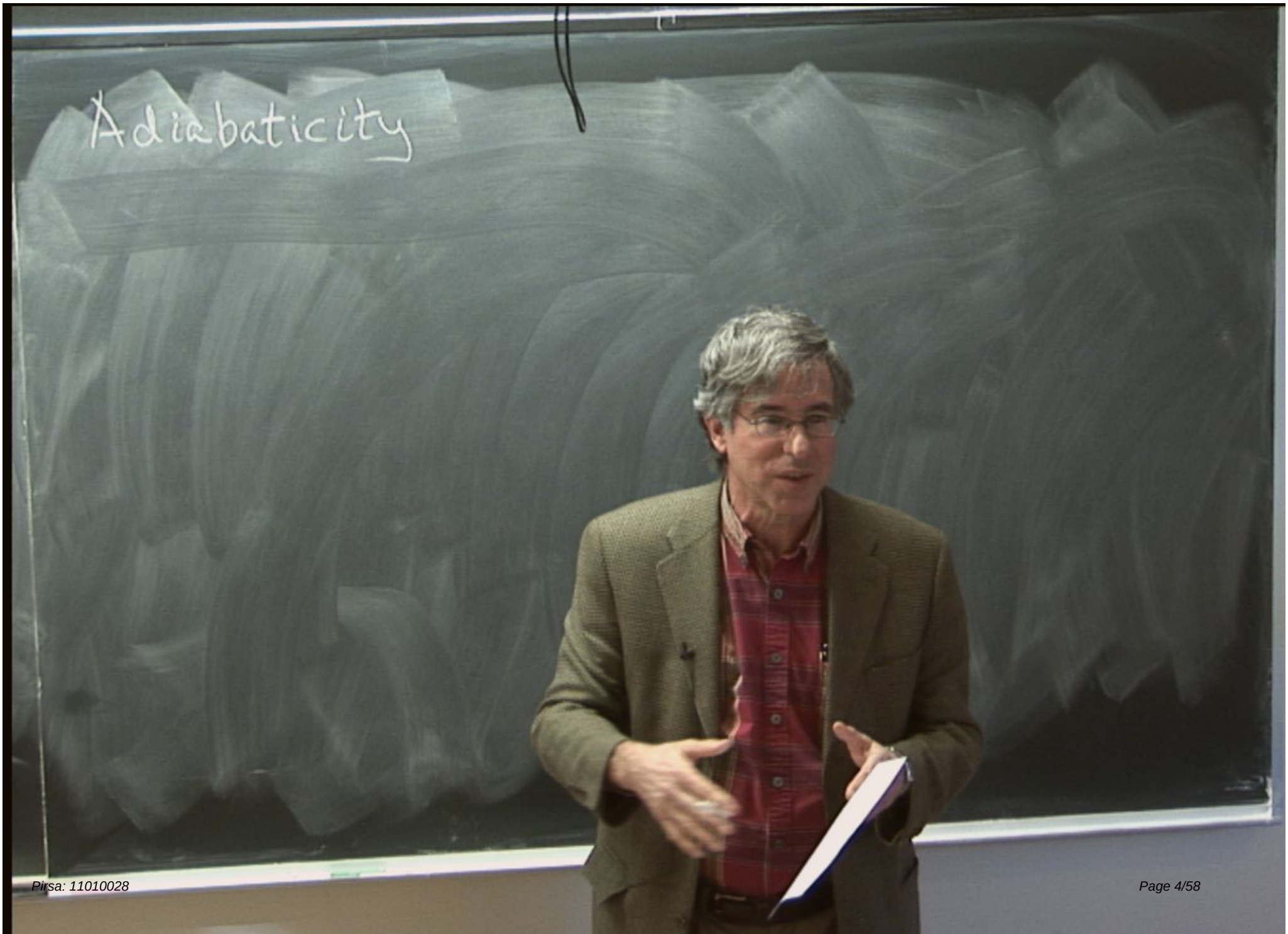
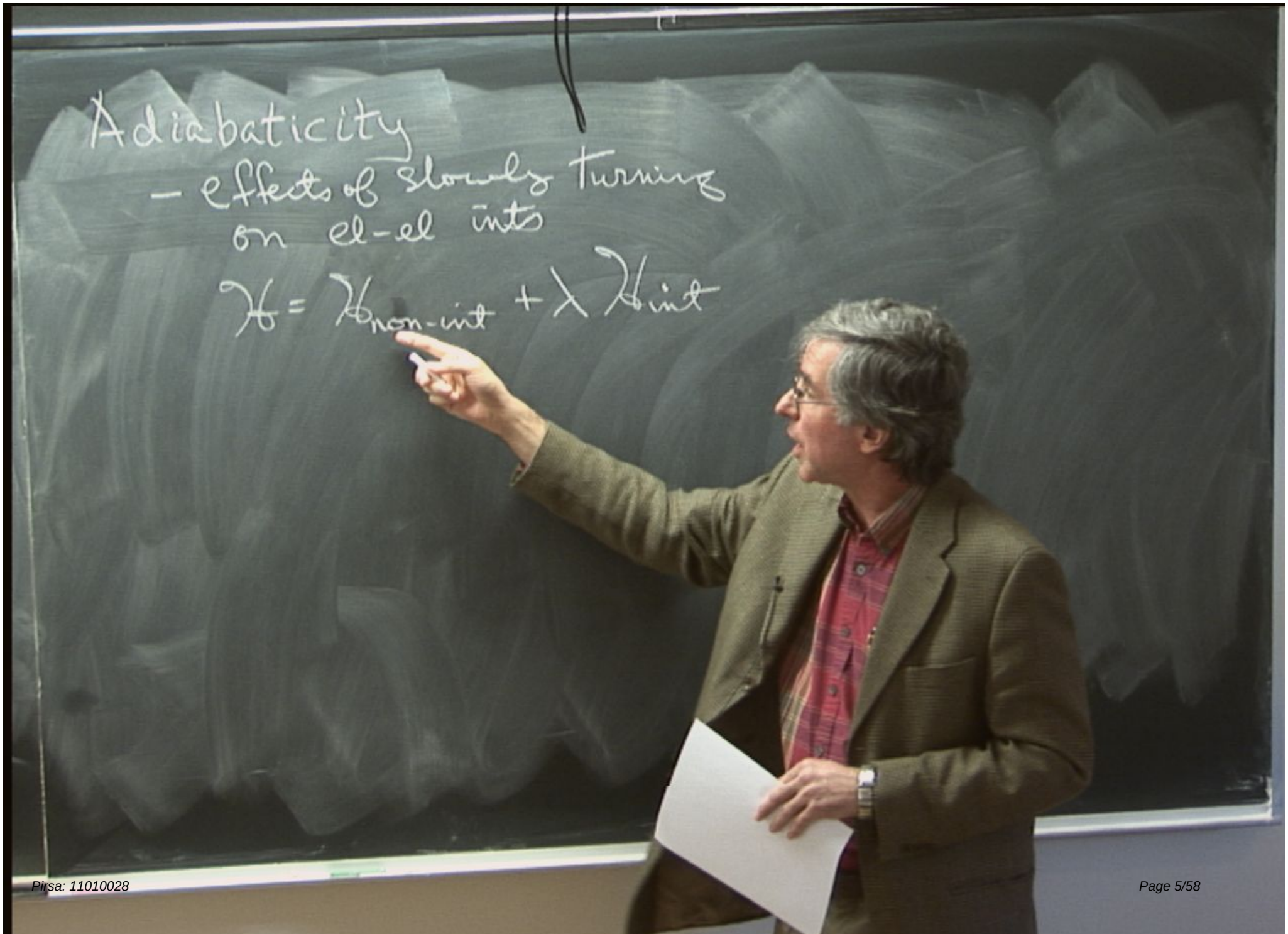
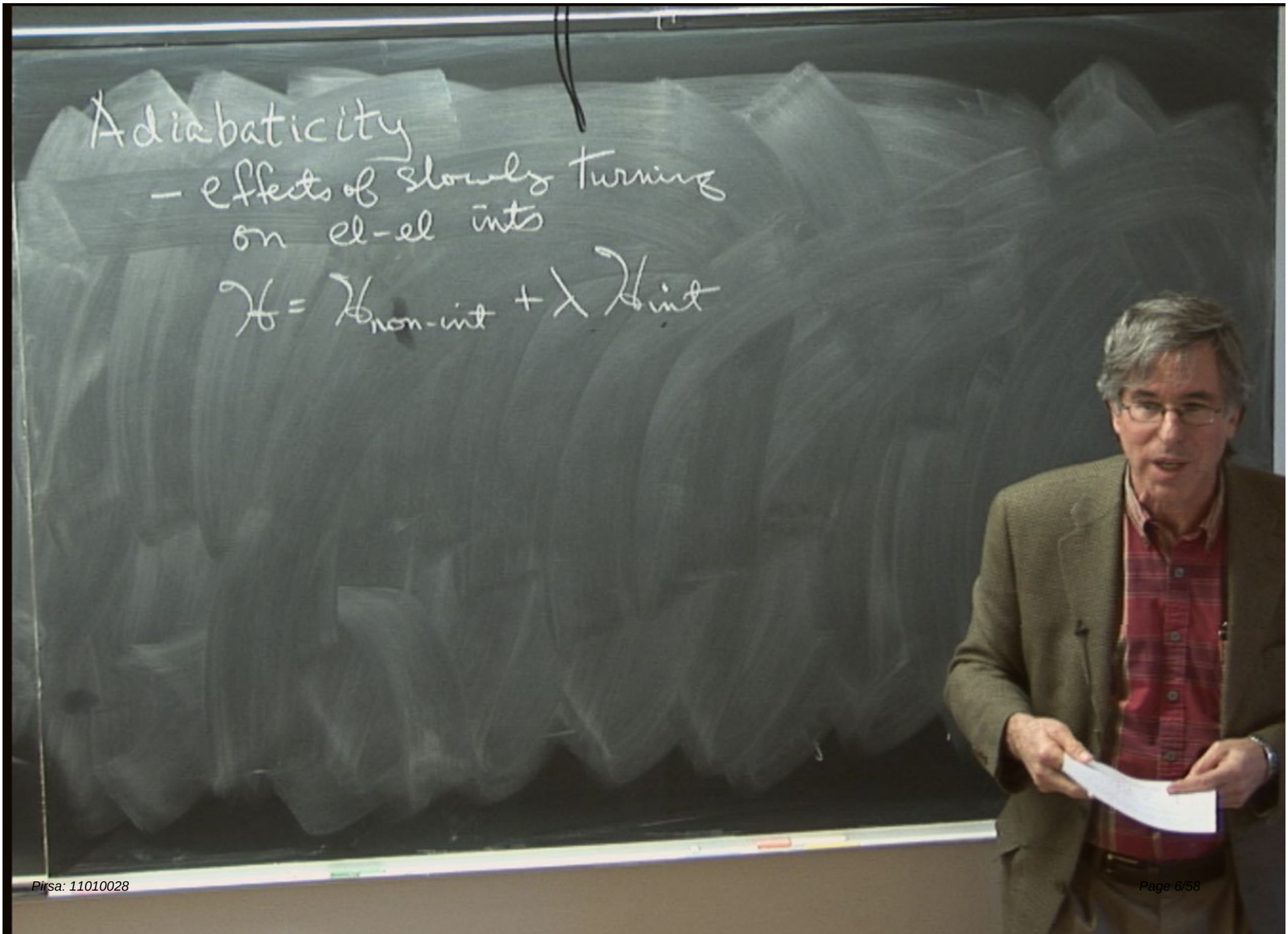

Adiabaticity


Adiabaticity
– effects of slowly turning
on el-el ints
$\mathcal{H} = \mathcal{H}_{non\text{-}int} + \lambda \mathcal{H}_{int}$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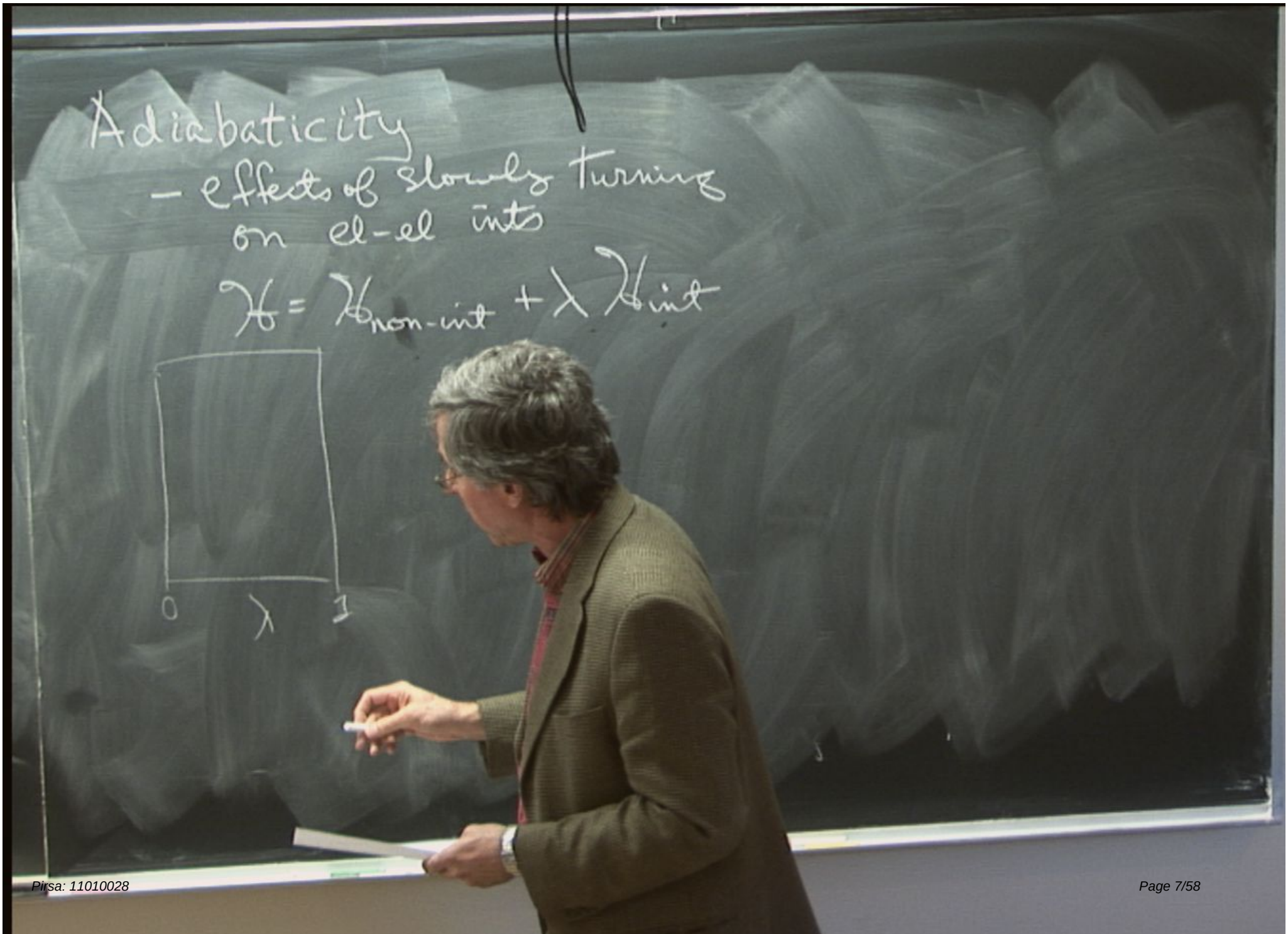
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$\mathcal{H} = \mathcal{H}_{non\text{-}int} + \lambda \mathcal{H}_{int}$
0
λ
1

Adiabaticity

– effects of slowly turning on el-el ints

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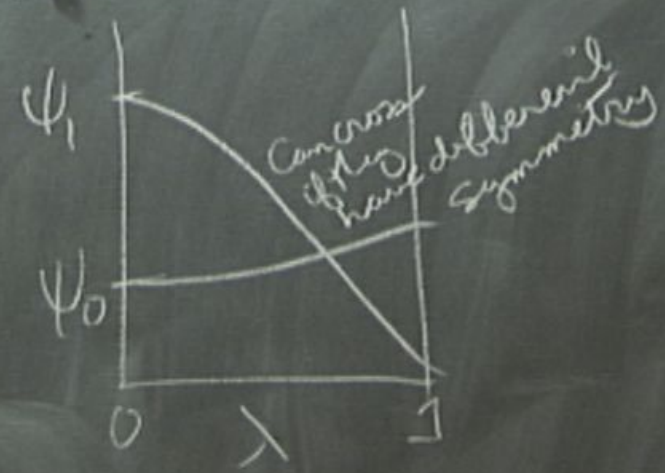

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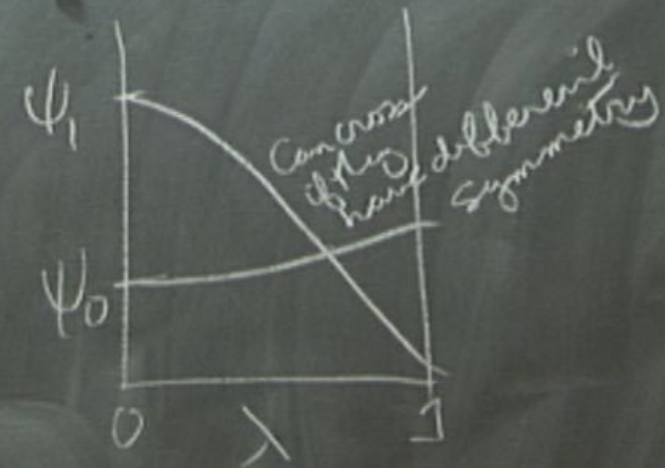

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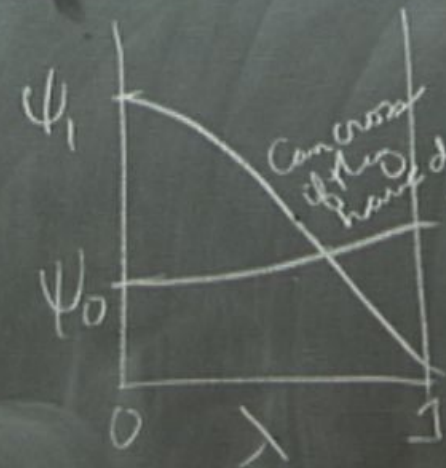
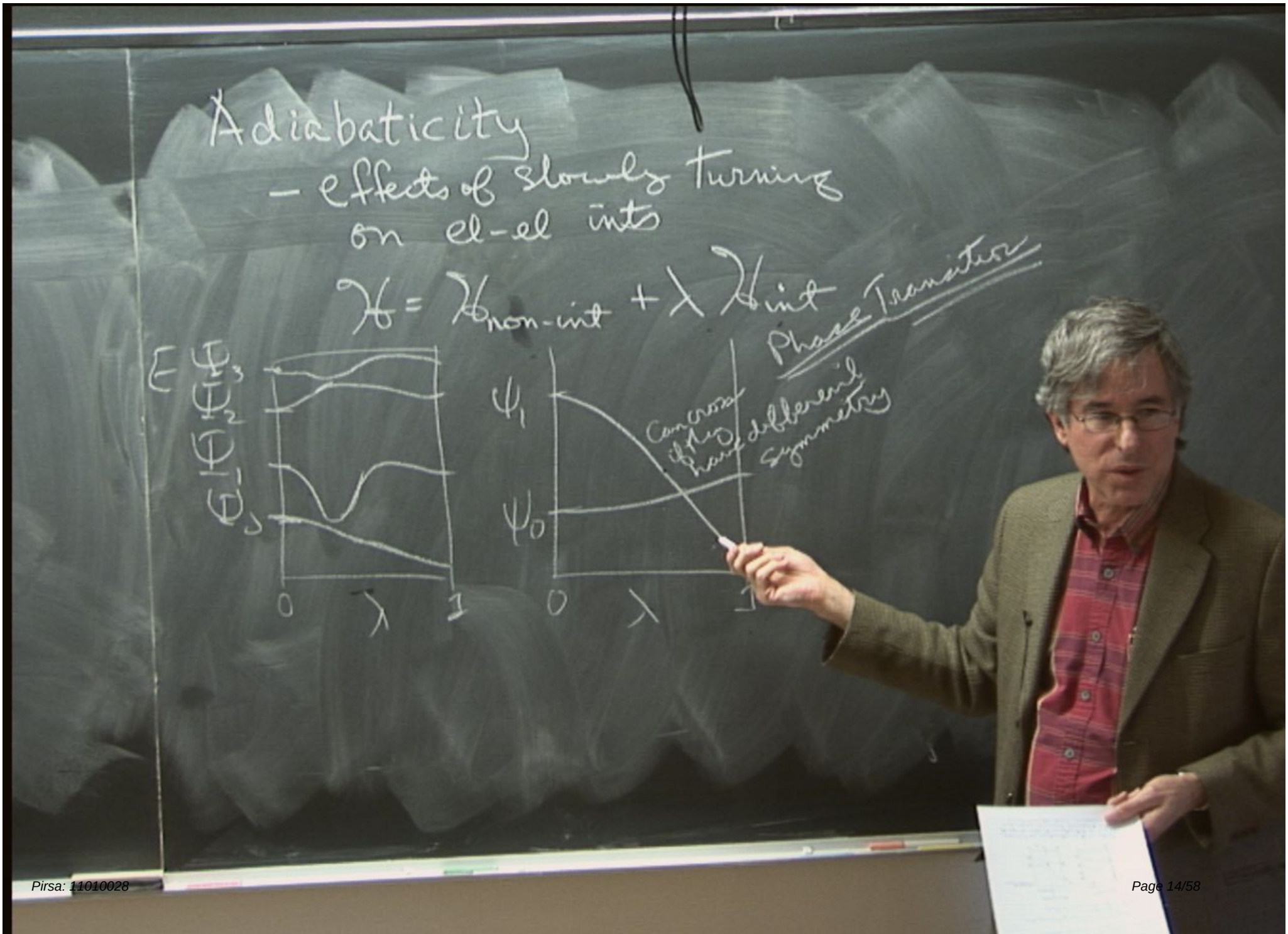


Phase Transition

Can cross if they have different symmetry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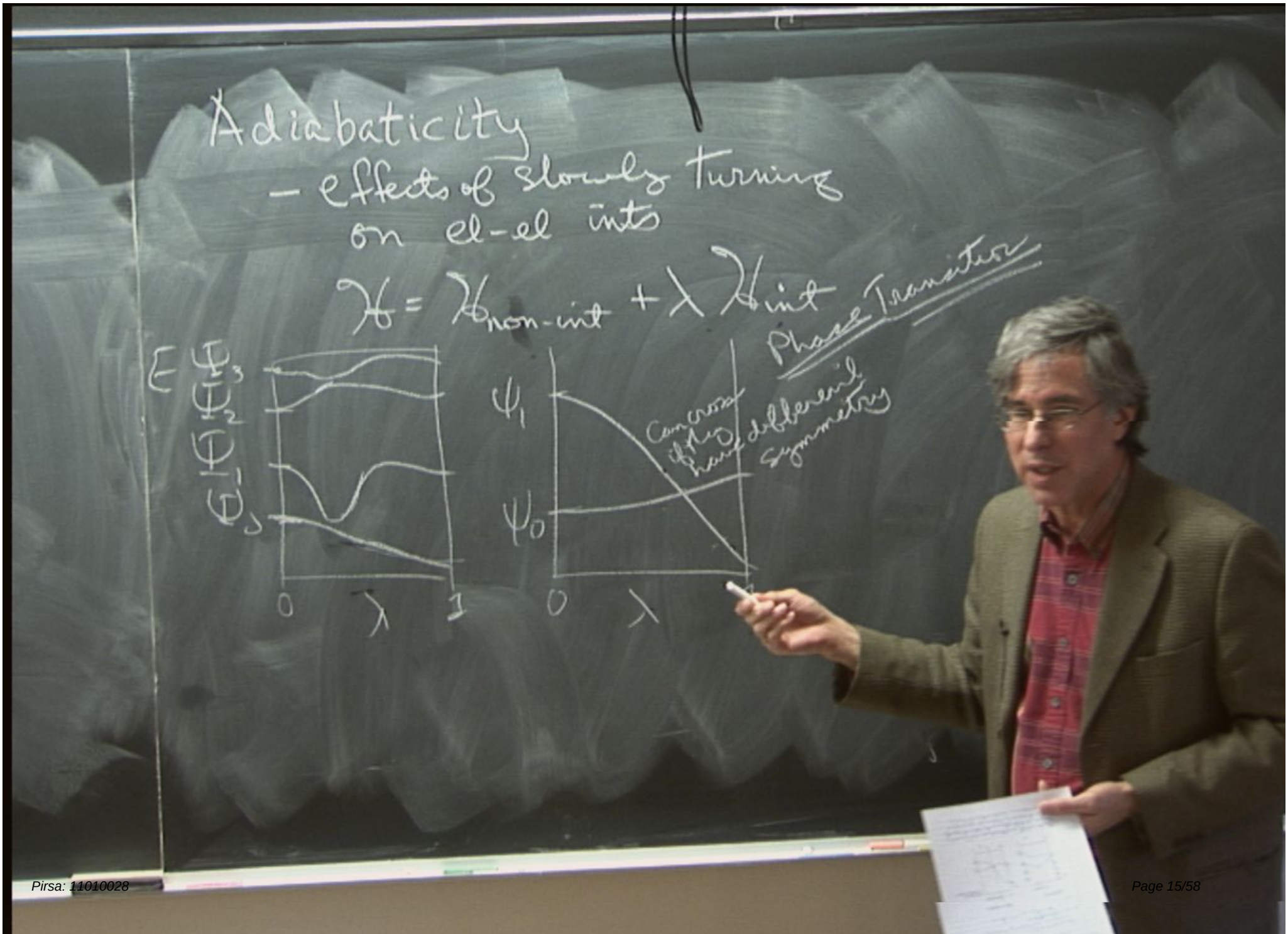
Phase Transition
E
Ψ_3
Ψ_2
Ψ_1
Ψ_0
0
λ
1
ψ_1
ψ_0
0
λ
1
Can cross if they have different symmetry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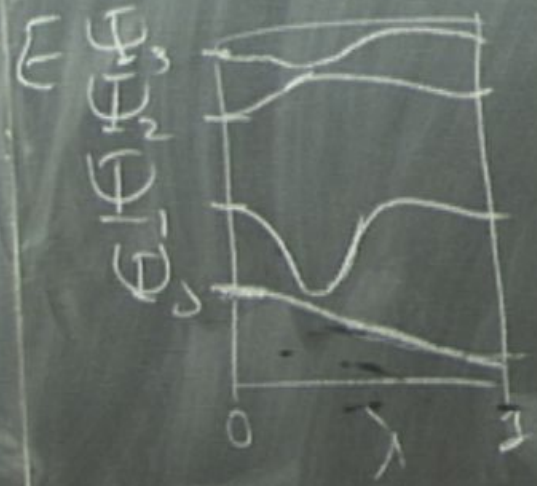

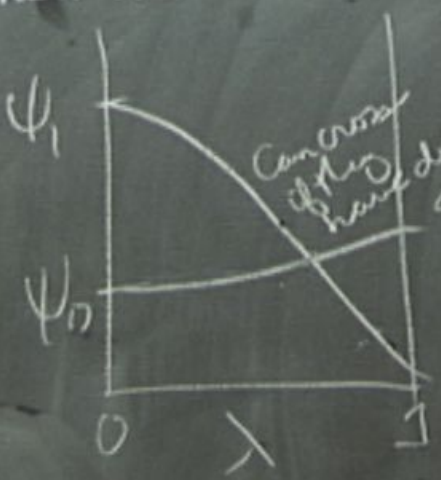

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Phase Transition

$$\Psi_0^{non\text{-}int}(\{n_{p,\sigma}\}) \longrightarrow \Psi_0^{int}($$

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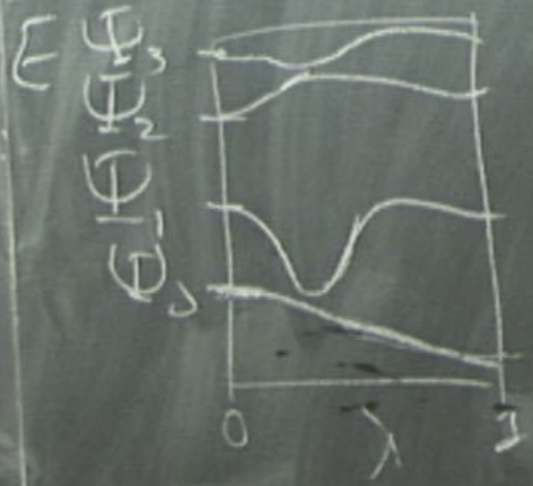

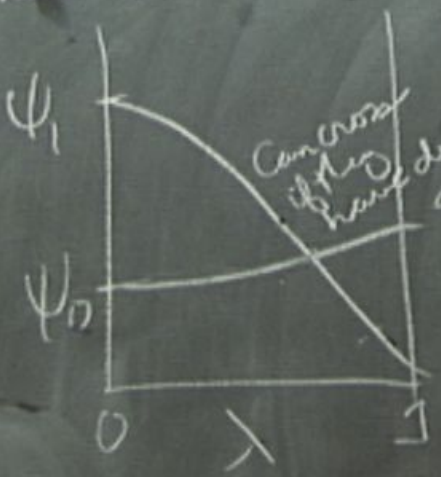

Can cross if they have different symmetry

Phase Transition

For fixed Ne

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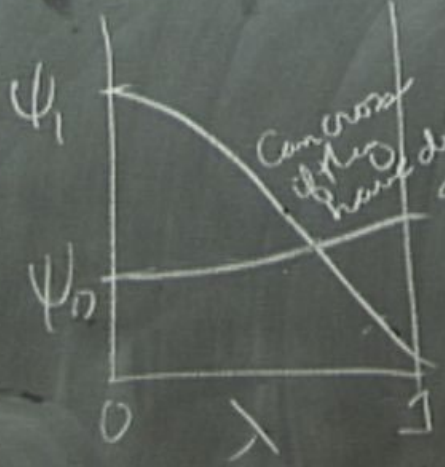

Can cross if two have different symmetry

Phase Transition

$$n_{p,\sigma} \begin{cases} 1 & \text{for } |\vec{p}| < p_F \\ 0 & \text{otherwise} \end{cases}$$

For fixed N_{el}

$$\Psi_0^{non\text{-}int}(\{n_{p,\sigma}\}) \longrightarrow \Psi_0^{int}(\{n_{p,\sigma}\})$$

Adiabaticity

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Assuming uniform isotropic liquid

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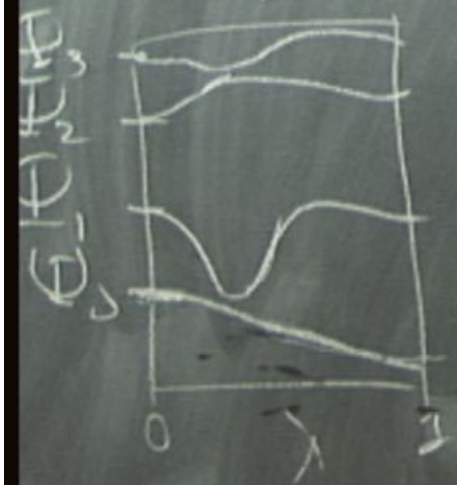

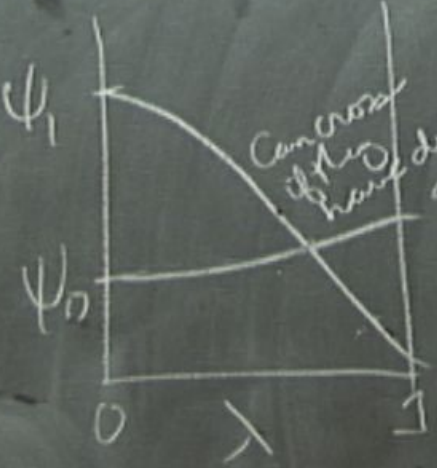

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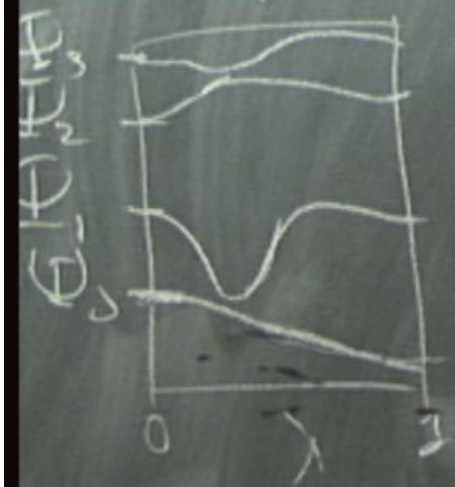

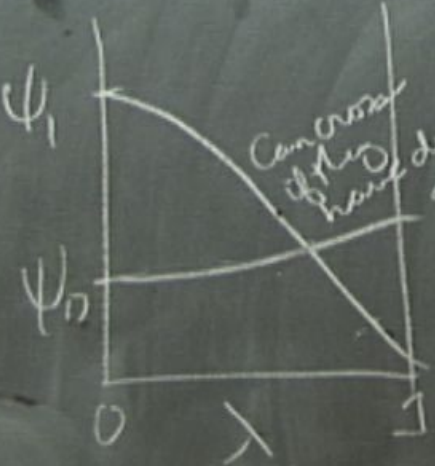

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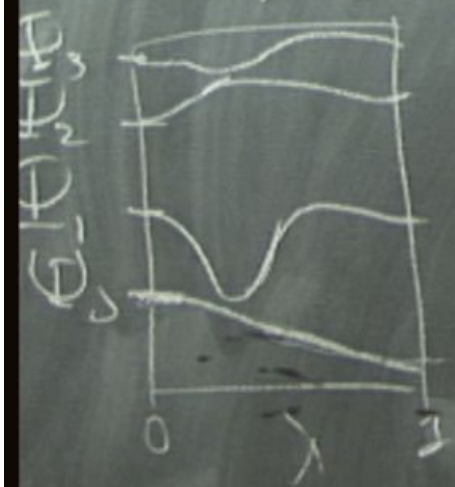
$$\Psi_0^{non\text{-}int}(\{n_{p\sigma}\})$$

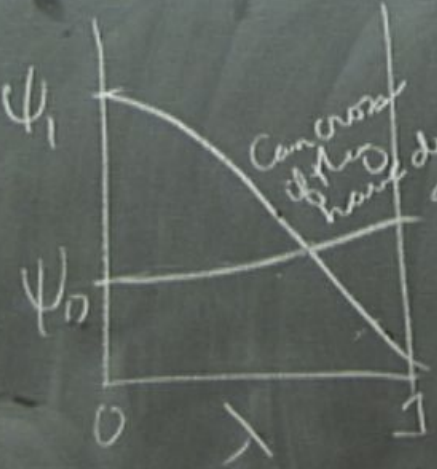
For fixed N_{el}

for both cases

$$\Psi_0^{int}(\{n_{p\sigma}\})$$

Phase Transition





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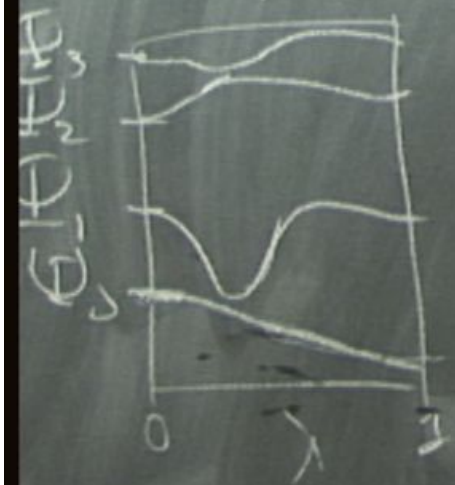

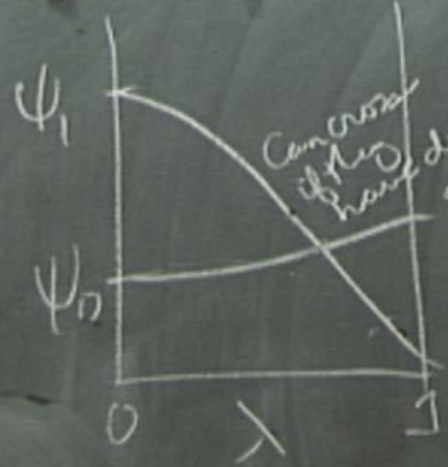

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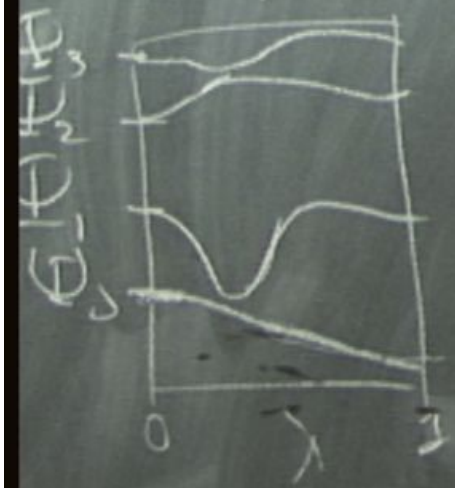
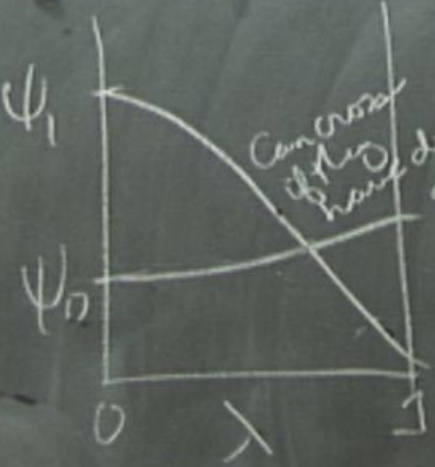
The states labeled by $\vec{p}, \sigma$





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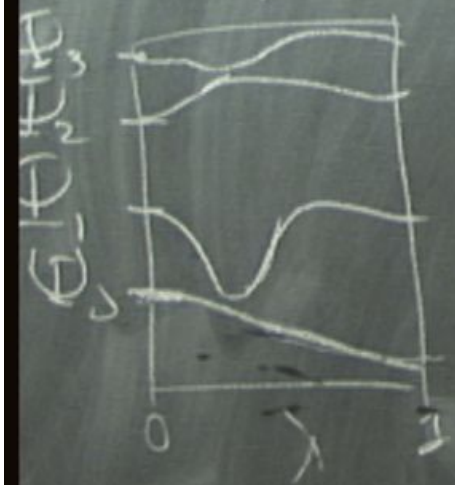
The states labeled by $\vec{p}, \sigma$

Same $\vec{p}, e, \sigma$ as for non-int case



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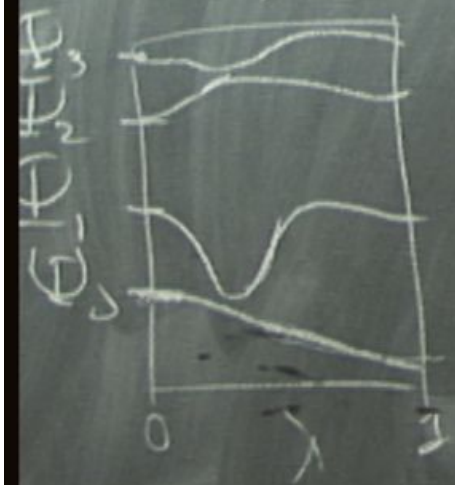

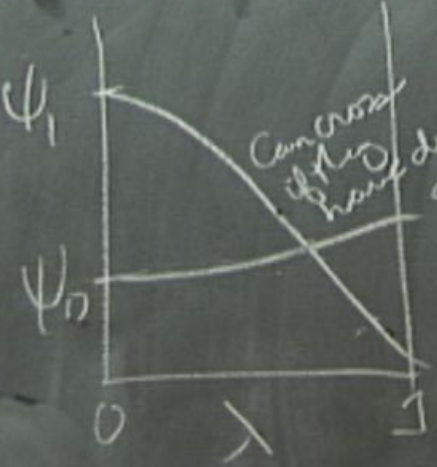

Phase Transition

Can cross if two have different symmetry

The states labeled by $\vec{p}, \sigma$

Same $\vec{p}, e, \sigma$ as for non-int case

What changes is $\varepsilon_{\vec{p},\sigma} \leftrightarrow m^*$

Adiabaticity

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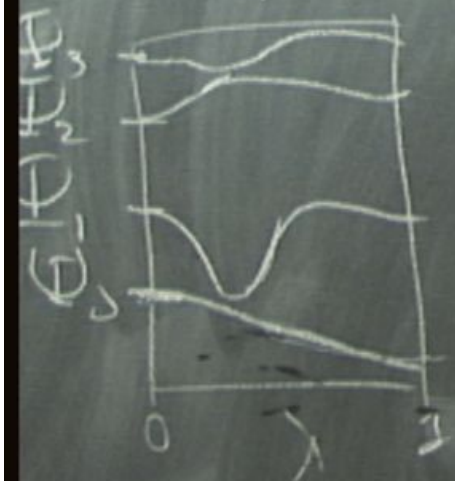
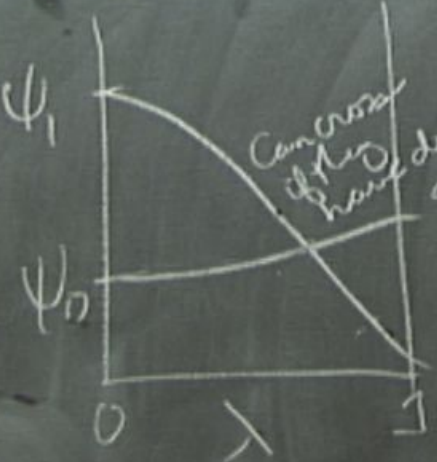
For fixed N_{el}

$\Psi_0^{non\text{-}int}(\{n_{p\sigma}\})$

for both cases

$\longrightarrow \Psi_0^{int}(\{n_{p\sigma}\})$





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The states labeled by $\vec{p}, \sigma$

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and hence also $N^*(0)$

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For fixed N_{el}

$$\Psi_0^{non\text{-}int}(\{n_{p\sigma}\})$$

for both cases

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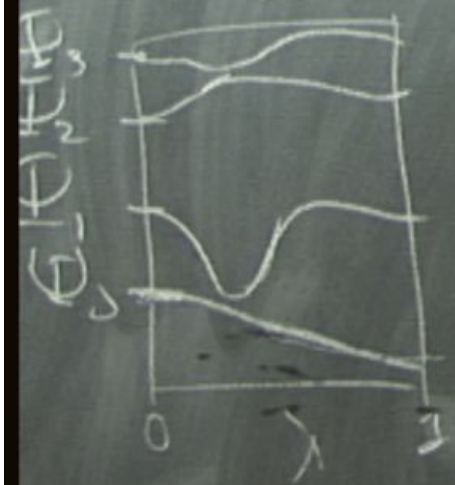

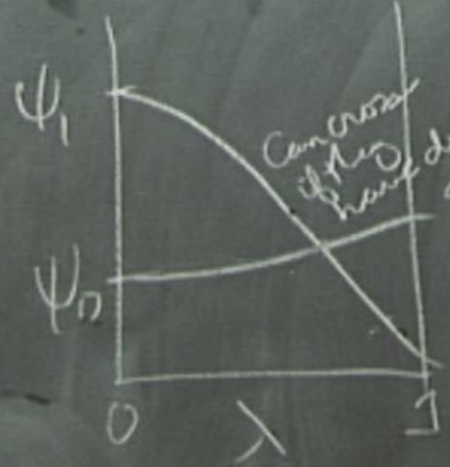

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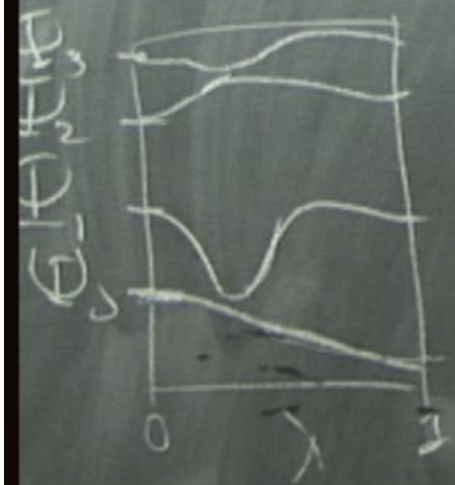

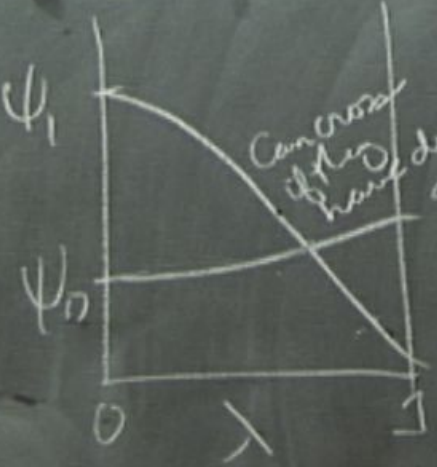

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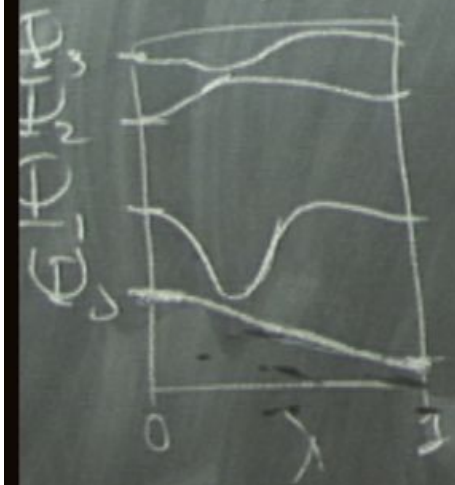

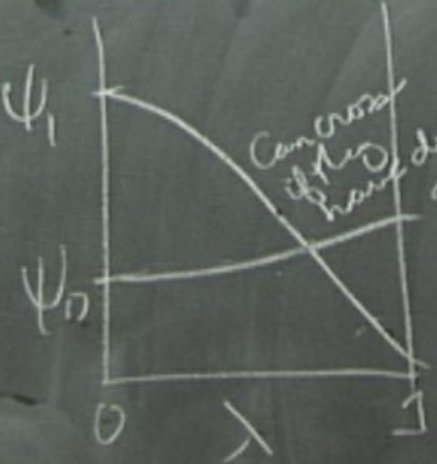

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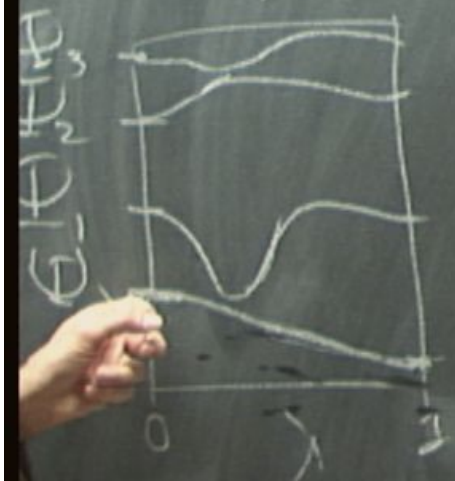
for both cases

$\longrightarrow \Psi_0^{int}(\{n_{p,\sigma}\})$



Phase Transition

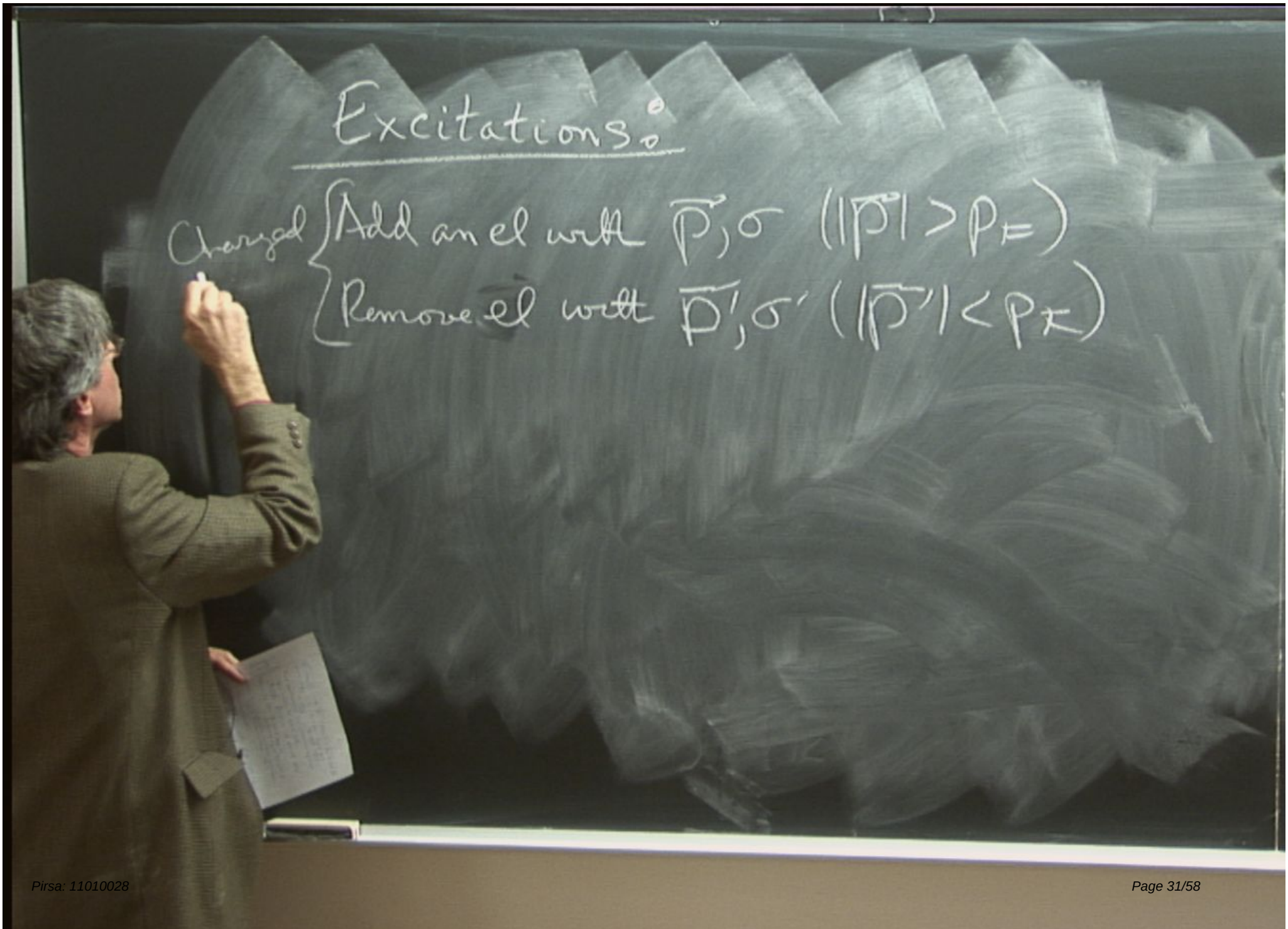
Can cross if two have different symmetry

The states labeled by $\vec{p}, \sigma$

Same $\vec{p}, e, \sigma$ as for non-int case

What changes is $\varepsilon_{\vec{p},\sigma} \leftrightarrow m^*$

$\vec{v}_{p,\sigma}$ and here also $N^*(0)$


Excitations:
Charged
Add an el with $\vec{p}, \sigma$ $(|\vec{p}| > p_F)$
Remove el with $\vec{p}', \sigma'$ $(|\vec{p}'| < p_F)$

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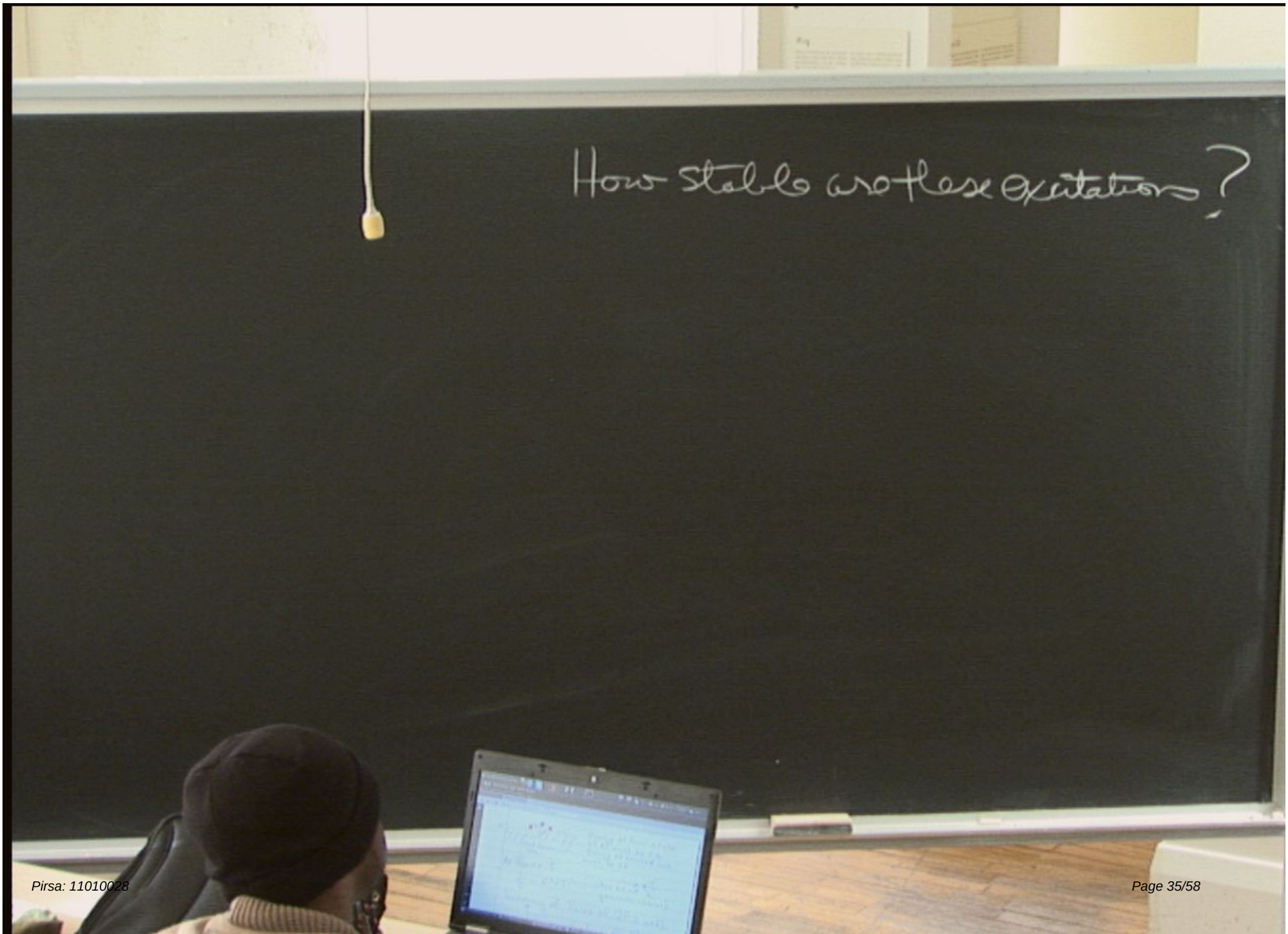
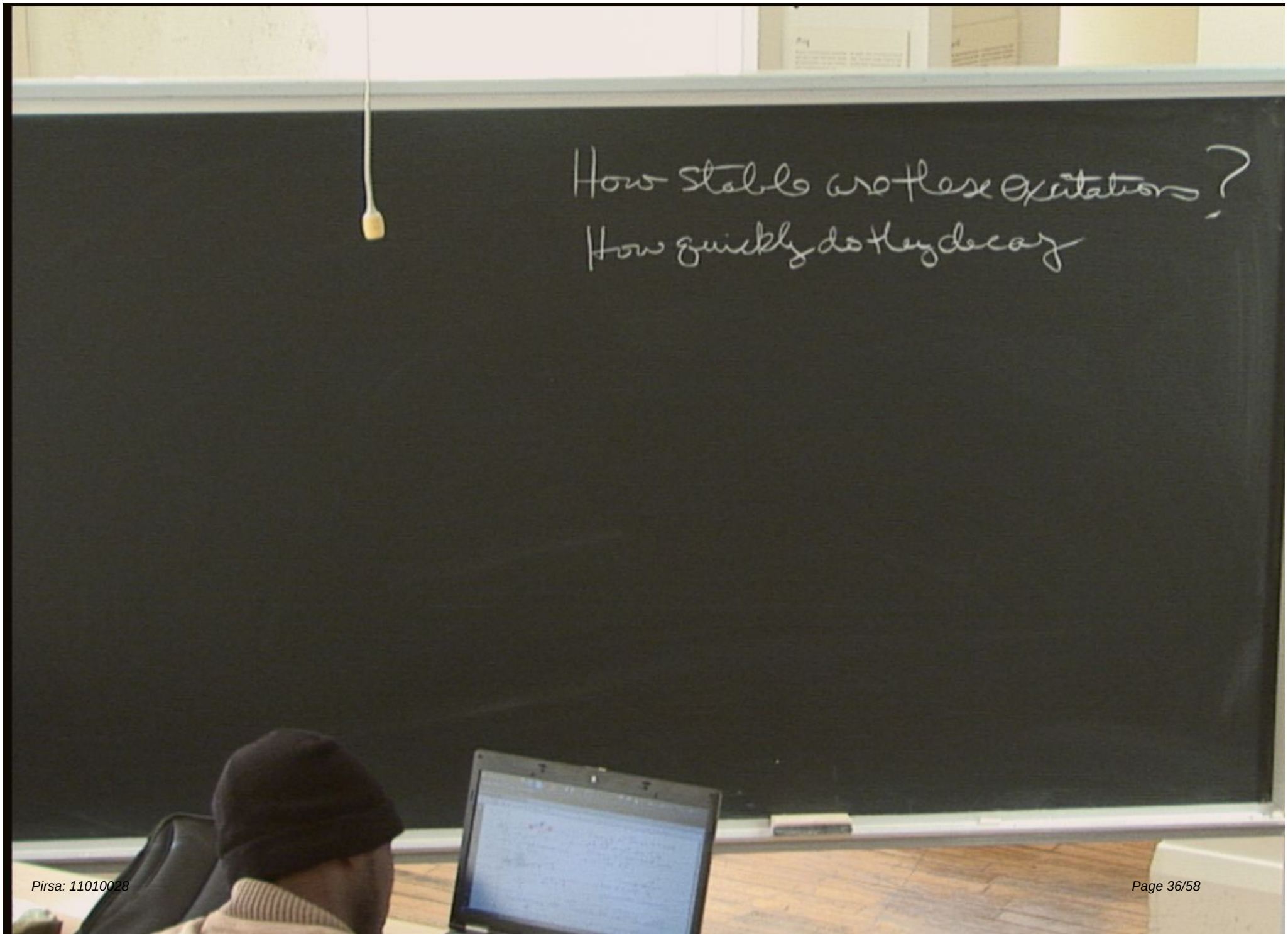
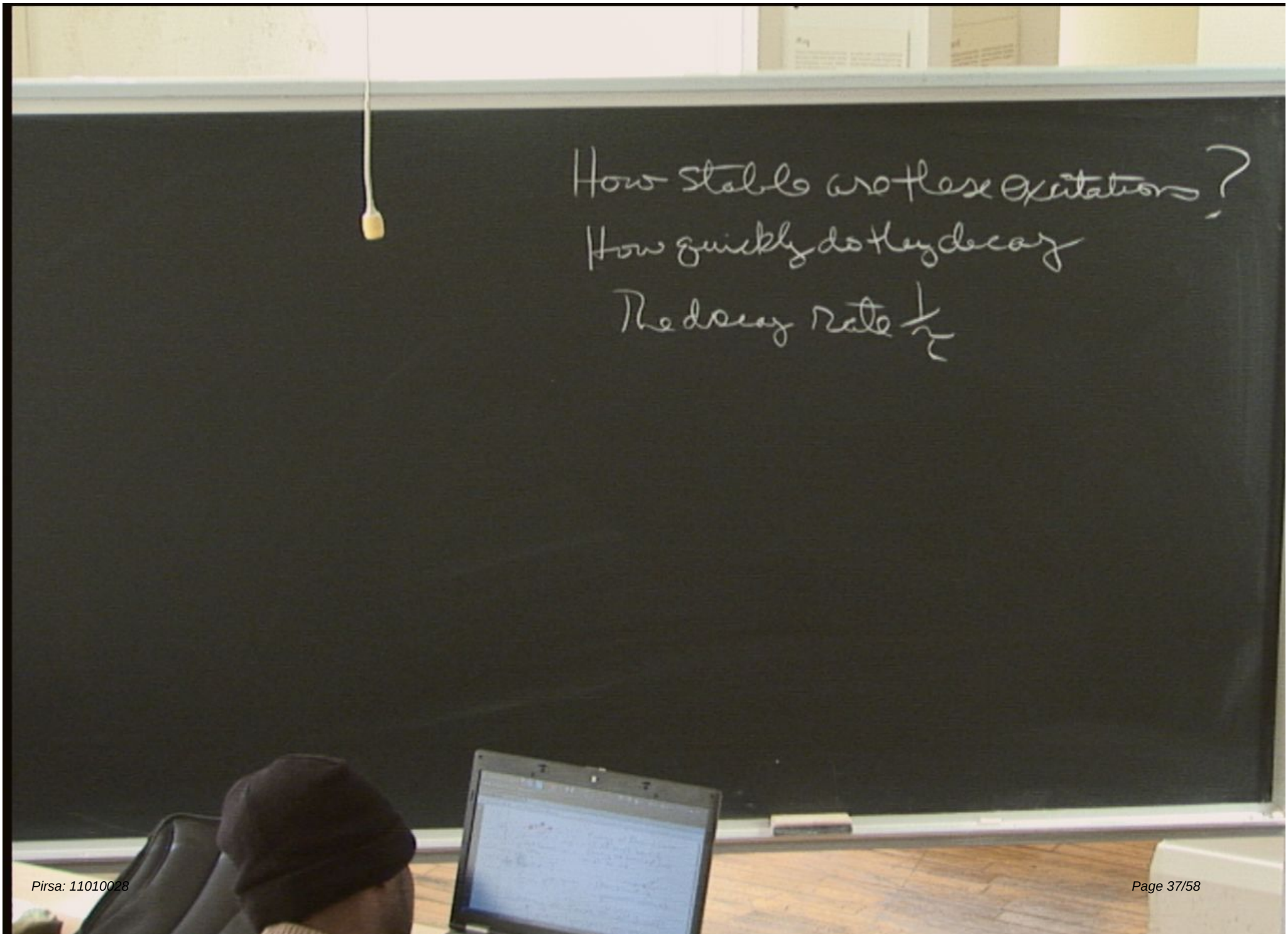

How stable are these excitations?


How stable are these excitations?
How quickly do they decay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The decay rate $\frac{1}{\tau}$

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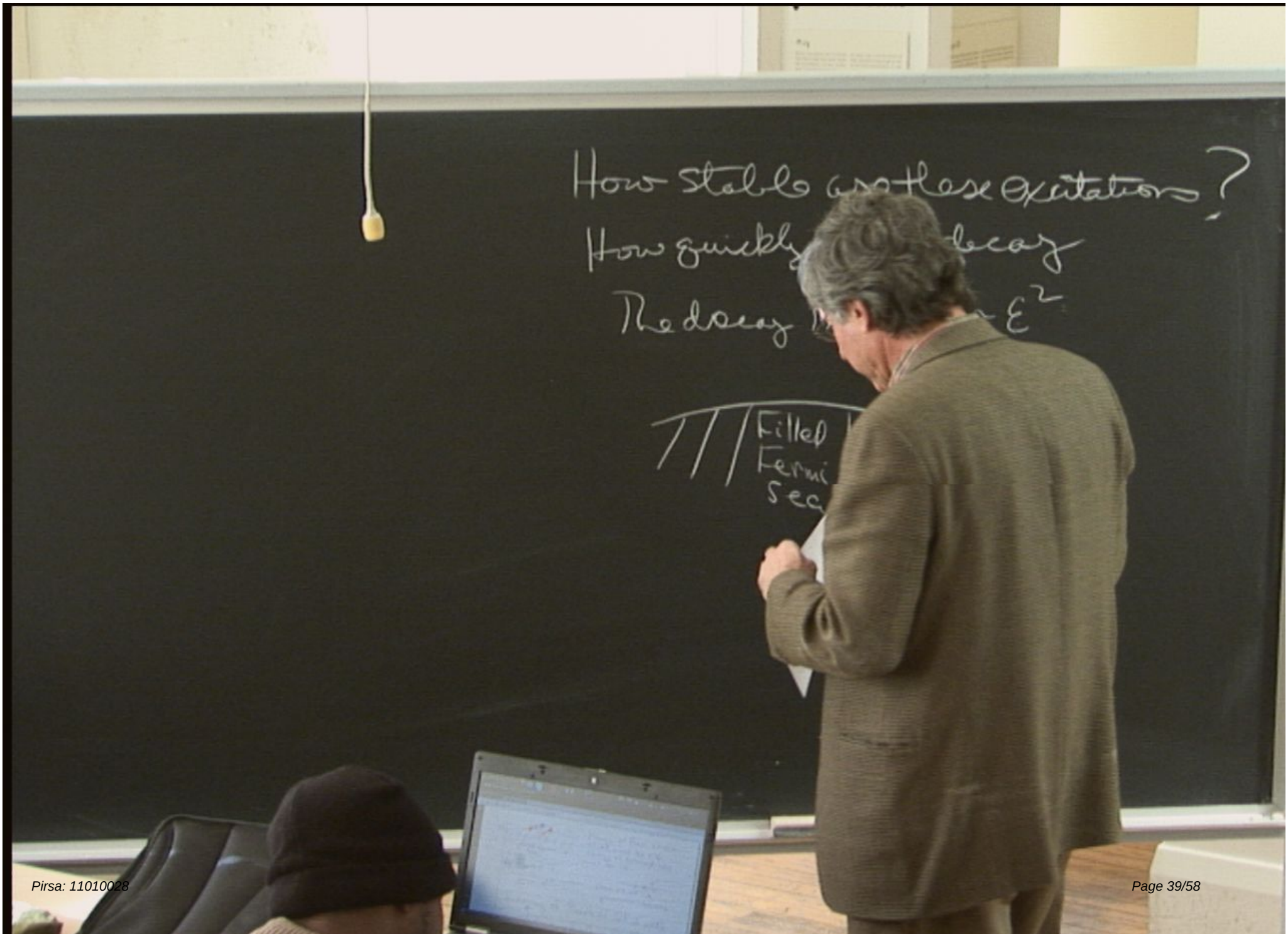
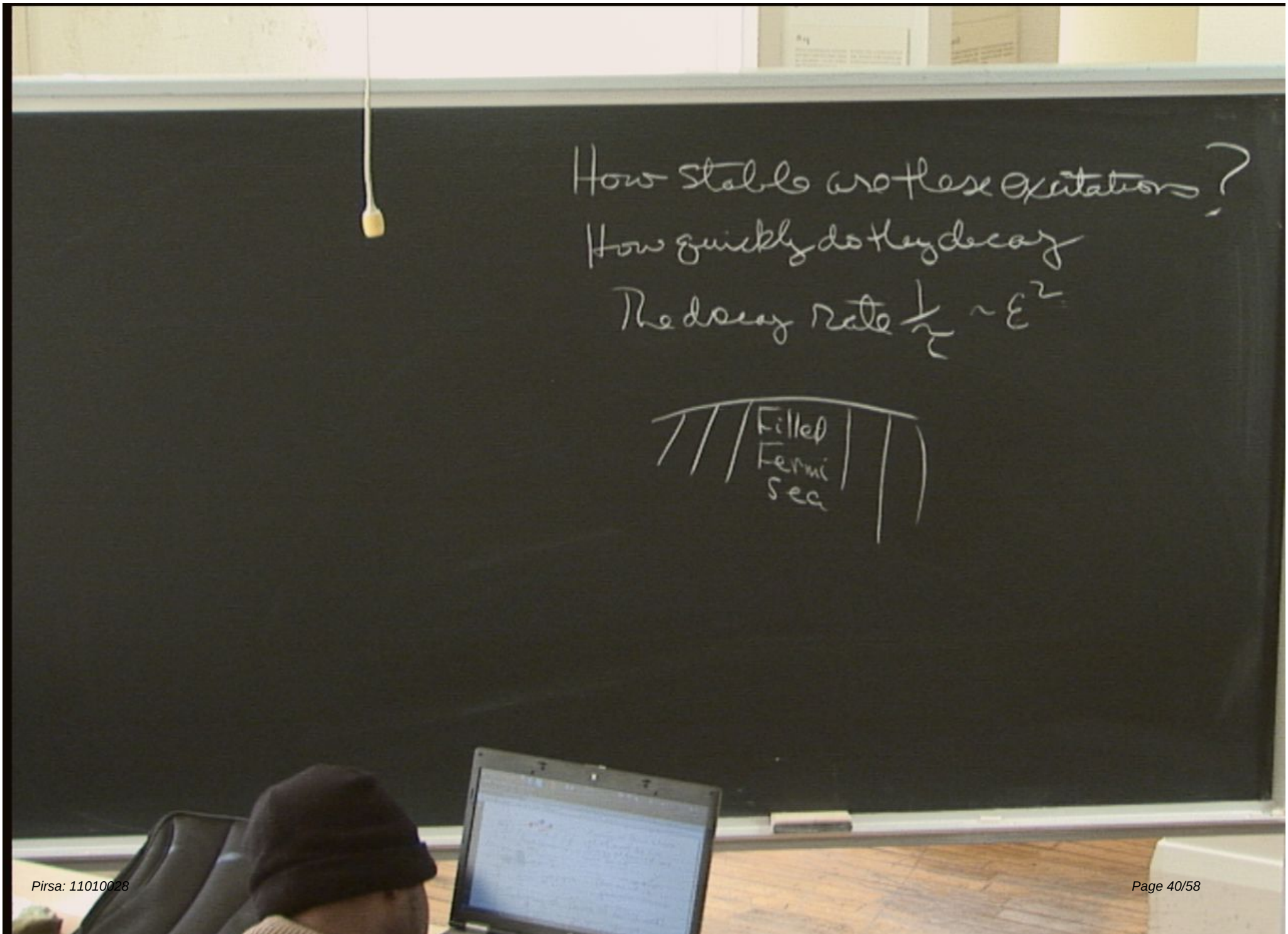
The decay rate $\frac{1}{\tau} \sim \varepsilon^2$


How stable are these excitations?
How quickly decay
Filled
Fermi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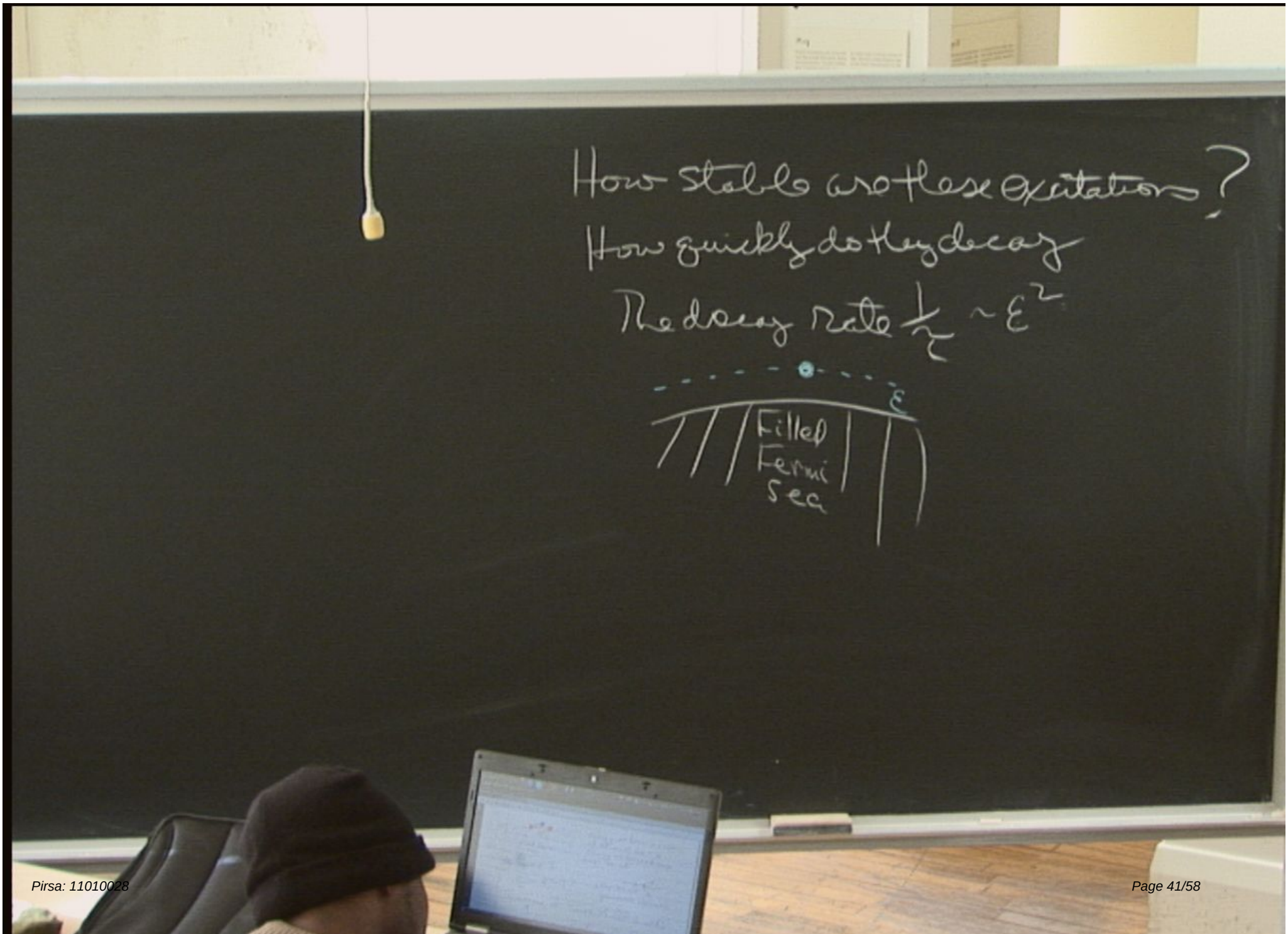
Sea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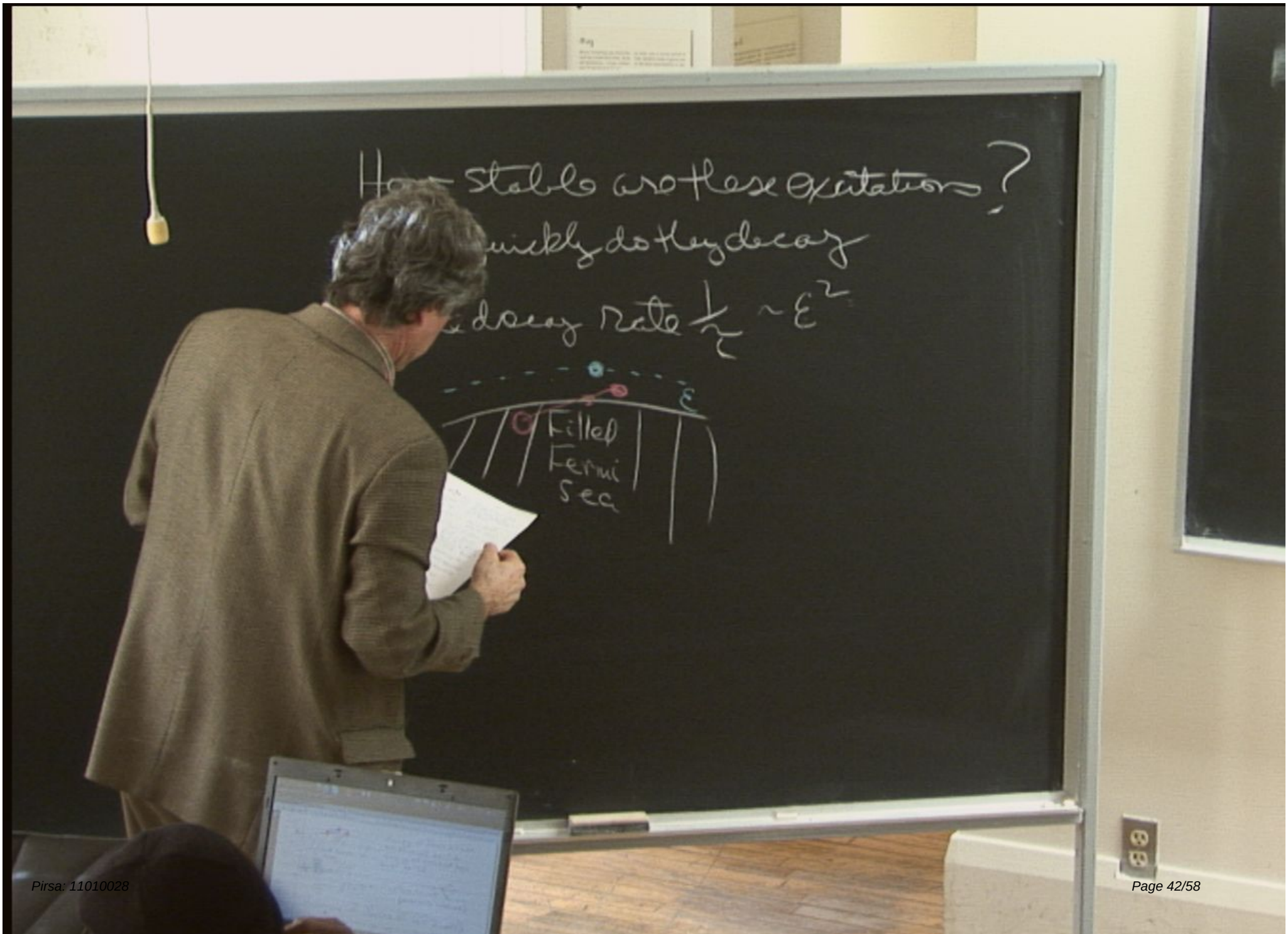
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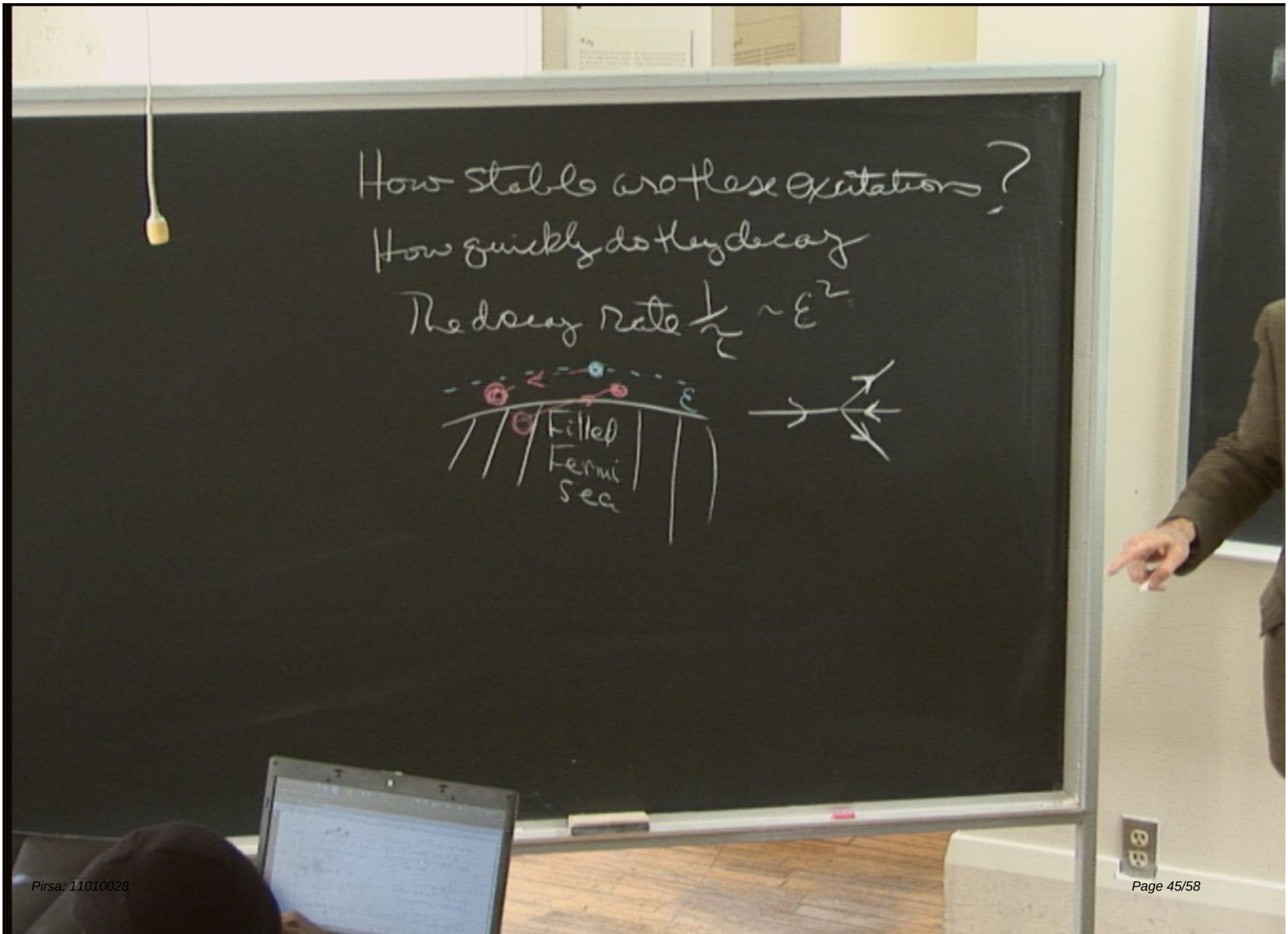
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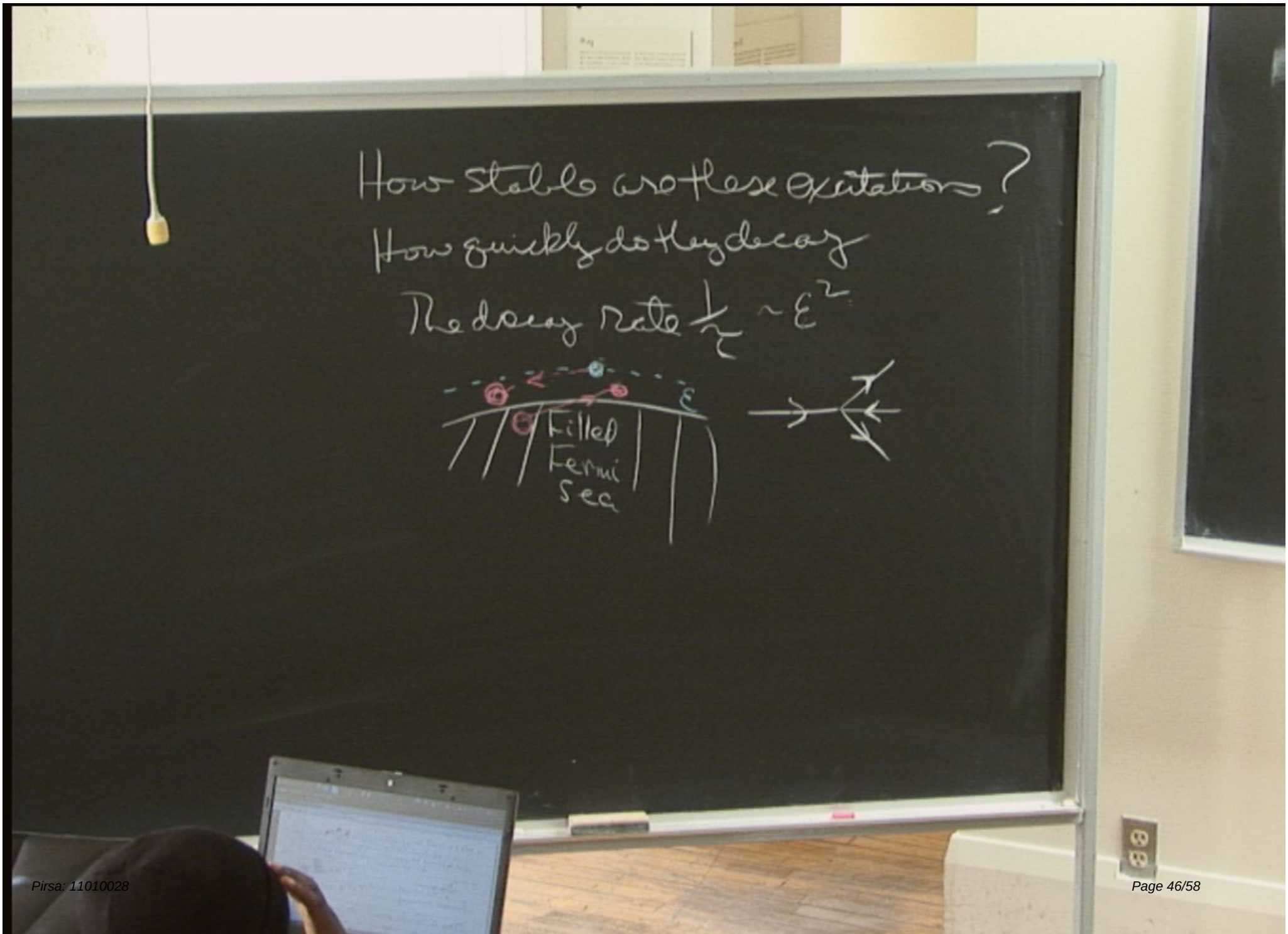
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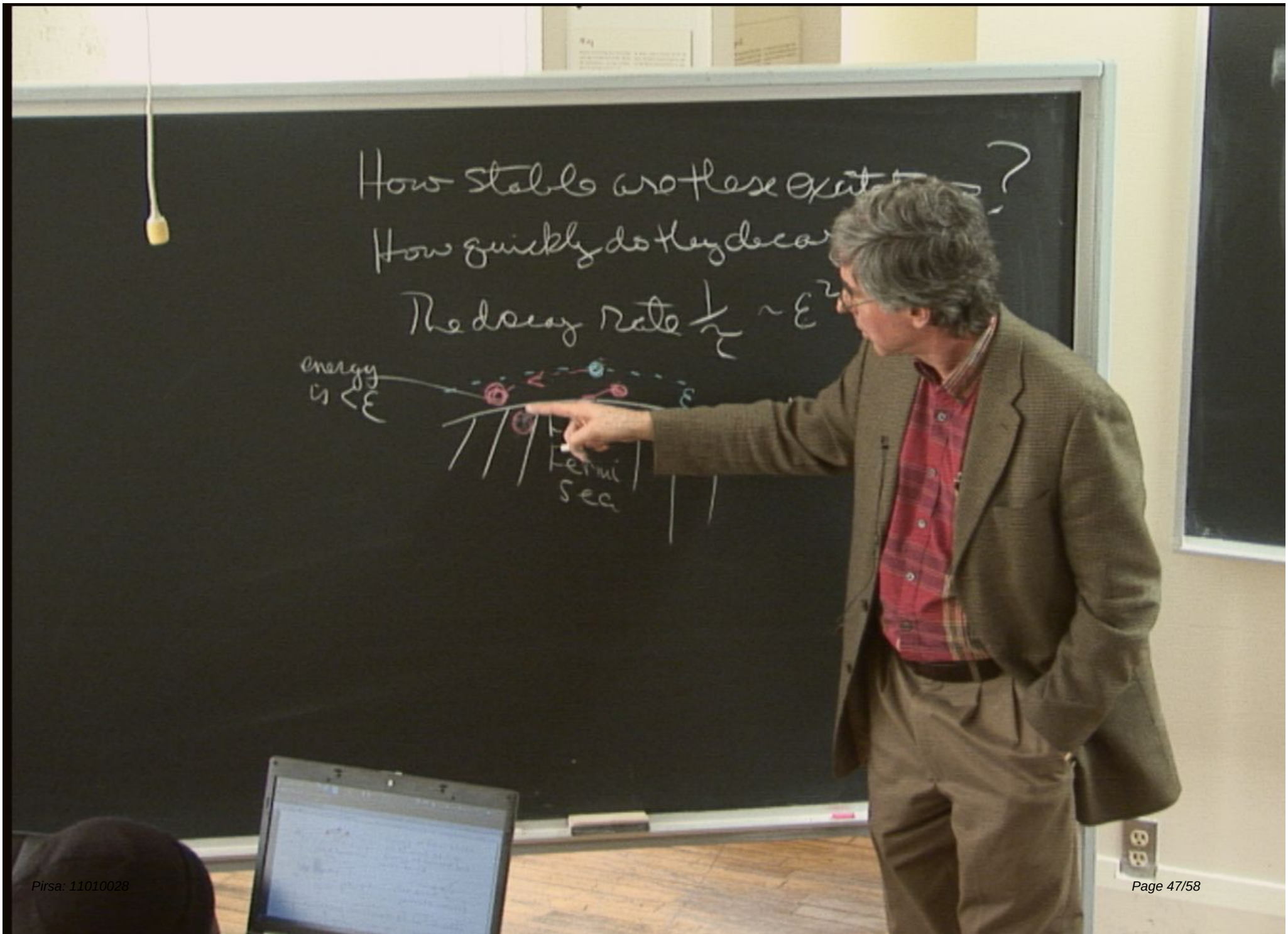
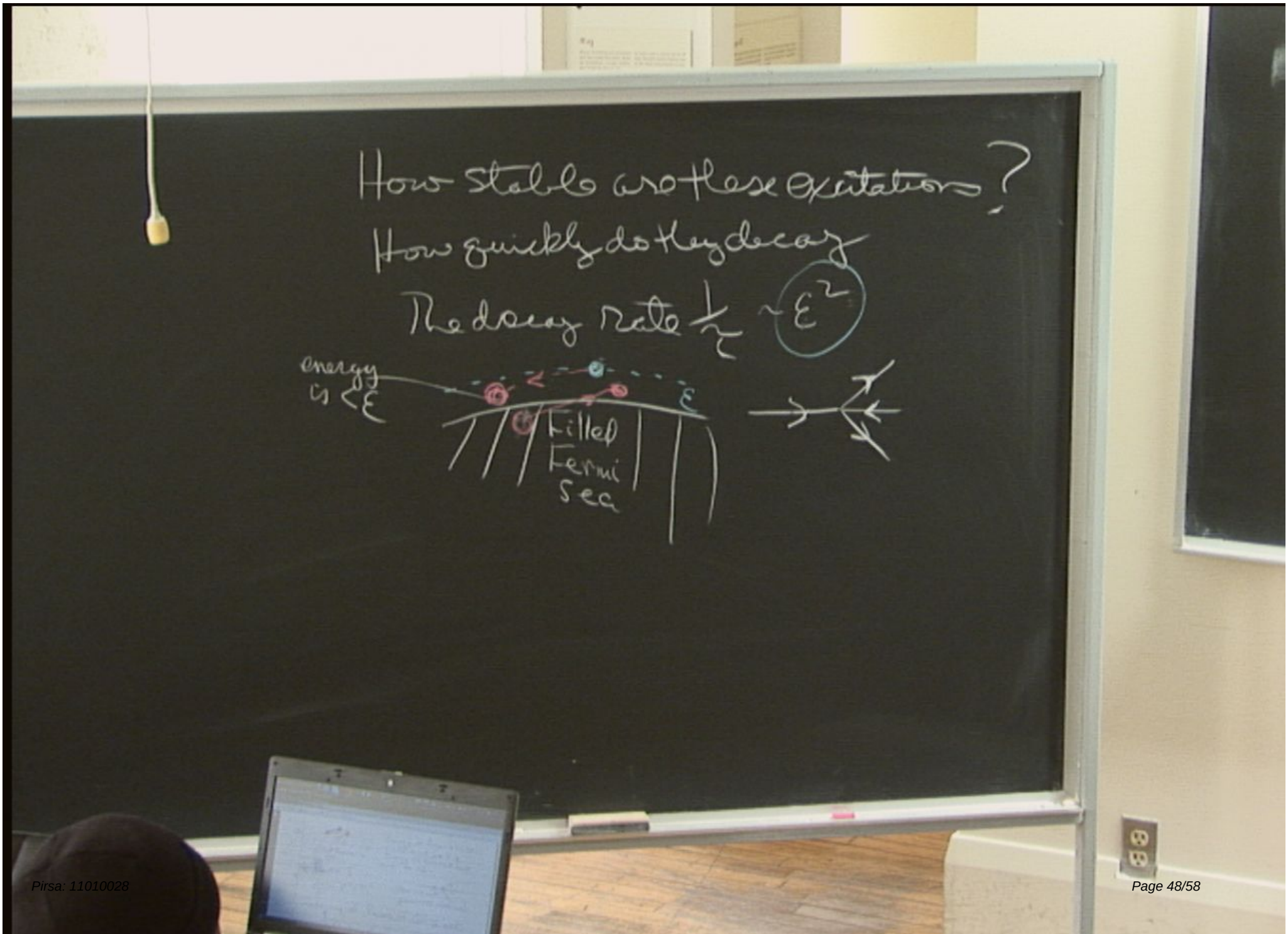

How stable are these exci
How quickly do they deca
The decay rate 1/τ ~ ε²
energy is < ε
ε
Fermi Sea


How stable are these excitations?
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ε
Filled Fermi Sea

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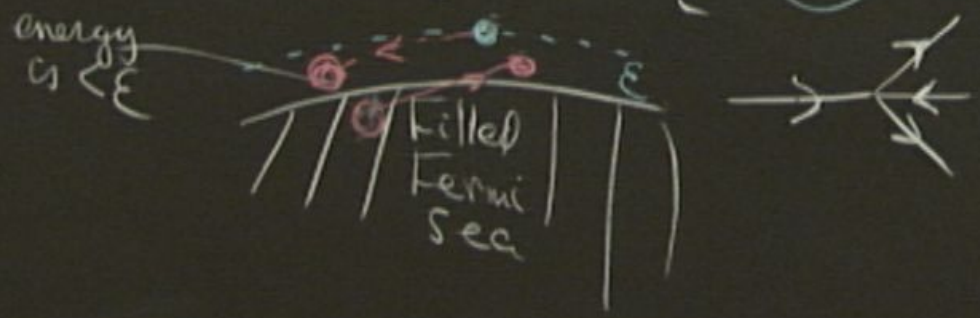
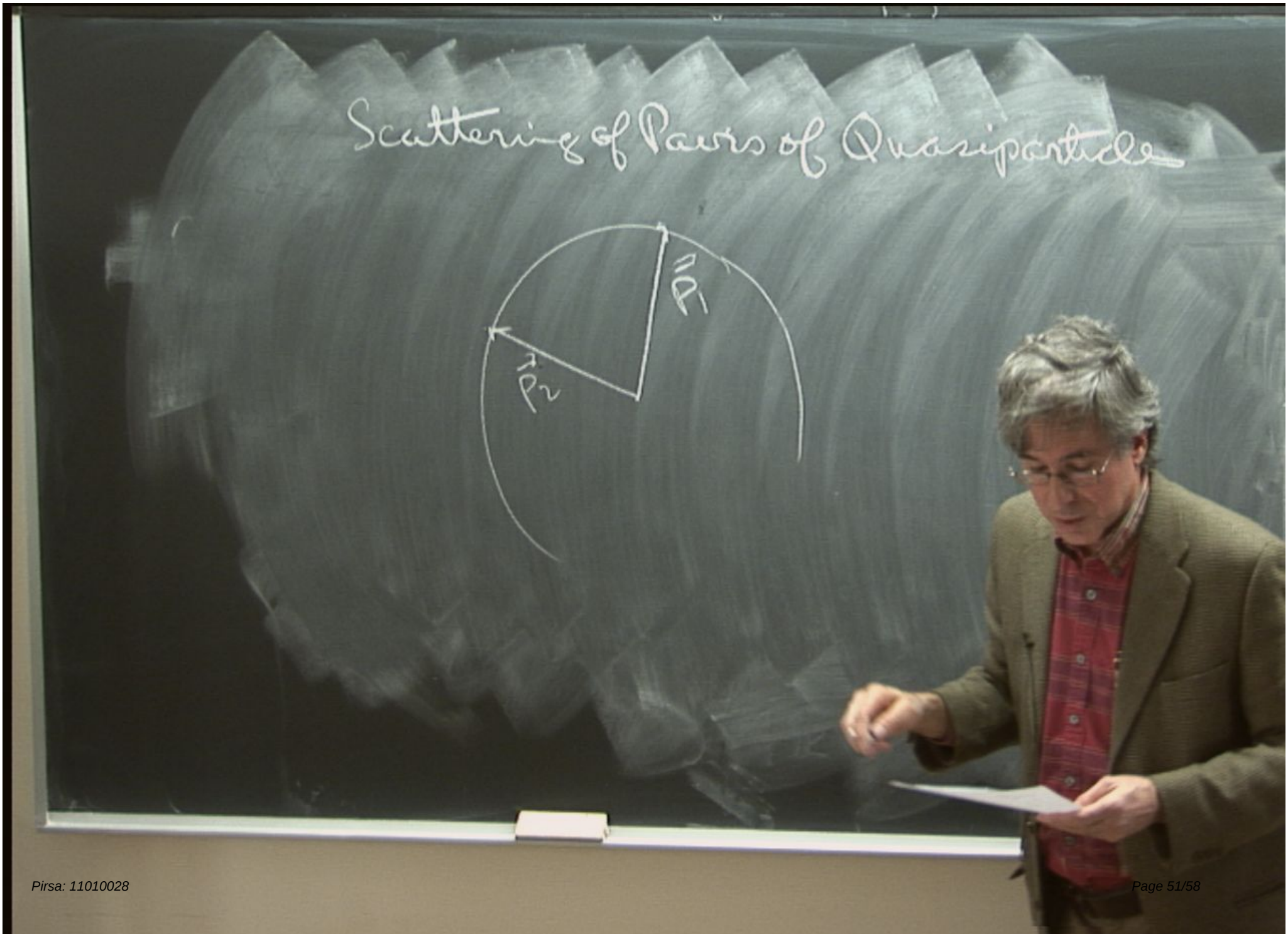


Scattering of Pairs of Quasiparticles


Scattering of Pairs of Quasiparticles
$\vec{p}_1$
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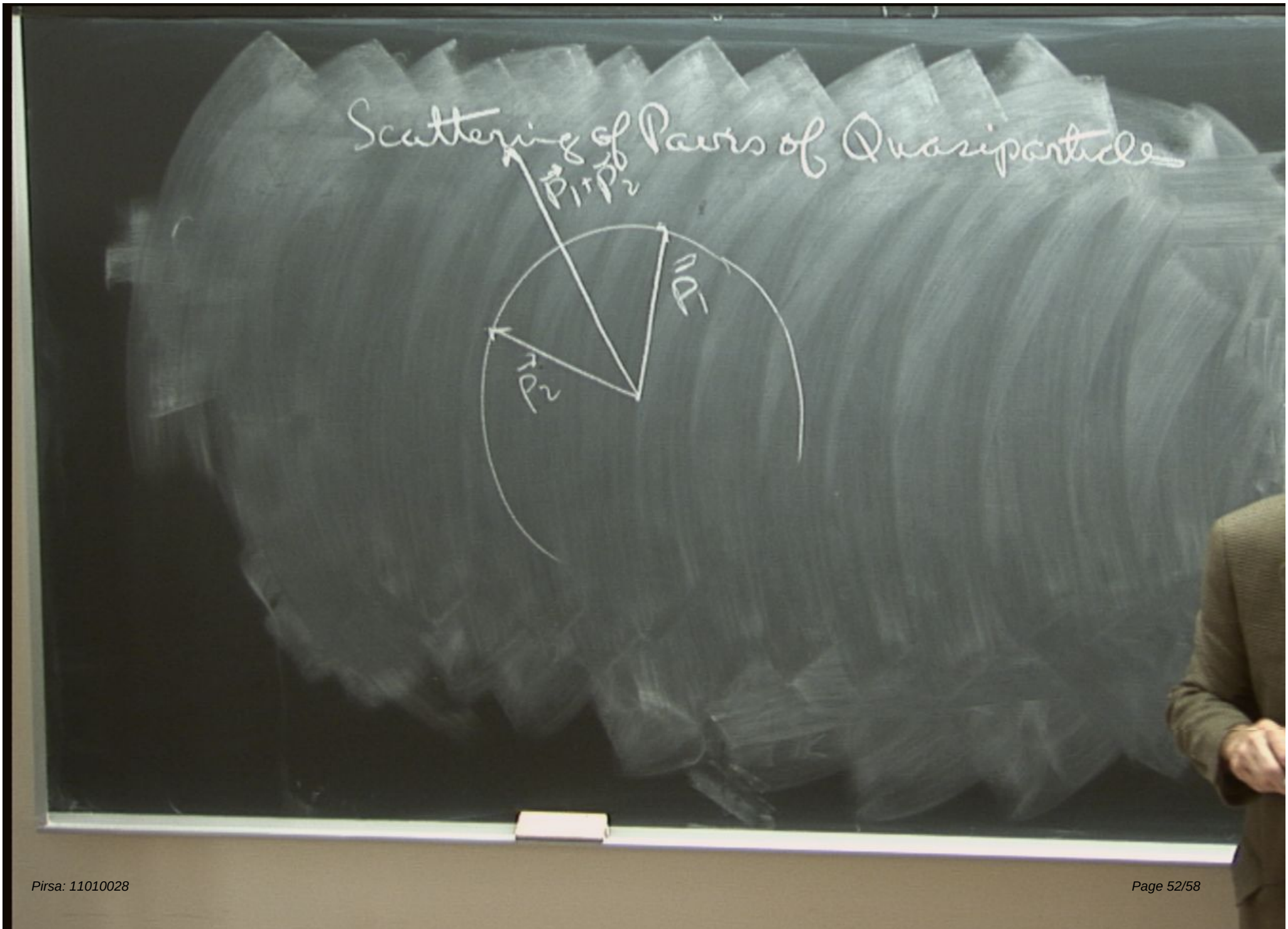
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$\vec{p}_1+\vec{p}_2$
$\vec{p}_1$
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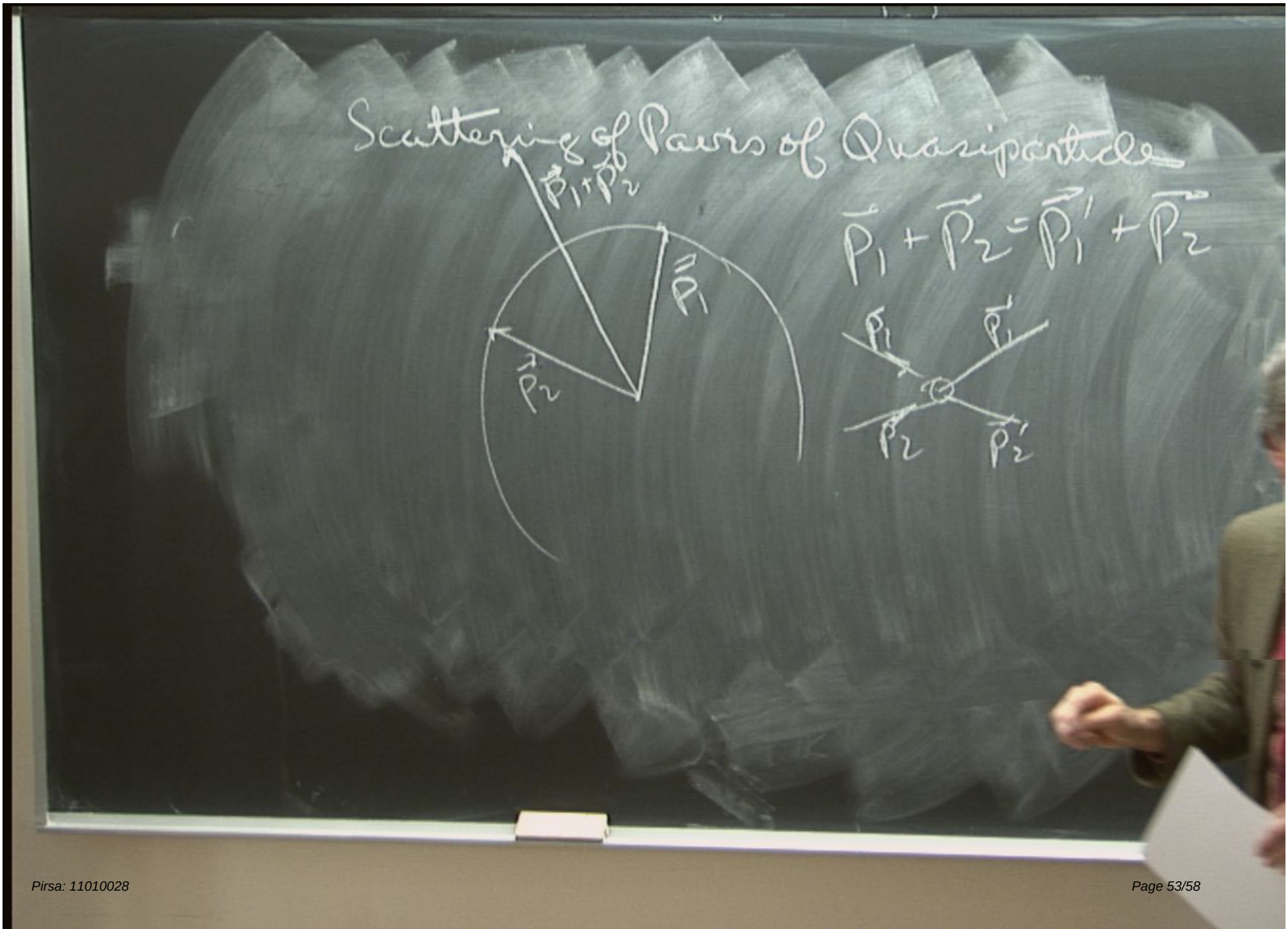
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$\vec{p}_1 + \vec{p}_2$
$\vec{p}_1$
$\vec{p}_2$
$\vec{p}_1 + \vec{p}_2 = \vec{p}_1{}' + \vec{p}_2{}'$
$\vec{p}_1$
$\vec{p}_1{}'$
$\vec{p}_2$
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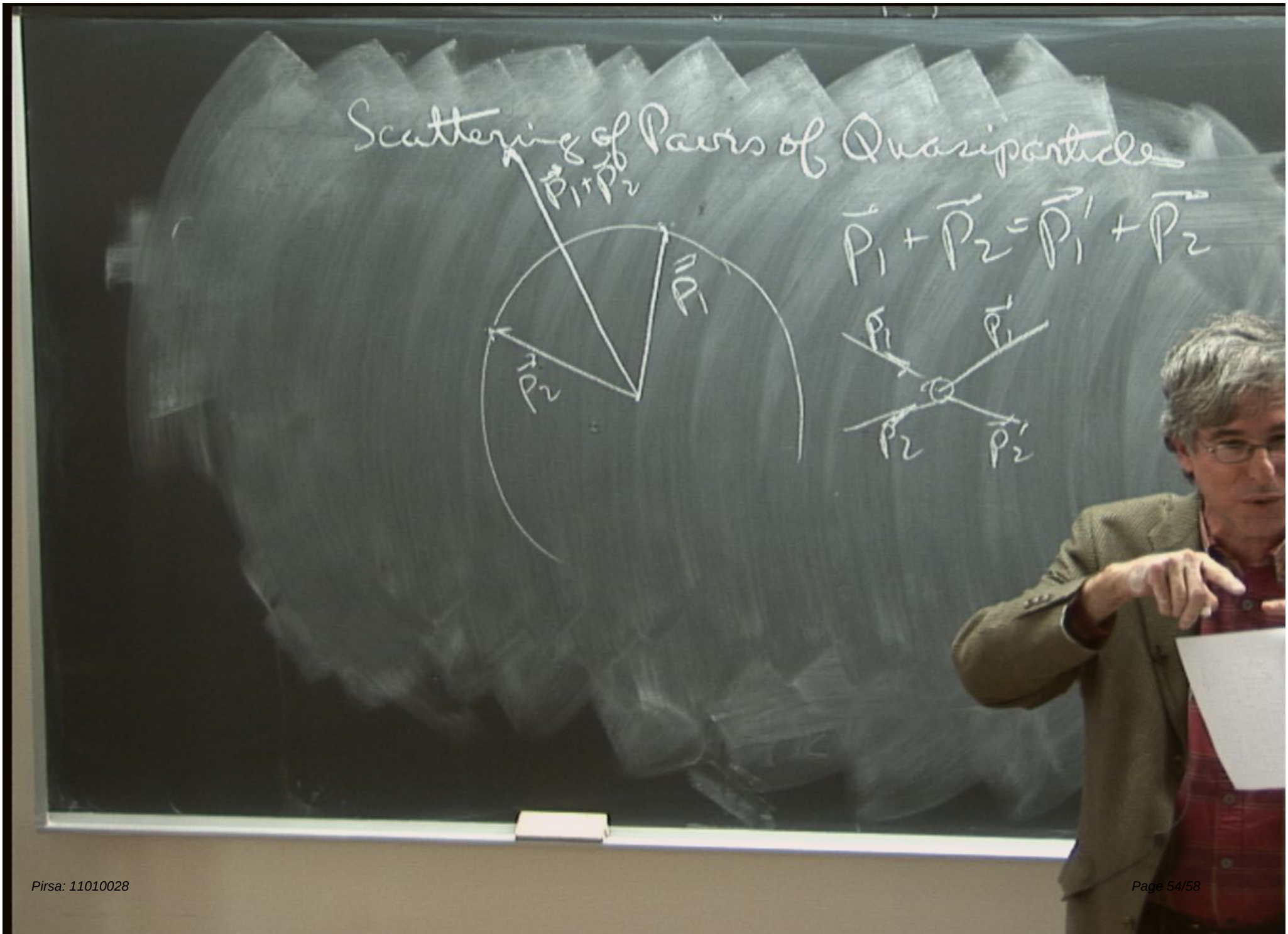
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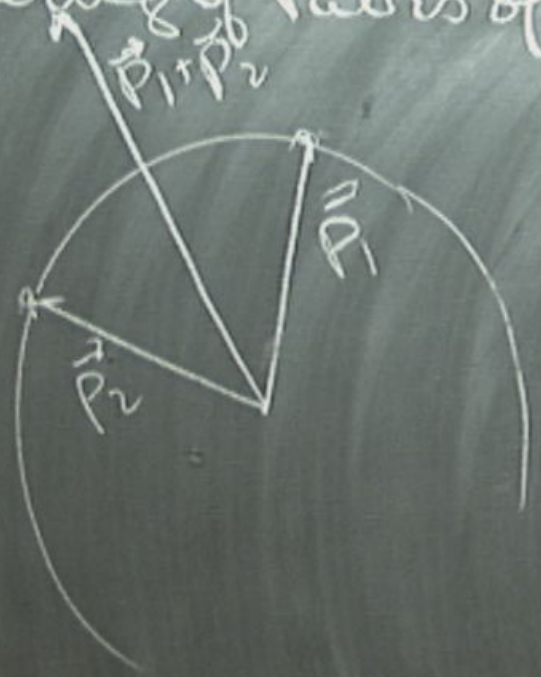

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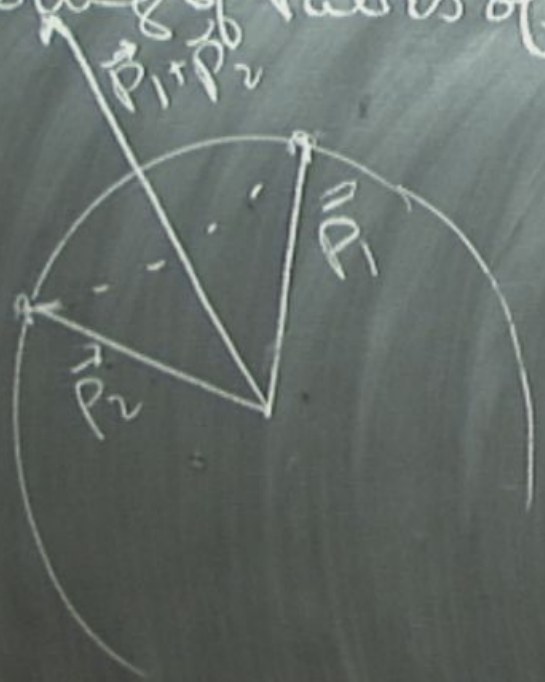

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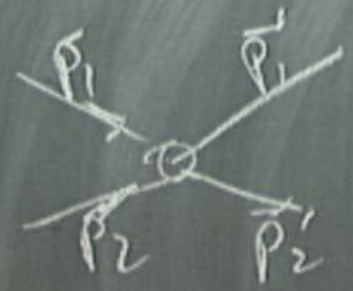
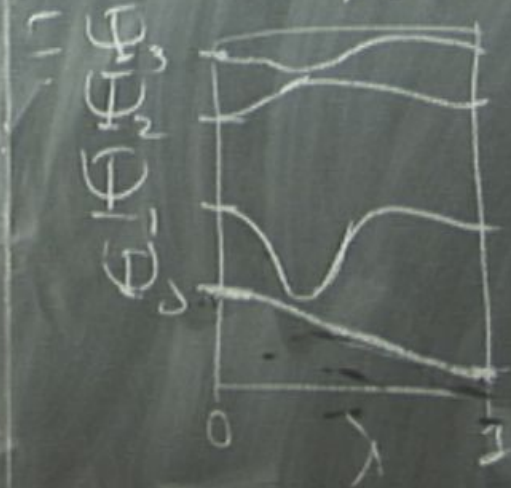


Adiabaticity

– effects of s

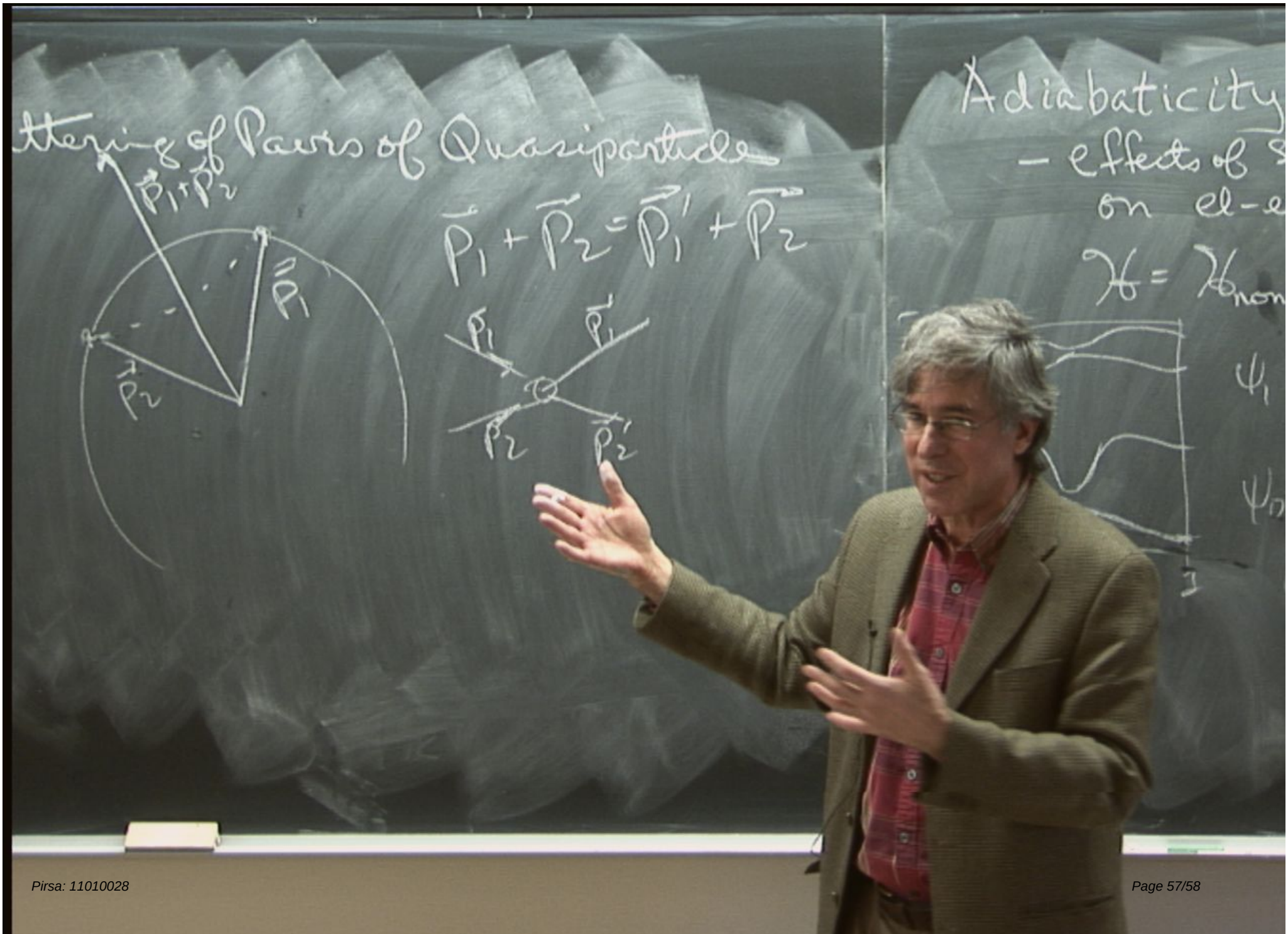
on el-e

$\mathcal{H} = \mathcal{H}_{non}$



ψ_1

ψ_0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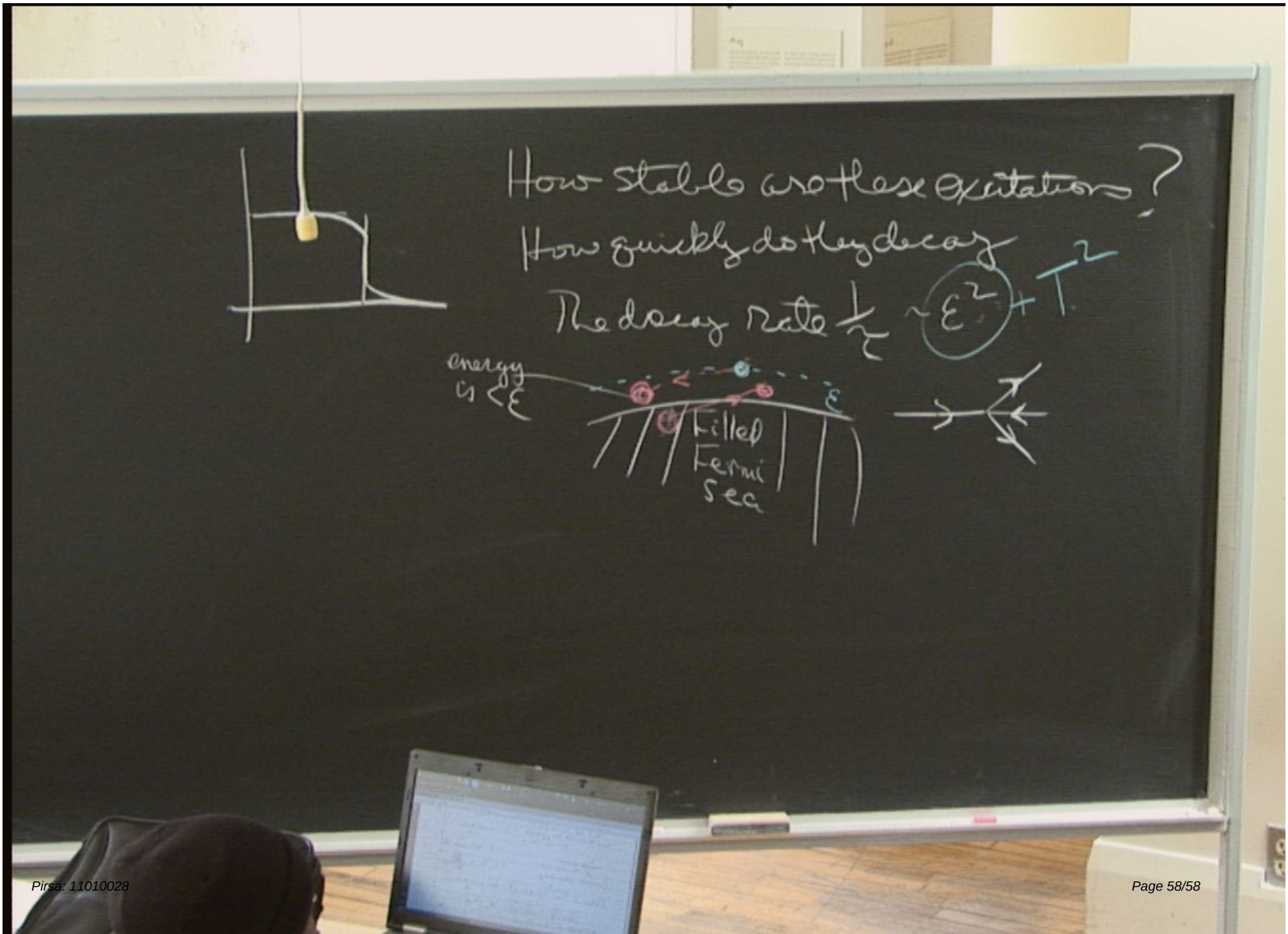
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ε
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