Title: Devaluation a natural and Hot solution to the cosmological Problem

Date: Dec 11, 2007 02:15 PM

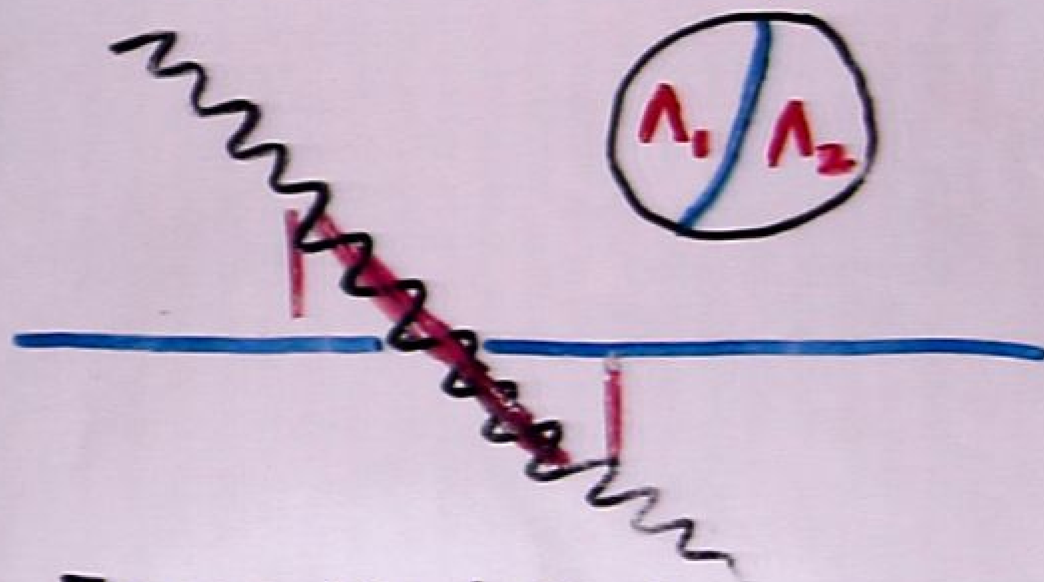
URL: http://pirsa.org/07120010

Abstract: TBA

Devaluation

A Technically Natural

Soln to the C.C. problem

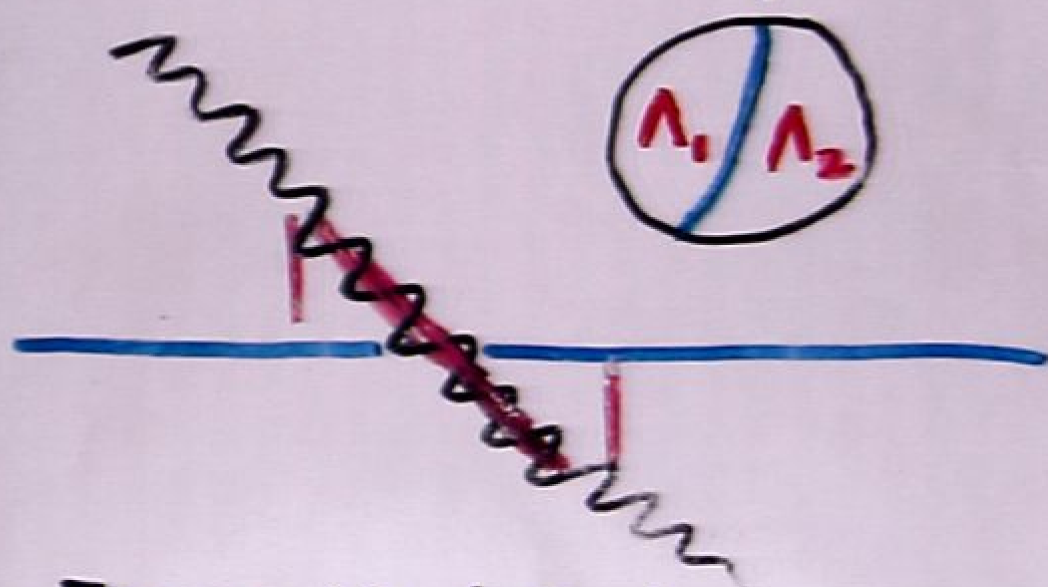


Freese, Liu, & Spolyar
Phys. Lett. B 634 119–124, 2006

Devaluation

A Technically Natural

Soln to the C.C. problem

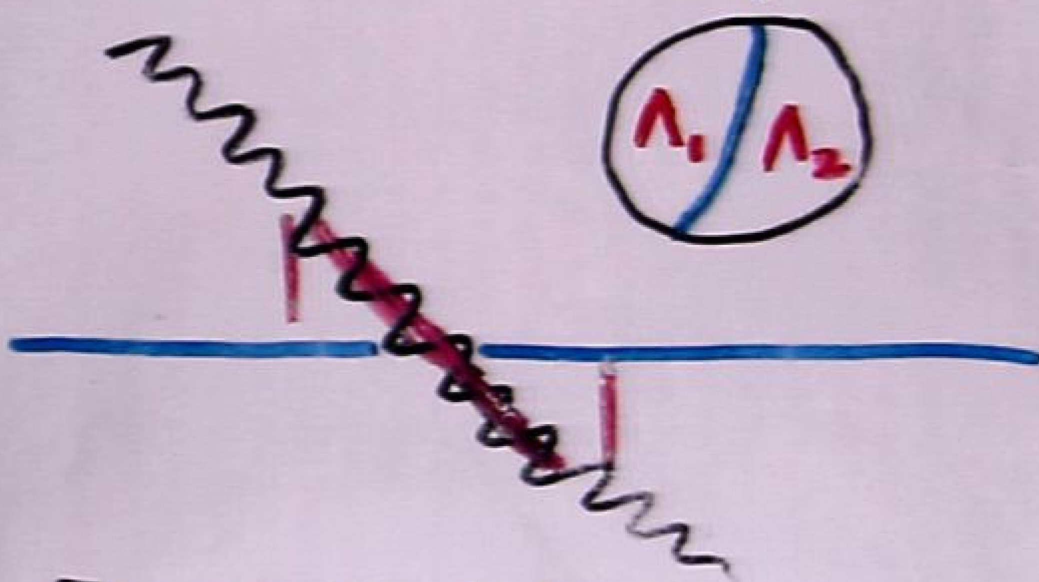


Freese, Liu, & Spolyar -
Phys. Lett. B 634 119-124, 2006

Devaluation

A Technically Natural

Soln to the C.C. problem

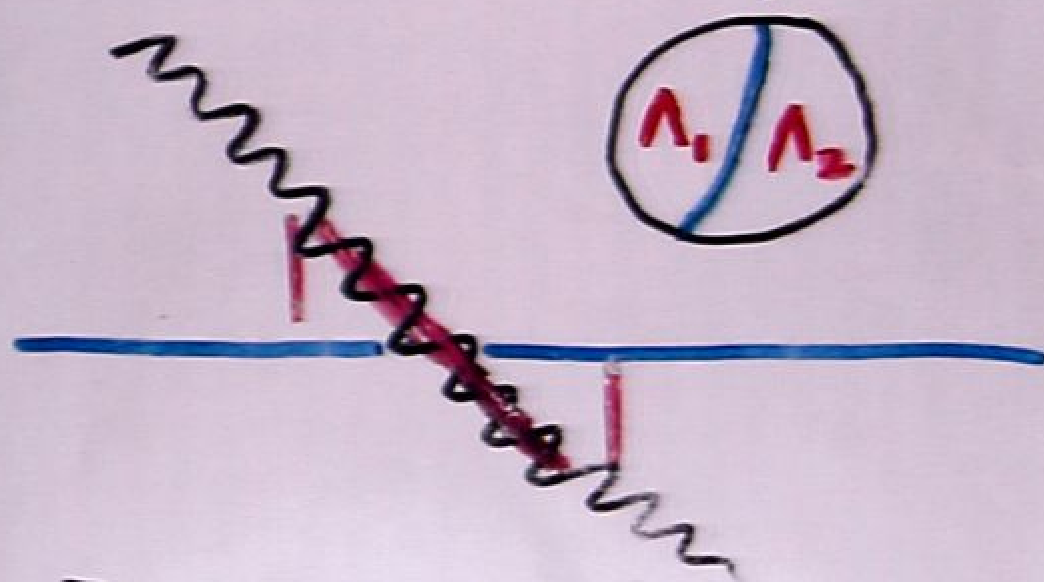


Freese, Liu, & Spolyar –
Phys. Lett. B 634 119–124, 2006

Devaluation

A Technically Natural

Soln to the C.C. problem

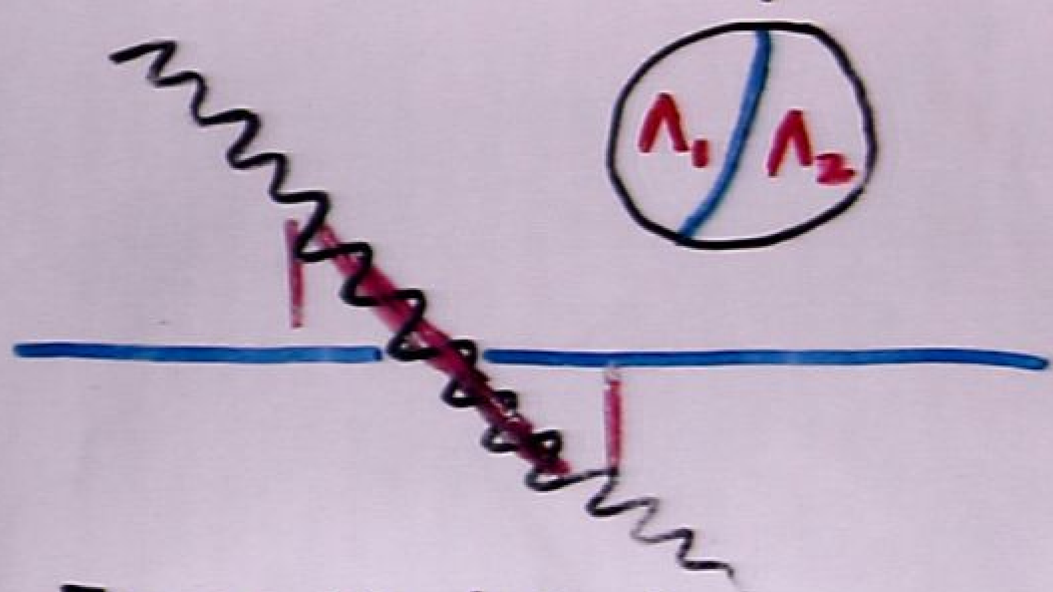


Freese, Liu, & Spolyar
Phys. Lett. B 634 119-124, 2006

Devaluation

A Technically Natural

Soln to the C.C. problem

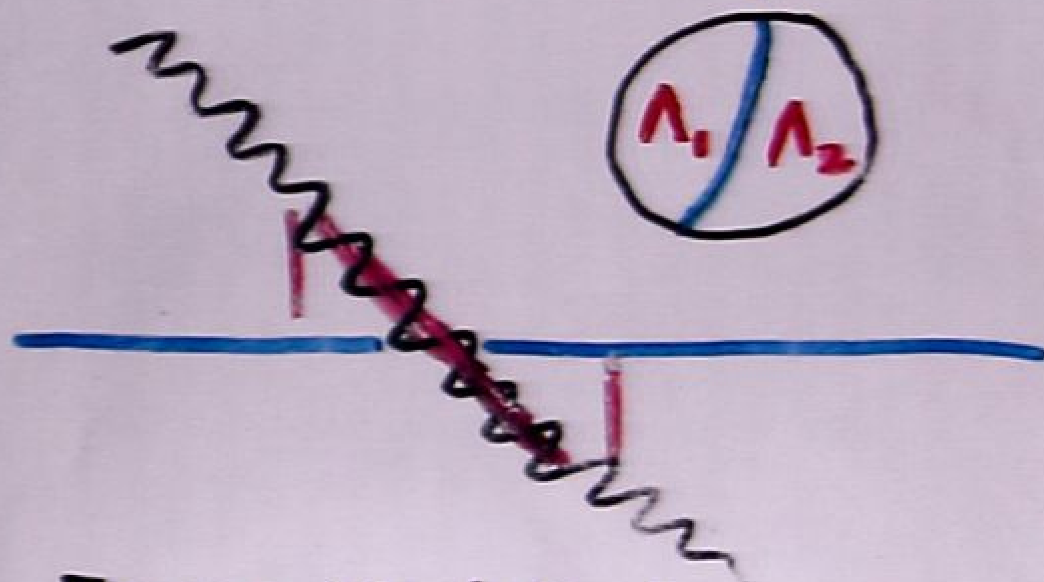


Freese, Liu, & Spolyar -
Phys. Lett. B 634 119-124, 2006

Devaluation

A Technically Natural

Soln to the C.C. problem



Freese, Liu, & Spolyar -
Phys. Lett. B 634 119-124, 2006

A Look Ahead

1) Motivation

2) Scenario

- Features Of The Model
- Domain Wall Evolution
- No-Go Postulate Into AdS

3) Future Work

A Look Ahead

1) Motivation

2) Scenario

- Features of Then Model
- Domain Wall Evolution
- No-Go Postulate Into Ads

3) Future Work

A Look Ahead

1) Motivation

2) Scenario

- Features Of Then Model
- Domain Wall Evolution
- No-Go Postulate Into Ads

3) Future Work

A Look Ahead

1) Motivation
2) Scenario
   - Features of Then Model
   - Domain Wall Evolution
   - No-Go Postulate Into AdS
3) Future Work

A Look Ahead

1) Motivation
2) Scenario
   - Features of Then Model
   - Domain Wall Evolution
   - No-Go Postulate Into Ads
3) Future Work

A Look Ahead

1) Motivation

2) Scenario

- Features of Then Model

- Domain Wall Evolution

- No-Go Postulate Into Ads

3) Future Work

A Look Ahead

1) Motivation
2) Scenario
   - Features of Then Model
   - Domain Wall Evolution
   - No-Go Postulate Into Ads
3) Future Work

A Look Ahead

1) Motivation

2) Scenario

- Features of The Model

- Domain Wall Evolution

- No-Go Postulate Into Ads

3) Future Work

A Look Ahead

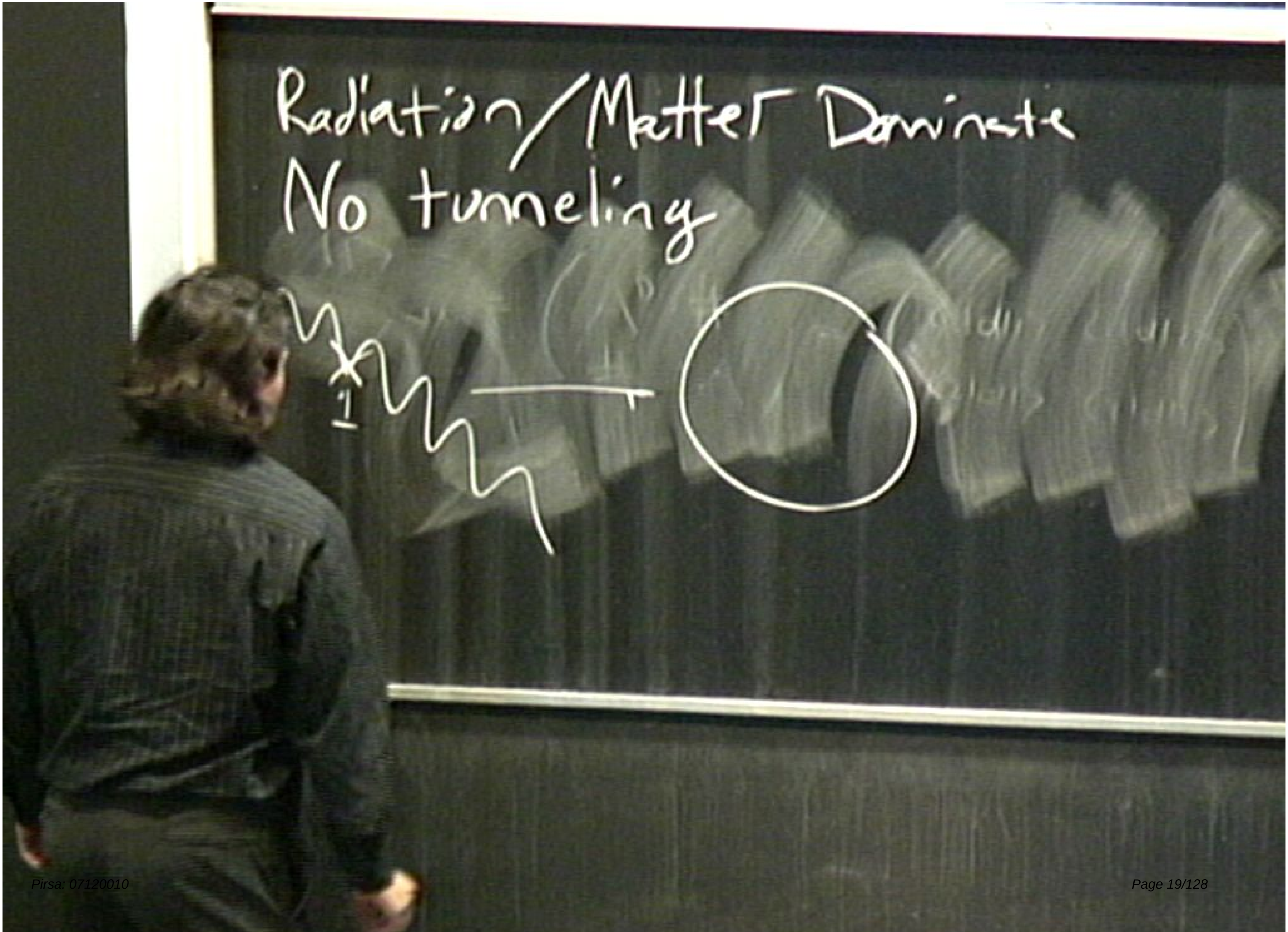
1) Motivation

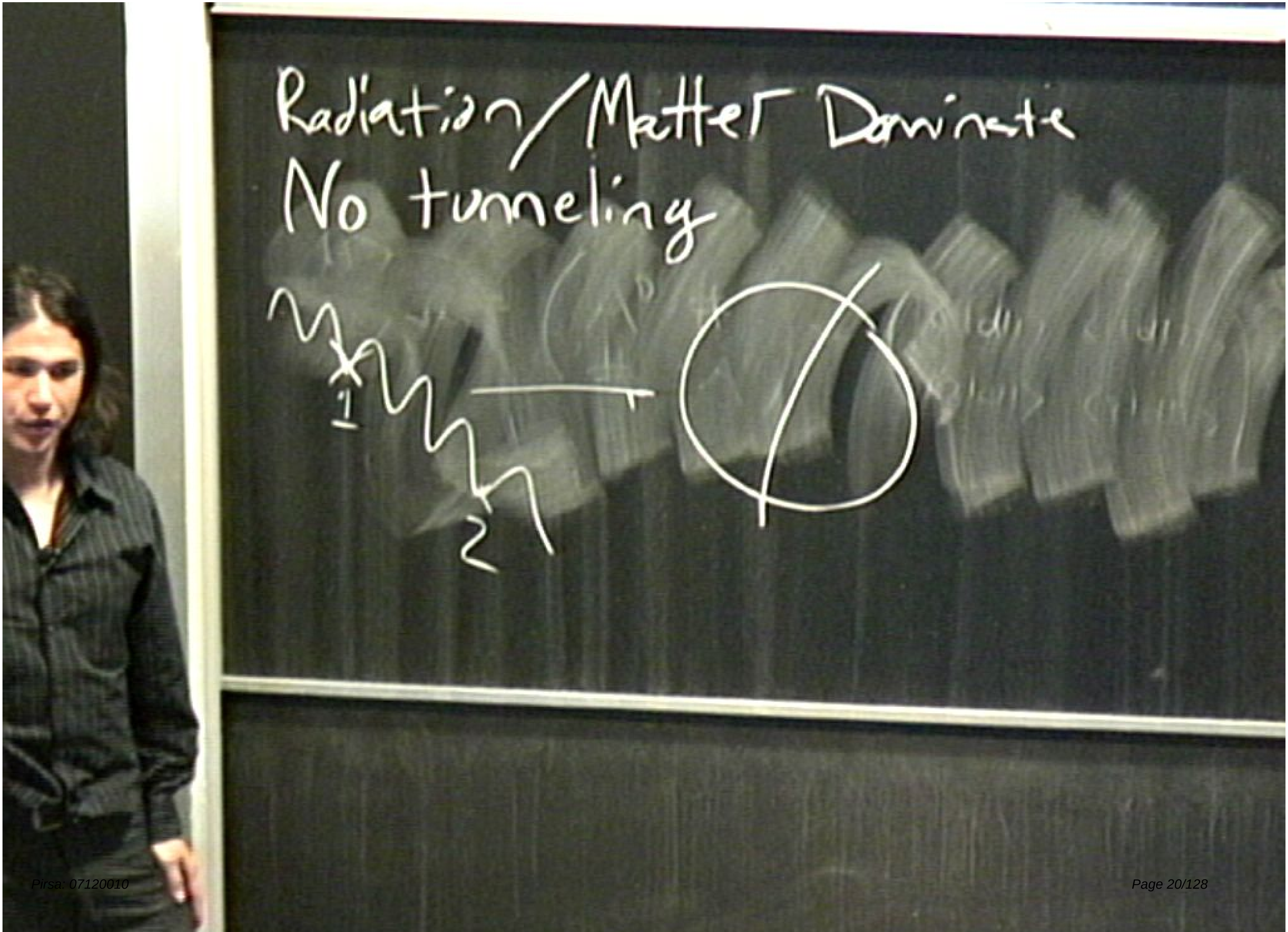
2) Scenario

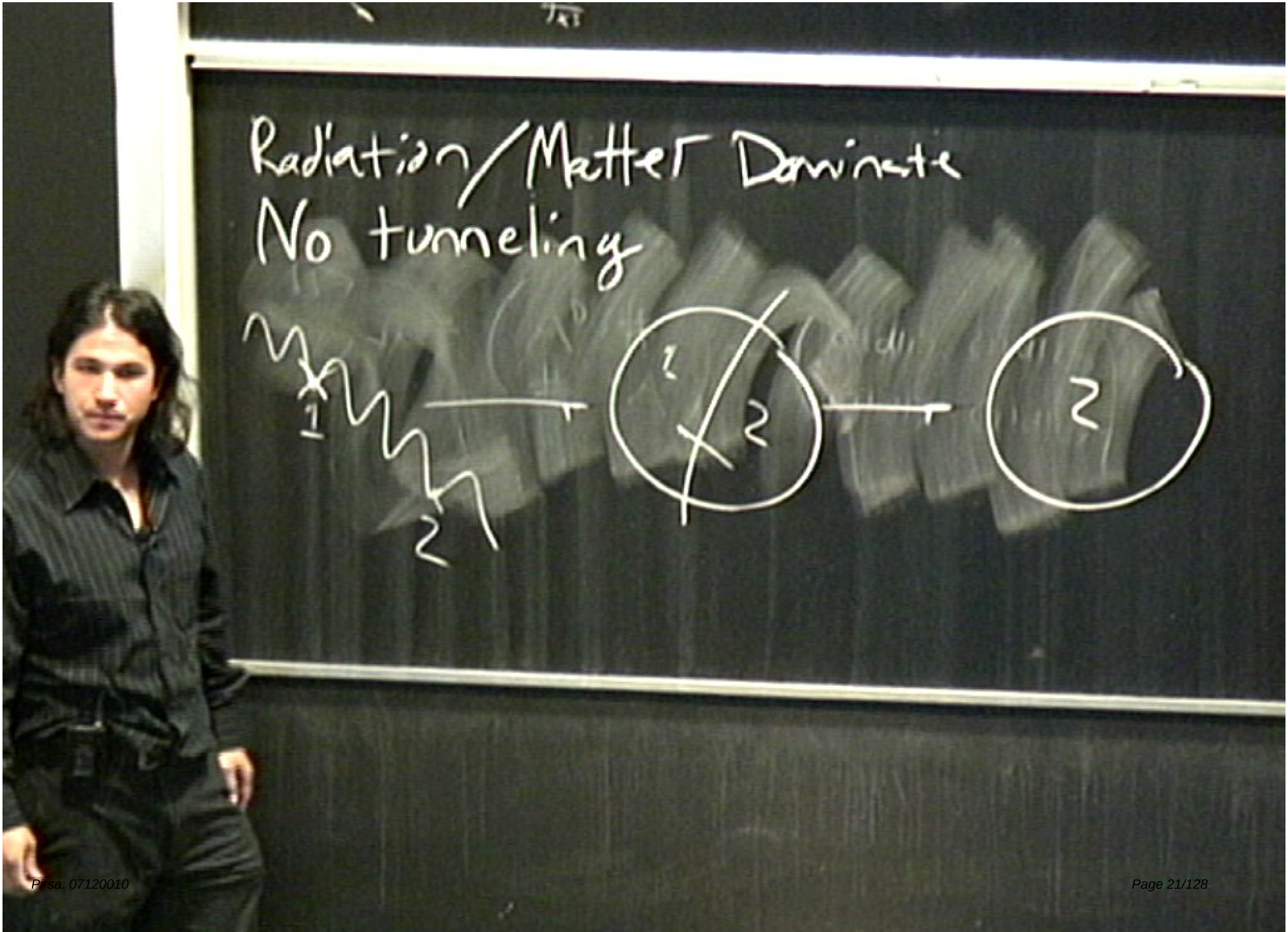
- Features of The Model
- Domain Wall Evolution
- No-Go Postulate Into AdS

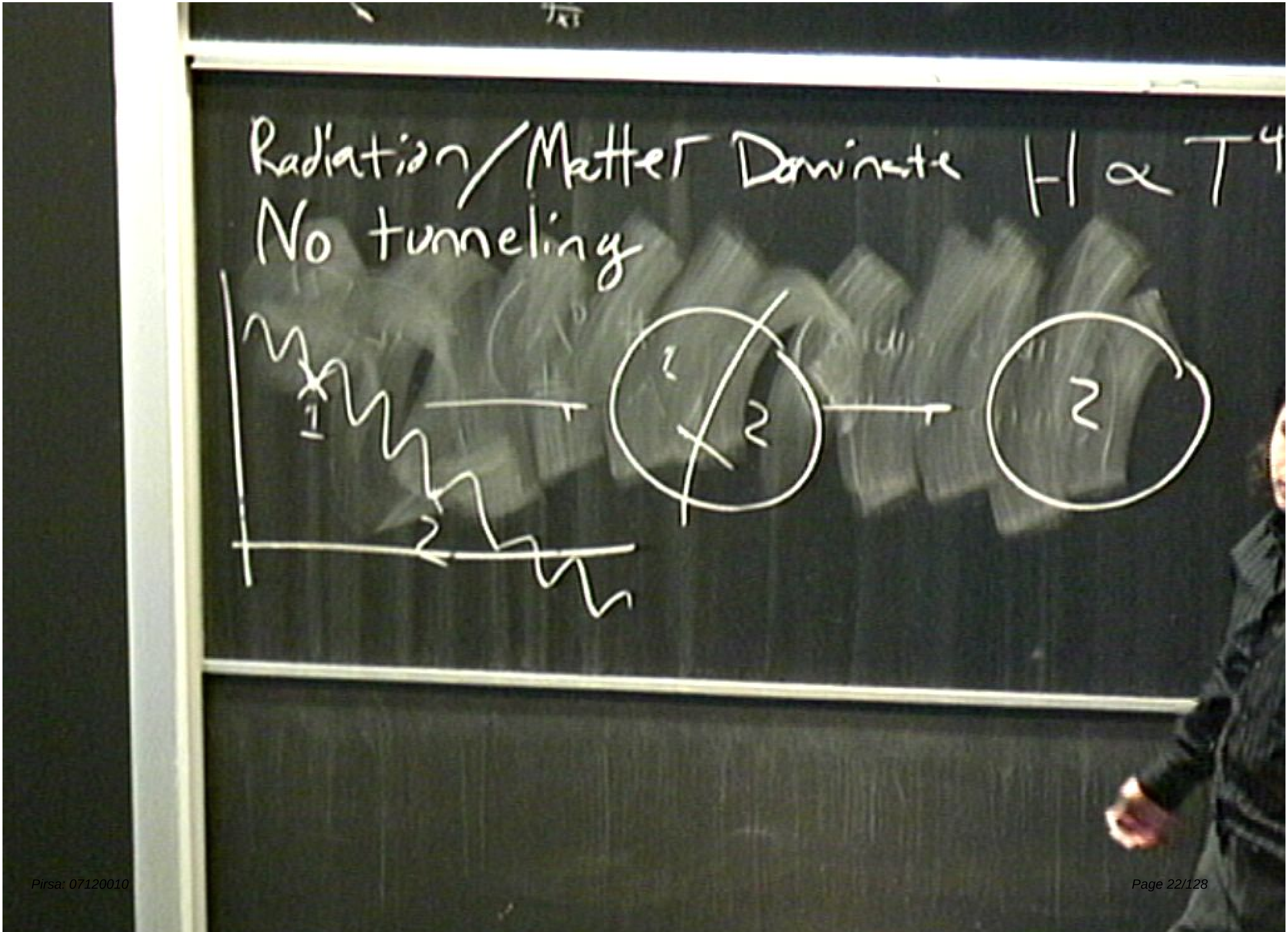
3) Future Work

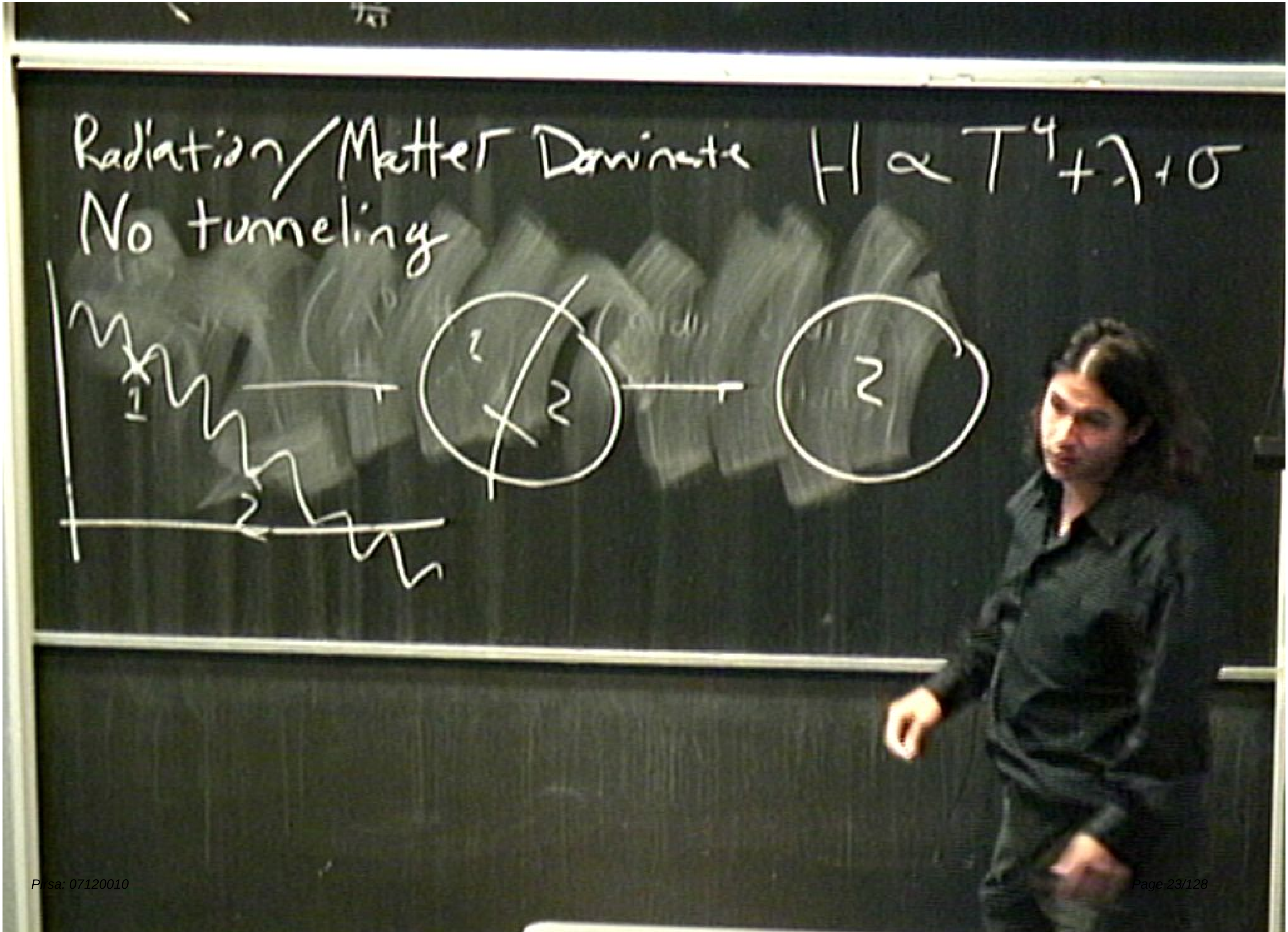

Radiation/Matter Dominate


Radiation/Matter Dominate
No tunneling
1


Radiation/Matter Dominate
No tunneling
1
2

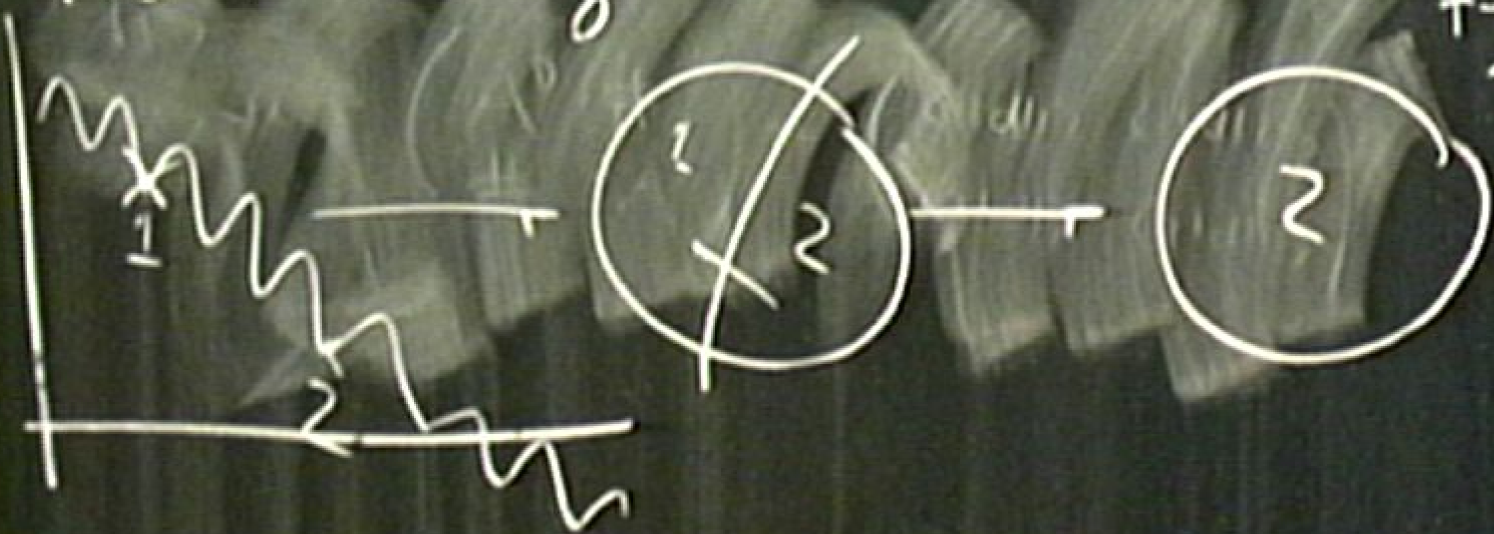

Radiation/Matter Dominate
No tunneling
1
2
1
2
2


Radiation/Matter Dominate
$H \propto T^4$
No tunneling
1
2
1
2
2


Radiation/Matter Dominate
H ∝ T⁴ + λ + σ
No tunneling
1
2
1
2
2

Radiation/Matter Dominate $H \propto T^4 + \lambda + \sigma + \rho$

No tunneling



Low Energy physics

two sources For Λ^4 Today* $\sim (10^{-3} eV)^4$

1) Zero point Energy (Electron-Field)

2) Spontaneous Symmetry Breaking

* Every phase transition.

Vacuum-Energy tensor

$$T_{\mu\nu}^{vac} = \langle \rho \rangle g_{\mu\nu}$$

Lorentz invariance

$$R_{\mu\nu} - \tfrac{1}{2} g_{\mu\nu} R - \lambda_0 g_{\mu\nu} = 4\pi G \left(T_{\mu\nu} + T_{\mu\nu}^{vac}\right)$$

$$\boxed{\lambda_{eff} = \lambda_0 + T_{\mu\nu}^{vac}}$$

Low Energy physics

two sources for

Λ^4 Today* $\sim (10^{-3}\, eV)^4$

1) zero point Energy (Electron-Field)

2) Spontaneous Symmetry Breaking

* Every phase transition.

Vacuum-Energy tensor

$$T_{\mu\nu}^{vac} = \langle \rho \rangle g_{\mu\nu}$$

Lorentz invariance

$$R_{\mu\nu} - \tfrac{1}{2} g_{\mu\nu} R - \lambda_B g_{\mu\nu} = 4\pi G \left(T_{\mu\nu} + T_{\mu\nu}^{vac} \right)$$

$$\boxed{\lambda_{eff} = \lambda_B + T_{\mu\nu}^{vac}}$$

Low Energy physics

two sources For

$\Lambda^4 \sim (10^{-3} eV)^4$ Today*

1) zero point Energy (Electron-Field)

2) Spontaneous Symmetry Breaking

* Energy phase transition.

Vacuum- Energy tensor

$$T_{\mu\nu}^{vac} = \langle \rho \rangle g_{\mu\nu}$$

Lorentz invariance

$$R_{\mu\nu} - \tfrac{1}{2} g_{\mu\nu} R - \lambda_B g_{\mu\nu} = 4\pi G \left(T_{\mu\nu} + T_{\mu\nu}^{vac} \right)$$

$$\boxed{\lambda_{eff} = \lambda_B + T_{\mu\nu}^{vac}}$$

Low Energy physics

two sources for

Today*

$$\Lambda^4 \sim (10^{-3}\,eV)^4$$

1) zero point Energy (Electron-Field)

2) Spontaneous Symmetry Breaking

* Every phase transition.

Vacuum Energy tensor

$$T_{\mu\nu}^{Vac} = \langle \rho \rangle \, g_{\mu\nu}$$

Lorentz invariance

$$R_{\mu\nu} - \tfrac{1}{2} g_{\mu\nu} R - \lambda_B g_{\mu\nu} = 4\pi G \left(T_{\mu\nu} + T_{\mu\nu}^{Vac} \right)$$

$$\boxed{\lambda_{eff} = \lambda_B + T_{\mu\nu}^{Vac}}$$

Low Energy physics

two sources For Λ^4

Today* $\sim (10^{-3} eV)^4$

1) Zero point Energy (Electron-Field)

2) Spontaneous Symmetry Breaking

* Every phase transition.

Vacuum Energy tensor

$$T_{\mu\nu}^{vac} = \langle \rho \rangle g_{\mu\nu}$$

Lorentz invariance

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R - \lambda_B g_{\mu\nu} = 4\pi G \left(T_{\mu\nu} + T_{\mu\nu}^{vac}\right)$$

$$\boxed{\lambda_{eff} = \lambda_B + T_{\mu\nu}^{vac}}$$

Examples

1) Zero point Energy (Electron-Field)

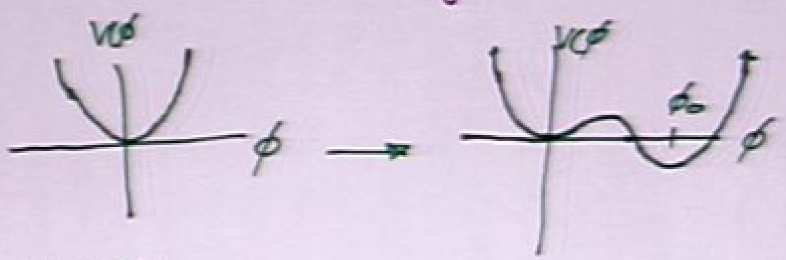
$$\langle \rho \rangle = \int_0^{\Lambda} \frac{4\pi k^2 \, dk}{(2\pi)^3} \sqrt{k^2+m^2} \simeq \Lambda^4$$

$\Lambda_{mpl}, \Lambda_{EW}$, etc.

2) S.S.B i.e. E.W theory

Higgs Mechanism $\langle \phi_0 \rangle \neq 0$

$V(\phi) = V_0 - \mu^2 |\phi|^2 + g|\phi|^4$ Suppose At Λ_{mpl} set $V_0 = 0$



$$V(\phi) = \langle \rho \rangle = V_0 - \frac{\mu^2}{4g} \Rightarrow \frac{-\mu^2}{4g} \text{ Big!}$$

Examples

1) Zero point Energy (Electron-Field)

$$\langle \rho \rangle = \int_0^{\Lambda} \frac{4\pi k^2\, dk}{(2\pi)^3} \sqrt{k^2+m^2} \simeq \Lambda^4$$

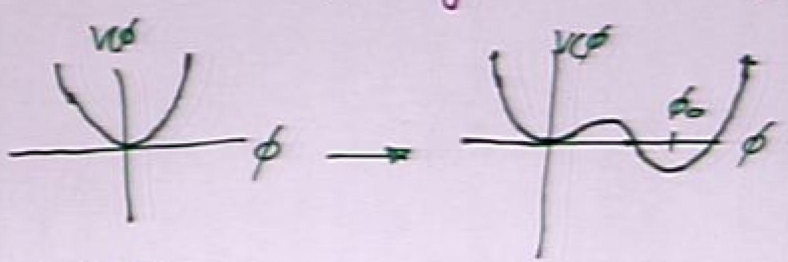
$\Lambda_{mpe}, \Lambda_{EW}$, etc.

2) S.S.B i.e. E.W theory

Higgs Mechanism $\langle \phi_0 \rangle \neq 0$

$V(\phi) = V_0 - \mu^2|\phi|^2 + g|\phi|^4$

Suppose At Λ_{mpe} set $V_0 = 0$



$V(\phi) = \langle \rho \rangle = V_0 - \frac{\mu^2}{4g} \Rightarrow \frac{-\mu^2}{4g}$ Big!

Possible Solution:

Compensating fields whose vacuum energy dynamically adjusts to cancel the large value of c.c. which arises from particle physics.

Our approach:

a dynamical solution involving post-inflation evolution of domain wall network

Possible Solution:

Compensating fields whose vacuum energy dynamically adjusts to cancel the large value of c.c. which arises from particle physics.

Our approach:

a dynamical solution involving post-inflation evolution of domain wall network

Possible Solution:

Compensating fields whose vacuum energy dynamically adjusts to cancel the large value of c.c. which arises from particle physics.

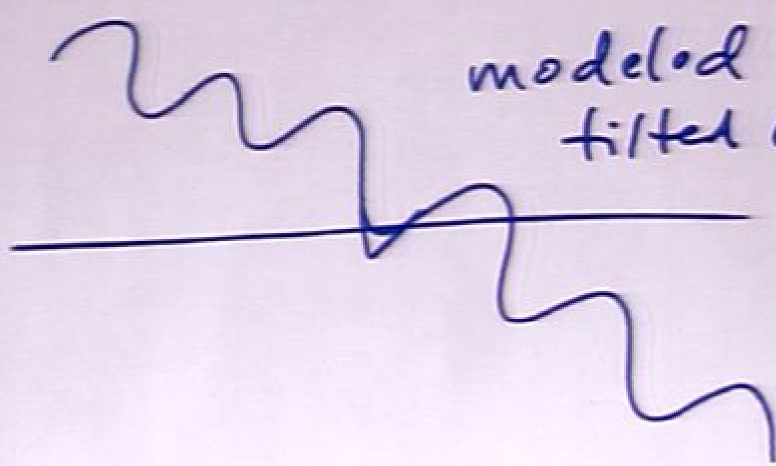
Our approach:

a dynamical solution involving post-inflation evolution of domain wall network

Required: ~~for~~ devaluation:

sufficiently rich potential with nearly degenerate minima spanning a range of both negative and positive values of vacuum energy

e.g. in stringy landscape?

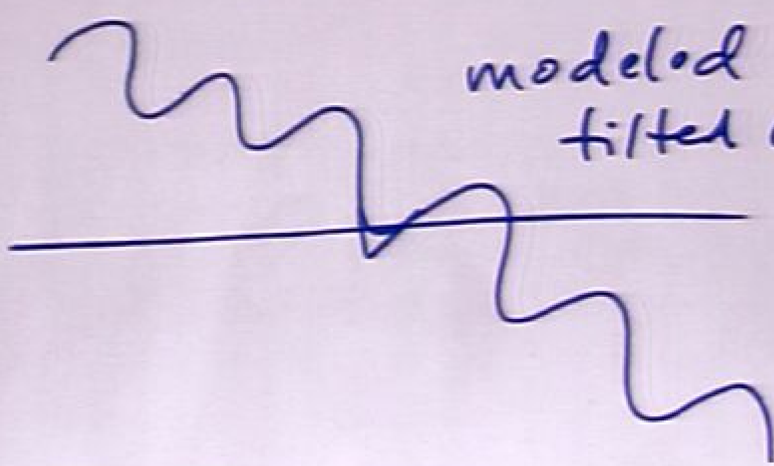


modeled on tilted cosine

Required: ~~for~~ devaluation:

sufficiently rich potential with nearly degenerate minima spanning a range of both negative and positive values of vacuum energy

e.g. in stringy landscape?

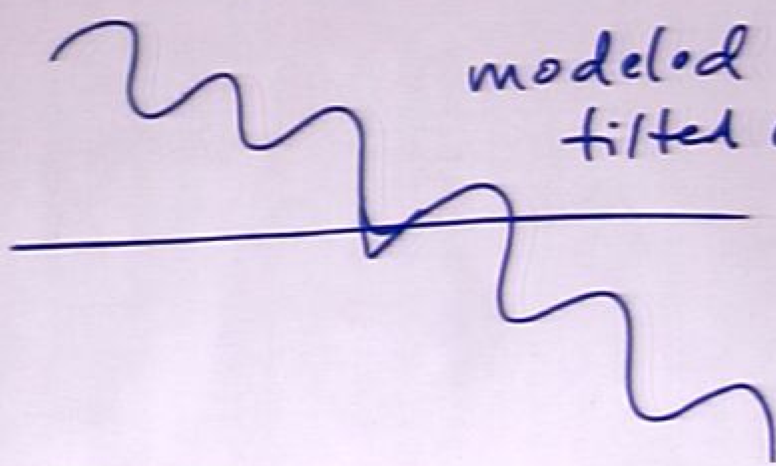


modeled on tilted cosine

Required: ~~for~~ devaluation:

sufficiently rich potential with nearly degenerate minima spanning a range of both negative and positive values of vacuum energy

e.g. in stringy landscape?

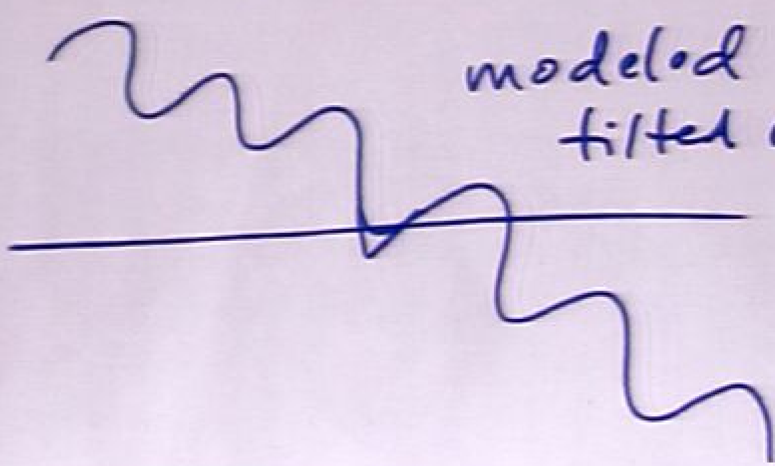


modeled on tilted cosine

Required: ~~for~~ devaluation:

sufficiently rich potential with nearly degenerate minima spanning a range of both negative and positive values of vacuum energy

e.g. in stringy landscape?

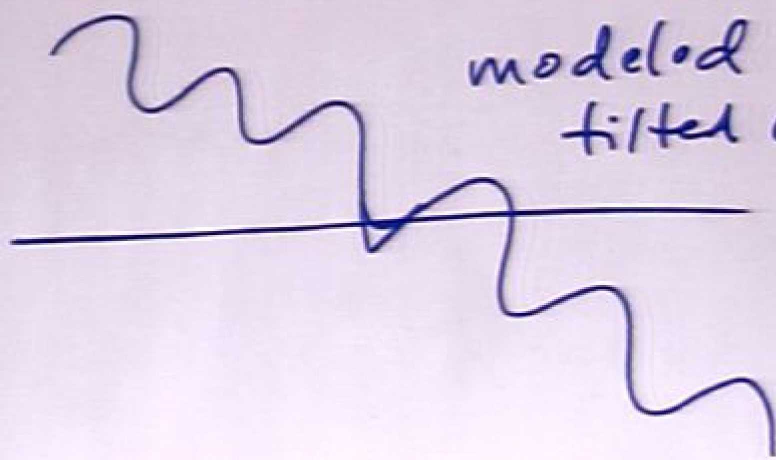


modeled on tilted cosine

Required: ~~for~~ devaluation:

sufficiently rich potential with nearly degenerate minima spanning a range of both negative and positive values of vacuum energy

e.g. in stringy landscape?



modeled on tilted cosine

Historical Notes:

1) Abbott's tunneling Model

2) Brown + TeitelBoin

3) Bousso + polchinski

4) Wilczek + March-Russell

All compensating fields which **Tunnel**

which have Natural parameters

But 1) No Reheating

2) Too Slow

3) Anthropic

Historical Notes:

1) Abbott's tunneling Model

2) Brown + TeitelBoin

3) Bousso + polchinski

4) Wilczek + March-Russell

All compensating fields which Tunnel

which have Natural parametrs

But 1) No Reheating

2) Too Slow

3) Anthropic

Devaluation

Consists of two (or more) Fields

$$V(\Psi, \Phi) = V_{inf}(\Psi) + V_{dev}(\Phi)$$

Two Stages Due to two fields

1) inflation (Rolling/tunneling)
   * End at pos. vacuum
   * reheating leads to Rad. - Domination

2) Devaluton - Compensating field.

Modeled on a tilted cosine

Devaluation

Consists of two (or more) Fields

$V(\psi, \Phi) = V_{inf}(\psi) + V_{dev}(\Phi)$

Two Stages Due to two fields

1) inflation (Rolling/tunneling)
   - End at pos. vacuum
   - reheating leads to Rad.-Domination

2) Devaluton - Compensating field.

Modeled on a tilted cosine

Devaluation

Consists of two (or more) Fields

$$V(\psi, \Phi) = V_{inf}(\psi) + V_{dev}(\Phi)$$

Two Stages Due to two fields

1) inflation (Rolling/tunneling)
   * End at pos. vacuum
   * reheating leads to Rad. - Domination

2) Devaluton - Compensating field.

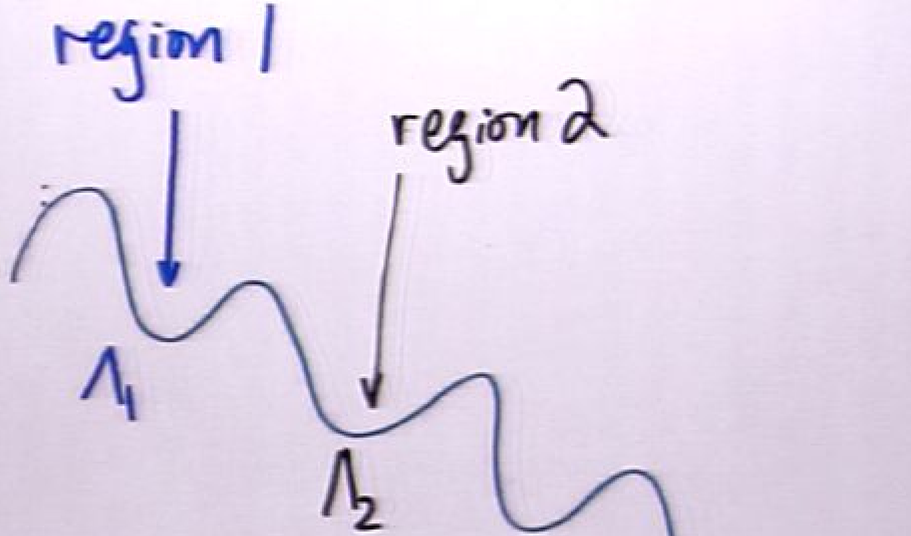
Modeled on a tilted cosine

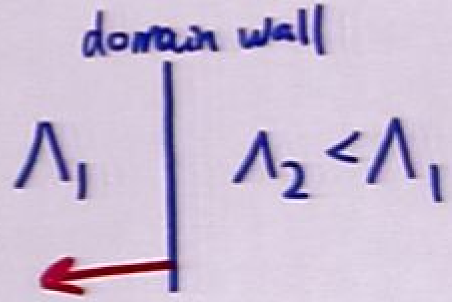
cont.

- We thermally Explore diffent parts of the potential
- Universe cools, different regions settle into difft parts of the potential. A domain Wall Network Forms
- Domain Wall Network drives the Universe toward Smaller & Smaller C.C.

But

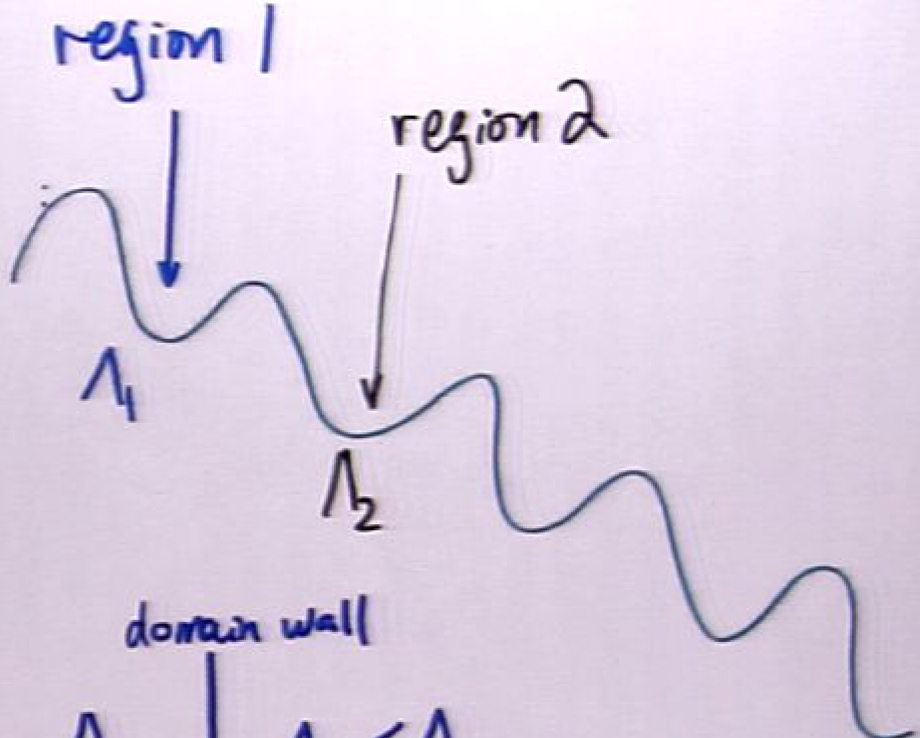
Domain wall feels pressure, moves into region of higher energy

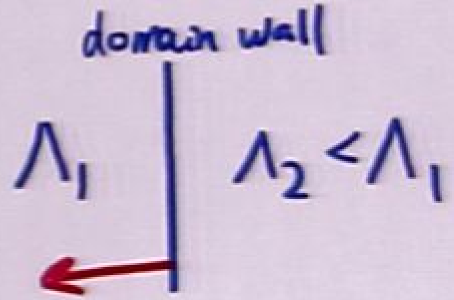




Lower energy region grows (wins)

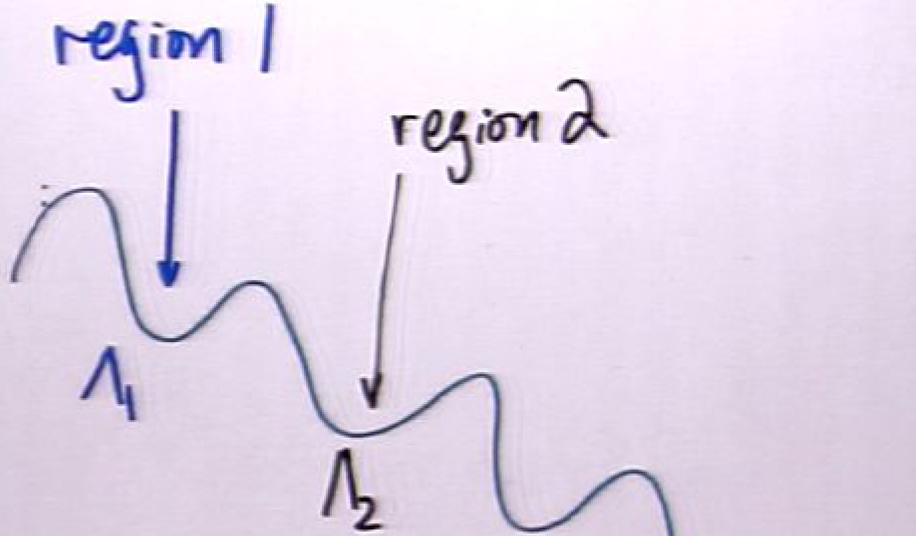
Domain wall separating 2 regions with different vacuum energies feels pressure, moves into region of higher energy. Domain walls sweep away regions of higher energy ⇒ lower energy

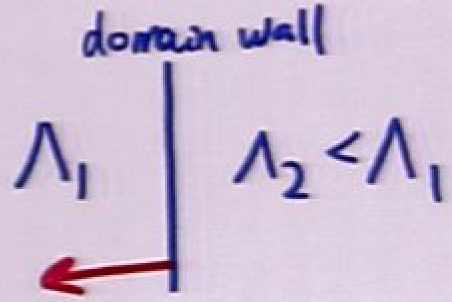




$\boxed{\text{Lower energy region grows (wins)}}$

Domain wall separating 2 regions with different vacuum energies feels pressure, moves into region of higher energy. Domain walls sweep away regions of higher energy ⇒ lower energy





Lower energy region grows (wins)

Domain wall separating 2 regions with different vacuum energies feels pressure, moves into region of higher energy. Domain walls sweep away regions of higher energy $\Rightarrow$ lower energy

- There exists a cut off s.t. the domain wall can't drive the universe below a small c.c. (not into AdS)
    - Roughly similar to Coleman-De Luccia

- There exists a cut off s.t. the domain wall can't drive the universe below a small c.c. (not into AdS)
  - Roughly similar to Coleman-De Luccia

- There exists a cut off s.t. the domain wall can't drive the Universe below a small c.c. (not into AdS)
  - Roughly similar to Coleman-De Luccia

- There exists a cut off s.t. the domain Wall can't drive the Universe Below a Small c.c. (not into AdS)
    - Roughly Similar to Coleman-De Luccia

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{devl}(\phi)$$

<u>inflaton:</u> Rolling or tunneling,
any energy scale as long as
reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant,
as long as value of potential
at end of inflation $\gtrsim 10\,\text{MeV}$

Devaluation removes this
remaining vacuum energy

0010

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{devl}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\gtrsim 10\,\text{MeV}$

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{devl}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\geq 10\,\mathrm{MeV}$

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{dev}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\geq 10\,\text{MeV}$

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{devl}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\gtrsim 10\,\text{MeV}$

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{devl}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\geq 10\,MeV$

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{devl}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\gtrsim$ 10 MeV

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{devl}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\gtrsim 10\,\text{MeV}$

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{devl}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\gtrsim 10$ MeV

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{devl}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\gtrsim 10\,\text{MeV}$

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{dev}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\geq 10\,\mathrm{MeV}$

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi, \phi) = V_{inf}(\psi) + V_{dev}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\gtrsim 10\,\mathrm{MeV}$

Devaluation removes this remaining vacuum energy

Concrete example:

$$V(\psi,\phi) = V_{inf}(\psi) + V_{dev}(\phi)$$

inflaton: Rolling or tunneling, any energy scale as long as reheat above nucleosynthesis

Requirements for inflaton:

(i) sufficient inflation

(ii) + reheating

Details are irrelevant, as long as value of potential at end of inflation $\geq 10\,\mathrm{MeV}$

Devaluation removes this remaining vacuum energy

Chain Inflation:

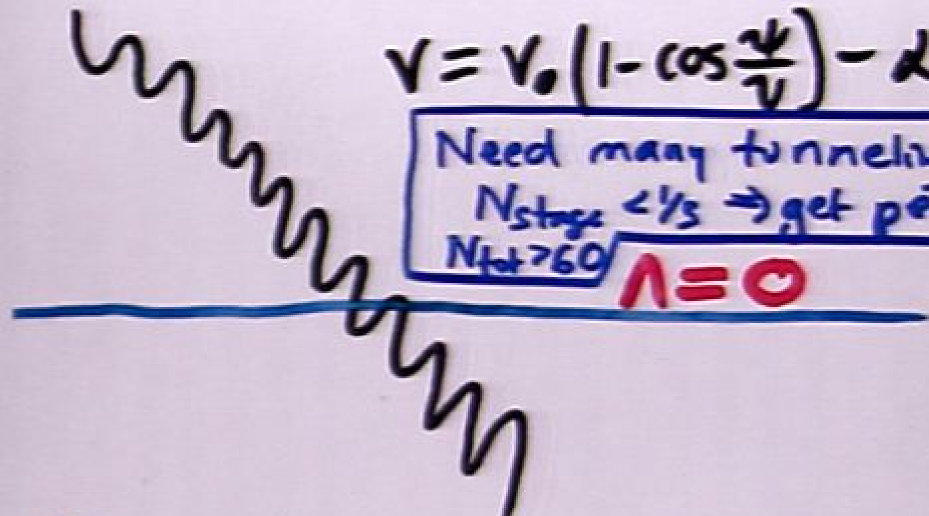
1) Freese + Spolyar JCAP 0507 (2005)
2) Freese, Liu, Spolyar PRD 72 (2005)

A Natural candidate For inflaton Field

3) Freese, Liu, Spolyar hep-th/0612056

$$V = V_0\left(1 - \cos\frac{\psi}{v}\right) - \lambda\psi$$

Need many tunneling events
$N_{stage} < 1/3 \rightarrow$ get percolation
$N_{tot} > 60$



1) Due to the tilt, any uncontrolled Vac. energy can Be absorbed By ψ

* Of course there must Be an arbitrary cut off Below zero, But unimportant

2) Stop at Last stage

- Coleman-de Luccia
  Gravity Notices
  Zero
- Affleck-de Luccia
  Thermal Bath
  can dramatically suppress tunneling

Precisely the necessary initial conditions.

n.b. Any further corrections are absorbed by shifting the devaluton.

Devaluation Field

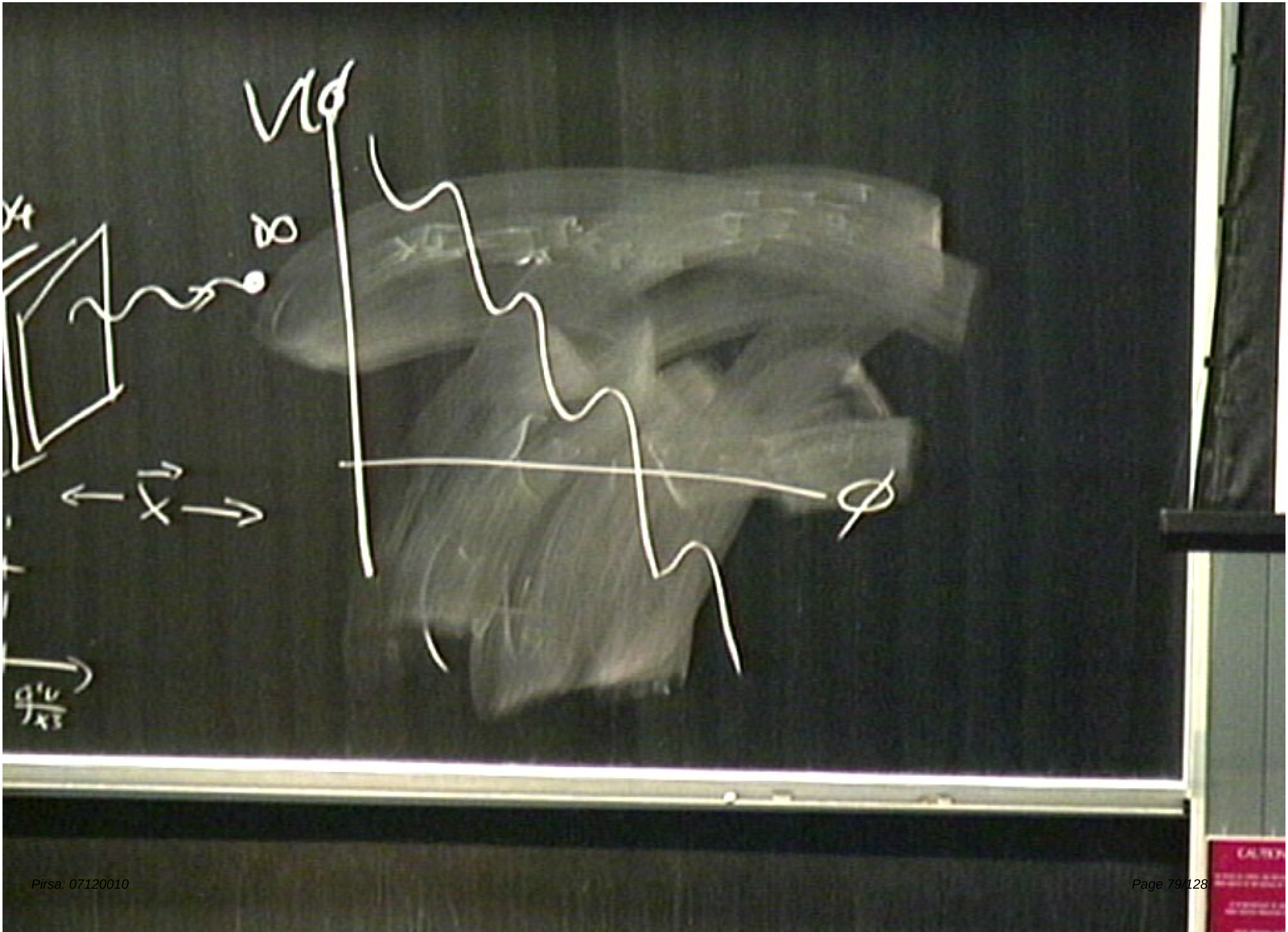
After inflation,
universe is radiation-dominated
proceeds through ordinary evolution
including nucleosynthesis

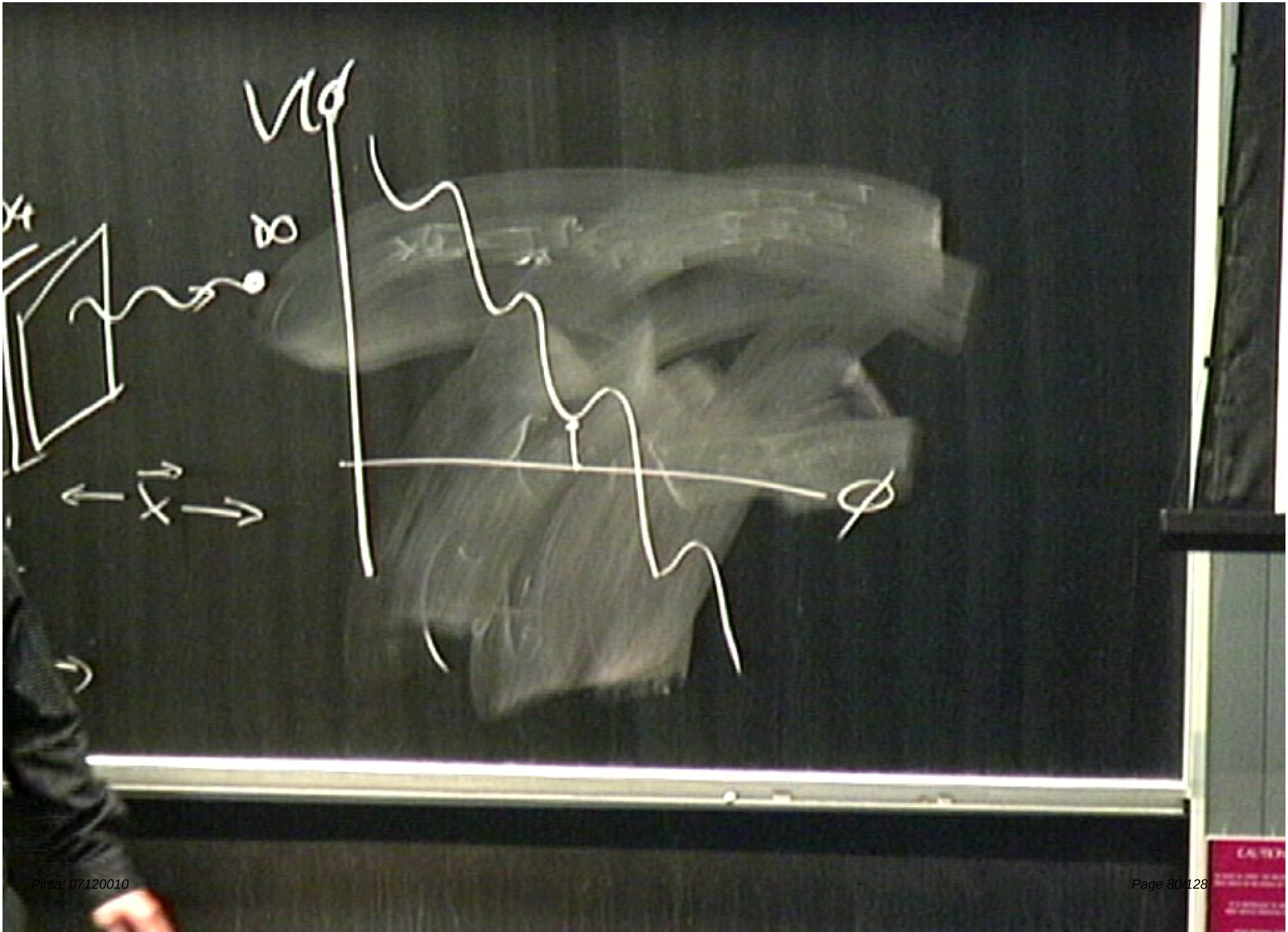
With V_{inf} in positive minimum
≥ 10 MeV,
it is now role of devaluton
to further drive vacuum
energy to zero. We take

$$V_{dev}(\phi) = V_0\left[1-\cos\frac{N\phi}{v}\right] - \eta\cos\left[\frac{\phi}{v}+\gamma\right]$$

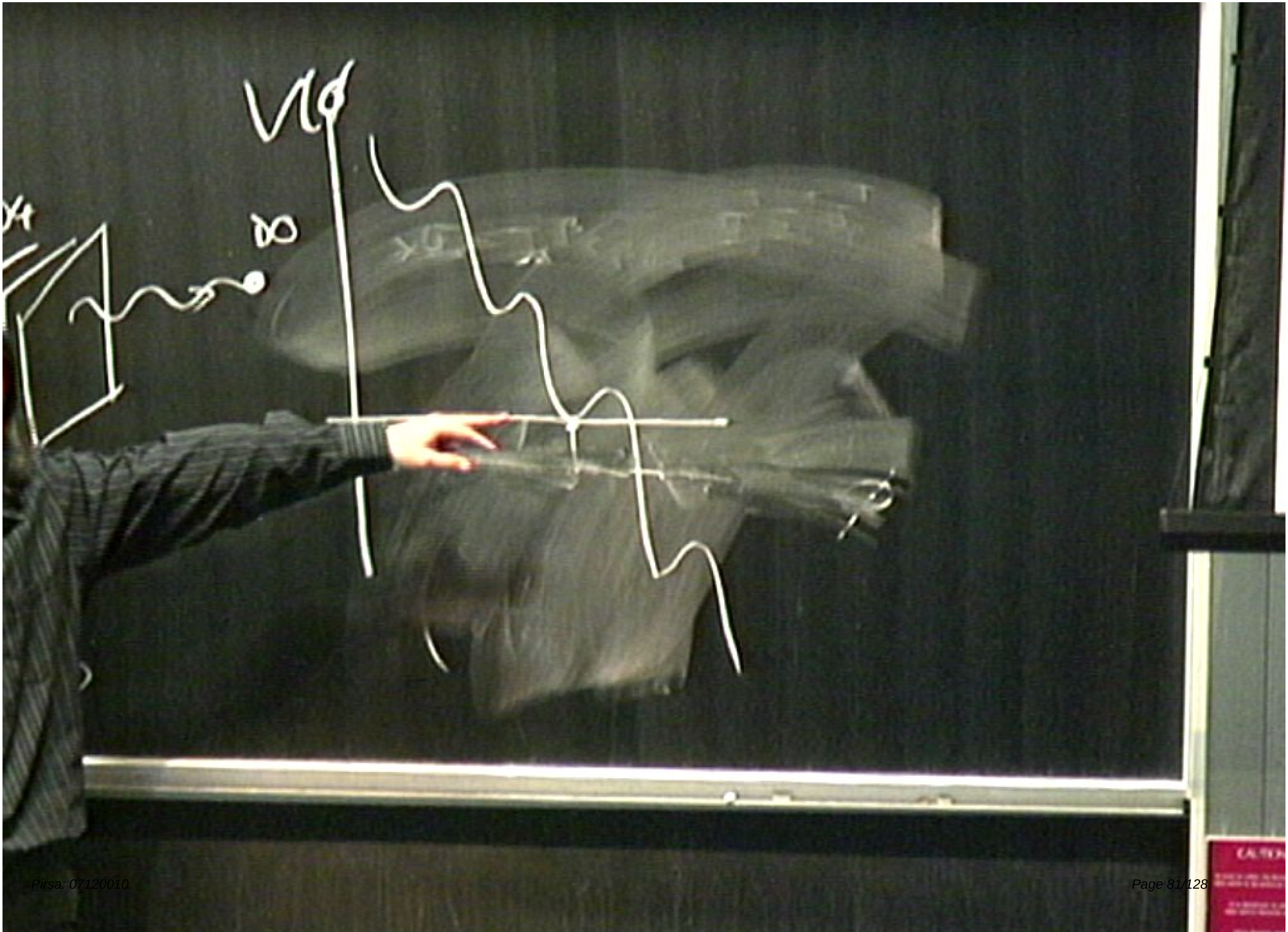
The potential is bounded and has
many minima with barriers in between

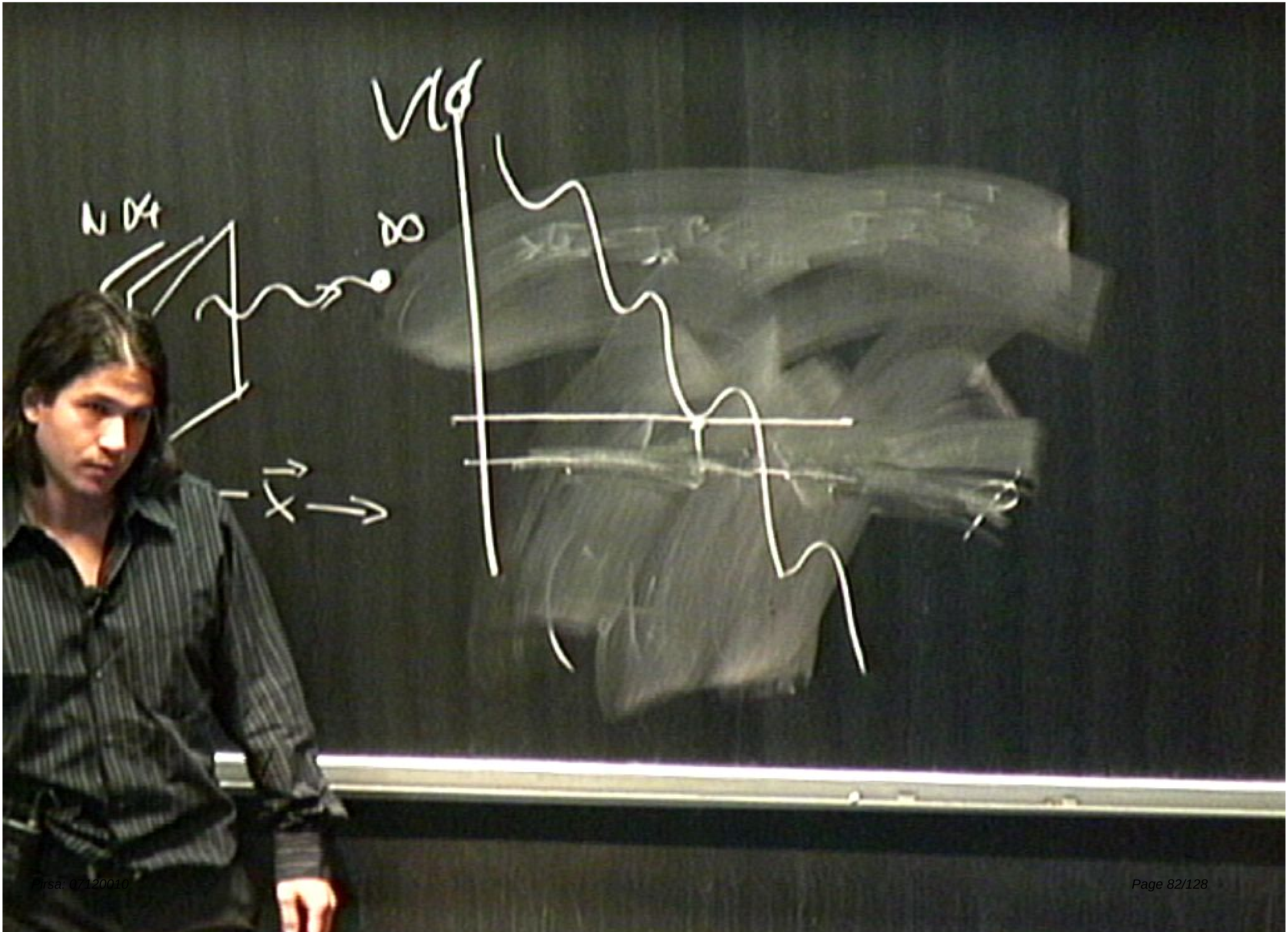
Similar to QCD axion
First term: instanton effects, 2^{nd} term:
soft breaking


V(φ)
φ
X

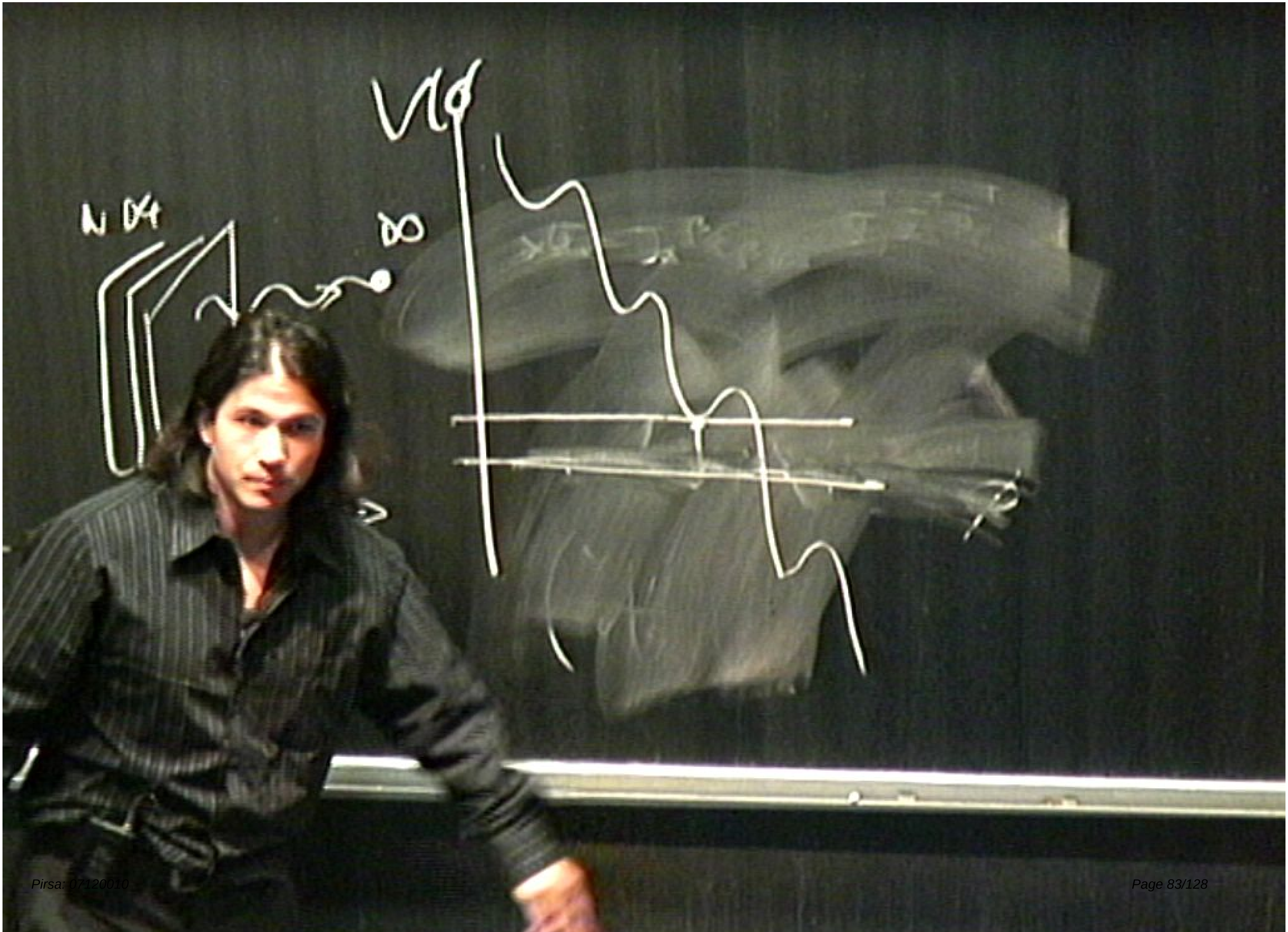


V(ϕ)
ϕ


V(φ)



$V(\phi)$
N D4
DO

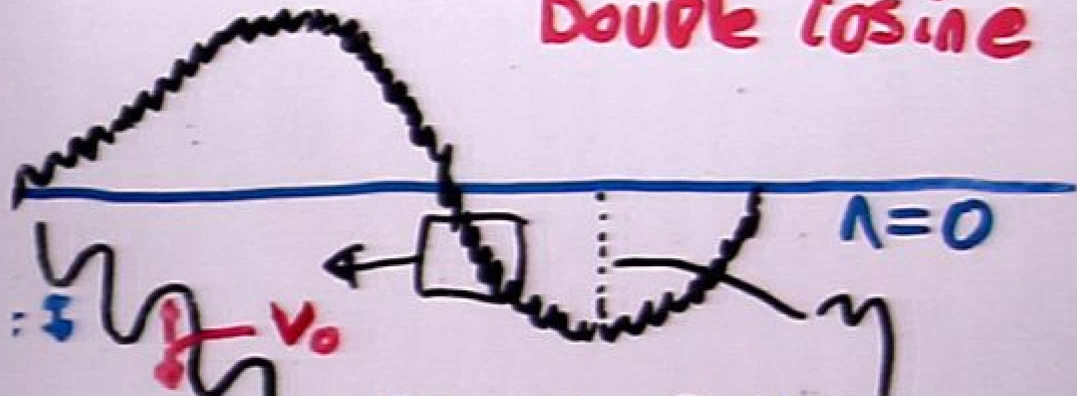

V(φ)
N D4
D0

Devaluton

Compensating field

$$V_0\left(1-\cos\frac{N\phi}{v}\right)-\eta\cos\left(\frac{\phi}{v}+\gamma\right)=V(\phi)$$

Double cosine



Energy diff $(\epsilon) \sim (10^{-3}\,eV)^4$

Barrier Height $< 100\,GeV$

$= V_0$ EW Breaking

In term of fields para.

$V_0 = m^2 v^2/N^2$ barrier height

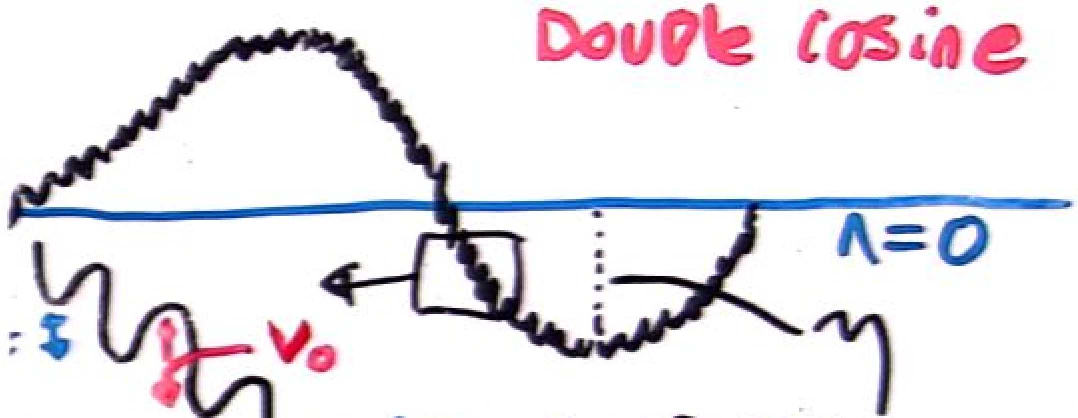
$\sigma = 8 m v^2/N^2$ Wall tension

$\epsilon = 2\pi\eta/N$ energy difference between minima

Compensating field   Devaluton

$$V_0\left(1-\cos\frac{N\phi}{v}\right)-\eta\cos\left(\frac{\Phi}{v}+\gamma\right)=V(\phi)$$

Double cosine



Energy diff $(\epsilon)\sim(10^{-3}\,eV)^4$

Barrier Height <100 GeV

$= V_0$ EW Breaking

In term of fields para.

$V_0 = m^2 v^2/N^2$ barrier height

$\sigma = 8 m v^2/N^2$ Wall tension

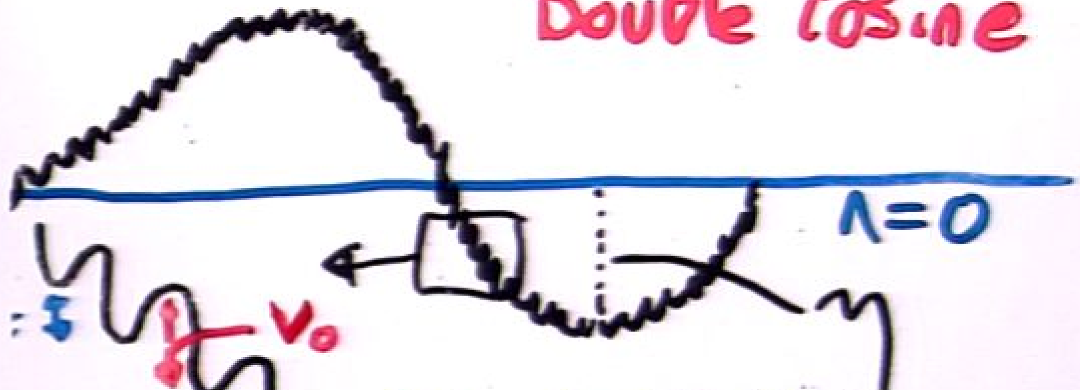
$\epsilon = 2\pi\eta/N$ energy difference between minima

Devaluton

Compensating field

$$V_0\left(1-\cos\frac{N\phi}{v}\right)-\eta\cos\left(\frac{\Phi}{v}+\gamma\right)=V(\Phi)$$

Double cosine



Energy diff (ϵ) ~ $(10^{-3}\,eV)^4$

Barrier Height < 100 GeV

= V_0 EW Breaking

In term of fields para.

$V_0 = m^2 v^2/N^2$ barrier height

$\sigma = 8 m v^2/N^2$ Wall tension

$\epsilon = 2\pi\eta/N$ energy difference between minima

Compensating Field

Origin of first term

Field Symm Under

$$\Phi \to \Phi + \text{constant}$$

* Axion, Moduli, etc

Ex Axion

$$\text{SSB} \xrightarrow[\text{Mex. Hat}]{} $$

$U(1)$

coupled to a gauge Group

Instantons cause SSB

$$U(1) \to Z(N)$$

Origin of 2nd term

We add a Second Soft Breaking term By Hand But it could Be introduced By coupling to another Field

Small tilt is natural

γ - phase

N - number of bumps

v - vev Mex. Hat.

$\Rightarrow$

$$V_{dev} =$$

$$V_0\left(1-\cos\frac{N\theta}{v}\right) - \eta\cos\left(\frac{\phi}{v}+\gamma\right)$$

↑ 1st Breaking Term

↑ 2nd Breaking Term

Due to tilt in potential, different minima have different energies, ranging from $-\eta \rightarrow +\eta$.

2) $\epsilon \leq (10^{-3}\,\mathrm{eV})^4$

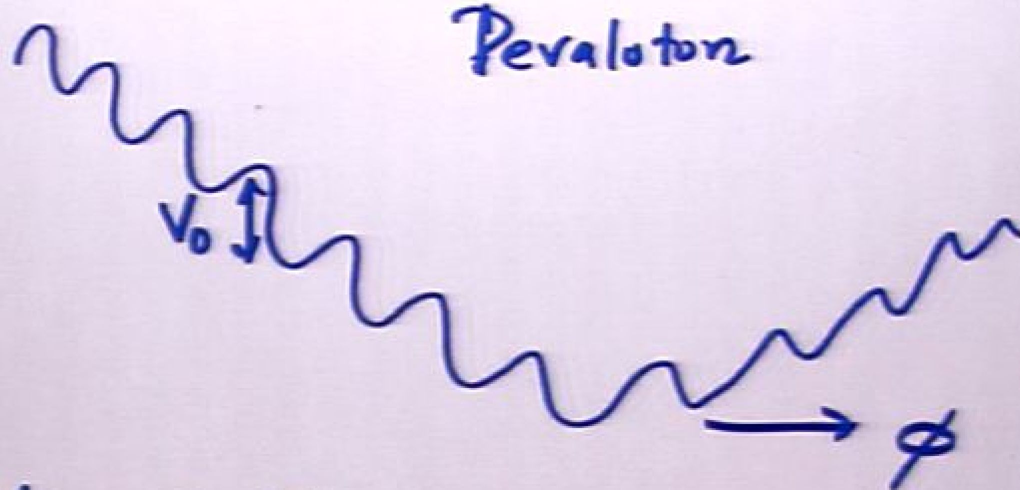
S.t. Near present day limit.

$\cong \Rightarrow 10^{10}$ diff. Vaccum States

→ Not 10^{200}

→ dynamical evolution toward unique vacuum state.

Peraloton



At $T > V_0$ = barrier height,
barriers go unnoticed
universe populates all values of ϕ

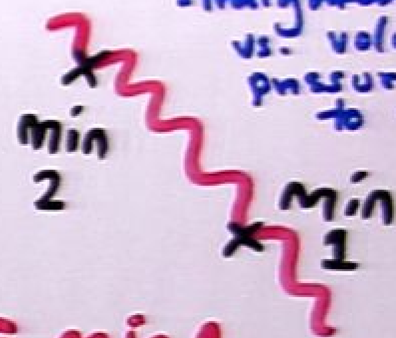
Once $T < V_0$, barriers become important.

Different patches of universe
fall into different minima,
separated by domain walls.

n.b. <u>NO TUNNELING!</u>

Domain Wall evolution

Two competing effects: surface tension to straighten walls vs. volume pressure due to energy diff. ϵ

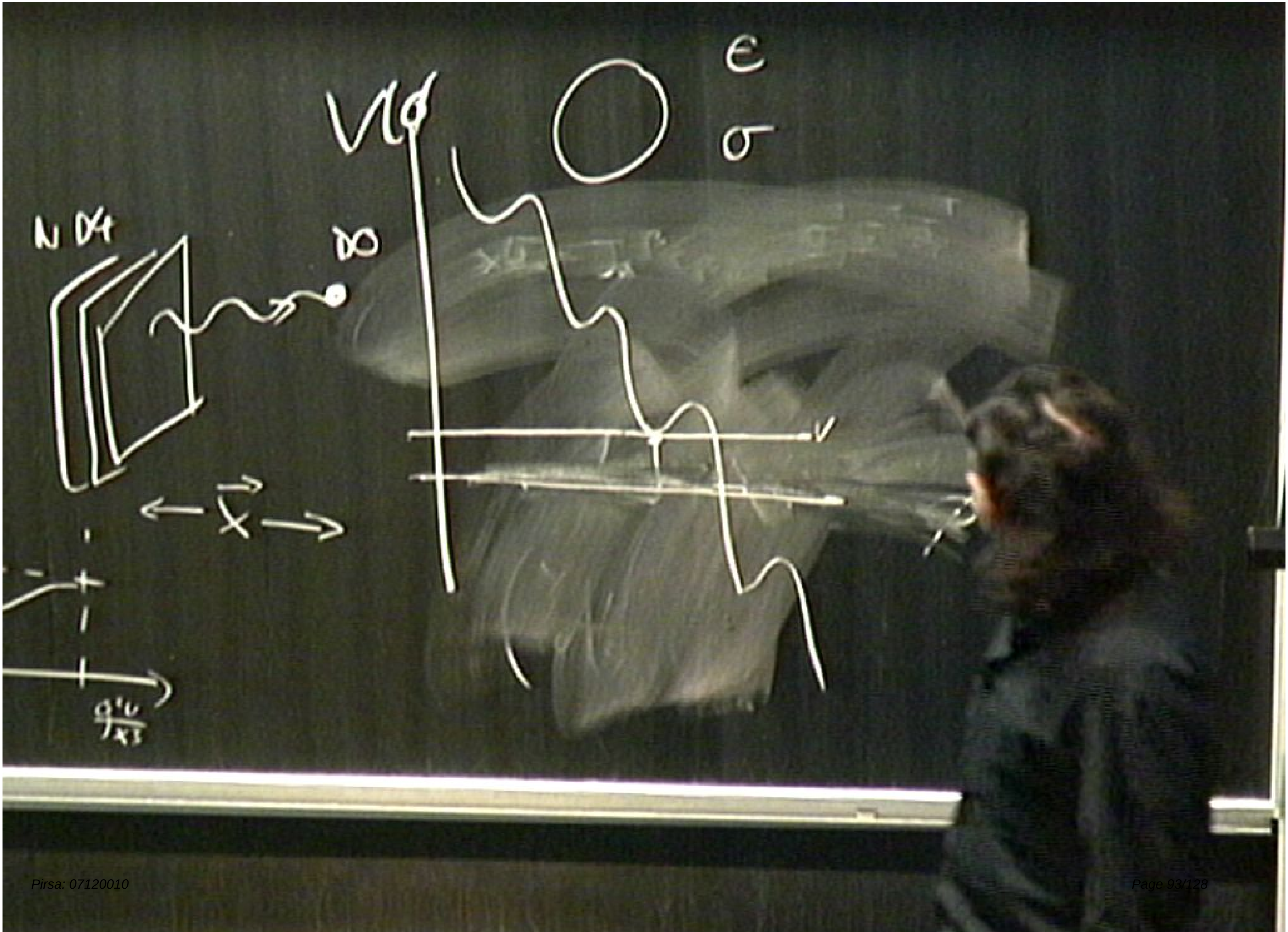


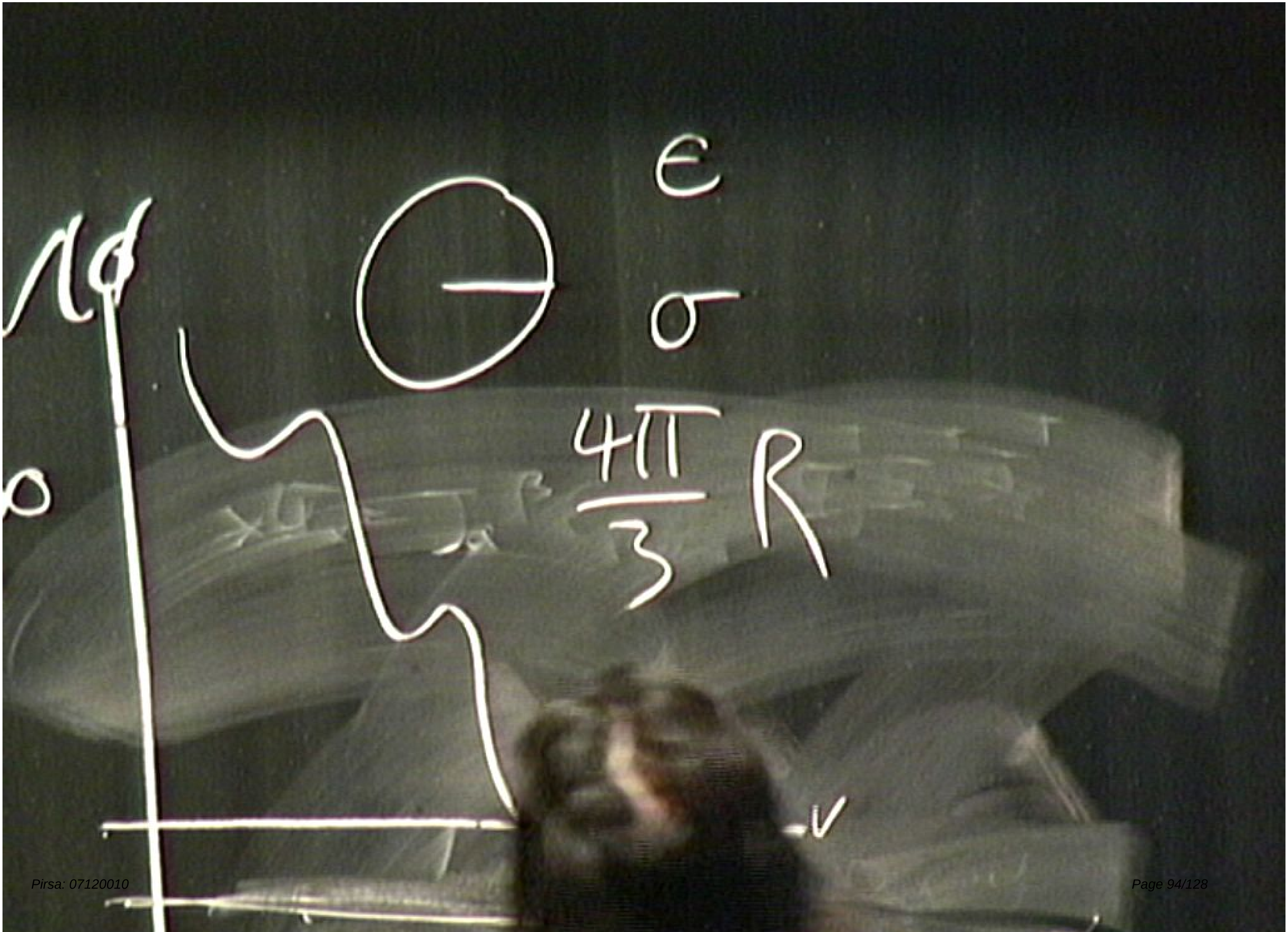
IF energy of min 1 $<$ Energy of Min 2

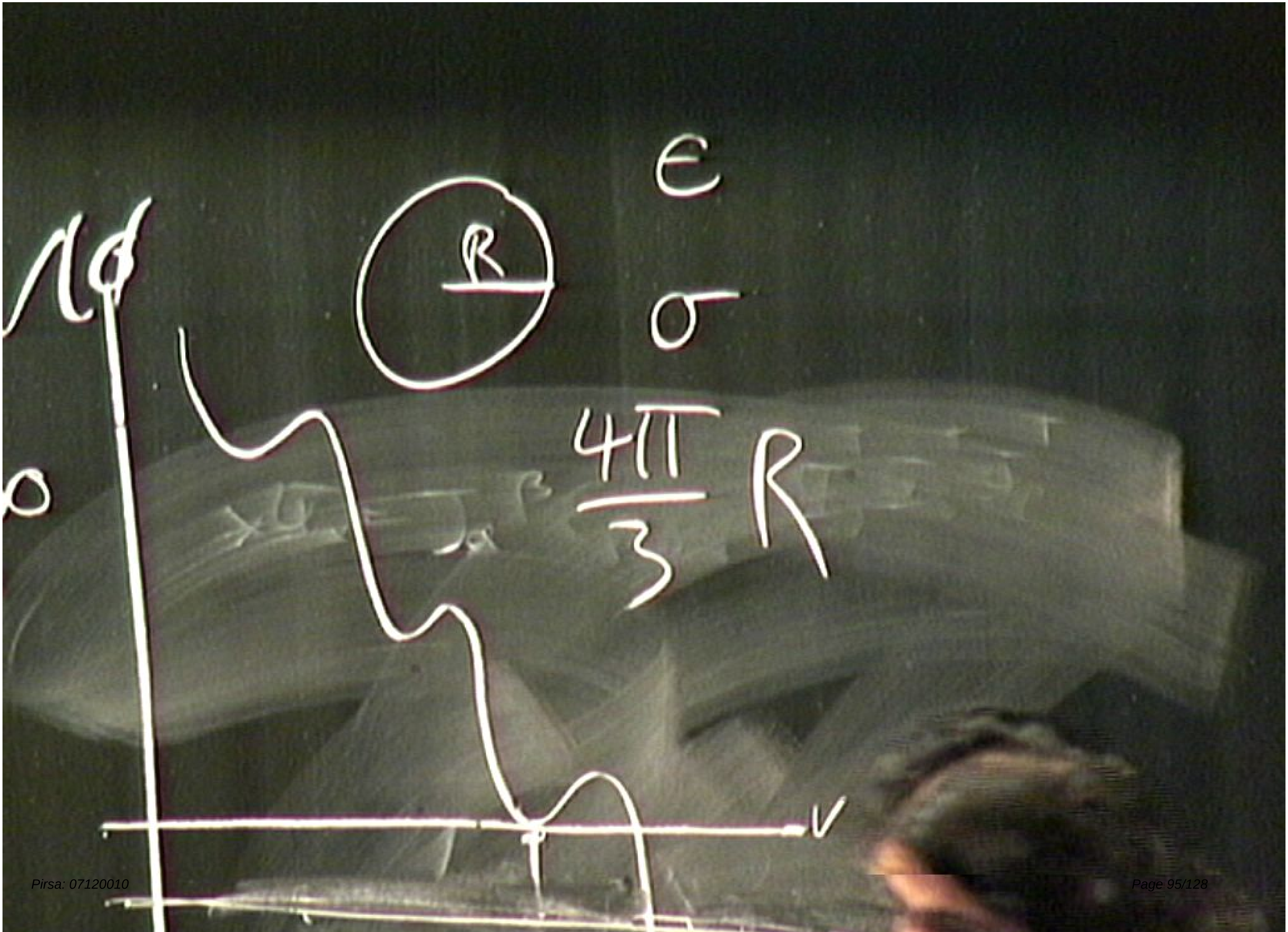
Domain Walls Move to Eliminate Higher energy minima For lower energy minima

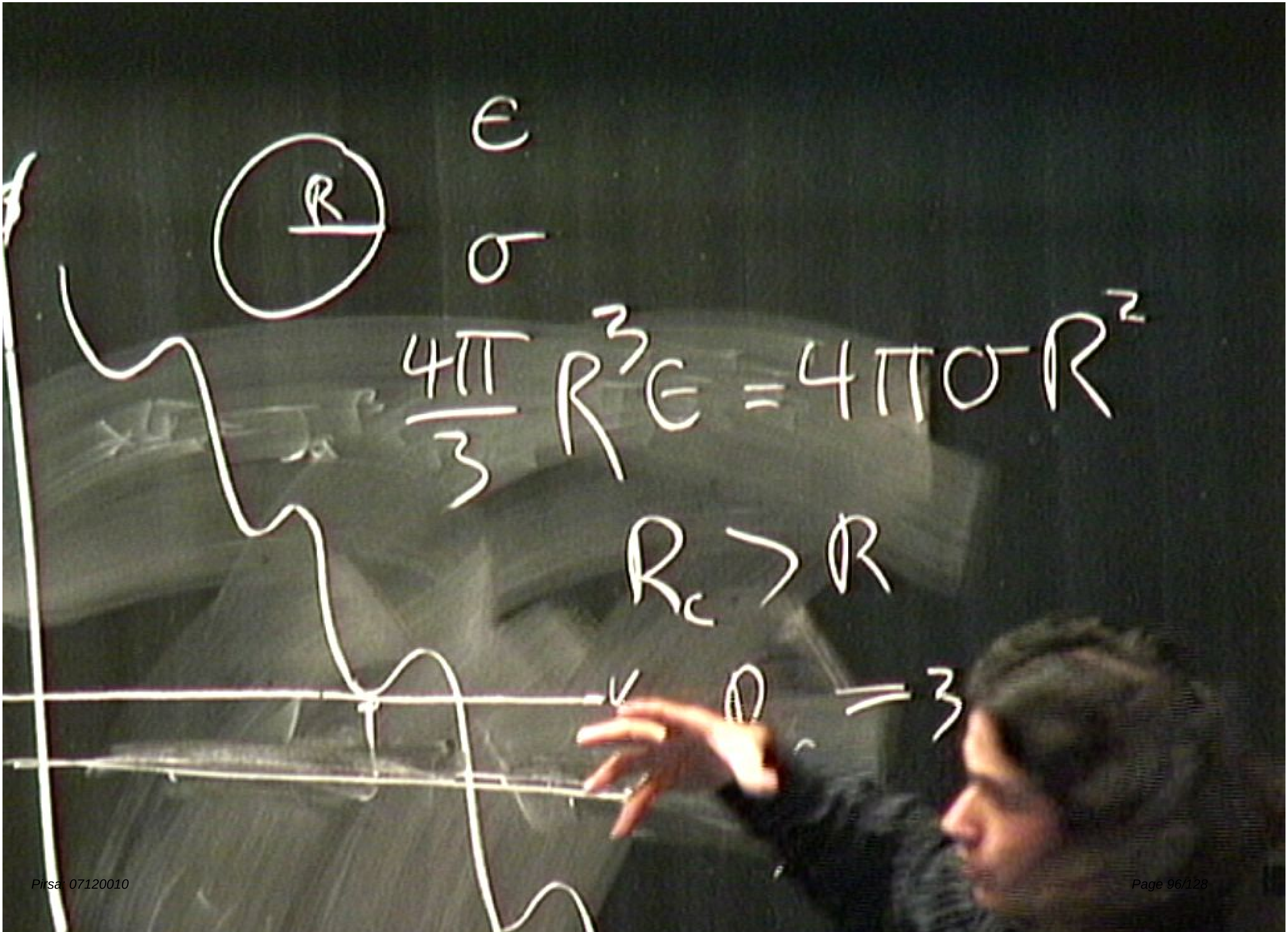
• universe Radiation dominated

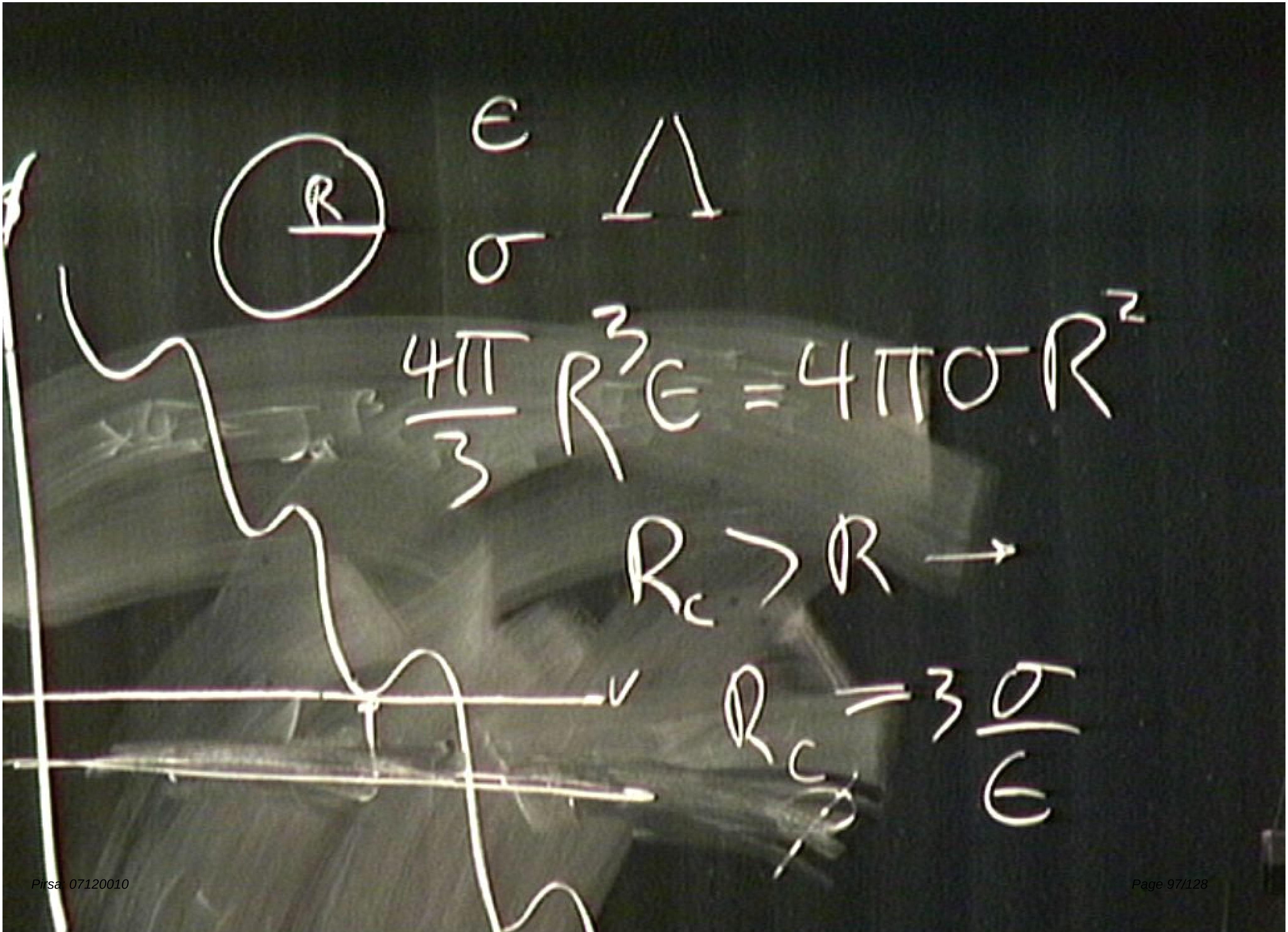
Horizon grows, More + More Regions


V(ϕ)
ε
σ
N D4
D0
X


ε
σ
4π/3 R

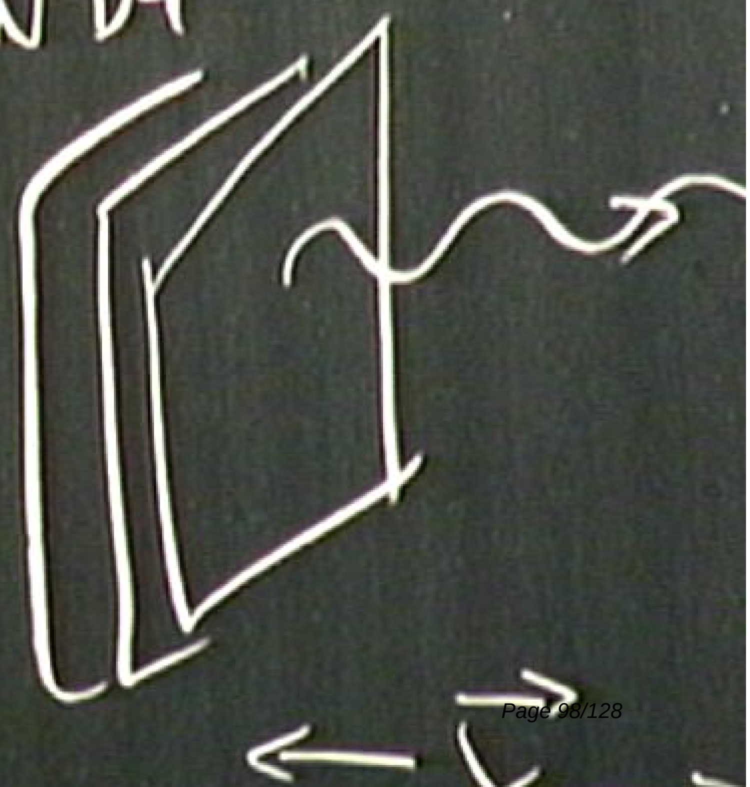

R
ε
σ
4π/3 R
V

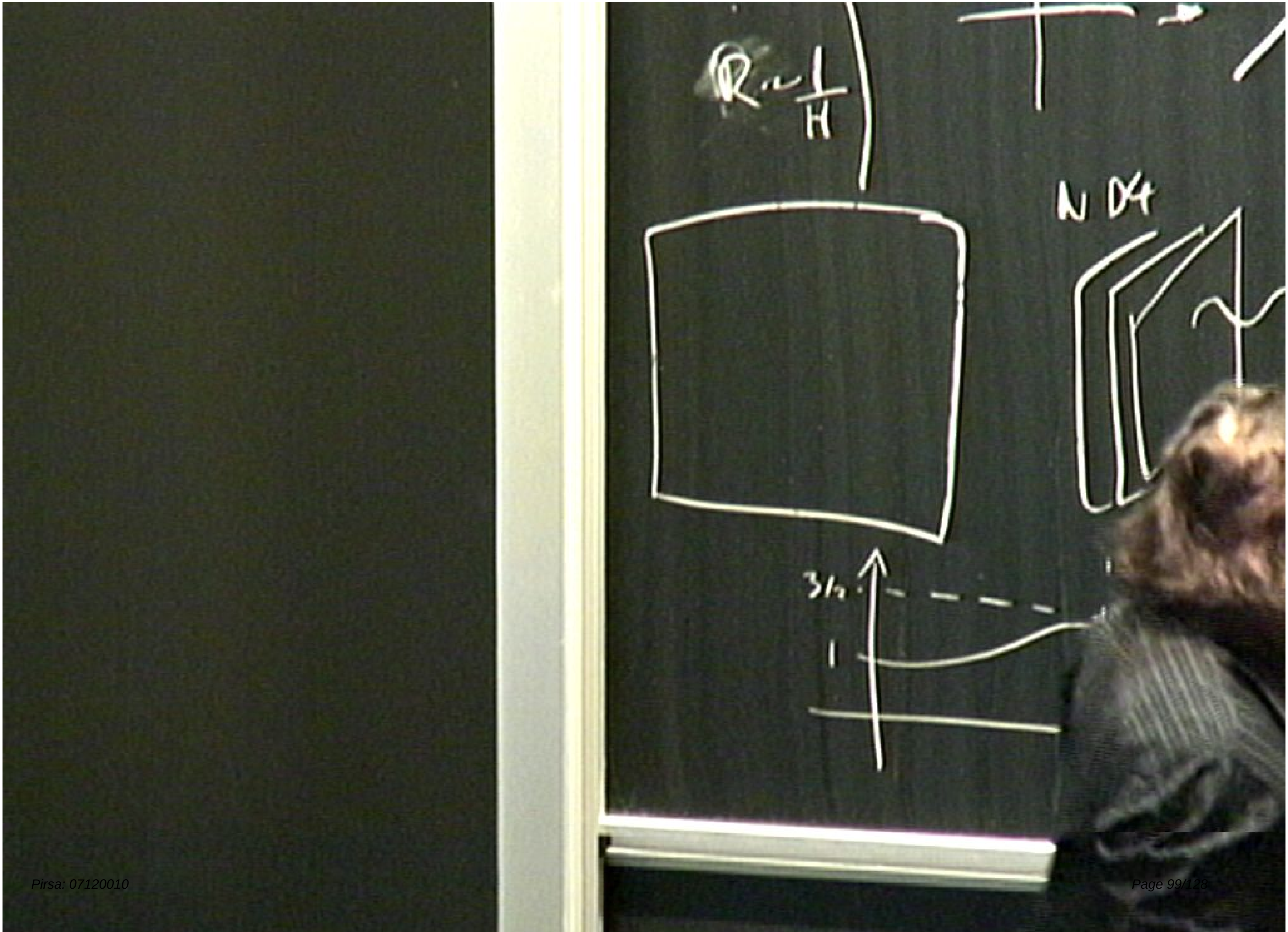

R
ε
σ
$\frac{4\pi}{3}R^3\epsilon = 4\pi\sigma R^2$
$R_c > R$

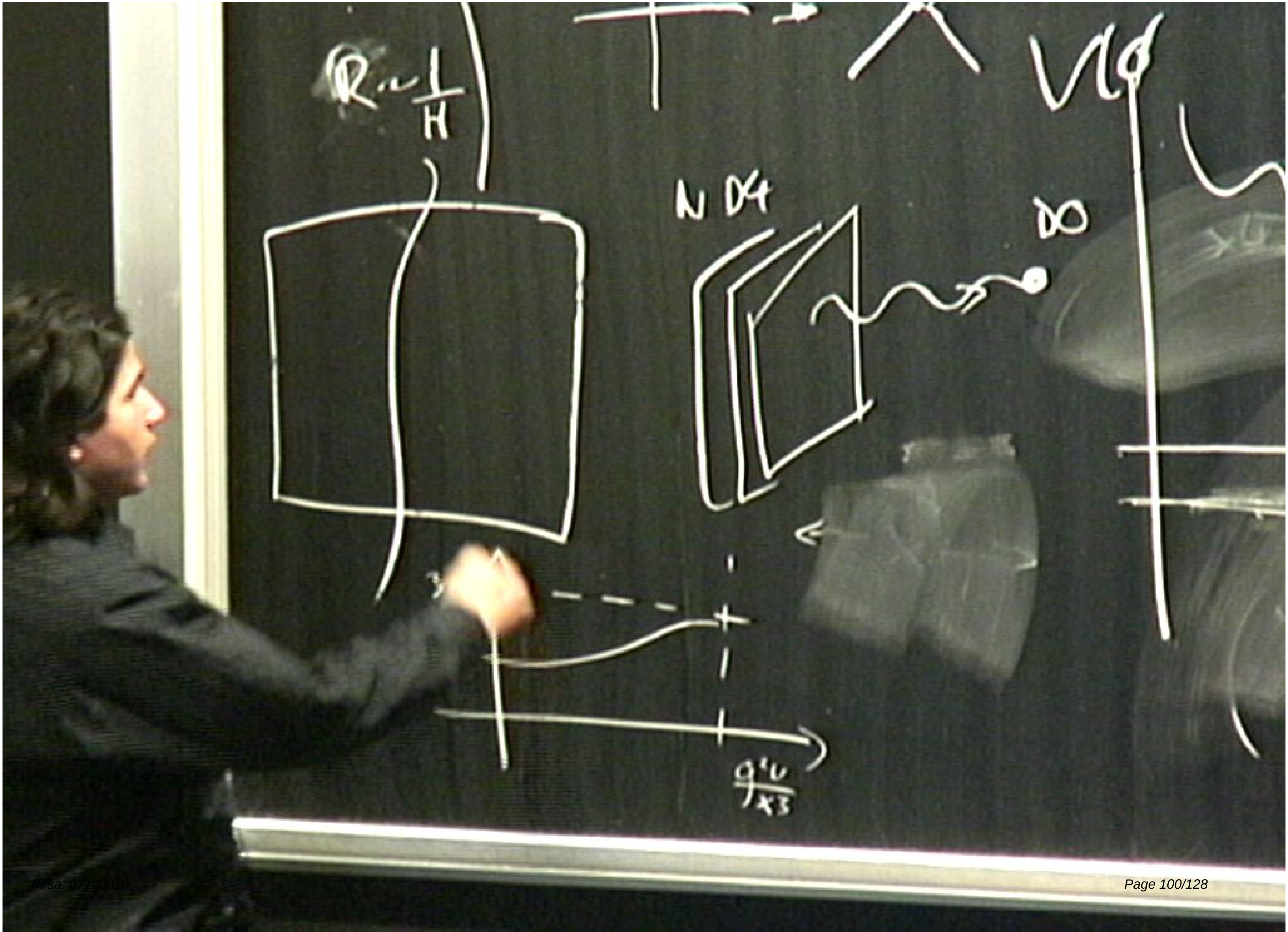

R
ϵ
Λ
σ
$\frac{4\pi}{3} R^3 \epsilon = 4\pi \sigma R^2$
$R_c > R \rightarrow$
$R_c = 3\frac{\sigma}{\epsilon}$

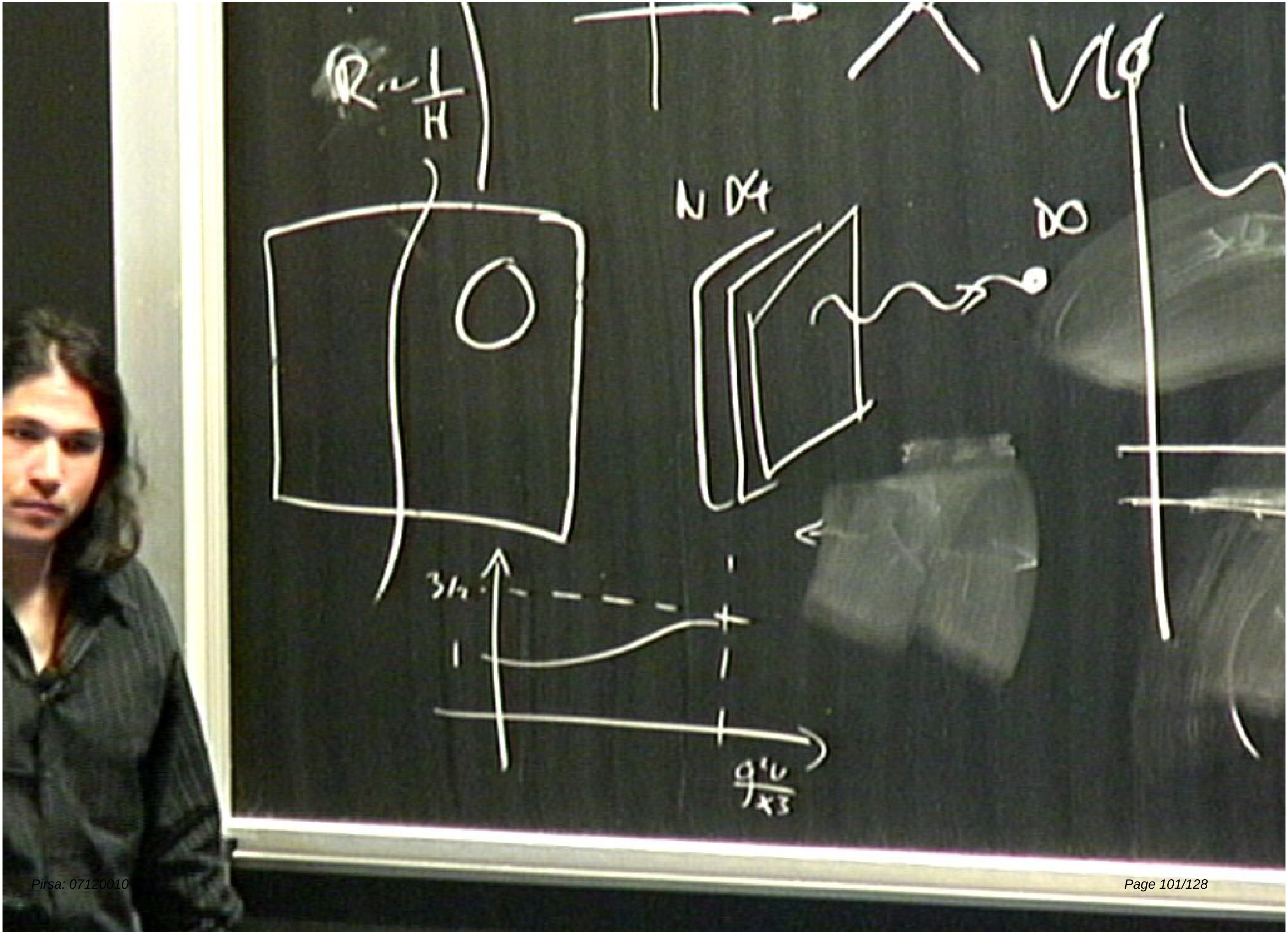
$R \sim \frac{1}{H}$

N D4

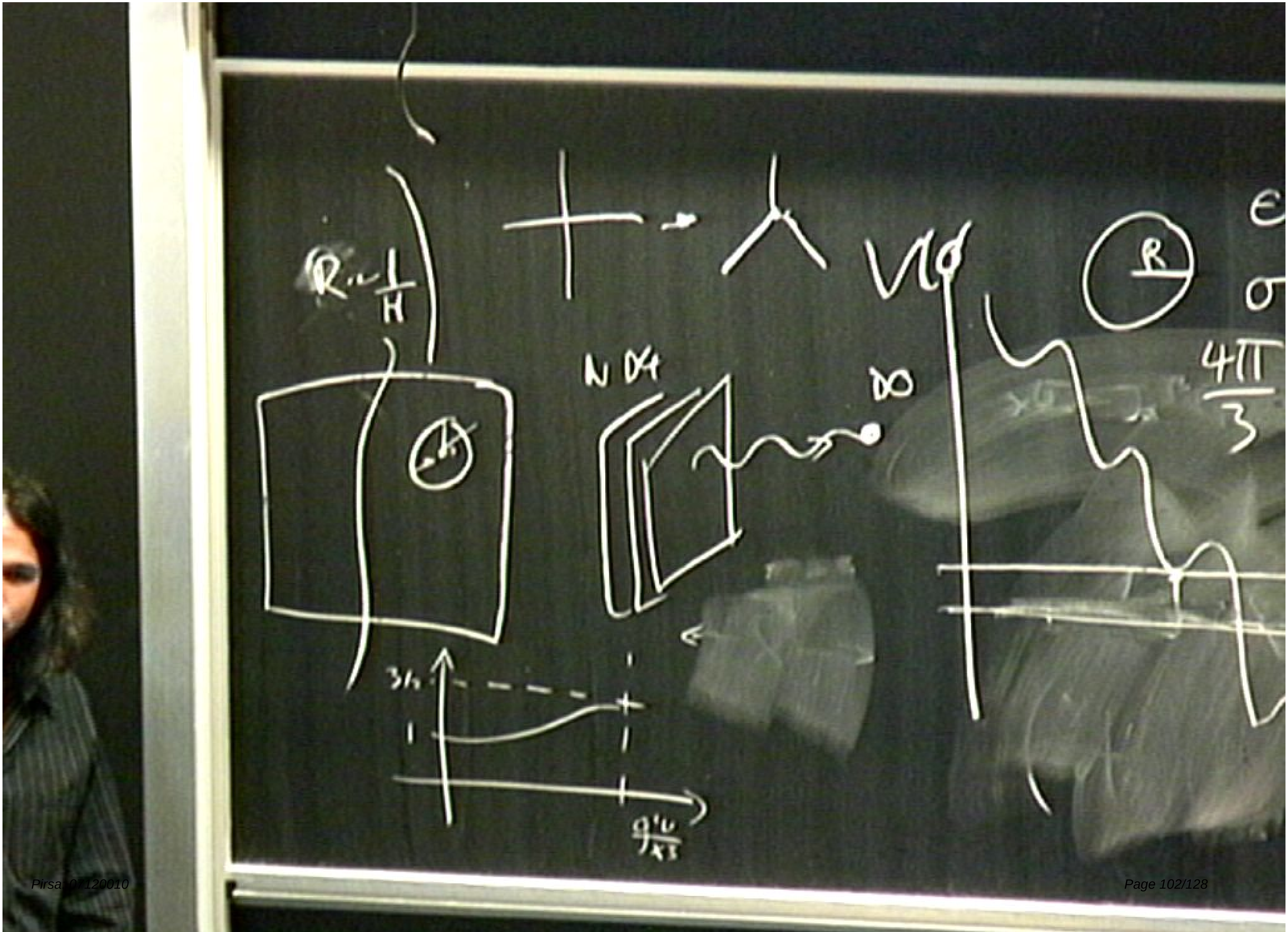



N D4
3/2
1


N D4
D0



N D4
D0
3/4
1


N D4
D0

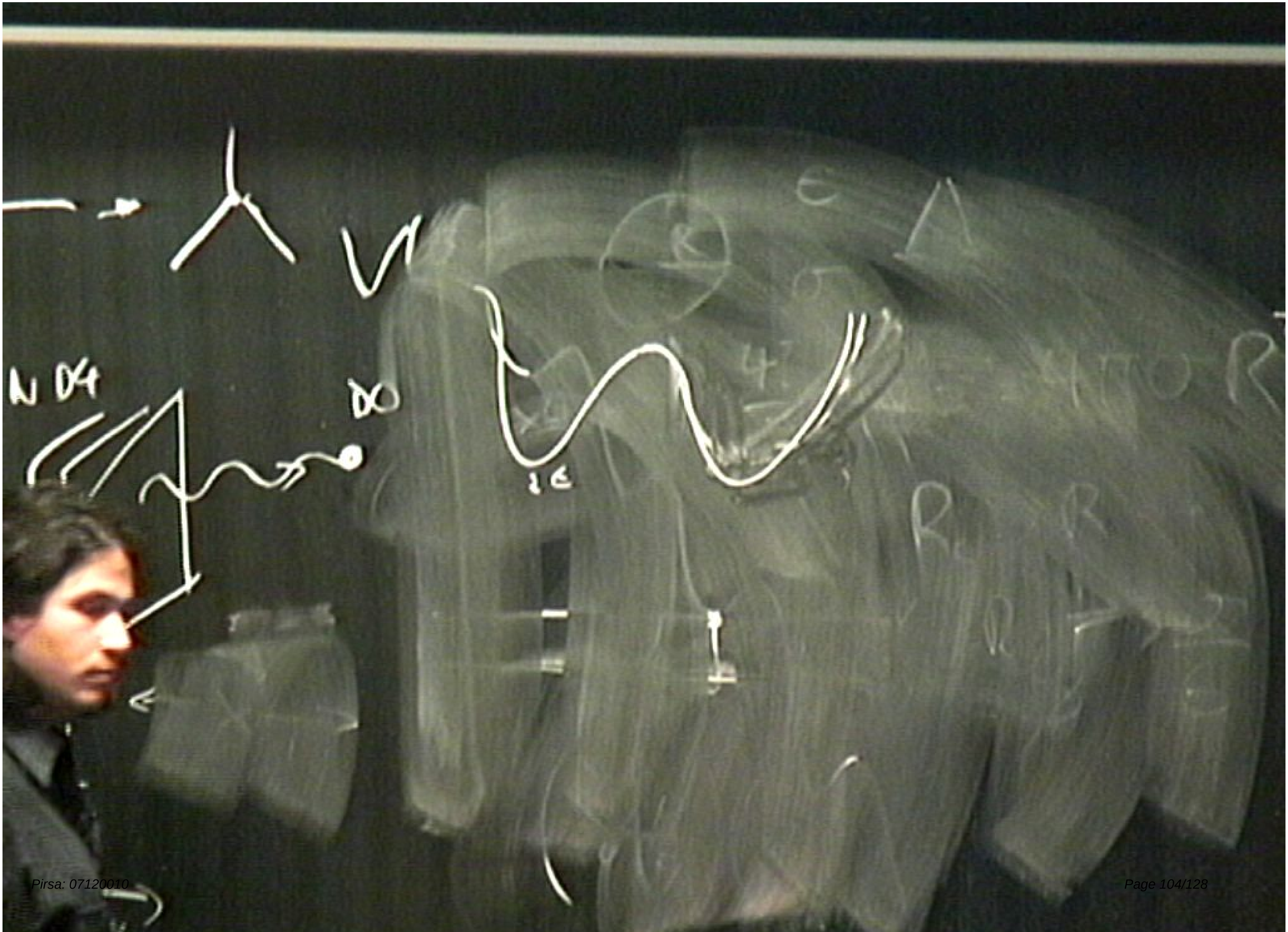
Heuristically

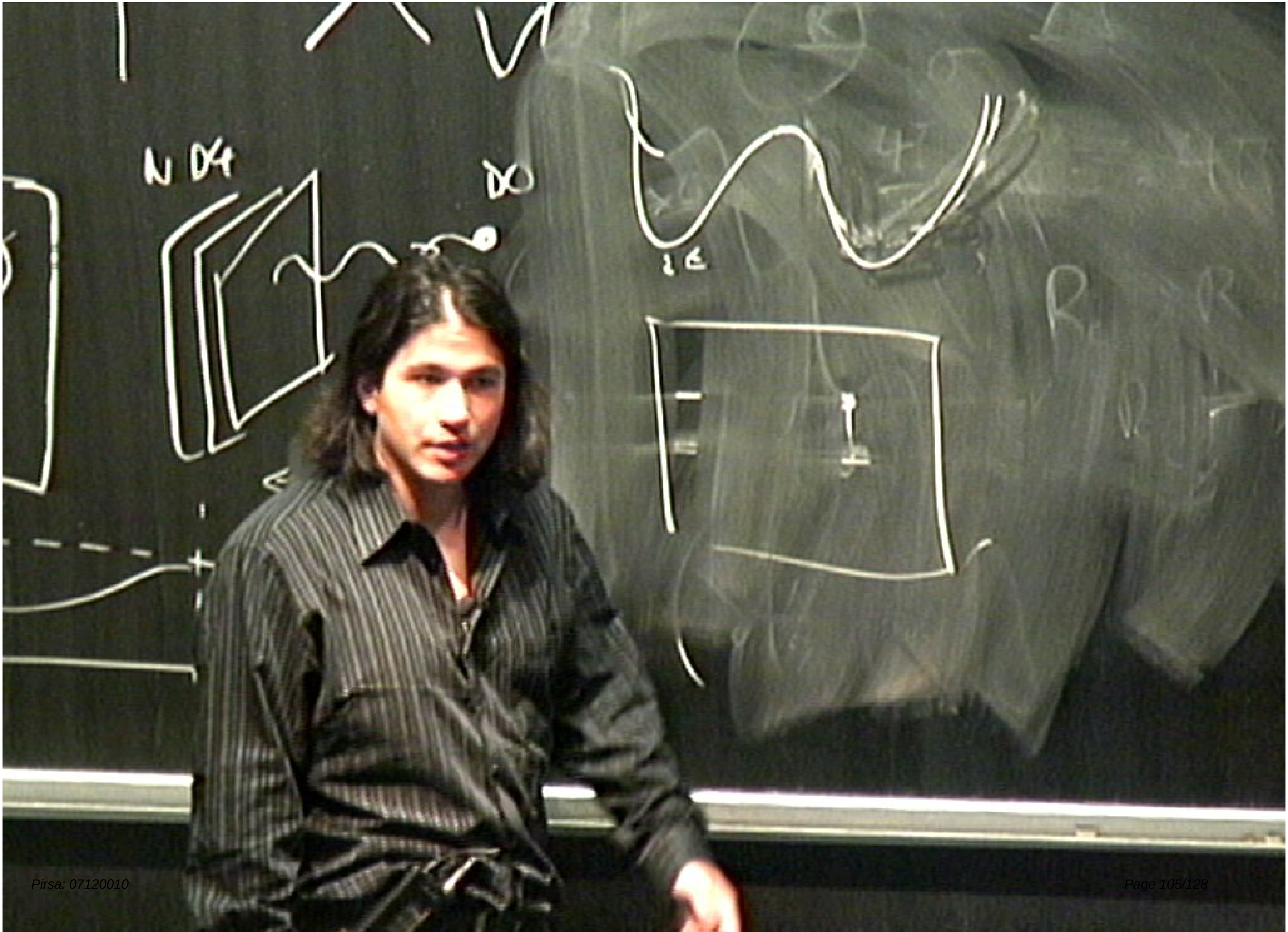
System wants to go to the lowest energy configuration

this consists of

1) Lowest possible Energy State
2) Eliminating D.W. Network

Further studies w/ Carlos Martins.




N D4
D0

Heuristically

System wants to go to the Lowest energy configuration

this consists of

1) Lowest possible Energy state

2) Eliminating D.W. Network

Further studies w/ Carlos Martins.

Driven to a Small C.C.

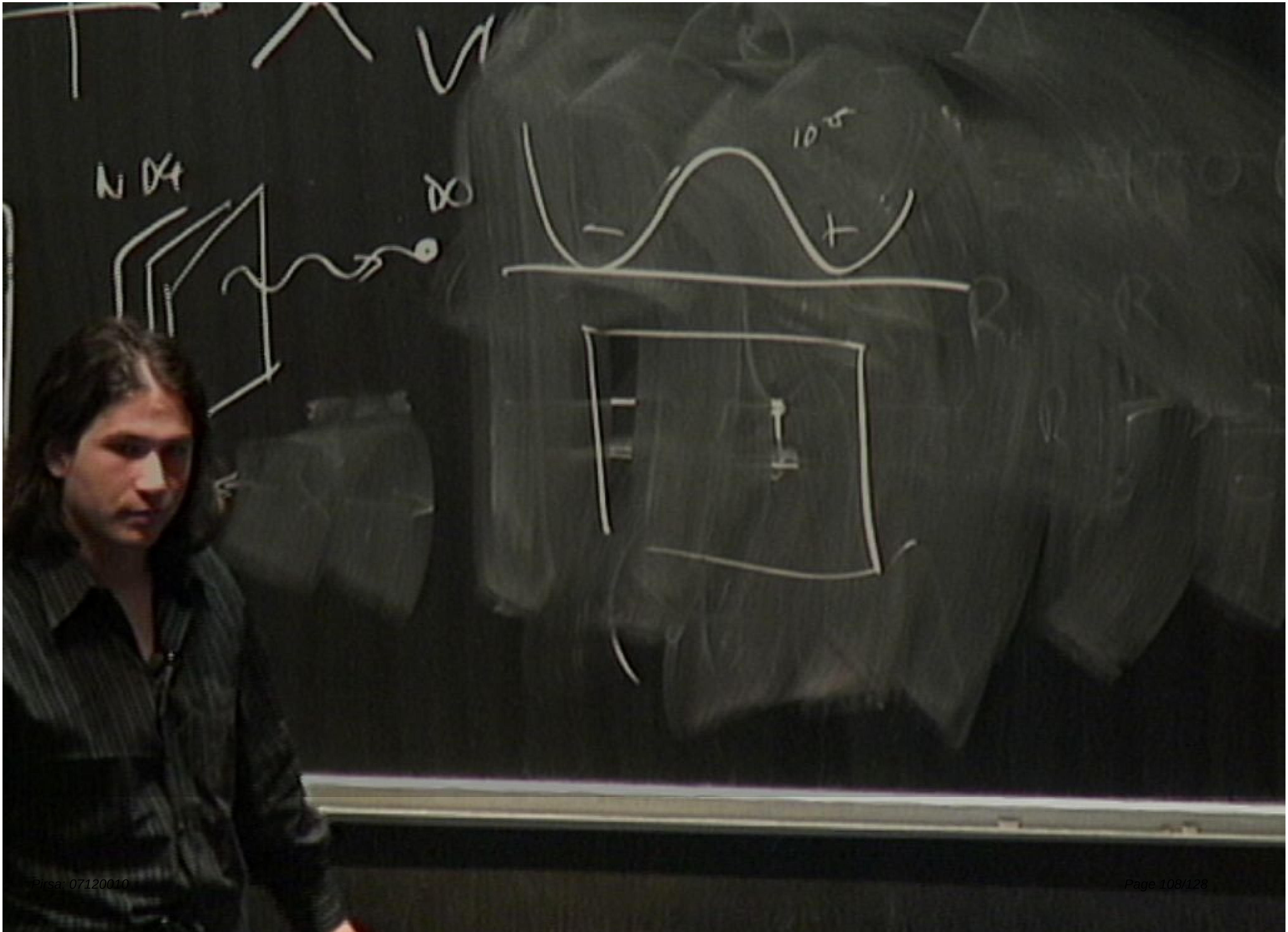
2nd → a Statistical Biasing can also quickly Drive a System to a Single Vacuum State eliminating D.W.N

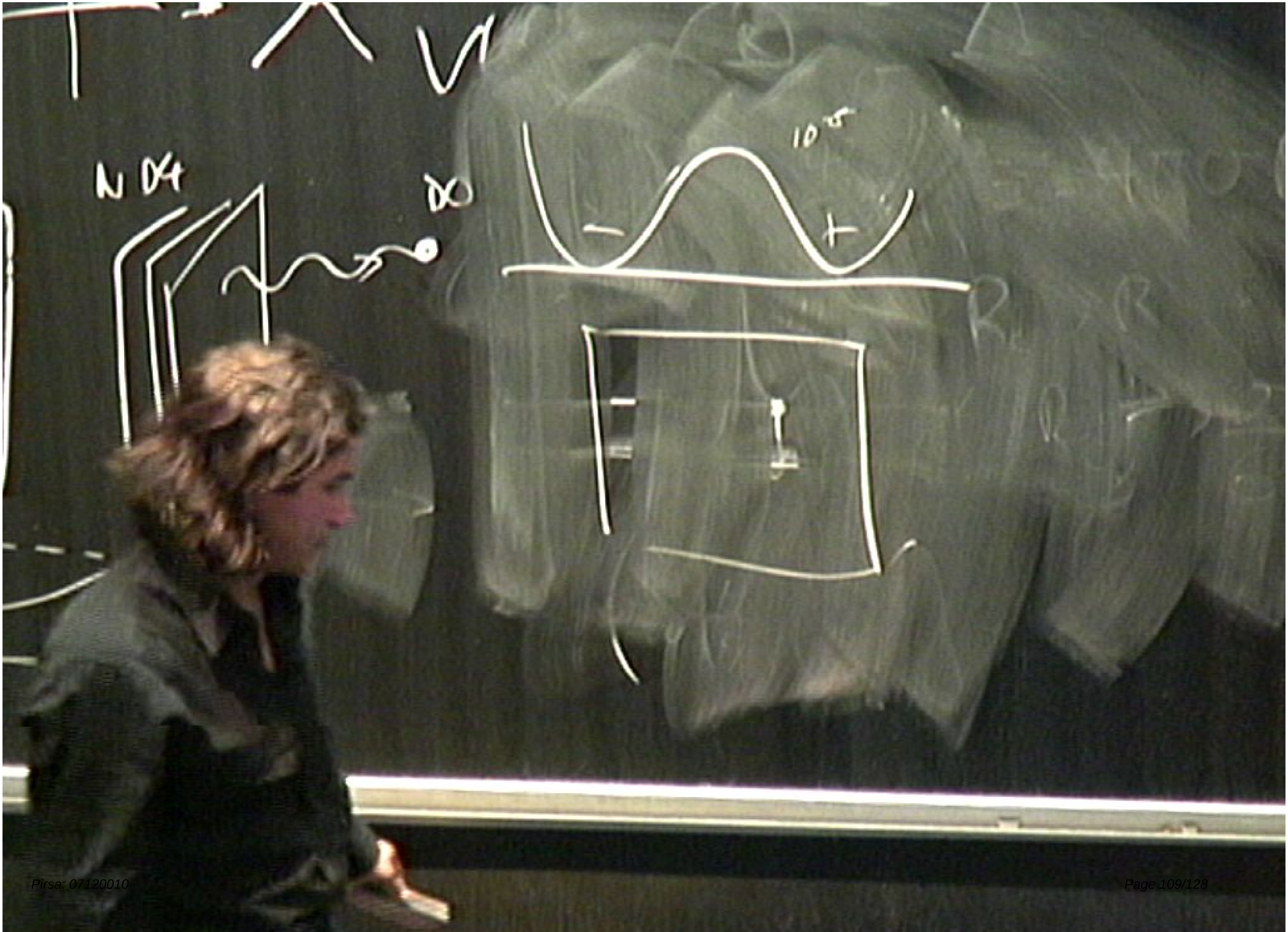
Bias in original probability dist, here Boltzman dist.

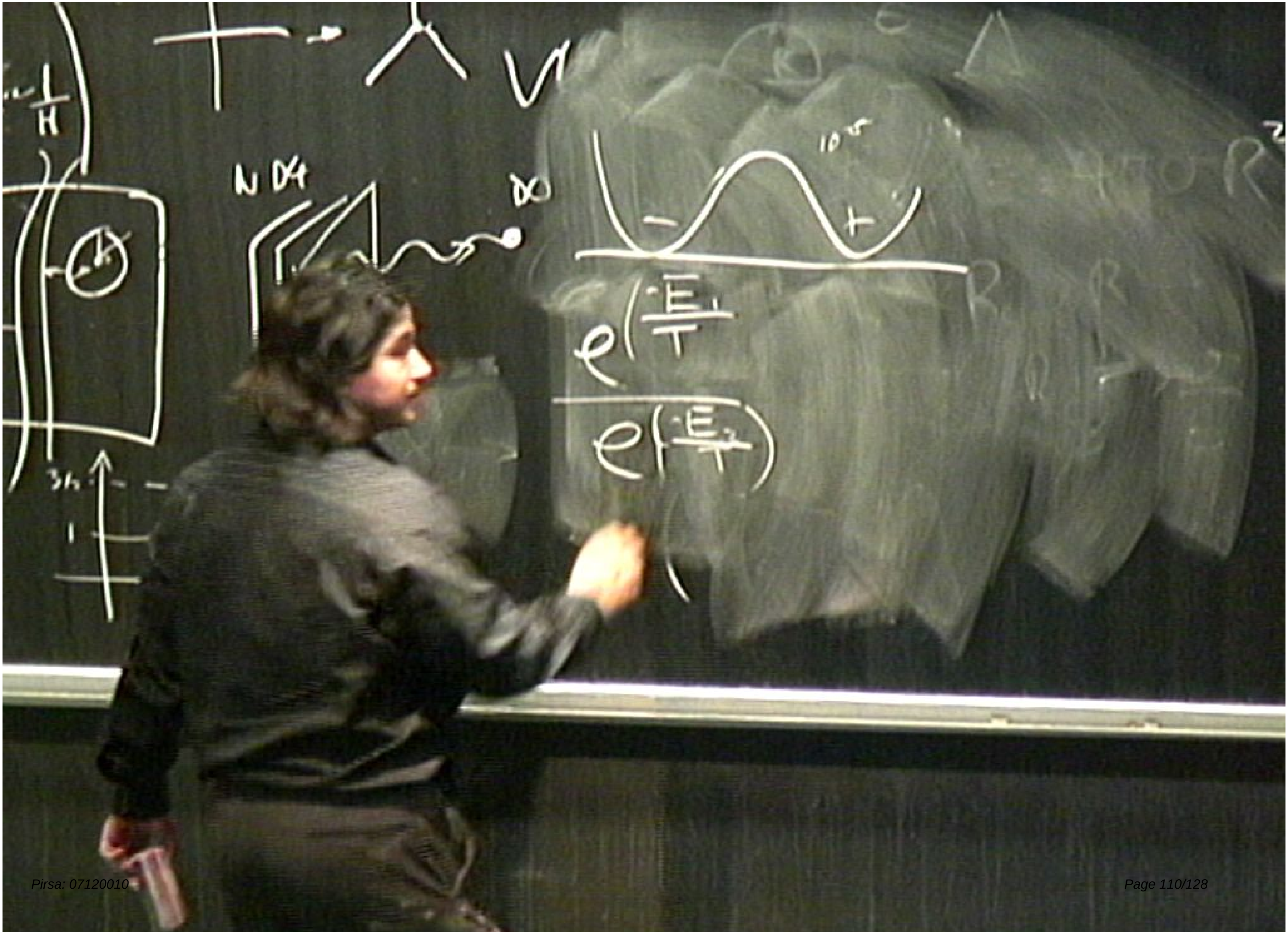
Biasing on the order of 10^{-8} Larson et al 1997

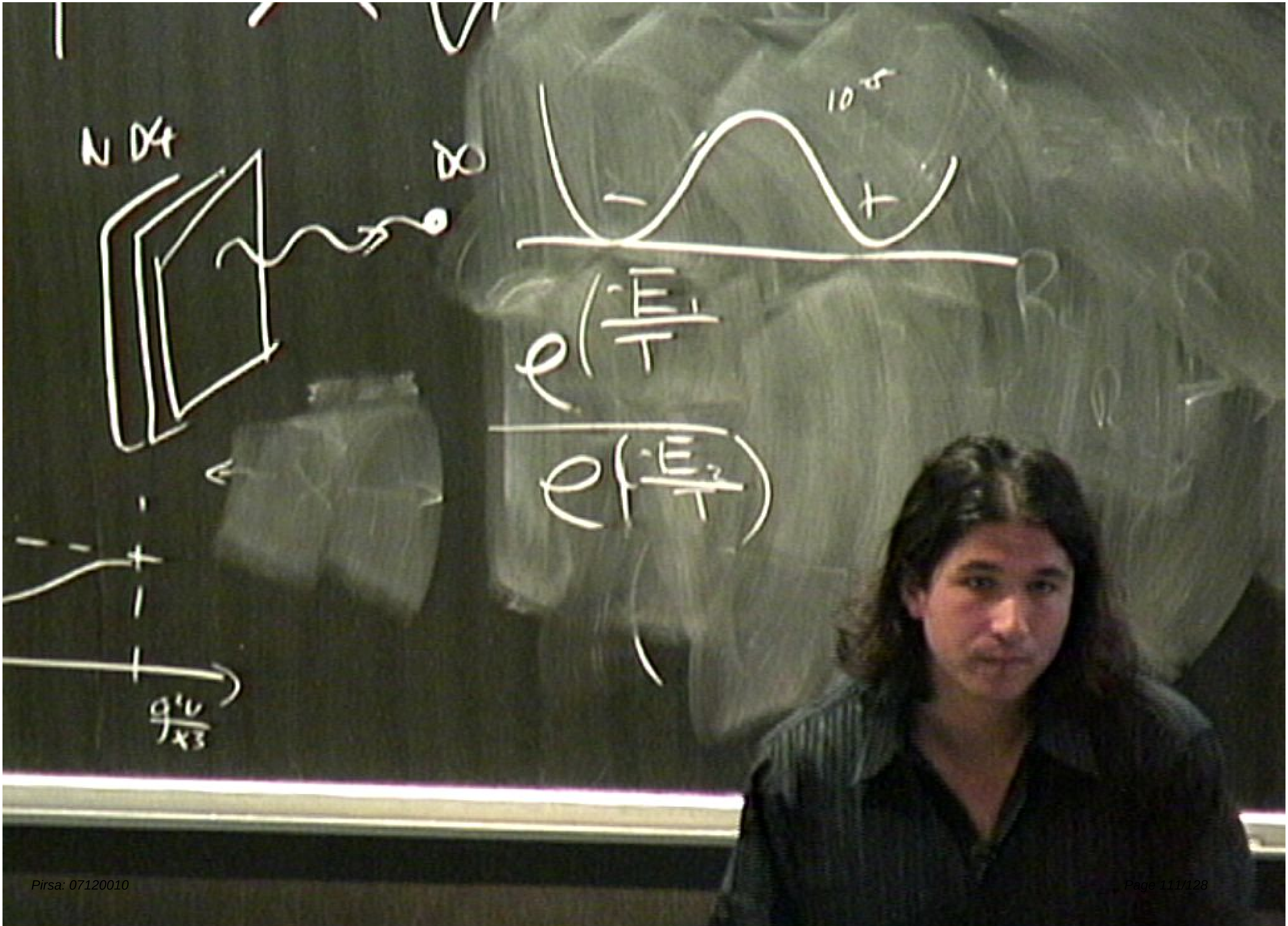
DWN appears at 100 GeV
disappears 10 MeV

n.b. - 2 - Vacuums only
- No pressure.


N D4
D0


N D4
D0




N D4
D0

two outstanding issues

A) domain Wall evolves sufficiently Fast

B) No-Go postulate. to AdS

A) yes, maybe

B) Maybe, ...

NEGATIVE ENERGY VACUA

No-Go postulate to AdS

proven for Vacuum Background.

M. Cvetic etal gr-qc/9306005

To Be driven to a Small C.C. requires walls to Sweep one into a lower + lower Energy state

Cvetic, Griffies, Soleng

But only possible For a Small ~~and~~ Negative C.C

M. Cvetic et al

1) Solve Einstein's Eqs. For Λ_1

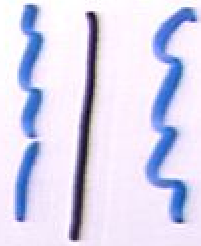
2) " " for Λ_2

3) Match accross the two Regions

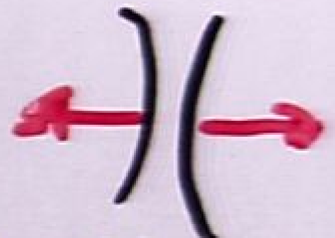
4) Find Matching cond.

Discover 3 types of Walls

Sweeping Wall



Stable Wall



Double Sweep

1) interested in 1st two walls

Dermination of class of walls

$$8\pi G\sigma_{static} = 2(\alpha_1 \pm \alpha_2)$$

$$\Lambda_i = -3\alpha_i^2$$

interested in case of $\sigma < \sigma_{static,\ sweeping\ wall}$

[Static walls Super Symmetric Walls $\sigma = \sigma_{static}$]

Setting $B=0$ i.e. $R \to \infty$

$$\Rightarrow (\Lambda_1+\Lambda_2)_{min} = -\frac{3}{2}\left[\frac{16\pi^2\sigma^2}{M_{Pl}^4} + \frac{M_{Pl}^4(\Delta\Lambda)^2}{16\times 9\pi^2\sigma^2}\right]$$

$$\Delta\Lambda = |\Lambda_1 - \Lambda_2|$$

$$\Delta\Lambda = \frac{8\pi\epsilon}{M_{Pl}^2}$$

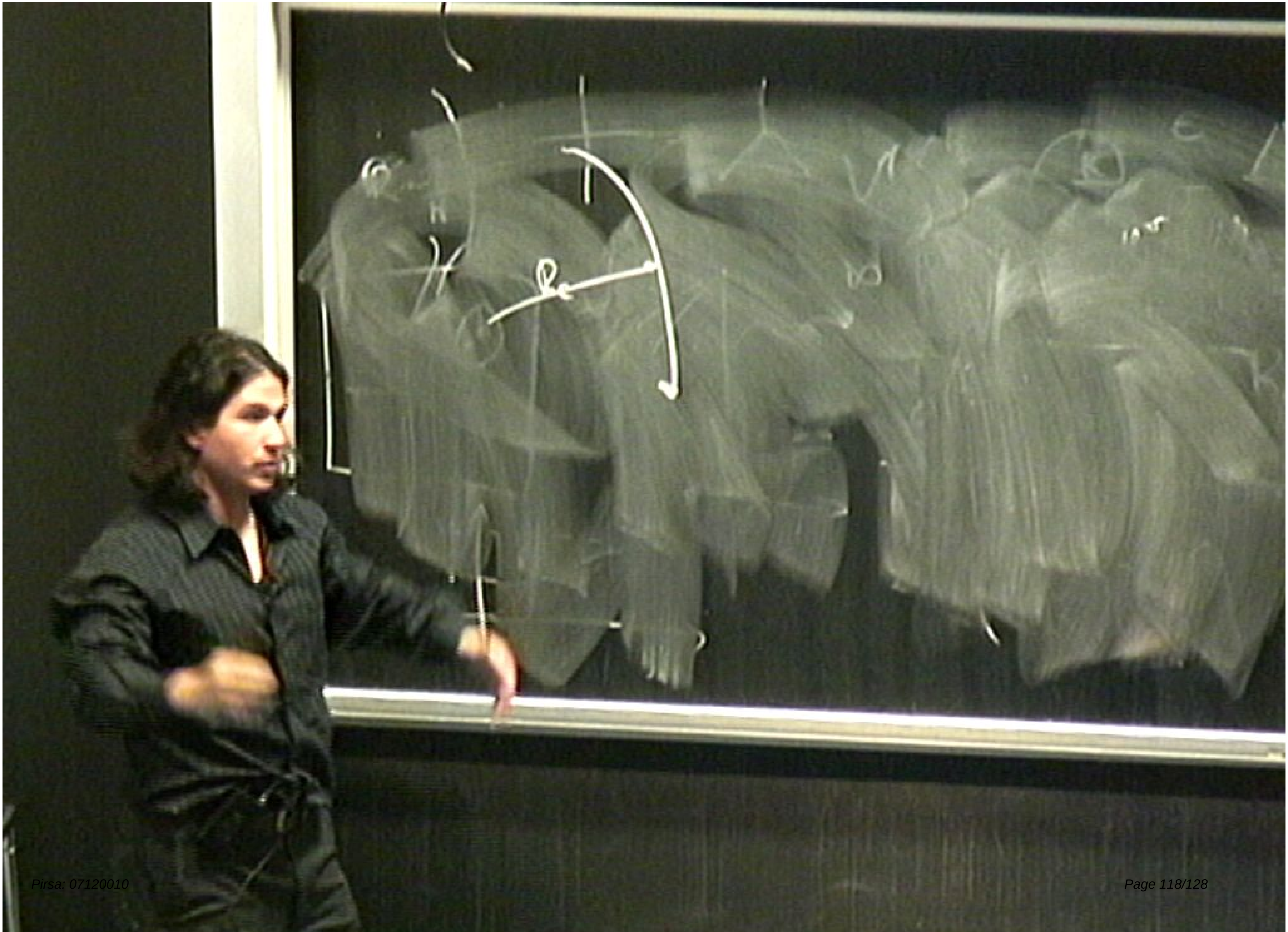
Setting $\epsilon = (10^{-3}\,eV)^4$

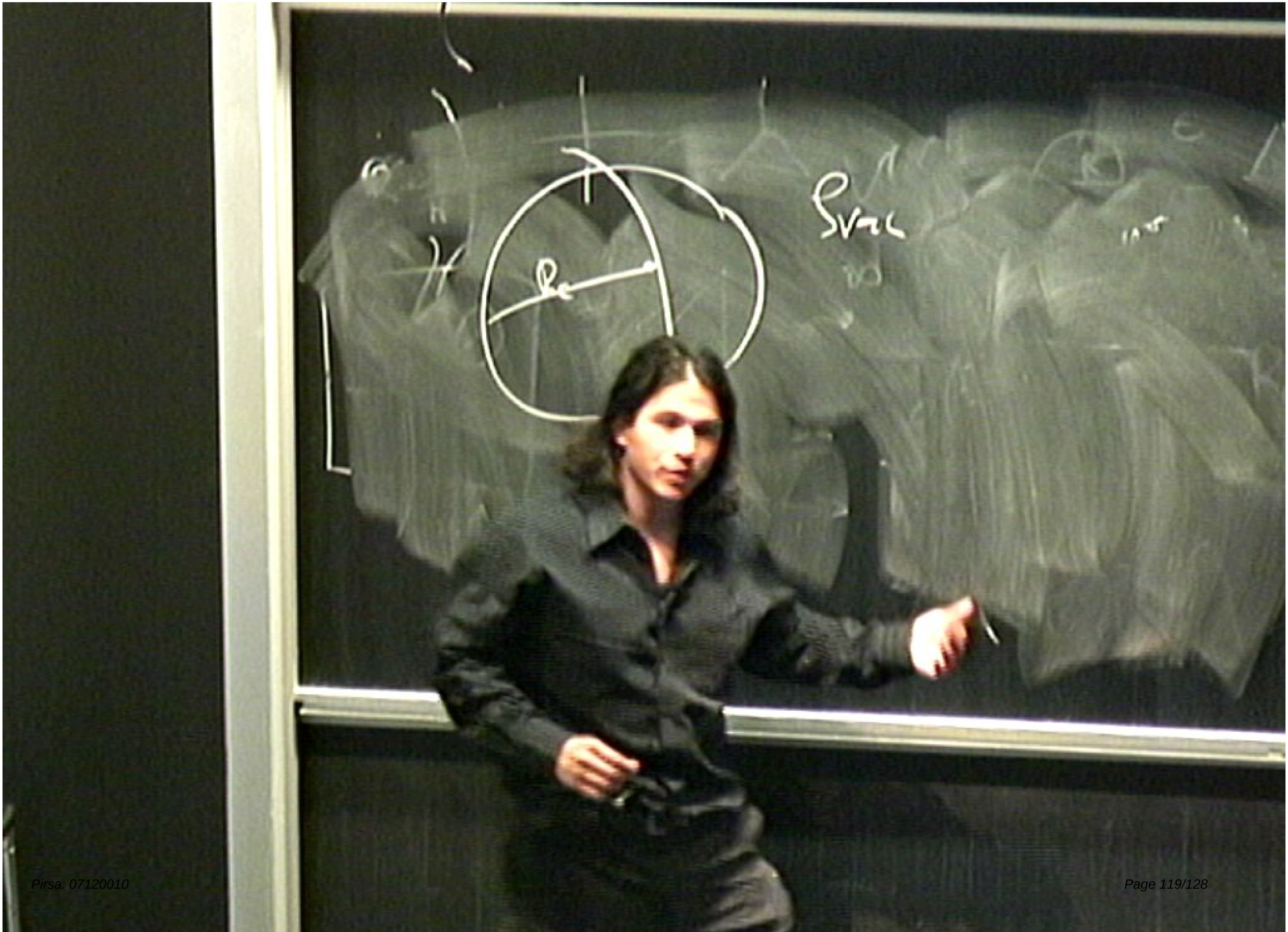
$$\Rightarrow (\rho_{v_1}+\rho_{v_2})_{min} = -(10^{-3}\,eV)^4\left(\frac{\sigma}{(10\,MeV)^3}\right)^{-2}\left(\frac{\epsilon}{(10^{-3}eV)^4}\right)^2$$

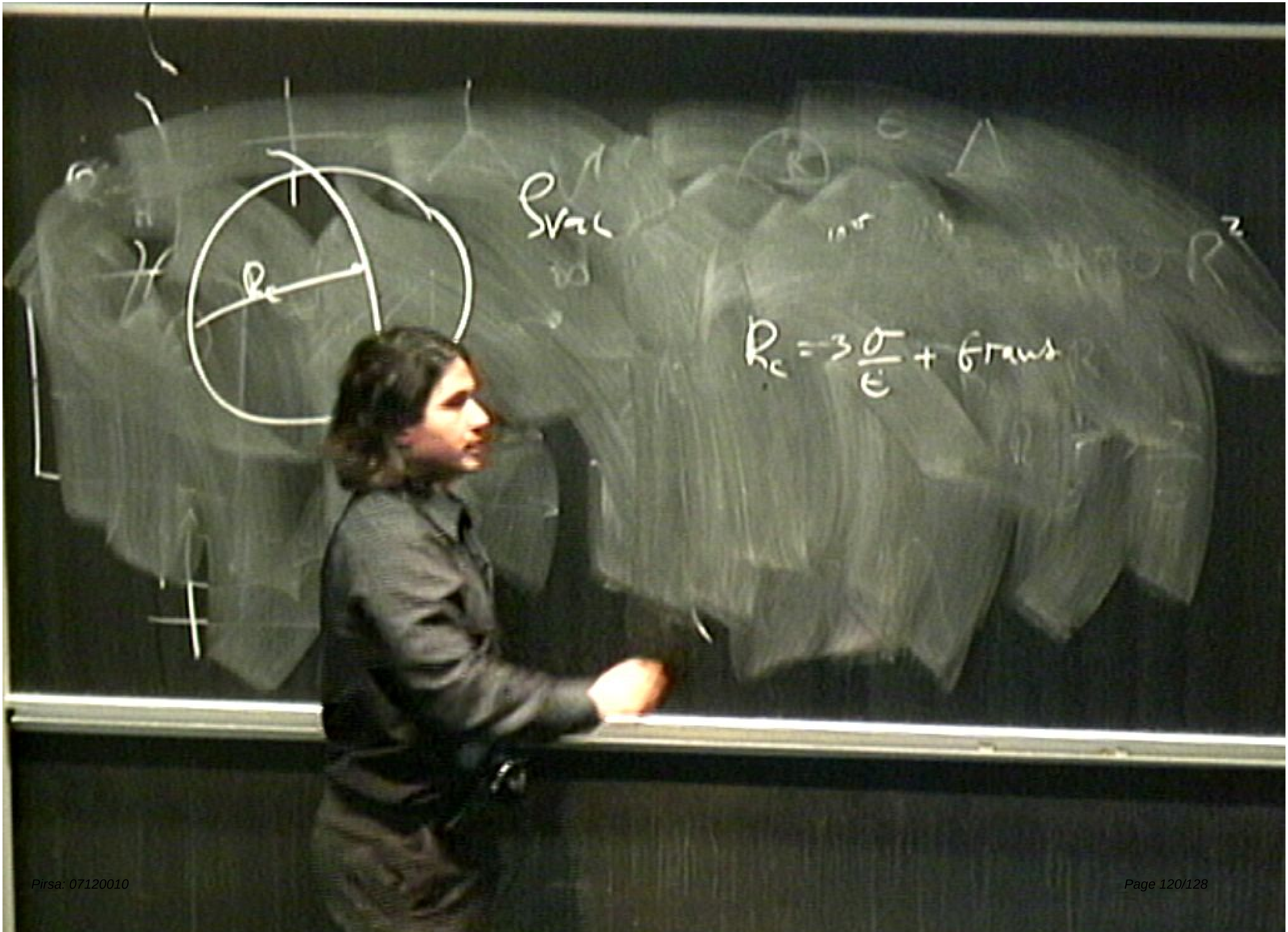
Universe is left with this small vac. energy

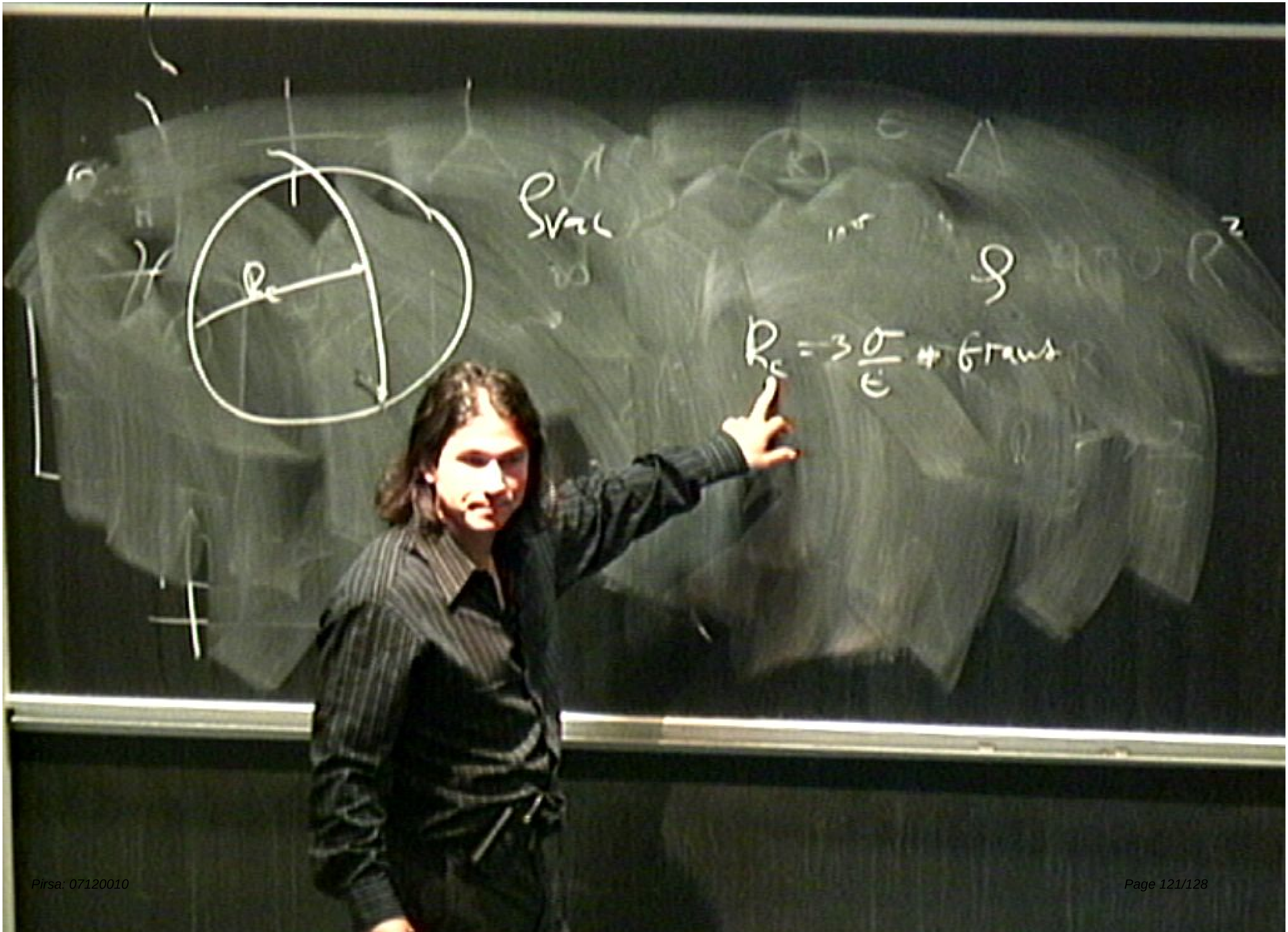
$$\rho_{v_i} = \frac{\Lambda_i}{8\pi G}$$

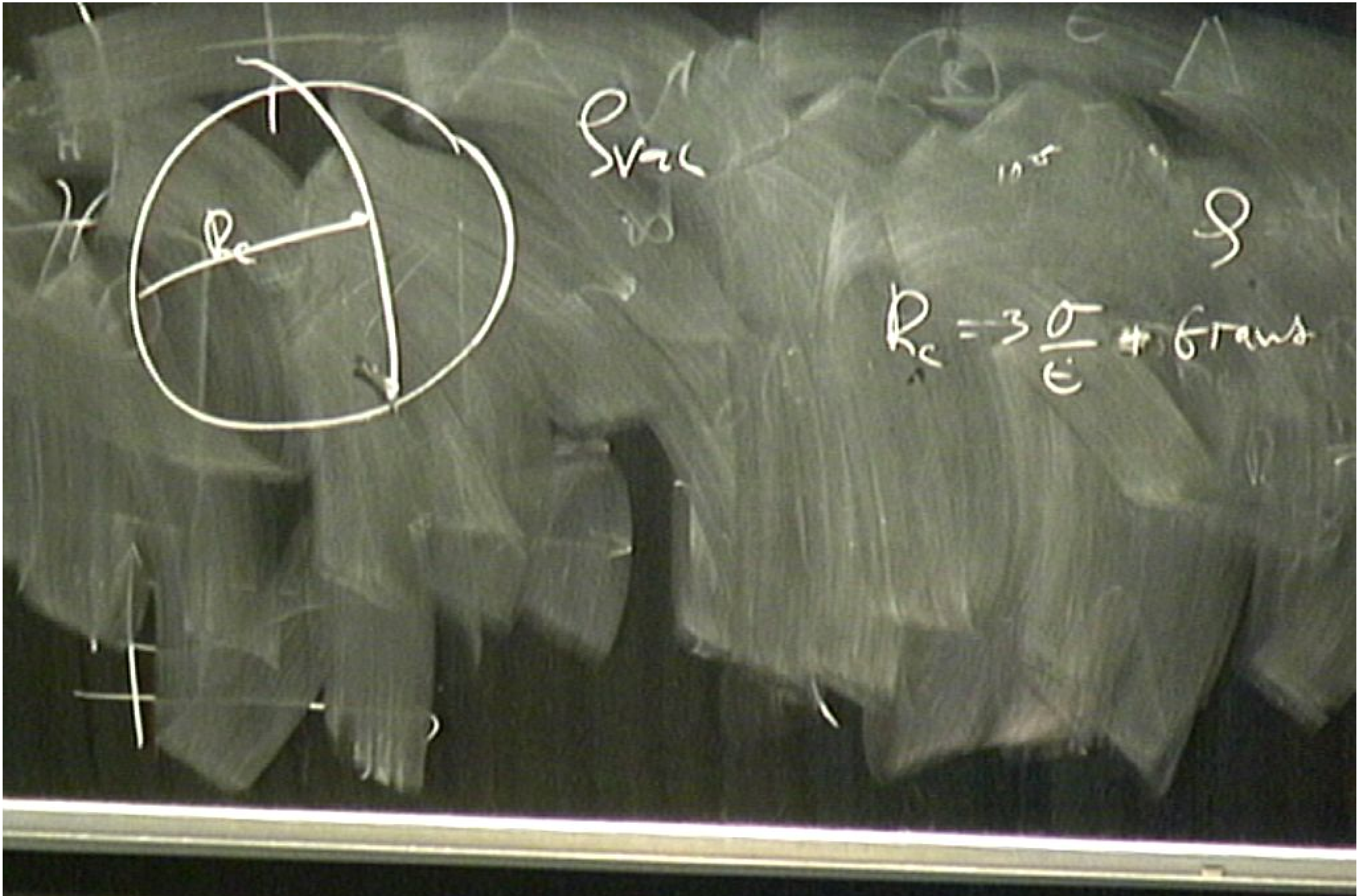
There is a min. negative value of c.c. Anything more negative prevents wall formation in the first place






ρvac
Rc = 3 σ/ε + Grav.


ρvac
Rc = 3 σ/ε


ρvac
Rc
Rc = 3 σ/ε

Heuristic argument

Define a grav. (Tolman) mass density

$$\rho_G = \rho + 3p$$

for a Neg Vacuum

$$\rho_G = +2|\rho_{vac}|$$

i.e. attractive

- Since dynamics of domain walls involves a competition between pressure and tension

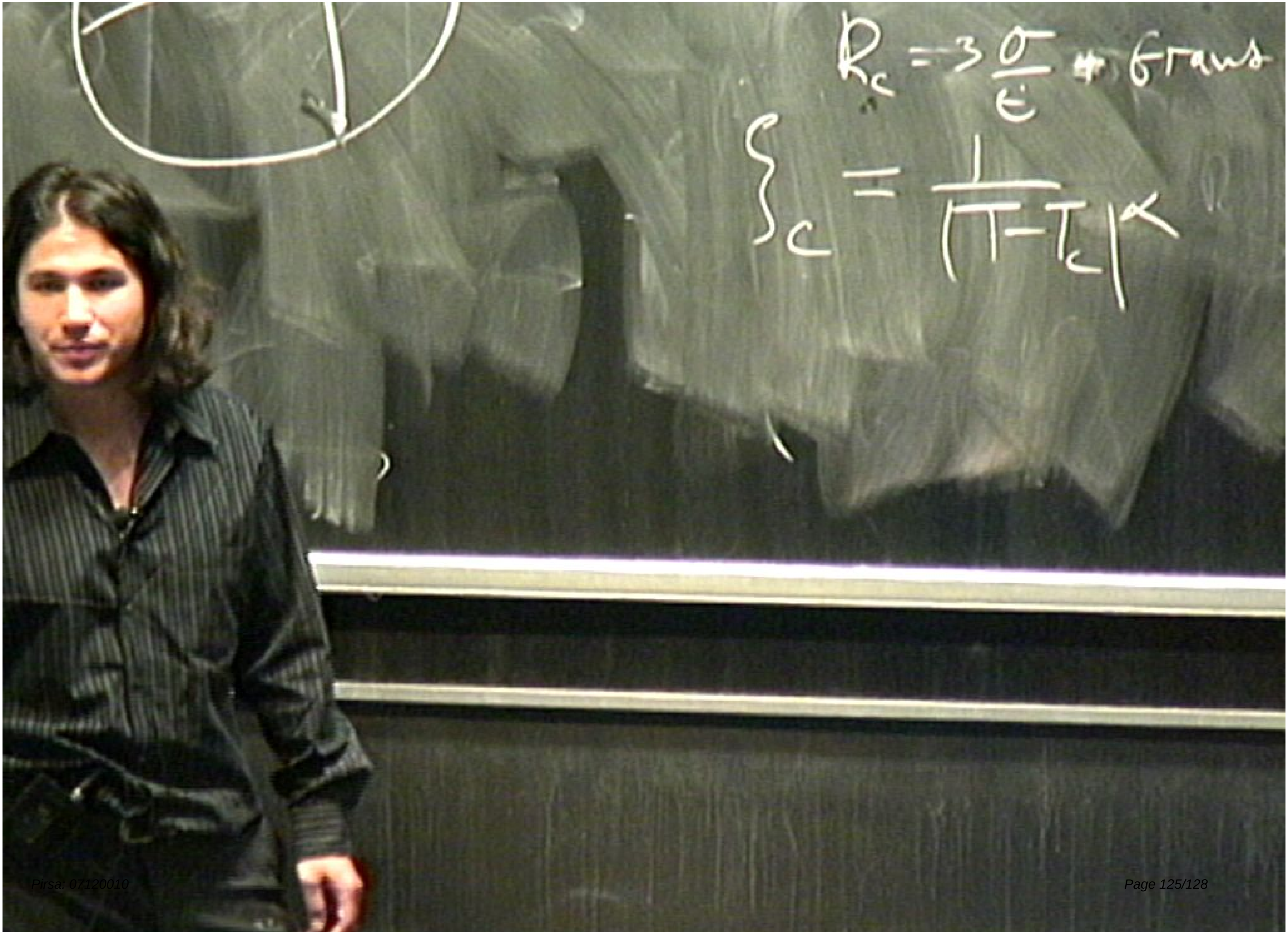
→ the ads force exhibits an attractive force on the wall

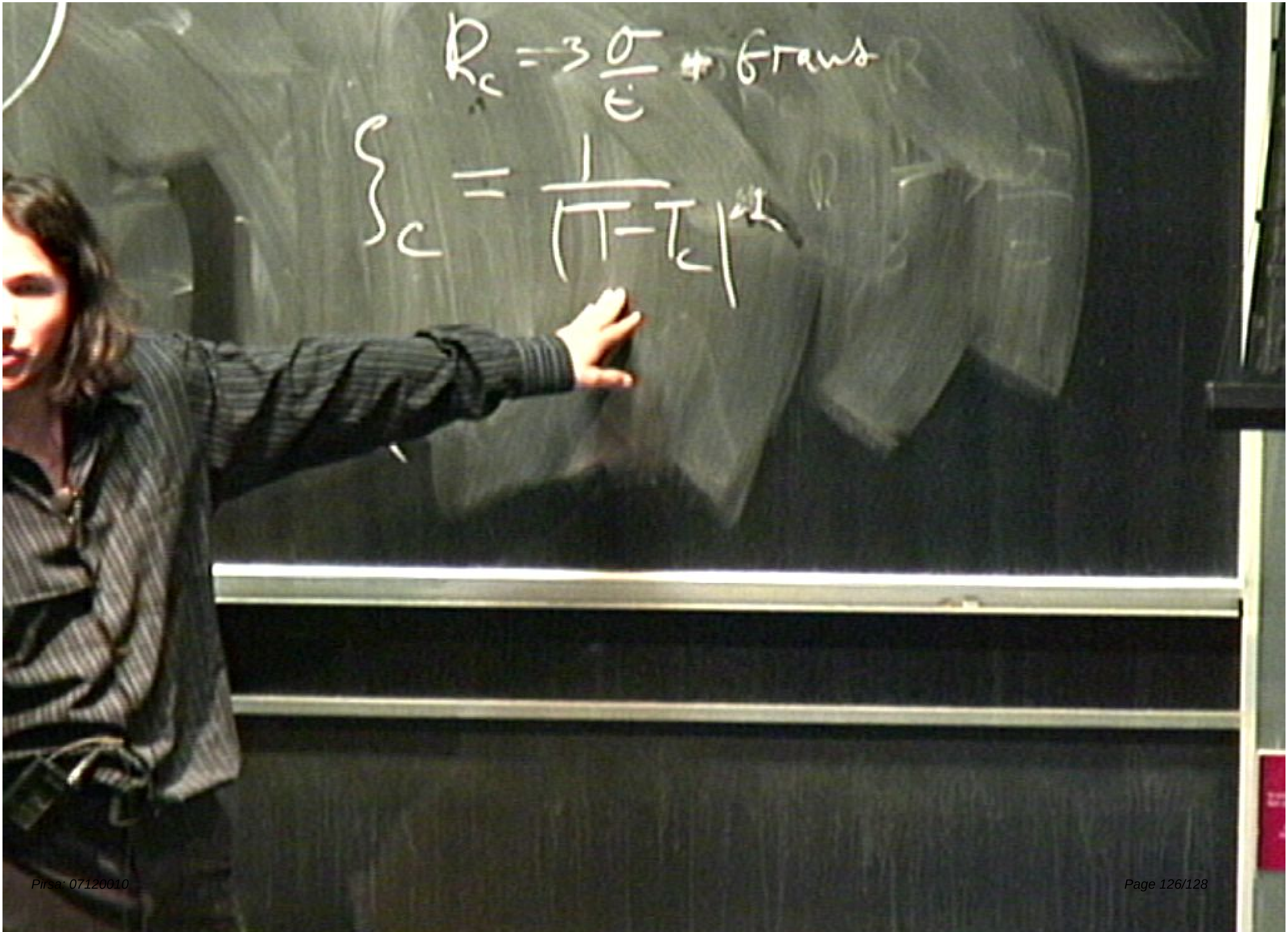
Conclusion

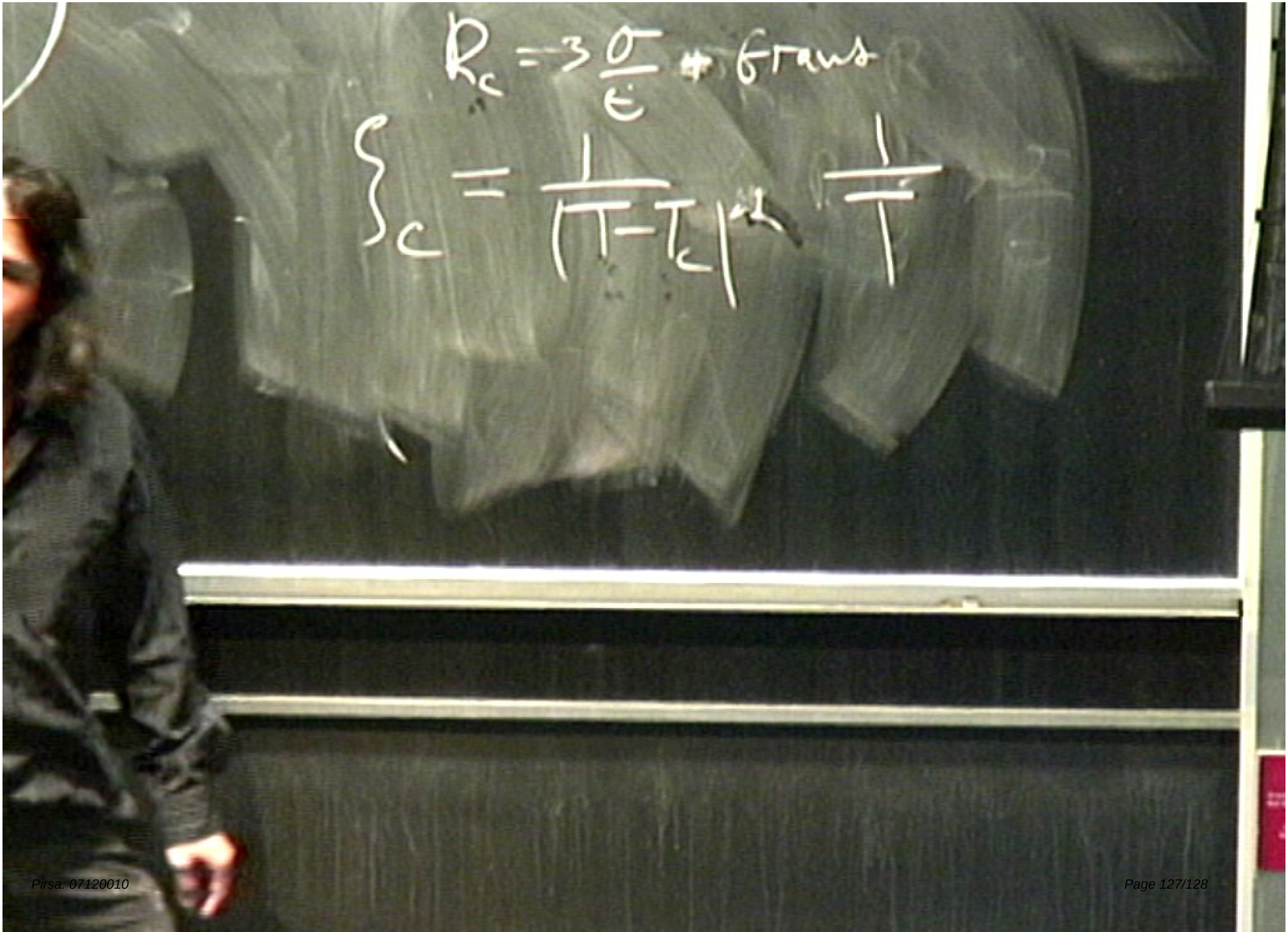
Devaluation: A dynamical, Domain Wall Driven solution to c.c. problem

- inflation
- reheating → rad'n domination
- T < barrier height, universe falls into diff. minima
- Domain Walls shove aside higher energy regions, drive vacuum → near zero

NOT ANTHROPIC


$R_c = 3\frac{\sigma}{\epsilon}$
$\xi_c = \frac{1}{|T-T_c|^{\kappa}}$


$R_c = 3\frac{\sigma}{\epsilon}$ Grans
$\xi_c = \frac{1}{|T-T_c|}$


R_c = 3 σ/ε # grans
ξ_c = 1/|T − T_c|

ℓ

$R_c = 3\frac{\sigma}{\epsilon}$ # grains

$$\xi_c = \frac{1}{|T-T_c|^{1/2}} \quad \frac{1}{T}$$