

Title: Informal Chalk and Talk

Date: Aug 04, 2011 10:30 AM

URL: <http://pirsa.org/11080148>

Abstract: Dr. Smolin is a faculty member at Perimeter Institute for Theoretical Physics and author of several books including most recently

Frontiers of Physics

QM - find $n +$

Frontiers of Physics

QM — find a truer theory

Domain

Gravity



Domain

Gravity

Domain

Gravity $\Rightarrow$ Cosmology

Domain

Gravity $\Rightarrow$ Cosmology, macroscopic

Domain

Not dots,
Gravity $\Rightarrow$ Cosmology, macroscopic

Domain

N of d.o.s, N of copies

Gravity $\Rightarrow$ Cosmology, macroscopic

Domain

N of d.o.s, N of copies

Gravity $\Rightarrow$ Cosmology, macroscopic, B H's

Domain

N of dots, N of copies

Gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

Domain

N of dots, N of copies, life
Gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

Frontiers of Physics

QM — find a true theory

Particle Physics:

Frontiers of Physics

QM — find a true theory

Particle Physics: Standard model

27

Frontiers of Physics

QM — find a true theory

Particle Physics: Standard model

27 free
punch

Frontiers of Physics

QM — find a truer theory

Particle Physics: Standard Model

27 free
parameters

Frontiers of Physics

QM — find a truer theory

Particle Physics: standard model '73 27 free parameters

Frontiers of Physics

QM — find a truer theory

Particle Physics: standard model '73 27 free
dark matter principles

Frontiers of Physics

QM — find a truer theory

Particle Physics: Standard model '73 27 free parameters
dark matter
dark energy?

Domain

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > T_{ev}$ $d < \lambda_{ev}$

Domain

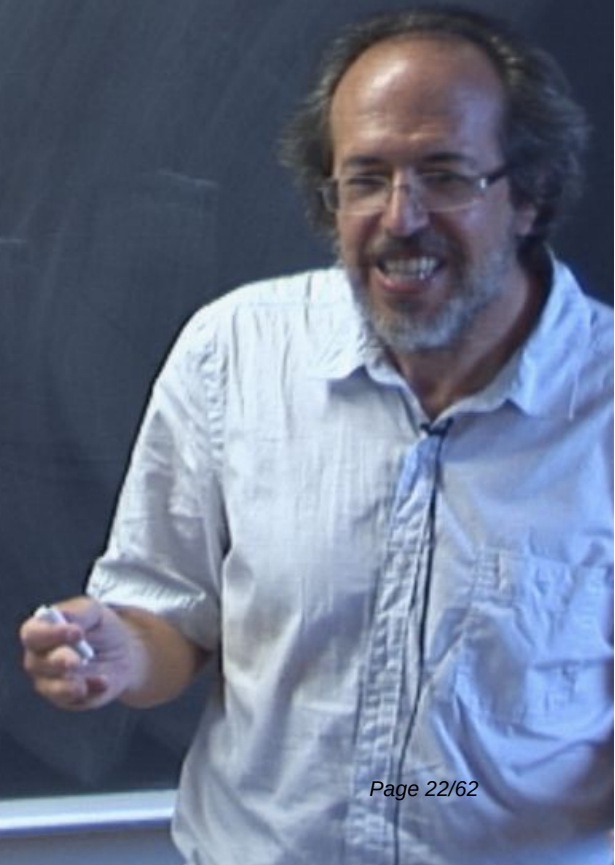
N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$$E > \text{TeV} \quad d < 10^{17} \text{ cm}$$

Domain

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BHs

$E > \text{TeV}$ $d < 10^{17} \text{ cm}$ accelerators
 $E \sim 10^{20} \text{ eV}$ cosmology



Domain

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BHs

$E > \text{TeV}$ $d < 10^{-17} \text{ cm}$ accelerators

$E \sim 10^{20} \text{ eV} \sim 10^8 \text{ TeV}$ cosmology

Frontiers of Physics

QM — find a true theory

Particle Physics: standard model '73 27%
dark matter?
dark energy?

Cosmology

Frontiers of Physics

QM — find a truer theory

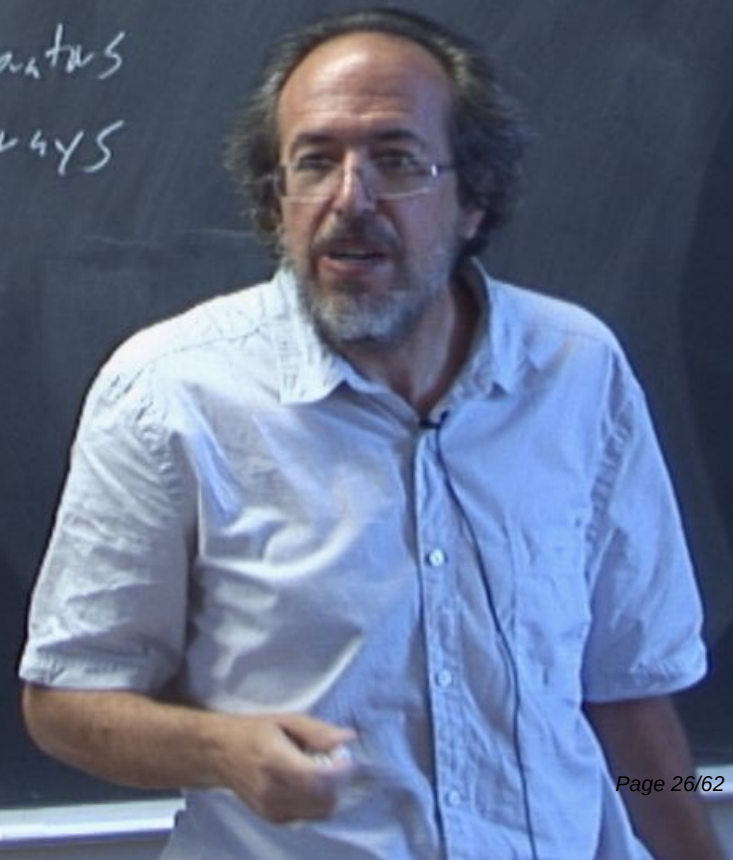
Particle Physics: Standard model '73 27 free parameters
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dark energy?

Special Relativity

Domain Boundary

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BHs

$E > \text{TeV}$ $d < 10^{17} \text{ cm}$ accelerators
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Domain Boundary

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Frontiers of Physics

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Particle Physics: Standard model '73 27 free parameters
dark matter?
dark energy?

Special Relativity

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

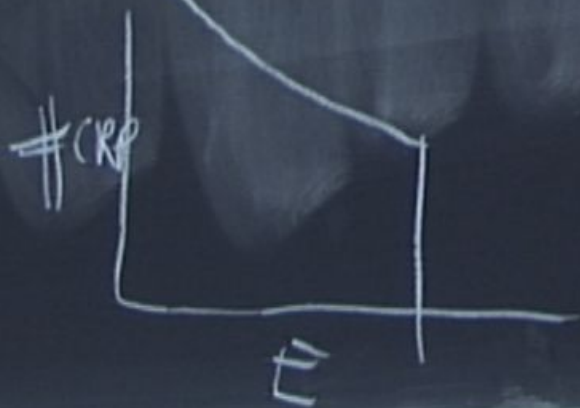
Domain Boundary

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BHs

$E > \text{TeV}$ $d < 10^{17} \text{ cm}$ accelerators

$E \sim 10^{20} \text{ eV} \sim 10^8 \text{ TeV} \sim 10^{11} \text{ cm}$ cosmology

$$\gamma \leq 10^{11}$$



Domain Boundary

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > T_{\text{ev}}$ $d < 10^{17} \text{ m}$ accretion

$E \sim 10^{20} \text{ eV}$

$\gamma \leq 10^{11}$

Cosmology

#CRP

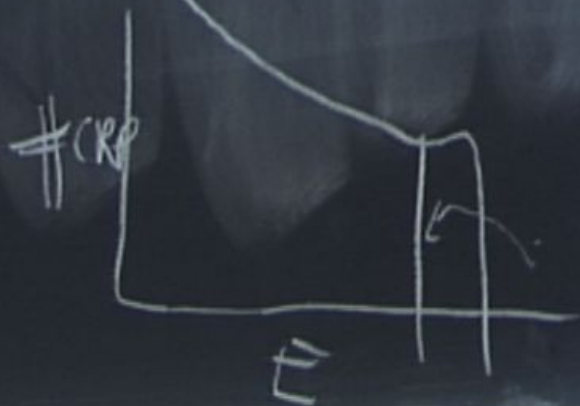
Domain Boundary

N of dots, N of copies, life
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$E > \text{TeV}$ $d < 10^{17} \text{ cm}$ accelerators

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Domain Boundary

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BHs

$E > \text{TeV}$ $d < 10^{-17} \text{ cm}$ accelerators

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Domain Boundary

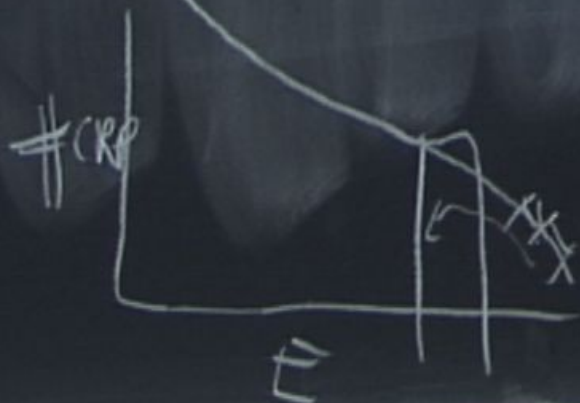
N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > \text{TeV}$ $d < 10^{-17} \text{ cm}$ accelerators

$E \sim 10^{20} \text{ eV} \sim 10^8 \text{ TeV} \sim 10^{11} \text{ GeV}$ cosmology

$$\gamma \leq 10^{11}$$

$$V(\gamma) = C +$$



Domain Boundary

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > T_{\text{Pl}}$ $d < 10^{-17} \text{ cm}$ accelerates

$E \sim 10^{19} \text{ TeV} \sim 10^{11} \text{ GeV}$ cosmology

$\gamma \leq$

$V(\gamma) = C + ?$

Domain Boundary

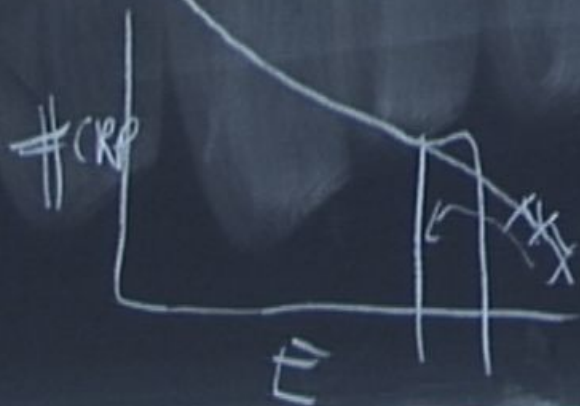
N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > \text{TeV}$ $d < 10^{17} \text{ cm}$ accelerators

$E \sim 10^{20} \text{ eV} \sim 10^8 \text{ TeV} \sim 10^{11} \text{ GeV}$ cosmology

$\gamma \leq 10^{11}$

$V(\gamma) = C + ?$



Domain Boundary

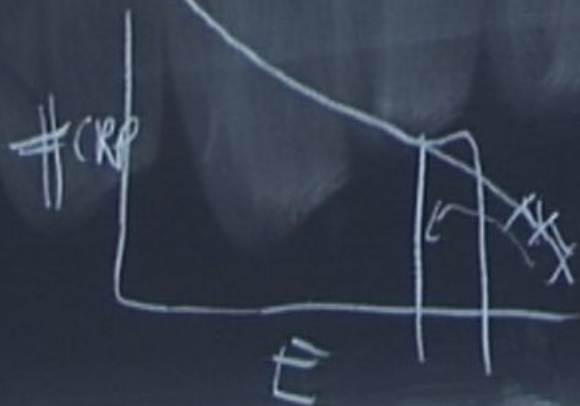
N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > \text{TeV}$ $d < 10^{17} \text{ cm}$ accelerators

$E \sim 10^{20} \text{ eV} \sim 10^8 \text{ TeV} \sim 10^{11} \text{ GeV}$ cosmology

$$\gamma \leq 10^{11}$$

$$V(\gamma) = C \pm E$$



Domain Boundary

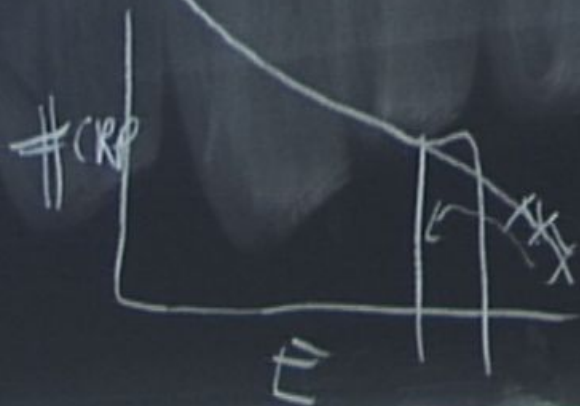
N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > \text{TeV}$ $d < 10^{17} \text{ cm}$ accelerators

$E \sim 10^{20} \text{ eV} \sim 10^8 \text{ TeV} \sim 10^{11} \text{ GeV}$ cosmology

$$\gamma \leq 10^{11}$$

$$V(\gamma) = C \pm \frac{E}{E_0}$$



Domain Boundary

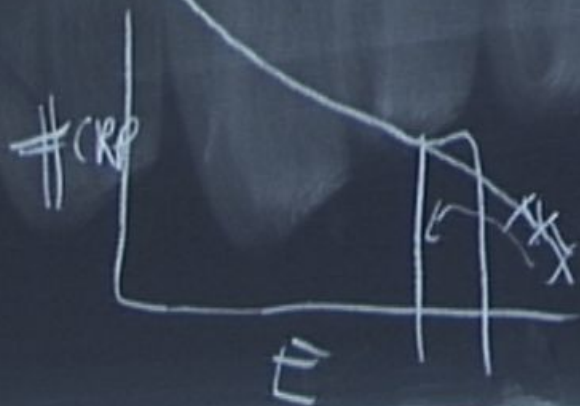
N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > \text{TeV}$ $d < 10^{17} \text{ cm}$ accelerators

$E \sim 10^{20} \text{ eV} \sim 10^8 \text{ TeV} \sim 10^{11} \text{ GeV}$ cosmology

$$\gamma \leq 10^{11}$$

$$V(\gamma) = C \pm \frac{E}{E_0} C$$



Domain Boundary

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH's

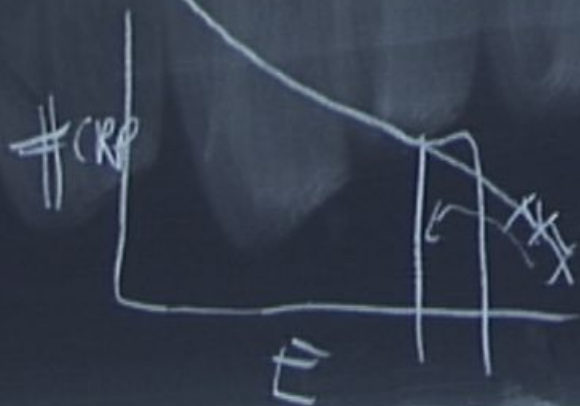
$E > \text{TeV}$ $d < 10^{-17} \text{ cm}$ accelerators

$E_0 > ?$

$E \sim 10^{20} \text{ eV} \sim 10^8 \text{ TeV} \sim 10^{11} \text{ GeV}$ cosmology

$\gamma \leq 10^{11}$

$$V(\gamma) = C \pm \frac{E}{E_0} C$$



Domain Boundary

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH's

$E > T_{\text{ev}}$ $1 / 10^{17} \text{ cm}$ accelerates

$E \sim 10^2$ $T_{\text{ev}} \sim 10^{11} \text{ cm}$ cosmology

$\gamma \leq$

$$V(r) = C \pm \frac{E}{E_0} C$$

$E_0 > ?$

Domain Boundary

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

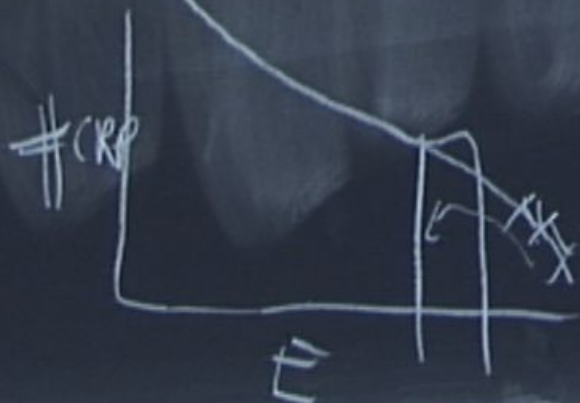
$$E > \text{TeV} \quad d < 10^{17} \text{ cm} \quad \text{accelerators}$$

$$E > ?$$

$$E \sim 10^{20} \text{ eV} \sim 10^8 \text{ TeV} \sim 10^{11} \text{ cm} \quad \text{cosmology}$$

$$\gamma \leq 10^{11}$$

$$V(\gamma) = C \pm \frac{E}{E_0} C$$



Domain Boundary

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > \text{TeV}$ $d < 10^{17} \text{ cm}$ accelerators

$E > ?$

$E \sim 10^{20} \text{ eV}$

10^{11} cm cosmology

$\gamma \leq 10$

$$V(r) = C \pm \frac{E}{E_0} C$$

L 

Domain Boundary

$$\Delta T = T \frac{E}{E_0}$$

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH's

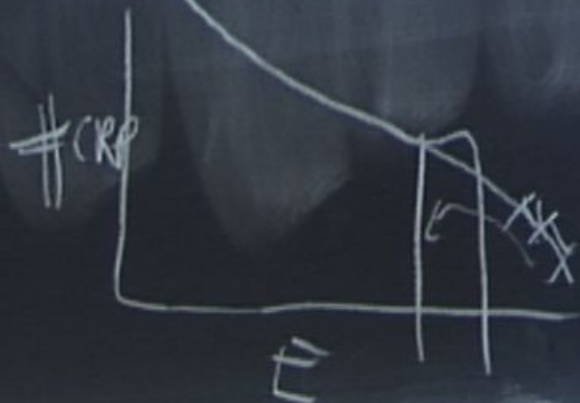
$E > T \text{ eV}$ $d < 10^{17} \text{ cm}$ accelerator

$E \sim 10^{20} \text{ eV} \sim 10^8 \text{ TeV} \sim 10^{11} \text{ GeV}$ cosmology

$$\gamma \leq 10^{11}$$

$E_0 > ?$

$$\frac{E}{E_0} c$$



Domain Boundary

$$\Delta T = T \frac{E}{E_0}$$

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > T \text{ eV}$ $d < 10^{-17} \text{ cm}$ accelerators

$$E \sim 10^{20} \text{ eV}$$

10^{11} cosmology

$$\gamma \leq 10^{11}$$

#CRP

$$E_0 > 12 E_{\text{plan}}$$

$$V(r) = C \pm \frac{E}{E_0} C$$

H

L 

Domain Boundary

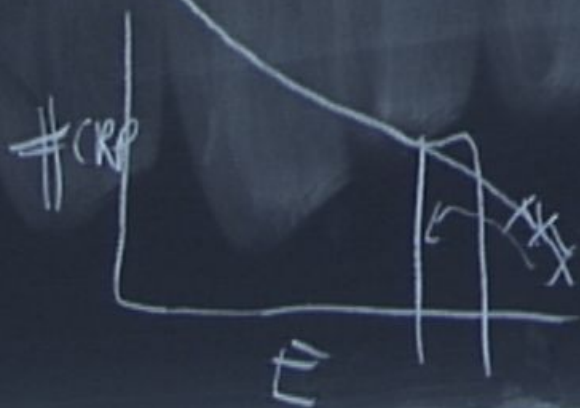
$$\Delta T = T \frac{E}{E_0}$$

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH's

$E > T_{ev}$ $d < 10^{17}$ cm accelerates

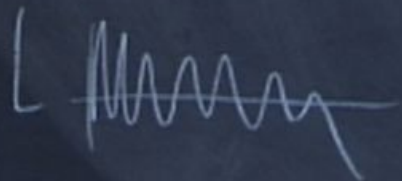
$E \sim 10^{20}$ eV $\sim 10^8$ TeV $\sim 10^{11}$ GeV cosmology

$$\gamma \leq 10^{11}$$



$$E_0 > 1.2 E_{pl}$$

$$V(\gamma) = C \pm \frac{E}{E_0} C$$



Domain Boundary

$$\Delta T = T \frac{E}{E_0}$$

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

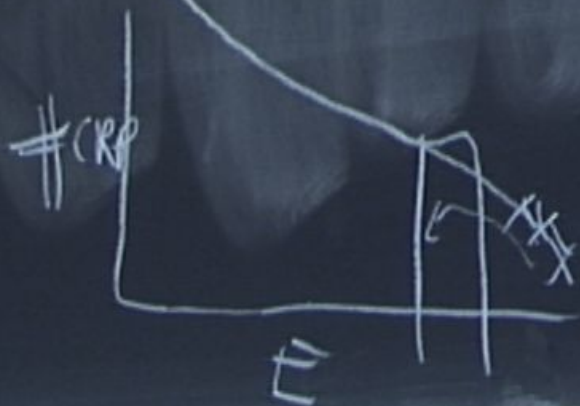
$$E > T_{\text{ev}} \quad d < 10^{17} \text{ cm} \quad \text{accelerators}$$

$$E \sim 10^{20} \text{ eV} \sim 10^8 T_{\text{ev}} \sim 10^{11} \text{ GeV} \quad \text{cosmology}$$

$$\gamma \leq 10^{11}$$

$$E_0 > 12 E_{\text{plan}}$$

$$V(\gamma) = C \pm \frac{E}{E_0} C$$



Domain Boundary

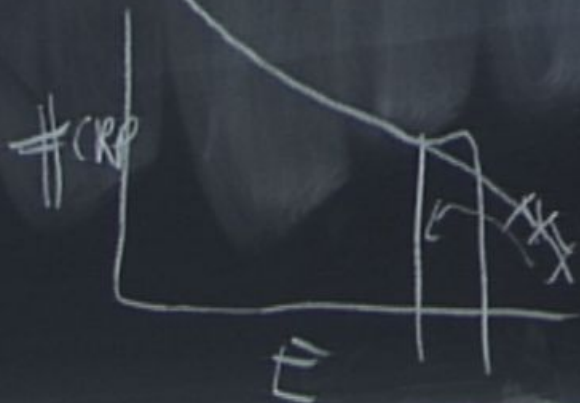
$$\Delta T = T \frac{E}{E_0}$$

N of dots, N of copies, life
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$$\gamma \leq 10^{11}$$



$$V(\gamma) = C$$

H
L

Domain Boundary

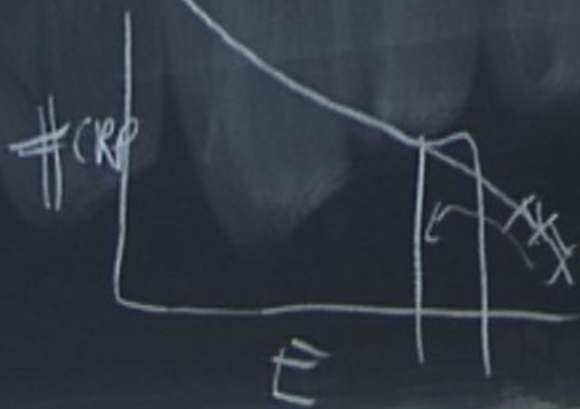
$$\Delta T = T \frac{E}{E_0}$$

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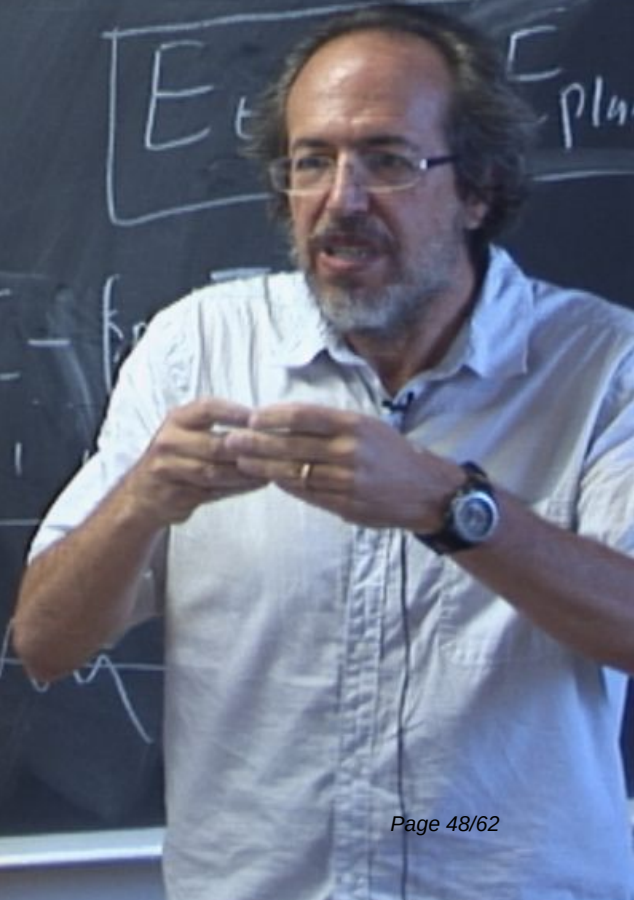
$\gamma \leq 10^{11}$



$$V(\gamma) = C - \dots$$

H
L

$$\boxed{E_t \quad E_{pl}}$$



Domain Boundary

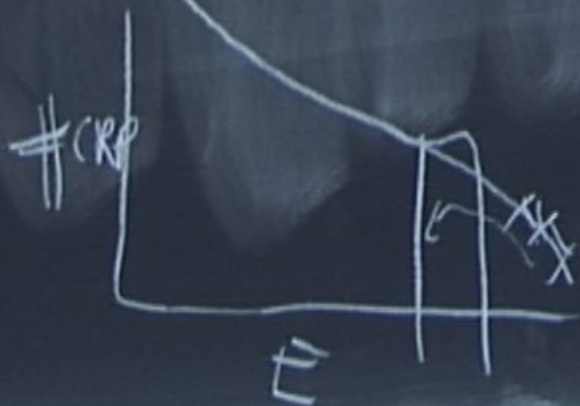
$$\Delta T = \frac{T E}{E_0}$$

N of dots, N of copies, life
gravity $\Rightarrow$ Cosmology, macroscopic, BH-s

$E > T_{ev}$ $d < 10^{17} \text{ cm}$ accelerates

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$$\gamma \leq 10^{11}$$



$$E_0 > 12 E_{pl}$$

$$V(\gamma) = C - \left(\frac{E_{pl}}{E_0} \right) \frac{E}{E_0}$$



Domain Boundary

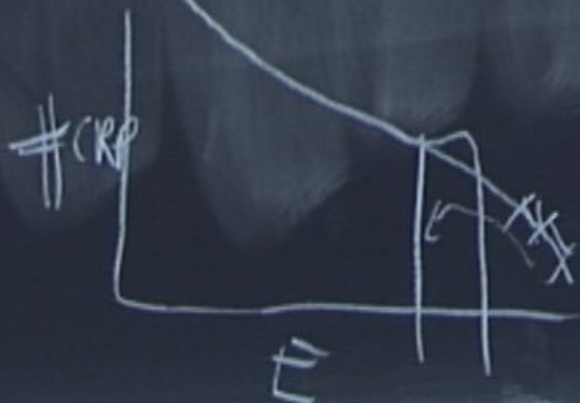
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$$E_0 > 1.2 E_{pl}$$

$$V(\gamma) = C - \left(\frac{E_{pl}}{E_0} \right) C$$

H



$$E_0 > 10^7 E_{pl}$$

polarized

Domain Boundary

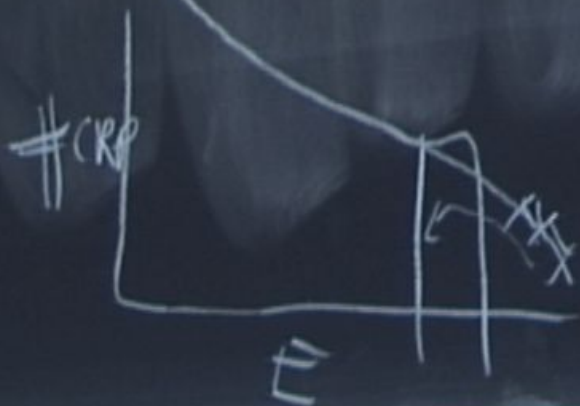
$$\Delta T = T \frac{E}{E_0}$$

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$$E_0 > 12 E_{pl}$$

$$V(\gamma) = C - \left(\frac{E_{pl}}{E_0} \right) C$$

H

L

$$E_0 > 10^7 E_{pl}$$

polarized

Frontiers of Physics

QM — find a truer theory

Particle Physics: Standard model '73 27 free parameters
dark matter?
dark energy?

Special Relativity $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \sim \frac{E}{m}$

Cosmology

Frontiers of Physics

QM — find a truer theory

Particle Physics: Standard model '73 27 free parameters
dark matter?
energy?

Special Relativity $\frac{1}{\sqrt{1-v^2/c^2}} \sim \frac{E}{m}$

Cosmology

Frontiers of Physics

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Cosmology $\rightarrow$ the universe

Frontiers of Physics

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dark energy?

Special Relativity

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \sim$$

Cosmology

$t > t_{\text{hul}}$

Frontiers of Physics

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dark matter
dark energy?

Special Relativity

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \sim \frac{E}{m}$$

Cosmology

$t > t_{\text{hydrogen}}$ $R < R_{\text{H}}$

Frontiers of Physics

QM — find a true theory

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dark matter?
dark energy?

Special Relativity $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \sim \frac{E}{m}$

Cosmology

further back in time

$t > t_{\text{hydrogen recombination}} \quad R < R_{\text{H}}$

Frontiers of Physics

QM — find a truer theory

Particle Physics: Standard model '73 27 free
dark matter
dark energy?

Special Relativity

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \sim \frac{E}{m}$$

Cosmology

$t > t_{\text{today}}$ $R < R_{\text{H}}$

- further back in time
- the far future

Frontiers of Physics

QM — find a truer theory

Particle Physics: Standard model '73 27 free
dark matter?
dark energy? — accelerated expansion

Special Relativity

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \sim \frac{E}{m}$$

Cosmology

$t > t_{\text{today}}$ $R < R_{\text{H}}$

- further back in time
- the far future -
- Far away

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dark energy? — accelerated expansion

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Cosmology

$t > t_{\text{hydrogen recombination}} \quad R < R_{\text{H}}$

- further back in time
- the far future?
- Far away?

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Special Relativity $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \sim \frac{E}{m}$

Cosmology

- further back in time
- the far future?
- Far away?

$t > t_{\text{hydrogen recombination}}$ $R < R_{\text{Hubble}}$
Singularity