

Title: PSI 2010 - Theoretical Physics - Lecture 5B

Date: Aug 27, 2010 10:30 AM

URL: <http://pirsa.org/10080037>

Abstract:

$$(\alpha|\uparrow\rangle + \beta|\downarrow\rangle)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$$

$$(\alpha|\uparrow\rangle + \beta|\downarrow\rangle)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k} (|\uparrow\rangle^k |\downarrow\rangle^{N-k})$$

$$(\alpha|\uparrow) + \beta|\downarrow\rangle)^N$$

$$= \sum_k \binom{N}{k} \alpha^k \beta^{N-k}$$

$$\binom{N}{N}$$

$$(\alpha|\uparrow\rangle + \beta|\downarrow\rangle)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k}$$

$$\langle 4 | \left(\frac{N_{\uparrow}}{N} \right) | 4 \rangle$$

$$= \sum_k \binom{N}{k} \alpha^k \beta^{N-k} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$$

$$= \sum_k \binom{N}{k} (|\alpha|^2)^k (|\beta|^2)^{N-k} \left(\frac{k}{N}\right)$$

$$\frac{k}{N} = |\alpha|^2$$

$$= \sum_k \binom{N}{k} \alpha^k \beta^{N-k} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$$

$$= \sum_k \binom{N}{k} (|\alpha|^2)^k (|\beta|^2)^{N-k} \left(\frac{k}{N}\right)$$

$$\frac{k}{N} = |\alpha|^2$$

$$(\alpha|\uparrow) + \beta|\downarrow)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k}$$

$$\langle 4 | \binom{N_{\uparrow}}{N} | 4 \rangle = \sum_k \binom{N}{k} (|\alpha|^2)^k (|\beta|^2)^{N-k}$$

$$1 = \langle 4 | 4 \rangle = \sum_k \binom{N}{k} (|\alpha|^2)^k (|\beta|^2)^{N-k}$$

$$(\alpha|\uparrow) + \beta|\downarrow)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k}$$

$$\langle 4 | \binom{N}{k} | 4 \rangle = \sum_k \binom{N}{k} (|\alpha|^2)^k (|\beta|^2)^{N-k}$$

$$1 = \langle 4 | 4 \rangle = \sum_k \binom{N}{k} (|\alpha|^2)^k (|\beta|^2)^{N-k}$$

$$\frac{1}{n!} \left(\sum_{h=1}^n \frac{1}{h!} \right)^n$$

$$\sum_n \frac{1}{n!} \left(\sum_{B \neq H} \right)^{3n}$$

$$\sum_n \frac{1}{n!} \left(\frac{S_{BH}}{n} \right)^{3n}$$

$$3n \log S_{BH} - 3n \log n - \log n!$$

$$\sum_n \frac{1}{n!} \left(\frac{S_{\text{BH}}}{n} \right)^{3n}$$

$$3n \log S_{\text{BH}} - 3n \log n - \log n!$$

$$= 3n \log S_{\text{BH}} - 4n \log n + n$$

$$\frac{d}{dn}$$

$$\frac{d}{dn} : 3 \log S_{\text{BH}} - 4 \log n - 3 = 0$$

$$\frac{d}{dn} : 3 \log S_{BH} - 4 \log n - 3 = 0$$

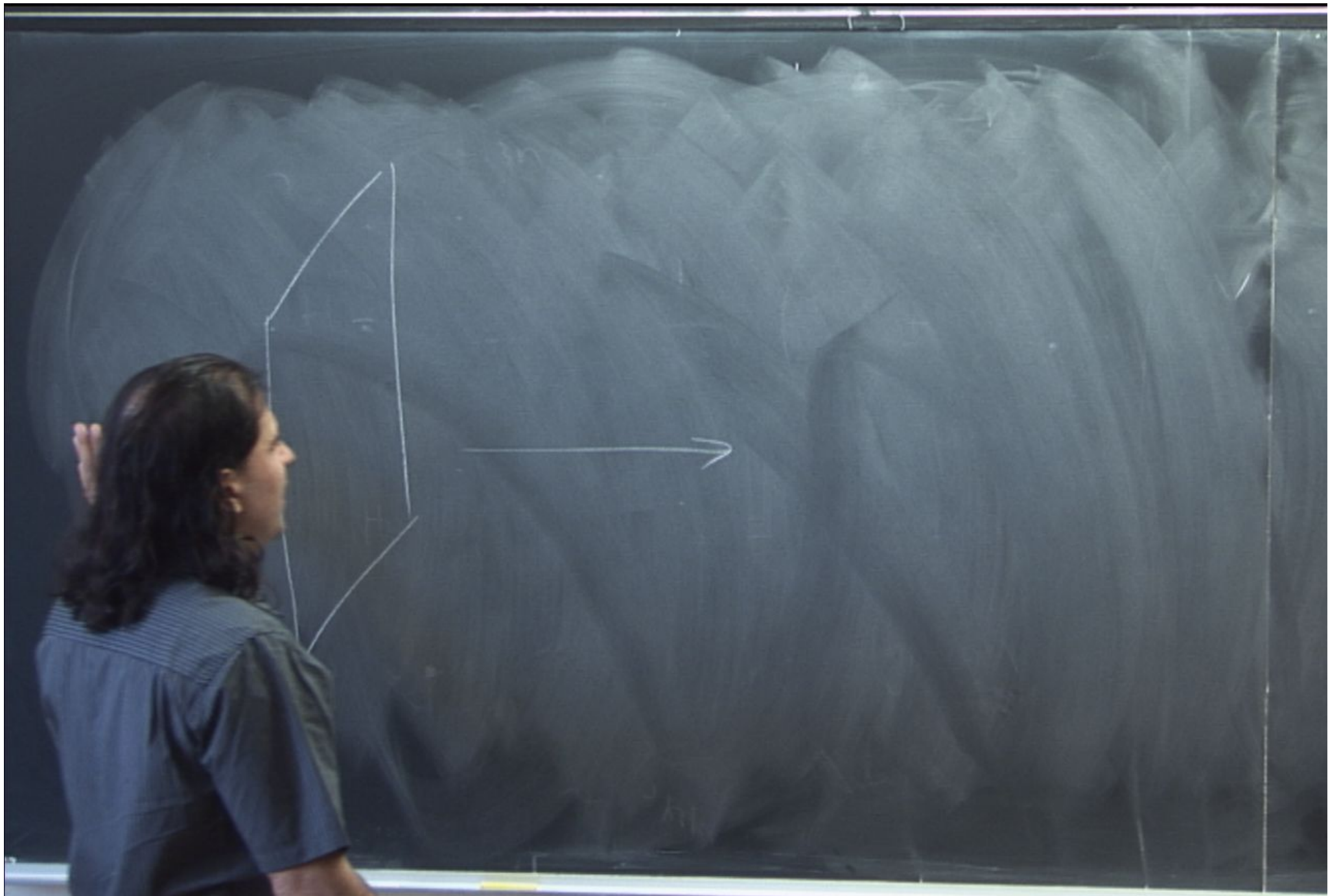
$$n = S_{BH}^{3/4}$$

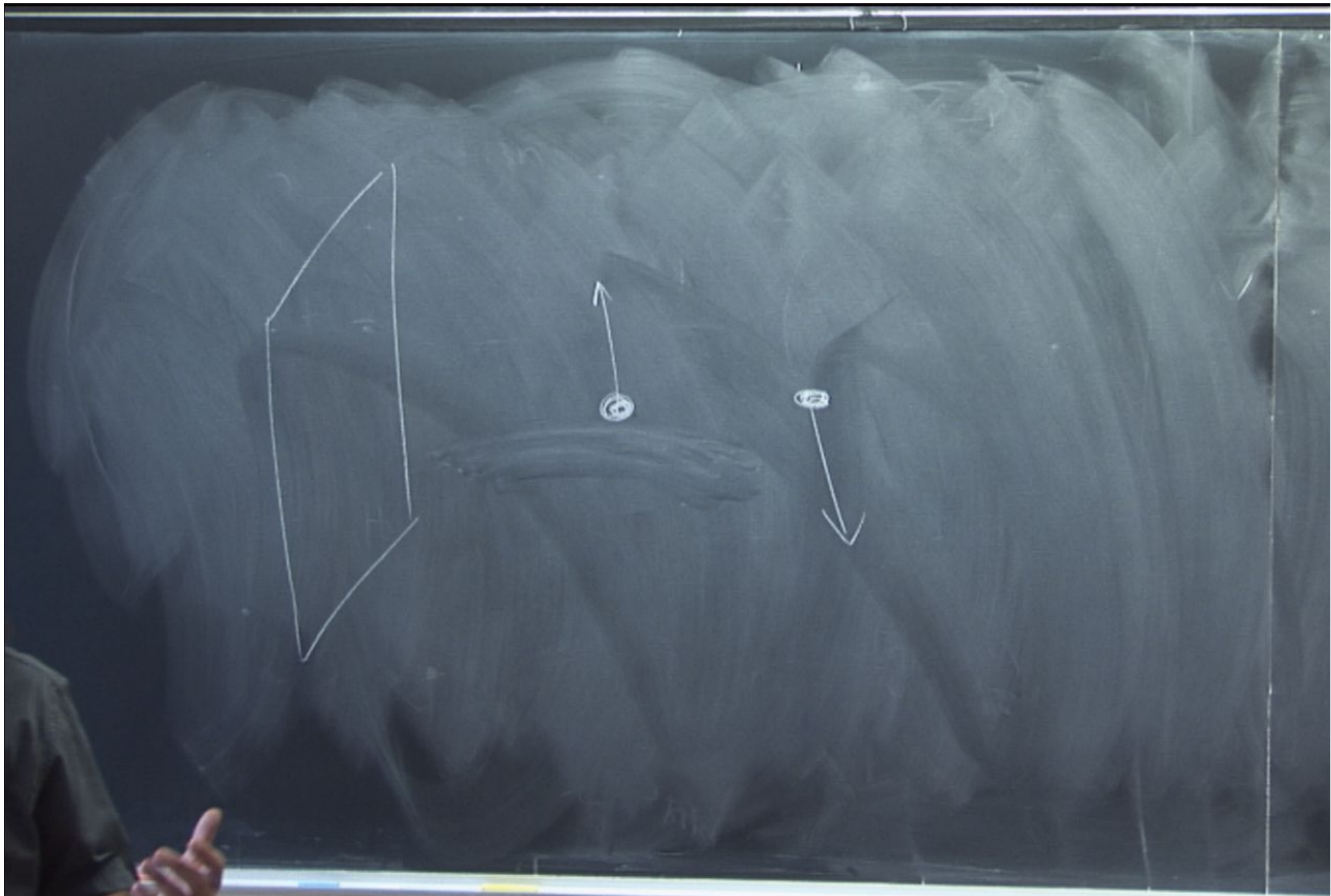
$$\dim H = \sum_n \frac{1}{n!} \left(\frac{S_{BH}}{n} \right)^{3n}$$

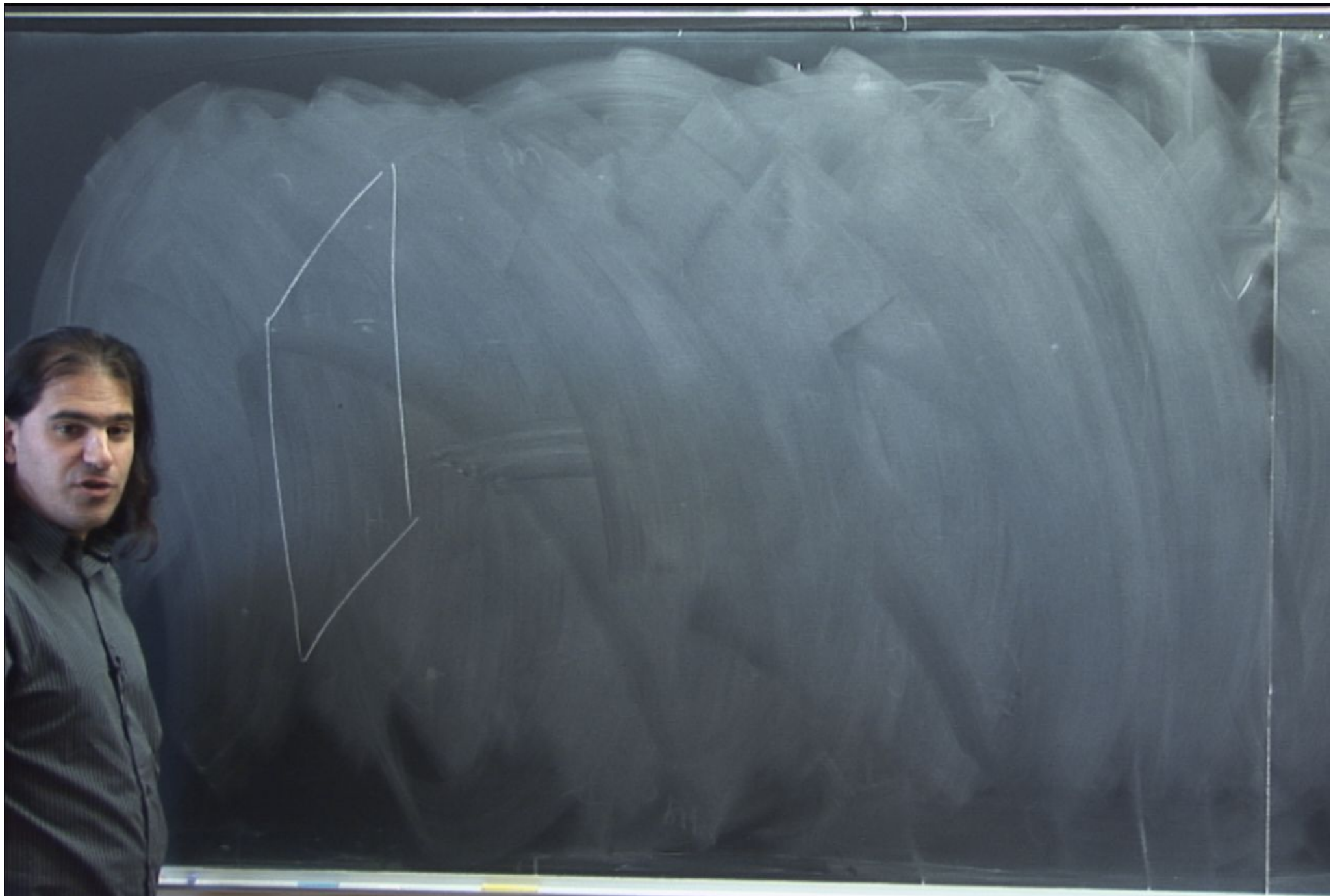
$$\log \dim H = 3n \log S_{BH} - 3n \log n - \log n!$$

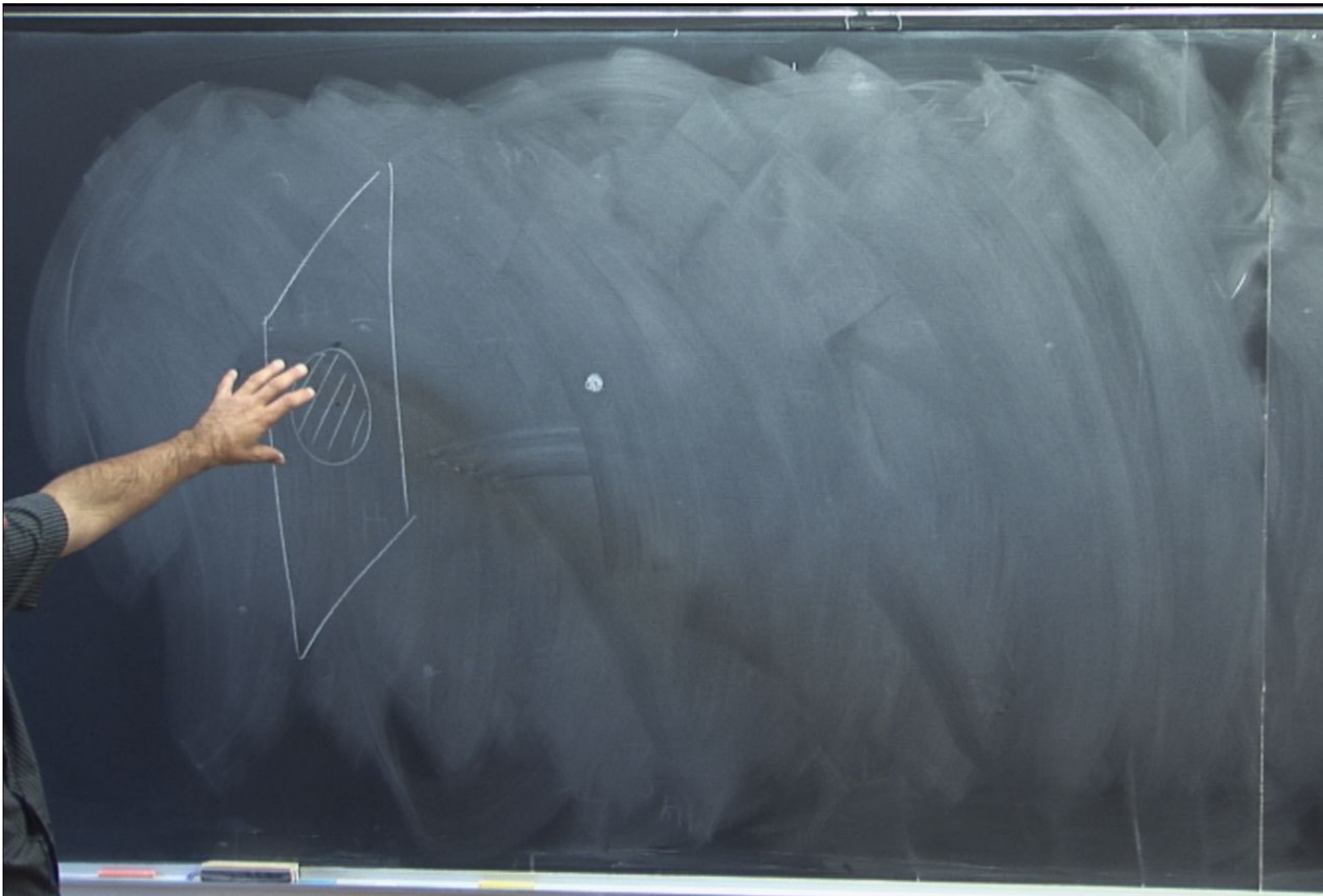
$$= 3n \log S_{BH} - 4n \log n + n$$

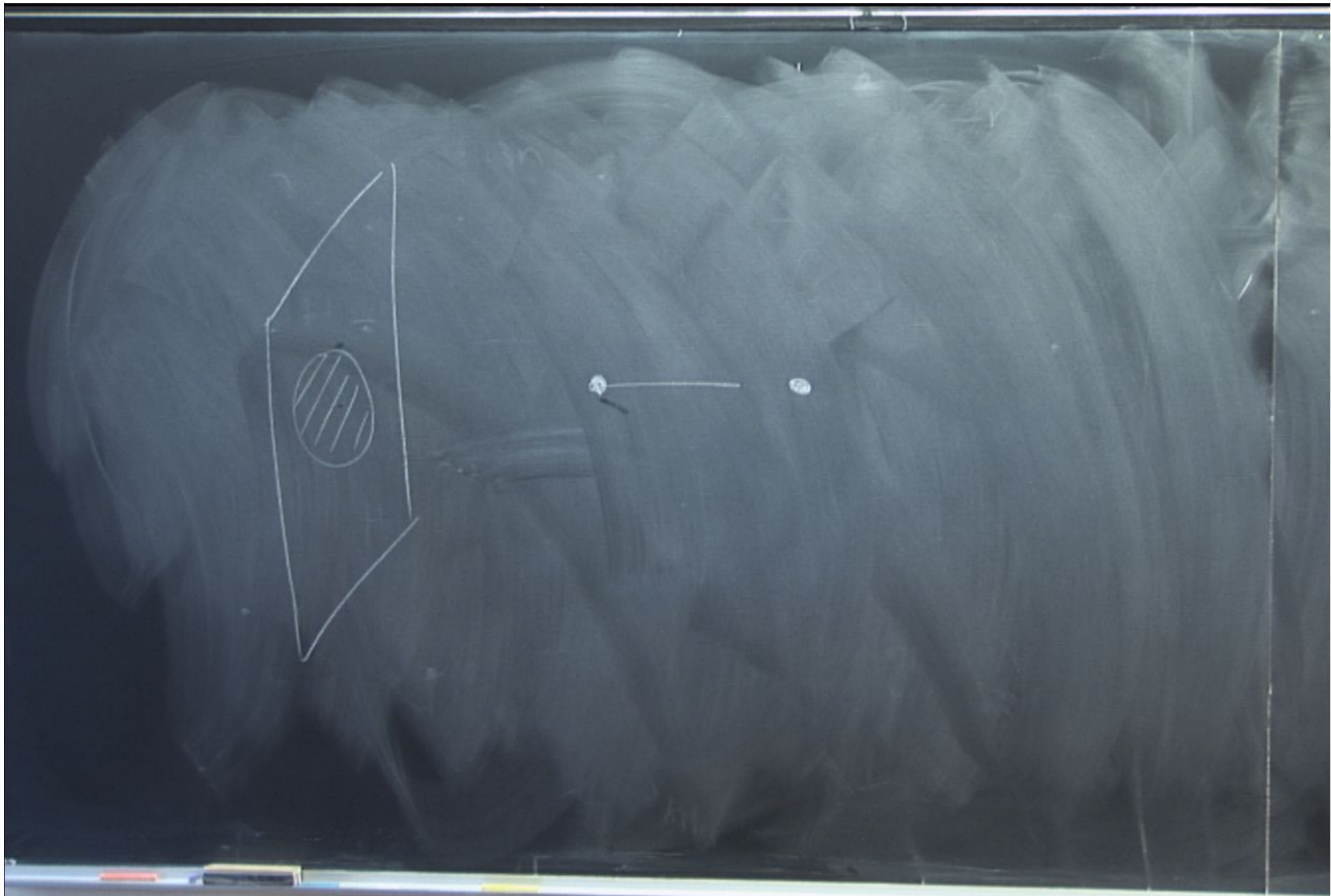
$$\sim S_{BH}^{3/4}$$

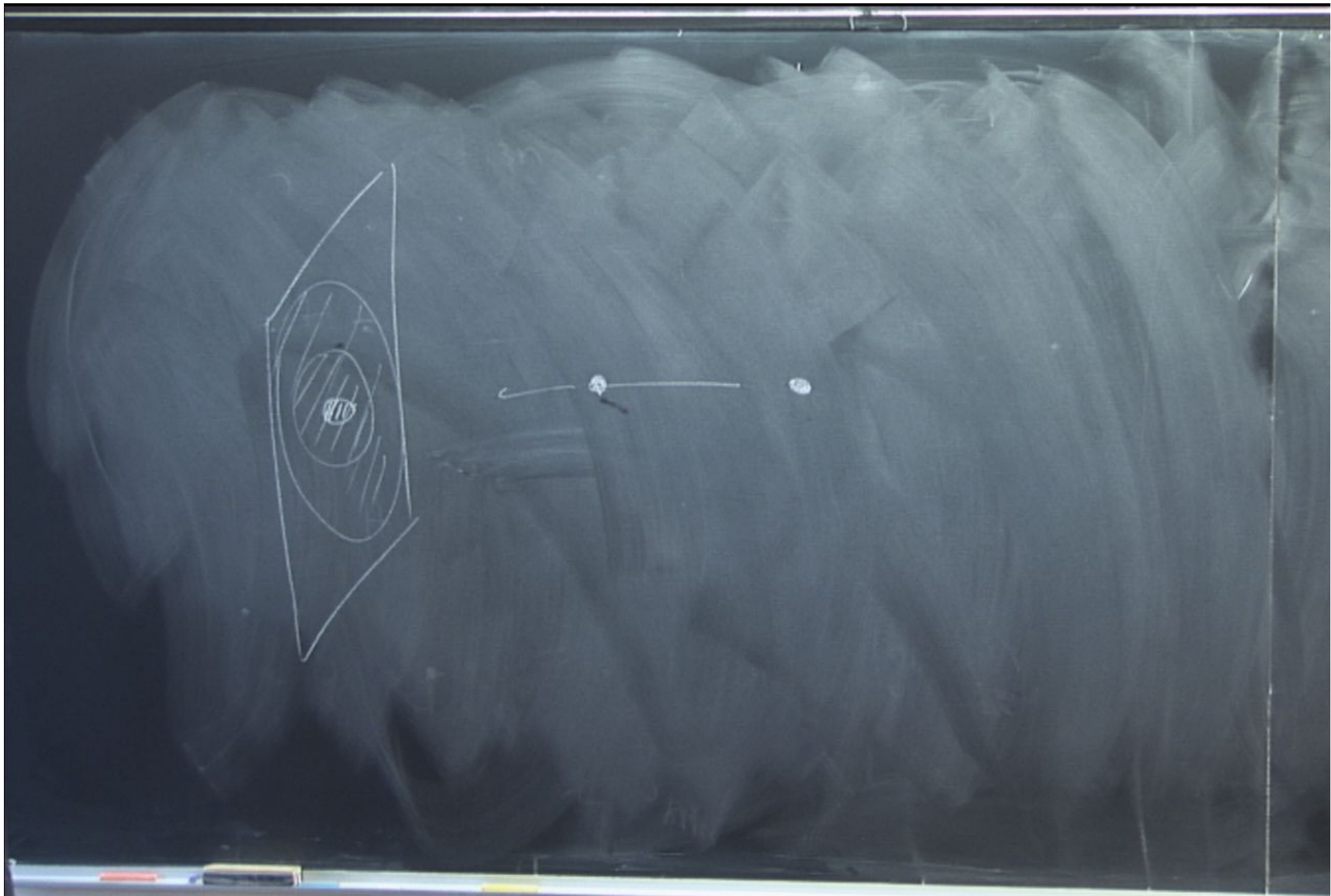


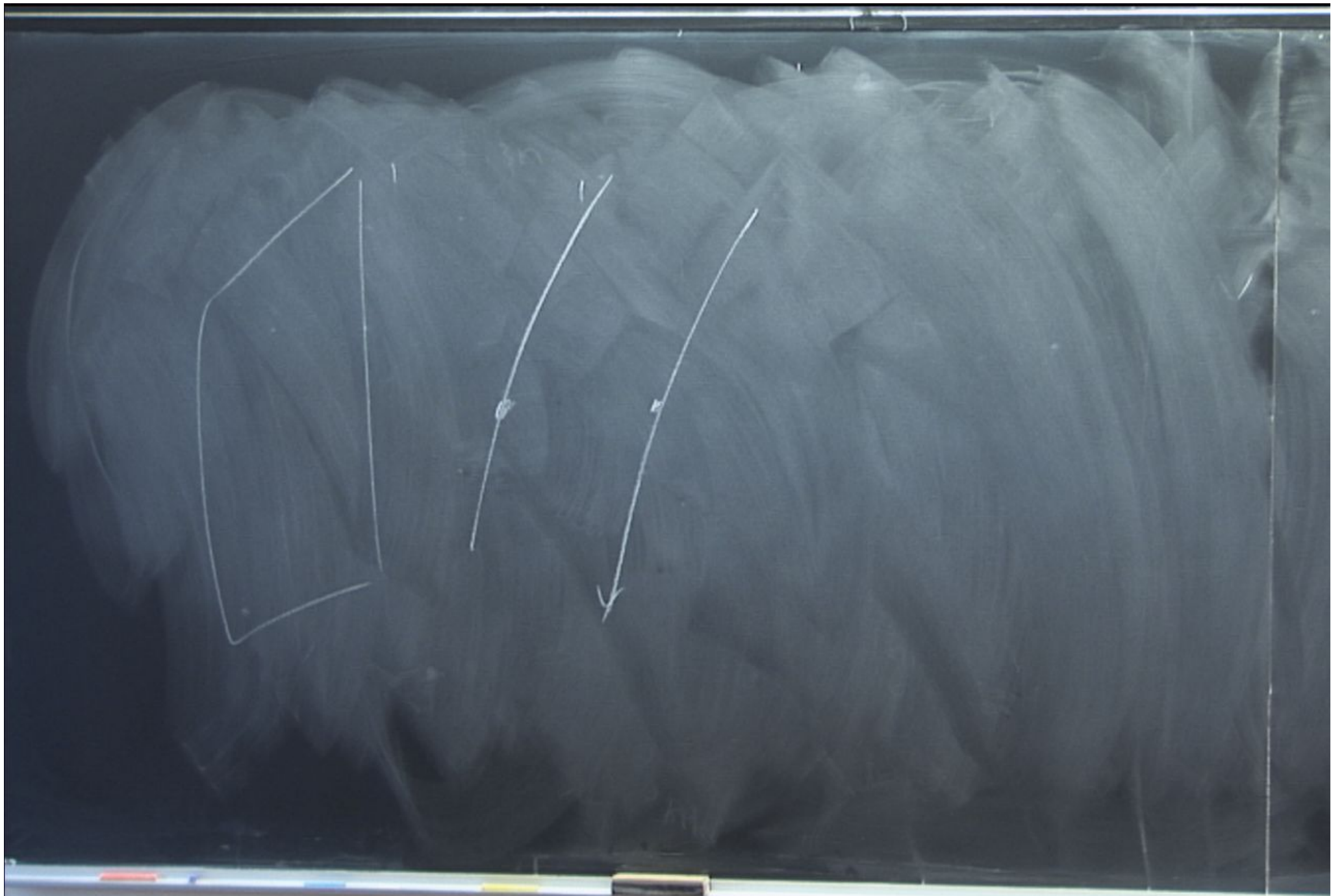












$$ds^2 = -dt^2 + d\vec{x}^2$$

$$ds^2 = dt^2 - d\vec{x}^2$$

Minkowski

$$ds^2 = dt^2 - e^{2Ht} d\vec{x}^2$$

de Sitter

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Minkowski

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de Sitter

Minkowski

$$dt e^{-Ht} = d\tau$$

de Sitter

Minkowski

$$dt e^{-Ht} = d\tau$$

de Sitter

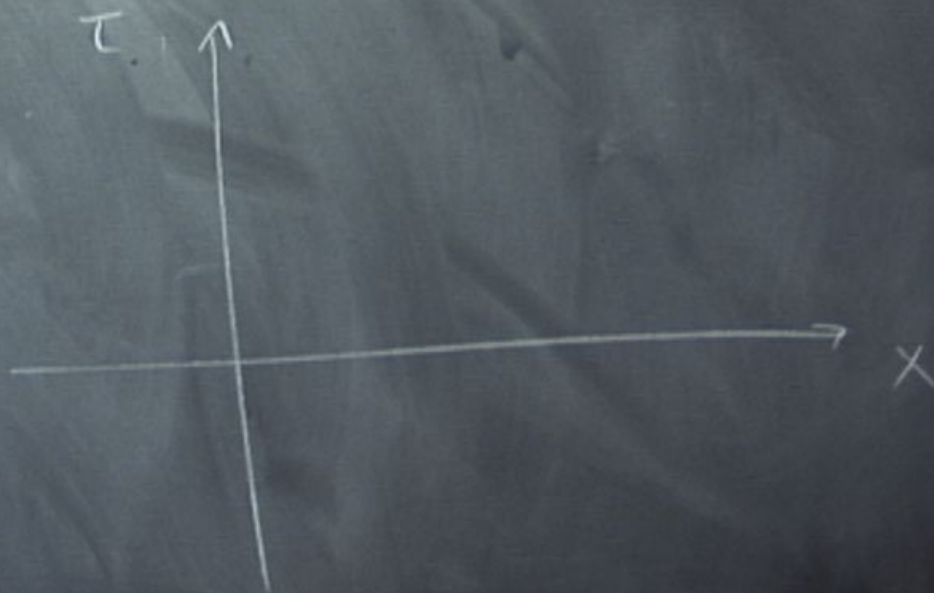
$$\frac{1}{2} \left(d\tau^2 - d\vec{x}^2 \right)$$

Minkowski

de Sitter

$$\frac{1}{2} \left(d\tau^2 - dx^2 \right)$$

$$dt e^{-Ht} = d\tau$$

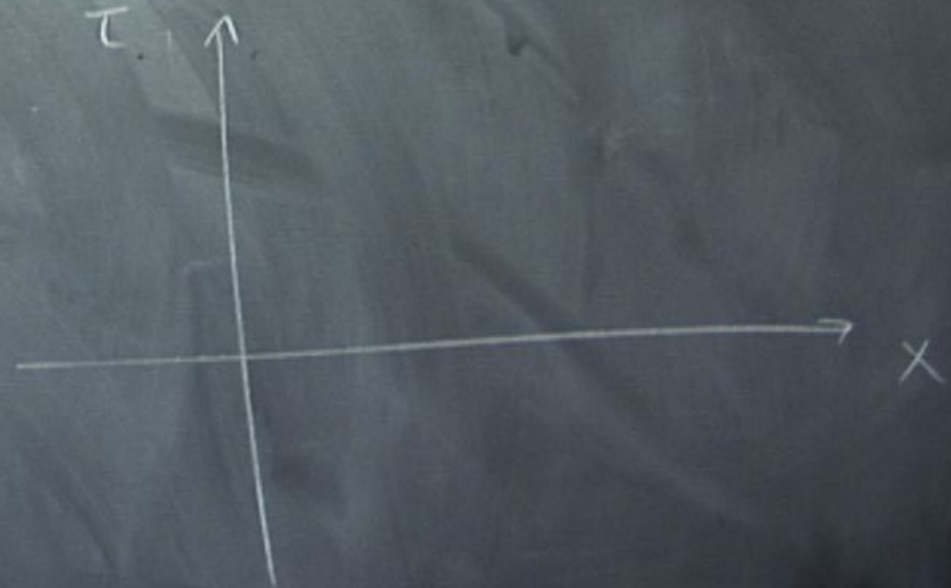


$$\tau \sim \text{const} + e^{-Ht}$$

$$dt e^{-Ht} = d\tau$$

Minkowski

de Sitter



$$\frac{1}{2} \left(d\tau^2 - dx^2 \right)$$

$$\tau \sim \text{const} + e^{-Ht}$$

$$t \rightarrow \infty$$

$$\tau \rightarrow 0$$

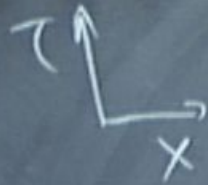
$$dt e^{-Ht} = d\tau$$

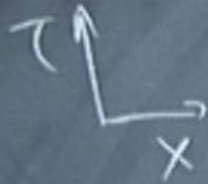
Minkowski

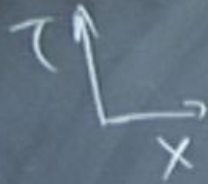
de Sitter

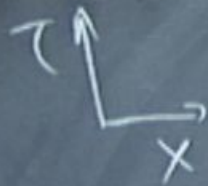
$$\frac{1}{2} \left(d\tau^2 - dx^2 \right)$$

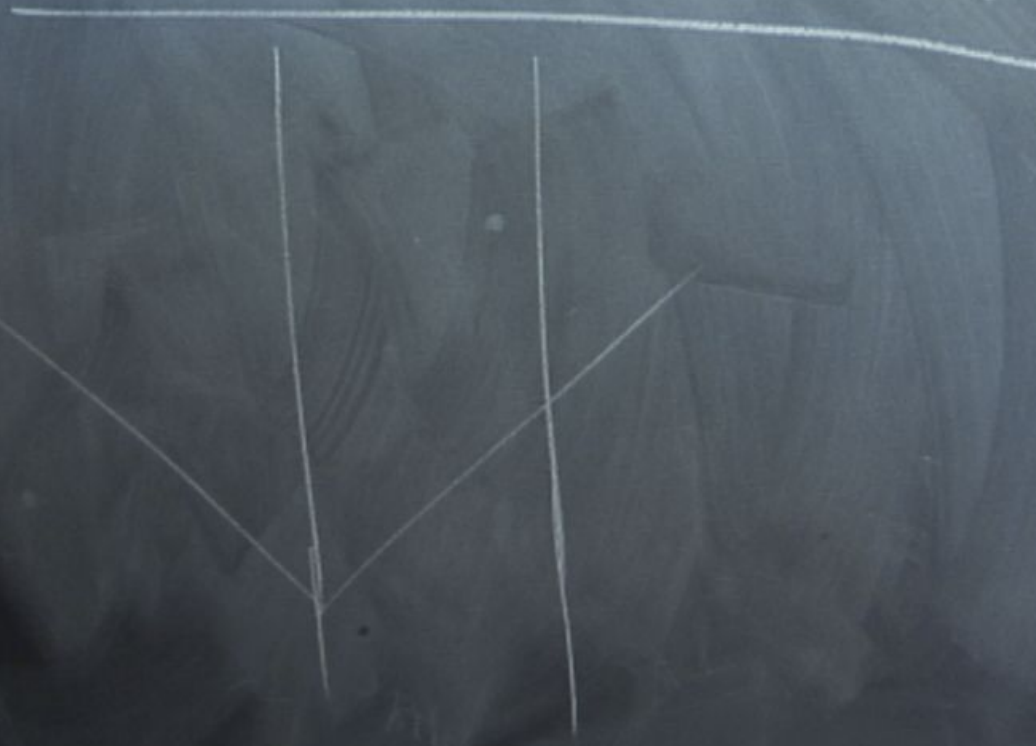
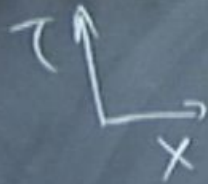


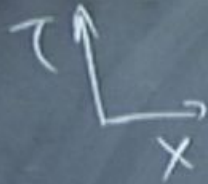


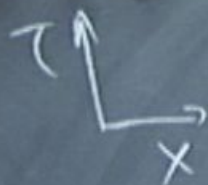


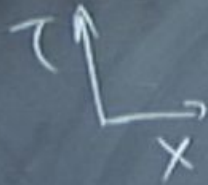


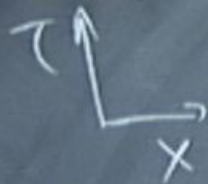












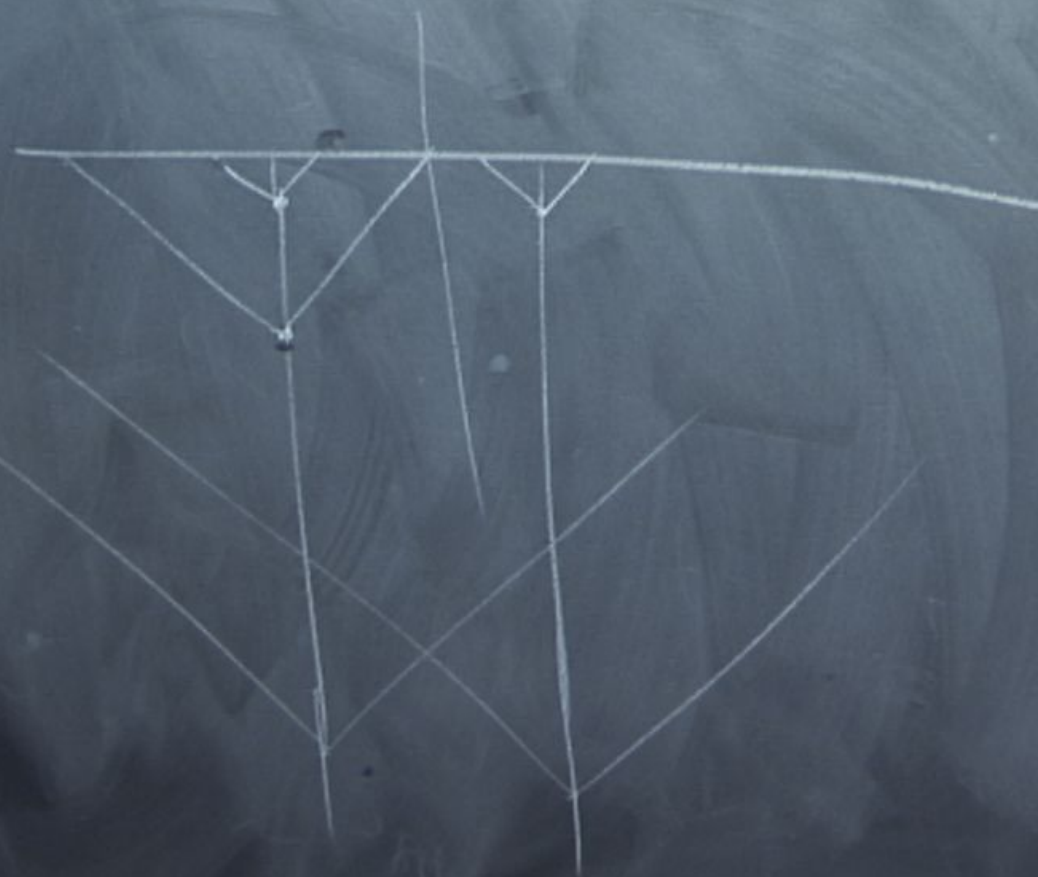
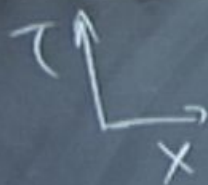
$$\tau \sim \text{const} - e^{-Ht}$$

$$t \rightarrow \infty$$

$$\tau \rightarrow 0$$

$$dt e^{-Ht} = d\tau$$





Hierarchy Problem

First: "the Higgs"

↑??
↑

10^{-23} cm 10^{19} GeV

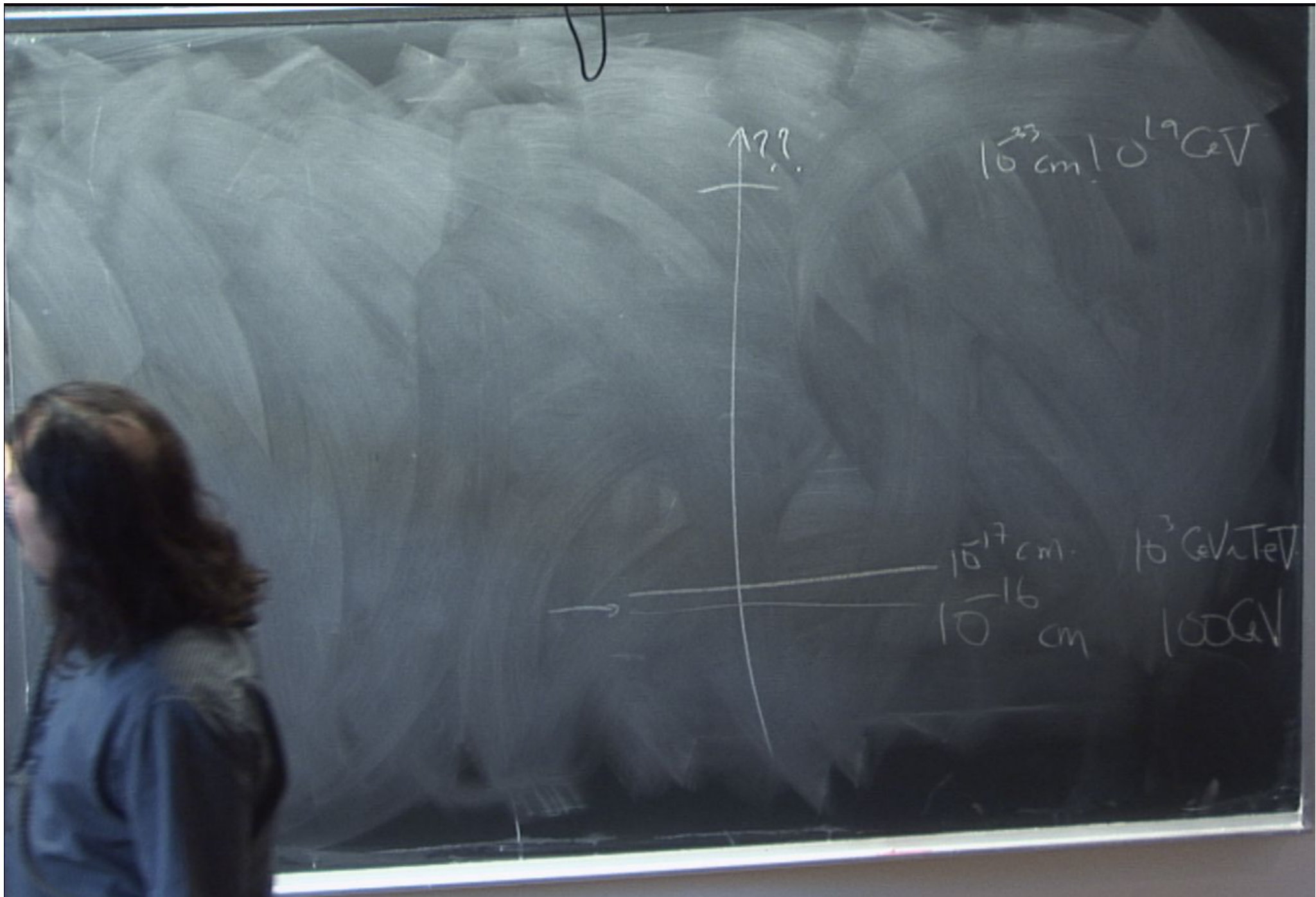
10^{-16} cm 100 GeV

↑??
..

10^{23} cm 10^{19} GeV

10^{17} cm. 10^3 GeV TeV

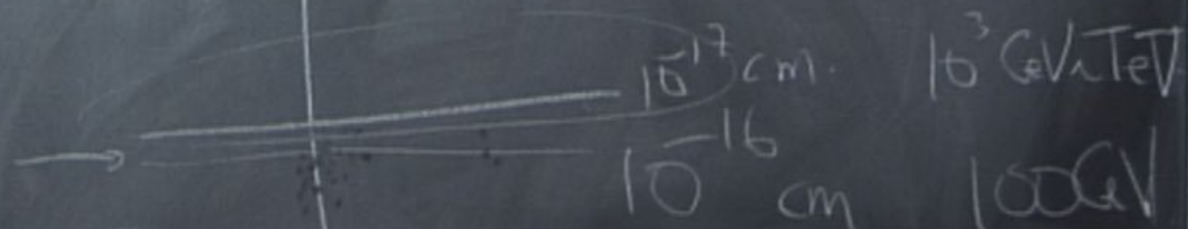
10^{16} cm 100 GeV

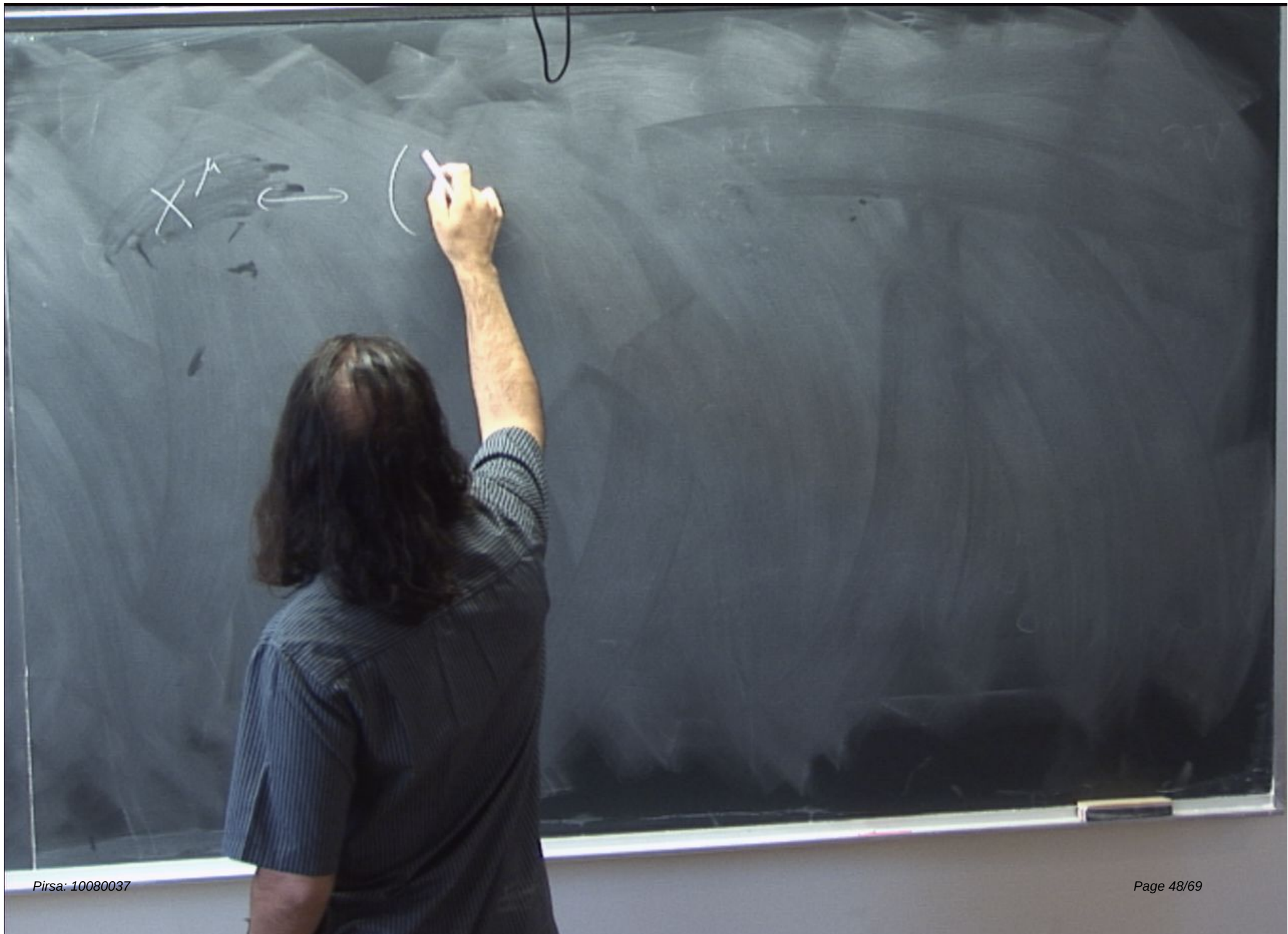


$$\theta_1, \theta_2 \rightarrow \theta_2, \theta_1$$

$$\theta_1^2 = 0$$

$$10^{-23} \text{ cm} / 10^{19} \text{ GeV}$$





$$X^{\mu} \longleftrightarrow \begin{pmatrix} X^0 + X^3 & X^1 - iX^2 \\ X^1 + iX^2 & X^0 - X^3 \end{pmatrix}.$$

$$X^{\mu} \mapsto \begin{pmatrix} x^0 + x^3 & x^1 - ix^2 \\ x^1 + ix^2 & x^0 - x^3 \end{pmatrix}$$

$$M \rightarrow L^{\dagger} M L \quad L \in \mathrm{SL}(2, \mathbb{C})$$

$$X^\mu \longleftrightarrow \begin{pmatrix} x^0 + x^3 & x^1 - ix^2 \\ x^1 + ix^2 & x^0 - x^3 \end{pmatrix}$$

$$M \rightarrow L^\dagger M L \quad L \in \mathrm{SL}(2, \mathbb{C})$$

X

$$X^\mu \longleftrightarrow \begin{pmatrix} x^0 + x^3 & x^1 - ix^2 \\ x^1 + ix^2 & x^0 - x^3 \end{pmatrix}$$

$$M \rightarrow L^\dagger M L \quad L \in \text{SL}(2, \mathbb{C})$$

$$X_{A\dot{B}}$$

$$X^{\mu} \longleftrightarrow \begin{pmatrix} x^0 + x^3 & x^1 - ix^2 \\ x^1 + ix^2 & x^0 - x^3 \end{pmatrix}$$

$$M \rightarrow L^{\dagger} M L \quad L \in \mathrm{SL}(2, \mathbb{C})$$

$$(X_{A\dot{B}})$$

$$X^\mu \longleftrightarrow \begin{pmatrix} x^0 + x^3 & x^1 - ix^2 \\ x^1 + ix^2 & x^0 - x^3 \end{pmatrix}$$

$$M \rightarrow L^\dagger M L \quad L \in \mathrm{SL}(2, \mathbb{C})$$

$$(x_{A\dot{B}}, \theta_A, \bar{\theta}_{\dot{B}})$$

$$X^\mu \longleftrightarrow \begin{pmatrix} x^0 + x^3 & x^1 - ix^2 \\ x^1 + ix^2 & x^0 - x^3 \end{pmatrix}$$

$$M \longrightarrow L^+ M \quad L \in \mathrm{SL}(2, \mathbb{C})$$

$$A=1,2$$

$$\dot{A}=1,2$$

$$\left(X_{A\dot{B}}, \Theta_A, \bar{\Theta}_{\dot{B}} \right) A$$

$$A=1,2$$

$$\dot{A}=1,2$$

$$\left(X_{A\dot{B}}, \Theta_A, \bar{\Theta}_{\dot{B}} \right) \text{ Anti-commuting}$$

$$\Theta_A \rightarrow \Theta_A + \xi_A.$$

$$\bar{\Theta}_{\dot{A}} \rightarrow \bar{\Theta}_{\dot{A}} + \bar{\xi}_{\dot{A}}.$$

$$A=1,2$$

$$\dot{A}=1,2$$

$$\Theta_A \rightarrow \Theta_A + \xi_A$$

$$\bar{\Theta}_{\dot{A}} \rightarrow \bar{\Theta}_{\dot{A}} + \bar{\xi}_{\dot{A}}$$

$$X_{A\dot{A}} \rightarrow X_{A\dot{A}} + \Theta_A \bar{\xi}_{\dot{A}} + \bar{\xi}_{\dot{A}} \Theta_A$$

$$A=1,2$$

$$\dot{A}=1,2$$

$$\Theta_A \rightarrow \Theta_A + \xi_A$$

$$\bar{\Theta}_{\dot{A}} \rightarrow \bar{\Theta}_{\dot{A}} + \bar{\xi}_{\dot{A}}$$

$$X_{A\dot{A}} \rightarrow X_{A\dot{A}} + \Theta_A \bar{\xi}_{\dot{A}} + \bar{\xi}_{\dot{A}} \Theta_{\dot{A}}$$

$$A=1,2$$

$$\dot{A}=1,2$$

$$\Theta_A \rightarrow \Theta_A + \xi_A$$

$$\bar{\Theta}_{\dot{A}} \rightarrow \bar{\Theta}_{\dot{A}} + \bar{\xi}_{\dot{A}}$$

$$X_{A\dot{A}} \rightarrow X_{A\dot{A}} + \Theta_A \bar{\xi}_{\dot{A}} + \bar{\xi}_{\dot{A}} \Theta_A$$

$$A=1,2$$

$$\dot{A}=1,2$$

$$\Theta_A \rightarrow \Theta_A + \xi_A$$

$$\bar{\Theta}_{\dot{A}} \rightarrow \bar{\Theta}_{\dot{A}} + \bar{\xi}_{\dot{A}}$$

$$X_{A\dot{A}} \rightarrow X_{A\dot{A}} + \Theta_A \bar{\xi}_{\dot{A}} + \bar{\xi}_{\dot{A}} \Theta_A$$

$$A=1,2$$

$$\dot{A}=1,2$$

$$\Theta_A \rightarrow \Theta_A + \xi_A$$

$$\bar{\Theta}_{\dot{A}} \rightarrow \bar{\Theta}_{\dot{A}} + \bar{\xi}_{\dot{A}}$$

$$X_{A\dot{A}} \rightarrow X_{A\dot{A}} + \Theta_A \bar{\xi}_{\dot{A}} + \bar{\xi}_{\dot{A}} \Theta_A$$

$$\Phi(x, \theta, \bar{\theta})$$

$$= B(x) + \theta F(x) + \dots$$

$$\theta^2$$

$$\Phi(x, \theta, \bar{\theta})$$

$$\theta^2 = \bar{\theta}$$

$$= B(x) + \theta F(x) + \dots$$

$$\Phi(x, \theta, \bar{\theta})$$

$$= B(x) + \theta F(x) + \dots$$

$$+ \theta_1 \theta_2 \theta_1 \theta_2 \dots$$

$$V = \int d^3k \left[\frac{1}{2} \sqrt{k^2 + m^2} \right]$$

$$V = \int d^3k \left[\frac{1}{2} \sqrt{k^2 + m_B^2} - \frac{1}{2} \sqrt{k^2 + m_F^2} \right]$$

$$V = \int d^3k \left[\frac{1}{2} \sqrt{k^2 + m_B^2} - \frac{1}{2} \sqrt{k^2 + m_F^2} \right]$$

$$= 0$$

$$V = \int d^3k \left[\frac{1}{2} \sqrt{k^2 + m_B^2} - \frac{1}{2} \sqrt{k^2 + m_F^2} \right]$$

$$= 0$$