

Title: 13/14 PSI - String Theory Review - Lecture 12

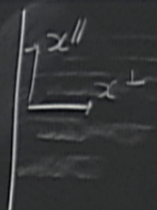
Date: Feb 12, 2014 10:15 AM

URL: <http://pirsa.org/14020032>

Abstract:

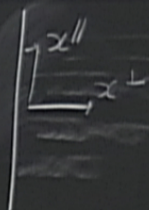
$$T_{\parallel L} = 0$$

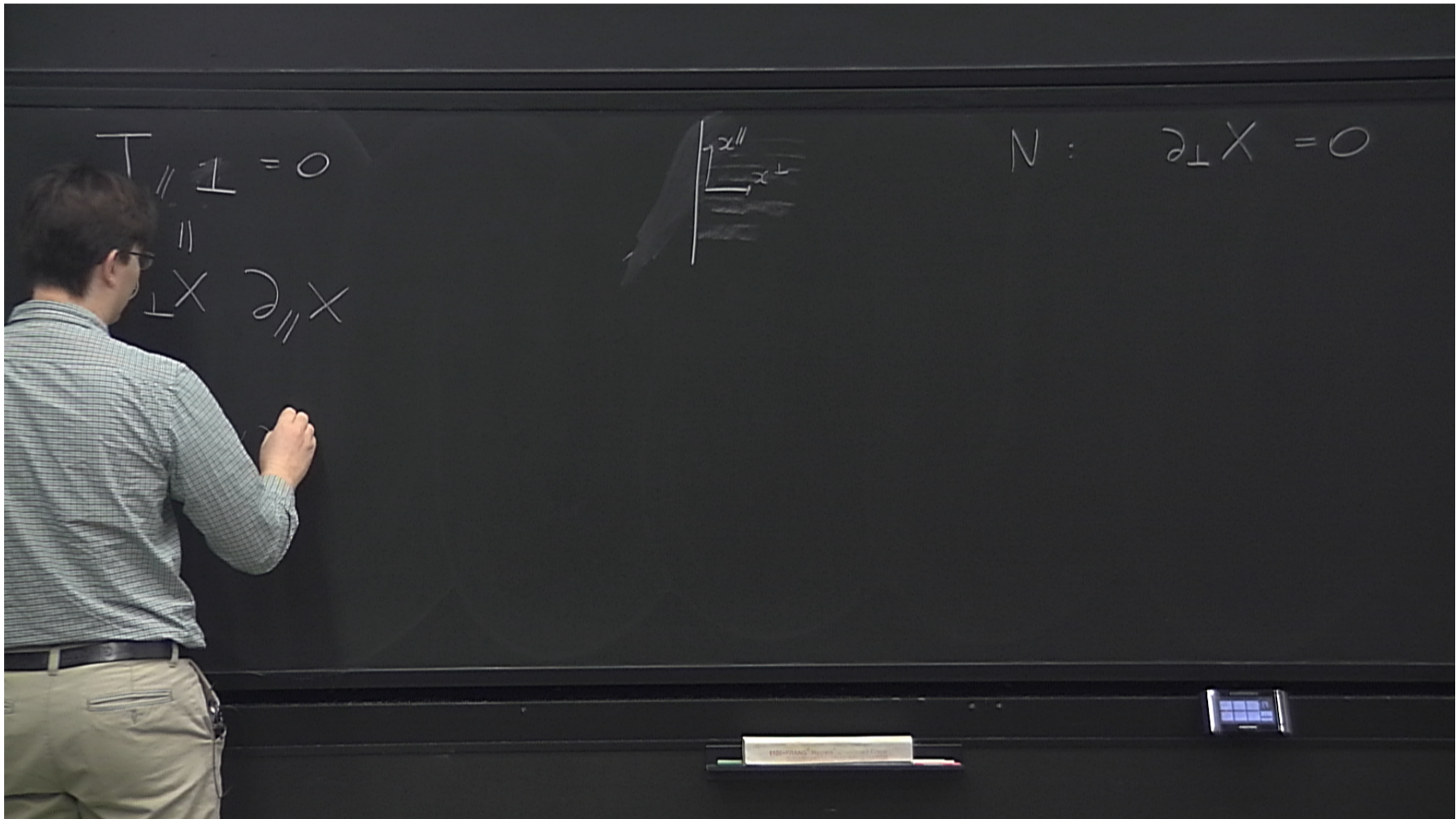
$$T_{\parallel L} = 0$$



$$T_{\parallel \perp} = 0$$

$$\begin{matrix} \parallel \\ \perp \end{matrix} \times \begin{matrix} \parallel \\ \perp \end{matrix} \times$$

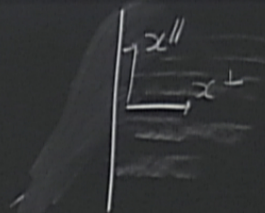




$$T_{\parallel\perp} = 0$$

$$\parallel$$

$$\partial_{\perp} X \partial_{\parallel} X$$



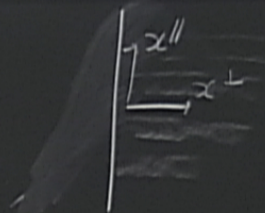
$$N \cdot \partial_{\perp} X|_2 = 0$$

$$D X = x$$

$$0 = \int_M \partial_{\alpha} X \partial^{\alpha} \delta X = - \int_M \partial_{\alpha} \partial^{\alpha} X \delta X + \int_M \partial_{\alpha} X \partial^{\alpha} \delta X$$

$$T_{\parallel} \cdot \mathbf{1} = 0$$

$$\partial_{\parallel} X$$



$$N : \quad \partial_{\perp} X|_{\Sigma} = 0$$

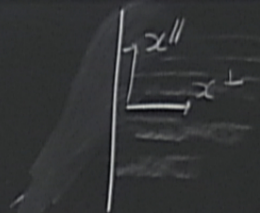
$$D : \quad X|_{\Sigma} = x.$$

$$\delta X = - \int_{\mathcal{M}} \partial_{\alpha} \partial^{\alpha} X \delta X + \int_{\partial \mathcal{M}} n \cdot \partial X \delta X$$

$$T_{\parallel\perp} = 0$$

$\parallel$

$$\partial_{\parallel} X$$



$$N : \quad \partial_{\perp} X|_{\Sigma} = 0$$

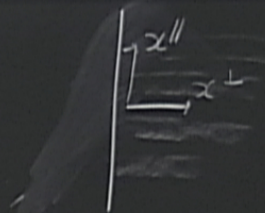
$$D : \quad X|_{\Sigma} = x. \quad \Rightarrow$$

$$\partial_{\alpha} X \partial^{\alpha} \delta X = - \int_{\mathcal{M}} \partial_{\alpha} \partial^{\alpha} X \delta X + \int_{\partial \mathcal{M}} n \cdot \partial X \delta X$$

$$T_{\parallel\perp} = 0$$

$$\parallel$$

$$\partial_{\perp} X \partial_{\parallel} X$$



$$N : \partial_{\perp} X| = 0$$

$$D : X|_{\partial\mathcal{M}} = \text{const} \Rightarrow$$

$$0 = \int_{\mathcal{M}} \partial_{\alpha} X \partial^{\alpha} \delta X = - \int_{\mathcal{M}} \partial_{\alpha} \partial^{\alpha} X \delta X + \int_{\partial\mathcal{M}} n^{\alpha} \partial_{\alpha} X \delta X$$

D_p BRANE

$$N: X^0 \dots X^{dL}$$

$$D: X^{dL+1} \dots X^{26}$$

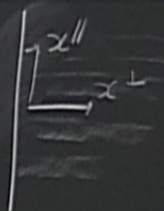
D_p BRANE

$$N: X^0 \dots X^{p-1}$$

$$D: X^{p+1} \dots X^{26}$$

$$T_{\parallel\perp} = 0$$

$$\partial_{\perp} X^{\mu} \partial_{\parallel} X_{\mu}$$



$$N : \quad \partial_{\perp} X|_{\sigma} = 0$$

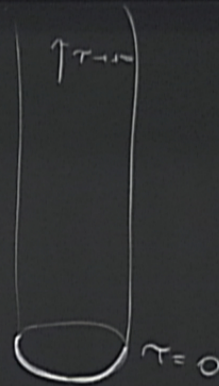
$$D : \quad X|_{\sigma} = x.$$

$$0 = \int_{\mathcal{M}} \partial_a X \partial^a \delta X = - \int_{\mathcal{M}} \partial_a \partial^a X \delta X + \int_{\partial \mathcal{M}} \partial_a X \delta X$$

$$N : \quad \partial_{\perp} X|_{\partial} = 0$$

$$D : \quad X|_{\partial} = x_0 \quad \Rightarrow \quad \partial_{\parallel} X = 0$$

$$- \int_{\partial} n \cdot \partial X \, dX$$



$\Rightarrow$ WHICH
SOURCES?

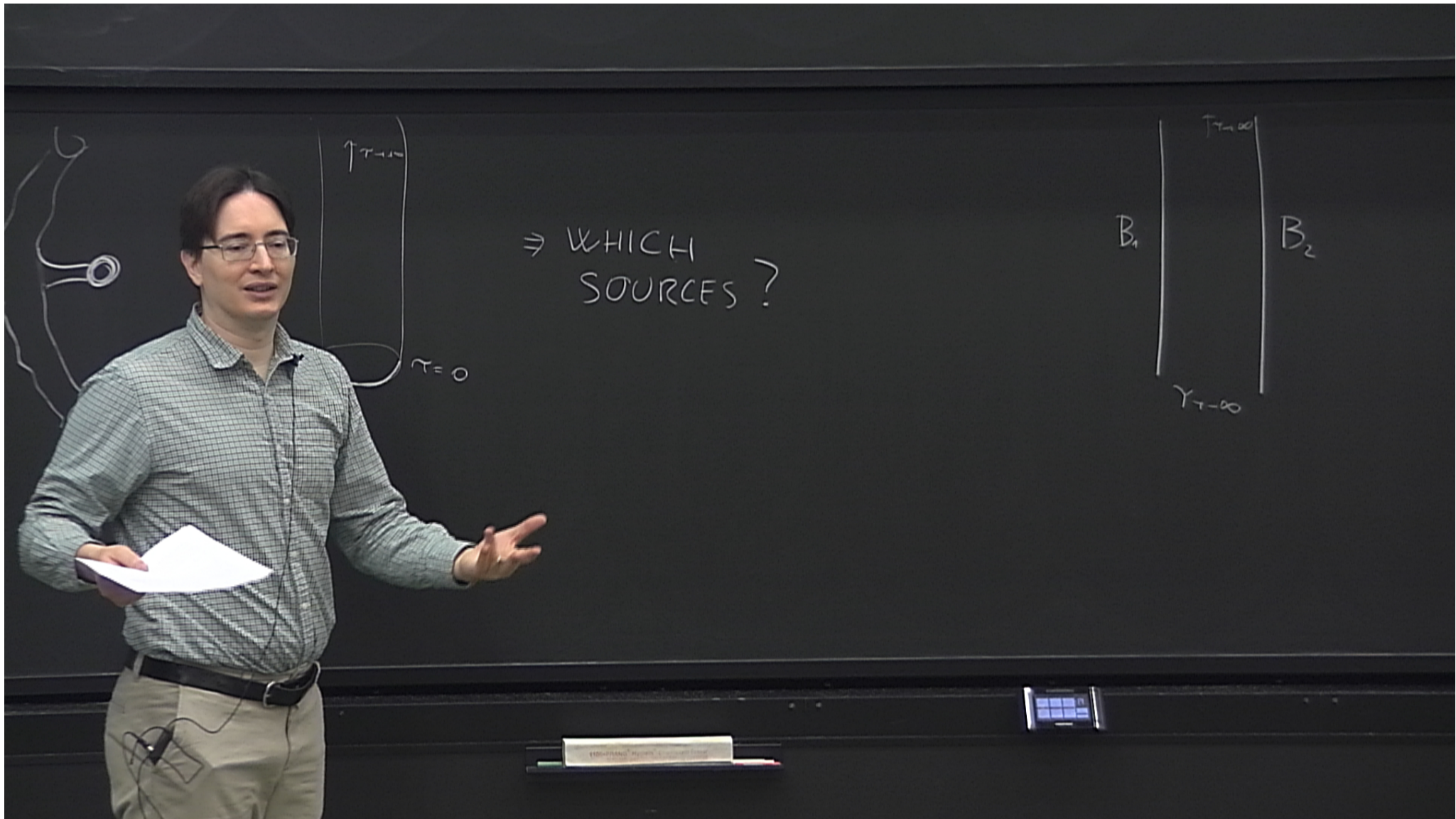




$\uparrow \tau_{-1}$

$\Rightarrow$ WHICH
SOURCES?

B.



$$X = x - 2ip\tau + \sum_{n \neq 0} \left[\frac{i}{n} a_n e^{in(\sigma + i\tau)} - \frac{i}{n} \bar{a}_n e^{-in(\sigma - i\tau)} \right]$$

$$X = x - 2ip\tau + \sum_{n \neq 0} \left[\frac{i}{n} a_n e^{in(\sigma + i\tau)} - \frac{i}{n} \bar{a}_n e^{-in(\sigma - i\tau)} \right]$$

$$\tau=0 \quad N: \begin{matrix} \partial \\ (a_n - \bar{a}_{-n}) |N\rangle = 0 \\ \partial_\tau X|_{\tau=0} = 0 \end{matrix}$$

$$\hat{p} |N\rangle = 0$$

$$X = x - 2ip\tau + \sum_{n \neq 0} \left[\frac{i}{n} a_n e^{in(\sigma + i\tau)} - \frac{i}{n} \bar{a}_n e^{-in(\sigma - i\tau)} \right]$$

$$\tau=0 \quad N: \begin{matrix} \partial \\ (a_n - \bar{a}_{-n}) |N\rangle = 0 \\ \partial_\tau X|_{\tau=0} \end{matrix} \quad \hat{p} |N\rangle = 0 \quad |N\rangle = e^{\sum_{n>0} \frac{1}{n} a_{-n} \bar{a}_n} |0\rangle$$

$$X = x - 2ip\tau + \sum_{n \neq 0} \left[\frac{i}{n} a_n e^{in(\sigma + \tau)} - \frac{i}{n} \bar{a}_n e^{-in(\sigma - \tau)} \right]$$

$$\tau=0 \quad N: \quad \partial_{\tau} X|_{\tau=0} = 0 \quad (a_n - \bar{a}_{-n})|0\rangle = 0$$

$$\hat{p} |N\rangle = 0$$

$$|N\rangle = e^{\sum_{n>0} \frac{1}{n} a_{-n} \bar{a}_n} |0\rangle$$

$$X = x - 2ip\tau + \sum_{n \neq 0} \left[\frac{i}{n} a_n e^{in(\sigma + \tau)} - \frac{i}{n} \bar{a}_n e^{-in(\sigma + \tau)} \right]$$

$$N: \begin{matrix} \partial \\ \partial_\tau X|_{\tau=0} \end{matrix} (a_n - \bar{a}_{-n}) |N\rangle = 0 \quad \hat{p} |N\rangle = 0 \quad |N\rangle = e^{\sum_{n>0} \frac{1}{n} a_{-n} \bar{a}_n} |0\rangle$$

$$D: (a_n + \bar{a}_{-n}) |D\rangle = 0$$

$$X = x - 2ip\tau + \sum_{n \neq 0} \left[\frac{i}{n} a_n e^{in(\sigma + \tau)} - \frac{i}{n} \bar{a}_n e^{-in(\sigma - \tau)} \right]$$

$$\tau=0 \quad N: \begin{matrix} \partial \\ (a_n - \bar{a}_{-n}) |N\rangle = 0 \\ \partial_\tau X|_{\tau=0} = 0 \end{matrix} \quad \hat{p} |N\rangle = 0 \quad |N\rangle = e^{\sum_{n>0} \frac{1}{n} a_{-n} \bar{a}_n} |0\rangle$$

$$D: \begin{matrix} (a_n + \bar{a}_{-n}) |D\rangle = 0 \\ X|_{\tau=0} = x_0 \end{matrix} \quad \hat{x} |D\rangle = x_0 |D\rangle$$

$$X = x - 2ip\tau + \sum_{n \neq 0} \left[\frac{i}{n} a_n e^{in(\sigma + i\tau)} - \frac{i}{n} \bar{a}_n e^{-in(\sigma - i\tau)} \right]$$

$$N: (a_n - \bar{a}_{-n}) |N\rangle \quad \hat{p} |N\rangle = 0 \quad |N\rangle = e^{\sum_{n>0} \frac{1}{n} a_n \bar{a}_{-n}} |0\rangle$$

$\partial_\tau X|_{\tau=0} = 0$

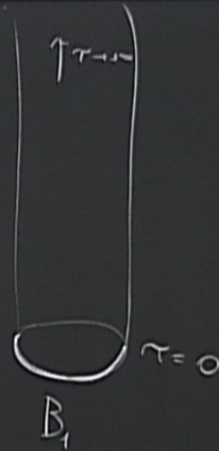
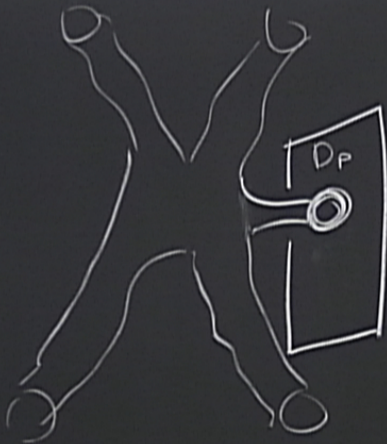
$$D: (a_n + \bar{a}_{-n}) |D\rangle = x_0 |D\rangle \quad |D\rangle = \int e^{ipx_0} e^{-\sum_{n>0} \frac{1}{n} a_n \bar{a}_{-n}} |p\rangle$$

$X|_{\tau=0} = x_0$

$$X = x - 2ip\tau + \sum_{n \neq 0} \left[\frac{i}{n} a_n e^{in(\sigma+i\tau)} - \frac{i}{n} \bar{a}_n e^{-in(\sigma-i\tau)} \right]$$

$$N: \begin{matrix} (a_n - \bar{a}_{-n}) |N\rangle = 0 \\ \partial_\tau X|_{\tau=0} = 0 \end{matrix} \quad \hat{p} |N\rangle = 0 \quad |N\rangle = e^{\sum_{n>0} \frac{1}{n} a_n \bar{a}_{-n}} |0\rangle$$

$$D: \begin{matrix} (a_n + \bar{a}_{-n}) |D\rangle = 0 \\ X|_{\tau=0} = x_0 \end{matrix} \quad \hat{x} |D\rangle = x_0 |D\rangle \quad |D\rangle = \int e^{ipx_0} e^{-\sum_{n>0} \frac{1}{n} a_n \bar{a}_{-n}} |p\rangle$$



$\Rightarrow$ WHICH SOURCES?

$$\left[\bar{a}_n e^{-in(\sigma-i\tau)} \right]$$

$$\sum_{n>0} \frac{1}{n} a_{-n} \bar{a}_{-n} |0\rangle$$

$$|Dp\rangle = \int d^{26-p-1} p_{\perp} e^{ip_{\perp} \cdot x_{\perp}}$$

$$\int e^{ipx_0} e^{-\sum_{n>0} \frac{1}{n} a_{-n} \bar{a}_{-n}} |p\rangle$$

$$\bar{a}_n e^{-im(\sigma-i\tau)}]$$

$$\sum_{n>0} \frac{1}{n} a_n \bar{a}_n$$

$$|0\rangle$$

$$|Dp\rangle = \int d^{26-p-1} p \, e^{ip \cdot x} e^{\sum_{n=0}^{26-p-1} a_n \bar{a}_n} e^{\sum_{n=p+1}^{26} a_n \bar{a}_n}$$

$$\int e^{ipx_0} e^{-\sum_{n>0} \frac{1}{n} a_n \bar{a}_n} |p\rangle$$

$$|D_p\rangle = \left(\prod_{n=1}^{26} e^{i p_n \cdot x_n} \right) e^{\sum_{n=0 \dots p} a_n^\mu \bar{a}_n^\mu} \sum_{n=p+1}^{26} a_n^\mu \bar{a}_n^\mu |p\rangle$$

$$\left[\bar{a}_n e^{-im(\sigma - i\tau)} \right]$$

$$\sum_{n \geq 0} \frac{1}{n} a_n \bar{a}_n$$

$$|0\rangle$$

$$|Dp\rangle = \int d^{26-p-1} p_\mu e^{ip \cdot x} e^{\sum_{\mu=0}^{26-p} a_\mu \bar{a}_\mu} e^{\sum_{\mu=p+1}^{26} a_\mu \bar{a}_\mu} |p\rangle$$

$$= \int \dots |p\rangle + \int \dots (a^0 \bar{a}_1 + a^1 \bar{a}_1 \dots - a^{\frac{d+1}{2}} \bar{a}_{-\frac{d+1}{2}} - a^{\frac{26}{2}} \bar{a}_{-\frac{26}{2}}) |p\rangle$$

$$\int e^{ipx_0} e^{-\sum_{n \geq 0} \frac{1}{n} a_n \bar{a}_n} |p\rangle$$

$$\left[\bar{a}_n e^{-im(\sigma - i\tau)} \right]$$

$$\sum_{n>0} \frac{1}{n} a_n \bar{a}_n$$

$$|0\rangle$$

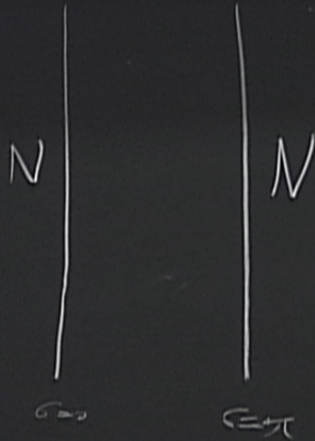
$$\int e^{ipx_0} e^{-\sum_{n>0} \frac{1}{n} a_n \bar{a}_n}$$

$$|Dp\rangle = \int d^{26-p-1} p_\mu e^{ip \cdot x_0} e^{\sum_{\mu=0 \dots p} a_\mu^\dagger \bar{a}_\mu} |p\rangle$$

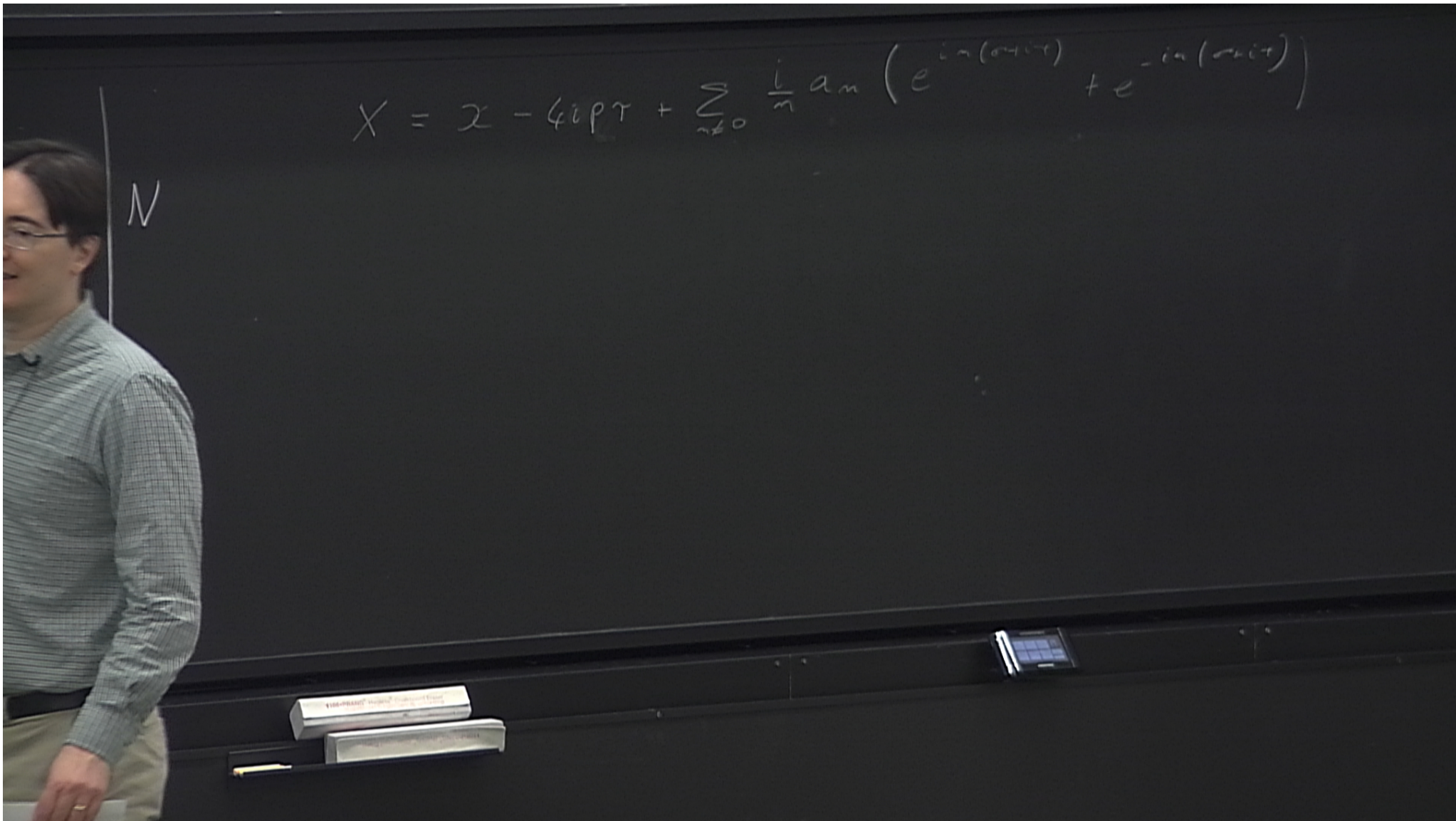
$$= \int \dots |p\rangle + \int \dots (a_0^\dagger \bar{a}_1^\dagger + a_1^\dagger \bar{a}_1^\dagger \dots - a_{-1}^\dagger \bar{a}_{-1}^\dagger \dots - a_{-26}^\dagger \bar{a}_{-26}^\dagger) |p\rangle$$

$$\begin{aligned}
 |D_p\rangle &= \int d^{26-p-1}p \, e^{ip \cdot x_0} \sum_{n \geq 0} \left[\sum_{\mu=0 \dots p} a_{-n}^{\mu} \bar{a}_{-n}^{\mu} - \sum_{\mu=p+1}^{26} a_{-n}^{\mu} \bar{a}_{-n}^{\mu} \right] \\
 &= \int \dots |P\rangle + \int \dots \left(a_{-1}^0 \bar{a}_{-1}^0 + a_{-1}^1 \bar{a}_{-1}^1 \dots - a_{-1}^{d+1} \bar{a}_{-1}^{d+1} \dots - a_{-1}^{26} \bar{a}_{-1}^{26} \right) |P\rangle
 \end{aligned}$$

OPEN
STRINGS



$$X = x - 4ip\tau + \sum_{n \neq 0} \frac{i}{n} a_n \left(e^{in(\sigma + i\tau)} + e^{in(\sigma - i\tau)} \right)$$



OPEN
STRINGS

$$S = T - i\sigma$$

N

N

$$\partial_\sigma X = 0$$

$$\sigma = 0$$

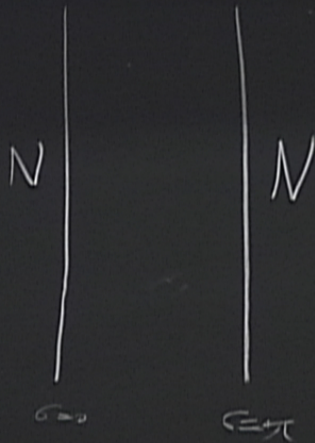
$$\sigma = \pi$$

$$i\partial_\sigma X + i\partial_{\bar{\sigma}} X \Big|_{\sigma=0} = 0$$

$$X = x - 4i\alpha' p\tau + \sum_{n \neq 0} \frac{i}{n} a_n \left(e^{in(\sigma - \tau)} + \right)$$

OPEN
STRINGS

$$S = T - i\sigma$$



$$\partial_\sigma X = 0$$

$$\sigma=0$$

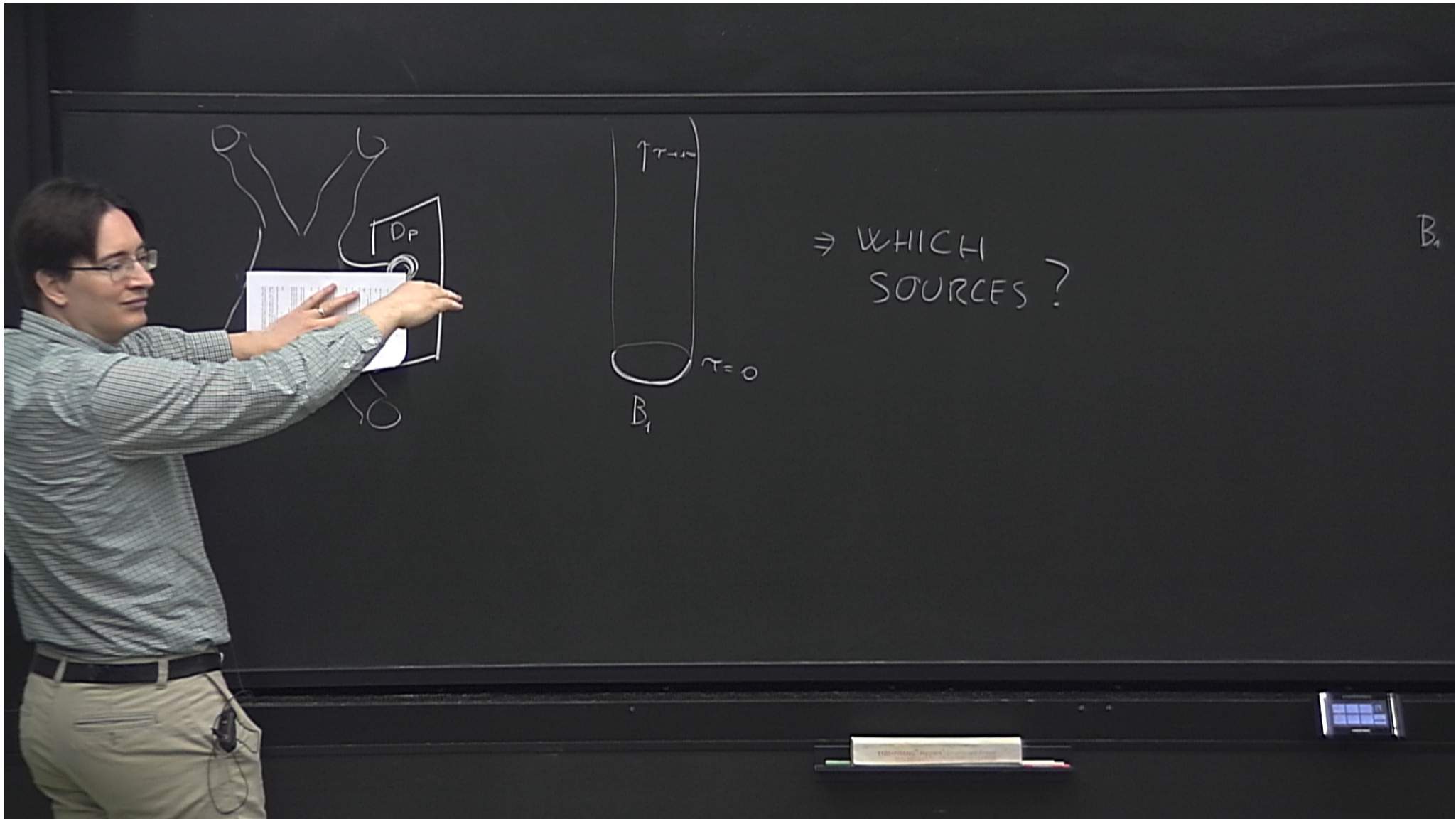
$$\sigma=\pi$$

$$i\partial_\sigma X + i\partial_{\bar{\sigma}} X \Big|_{\sigma=0} = 0$$

$$X = x - 4\pi\alpha' + \sum_{n \neq 0} \frac{i}{n} a_n \left(e^{in(\sigma-\tau)} + \right)$$

$$H_{\text{open}} :$$

$$a_{-1} a_{-1} |p\rangle$$



N
 $\in \pi$

$$X = x - 4ip\tau + \sum_{n \neq 0} \frac{i}{n} a_n \left(e^{in(\sigma + i\tau)} + e^{-in(\sigma + i\tau)} \right)$$

$$H_{\text{open}} : a_{-1}^{\dagger} a_{-2}^{\dagger} |P\rangle$$

$$|P\rangle \quad P^2 = \frac{1}{2}$$

$$\in_n a_{-1}^{\dagger} |P\rangle \quad P^2 = 0$$

$$X = x - 4ip\tau + \sum_{n \neq 0} \frac{i}{n} a_n \left(e^{in(\sigma+\tau)} + e^{-in(\sigma+\tau)} \right)$$

$$H_{open} : a_{-1}^{\mu} a_{-1}^{\nu} |P\rangle$$

$$|P\rangle \quad P^2 = \frac{1}{2}$$

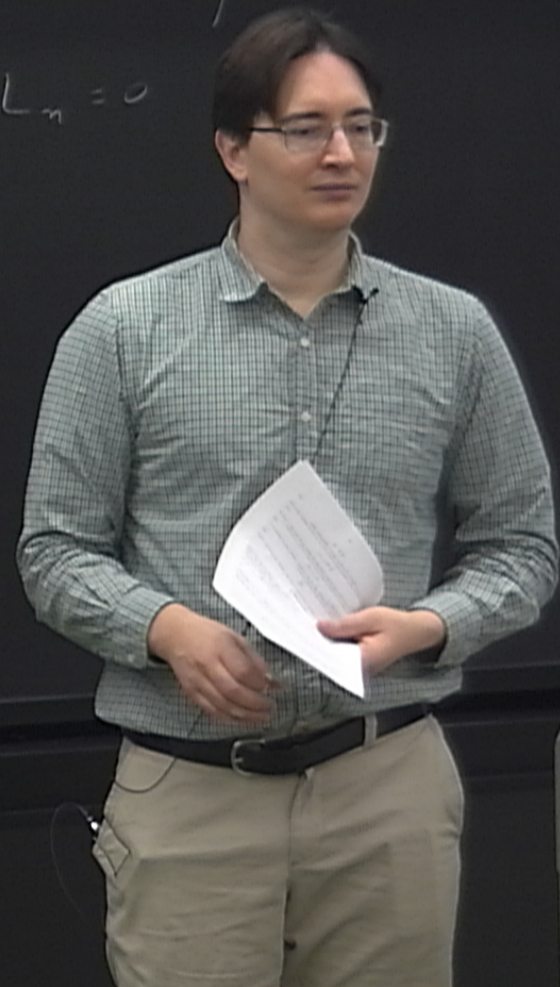
$$\epsilon_{\mu} a_{-1}^{\mu} |P\rangle \quad P^2 = 0$$

$$\epsilon_{\mu} p^{\mu} = 0$$

$$NULL : \epsilon^{\mu} \sim p^{\mu}$$

$$L_0 = 1 \quad L_n = 0$$

$$L_0 = 2P^2 + N$$



$$X = x - 4ip\tau + \sum_{n \neq 0} \frac{i}{n} a_n \left(e^{in(\sigma+\tau)} + e^{-in(\sigma+\tau)} \right)$$

$$H_{open} : a_{-1}^{\mu} a_{-1}^{\mu} |P\rangle$$

$$L_0 = 1 \quad L_n = 0 \quad n > 0$$

$$L_0 = 2p^2 + N$$

$$|P\rangle \quad p^2 = \frac{1}{2}$$

$$\epsilon_{\mu} a_{-1}^{\mu} |P\rangle \quad p^2 = 0$$

$$\epsilon_{\mu} p^{\mu} = 0$$

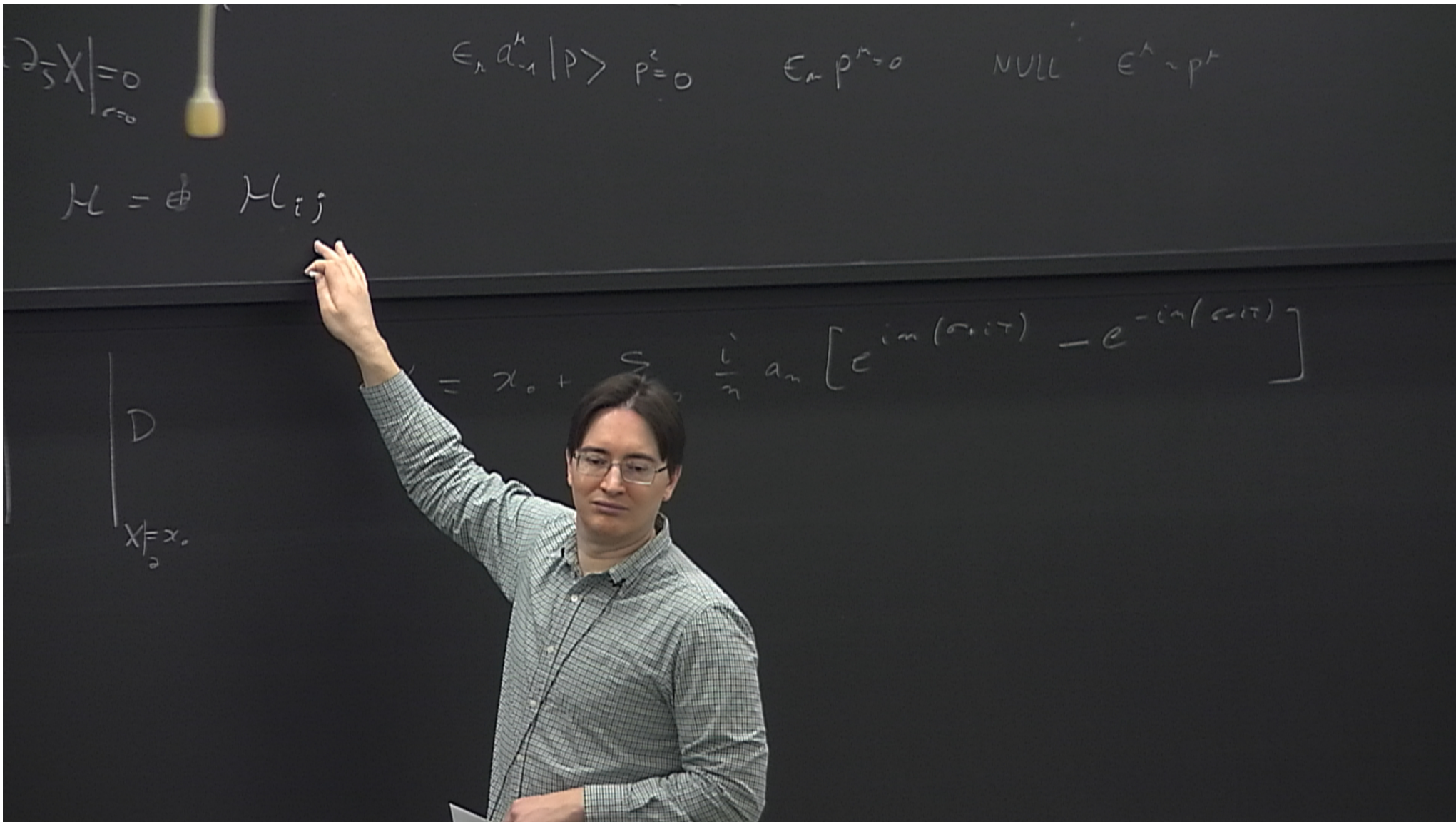
$$NULL : \epsilon^{\mu} \sim p^{\mu}$$

$$\begin{array}{c|c} D & D \\ \hline X=x_0 & X=x_0 \end{array}$$

$$X = x_0 + \sum_{n \neq 0} \frac{i}{n} a_n \left[e^{in(\sigma + i\tau)} - e^{-in(\sigma + i\tau)} \right]$$

D

$X|_2 = x_0$



$$\partial_5 X|_{\tau=0} = 0$$

$$\epsilon_n a_{-n} |P\rangle \quad P^2 = 0$$

$$\epsilon_n p^n = 0$$

$$\text{NULL} \quad \epsilon^\mu \sim p^\mu$$

$$\mathcal{H} = \oplus \mathcal{H}_i; \quad \Rightarrow \quad \mathcal{H}_{\text{BB}} \otimes \mathbb{C}^{N^2}$$

$$\left| \begin{array}{c} D \\ X|_{\tau=0} = x_0 \end{array} \right.$$

$$X = x_0 + \sum_{n \neq 0} \frac{i}{n} a_n \left[e^{in(\sigma + i\tau)} - e^{-in(\sigma + i\tau)} \right]$$

$$\partial_5 X|_{\tau=0} = 0$$

$$\epsilon_n a_{-n} |P\rangle \quad P^2 = 0$$

$$\epsilon_n p^n = 0$$

$$\text{NULL} \quad \epsilon^\mu \sim p^\mu$$

$$\mathcal{H} = \oplus \mathcal{H}_{ij} \Rightarrow \mathcal{H}_{\text{BB}} \otimes \mathbb{C}^{N^2}$$

$$|P, i, j\rangle$$

$$\left| \begin{array}{c} D \\ X|_{\tau=0} = x_0 \end{array} \right.$$

$$X = x_0 + \sum_{n \neq 0} \frac{i}{n} a_n \left[e^{in(\sigma+i\tau)} - e^{-in(\sigma+i\tau)} \right]$$

$$\mathcal{H} = \bigoplus \mathcal{H}_{ij} \Rightarrow \mathcal{H}_{\alpha\beta} \subset \mathbb{C}^N \quad |p, i, j\rangle$$

$$\left| \begin{array}{c} D \\ X = x_0 \end{array} \right.$$

$$X = x_0 + \sum_{n \neq 0} \frac{i}{n} a_n \left[e^{in(\sigma + i\tau)} - e^{-in(\sigma + i\tau)} \right]$$

$$Dd$$

$$|p\rangle$$

$$\begin{aligned} p^0 \dots p^d &\neq 0 \\ p^{d+1} \dots p^{2d} &= 0 \end{aligned}$$

$$\mathcal{H} = \bigoplus \mathcal{H}_{ij} \Rightarrow \mathcal{H}_{\text{BB}} \otimes \mathbb{C}^N \quad |p, i, j\rangle$$

$$\left| \begin{array}{c} D \\ X = x_0 \end{array} \right.$$

$$X = x_0 + \sum_{n \neq 0} \frac{i}{n} a_n \left[e^{in(\sigma + i\tau)} - e^{-in(\sigma + i\tau)} \right]$$

Dd

$|p\rangle$

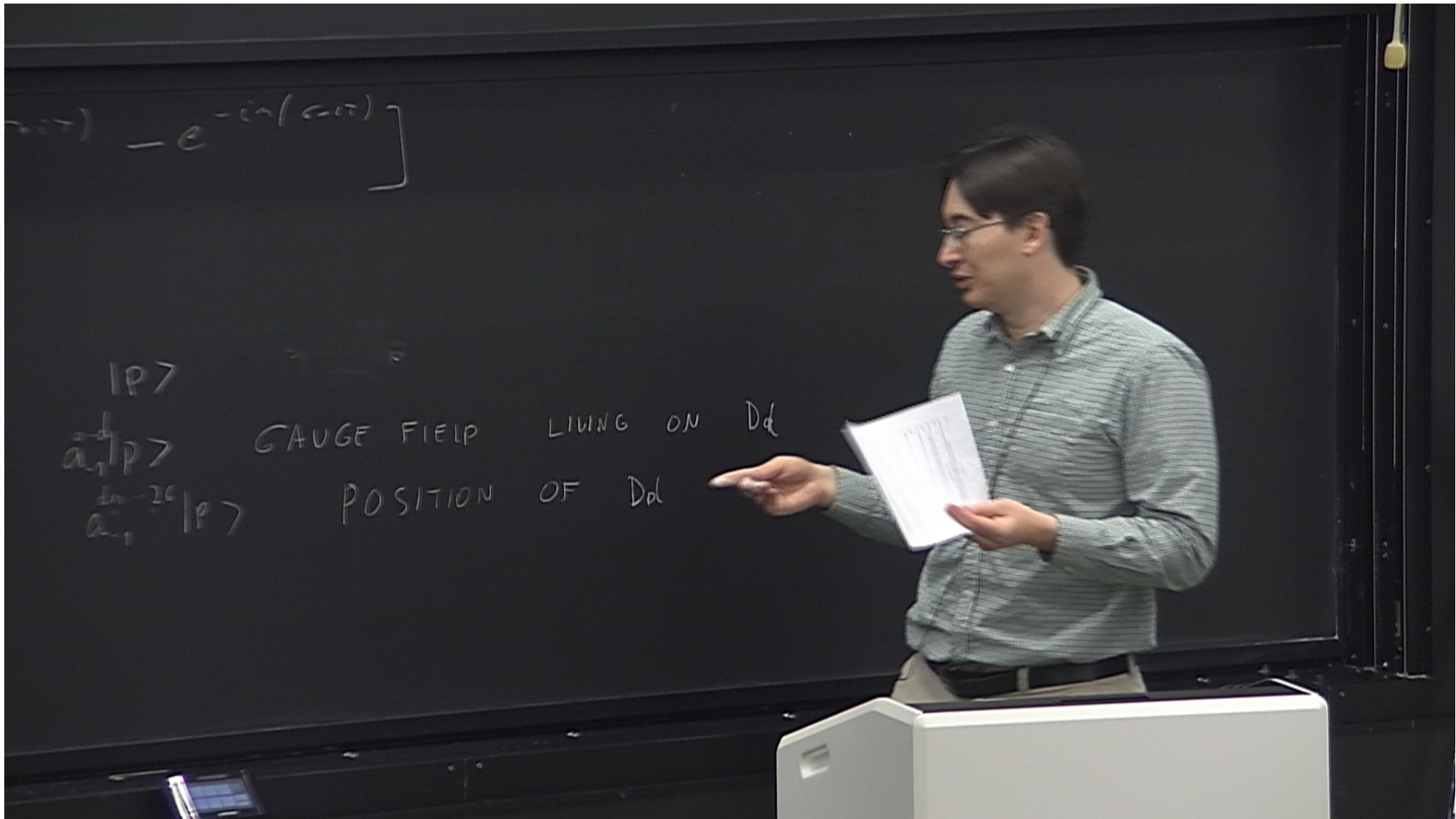
$$\begin{aligned} p^0 \dots p^d &\neq 0 \\ p^{d+1} \dots p^{26} &= 0 \end{aligned}$$

$|p\rangle$

$a_{-1}^{0\dots d} |p\rangle$

$a_{-1}^{d+1\dots 26} |p\rangle$

GAUGE FIELD



$$\rightarrow -e^{-i\pi/2} = -i$$

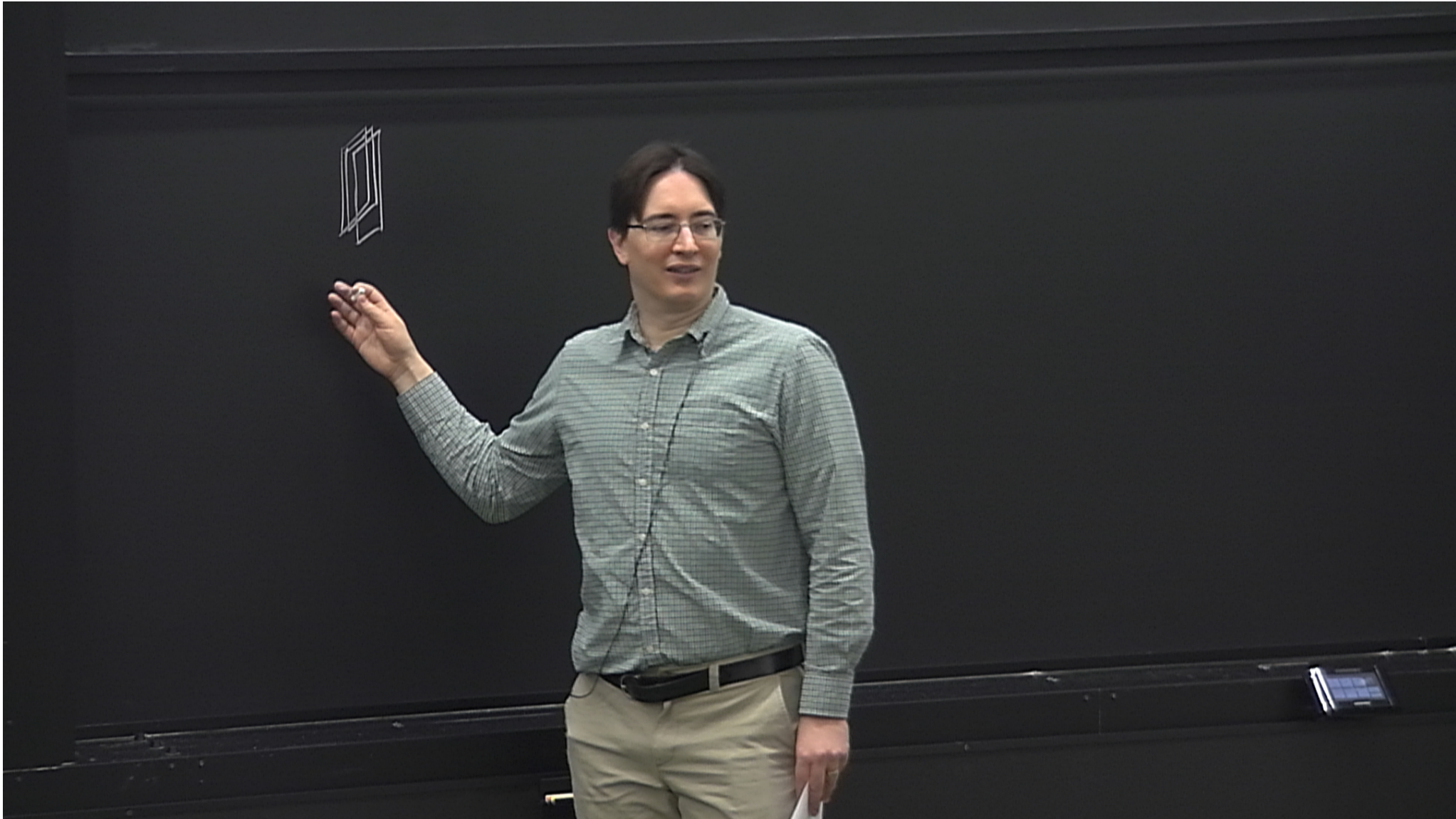
$|p\rangle$

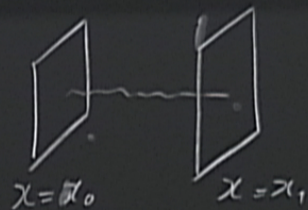
$a_1^\dagger |p\rangle$

$a_1^{-2\epsilon} |p\rangle$

GAUGE FIELD LIVING ON D_d

POSITION OF D_d

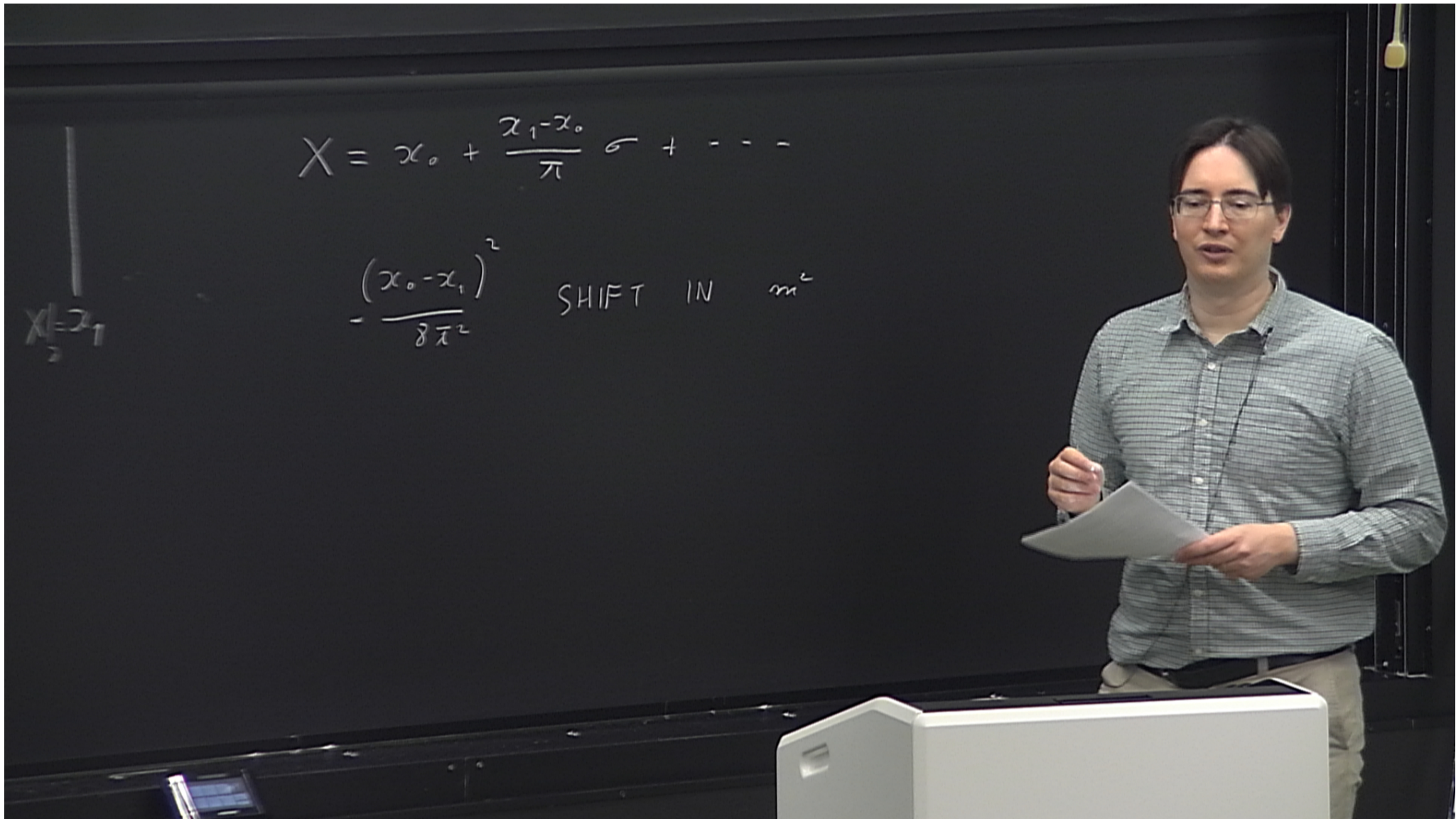




$$X|_2 = x_0$$

$$X|_2 = x_1$$

$$X = x_0 + \frac{x_1 - x_0}{\dots}$$



$$X = x_0 + \frac{x_1 - x_0}{\pi} \sigma + \dots$$

$$- \frac{(x_0 - x_1)^2}{8\lambda^2} \quad \text{SHIFT IN } m^2$$

$$x_1 = x_0$$

$$\begin{array}{c}
 | \\
 X^\mu \\
 \\
 X^\mu|_2 \subset \mathcal{L} \in \mathbb{R}^{25,1} \\
 \partial_\mu X^\mu \subset T\mathcal{L}
 \end{array}$$

$$X^\mu$$

$$T_{\parallel} \perp = \partial_{\parallel} t$$

$$X^\mu|_2 \subset \mathcal{L} \in \mathbb{R}^{2S,1}$$

$$\partial_{\parallel} X^\mu \subset T\mathcal{L}$$

$$X^\mu$$

$$T_{\parallel\perp} = \partial_{\parallel} t$$

$$\partial_{\parallel} \int dx_{\perp} T^{\perp\parallel}$$

$$X^\mu|_{\mathcal{L}} \subset \mathcal{L} \in \mathbb{R}^{2S,1}$$

$$\partial_{\parallel} X^\mu \subset T\mathcal{L}$$

$$X^\mu$$

$$T_{\parallel\perp} = \partial_{\parallel} t$$

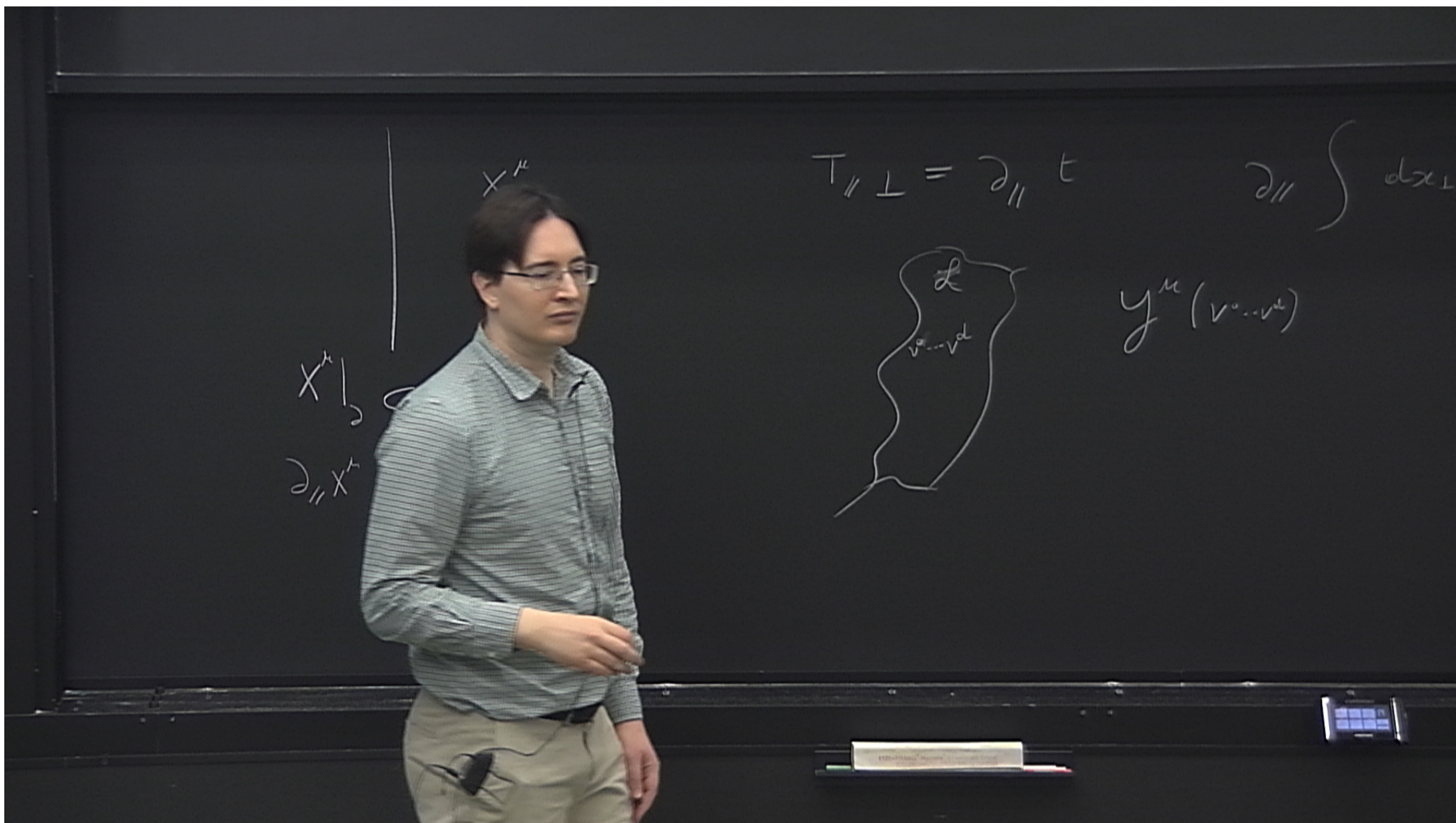
$$\partial_{\parallel} \int dx_{\perp} T^{\parallel\parallel}$$

$$X^\mu|_{\mathcal{L}} \subset \mathcal{L} \in \mathbb{R}^{2S,1}$$

$$\partial_{\parallel} X^\mu \subset T\mathcal{L}$$

$$\partial_{||} \int dx_{\perp} T^{||} = - \int dx_{\perp} \partial_{\perp} T^{||} = \left. T^{||} \right|_{\partial} = \partial_{||} t$$

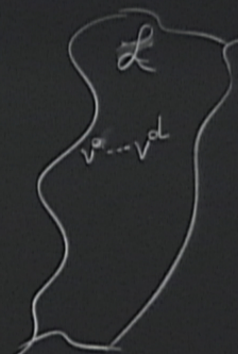




$$\partial_{||} \int dx_{\perp} T^{||} = - \int dx_{\perp} \partial_{\perp} T^{||} = \left. T^{||} \right|_2 = \partial_{||} t$$

$$-v^e) \int \sqrt{\det \frac{\partial \gamma^a}{\partial v^a} \frac{\partial \gamma^b}{\partial v^b} G_{\mu\nu}(\gamma)} d\gamma$$

$$\begin{array}{c}
 X^\mu \\
 | \\
 X^\mu|_2 \subset \mathcal{L} \in \mathbb{R}^{2S,1} \\
 \partial_\parallel X^\mu \subset T\mathcal{L}
 \end{array}$$

$$\int_{\mathcal{M}} A^\mu(x) \partial_\parallel X^\mu dx^\mu$$


$$T_\parallel \perp = \partial_\parallel t$$

$$\partial_\parallel \int dx^\mu$$

$$y^\mu(v^0, \dots, v^d)$$

$$\partial_{||} \int dx_{\perp} T^{||} = - \int dx_{\perp} \partial_{\perp} T^{||} = \left. T^{||} \right|_{\partial} = \partial_{||} t$$

$$\int \sqrt{-\det \frac{\partial y^{\mu}}{\partial x^a} \frac{\partial y^{\nu}}{\partial x^b} G_{\mu\nu}(y)} dx^a + \dots - \partial^{\mu} T_{\mu\nu}$$

$$\partial_{||} \int dx_{\perp} T^{||} = - \int dx_{\perp} \partial_{\perp} T^{||} = \left. T^{||} \right|_{\partial} = \partial_{||} t$$

$$\dots v^{\mu}) \int \sqrt{\det \frac{\partial y^{\mu}}{\partial x^{\alpha}} \frac{\partial y^{\nu}}{\partial x^{\beta}}} G_{\mu\nu}(Y) dx^{\alpha} + \dots - x^{\mu} T^{\mu\nu}$$

$$+ O^{\mu} \partial_{||} X_{\mu} \quad O^{\mu} = \frac{\delta S}{\delta y^{\mu}}$$

$$\partial_{||} \int dx_{\perp} T^{||} = - \int dx_{\perp} \partial_{\perp} T^{||} = \left. T^{||} \right|_{\partial} = \partial_{||} t$$

$$\dots v^{\mu}) \int \sqrt{\det \frac{\partial y^{\mu}}{\partial x^a} \frac{\partial y^{\nu}}{\partial x^b} G_{\mu\nu}(Y)} dx^a dx^b + \dots - x^{\mu} T^{\mu\nu}$$

$$+ O^{\mu} \partial_{||} X_{\mu} \quad O^{\mu} = \frac{\delta S}{\delta y^{\mu}}$$

$$\int \sqrt{\det G^{a-b_1, a-b_2, \dots, a-b_n}}$$

$\int \sqrt{0 \leq t \leq t_1, 0 \leq t_1}$

$$Y_{T \rightarrow \infty}$$

$$T^{\mu\nu} = m \dot{x}^\mu \dot{x}^\nu$$

$$\partial_{||} \int dx_{\perp} T^{||||} = - \int dx_{\perp} \partial_{\perp} T^{I||} = \left. T^{I||} \right|_{\partial} = \partial_{||} t$$

$$\int \sqrt{\det \frac{\partial y^a}{\partial x^\mu} \frac{\partial y^b}{\partial x^\nu} G_{ab}(Y)} dx^{\mu_1} \dots dx^{\mu_n} + \dots - \partial^{\mu} T^{\mu\nu}$$

$$+ O^{\mu} \partial_{||} X_{\mu} \quad O^{\mu} = \frac{\delta S}{\delta y^{\mu}}$$

$$\int \sqrt{\det G^{a_1 \dots a_n, a_1 \dots a_n}}$$

$\gamma_{+-\infty}$

$$g^{\mu\nu} \rightarrow e^{2\Phi} g^{\mu\nu}$$

$$T^{\mu\nu} = m u^\mu u^\nu$$

$$\partial_{||} \int dx_{\perp} T^{||} = - \int dx_{\perp} \partial_{\perp} T^{\perp||} = \left. T^{\perp||} \right|_{\partial} = \partial_{||} t$$

$$\int \sqrt{\det \frac{\partial x^a}{\partial y^a} \frac{\partial x^b}{\partial y^b} G_{\mu\nu}(Y^a)} dy^{d_1} + \dots - \partial^{\mu} T^{\mu\nu}$$

$$O^{\mu} = \frac{\delta S}{\delta y^{\mu}}$$

$$\int \sqrt{\det G^{a-d_1, a \dots d_{t_1}}}$$