

Title: PSI 2018/2019 - String Theory Review - Lecture 11

Speakers: Davide Gaiotto

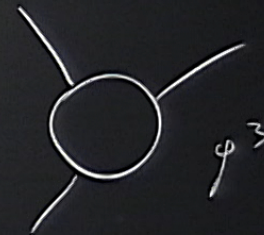
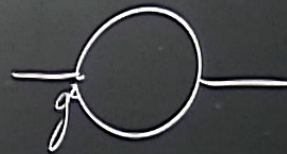
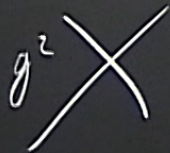
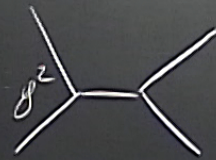
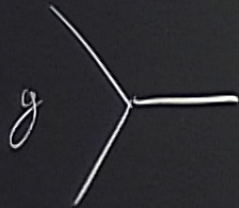
Collection: PSI 2018/2019 - String Theory Review (Gaiotto)

Date: April 08, 2019 - 10:15 AM

URL: <http://pirsa.org/19040036>

$$\frac{1}{g^2} S_{\text{CF-T}} = \frac{1}{g^2} (\partial \phi^2 + \phi^2 + \phi^3 + \phi^4 \dots)$$

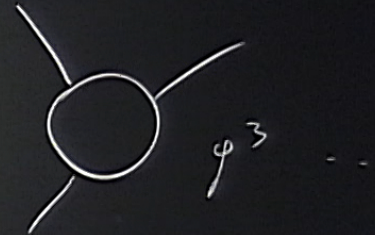
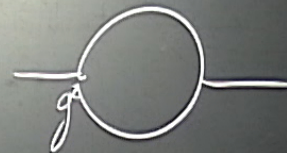
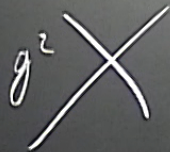
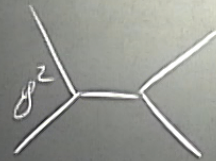
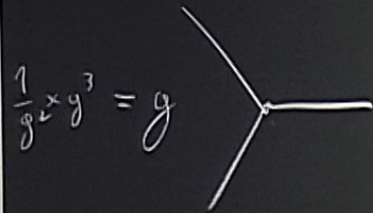
$$= (\partial \tilde{\phi})^2 + \tilde{\phi}^2 + g \phi^3 + g^2 \phi^4 \dots$$



$$A_{n,l} = g^{2l+n-2}$$

$$A_{n,l}^{\text{STRING}} = g_s^{2l+n-2} \left\{ \mathcal{M}_{n,l} \dots \right.$$

$= (\partial \phi)$



$$A_{n,l} = g^{2l+n-2}$$

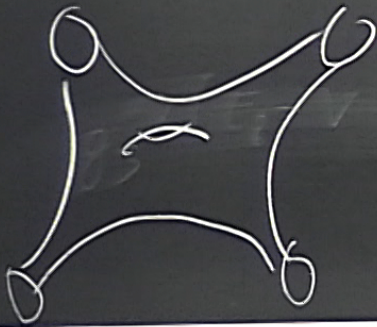
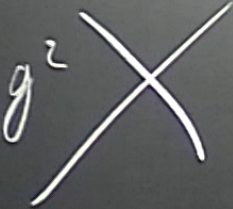
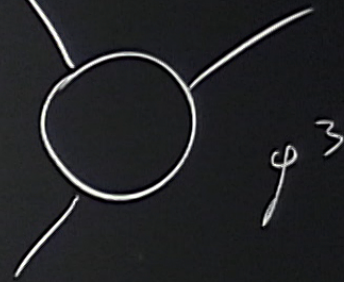
$35 \quad 2(E-V) = E$

$$A_{n,l}^{\text{STRING}} =$$

$$g_s^{2l+n-2}$$

$$\left. \begin{array}{l} \dots \\ \dots \\ \dots \end{array} \right\} \mathcal{M}_{n,l}$$

g^2 (tree-level vertex)
 g^2 (one-loop with 2 external lines)
 g^3 (one-loop with 3 external lines)
 g^2 (crossing lines)
 $n-2$ (on the left margin)
 $A_{n,l}^{\text{STRING}} = g_s^{2l+n-2} M_{n,l}$
 $\frac{1}{2\pi} \int \int R^{(2)}$ (above the exponent)
 $M_{n,l}$ (under a large curly brace)

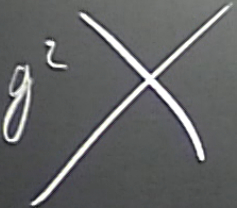
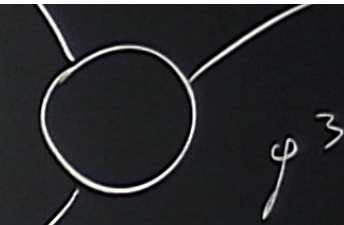
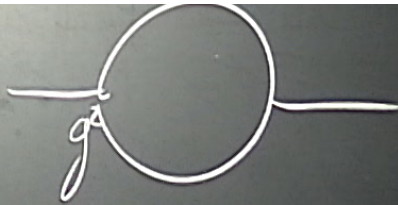
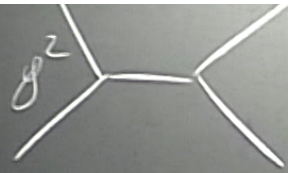


$A_{n,l}^{\text{STRING}}$

$=$

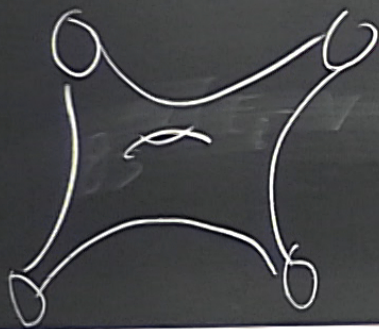
$$g_s^{\frac{1}{2\pi} \int_{\Sigma} R^{(2)}}^{2l+n-2}$$

$\mathcal{M}_{n,l}$



$$-\frac{1}{2\pi} \int \int R^{(2)} \Phi(X)$$

$$\boxed{2l + n - 2}$$



$$g_s A_{n,l}^{\text{STRING}} =$$

g_s

$M_{n,l}$

$$\Gamma_{m,l} = g_s$$

$$\mathcal{M}_{n,l}$$

$$\int \mathcal{QED} + \int A_m \dot{x}^m ds$$



$$\int_{\mathcal{M}_{n,l}} \dots ds$$

$$\int_{\text{QED}} + \int A_m (\dot{x}^\mu + \delta^\mu) (\dot{y}^\mu + \delta^\mu) + m \int \sqrt{(\dot{x} + \delta)^2} ds$$



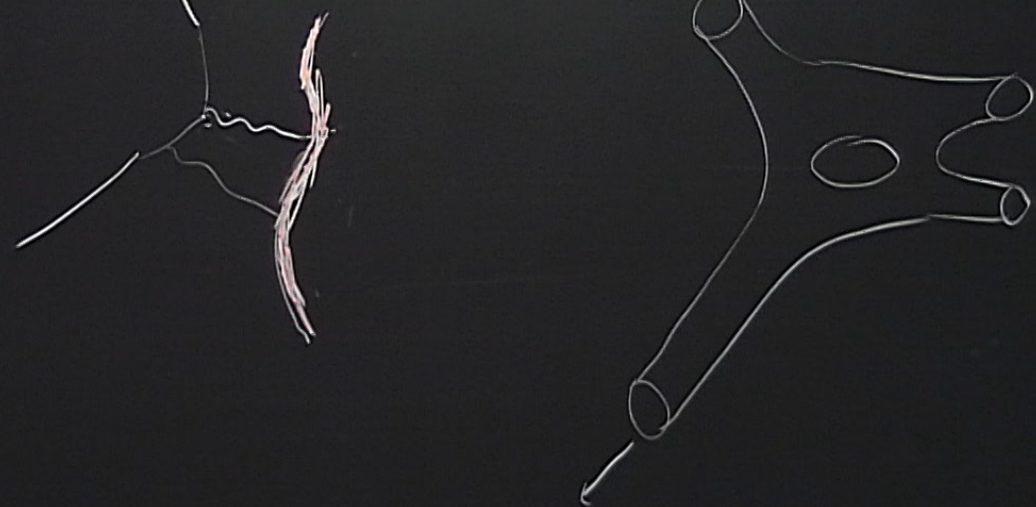


$$\mathcal{L}_{\text{QED}} + \int A_\mu [\dot{x}^\mu + \delta^\mu] (\dot{x}^\mu + \delta^\mu) + m \int \sqrt{(\dot{x} + \delta)^2} ds$$

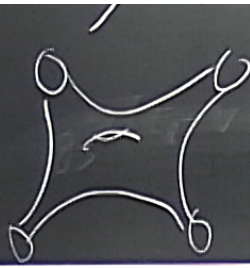


$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu} \quad \mu, \nu = 0, 1, 2, 3$$

$$S_{QED} + \int A_\mu [\dot{x}^\mu + \delta^\mu] (i\dot{L}^\mu + \dot{S}^\mu) + m \int \sqrt{(\dot{x} + \delta)^2} ds$$



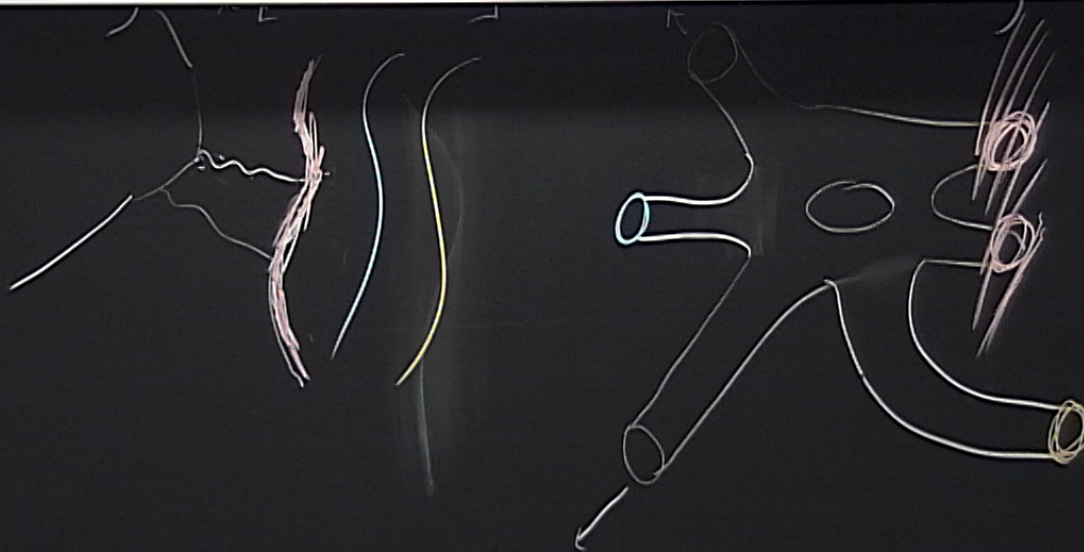
$$A_{n,l} = g^{2l+n-2}$$



$$\text{STRING } A_{n,l} =$$

$$g_s^{\frac{2l+n-2}{2}}$$

$$\int \mathcal{M}_{n,l}$$



$$A_n = \sum_{\ell = \# \text{ HANDLES}} \sum_{b = \# \text{ BOUNDARIES}}$$

$$B_1 \cdots B_b \in D$$

$$\sum$$

$$g_s^{2\ell + m + b - 2}$$

$$A_{m, g_s} [B_1, \dots, B_b]$$

$$= \sum_{\ell = \# \text{ HANDLES}} \sum_{b_1 = \# \text{ BOUNDARIES}}$$

$$g_s^{2\ell + m - 2}$$

$$(g_s N_a)^{b_a}$$

$$A_{m, \ell, b_1, \dots, b_a}$$

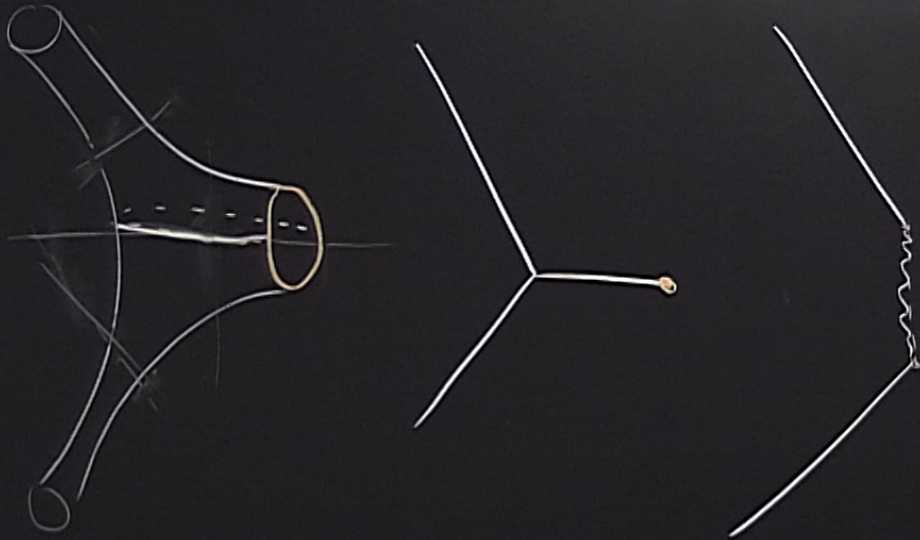
$$D = \left[\underbrace{B_1, \dots, B_{N_1}}_{N_1}, \underbrace{B_1, B_2, \dots, B_{N_2}}_{N_2}, \dots \right]$$

OF TYPE B_a

$$A_n = \sum_{\ell = \# \text{ HANDLES}} \sum_{b = \# \text{ BOUNDARIES}} B_1 \cdots B_b \in D \sum_{g_s} g_s^{2\ell + n + b - 2} A_{n, g_s} [B_1, \dots, B_b]$$

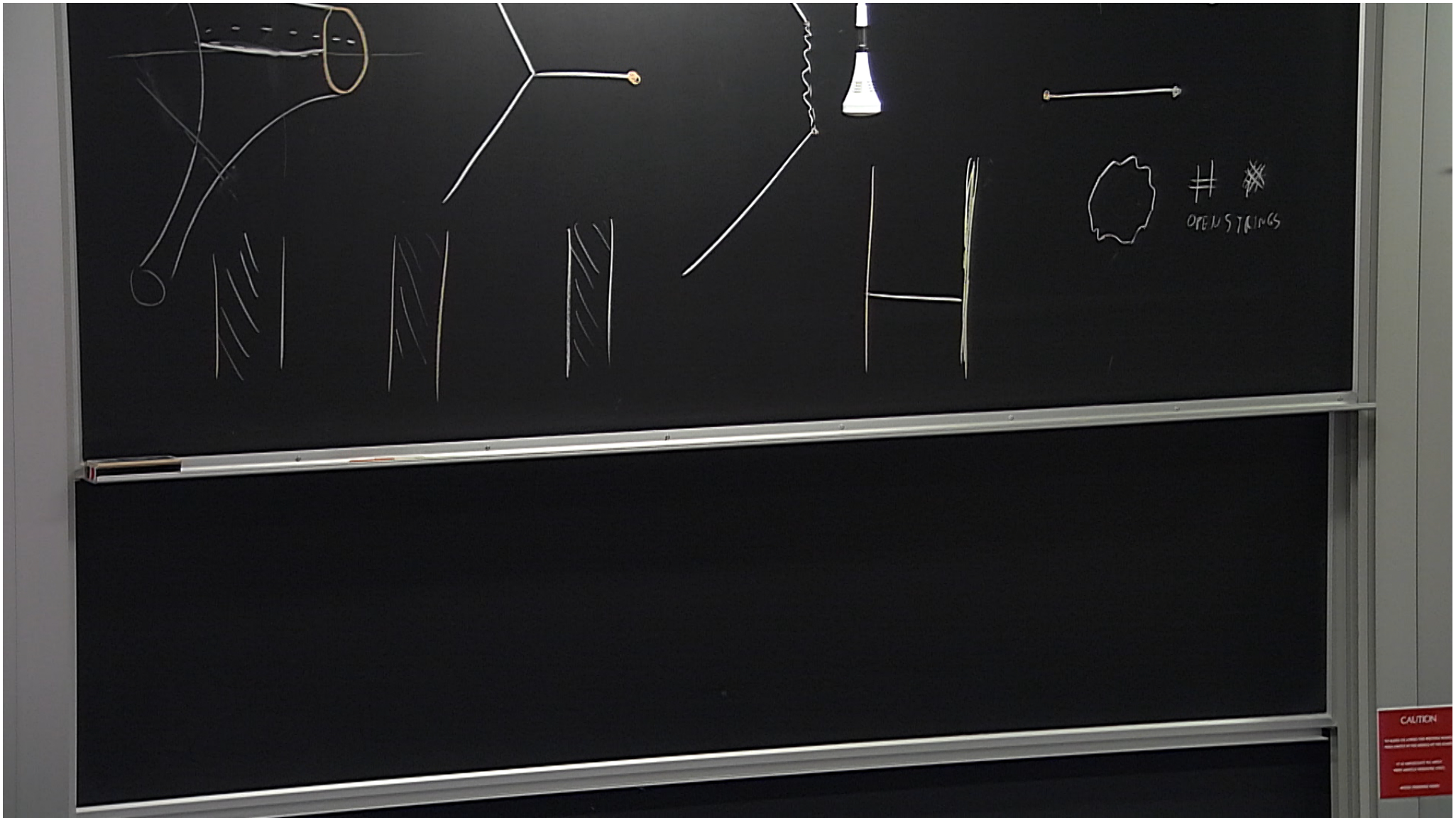
$$= \sum_{\ell = \# \text{ HANDLES}} \sum_{b_1 = \# \text{ BOUNDARIES OF TYPE } B_a} g_s^{2\ell + n - 2} \prod_a (g_s N_a)^{b_a} A_{n, \ell, b_1, \dots, b_a}$$

$$D = [\underbrace{B_1, \dots, B_1}_{N_1}, \underbrace{B_2, \dots, B_2}_{N_2}, \dots]$$



CAUTION
Do not touch the device when it is powered on.
All in compliance with CEI
EN 60950-1:2006

CAUTION
Do not touch the device when it is powered on.
All in compliance with CEI
EN 60950-1:2006

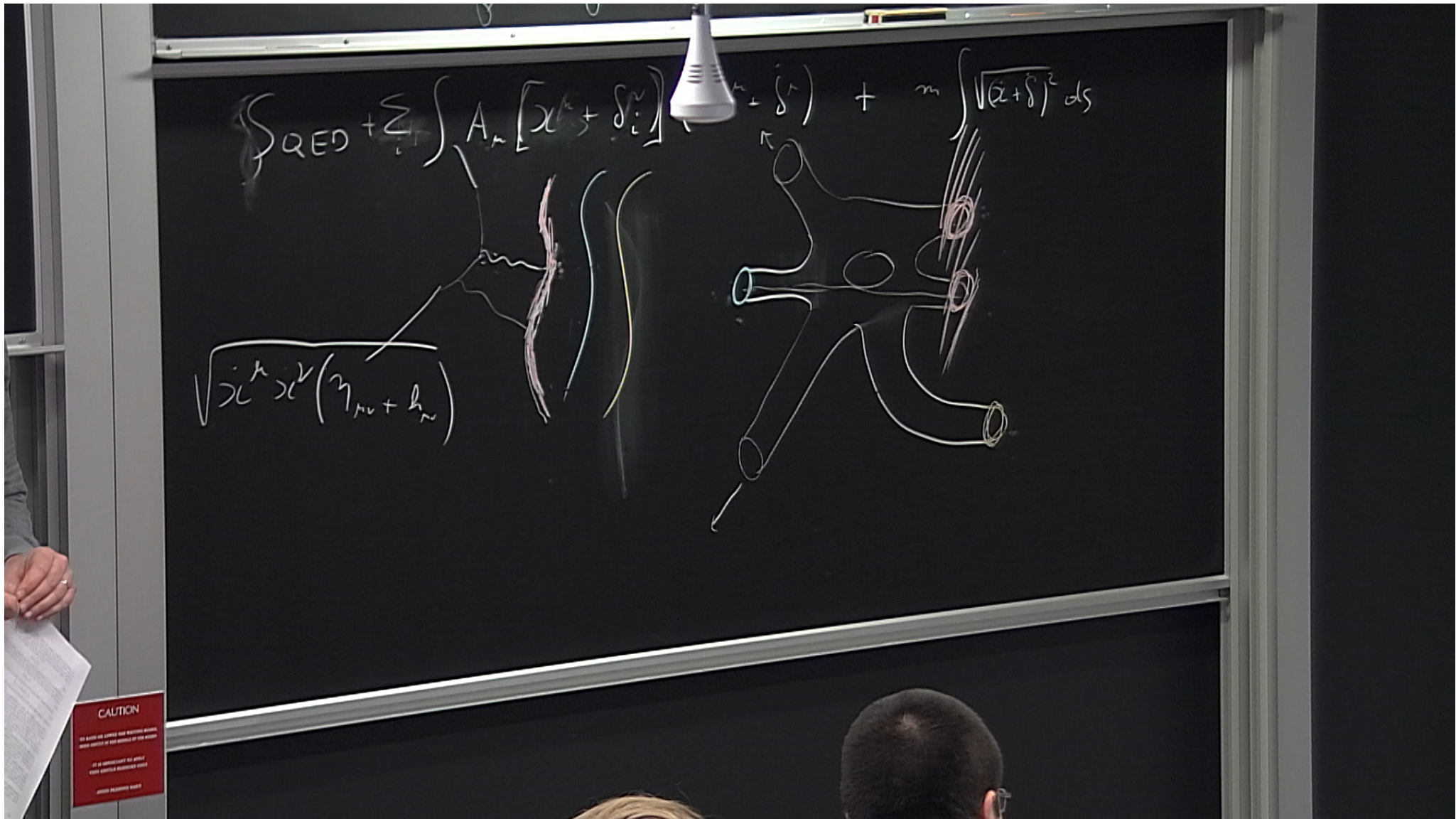


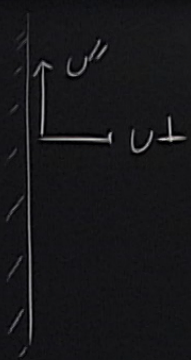
$$\begin{array}{c} \text{SINGE - PARTICLE} \\ H_1 \end{array} = H_{\text{cl}} \oplus \sum_{\substack{a, a' = 1 \\ \in \mathbb{N}}}^{\text{BRAVES}} H_{B_a, B_{a'}}^{\text{OPEN}}$$

CAUTION
 DO NOT TOUCH THE SURFACE OF THE BOARD
 IF IT IS NECESSARY TO CLEAN THE BOARD, PLEASE CONTACT THE MAINTENANCE DEPARTMENT

$$\int QED + \sum_i \int A_\mu [x^\mu + \delta x^\mu] + m \int \sqrt{(x + \delta)^2} ds$$

$$\sqrt{g_{\mu\nu}} = \sqrt{\eta_{\mu\nu} + h_{\mu\nu}}$$





$$c_{\perp} = 0$$

$$b_{\parallel} = 0$$

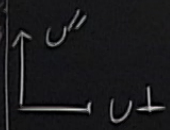
$$T_{\perp} = 0$$

$$\frac{\partial \mu_{\parallel}}{\partial t} = J_{\perp}$$

~~$$\frac{\partial \mu_{\parallel}}{\partial t} = T_{\perp}$$~~

CAUTION
 NEVER USE WRITING INSTRUMENTS IN THE VICINITY OF THE BOARD.
 ALWAYS KEEP AN EYE ON THE BOARD DURING LECTURE.
 DO NOT TOUCH THE BOARD.

CAUTION
 NEVER USE WRITING INSTRUMENTS IN THE VICINITY OF THE BOARD.
 ALWAYS KEEP AN EYE ON THE BOARD DURING LECTURE.
 DO NOT TOUCH THE BOARD.



$$c_{\perp} = 0$$

$$b_{\perp} = 0$$

$$T_x = 0$$

$$\partial_{\parallel} X^h \partial_{\perp} X^h = 0$$

$$\partial_{\mu_{\parallel}} j_{\mu_{\parallel}}^m = J^{\perp} |_{\partial}$$

~~$$\partial_{\mu_{\parallel}} j_{\mu_{\parallel}}^m = T^{\perp} |_{\partial}$$~~

$$\int_{\mathbb{R}^{d-2,1} \times \mathbb{R}^+} J^{\perp} A_m + \int_{\mathbb{R}^{d-2,1}} j_{\partial}^m A_m |_{\partial}$$