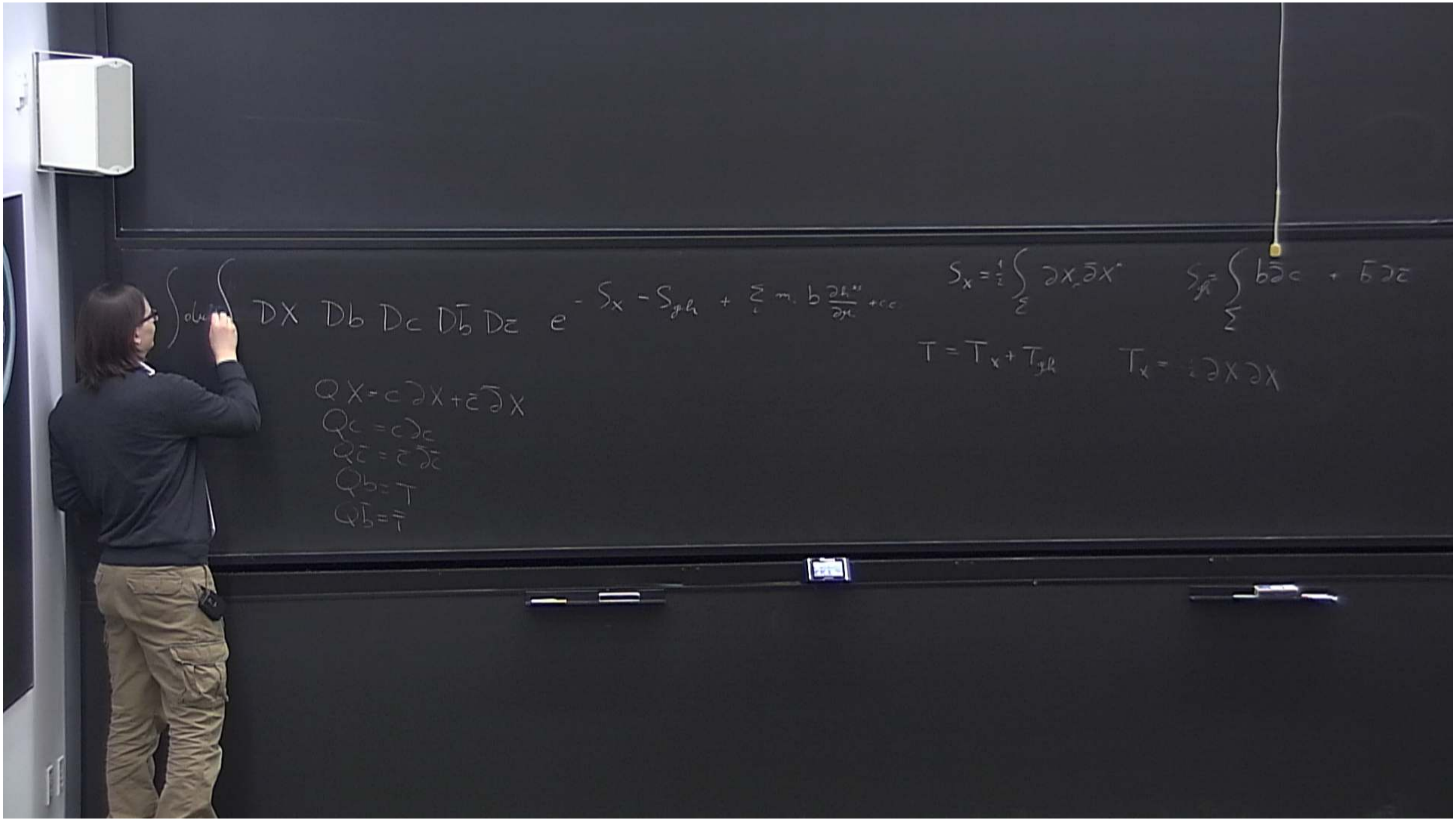
Title: PSI 2015/2016 String Theory - Lecture 7

Date: Feb 09, 2016 10:15 AM

URL: http://pirsa.org/16020041

Abstract:


$DX\ Db\ Dc\ D\bar{b}\ D\bar{c}\ e^{-S_X - S_{gh} + \sum_i m_i b \frac{\partial h}{\partial m} + c.c.}$
$QX = c\partial X + \bar{c}\bar{\partial} X$
$Qc = c\partial c$
$Q\bar{c} = \bar{c}\bar{\partial}\bar{c}$
$Qb = T$
$Q\bar{b} = \bar{T}$
$S_X = \frac{1}{2}\int_\Sigma \partial X \bar{\partial} X$
$S_{gh} = \int_\Sigma b\bar{\partial} c + \bar{b}\partial\bar{c}$
$T = T_X + T_{gh}$
$T_X = \partial X \partial X$

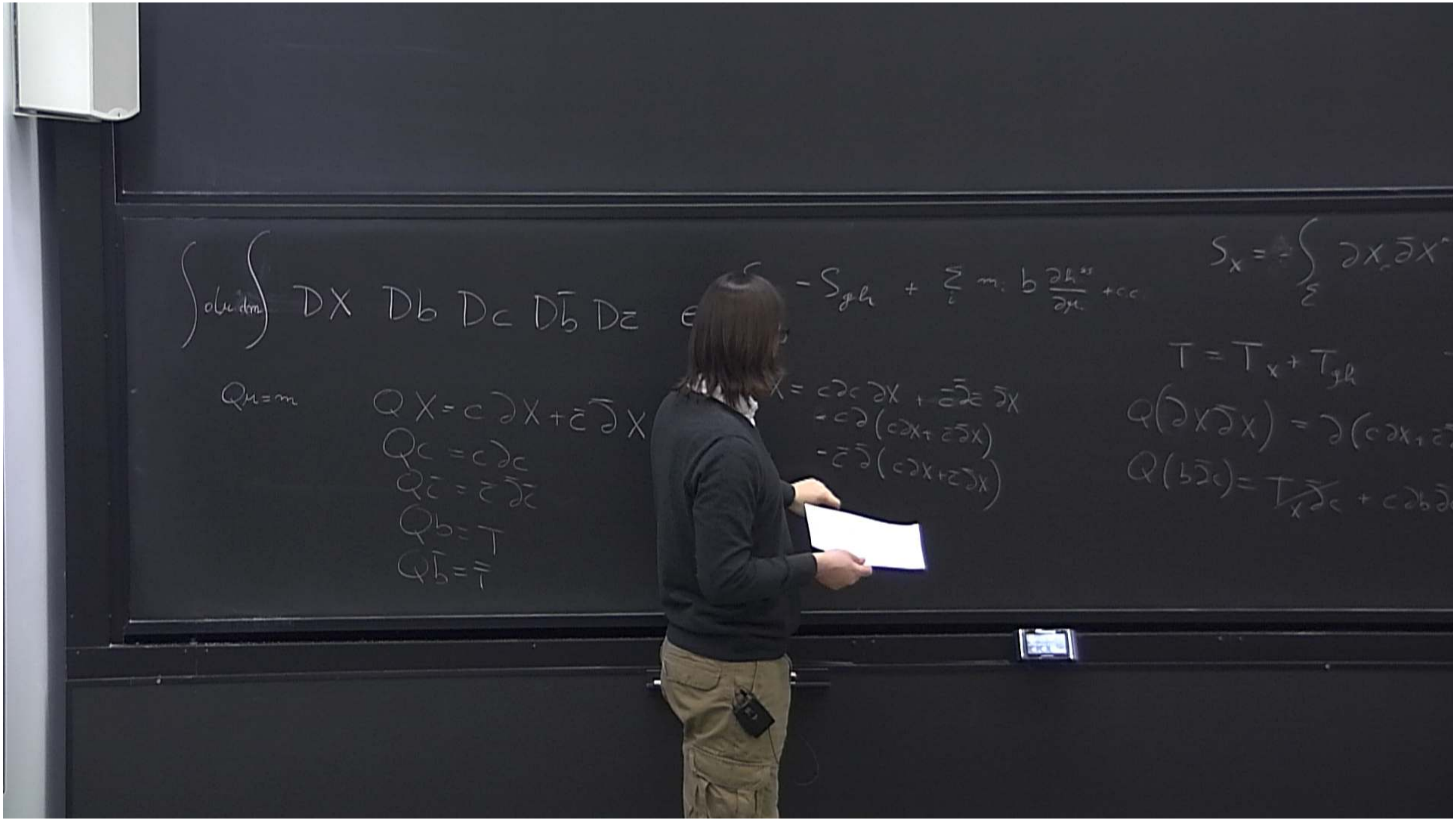
$$e^{-S_X - S_{gh} + \sum_i m_i\, b \frac{\partial h^{as}}{\partial m_i} + c.c.}$$

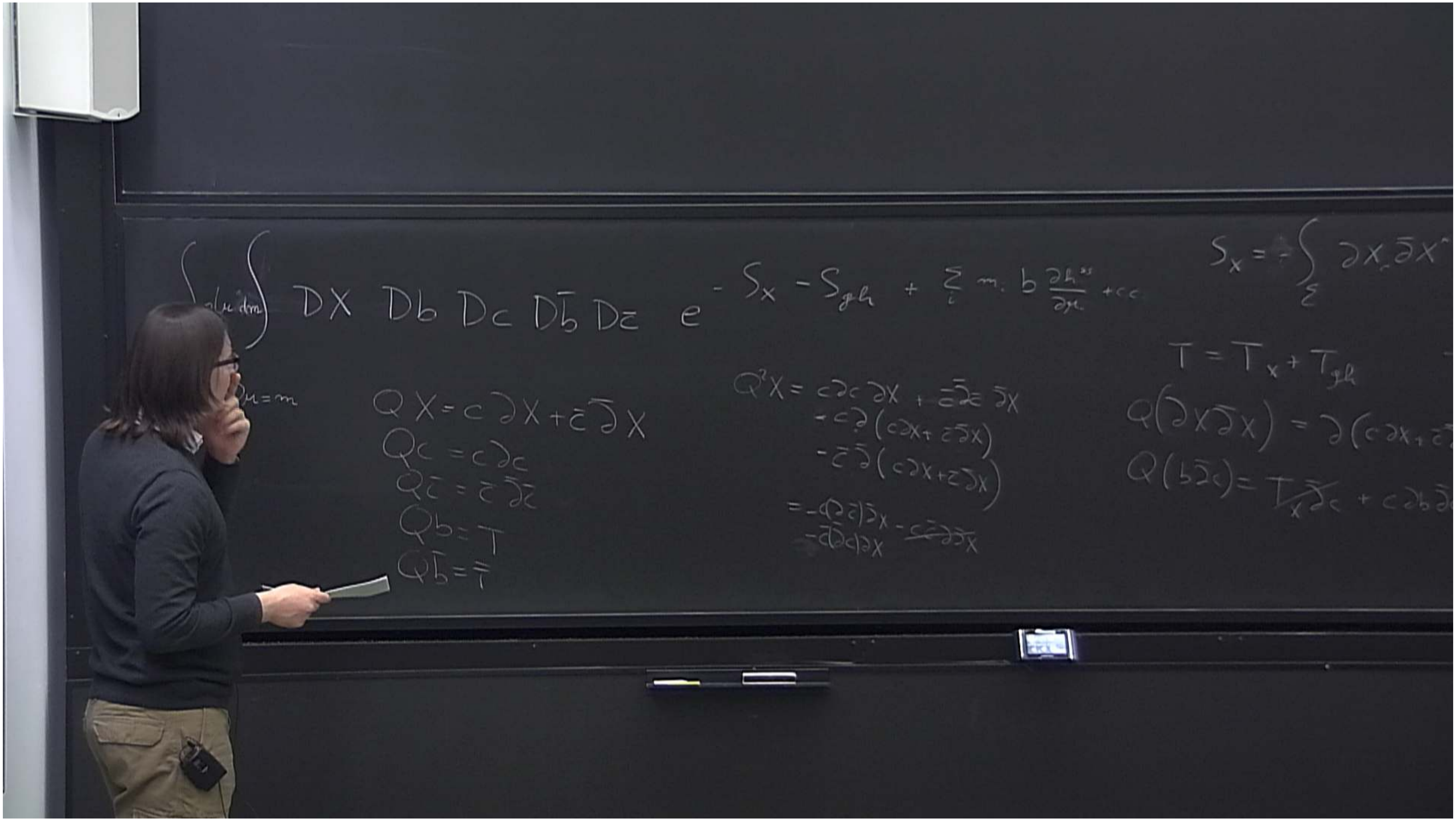
$$S_X = \int_\Sigma \partial X_\mu \bar\partial X^\mu \qquad S_{gh} = \int_\Sigma b\bar\partial c + \bar b \partial \bar c$$

$$T = T_X + T_{gh} \qquad T_X = \partial X \partial X \qquad T_{gh} = c\partial b + 2(\partial c) b$$

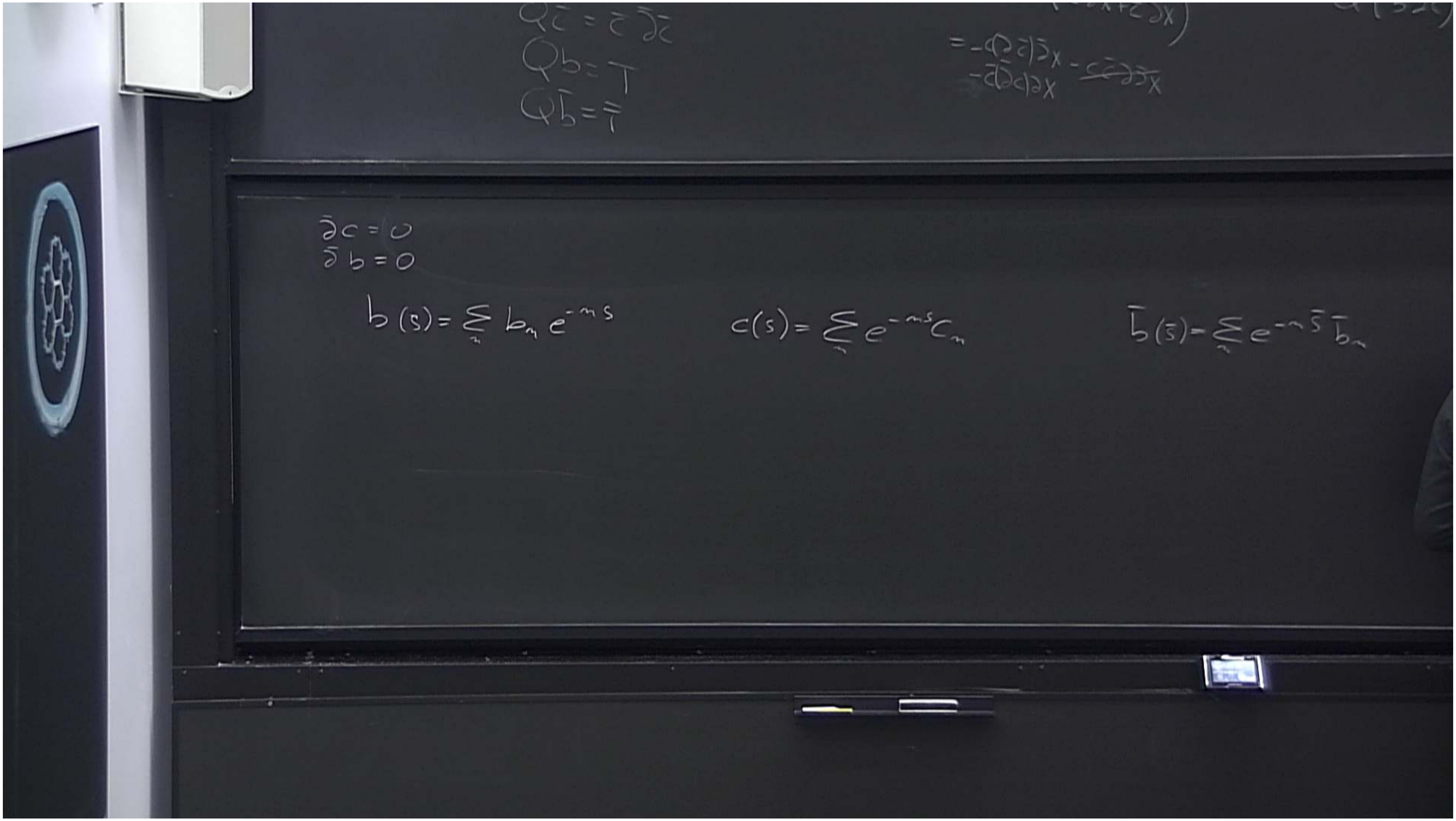
$$Q(\partial X \bar\partial X) = \partial(c\partial X + \bar c \bar\partial X)\bar\partial X + c.c. = \partial(c\partial X \bar\partial X) + \partial X \cancel{\partial X}\, \bar\partial c + c.c.$$

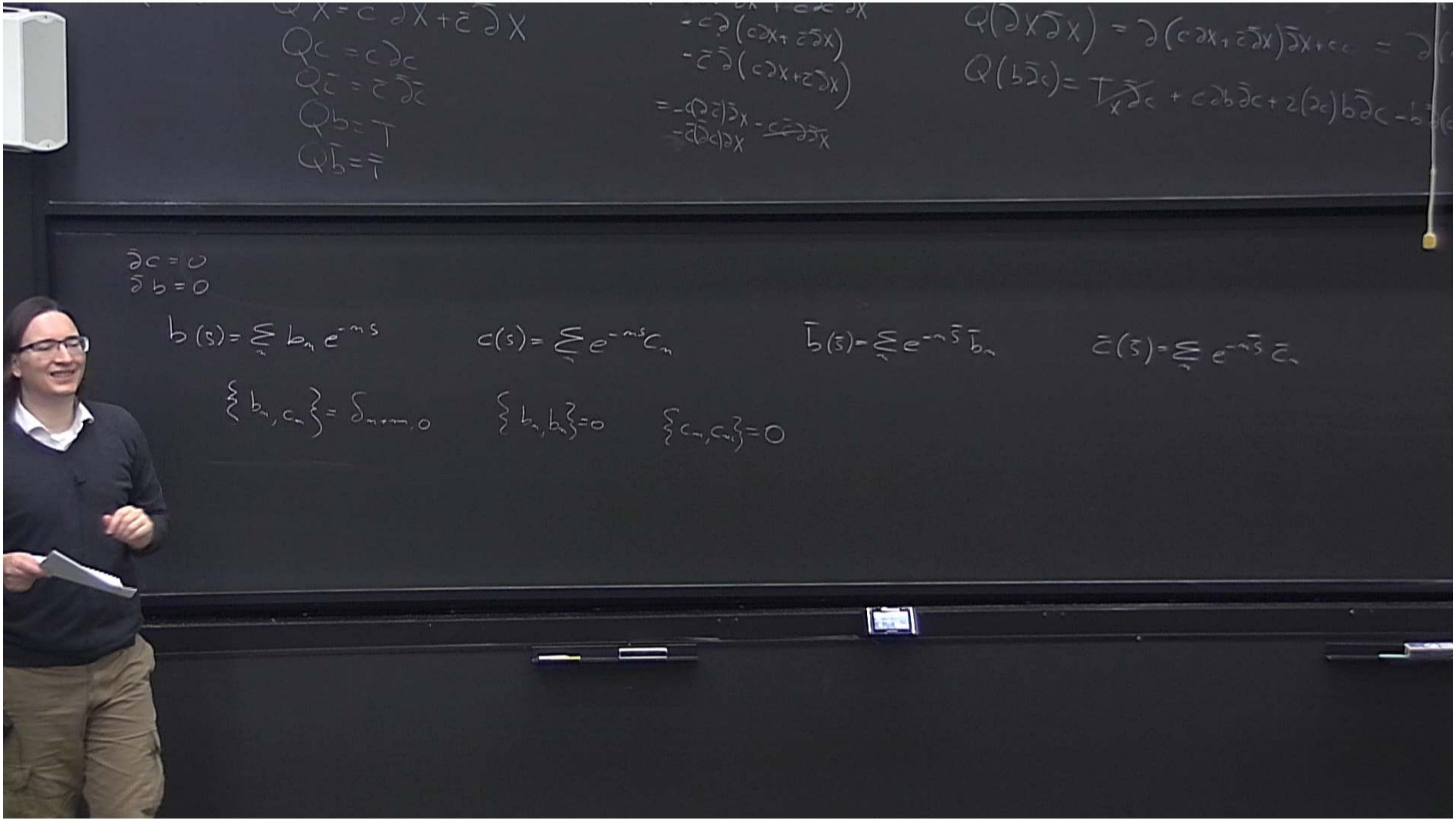
$$Q(b\bar\partial c) = \cancel{T_X \bar\partial c} + c\partial b \bar\partial c + 2(\partial c) b \bar\partial c - b\bar\partial(c\partial c) = -\partial(bc\bar\partial c)$$

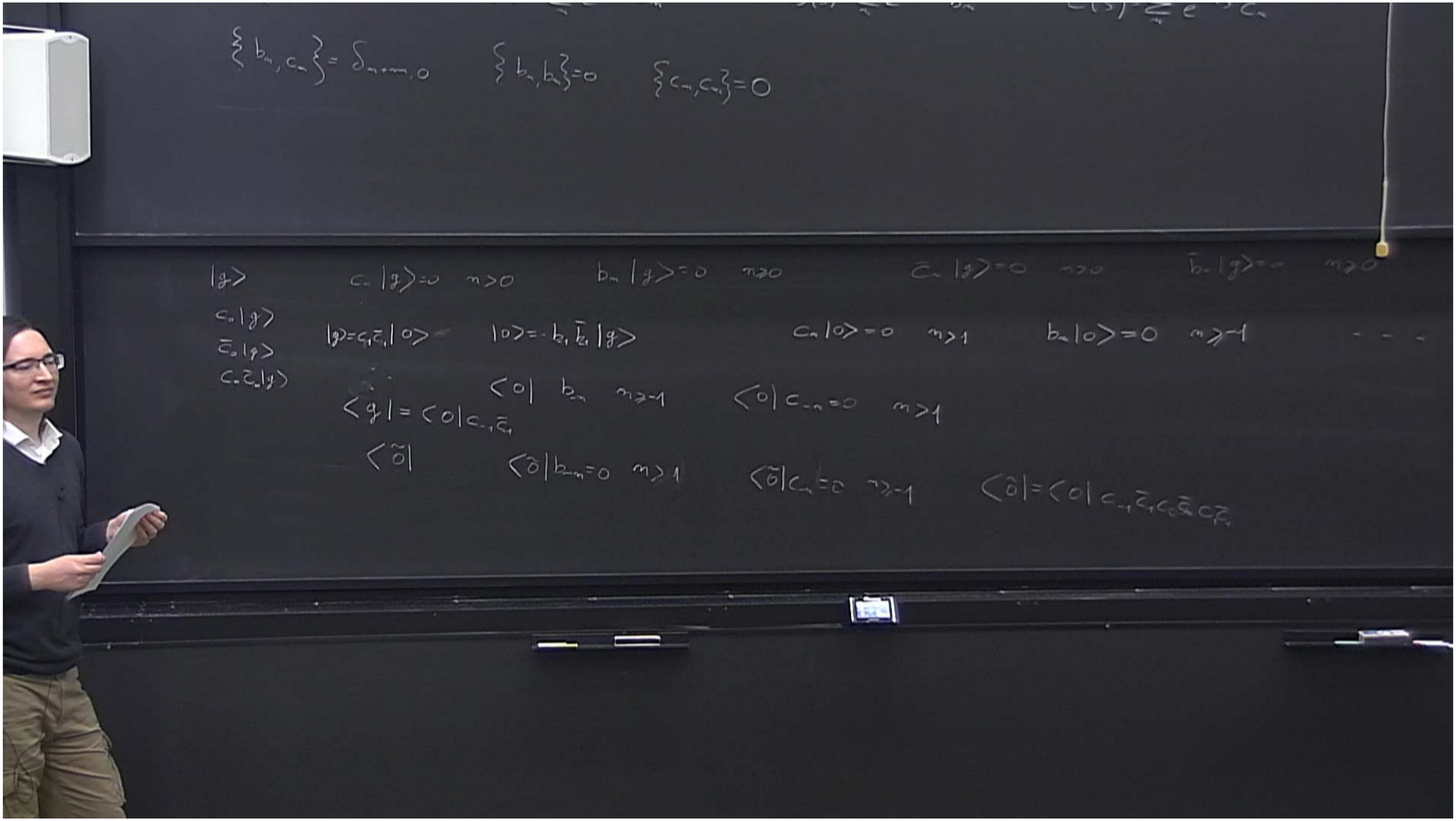

DX Db Dc Db̄ Dc̄
Qm = m
QX = c∂X + c̄∂̄X
Qc = c∂c
Qc̄ = c̄∂̄c̄
Qb = T
Qb̄ = T̄
T = T_X + T_gh



DX Db Dc Db̄ Dc̄ e
QX = c∂X + c̄∂̄X
Qc = c∂c
Qc̄ = c̄∂̄c̄
Qb = T
Qb̄ = T̄
T = T_X + T_gh


$Q\bar{c} = \bar{c}\bar{\partial}\bar{c}$
$Qb = T$
$Q\bar{b} = \bar{T}$
$\bar{\partial} c = 0$
$\bar{\partial} b = 0$
$b(s) = \sum_n b_n e^{-ns}$
$c(s) = \sum_n e^{-ns} c_n$
$\bar{b}(\bar{s}) = \sum_n e^{-n\bar{s}} \bar{b}_n$


$Qc = c\partial c$
$Q\bar{c} = \bar{c}\bar{\partial}\bar{c}$
$Qb = T$
$Q\bar{b} = \bar{T}$
$\bar{\partial}c = 0$
$\bar{\partial}b = 0$
$b(s) = \sum_n b_n e^{-ns}$
$c(s) = \sum_n e^{-ns} c_n$
$\bar{b}(\bar{s}) = \sum_n e^{-n\bar{s}} \bar{b}_n$
$\bar{c}(\bar{s}) = \sum_n e^{-n\bar{s}} \bar{c}_n$
$\{b_n, c_m\} = \delta_{n+m,0}$
$\{b_n, b_m\} = 0$
$\{c_n, c_m\} = 0$


{b_n, c_m} = δ_{n+m,0}
{b_n, b_m} = 0
{c_n, c_m} = 0
|g⟩
c_n |g⟩ = 0 n > 0
b_n |g⟩ = 0 n ≥ 0
c_0 |g⟩
c̄_0 |g⟩
c_0 c̄_0 |g⟩
|g⟩ = c_1 c̄_1 |0⟩
|0⟩ = - b_1 b̄_1 |g⟩
c_n |0⟩ = 0 n > 1
b_n |0⟩ = 0 n ≥ -1
⟨0| b_n n ≥ -1
⟨0| c_{-n} = 0 n > 1
⟨g| = ⟨0| c_{-1} c̄_{-1}
⟨õ|
⟨õ| b_{-n} = 0 n > 1
⟨õ| c_n = 0 n ≥ -1

$$\langle \tilde{0} | 0 \rangle = 1$$

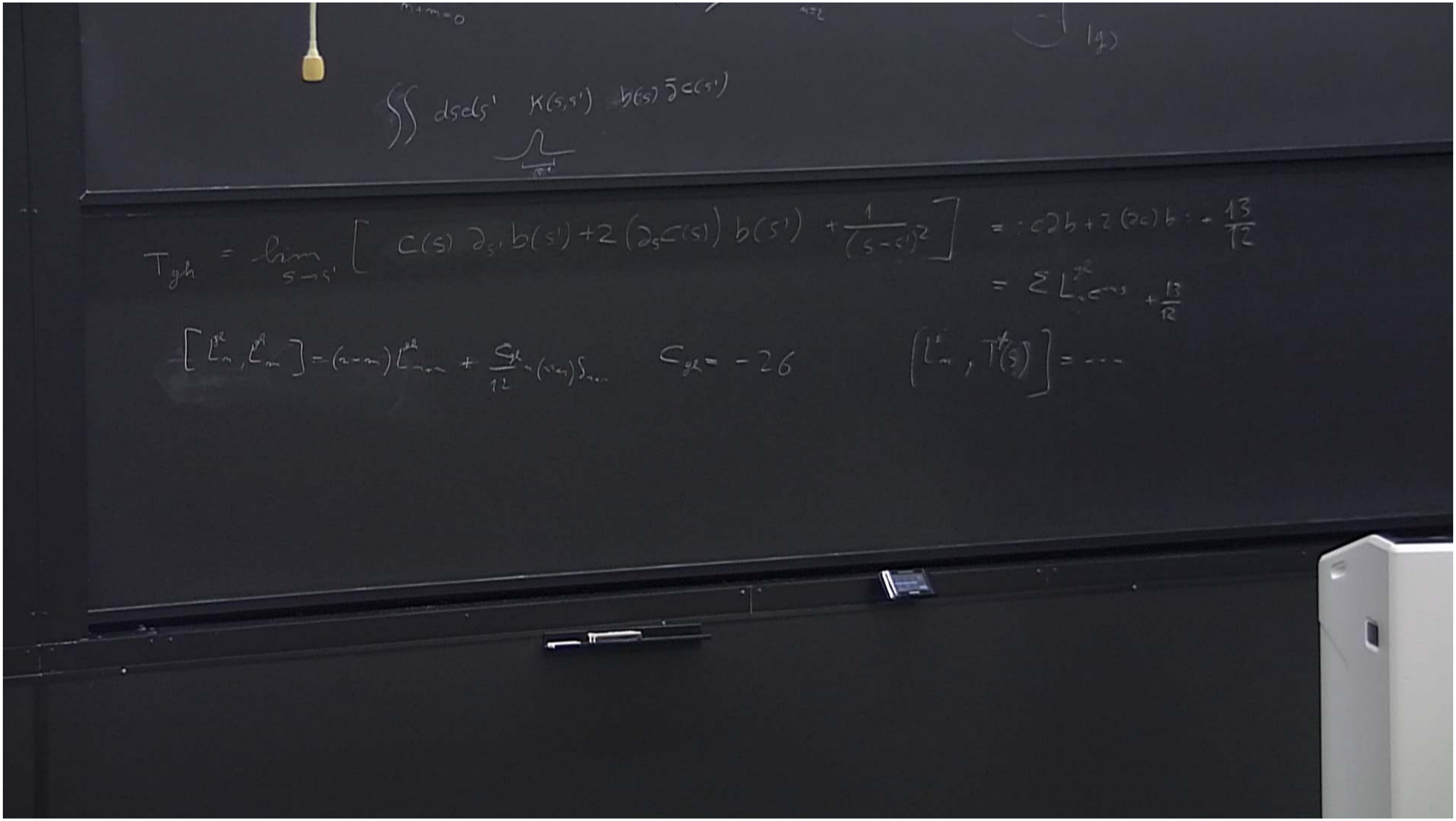
$$\langle \tilde{0} | c(s)\, b(s') | 0 \rangle = \frac{e^{2s'-s}}{e^{s}-e^{s'}}$$

$$\langle g | c_0 \bar{c}_0 | g \rangle = 1$$

$$\langle g | c_0 \bar{c}_0 \; c(s)\, b(s') | g \rangle$$

$\langle g |$

$| g \rangle$


$\iint ds\,ds'\; K(s,s')\; b(s)\,\bar{\partial} c(s')$
$T_{gh} = \lim_{s\to s'} \left[c(s)\,\partial_{s'} b(s') + 2(\partial_s c(s))\, b(s') + \frac{1}{(s-s')^2} \right] = :c\partial b + 2(\partial c) b: + \frac{13}{12}$
$= \sum L^{gh}_n e^{-ns} + \frac{13}{12}$
$[L^{gh}_n, L^{gh}_m] = (n-m) L^{gh}_{n+m} + \frac{c_{gh}}{12} n(n^2-1)\delta_{n+m}$
$c_{gh} = -26$
$[L_m, T^{gh}(s)] = \cdots$

$$L^{gh}_m = -\sum_n (n+m) :c_n b_{m-n}:$$

$$J_{gh}(s) = \lim_{s\to s'} \left[c(s)\, b(s') - \frac{1}{(s-s')} \right] = :cb: - \frac{3}{2} = \sum J_n e^{-ns}$$

J_s $\quad$ $J_{\bar s}$

J_0 $\quad$ $\bar{J}_0$

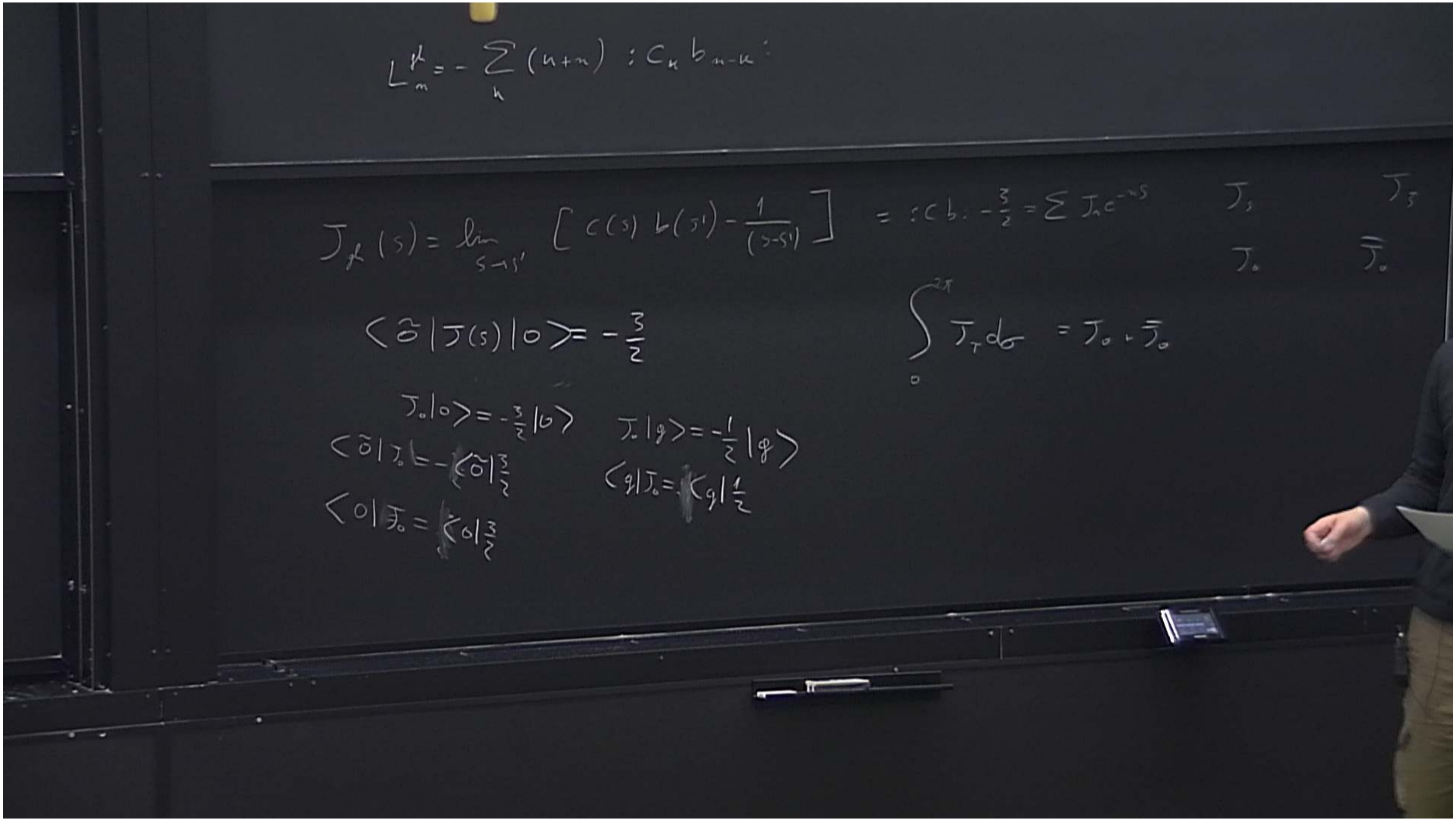
$$\langle \hat{0} | J(s) | 0 \rangle = -\frac{3}{2}$$

$$\int_0^{2\pi} J_\tau \, d\sigma = J_0 + \bar{J}_0$$

$J_0 |0\rangle = -\frac{3}{2}$ $\qquad$ $J_0 |g\rangle = -\frac{1}{2}$

$\langle \hat{0} | J_0 = -\frac{3}{2}$ $\qquad$ $\langle g | J_0 = \frac{1}{2}$

$\langle 0 | \bar{J}_0 = \frac{3}{2}$


$L_m^{\ell} = -\sum_k (m+k) :c_k b_{m-k}:$
$J_\ell(s) = \lim_{s \to s'} \left[c(s) b(s') - \frac{1}{(s-s')} \right] = :cb: - \frac{3}{2} = \sum J_n e^{-ns}$
J_3 J_3
J_0 $\bar{J}_0$
$\int_0^{2\pi} J_\tau d\sigma = J_0 + \bar{J}_0$
$\langle \tilde{0} | J(s) | 0 \rangle = -\frac{3}{2}$
$J_0 |0\rangle = -\frac{3}{2} |0\rangle$
$J_0 |g\rangle = -\frac{1}{2} |g\rangle$
$\langle \tilde{0} | J_0 = -\langle \tilde{0} | \frac{3}{2}$
$\langle g | J_0 = \langle g | \frac{1}{2}$
$\langle 0 | J_0 = \langle 0 | \frac{3}{2}$