Title: PSI 2016/2017 String Theory (Review) - Lecture 7

Date: Mar 01, 2017 10:00 AM

URL: http://pirsa.org/17030022

Abstract:

$$\int u \, \bar{\partial} v + \cdots$$

$$u = \left(\frac{ds'}{ds}\right)^{1-\Delta} u'$$

$$v = \left(\frac{ds'}{ds}\right)^{\Delta} v'$$

$$T = (1-\Delta)\, \partial v \, u + \Delta \, v \, \partial u$$

$$= \partial v \, u - \Delta \, \partial (v u)$$

$$T(z)\, v(w) \sim \cdots$$

$$T(z)\, v(w) \sim \cdots$$

$$S_{bc} = \int b\, \partial_{\bar{s}} c^s + b_{\bar{s}\bar{s}} \partial_s c^{\bar{s}}$$

$$= \int b \bar{\partial} c + \text{c.c.}$$

$$T = \lim_{s \to s'} \left[\quad c\, \partial b + 2\, \partial c\, b \right.$$

$b_{ss} = b \qquad b_{\bar{s}\bar{s}} = \bar{b}$

$c^s = c \qquad c^{\bar{s}} = \bar{c}$

$$b_{s's'} = \left(\frac{ds'}{ds}\right)^2 b_{s's'}(s'(s))$$

$$c^s = \left(\frac{ds'}{ds}\right)^{-1} c^{\bar{s}}(s'(s))$$

$$S_{bc} = \int b_{ss}\,\partial_{\bar{s}} c^{s} + b_{\bar{s}\bar{s}}\,\partial_{s} c^{\bar{s}}$$

$$= \int b\,\bar{\partial} c + c.c.$$

$$T = \lim_{s \to s'} \left[c(s)\,\partial_{s'} b(s') + 2\,\partial_s c(s)\, b(s') + \frac{1}{(s-s')^2} \right]$$

$$J_{gh} = \lim_{s \to s'} \left[c(s)\, b(s') - \frac{1}{s-s'} \right]$$

$$b_{ss} = b \qquad b_{\bar{s}\bar{s}} = \bar{b}$$

$$c^{s} = c \qquad c^{\bar{s}} = \bar{c}$$

$$b_{ss} = \left(\frac{ds'}{ds}\right)^{2} b_{s's'}(s'(s))$$

$$c^{s} = \left(\frac{ds'}{ds}\right)^{-1} c^{s'}(s'(s))$$

$$c(s)\, b(s') \sim \frac{1}{s-s'} + \cdots$$

$$\{b_0, c_0\} = 1$$

$$1$$

$$\frac{1}{(e^{s}-e^{s'})^2}$$

$$\frac{1}{e^{s}-e^{s'}}$$

$$b(s) = \sum_{n=-\infty}^{\infty} b_n e^{-ns}$$

$$c(s) = \sum_{n=-\infty}^{\infty} c_n e^{-ns}$$

$$\{b_n, c_m\} = \delta_{n+m,0}$$

$$\{b_n, b_m\} = 0$$

$$\{c_m, c_n\} = 0$$

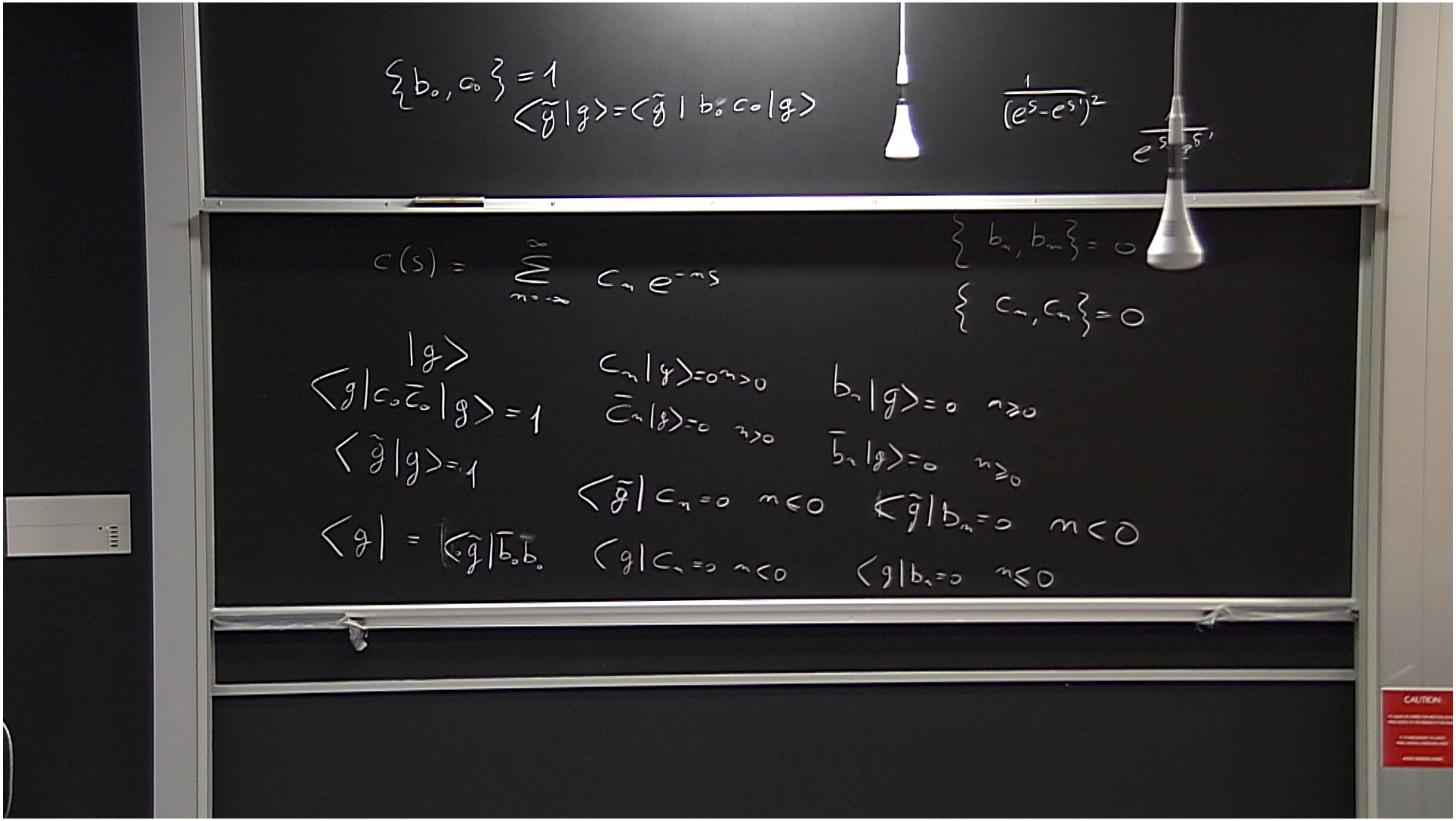
$$|g\rangle$$

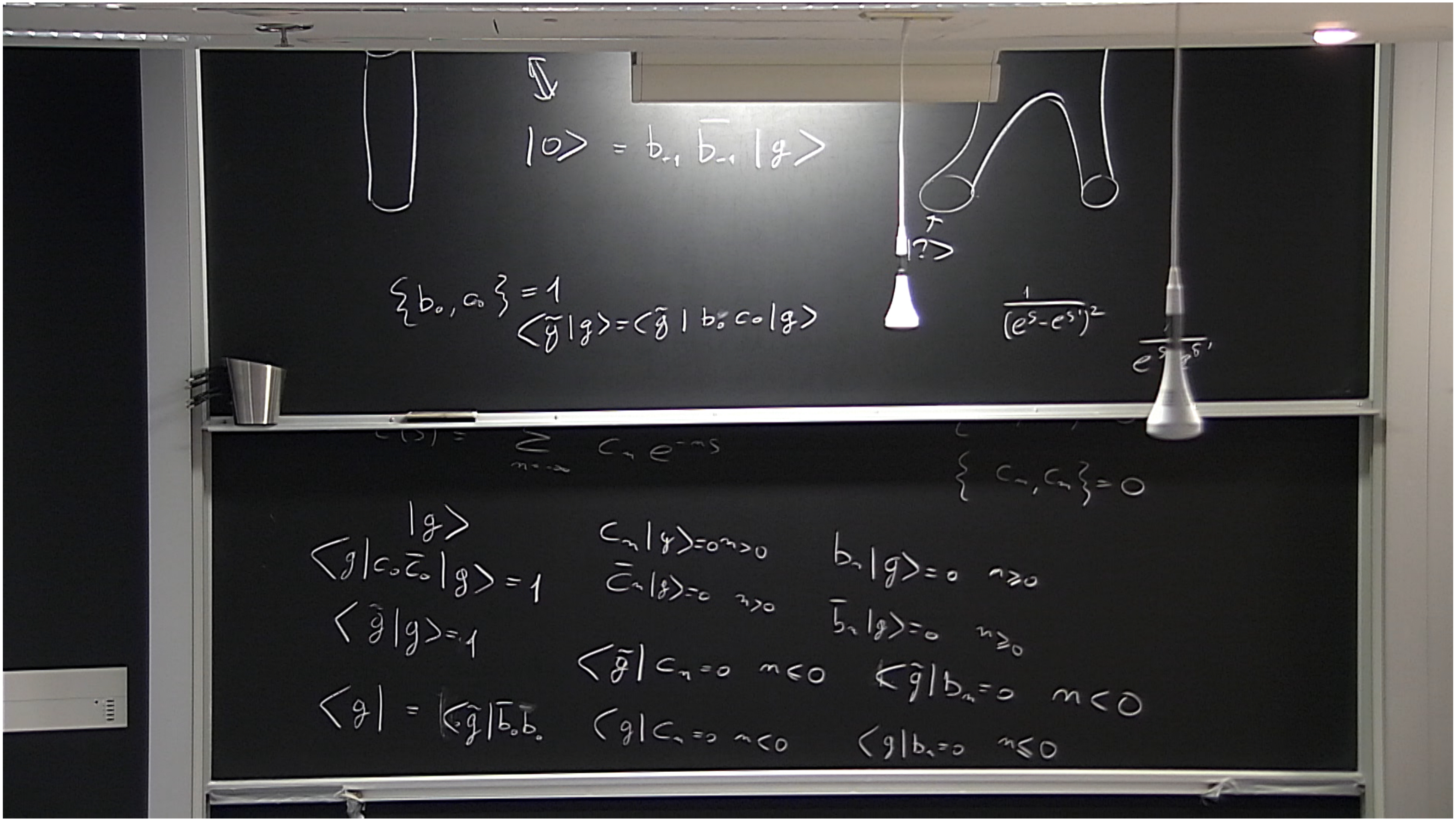
$$c_n|g\rangle = 0 \quad n>0$$

$$\bar{c}_n|g\rangle = 0 \quad n>0$$

$$b_n|g\rangle = 0 \quad n\geq 0$$

$$\bar{b}_n|g\rangle = 0 \quad n\geq 0$$


$\{b_0, c_0\} = 1$
$\langle \tilde{g} | g \rangle = \langle \tilde{g} | b_0 c_0 | g \rangle$
$\frac{1}{(e^{s} - e^{s'})^2}$
$\frac{1}{e^{s} - e^{s'}}$
$c(s) = \sum_{n=-\infty}^{\infty} c_n e^{-ns}$
$\{b_n, b_m\} = 0$
$\{c_m, c_n\} = 0$
$|g\rangle$
$\langle g | c_0 \bar{c}_0 | g \rangle = 1$
$\langle \tilde{g} | g \rangle = 1$
$c_n | g \rangle = 0 \quad n > 0$
$\bar{c}_n | g \rangle = 0 \quad n > 0$
$b_n | g \rangle = 0 \quad n \geq 0$
$\bar{b}_n | g \rangle = 0 \quad n \geq 0$
$\langle \tilde{g} | c_n = 0 \quad n \leq 0$
$\langle \tilde{g} | b_n = 0 \quad n < 0$
$\langle g | = \langle \tilde{g} | \bar{b}_0 b_0$
$\langle g | c_n = 0 \quad n < 0$
$\langle g | b_n = 0 \quad n \leq 0$


$|0\rangle = b_{-1}\bar{b}_{-1}|g\rangle$
$|?\rangle$
$\{b_0, c_0\} = 1$
$\langle\tilde{g}|g\rangle = \langle\tilde{g}|b_0 c_0|g\rangle$
$\frac{1}{(e^{s}-e^{s'})^2}$
$\{c_{-n}, c_n\} = 0$
$|g\rangle$
$\langle g|c_0\bar{c}_0|g\rangle = 1$
$\langle\tilde{g}|g\rangle = 1$
$\langle g| = \langle\tilde{g}|\bar{b}_0 b_0$
$c_n|g\rangle = 0 \quad n>0$
$\bar{c}_n|g\rangle = 0 \quad n>0$
$b_n|g\rangle = 0 \quad n\geq 0$
$\bar{b}_n|g\rangle = 0 \quad n\geq 0$
$\langle\tilde{g}|c_n = 0 \quad n\leq 0$
$\langle\tilde{g}|b_n = 0 \quad n<0$
$\langle g|c_n = 0 \quad n<0$
$\langle g|b_n = 0 \quad n\leq 0$

$$S_{bc} = \int b_{ss}\, \partial_{\bar{s}} c^{s} + b_{\bar{s}\bar{s}}\, \partial_{s} c^{\bar{s}}$$

$$= \int b\, \bar{\partial} c + c.c.$$

$$T' = \lim_{s \to s'} \left[c(s)\, \partial_{s'} b(s') + 2\, \partial_s c(s)\, b(s') + \frac{1}{(s-s')^2} \right]$$

$$J_{gh} = \lim_{s \to s'} \left[c(s)\, b(s') - \frac{1}{s-s'} \right]$$

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$$c^{s} = \left(\frac{ds'}{ds}\right)^{-1} c^{\bar{s}}(s'(s))$$

$$c(s)\, b(s') \sim \frac{1}{s-s'} + \dots$$

$$(s-s')^2$$

$$J_{gh} = \lim_{s \to s'} \left[c(s)\, b(s') - \frac{1}{s-s'} \right]$$

$$c(s)\, b(s') \sim \frac{1}{s-s'} + \dots$$

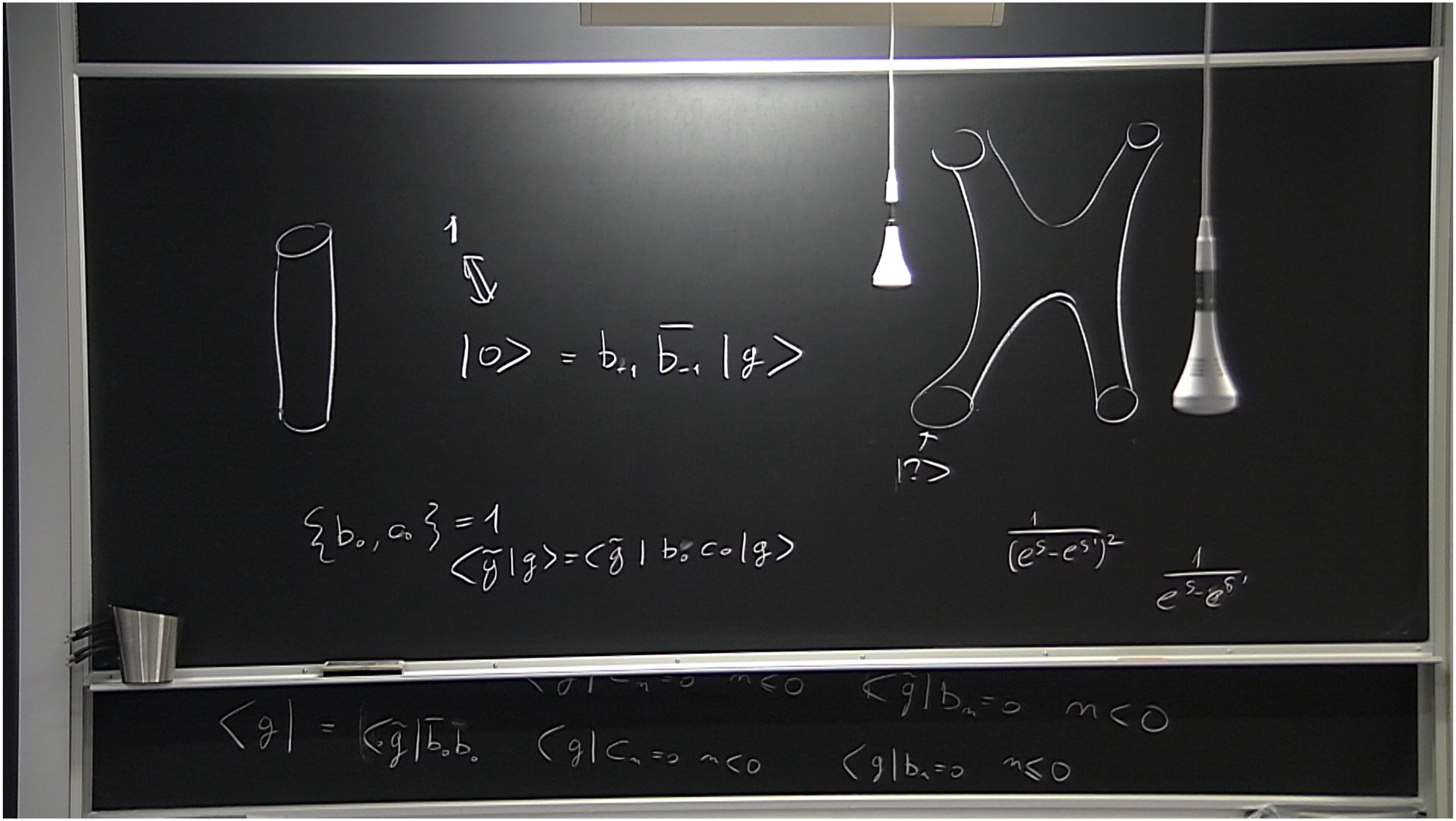
$$[J^{gh}_n, J^{gh}_m] = n\, \delta_{n+m}$$

$$[L, J^{gh}(s)] = \partial\left(e^{-ns} J(s)\right) + \frac{3}{2} \dots$$

$$\xrightarrow[b_0]{} \quad c_0|g\rangle \; \underset{c_0}{\overset{c_0}{\rightleftarrows}} \; c_0|g\rangle$$

$$[L_n, L_m] = (n-m) L_{n+m} + \frac{\overbrace{c_{gh}}^{=-26}}{12} n(n^2-1)\, \delta_{n+m,0}$$

$$T = \sum L_n e^{-ns} - \frac{c}{24}$$


1
|0> = b₋₁ b̄₋₁ |g>
|?>
{b₀, c₀} = 1
<g̃|g> = <g̃| b₀ c₀ |g>
1 / (e^s − e^s')²
1 / (e^s − e^s')
<g| = <g̃| b̄₀ b₀
<g| c_n = 0 n<0
<g| b_n = 0 n≤0
<g̃| b_n = 0 n<0
<g̃| c_n = 0 n≤0

$$\ldots |V(k)\rangle_n \ldots$$

$$QX = c\partial X + \bar{c}\bar{\partial} X$$

$$Qc = -c\partial c \qquad Qb = T_{gh} + T_X$$

gh + MATTER $\qquad$ $H_{gh} \otimes H_{X^\mu}$

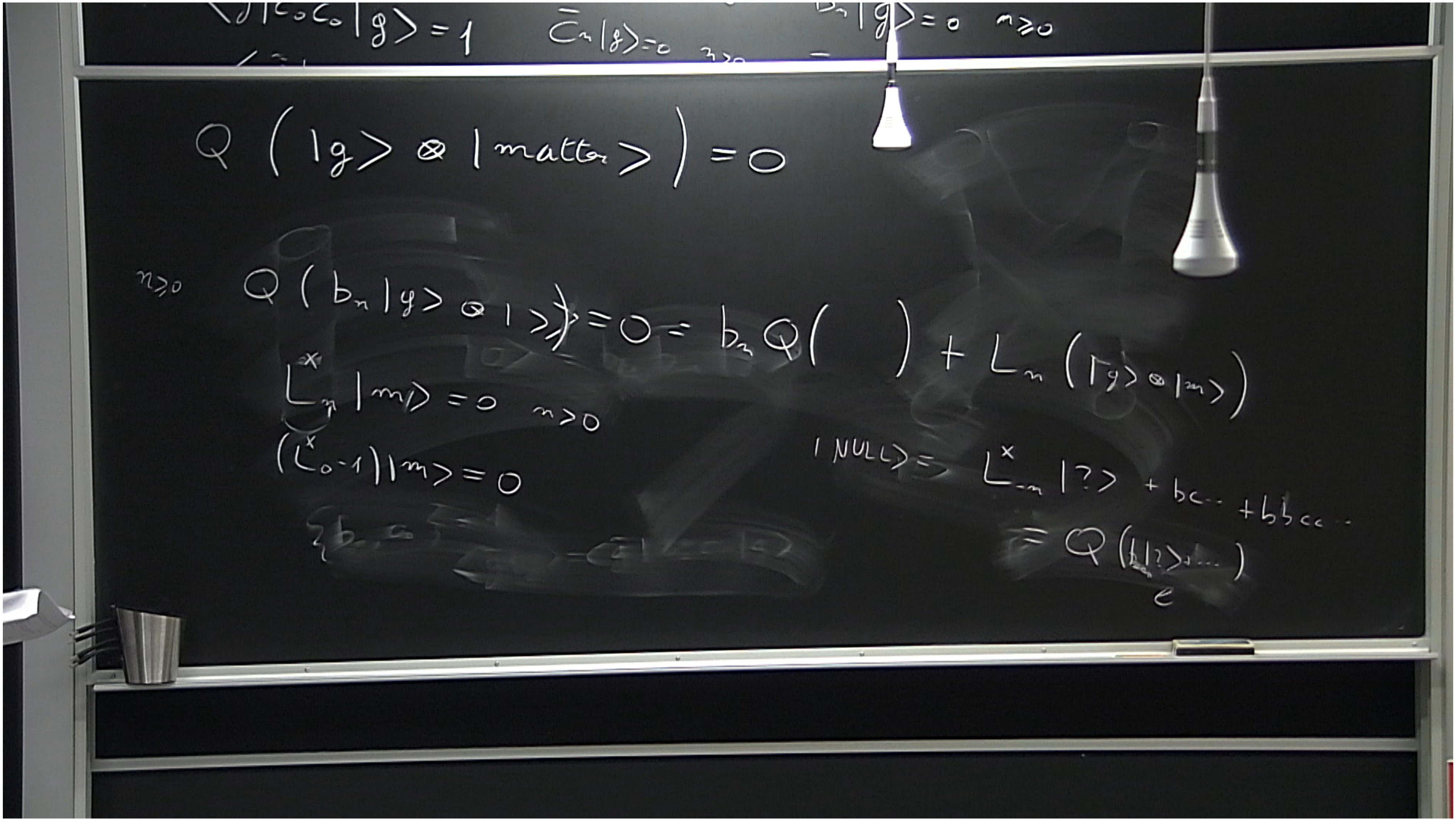
X^μ $\qquad$ $|\cdots\rangle \otimes |\cdots\rangle$

$$Q = \oint c\, T_{X^\mu} + bc\partial c + c.c.$$

$$Q\,|\mathrm{PHY}\rangle = 0$$

$$|\mathrm{NULL}\rangle = Q \ldots$$

$$Q^2 = 0 \qquad \{Q, b_n\} = L_n$$



⟨g|c₀c̄₀|g⟩ = 1   c̄ₙ|g⟩ = 0 n≥0   bₙ|g⟩ = 0 n≥0
Q (|g⟩ ⊗ |matter⟩) = 0
n≥0   Q (bₙ|g⟩ ⊗ | ⟩) = 0 = bₙ Q(   ) + Lₙ (|g⟩ ⊗ |m⟩)
Lˣₙ |m⟩ = 0   n>0
(Lˣ₀ − 1) |m⟩ = 0
|NULL⟩ = Lˣ₋ₙ |?⟩ + bc.. + bbcc..
= Q (b|?⟩ + ...)

$\langle g|c_0 c_0|g\rangle = 1 \qquad \bar{c}_n|g\rangle = 0 \quad n\geq 0 \qquad b_n|g\rangle = 0 \quad n\geq 0$

$$Q\left(|g\rangle \otimes |\text{matter}\rangle\right) = 0$$

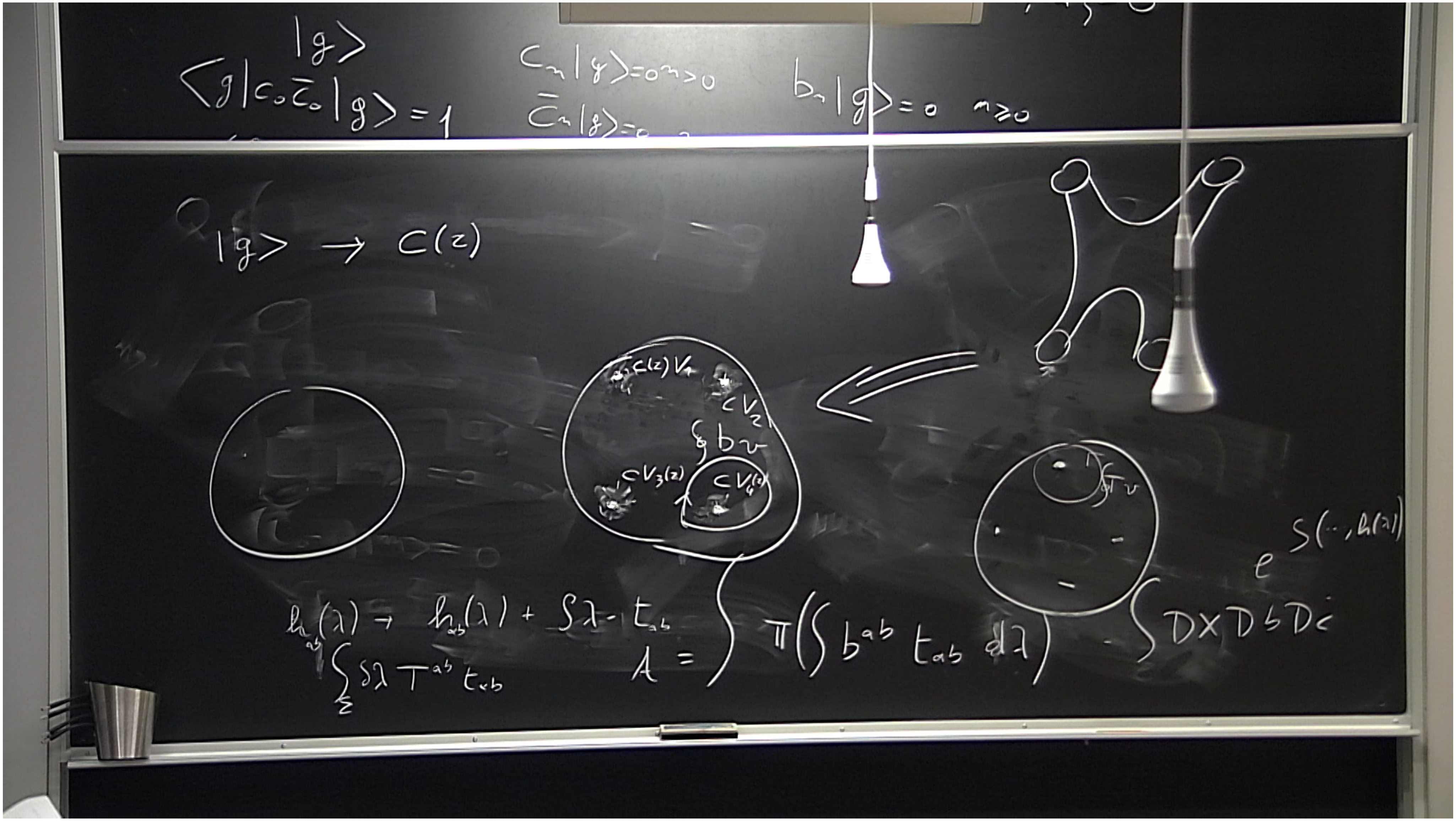
$n\geq 0$ $\quad Q\left(b_n|g\rangle \otimes |\;\rangle\right) = 0 = b_n Q(\qquad) + L_n\left(|g\rangle \otimes |m\rangle\right)$

$L^X_n|m\rangle = 0 \quad n>0$

$(L^X_0 - 1)|m\rangle = 0$

$|NULL\rangle = L^X_{-n}|?\rangle + bc\cdots + bbcc\cdots$

$= Q\left(b_{-n}|?\rangle + \dots\right)$


|g>
<g|c₀c̄₀|g> = 1
cₙ|g> = 0 n>0
c̄ₙ|g> =
bₙ|g> = 0 n≥0
|g> → c(z)
c(z)V₁
cV₂
∮bv
cV₃(z)
cV₄(z)
∮T v
h_ab(λ) → h_ab(λ) + δλ · t_ab
∫ δλ T^ab t_ab
A = ∫ Π(∫ b^ab t_ab dλ) · ∫ DX Db Dc
e^S(.., h(λ))