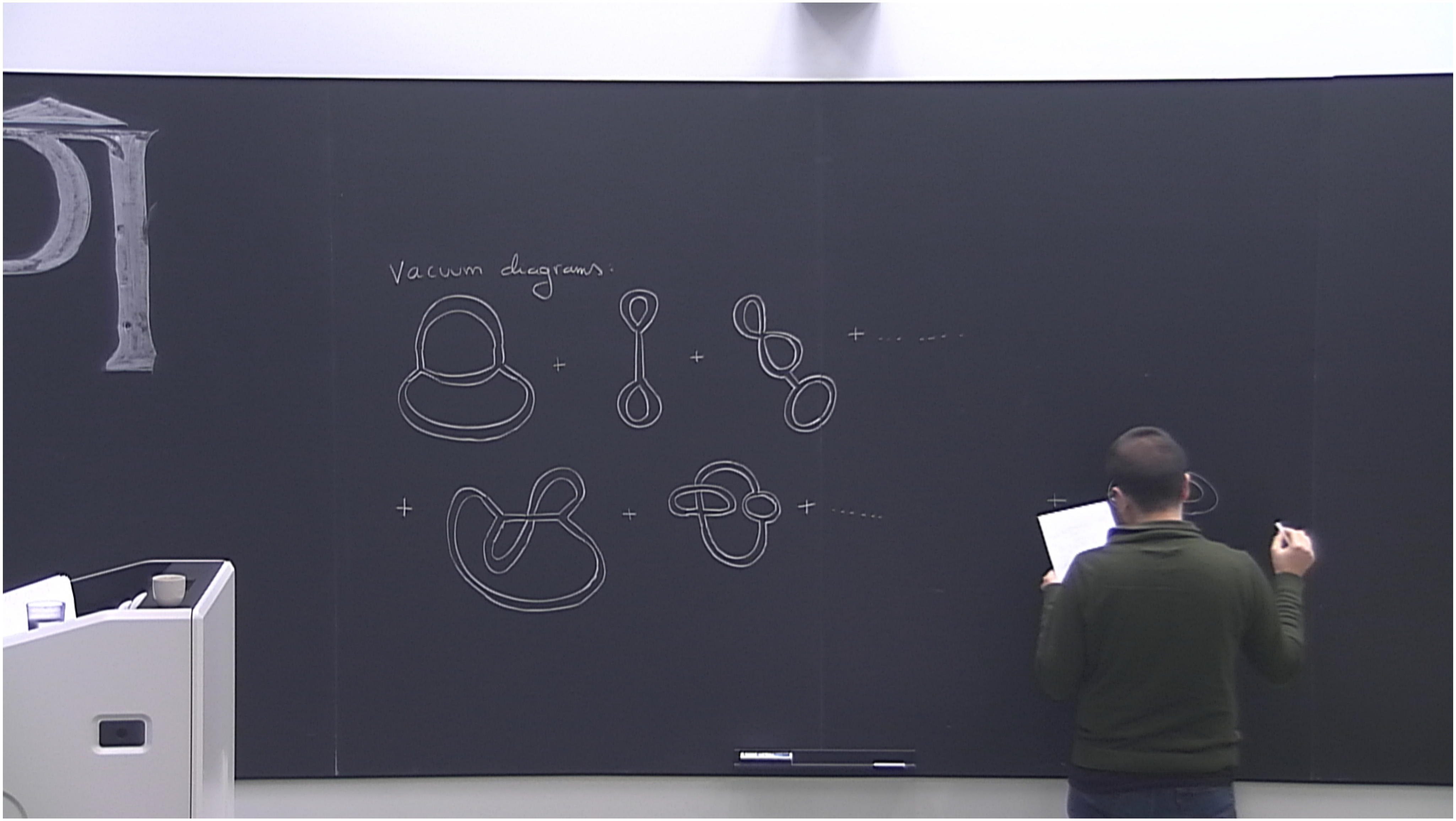
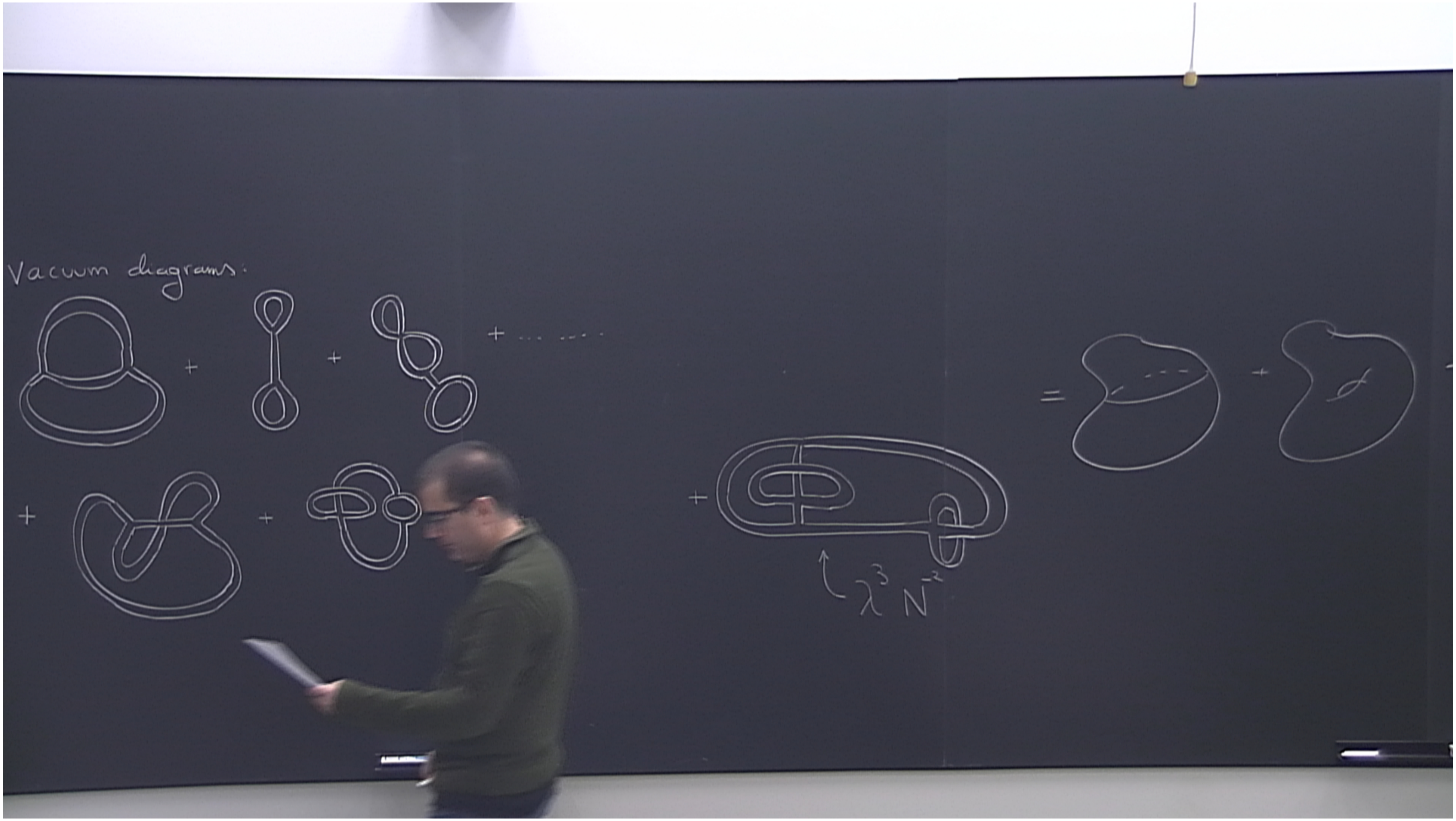
Title: PSI 2015/2016 Explorations in String Theory - Pedro Vieira - 2

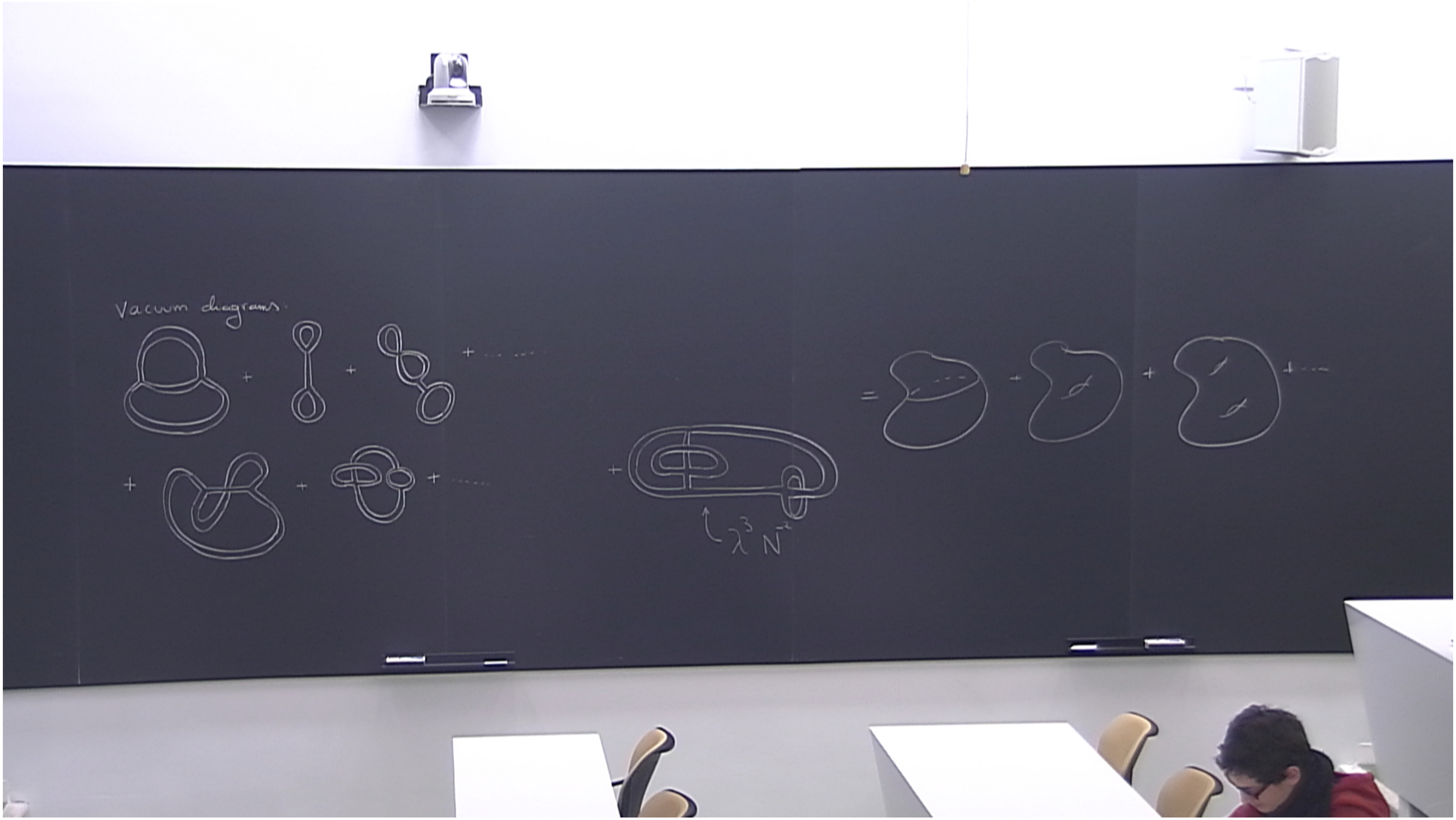
Date: Mar 22, 2016 11:30 AM

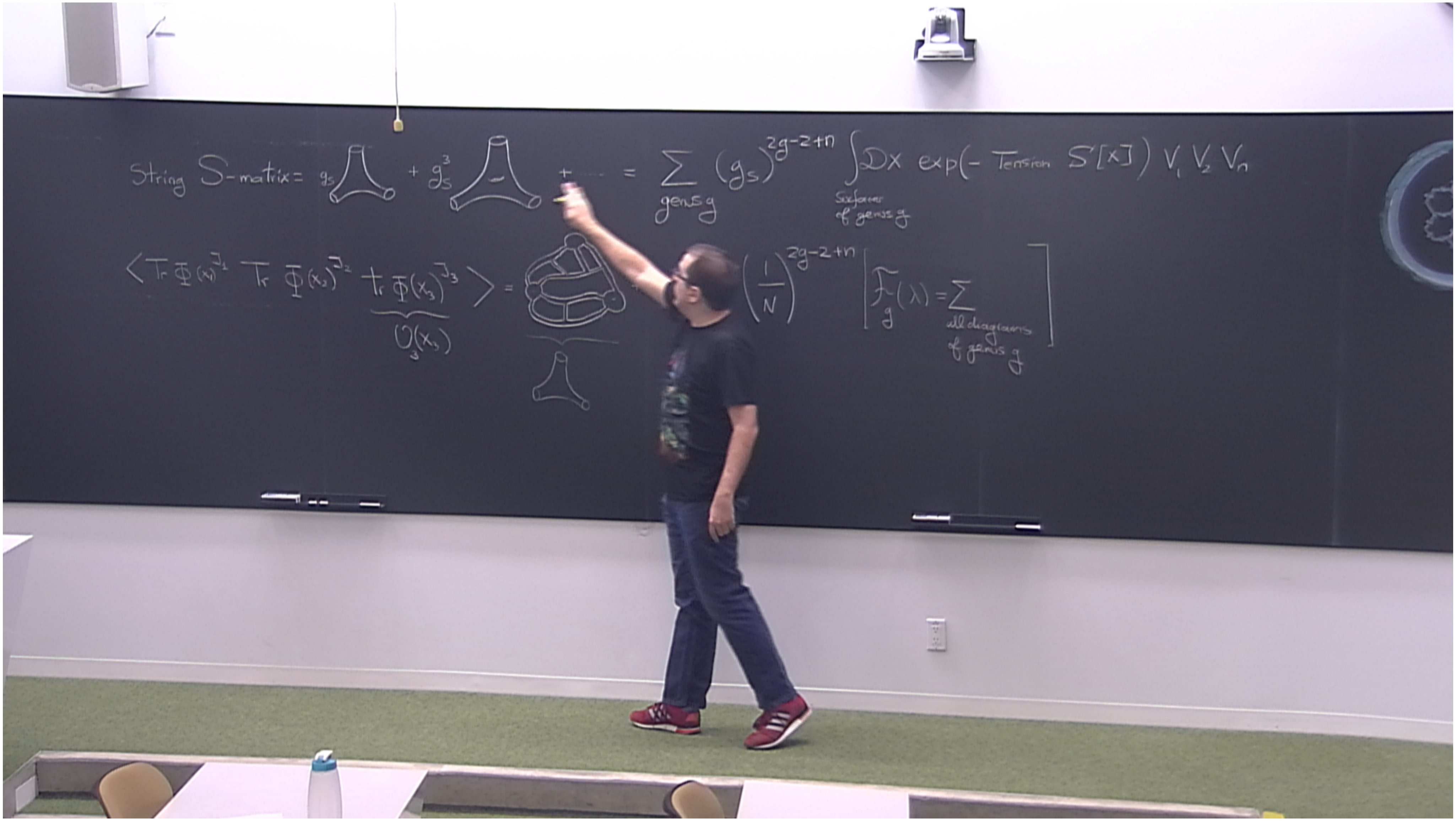
URL: http://pirsa.org/16030064

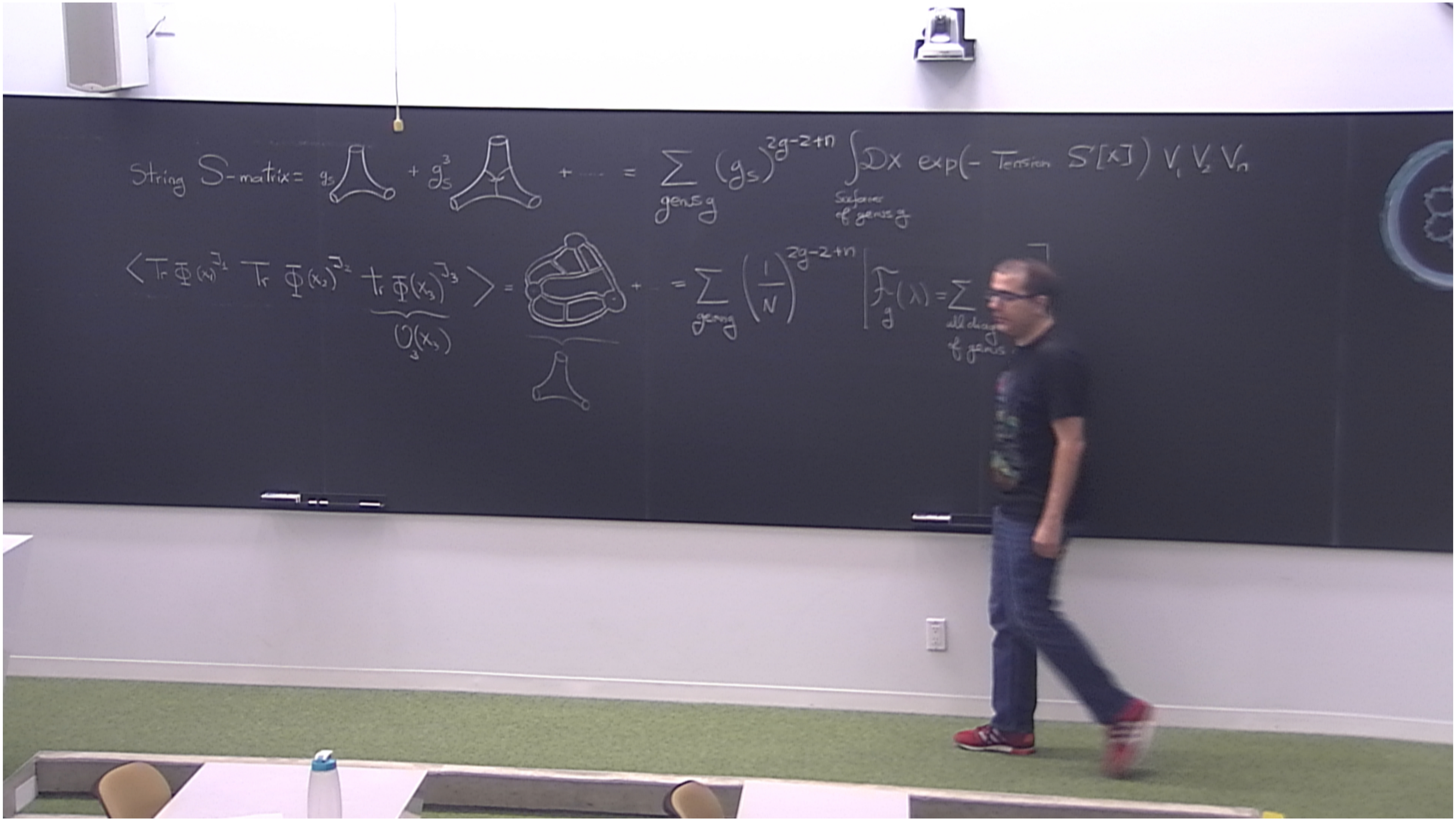
Abstract:

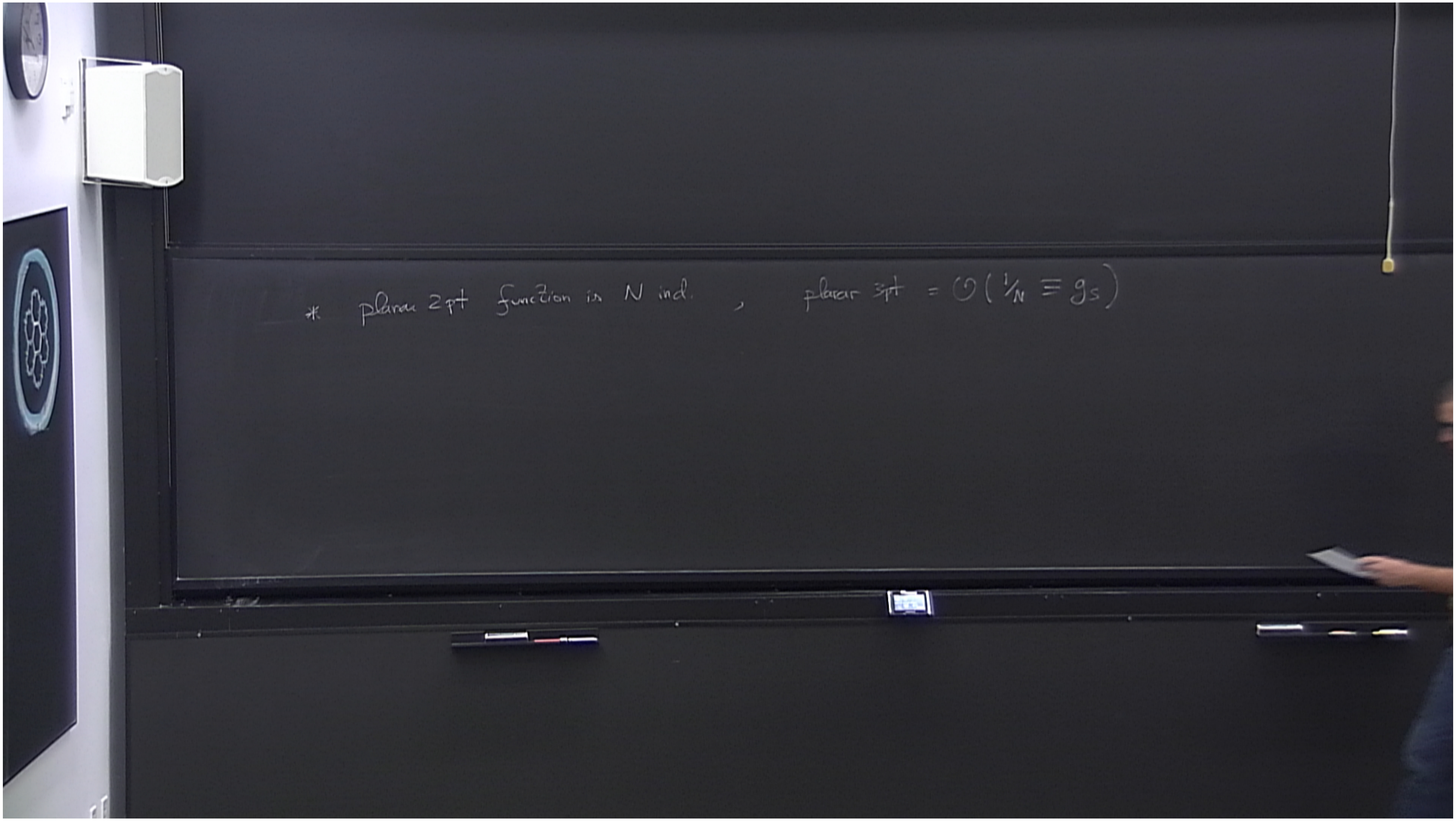

Vacuum diagrams:

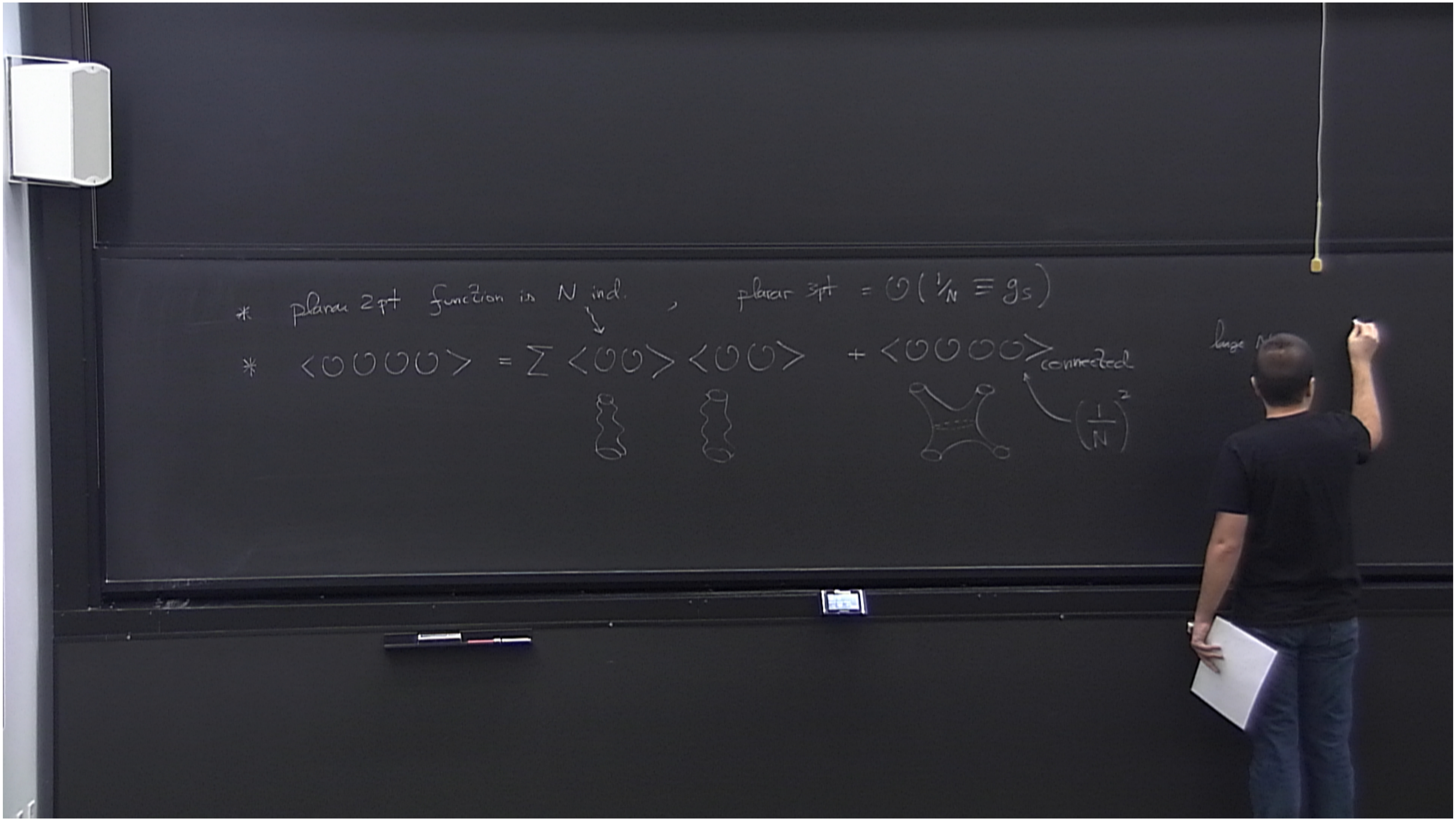

Vacuum diagrams.
$\lambda^3 N^{-2}$

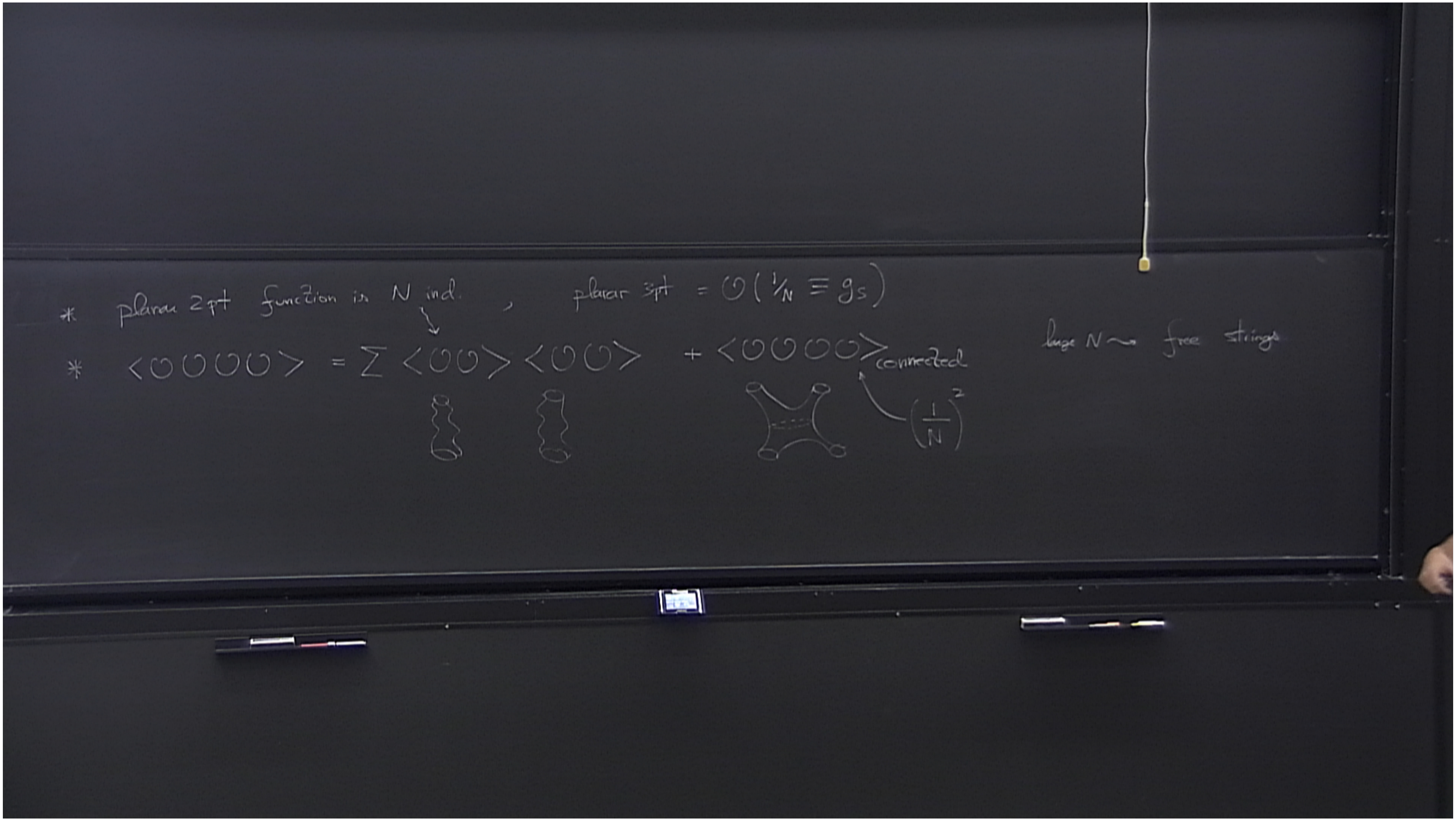

Vacuum diagrams:
$\lambda^3 N^{-2}$


String S-matrix = gs + gs3 + ... = Σ genus g (gs)2g-2+n ∫DX exp(- Tension S[X]) V1 V2 Vn
Surfaces of genus g
⟨Tr Φ(x1)J1 Tr Φ(x2)J2 Tr Φ(x3)J3⟩ =
O3(x3)
(1/N)2g-2+n [Fg(λ) = Σ all diagrams of genus g]


String S-matrix = g_s + g_s^3 + ... = Σ_{genus g} (g_s)^{2g-2+n} ∫ Dx exp(- Tension S[x]) V_1 V_2 V_n
Surface of genus g
⟨Tr Φ(x_1)^{J_1} Tr Φ(x_2)^{J_2} tr Φ(x_3)^{J_3}⟩ = + ... = Σ_{genus g} (1/N)^{2g-2+n} F_g(λ) = Σ
O_3(x_3)
all diagrams of genus

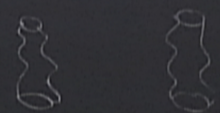

* planar 2pt function is N ind. , planar 3pt = $\mathcal{O}(1/N \equiv g_s)$


* planar 2pt function is N ind. , planar 3pt $= \mathcal{O}(1/N \equiv g_s)$
* $\langle \mathcal{O}\mathcal{O}\mathcal{O}\mathcal{O} \rangle = \sum \langle \mathcal{O}\mathcal{O} \rangle \langle \mathcal{O}\mathcal{O} \rangle + \langle \mathcal{O}\mathcal{O}\mathcal{O}\mathcal{O} \rangle_{\text{connected}}$
$\left(\frac{1}{N}\right)^2$
large N

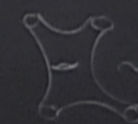

* planar 2pt function is N ind. , planar 3pt = O(1/N ≡ g_s)
* <OOOO> = Σ <OO><OO> + <OOOOO> connected
(1/N)^2
large N ~ free strings

* planar 2pt function is N ind. , planar 3pt $= \mathcal{O}(1/N \equiv g_s)$

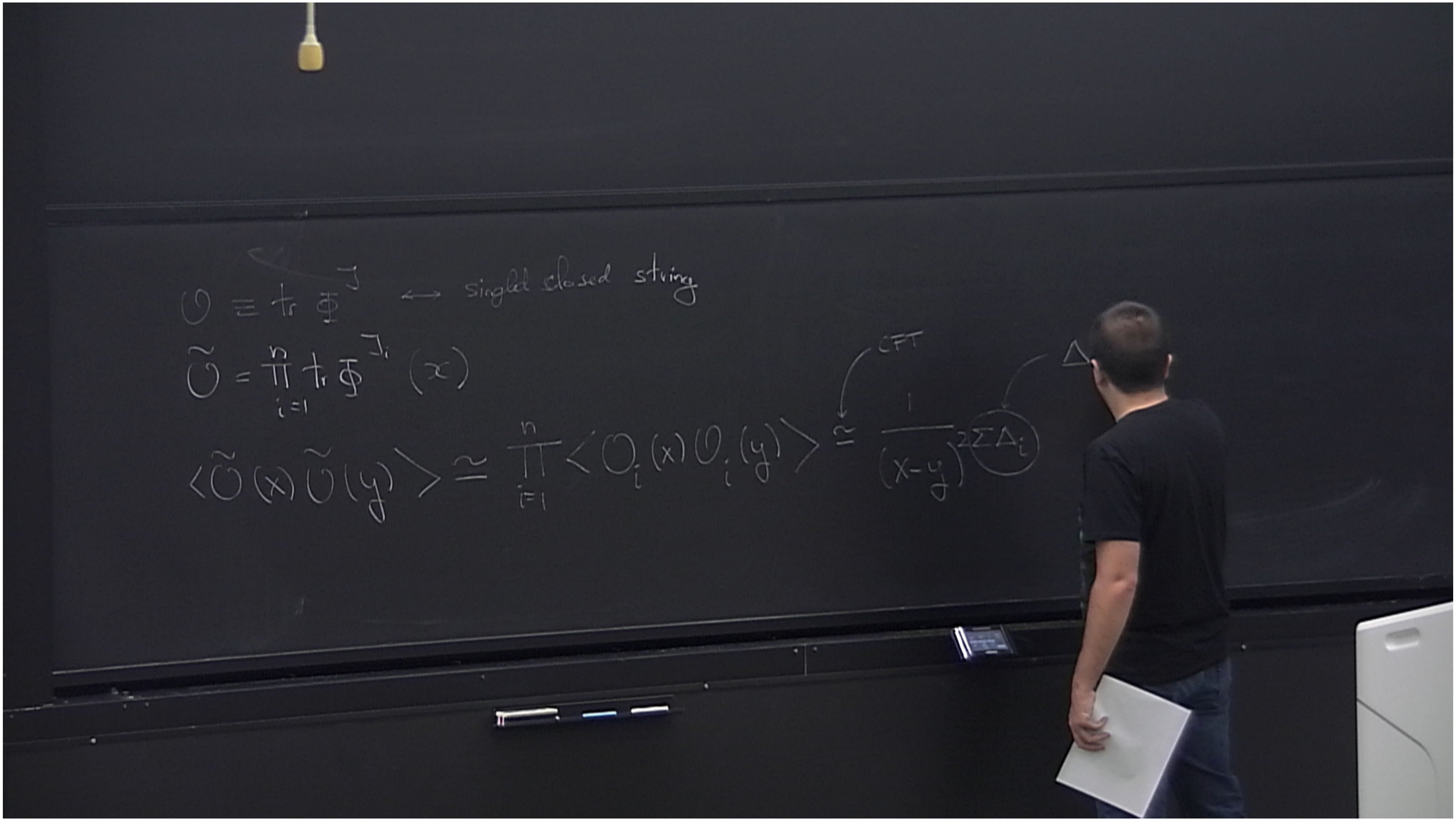
* $\langle \mathcal{O}\mathcal{O}\mathcal{O}\mathcal{O} \rangle = \sum \langle \mathcal{O}\mathcal{O} \rangle \langle \mathcal{O}\mathcal{O} \rangle + \langle \mathcal{O}\mathcal{O}\mathcal{O}\mathcal{O} \rangle_{\text{connected}} + \underbrace{\quad}_{\text{higher genus}}$ large $N \sim$ free strings

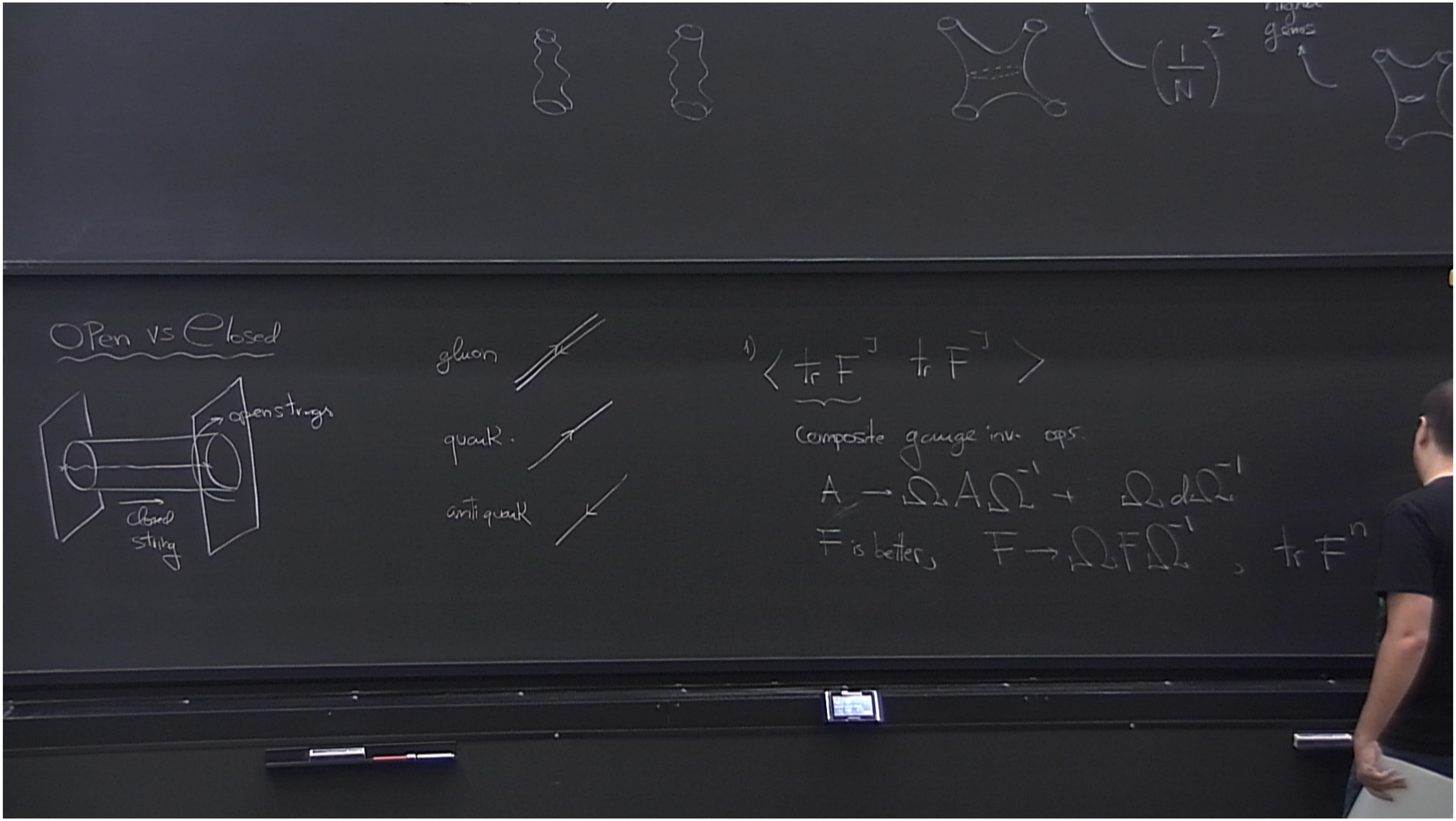


$\left(\frac{1}{N}\right)^2$

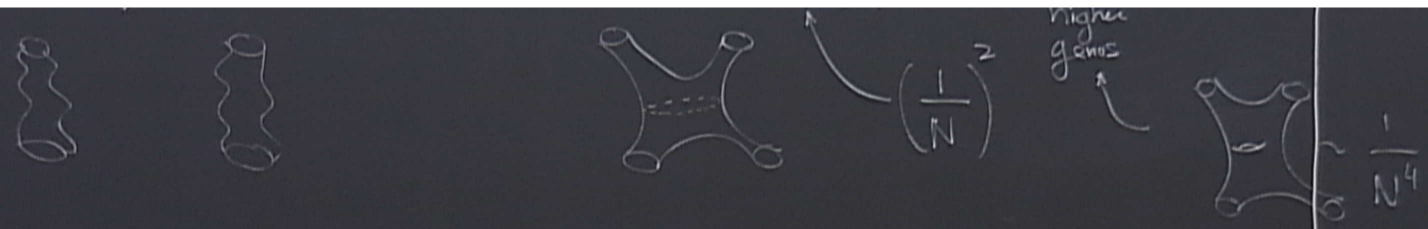


$\sim \frac{1}{N^4}$


$\mathcal{O} \equiv \mathrm{tr}\, \Phi^{J}$ ⟷ singlet closed string
$\tilde{\mathcal{O}} = \prod_{i=1}^{n} \mathrm{tr}\, \Phi^{J_i}(x)$
$\langle \tilde{\mathcal{O}}(x) \tilde{\mathcal{O}}(y) \rangle \simeq \prod_{i=1}^{n} \langle \mathcal{O}_i(x) \mathcal{O}_i(y) \rangle \simeq \frac{1}{(x-y)^{2\Sigma\Delta_i}}$
CFT
Δ



OPen vs Closed
open strings
closed string
gluon
quark .
anti quark
1) $\langle \mathrm{tr}\, F^J \ \mathrm{tr}\, F^J \rangle$
Composite gauge inv. ops.
$A \to \Omega A \Omega^{-1} + \Omega d \Omega^{-1}$
F is better, $F \to \Omega F \Omega^{-1}$, $\mathrm{tr}\, F^n$
$\left(\frac{1}{N}\right)^2$



gluon

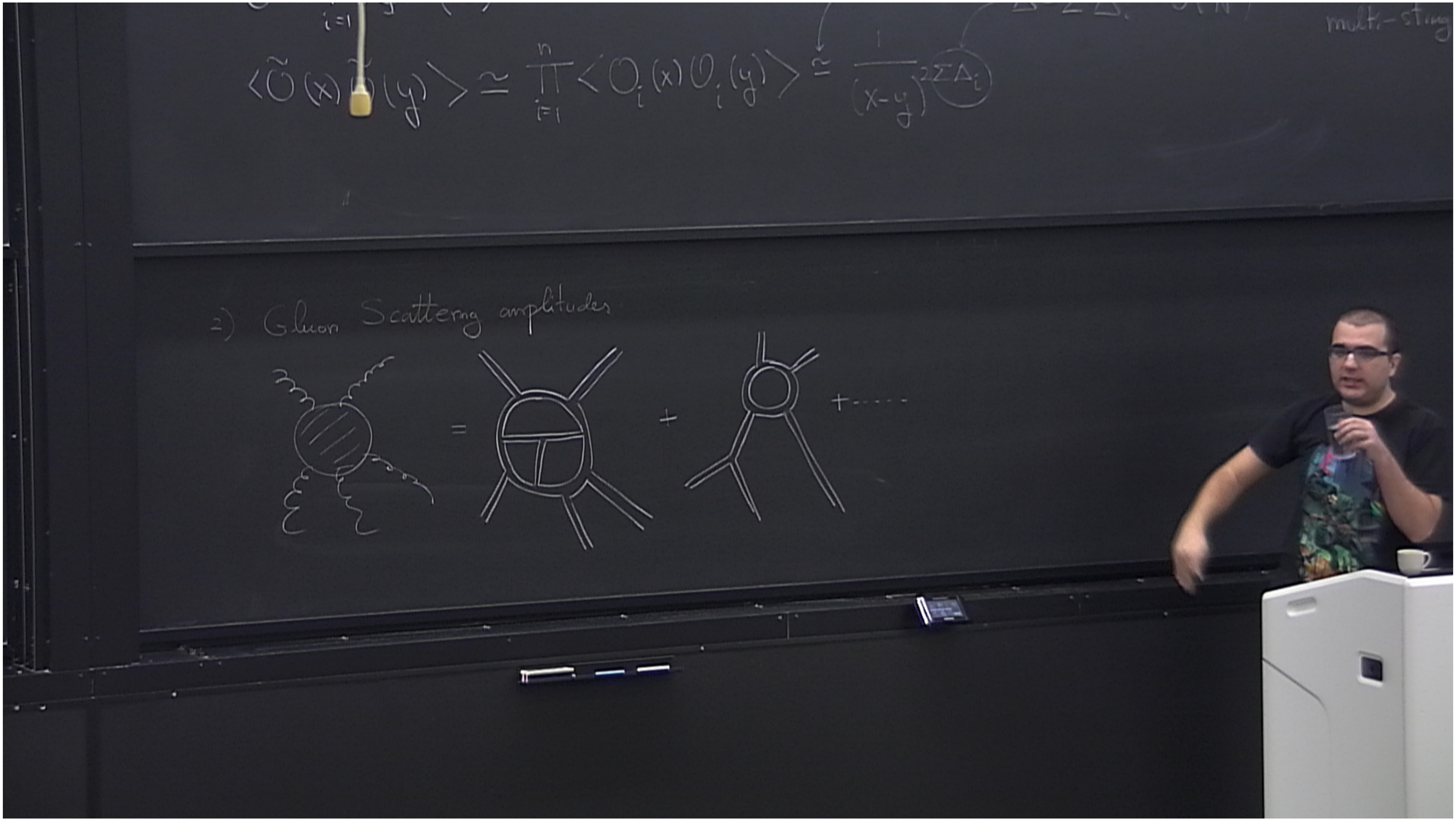
quark

anti quark

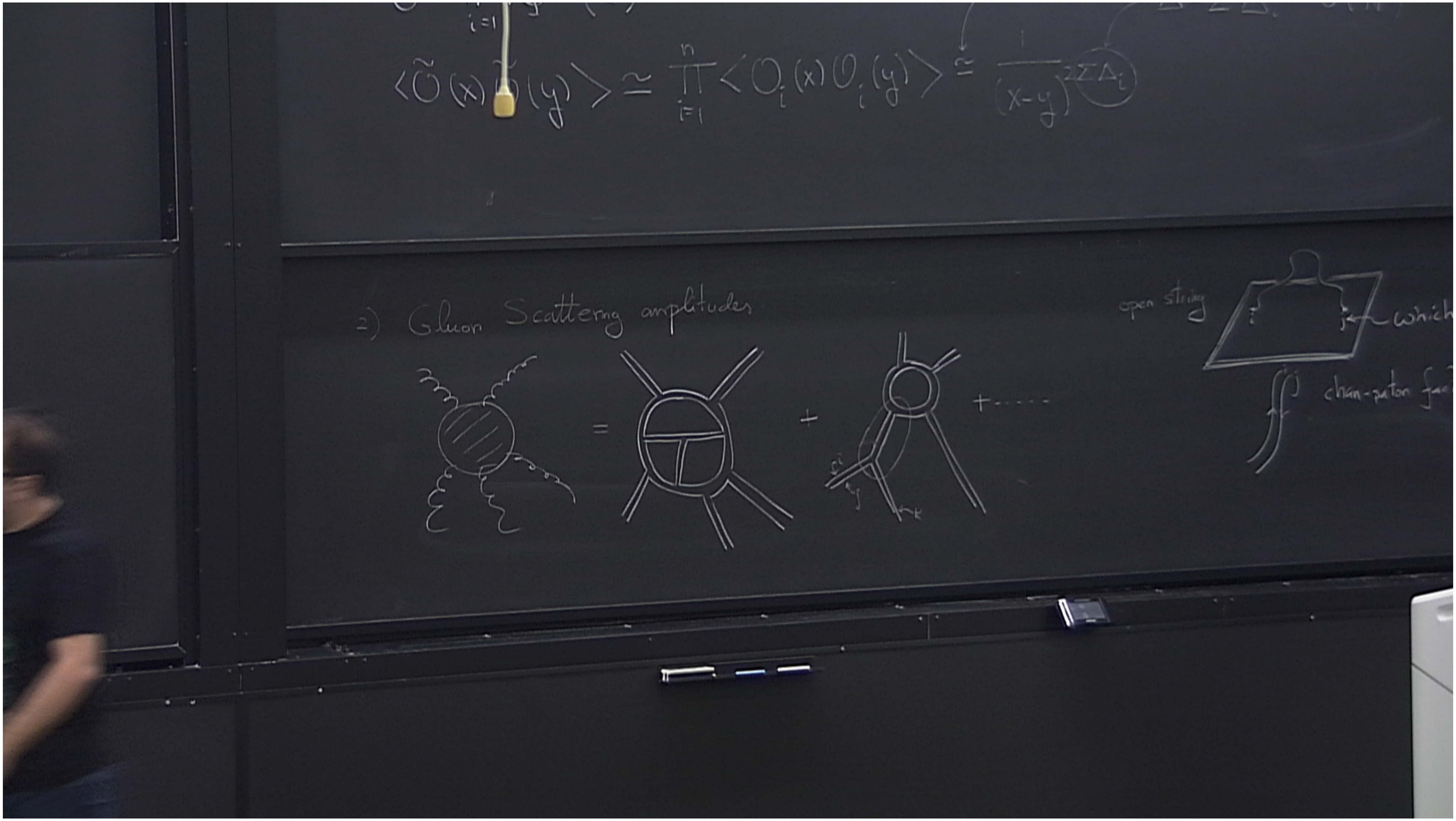
1) $\langle \underbrace{\mathrm{tr}\, F^J}_{\text{composite gauge inv. ops.}} \ \mathrm{tr}\, F^J \rangle$

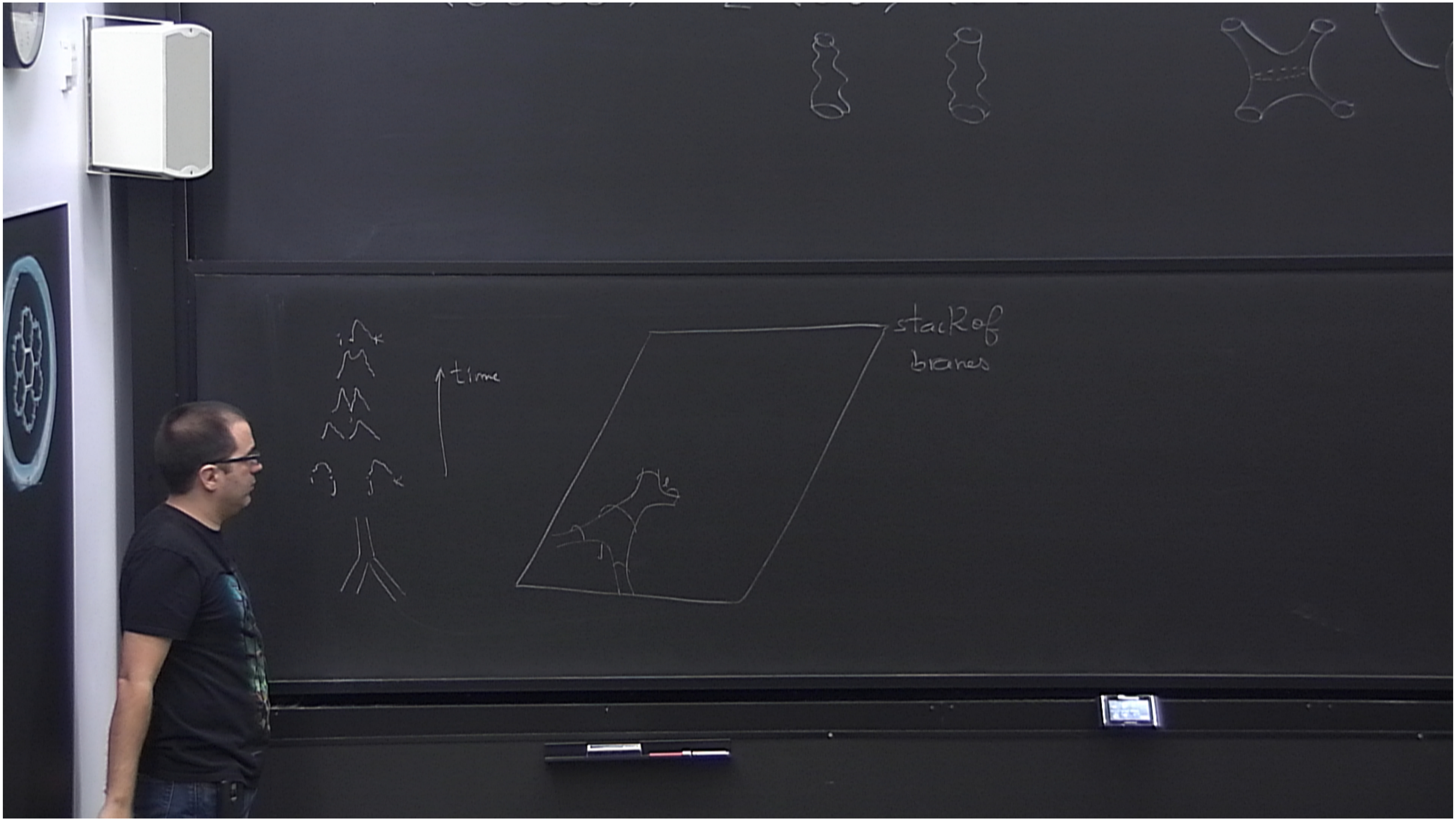
$$A \to \Omega A \Omega^{-1} + \Omega d \Omega^{-1}$$

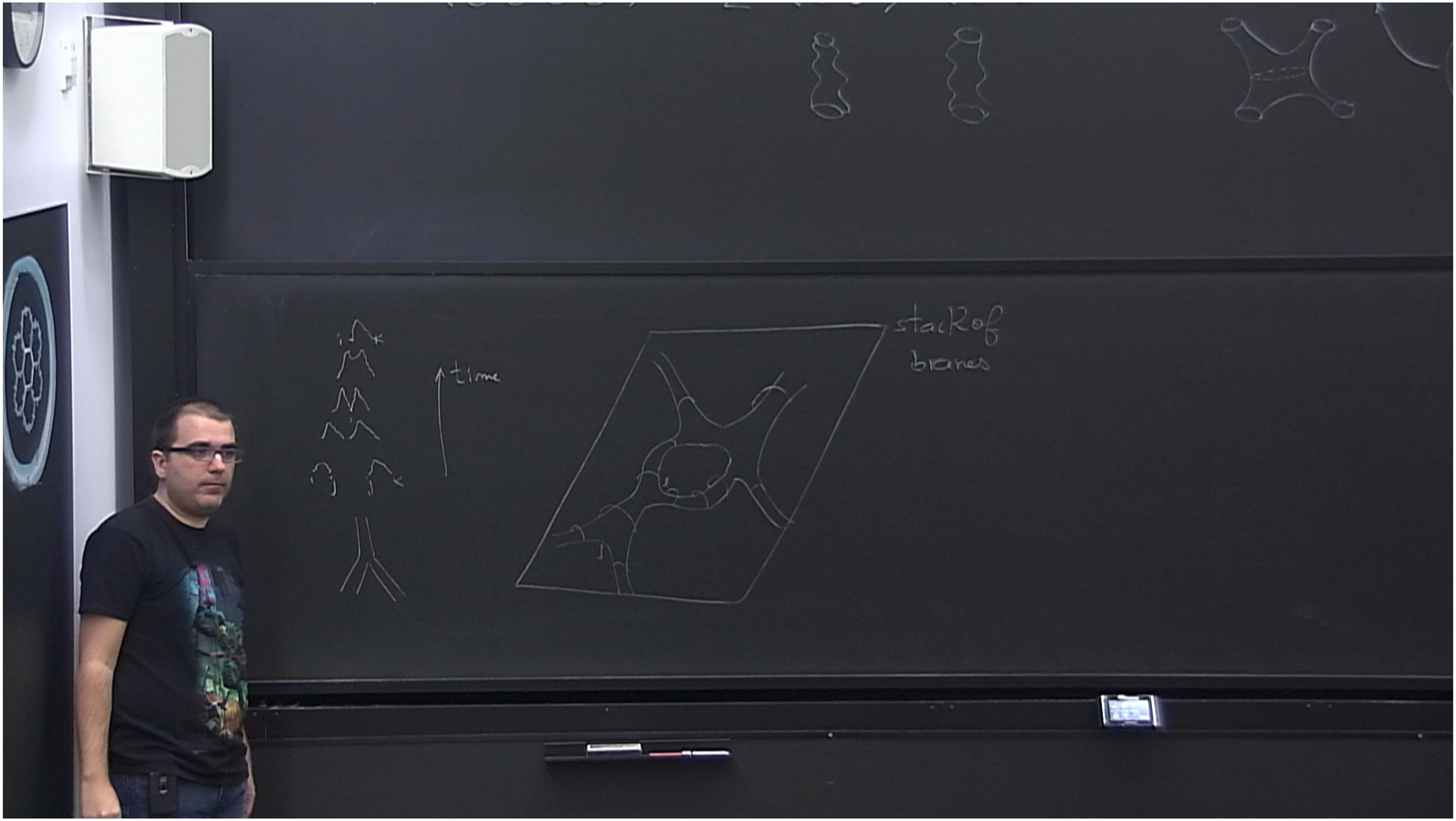
F is better, $F \to \Omega F \Omega^{-1}$, $\mathrm{tr}\, F^n$ is perfect.

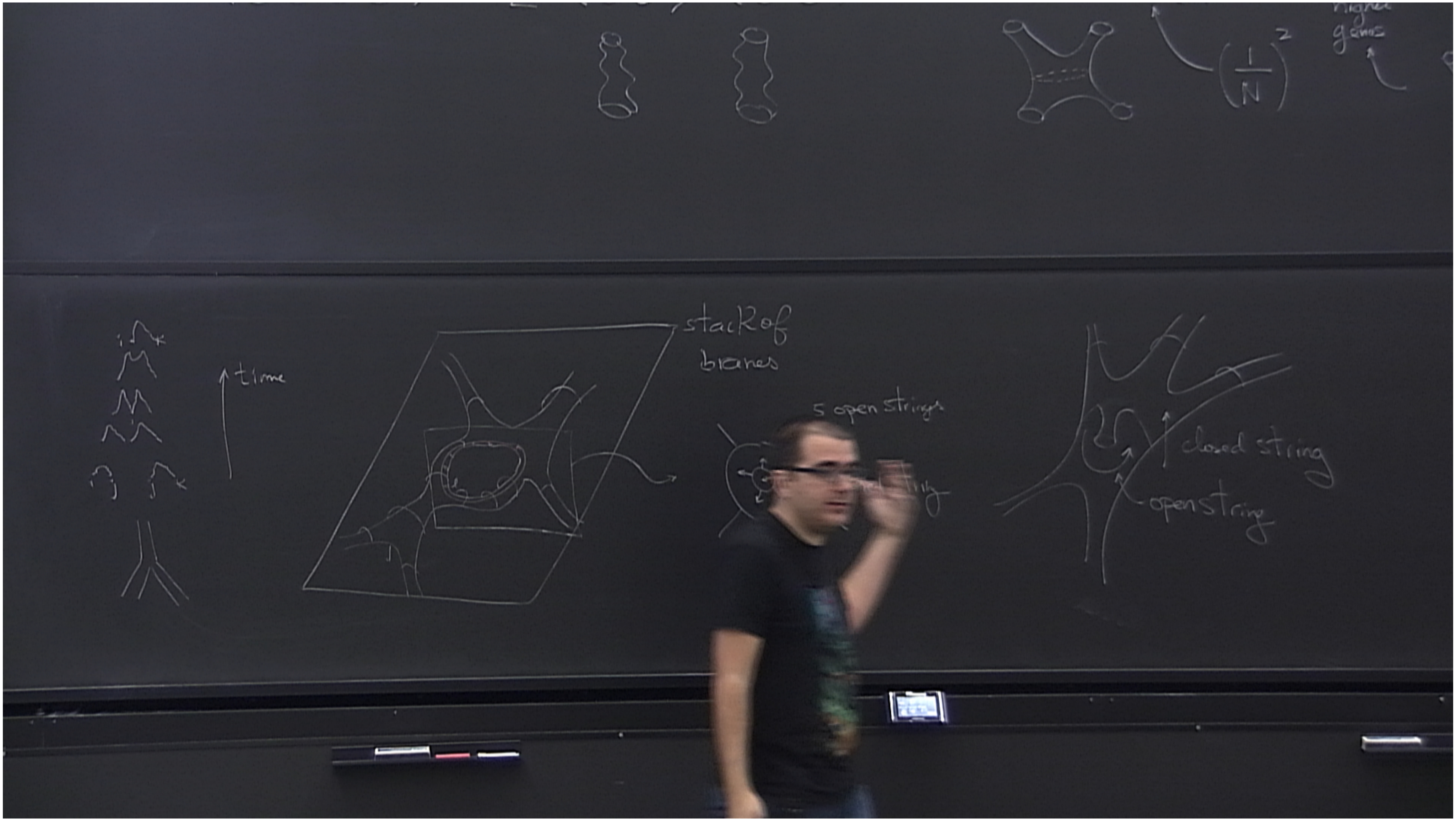


$\langle \tilde{O}(x) \tilde{O}(y) \rangle \simeq \prod_{i=1}^{n} \langle O_i(x) O_i(y) \rangle \simeq \frac{1}{(x-y)^{2\sum \Delta_i}}$
multi-string
2) Gluon Scattering amplitudes
= + + ...

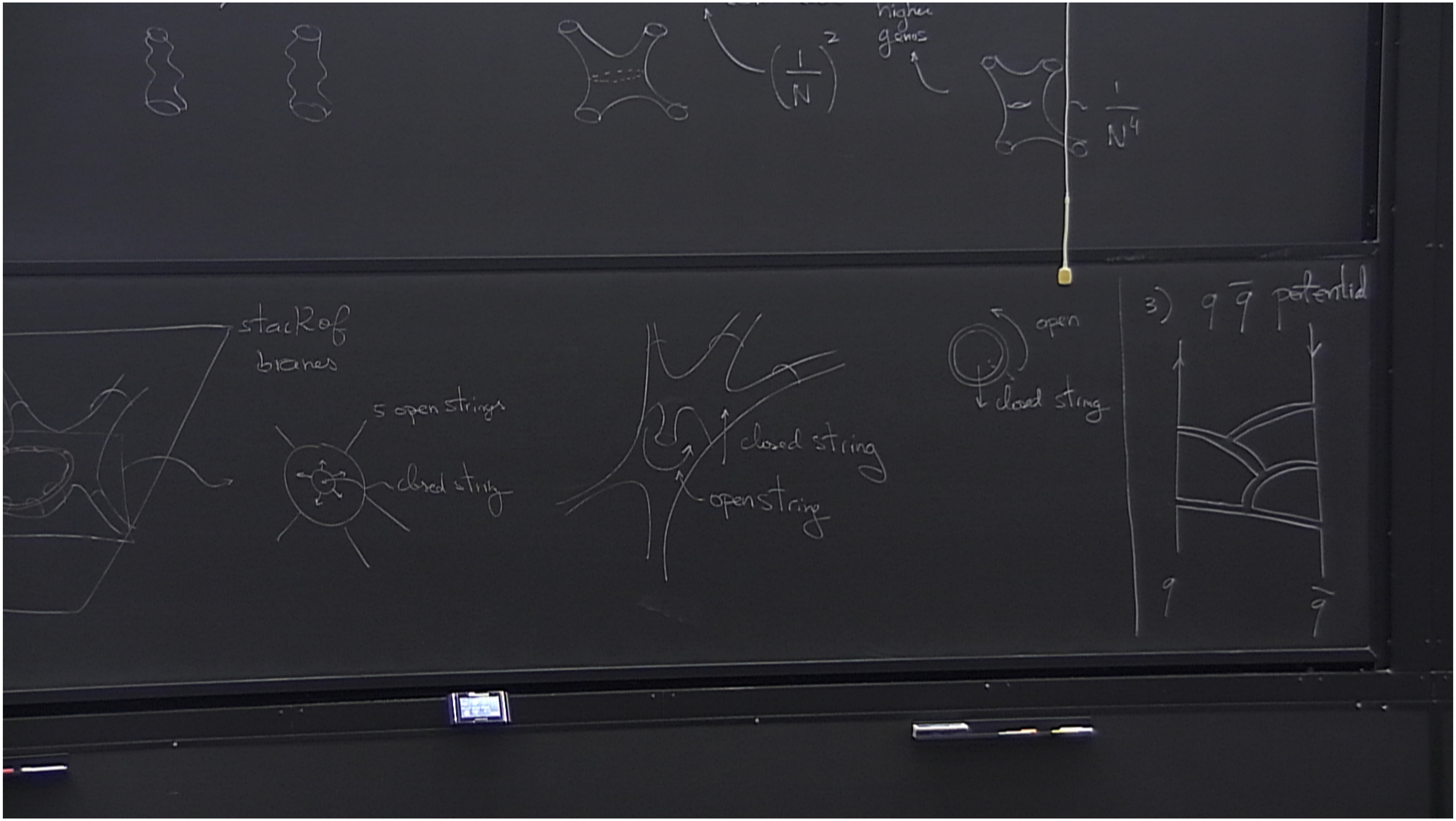

$\langle \tilde{O}(x)\tilde{O}(y)\rangle \simeq \prod_{i=1}^{n} \langle O_i(x) O_i(y)\rangle \simeq \frac{1}{(x-y)^{2\Sigma\Delta_i}}$
2) Gluon Scattering amplitudes
open string
which
chan-paton

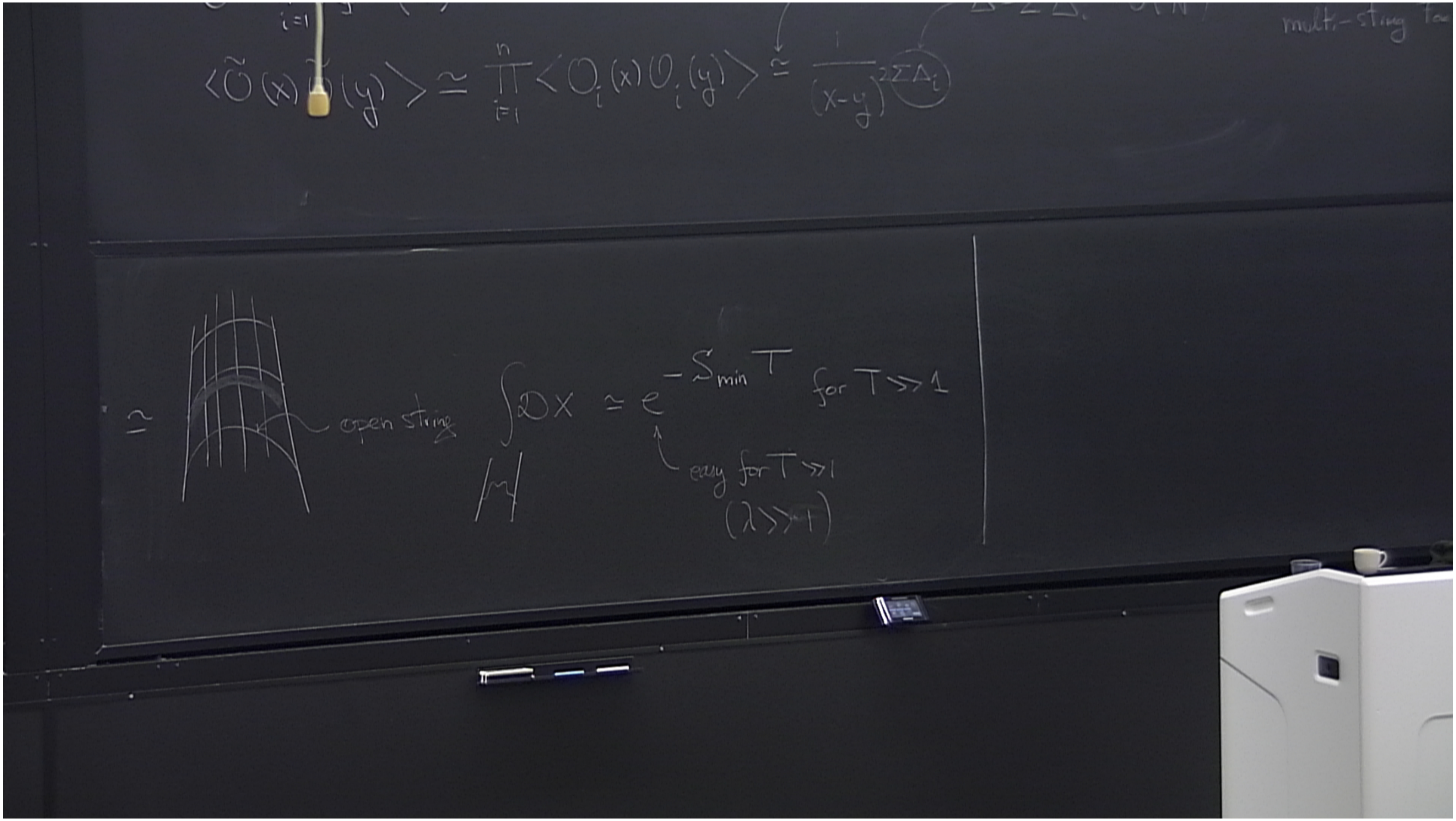

time
stack of
branes

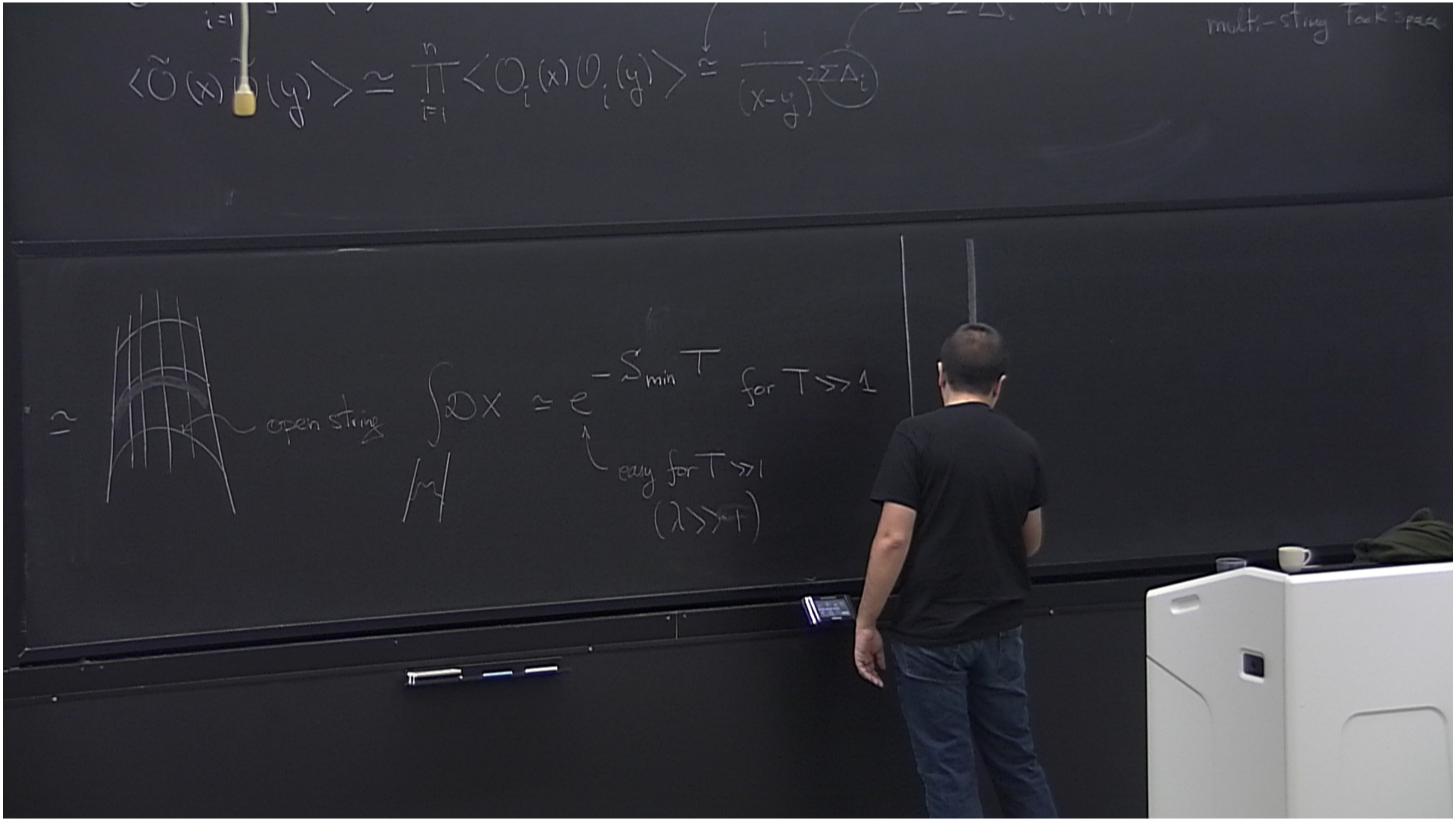

time
stack of
branes

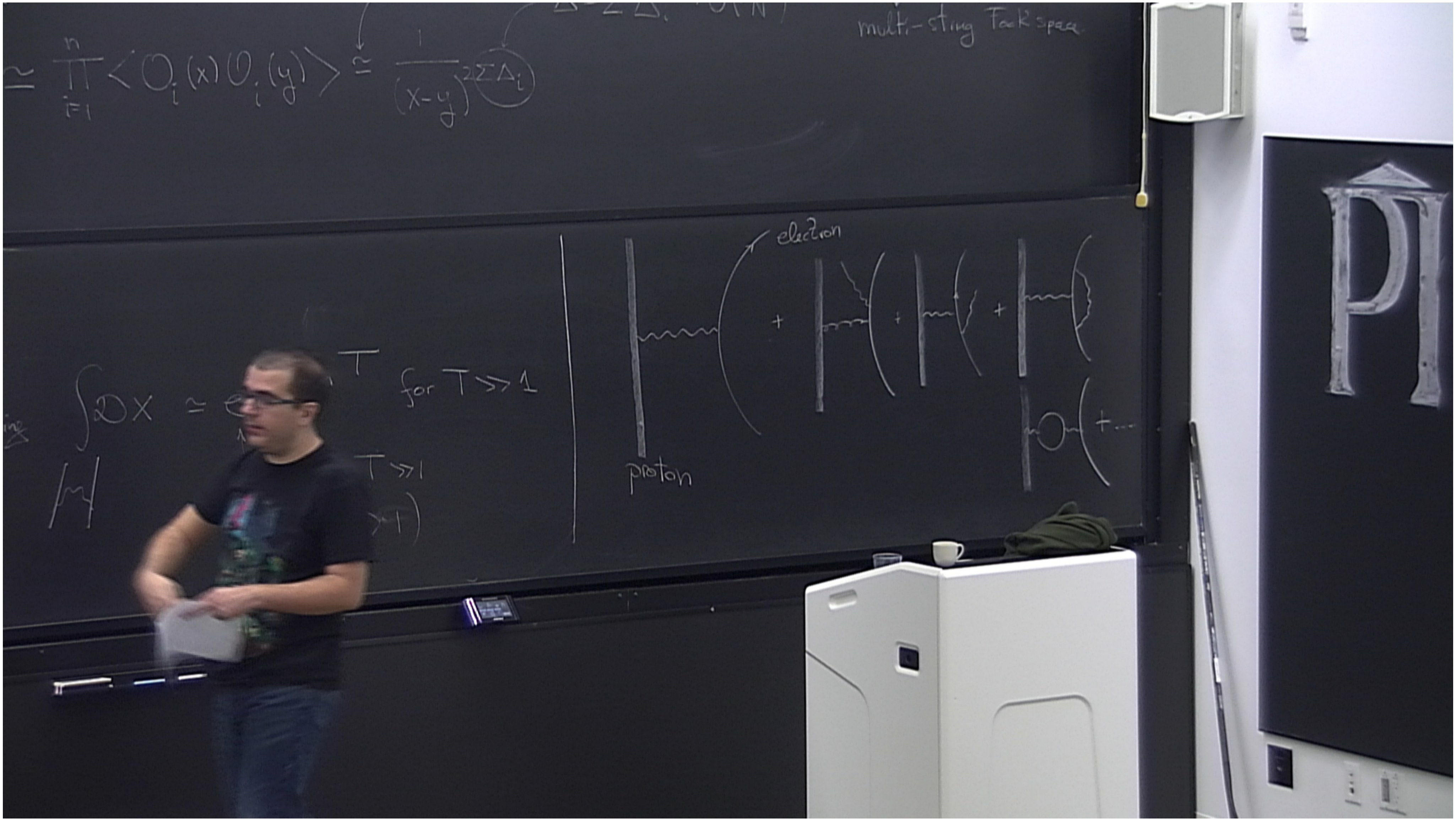


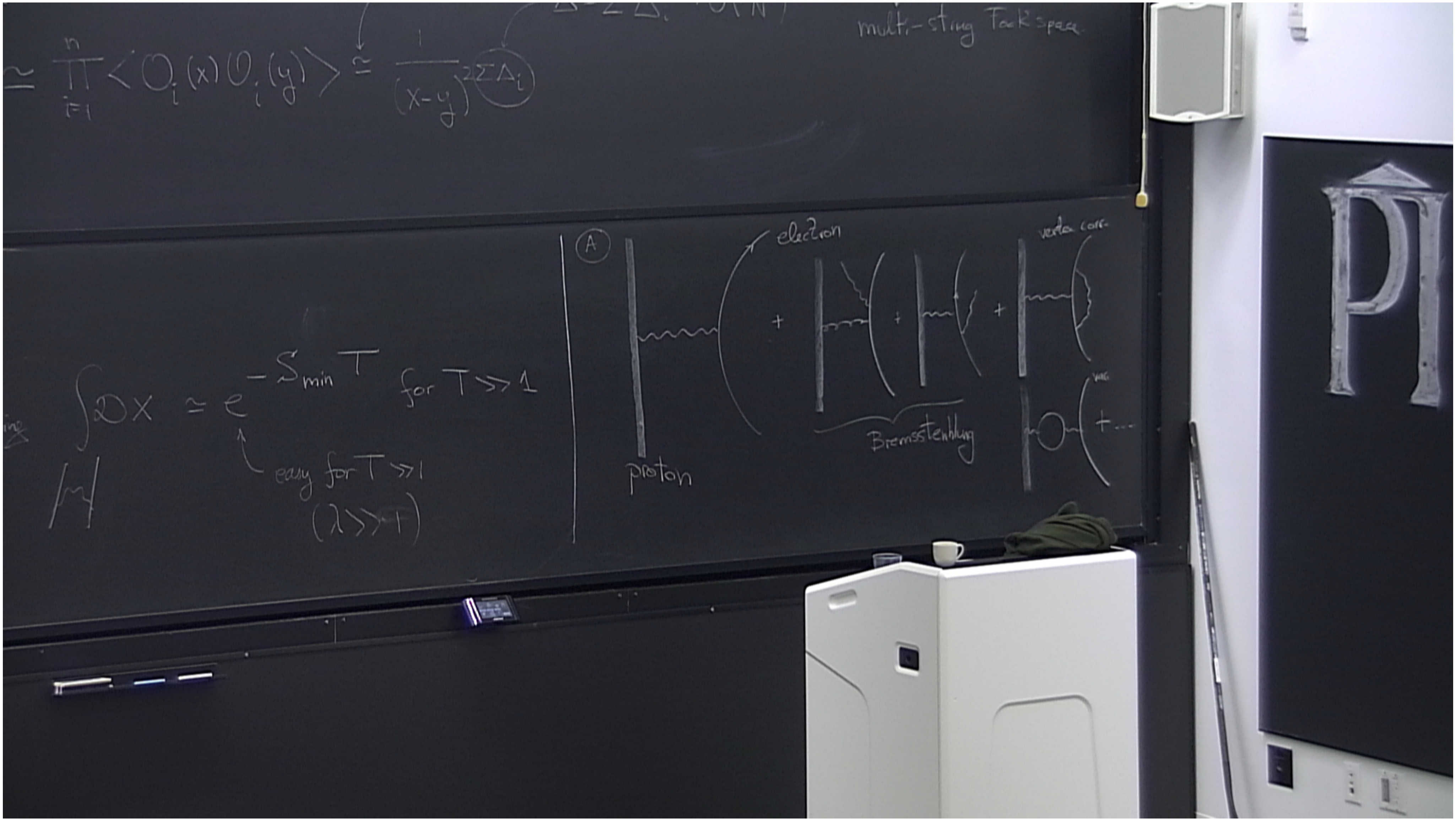
time
stack of
branes
open strings
closed string
open string

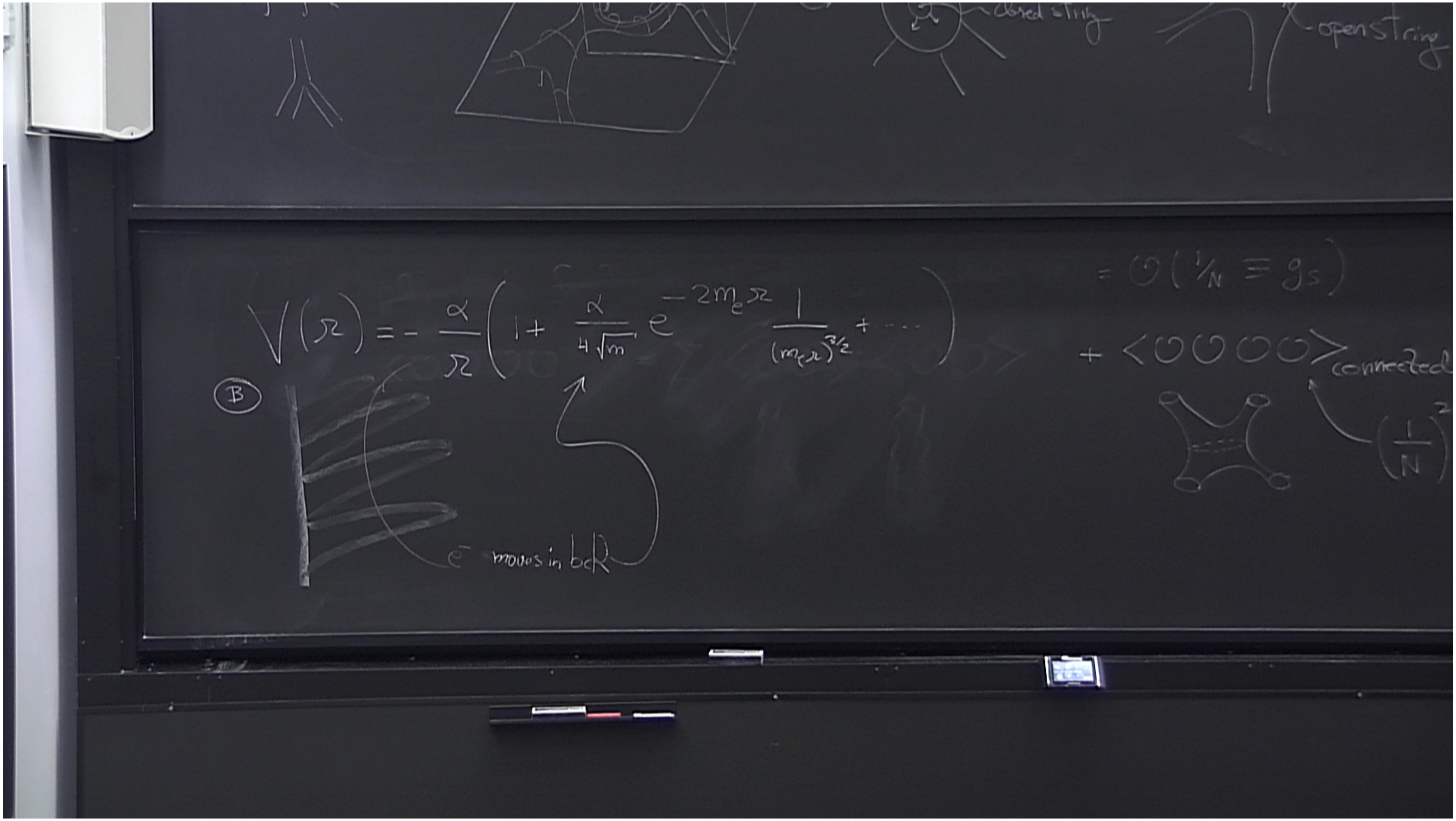

higher
genus
(1/N)^2
~ 1/N^4
stack of
branes
5 open strings
closed string
closed string
open string
open
closed string
3) q q̄ potential
q
q̄

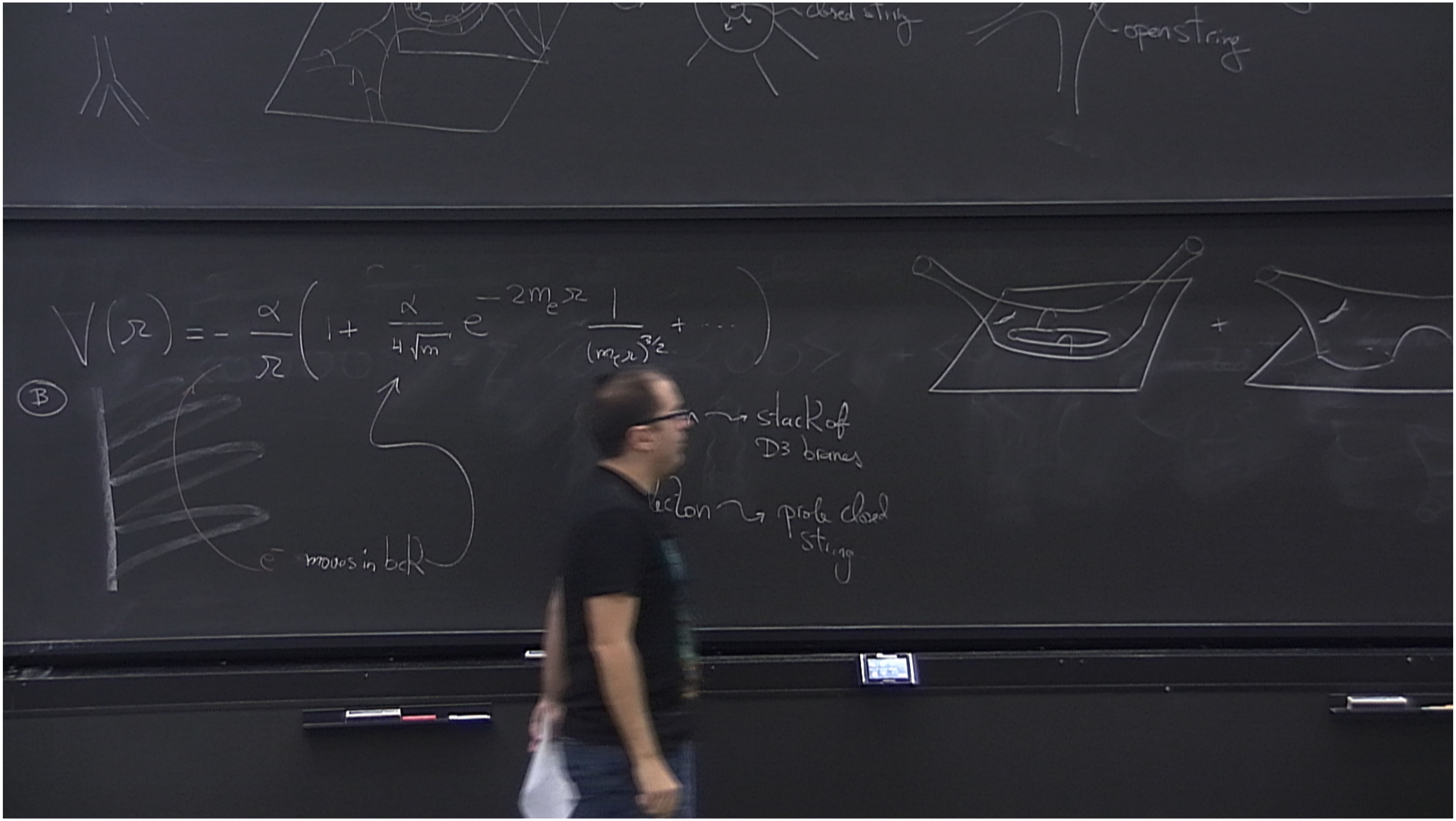

multi-string
$\langle \tilde{O}(x)\tilde{O}(y)\rangle \simeq \prod_{i=1}^{n}\langle O_i(x) O_i(y)\rangle \simeq \frac{1}{(x-y)^{2\sum\Delta_i}}$
open string
$\int \mathcal{D}X \simeq e^{-S_{min}T}$ for $T \gg 1$
easy for $T \gg 1$
$(\lambda \gg 1)$


multi-string Fock space
open string
easy for T >> 1

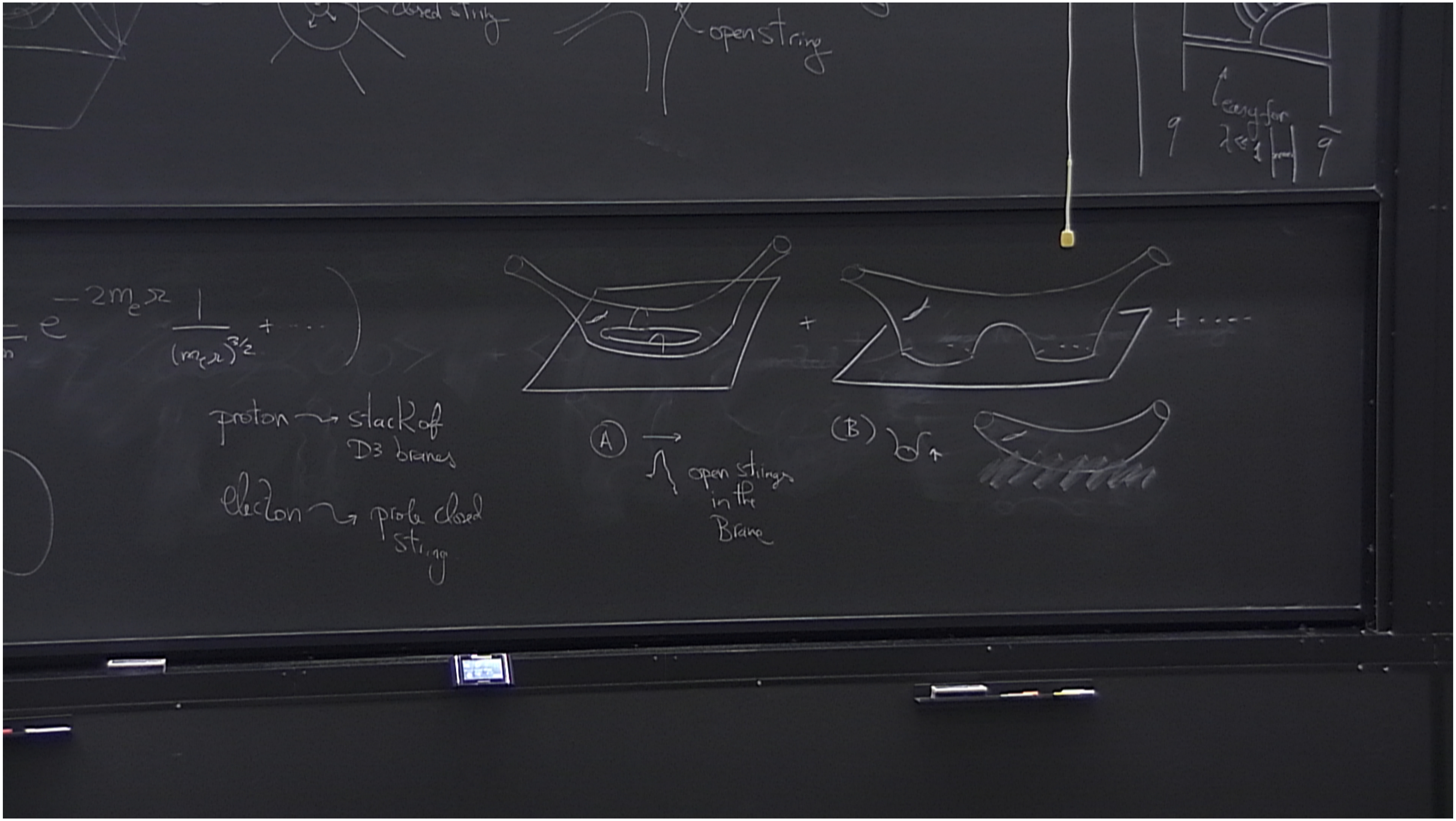

multi-string Fock space
electron
proton
for T >> 1
T >> 1

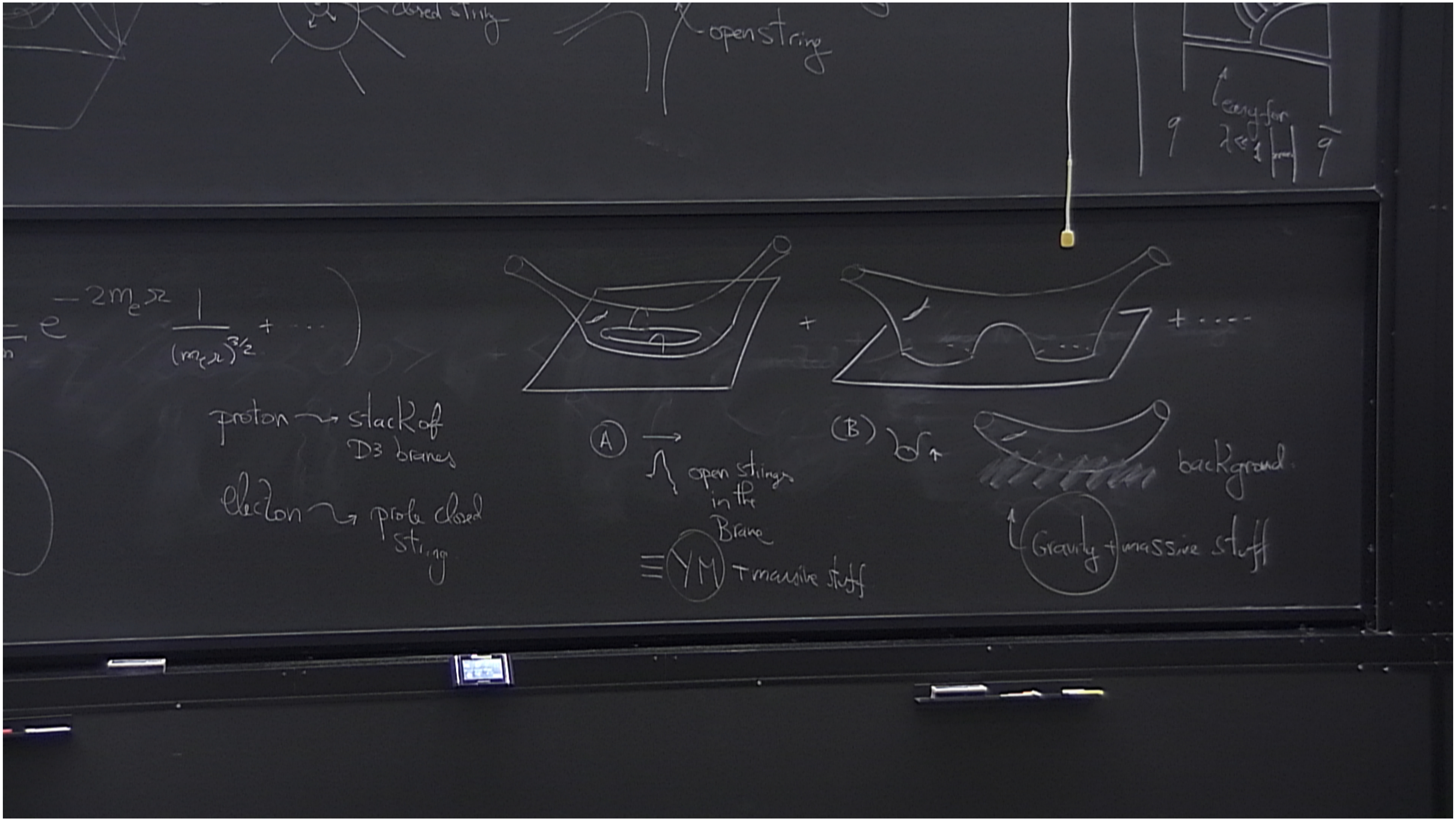

multi-string Fock space
electron
vertex corr.
proton
for T >> 1
easy for T >> 1
Bremsstrahlung

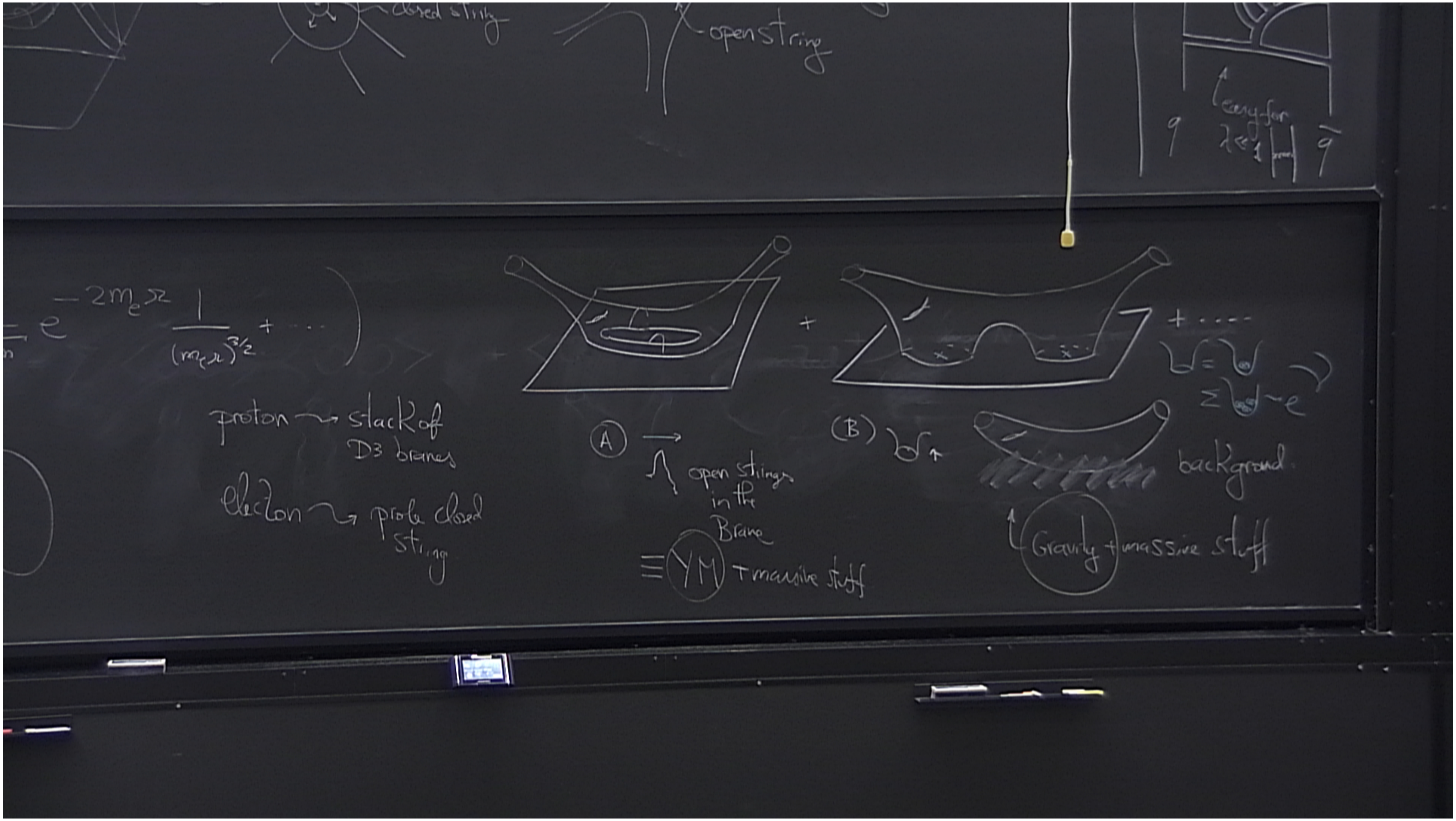

closed string
open string
$V(r) = -\frac{\alpha}{r}\left(1 + \frac{\alpha}{4\sqrt{m}} e^{-2m_e r} \frac{1}{(m_e r)^{3/2}} + \cdots\right)$
$= O(1/N = g_s)$
$+ \langle \circ\circ\circ\circ \rangle_{\text{connected}}$
$\left(\frac{1}{N}\right)^2$
B
e^- moves in bck



closed string
open string
$V(r) = -\frac{\alpha}{r}\left(1 + \frac{\alpha}{4\sqrt{m}} e^{-2m_e r} \frac{1}{(m_e r)^{3/2}} + \cdots\right)$
B
e^- moves in bcR
stack of D3 branes
probe closed string


closed string
open string
proton → stack of D3 branes
electron → probe closed string
(A)
open strings in the Brane
(B)


open string
proton → stack of D3 branes
electron → probe closed string
(A)
open strings in the Brane
≡ YM + massive stuff
(B)
background
Gravity + massive stuff


closed string
open string
easy for
proton → stack of D3 branes
electron → probe closed string
open strings in the Brane
≡ YM + massive stuff
background
Gravity + massive stuff