Title: Asymptotic Fragility, Near AdS2 Holography and T\barT deformation

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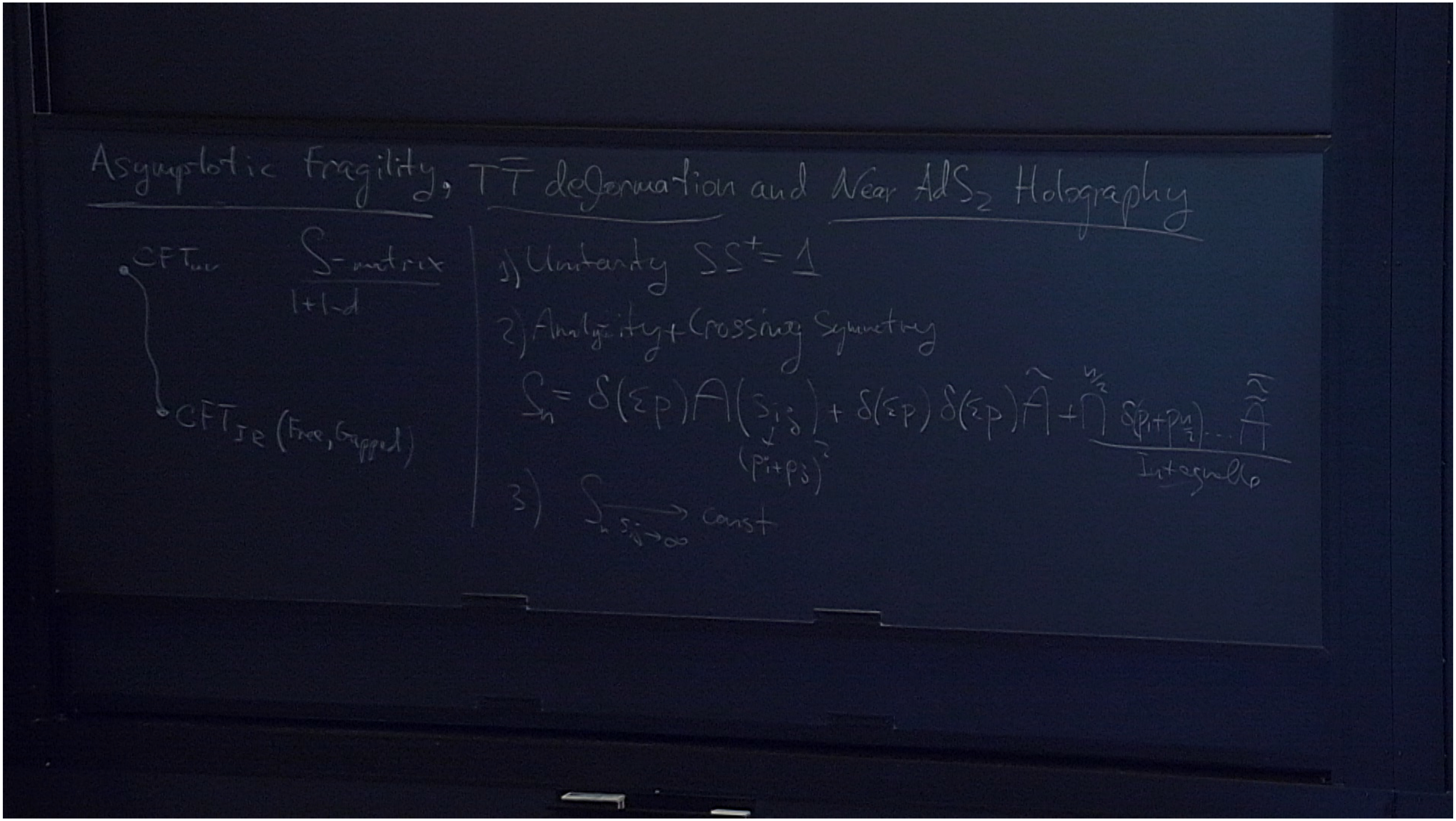
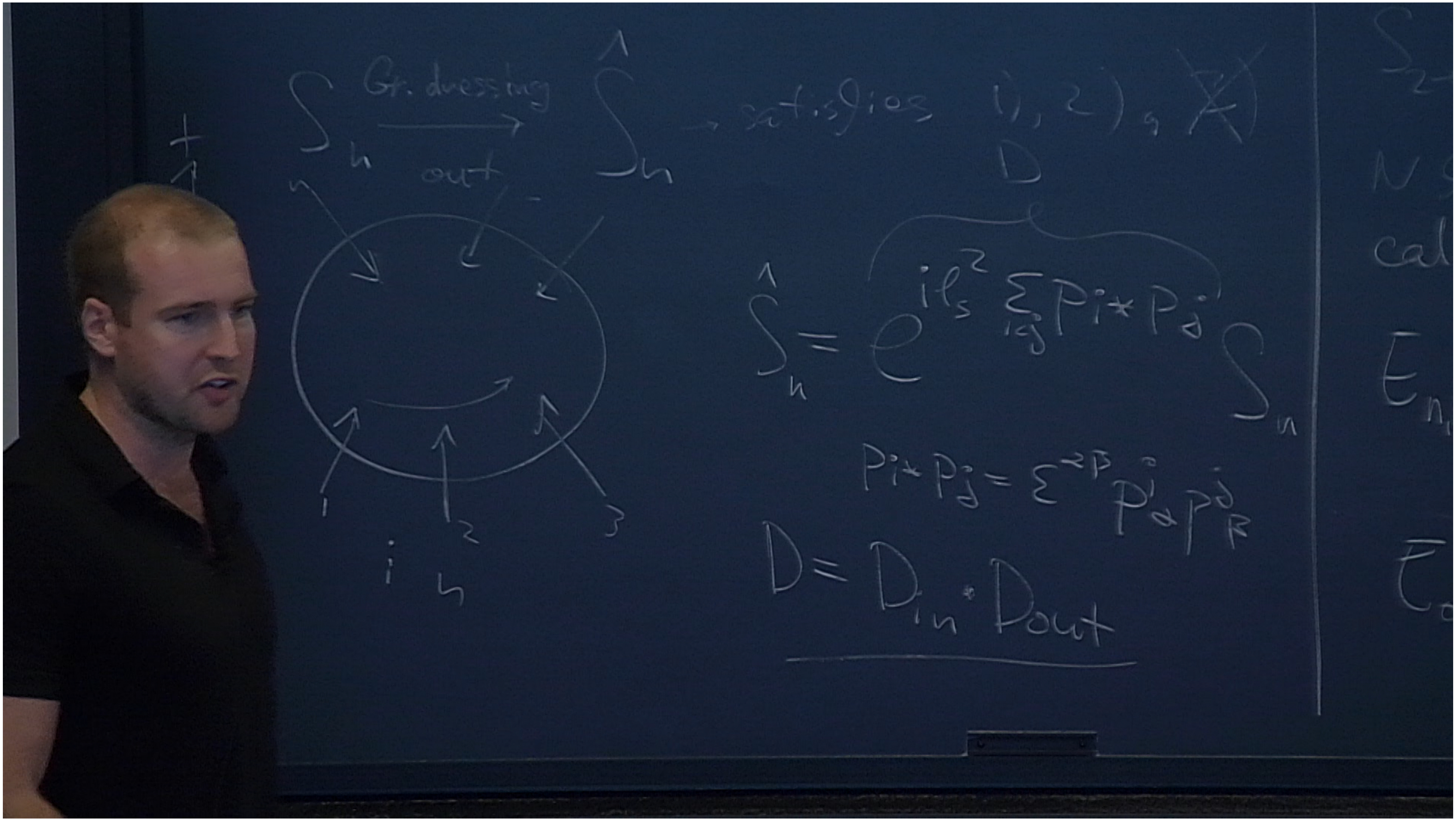
Abstract: <p>After reviewing the three things in the title I will argue that they represent the same physical phenomenon. In details, Jackiwâ€“Teitelboim (JT) gravity coupled to an arbitrary quantum field theory results in a gravitational dressing of field theoretical scattering amplitudes. The exact expression for the dressed S-matrix was previously known as a solvable example of a novel UV asymptotic behavior, dubbed asymptotic fragility. This dressing is equivalent to the T\barT deformation of the initial quantum field theory compactified on a circle. The same dressed S-matrix is also obtained as a flat space limit of the near AdS2 holography based on (JT) gravity. In order to preserve the flat space unitarity, however, the conventional Schwarzian dressing of boundary correlators needs to be slightly extended. As an intermediate result I will present a new simple expression for flat space amplitudes of massive particles in terms of correlators of holographic CFTâ€™s. </p>



Asymptotic Fragility, $T\bar{T}$ deformation and Near AdS_2 Holography
CFT_{UV}
S-matrix
1+1-d
CFT_{IR} (Free, Gapped)
1) Unitarity $SS^\dagger = 1$
2) Analyticity + Crossing Symmetry
$S_n = \delta(\Sigma p) A(s_{ij}) + \delta(\Sigma p)\,\delta(\Sigma p)\,\tilde{A} + \underbrace{\prod^{n/2} \delta(p_1 + p_{n/2}) \dots \tilde{\tilde{A}}}_{\text{Integrable}}$
$s_{ij} \to (p_i + p_j)^2$
3) $S_n \xrightarrow[s_{ij} \to \infty]{} \text{const}$


Gr. dressing
out
satisfies 1), 2), 3)
D
D = D_in * D_out

$$\hat{S}_{2\to 2} \xrightarrow[s\to\infty]{} e^{i\ell_s^2 s}$$

N free bosons $S = \Sigma \longrightarrow \hat{S} \longrightarrow$ comp. on R

calculate energy spectrum w TBA:

$$E_{n,\tilde{n}} = \sqrt{\frac{(n-\tilde{n})^2 4\pi^2}{R^2} + \frac{R^2}{\ell_s^4} + \frac{\left(n+\tilde{n} - \frac{N}{12}\right)4\pi}{\ell_s^2}}$$

$$E_0 = \sqrt{\frac{R^2}{\ell_s^4} - \frac{N}{12\ell_s^2}4\pi} \not\approx \frac{c_{uv}}{R}$$

$$T = T_{zz}\ , \quad \bar{T} = T_{\bar{z}\bar{z}}$$

$$T = \frac{1}{4}\left(T_{xx} - T_{yy} + 2i T_{xy}\right)$$

$$\Theta = \left(T_{xx} + T_{yy}\right)\frac{1}{4}$$

$$C(z,z') = T(z)\,\bar{T}(z') - \Theta(z)\,\Theta(z')$$

$$\exists \lim_{z \to z'} C(z,z') \equiv T\bar{T}$$

$$\langle n|\partial_{\bar{z}} C(z,z')|n\rangle = 0$$

$$H|n\rangle = E_n|n\rangle\ , \quad P|n\rangle = P_n$$

<u>Eucl</u> $S_1 \times S_1$

$R \ll L$

$$\partial_{\bar{z}} T = \partial_z \Theta$$

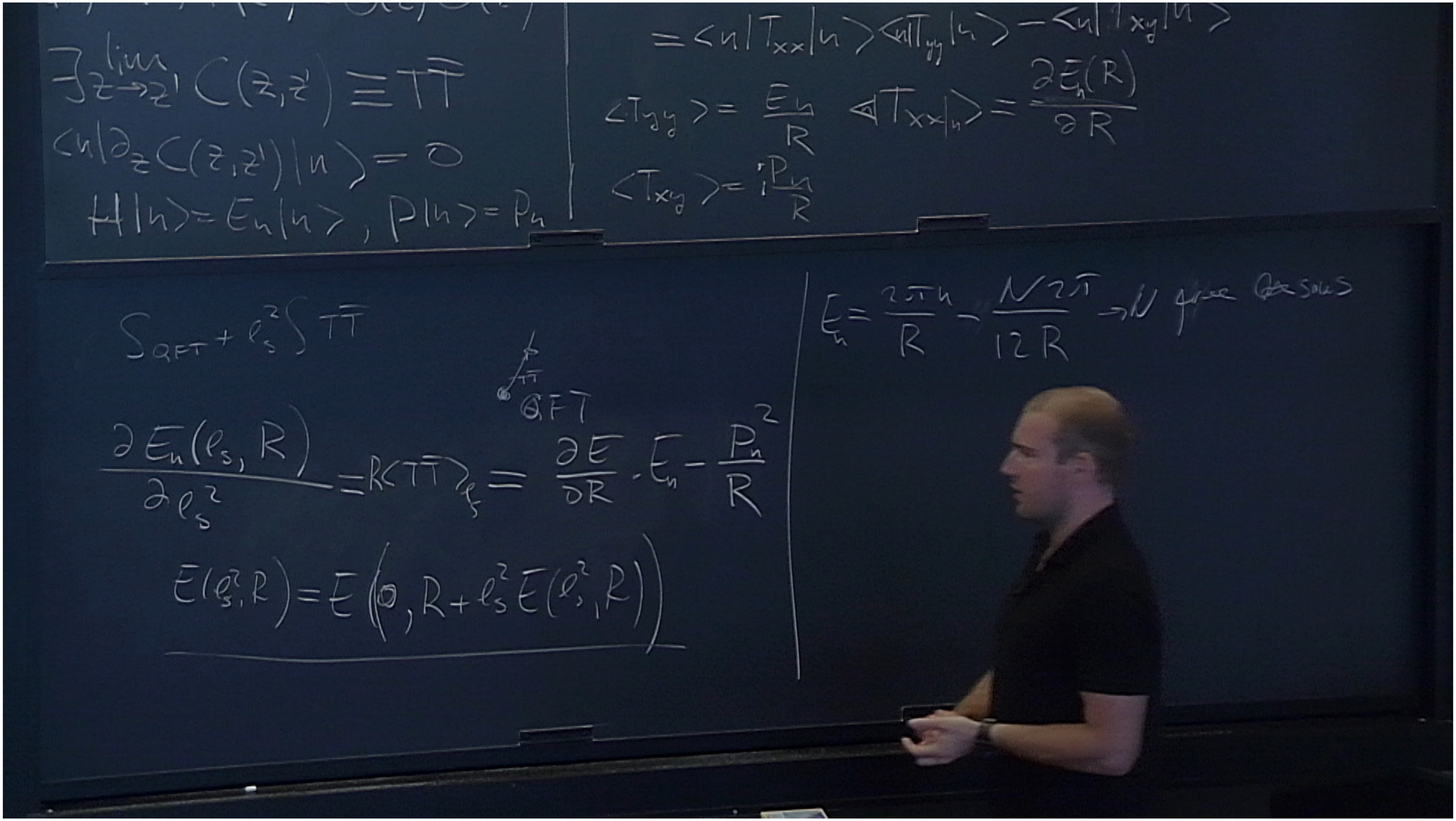
$$\langle n|T\bar{T}|n\rangle \underset{|z-z'|\to\infty}{=} \langle n|T|n\rangle\langle n|\bar{T}|n\rangle - \langle n|\Theta|n\rangle^2 =$$

$$= \langle n|T_{xx}|n\rangle\langle n|T_{yy}|n\rangle - \langle n|T_{xy}|n\rangle^2$$

$$\langle T_{yy}\rangle = \frac{E_n}{R} \qquad \langle T_{xx}|n\rangle = \frac{\partial E_n(R)}{\partial R}$$

$$\langle T_{xy}\rangle = \frac{P_n}{R}$$

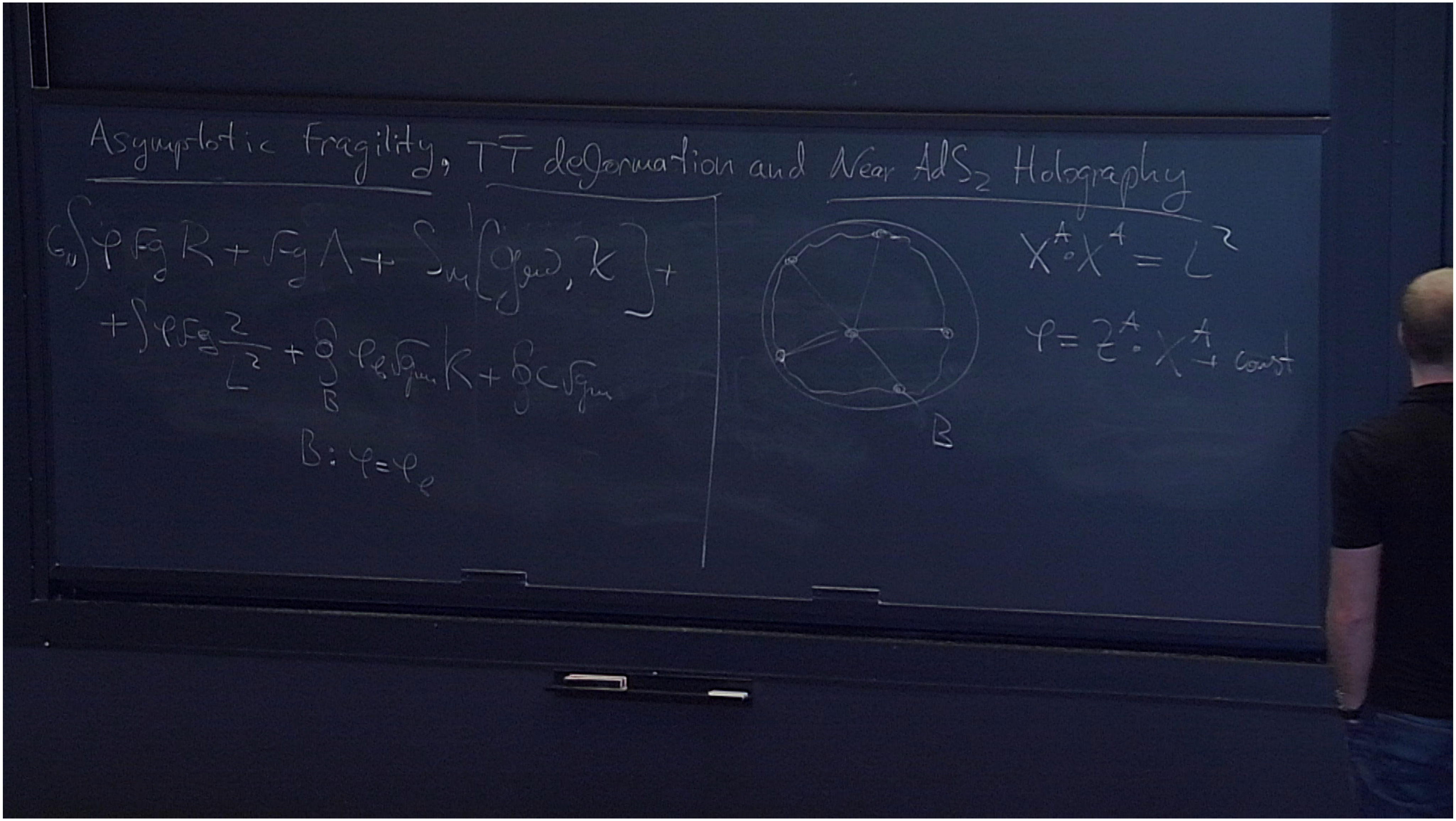
$$S_{QFT} + \ell_s^2 \int T\bar{T}$$


$\exists \lim_{z \to z'} C(z,z') \equiv T\bar{T}$
$\langle n | \partial_z C(z,z') | n \rangle = 0$
$H|n\rangle = E_n |n\rangle$, $P|n\rangle = P_n$
$= \langle n|T_{xx}|n\rangle \langle n|T_{yy}|n\rangle - \langle n|T_{xy}|n\rangle$
$\langle T_{yy} \rangle = \frac{E_n}{R}$ $\langle T_{xx} \rangle = \frac{\partial E_n(R)}{\partial R}$
$\langle T_{xy} \rangle = i\frac{P_n}{R}$
$S_{QFT} + \ell_s^2 \int T\bar{T}$
QFT
$\frac{\partial E_n(\ell_s, R)}{\partial \ell_s^2} = R\langle T\bar{T}\rangle_{\ell_s} = \frac{\partial E}{\partial R} \cdot E_n - \frac{P_n^2}{R}$
$E(\ell_s^2, R) = E(0, R + \ell_s^2 E(\ell_s^2, R))$
$E_n = \frac{2\pi n}{R} - \frac{N 2\pi}{12 R}$ → N free bosons

Asymptotic Fragility, $T\bar{T}$ deformation and Near AdS_2 Holography

$$\int \sqrt{g}\, R + \sqrt{g}\, \Lambda + S_M[g_{\mu\nu}, \chi]$$

$$T^{(n)}_{\mu\nu} = 0$$


Asymptotic Fragility, $T\bar{T}$ deformation and Near AdS_2 Holography
$G_N \int \varphi \sqrt{-g} R + \sqrt{-g} \Lambda + S_M[g_{\mu\nu}, \chi] + \int \varphi \sqrt{-g} \frac{2}{L^2} + \oint_B \varphi_b \sqrt{g_{uu}} K + \oint c \sqrt{g_{uu}}$
$B: \varphi = \varphi_b$
B
$X^A \cdot X^A = L^2$
$\varphi = Z^A \cdot X^A + \text{const}$

$$= \langle n|T_{xx}|n\rangle\langle n|T_{yy}|n\rangle - \langle n|T_{xy}|n\rangle$$

$$\exists \lim_{z\to z'} C(z,z') \equiv T\bar{T}$$

$$\langle n|\partial_z C(z,z')|n\rangle = 0$$

$$H|n\rangle = E_n|n\rangle,\quad P|n\rangle = P_n$$

$$\langle T_{yy}\rangle = \frac{E_n}{R} \qquad \langle T_{xx}|n\rangle = \frac{\partial E_n(R)}{\partial R}$$

$$\langle T_{xy}\rangle = i\frac{P_n}{R}$$

1) Decouple Gravity

$$\langle O_1(\theta(u_1)) \ldots O_n(\theta(u_n))\rangle \longrightarrow \langle O_1 \ldots O_2\rangle = \quad u \to \theta(u)$$

2) Boundary action:

$$S_{Sch} = L^2 \int du \left(\theta'(u)^2 - \frac{\theta''(u)^2}{\theta'(u)^2} \ldots \right) \quad = \int D\theta\, e^{iS_{Schw}} \prod_i \theta'^{\Delta_i} \langle O_i(\theta_i(u)) \ldots \rangle$$