Title: Lecture - Beautiful Papers

Speakers: Pedro Vieira

Collection/Series: Beautiful Papers - October 7, 2024 - January 31, 2025

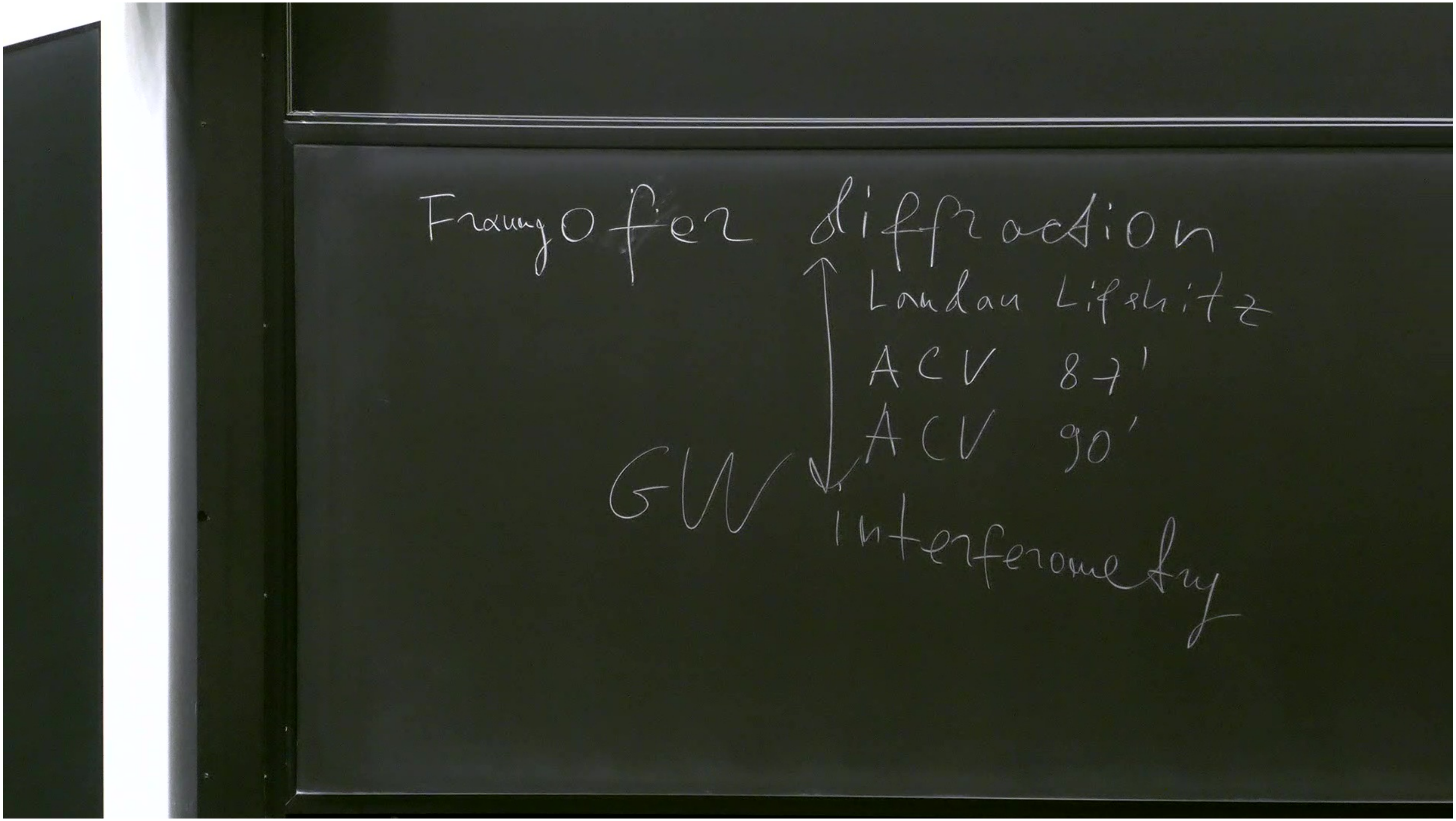
Subject: Other

Date: December 06, 2024 - 9:15 AM

URL: https://pirsa.org/24120014

Abstract:

Note room change on December 6 to Time Room (2nd Floor)


Fraunhofer diffraction
Landau Lifshitz
ACV 87'
ACV 90'
GW
interferometry

n

itz

$$a(s,q) \sim s \int d^2 b \, e^{i\vec{q}\cdot\vec{b}} \left[e^{2i\delta(s,b)} - 1 \right]$$

$$\delta(s,b) = \left(\frac{b_c}{b} \right)^{D-4} + \dots \cancel{e^{-\frac{b^2}{\ln s}}}$$

fy

$$[e^{2i\delta(\vartheta,b)} - 1]$$

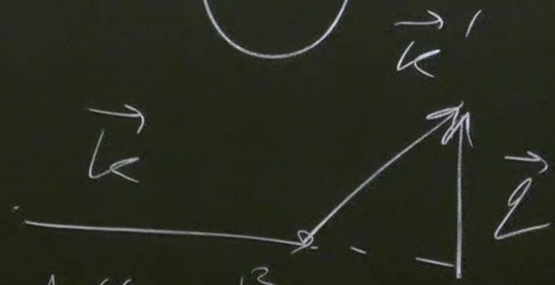
m

$$e^{ikz} \longrightarrow$$

$\vec{z}$

U

$$\cancel{e^{-\frac{b^2}{\ldots}}}$$



$$-\frac{\hbar^2\Delta}{2m}\psi + U\psi = E\psi = \frac{\hbar^2 k^2}{2m}\psi$$

$$\psi = e^{ikz}\, e^{2i\delta(\vec{b})} \qquad f_q = -\int e^{-i\vec{q}\vec{b}} \left(e^{2i\delta} - 1 \right) d^2 b$$

$$\delta(\vec{b}) = \frac{1}{\hbar v} \int_{-\infty}^{\infty} U\, dz \,, \qquad e^{-ik'z} = e^{-ikz - i\vec{q}\vec{b}}$$

$$\sqrt{s}\,\theta \sim \vec{q} = \frac{\partial \delta}{\partial b} \Rightarrow \theta = \frac{1}{\sqrt{s}} \frac{\partial \delta}{\partial b}$$

$$\psi = e^{ikz} e^{2i\delta(\vec{b})} \qquad f_q = \ldots \int e^{-i\vec{q}\vec{b}} \left(e^{2i\delta} - 1\right) d^2 b \qquad e^{-ik'\vec{r}}$$

$$\delta(\vec{b}) = \frac{1}{\hbar v} \int_{-\infty}^{\infty} U\, dz \,, \qquad e^{-ik'z} = e^{-ikz - i\vec{q}\vec{b}}$$

$$D = 4 - \epsilon \qquad \mathcal{N} = \qquad \mathcal{N} =$$

$$\sqrt{s}\,\theta \sim q = \frac{\partial \delta}{\partial b} \Rightarrow \theta = \frac{1}{\sqrt{s}} \frac{\partial \delta}{\partial b} = \frac{G\sqrt{s}}{b} + \left(\frac{G\sqrt{s}}{b}\right)^3$$

$$\theta \to V_{eff} \to \text{waveforms}$$

$$\psi = e^{ikz}\, e^{2i\delta(\vec{b})} \qquad f_q = \int e^{-i\vec{q}\vec{b}}\left(e^{2i\delta} - 1\right) d^2 b \qquad e^{-ik'\vec{z}} = e$$

$$\mathcal{N} = 8$$

$$\delta(\vec{b}) = \frac{1}{\hbar v}\int_{-\infty}^{\infty} U\, dz\,, \qquad e^{-ik'z} = e^{-ikz - i\vec{q}\vec{b}}$$

$$\mathcal{N} = 4$$

$$D = 4 - \epsilon$$

$$\sqrt{s}\,\theta \sim \vec{q} = \frac{\partial \delta}{\partial b} \Rightarrow \theta = \frac{1}{\sqrt{s}}\frac{\partial \delta}{\partial b} = \underbrace{\frac{G\sqrt{s}}{b} + \left(\frac{G\sqrt{s}}{b}\right)^3}\,,$$

$$\Theta \to H_{eff} \to \text{waveforms}$$

$$\psi = e^{ikz}\, e^{2i\delta(\vec b)} \qquad f_q = \int e^{-i\vec q \vec b}\left(e^{2i\delta} - 1\right) d^2 b \qquad e^{-ik'\vec z} = e$$

$$\mathcal{N} = 8$$

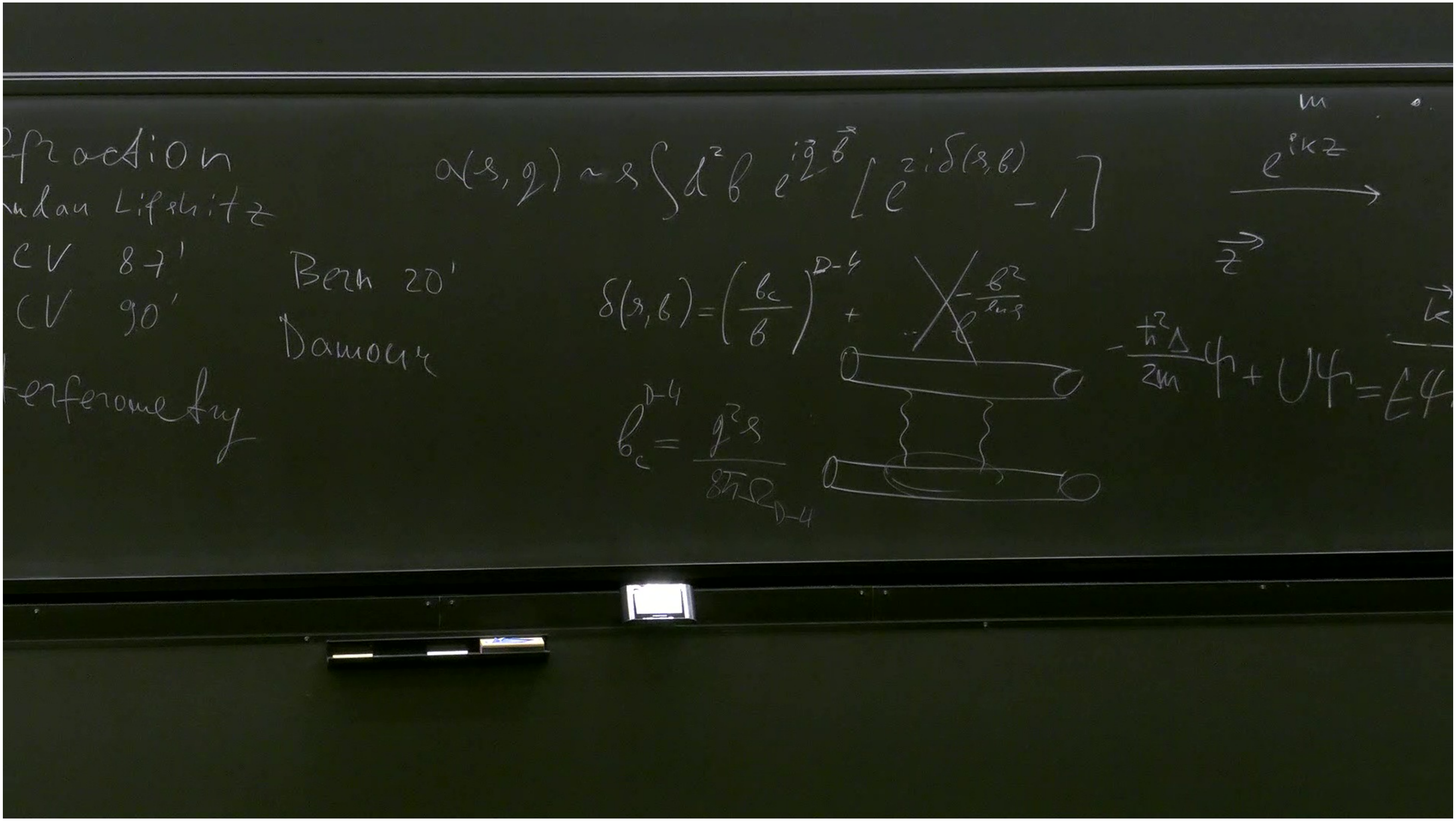
$$\mathcal{N} = 4$$

$$\delta(\vec b, v) = \frac{1}{4v}\int_{-\infty}^{\infty} U\, dz \, , \qquad e^{-ik'z} = e^{-ikz - i\vec q \vec b}$$

$$D = 4 - \epsilon$$

$$\sqrt{s}\,\theta \sim q = \frac{\partial \delta}{\partial b} \Rightarrow \theta = \frac{1}{\sqrt{s}}\frac{\partial \delta}{\partial b} = \frac{G\sqrt{s}}{b} + \left(\frac{G\sqrt{s}}{b}\right)^3$$

$\theta \to V_{eff} \to$ waveforms


fraction
ndau Lifshitz
CV 87'
CV 90'
terferometry
Bern 20'
Damour
$a(s,q) \sim s \int d^2b \, e^{i\vec{q}\cdot\vec{b}} \left[e^{2i\delta(s,b)} - 1 \right]$
$\delta(s,b) = \left(\frac{b_c}{b}\right)^{D-4} + \cancel{\ldots e^{-\frac{b^2}{4 \ln s}}}$
$b_c^{D-4} = \frac{g^2 s}{8\pi \Omega_{D-4}}$
e^{ikz}
$\vec{z}$
$\vec{k}$
$-\frac{\hbar^2 \Delta}{2m}\psi + U\psi = E\psi$

High-energy scattering of light particles

Superstring theory $2 \to 2$

$\lambda_s, b, R = 2G\sqrt{s}$

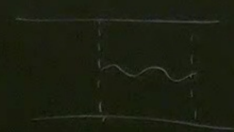
$\lambda_p = g \lambda_s$

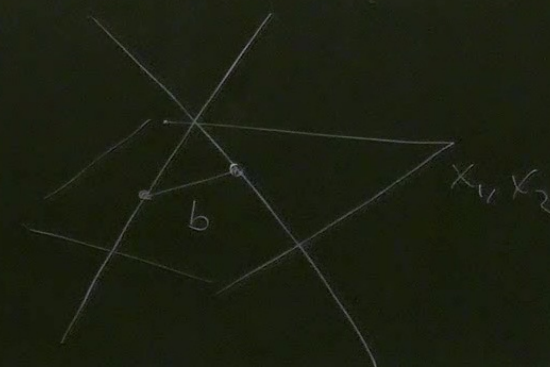
$b \gg R, \lambda_s$ Eikonal regime

$$S(b,s) = e^{2\cdot\delta_0(b,s)}$$

$$\delta_0(b,s) = \frac{G\sqrt{s}}{\hbar}\log b$$

$$h = (h^{++}, h^{--}, \Phi)$$





$R/b \ll 1$

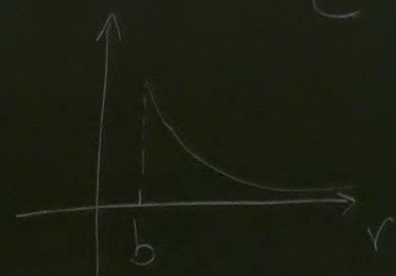
$$S(b,s) = e^{\frac{i}{\hbar}A} = e^{\frac{i}{\hbar}\int d^2x\,(\mathcal{L}_h + \mathcal{L}_e + h^{++}T_{++} + h^{--}T_{--})}$$

$R \gg b, \lambda_s$ Gravitational regime

$h^{\pm\pm} \sim \delta(x^{\mp})\, \delta(\vec{x} \pm \frac{\vec{b}}{2})$

$\Phi \sim \theta(x^+ x^-)\, \phi$

$\frac{d\phi}{dr^2} \sim \frac{\rho(r^2)}{r^2}$



$b < b_c$

$\rho(0) = 0$

$b_c = \sqrt{\frac{3\sqrt{3}}{2}}\, R$

$\rho(0) \neq 0$ strong field

$\phi \in \mathbb{C},\ \rho(0) = 0$

$e^{-S_{BH}\left(\frac{\sqrt{s}}{2}\right)}$

$$|S(b,s)|^2 = \begin{cases} \exp\left[-\frac{R\sqrt{s}}{\hbar}\pi + O(b)\right] \\ \exp\left[-\frac{2\sqrt{2}}{3}\frac{R\sqrt{s}}{\hbar}\left(1 - \frac{b^2}{b_c^2}\right)^{3/2}\right] \end{cases}$$

$M \sim (b_c^2 - b^2)^{3/4}$

b

Weak

$A(s, b$

egime

$b<b_c$

$\rho(0)=0$

$b_c=\sqrt{\frac{3\sqrt{3}}{2}}\,R$

$\rho(0)\neq 0$ strong field

$\phi\in\mathbb{C}\,,\ \rho(0)=0$

$b>b_c$

weak-field

$$A(s,b)=2Gs\left(\log b+\frac{4R^2}{b^2}+\dots\right)$$

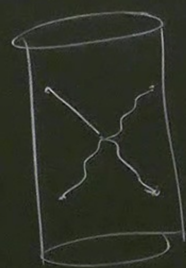
$$e^{-S_{BH}\left(\frac{\sqrt{s}}{2}\right)}$$

$$|S(b,s)|^2=\begin{cases}\exp\left[-\frac{R\sqrt{s}}{\hbar}\pi+O(b)\right] & b\ll R\\ \exp\left[-\frac{2\sqrt{2}}{3}\frac{R\sqrt{s}}{\hbar}\left(1-\frac{b^2}{b_c^2}\right)^{3/2}\right] & b\to b_c^-\end{cases}$$

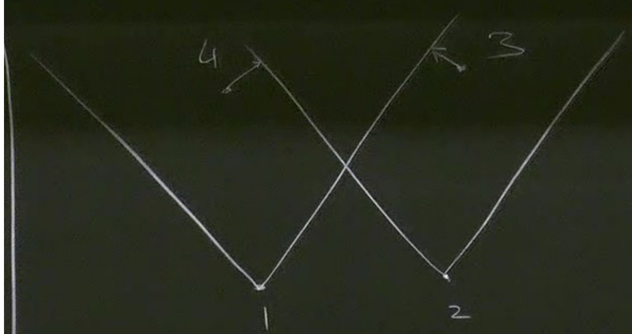
r

Cornalba, 2008 . Eikonal methods in AdS/CFT

$2 \to 2$ s-matrix in AdS $\longleftrightarrow$ 4 pt function in CFT



Regge limit $(J \to \infty)$ $\longleftrightarrow$ light-cone limit $(J \to \infty)$



$$O_1(x_1)\, O_3(x_3) = \sum_{\Delta, J} \frac{1}{|x_{13}|^{\Delta_1+\Delta_3-\Delta}}\, C^{J}_{\Delta_1\Delta_3\Delta} \times \frac{x_{13}^{\mu_1} \times \cdots x_{13}^{\mu_J}}{|x_{13}|^{J}}$$

$$\times\, O^{\mu_1 \cdots \mu_J}(x_1)$$

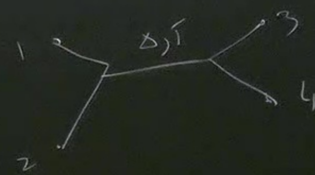
$|x_{13}| \to 0$, x_{13}^{μ} is finite

$$|x_{13}|^{-(\cancel{\Delta_1+\Delta_3} - \Delta + J)}$$

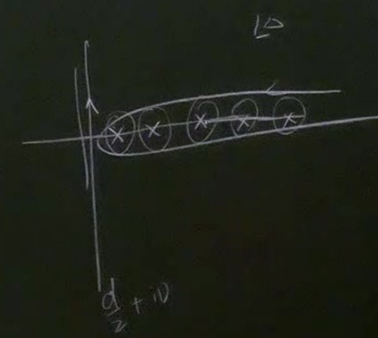
$$\tau = \Delta - J \geq 2$$

$$\Delta \geq J + d - 2$$

$$z\bar{z} = \frac{x_{13}^2\, x_{24}^2}{x_{12}^2\, x_{34}^2}\,, \quad (1-z)(1-\bar{z}) = \frac{x_{14}^2\, x_{23}^2}{\cdots}$$



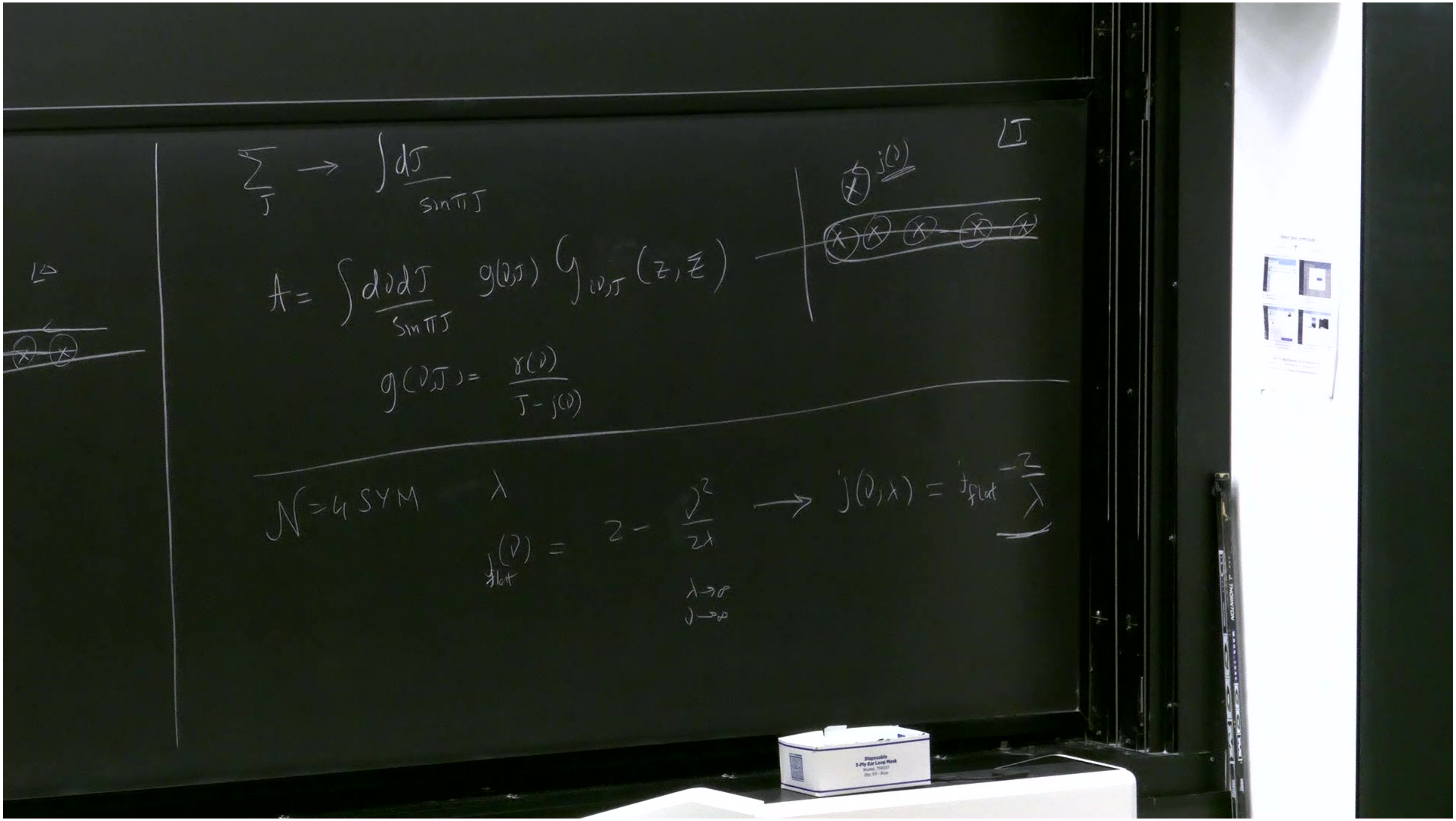
$$\Delta = \frac{d}{2} + i\nu$$

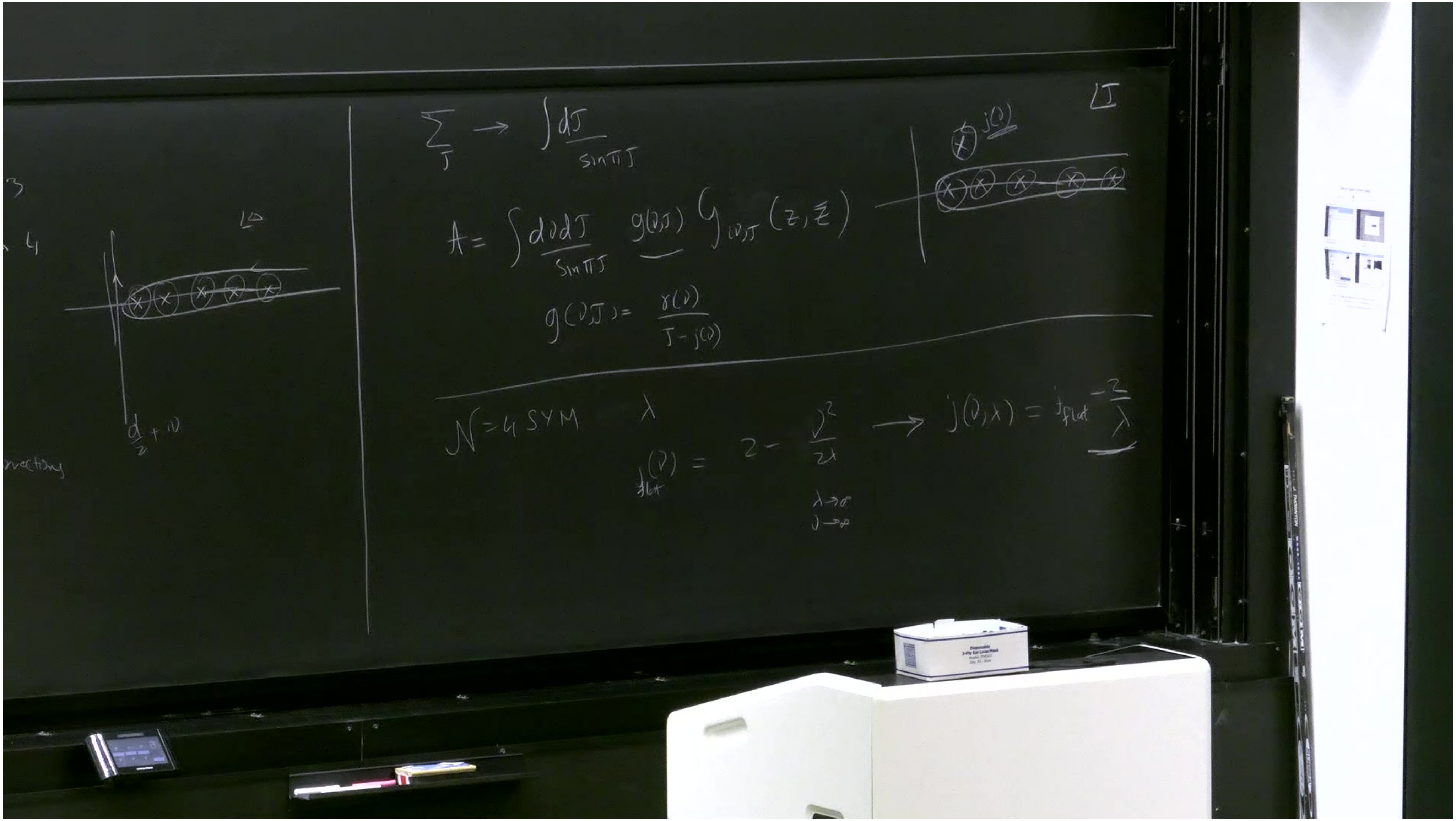


$$A(z,\bar{z}) = \langle O_1(x_1)\, O_2(x_2)\, O_3(x_3)\, O_4(x_4) \rangle$$

$$= \sum_{\Delta, J} \frac{C^J_{\Delta_1 \Delta_3 \Delta}\, C^J_{\Delta_2 \Delta_4 \Delta}}{x_{12}\;\; x_{34}}\, F_{\Delta, J}$$

$$= \sum_{J \geq 0} \int d\nu\;\; g_J(\nu)\;\; G_{\nu, J}(z, \bar{z})$$


$\sum_J \to \int \frac{dJ}{\sin \pi J}$
$A = \int \frac{d\nu\, dJ}{\sin \pi J}\, g(\nu,J)\, G_{\nu,J}(z,\bar{z})$
$g(\nu,J) = \frac{\gamma(\nu)}{J - j(\nu)}$
$j(\nu)$
$\mathcal{N}=4$ SYM λ
$j_{flat}(\nu) = 2 - \frac{\nu^2}{2\lambda} \longrightarrow j(\nu,\lambda) = j_{flat} - \frac{2}{\lambda}$
$\lambda \to \infty$
$\nu \to \infty$


$\sum_J \to \int \frac{dJ}{\sin \pi J}$
$A = \int \frac{d\nu dJ}{\sin \pi J} \, g(\nu,J) \, G_{\nu,J}(z,\bar{z})$
$g(\nu,J) = \frac{\gamma(\nu)}{J - j(\nu)}$
$\mathcal{N}=4$ SYM λ
$j_{flat}(\nu) = 2 - \frac{\nu^2}{2\lambda}$
$\lambda \to \infty$
$\nu \to \infty$
$\to j(\nu,\lambda) = j_{flat} - \frac{2}{\lambda}$
$j(\nu)$
$\frac{d}{2} + i\nu$