$$\int dM \exp\left[-\frac{N}{\lambda} \mathrm{Tr} f(M)\right]$$

M was an $N \times N$ Hermitian Matrix.

Sym $M \to U M U^{-1}$

Used to set $M = D$

$d_1 \ldots d_N$ (eigenvalues)

$$\rho(x) = \frac{1}{N}\sum_i \delta(x - d_i)$$

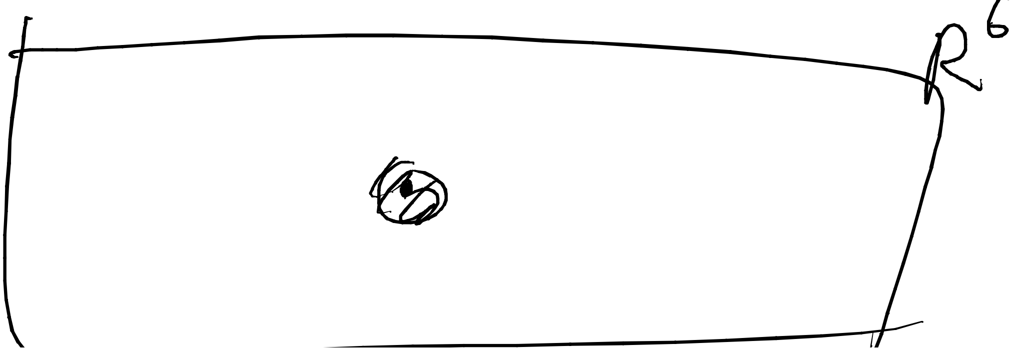
$f(M) = \frac{M^2}{2}$ | $\rho = \frac{1}{\pi}\frac{\sqrt{4\lambda - x^2}}{2\lambda}$

$$Z = \int \prod d(d_i) \exp\left[-\frac{N}{\lambda}\sum_i f(d_i) + \sum_{i \neq j} \ln|d_i - d_j|\right]$$

$$\to -N^2\left[\frac{1}{\lambda}\int dx\, \rho(x) f(x) - \int dx\, dy\, \rho(x)\rho(y) \ln|x-y|\right]$$

IIB THEORY.

D3 BRANE (TRANSLATIONALLY INV IN 3+1 DIMENSIONS)



$$ds^2 = f^{-1/2}\left[-dt^2 + \sum_{i=1}^{3} dx_i^2\right] + f^{1/2}\left[dr^2 + r^2 d\Omega_5^2\right].$$

$$f = \left(1 + \frac{R^4}{r^4}\right) \quad ; \quad R^4 = \text{const} = 4\pi g_s N \alpha'^2$$

$$F_5 = (1+*)\left[dt \wedge dx_1 \wedge dx_2 \wedge dx_3 \wedge d f^{-1}\right].$$

$$\omega = \text{Energy scale} \quad \left(\omega \ll \frac{1}{\sqrt{\alpha'}}\right).$$

$$e^{i\omega t}. \longleftrightarrow \quad f \sim \frac{R^4}{r^4}$$

$$\tau = f^{-1/4} t \quad \Big| \; e^{i\omega t} = e^{i\omega \tau f^{1/4}}$$

$$e^{i\frac{\omega R}{r}\tau} \quad \omega \qquad \omega_{loc} = \frac{\omega R}{r}$$

WHEN $r \to 0$
ω_{loc} ARBIT LARGE

~~For~~ FOR ANY FIXED SMALL ω

MINIMALLY COUPLED SCALAR (E.g. DIL)

$$\frac{1}{\sqrt{g}}\partial_\mu \sqrt{g}\, g^{\mu\nu}\partial_\nu \phi = 0.$$

$$\phi = \phi(r,t) = \phi(r)\, e^{-i\omega t}.$$

$$\sqrt{g} = f^{1/2} r^5. \quad ; \quad g^{rr} = f^{-1/2} \quad ; \quad g^{tt} = -f^{1/2}.$$

$$\frac{1}{f^{1/2} r^5}\partial_r f^{1/2} r^5 f^{-1/2}\partial_r \phi - \frac{1}{f^{1/2} r^5}\partial_t f^{1/2} r^5 f^{1/2}\partial_t \phi$$

$$\partial_r r^5 \partial_r \phi + f r^5 \omega^2 \phi = 0$$

$$x = r$$

$\bar{R}$

$$\partial_x x^3 \partial_x \phi + (\omega^2 R^2)\left(1+\frac{1}{x^4}\right)\phi = 0.$$

$$\phi = \left(\chi/x^2\right)$$

$$\boxed{x^2\frac{\partial^2}{\partial x^2}\chi + x\frac{\partial}{\partial x}\chi - 4\chi + (\omega^2R^2)\left[x^2+\frac{1}{x^2}\right]\chi = 0}$$

$$\left(x\frac{\partial}{\partial x}\, x\frac{\partial}{\partial x}\right) \Leftrightarrow x = \frac{1}{x'}$$

DIFF EQ INV UNDER $x \leftrightarrow 1/x$

WHEN $\frac{\omega^2R^2}{x^2}$ Negligible. [Provided $\frac{\omega^2R^2}{x^2} \ll 1$].

SOLN $=$ $J_2(\omega R x)$, $Y_2(\omega R x)$ [LIN COMB]

WHEN $\omega^2R^2x^2$ Negligible [Provided $\omega^2R^2x^2 \ll 1$].

SOLN L.C OF $J_2\left(\frac{\omega R}{x}\right)$, $Y_2\left(\frac{\omega R}{x}\right)$.

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

x, r SMALL -

ν, n LARGE

$e^{i\# \frac{1}{n}}$ At LARGE $1/n$ (ie small n).

$H_2^{(1)}(\alpha) = \sqrt{\frac{2}{\pi\alpha}}\, e^{i\left[\alpha - \pi - \frac{\pi}{4}\right]}$ (At large α)

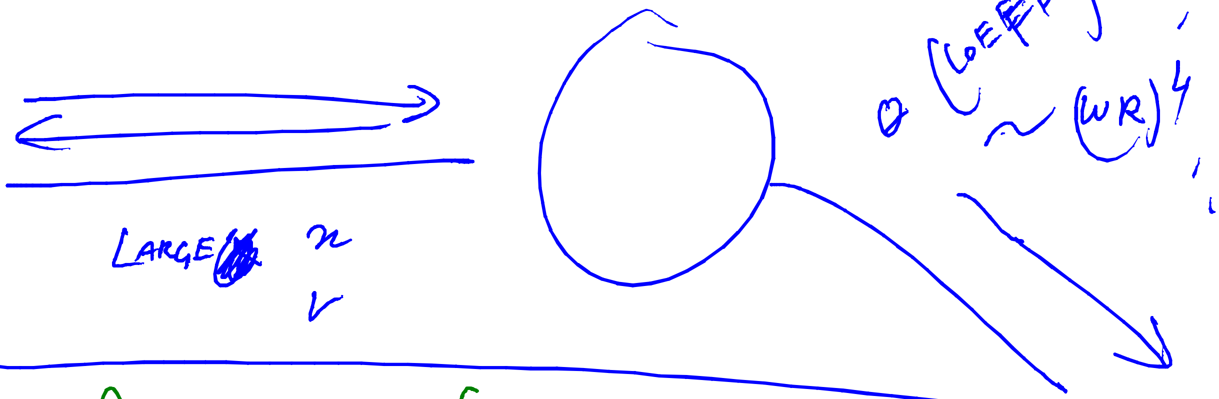
Small α, $H_2^{(1)} = -\frac{1}{\pi}\left(\frac{2}{\alpha}\right)^2$

$\alpha = \frac{\omega R}{n}$. | Mode $= \theta\, H_2^{(1)}\left(\frac{\omega R}{n}\right)$

$\cancel{\theta\left(\frac{\omega R}{n}\right)^2}$ $\theta\left(\frac{n}{\omega R}\right)^2$ | $J_2(x\omega R) \sim (x\omega R)^2$

$\theta = (\omega R)^4$

SCATTERING CALCULATION.



θ (COEFF) $\sim (\omega R)^4$

LARGE n, ν

POLCHINSKI.

O + { Gauge Bosons + SUSY Partners. / Osc

GRAV + OSC

$\boxed{\mathcal{N}=4 \text{ SYM}}$ Dynamics of Gauge Bosons + Additional Interactions $\cancel{(\alpha')^2 F^4}$

$(\alpha')^2 F^4$