Fermionic spectral functions in AdS/CFT

prediction of the behavior of spin $\frac{3}{2}$ field

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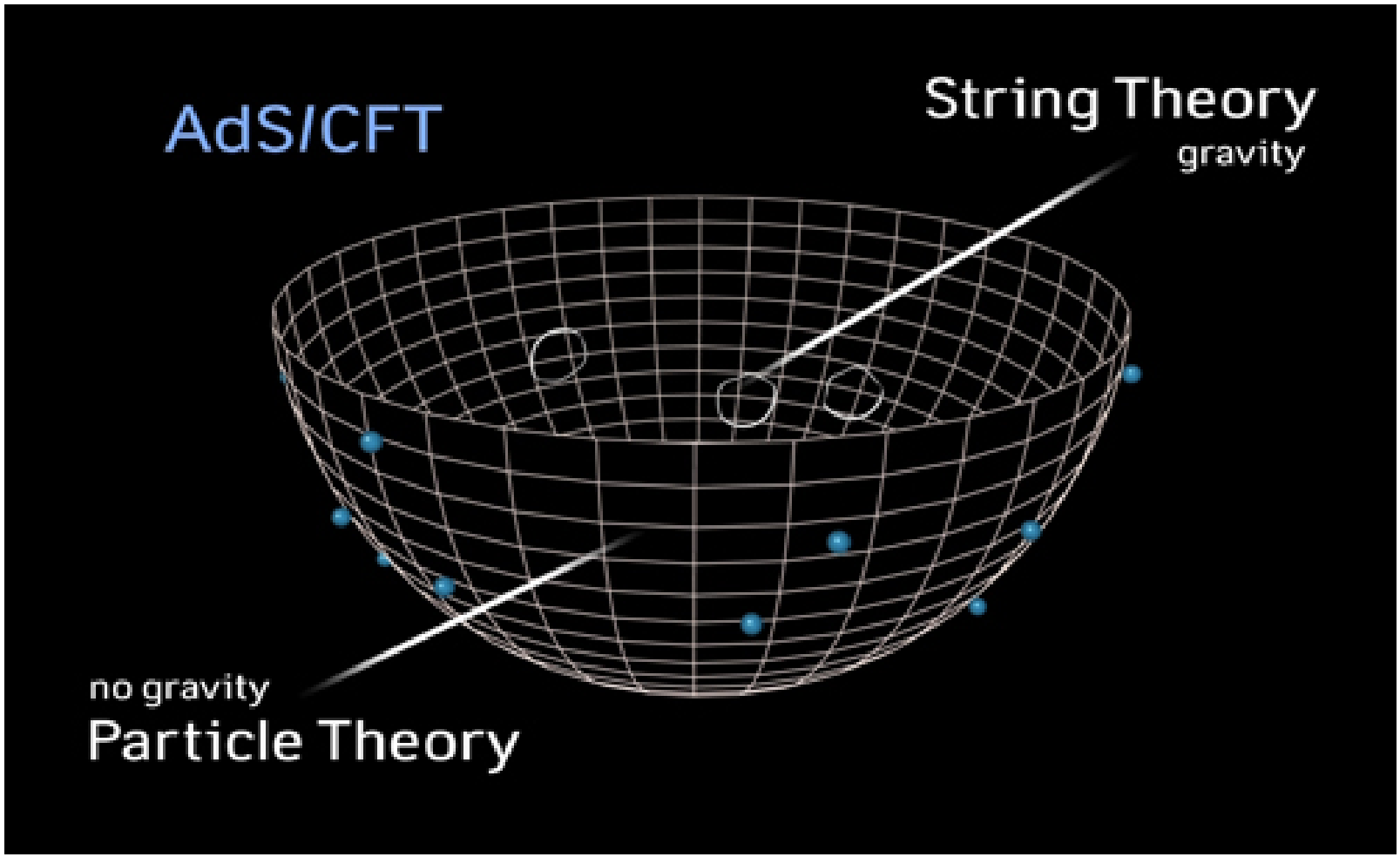
Anti de Sitter/Conformal Field Theory



Green's function

Do you remember what is a Green's function?
just the inverse of an operator!

$$LG(x) = \delta(x) \tag{1}$$

and for example for the scalar field equation, the Green's function is:

$$(\Box - m^2)G(x) = \delta(x) \tag{2}$$

if we transform to fourier space, then we get

$$G(k_\mu) = \frac{i}{\omega^2 - u^2 + i\epsilon} \tag{3}$$

$$u^2 = \vec{k}^2 + m^2 \tag{4}$$

Spectral reps of G_R

Now we turn to the spectral representation of the retarded and advanced Green's Function.

$$G_R(\omega) = \int_{-\infty}^{+\infty} \frac{A(\omega')}{\omega - \omega' + i\epsilon} \tag{5}$$

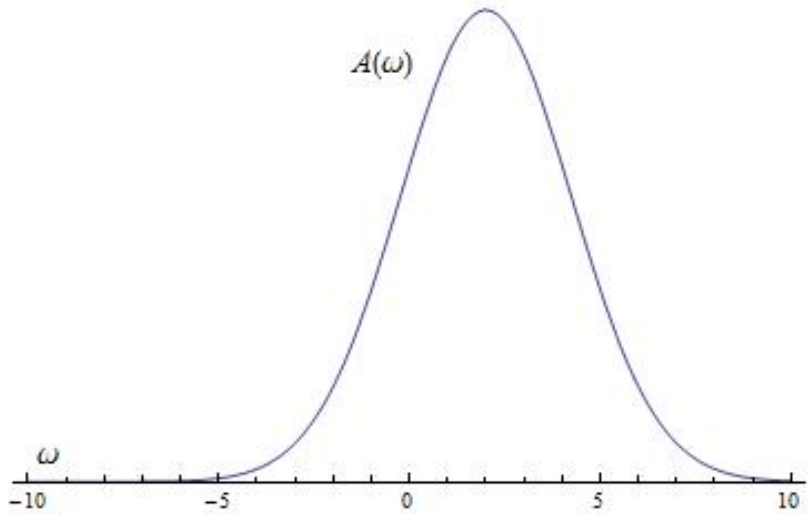
$$G_A(\omega) = \int_{-\infty}^{+\infty} \frac{A(\bar{\omega}')}{\omega - \omega' - i\epsilon} \tag{6}$$

the relationship between G_R and $A(\omega)$ is that

$$A(\omega) = -\frac{ImG_R}{\pi} \tag{7}$$

Picture

It's easy to see that the Green's Function is divergent when ω goes to u, so what's the corresponding behavior of the spectral function?
There should be a delta function behavior!
If there are interaction, then the spectral function will behave like this.



AdS/CFT and spectral function

The AdS/CFT correspondence tells us that if we want to calculate the Green's function in the conformal field theory, we just need to solve the corresponding classical field equation in Anti de sitter space,and expand the solution around the boundary.

$$\phi \rightsquigarrow Br^{\Delta_+} + Ar^{\Delta_-} \tag{8}$$

then G_R is just B/A.

field equation

particle	higgs	electton	photon	gravitino
spin	0	1/2	1	3/2

Now we turn to the spin 3/2 field.
the field equation is as follows

$$\tilde{\gamma}^{\mu\nu\sigma} D_\nu \phi_\sigma - m_1 g^{\mu\sigma} \phi_\sigma - m_2 \tilde{\gamma}^{\mu\sigma} \phi_\sigma = 0 \tag{9}$$

field equation at work

After some algebra, we can split the field into several parts:

ϕ	ϕ_μ	ϕ_r	$\lambda = \tilde{\gamma}^M \phi_M$
spin	3/2	1/2	1/2

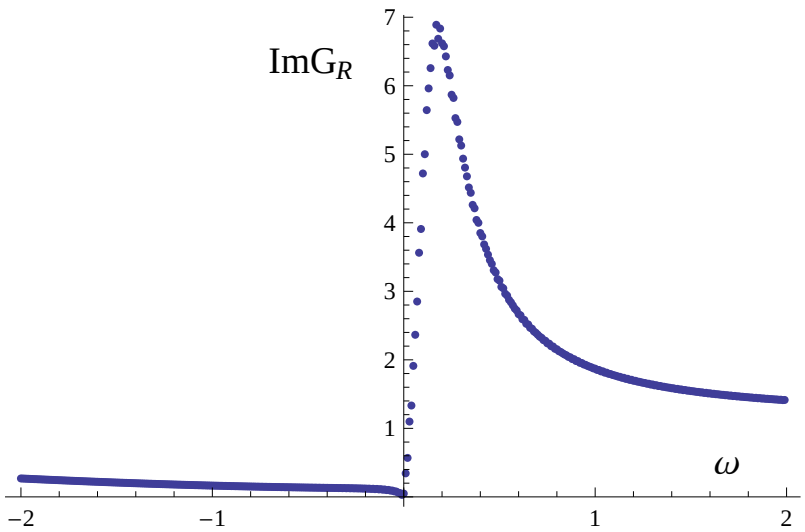
we just care about the spin 3/2 component so we can set ϕ_r and λ equal to zero,
then we will get that ϕ_t is zero, and the equation of ϕ_i turns out to be:

$$(\tilde{\gamma}^M \partial_M + B_r \tilde{\gamma}^r + m_2 - m_1)\psi^i = 0 \tag{10}$$

just a homogenous dirac equation in curved spacetime.

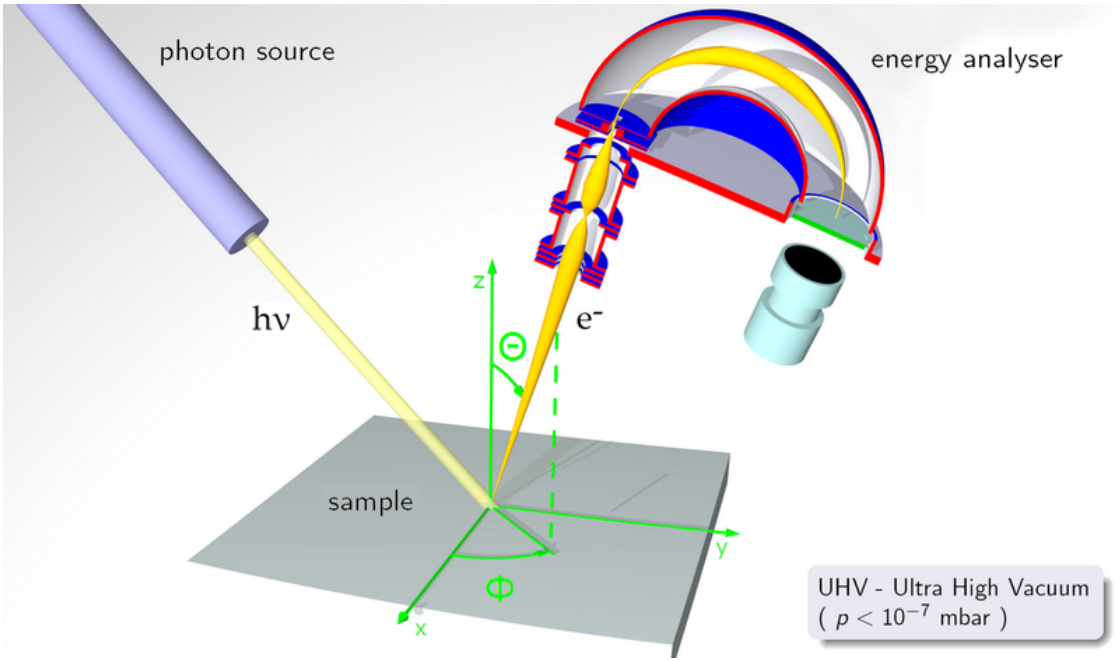
Prediction

After we solve the field equation, and apply the AdS/CFT result $G_R = B/A$,
we can get the graph of our Green's function as follows:



Experiment

ARPES: Angel-resolved photoemission spectroscopy



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Thank you for your listening!