Gong Talk

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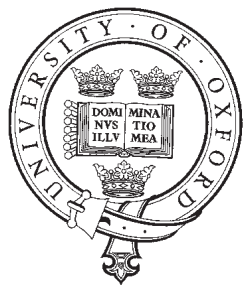


18.04.2013

Who we are

A.Starinets

R.Davison

S.Grozdanov

N.K.

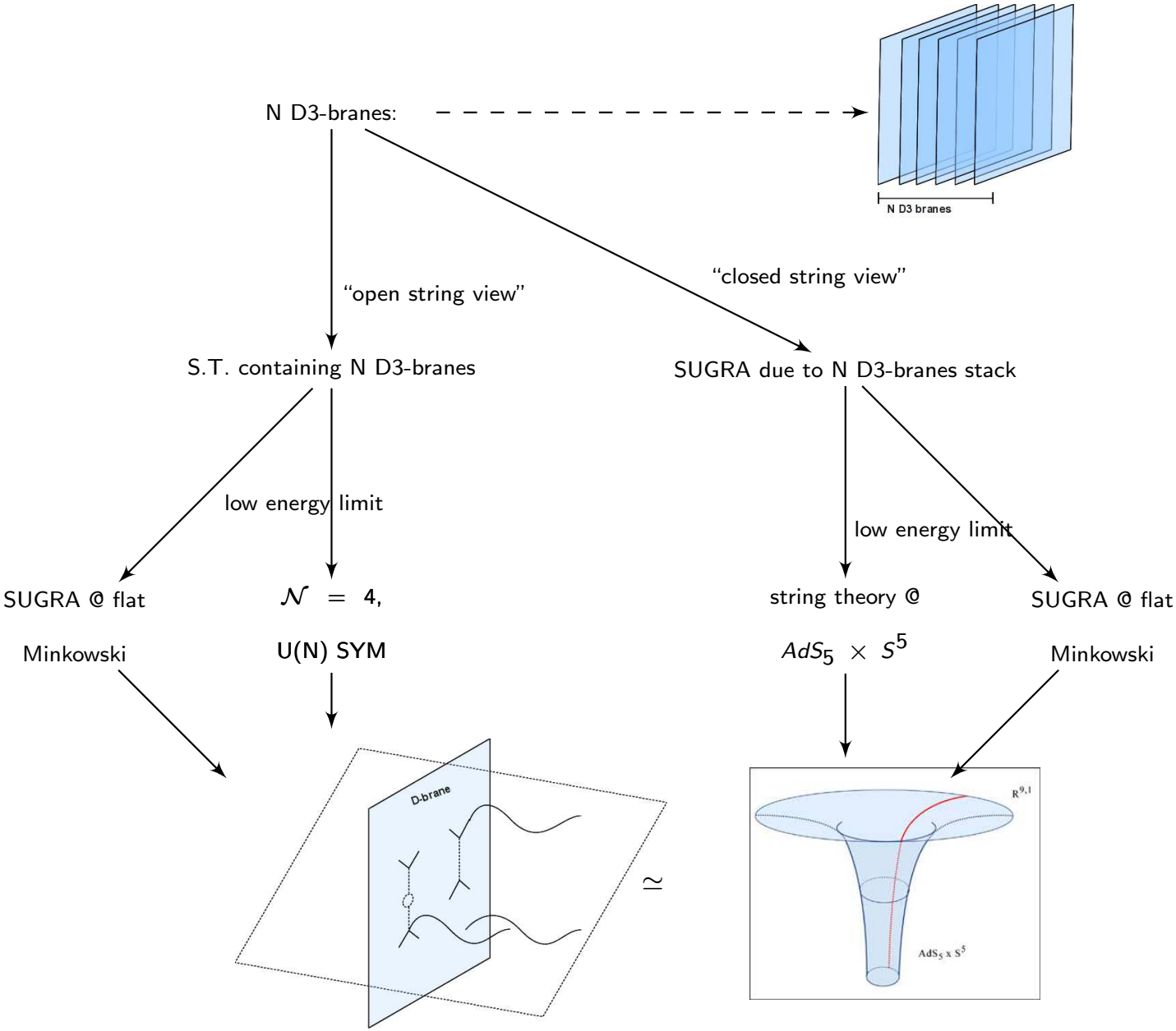
Framework

The Conjecture:

Type IIB string theory on $AdS_5 \times S^5$ *is equivalent* $\mathcal{N} = 4$ $U(N)$ *SYM in* $D = 4$

or in formula-form:

$$\langle \exp[\int dx^4 \phi_0 \mathcal{O}(x)] \rangle_{CFT} = Z_{string}[\phi(x,z)|_{z=0} = \phi_0(x)]$$


N D3-branes:
N D3 branes
"open string view"
"closed string view"
S.T. containing N D3-branes
SUGRA due to N D3-branes stack
low energy limit
low energy limit
SUGRA @ flat
Minkowski
$\mathcal{N} = 4$,
U(N) SYM
string theory @
$AdS_5 \times S^5$
SUGRA @ flat
Minkowski
D-brane
$\simeq$
$R^{9,1}$
$AdS_5 \times S^5$

What we do

We study $2D$ and $3D$ 'holographic' liquids @ $T \neq 0$ and $\mu \neq 0$.

We are particularly interested in hydrodynamics.

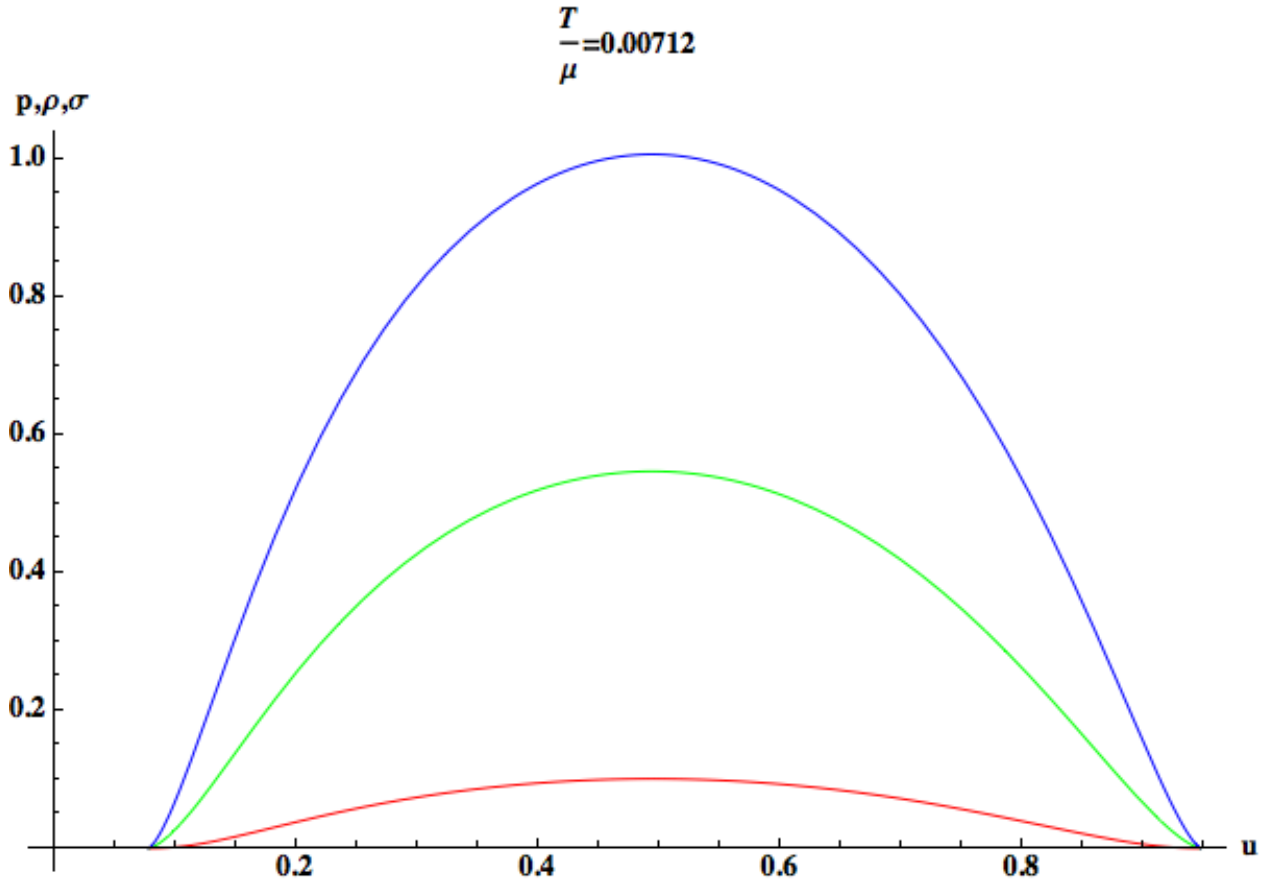
We set up bulk/gravity systems that capture features of interest.

Geometry examples include:

- $RN@AdS_5$, $RN@AdS_4$
- Lifshitz
- Electron Star
- $t-$dependent backgrounds
- ...

Example background

Example of 'realistic'/numerical background:



How we do it

We start from a (consistent) bulk action, e.g.

Einstein + Maxwell:

$$S = \frac{1}{4\kappa^2_{\{4,5\}}} \int d^{\{4,5\}}\sqrt{-g}\left(R - 2\Lambda - L^2 F_{\mu\nu}F^{\mu\nu}\right)$$

or Schutz:

$$S = \int d^4x\sqrt{-g}\left(\mathcal{L}_E + \mathcal{L}_M + \mathcal{L}_{fluid}\right)$$

where $\mathcal{L}_{fluid} = -p + \sigma u^a(\partial_a\phi + A_a) + \lambda(u^a u_a + 1)$

How we do it

For such systems we study linear perturbations:

$g_{\mu\nu} \to g^0_{\mu\nu} + \delta g_{\mu\nu}$, $A_\mu \to A^0_\mu + \delta A_\mu$, $p \to p + \delta p$, ..., etc.

Combined into g.i. variables and split according the remnant symmetry into shear/transverse and sound/longitudinal modes.

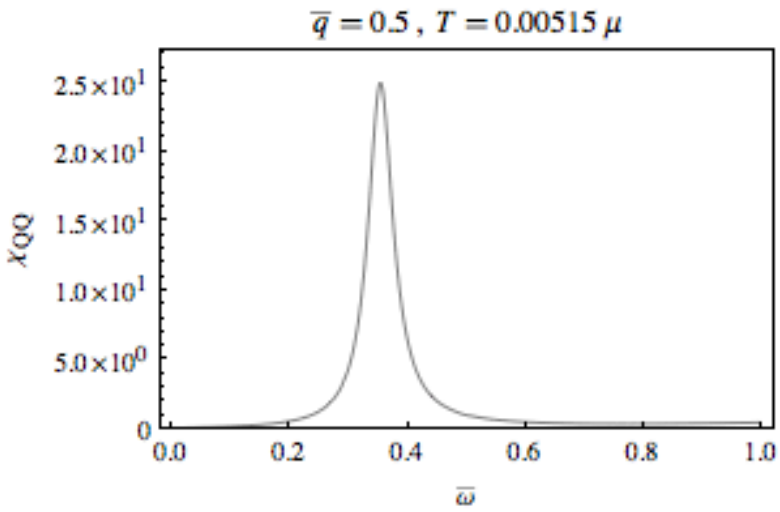
Solve linearised Einstein + Maxwell + ... e.o.m.'s

Depending on the background the treatment can be analytical, semi-analytical or purely numerically.

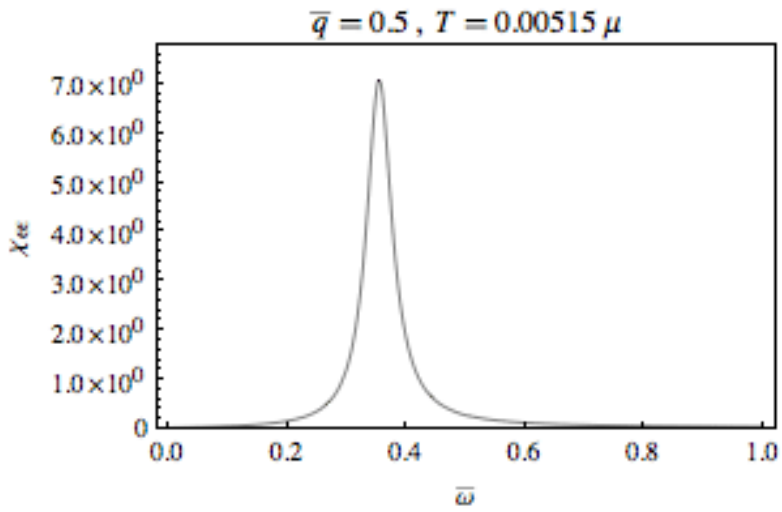
What do we get

Out of these process we can get spectral functions of the dual field theory side and/or QNMs $\sim$ poles of those Green's functions.

For example in the AdS_4 sound case the spectral function look like:



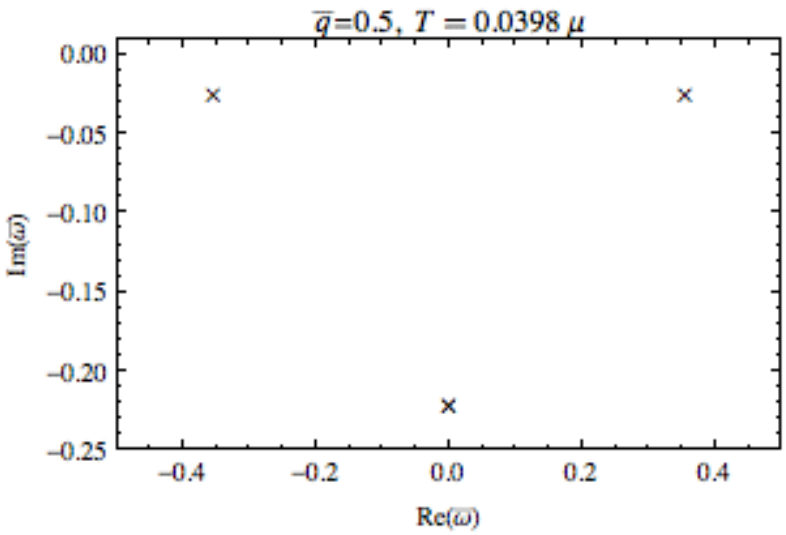
(a) Charge-Charge



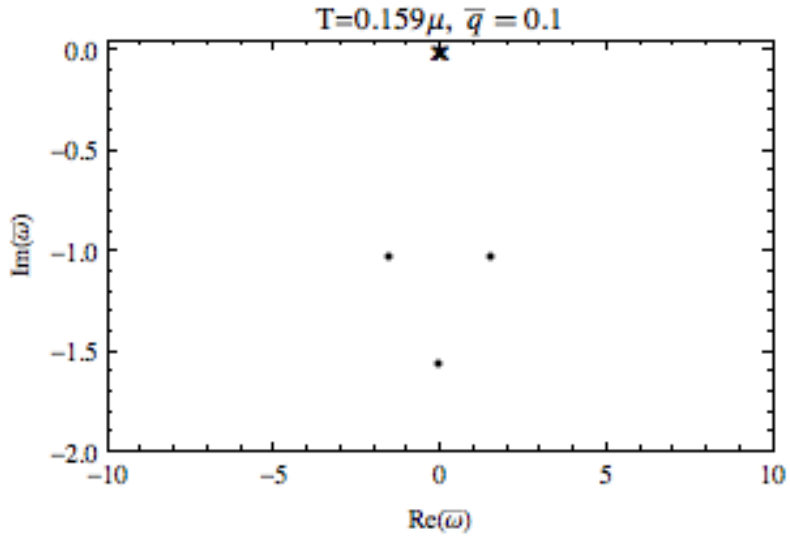
(b) Density-Density

What do we get

and the QNMs:



(c) v. temperature



(d) v. momentum

What do we get

Dispersion relations, temperature dependence

Transport

Characterisation of the ('universality') class of 'material' living in the field theory side (e.g. LFL, SM)

Out-of-equilibrium physics

In lieu of conclusions and outlook

- sQFT @$T, \mu \neq 0$
- 'Discrete' holography
- Fundamental of hydrodynamics
- More (and better) understood models/systems (some of them top-down)
- Out-of-equilibrium

Thank you!