

TRANSPORT PROPERTIES OF

$\mathcal{N} = 4$ SYM AT FINITE COUPLING

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P.B., Alex Buchel - JHEP 06 01: 103, 2006 - [hep-th/0510041]

Aim of the Work

- Study of the hydrodynamics for SYM theory with leading correction in the inverse 't Hooft coupling
 - ▣➤ Shear diffusion constant
 - ▣➤ Speed of sound
 - ▣➤ Bulk viscosity
- Consistent picture of the α' -corrected sugra hydrodynamics

Supergravity Approximation

- ➔ Gauge/string correspondence provides an effective description of strongly coupled gauge theories in terms of supergravity black brane background
- ➔ Large- N $\mathcal{N} = 4$ $SU(N)$ SYM at large 't Hooft coupling \sim IIB-sugra in near-extremal black 3-brane background
- ➔ Hydrodynamics approximation: $\omega \rightarrow 0$, $q \rightarrow 0$, $\frac{\omega}{q} = \text{const}$
 - Shear viscosity η (Policastro, Son, Starinets - [hep-th/0104066], [hep-th/0205052]):

$$\eta = \frac{\pi}{8} N^2 T^3$$

- Speed of sound c_s and bulk viscosity ζ (Policastro, Son, Starinets - [hep-th/0210220]):

$$c_s = \frac{1}{\sqrt{3}} \qquad \zeta = 0$$

Leading α' -corrections (1)

- ➔ 10-dim type-IIB action with leading α' -corrections:

$$I = I_{sugra} + \frac{1}{16\pi G_{10}} \int d^{10}x \sqrt{-g} \gamma e^{-\frac{3}{2}\phi} W$$

with

$$\gamma = \frac{1}{8} \zeta(3) (\alpha')^3, \quad W \sim C^4$$

- ➔ Important features:

- ▣➔ The entropy density differs from B.H. formula
- ▣➔ T_H, S, E, F are α' -corrected
- ▣➔ $R(S^5)$ not constant

Leading α' -corrections (2)

- Analysis of perturbations in the background geometry
- Shear channel (Buchel, Liu, Starinets - [hep-th/0406264]):

$$\frac{\eta}{s} = \frac{1}{4\pi} (1 + 135\gamma + \mathcal{O}(\gamma^2))$$

- Sound channel:

$$\omega = c_s q - i \frac{2}{3} \frac{q^2}{T} \frac{\eta}{s} \left(1 + \frac{3\zeta}{4\eta} \right) \rightarrow \omega = c_s q - i \frac{\Gamma_s}{2\pi T} q^2 + \mathcal{O}(q^3)$$

$$c_s = \frac{1}{\sqrt{3}} + \mathcal{O}(\gamma^2) \quad \Gamma_s = \frac{1}{3} + 40\gamma + \mathcal{O}(\gamma^2)$$

- Bulk viscosity: $\zeta = \mathcal{O}(\gamma^2)$