Supercharge diffusion from AdS/CFT

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Work in collaboration with G.Policastro [1206.2067]

LPTENS

The supercharge diffusion constant

Motivation : Examine universality properties of the diffusion constant

For all theories admitting an Einstein gravity dual (e.g. charged black holes dual to theories with chemical potential or the near-horizon region of general Dp-branes)

$$\frac{\eta}{s} = \frac{1}{4\pi}$$

- Hydrodynamic limit of $\mathcal{N} = 4$ SYM at finite temperature
- Excitation related to fluctuations of the supercharge densities $\Rightarrow$ *phonino*
- The diffusion constant D_s determines the damping of the phonino excitation.

Two ways to calculate the diffusion constant :

- Pole of the supercurrent correlator
- Kubo formula : Relation of the diffusion constant with the low momentum, low frequency limit of the supercurrent correlator

$$\varepsilon D_s = -\frac{1}{12} \lim_{\omega \to 0} \left[\lim_{k \to 0} (i\gamma^1)^{\alpha\dot{\alpha}} \operatorname{Im} G^{ii}_{\alpha\dot{\alpha}}(\vec{k}, \omega) \right]$$

Finite temperature results

- The retarded correlator of the supercurrents (dual to the gravitino ψ_i^α) is defined as:

$$G_{ij}^{\alpha\dot{\beta}}(k) = \int d^4x e^{-ik\cdot x} i\theta(x^0)\langle\{S_i^\alpha(x), \bar{S}_j^{\dot{\beta}}(0)\}\rangle$$

◇ The background metric:

$$ds^2 = \frac{\pi^2 T^2 R^2}{u}(-f(u)dt^2 + dx^2 + dy^2 + dz^2) + \frac{R^2}{4f(u)u^2}du^2$$

with $f(u) = 1 - u^2$.

◇ The bulk action for the gravitino:

$$S = \int d^4x\sqrt{-g}(\bar{\Psi}_\mu \Gamma^{\mu\nu\rho} D_\nu \Psi_\rho - m\bar{\Psi}_\mu \Gamma^{\mu\nu}\Psi_\nu)$$

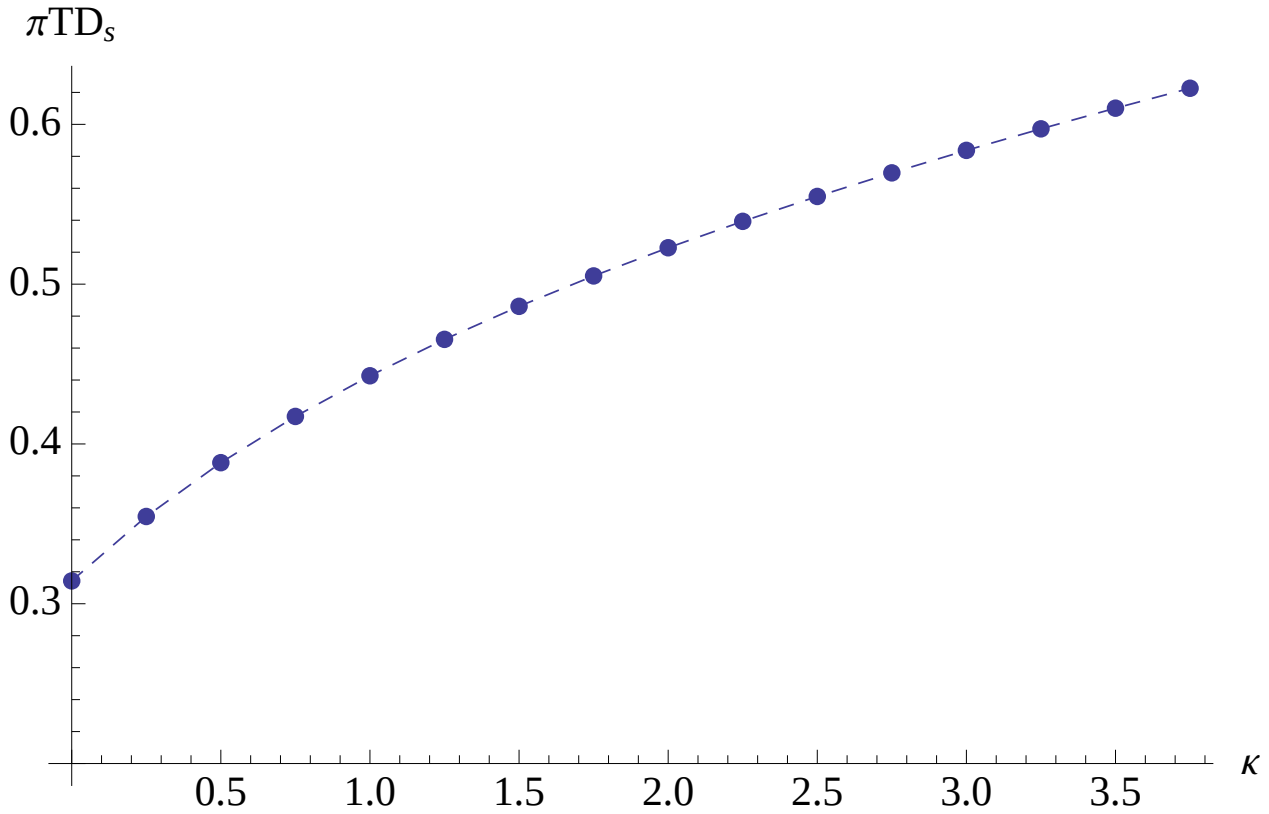
$$\boxed{D_s = \frac{2\sqrt{2}}{9\pi T}}$$

Finite temperature and chemical potential results

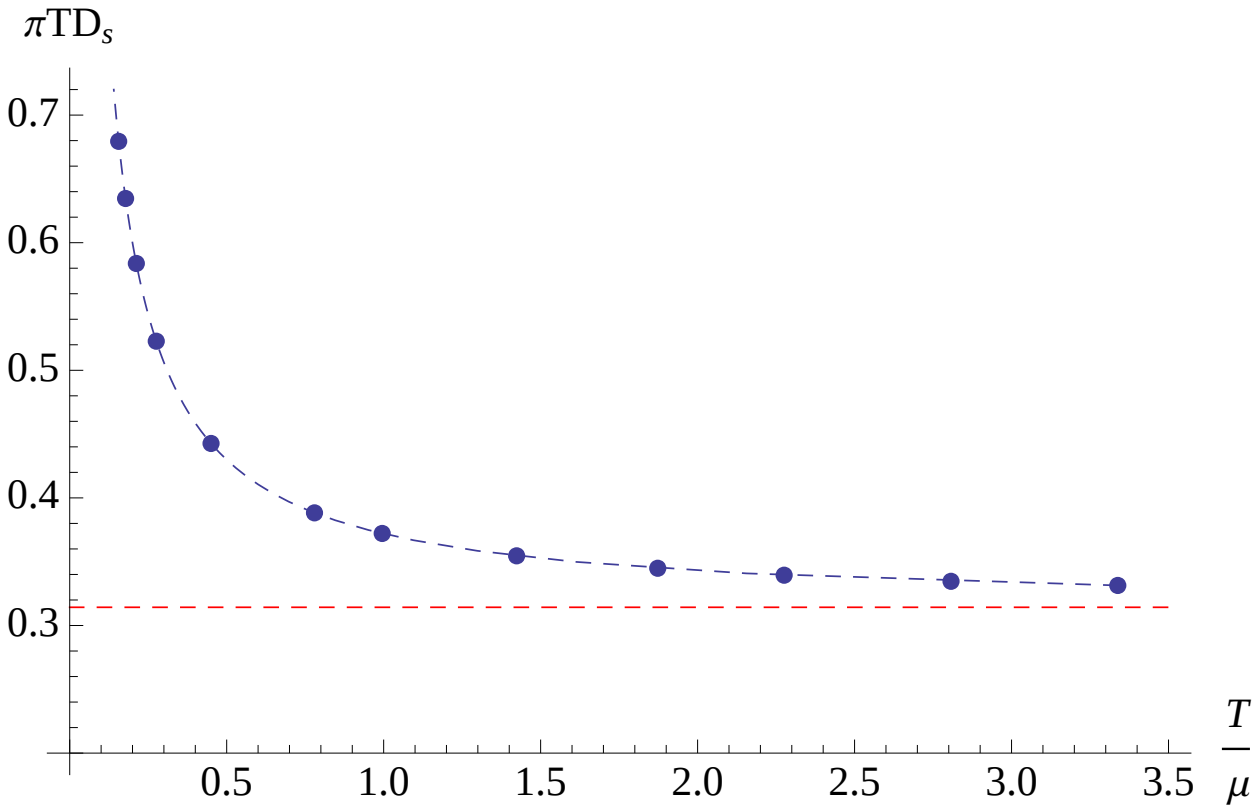
Background

Finite temperature and chemical potential STU black hole

Solution of $\mathcal{N} = 2$, $d = 5$ SUGRA with three abelian charges



Finite temperature and chemical potential results



Conclusion

The diffusion constant varies with the chemical potential $\Rightarrow$ No universality property!

Thank you!