Unexpected Low Energy Spectral Weight in Holographic Theories

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Stanford University

arXiv:17xx.xxxx Goutéraux, VM

See also:

arXiv:1612.03466 Goutéraux, VM

arXiv:1210.1590 Anantua, Hartnoll, VM, Ramirez

Spectral Weight: A Fermi Surface Diagnostic

Spectral weight directly counts the degrees of freedom at a given frequency and momentum.

$$\sigma(k) = \lim_{\omega \to 0} \frac{\mathrm{Im} G^R_{JJ}(\omega, k)}{\omega}$$

Spectral decomposition

$$\mathrm{Im}\, G^R_{JJ}(\omega, k) = \sum_{n,m} e^{-\beta E_m} |\langle n | J(k) | m \rangle|^2 \delta(\omega - E_m + E_n)$$

Perturbing momentum (k)

$n \to k'$, $m \to k''$

$\delta(k - k' + k'')$

$$G^R_{J_\perp J \perp}(\omega, k) \sim \frac{\delta A_{(1)}}{\delta A_{(0)}}$$

Spectral weight in semi-local quantum liquids

Hyperscaling-violating geometry [Hartnoll, Shaghoulian; 2012]

$$ds^2 = \frac{L^2}{r^2}\left(-r^{\frac{4(z-1)}{\theta-2}}dt^2 + g_0 r^{-\frac{2\theta}{\theta-2}}dr^2 + dx_i^2\right)$$

Semi-local limit

[Anantua, Hartnoll, VM, Ramirez; 2012]

$z \to \infty, \eta = -\frac{\theta}{z}$ *fixed*

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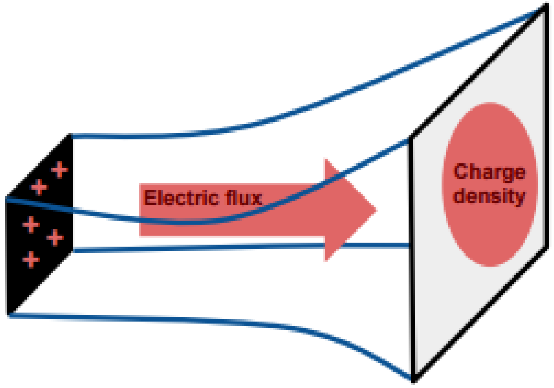

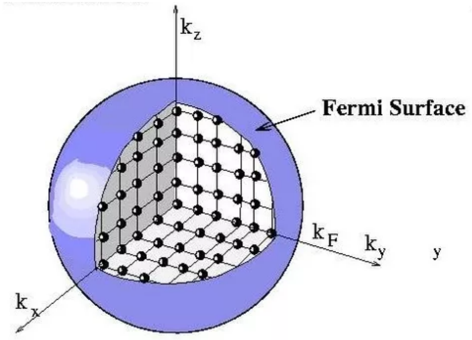

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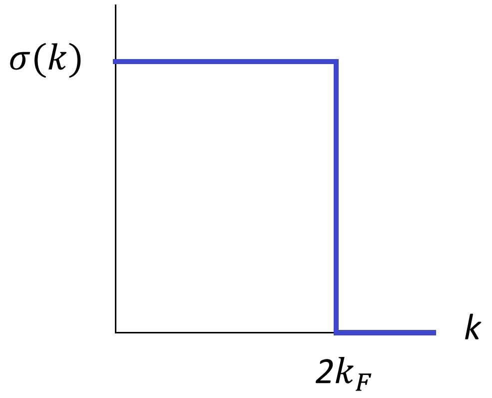

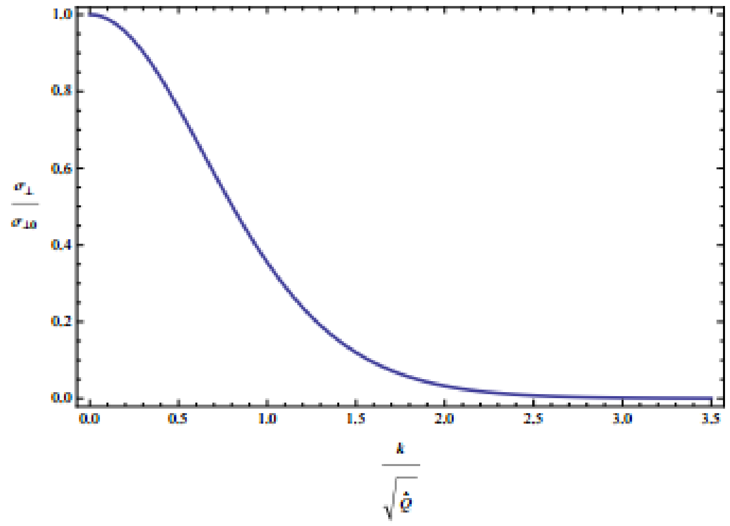

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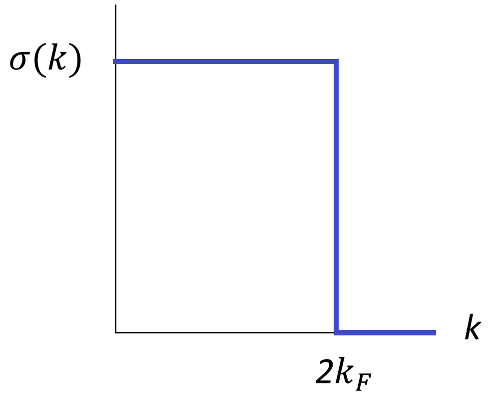

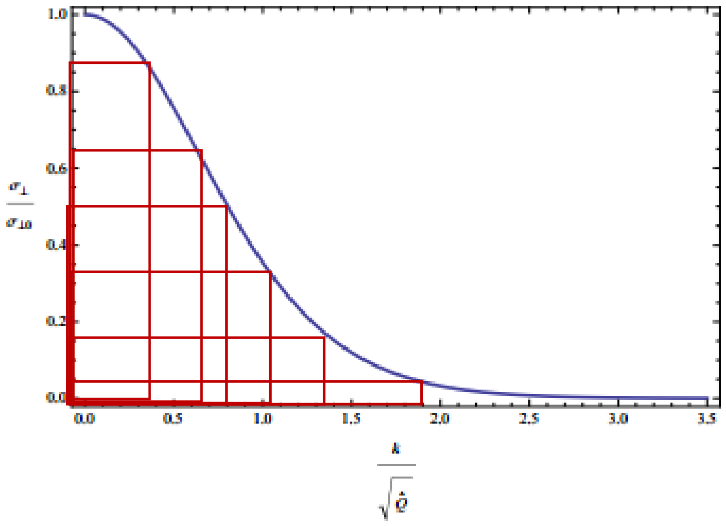


Electric flux
Charge density
Charged condensate
Electric flux
Charge density
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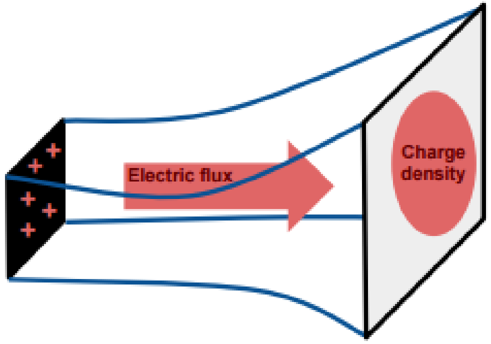
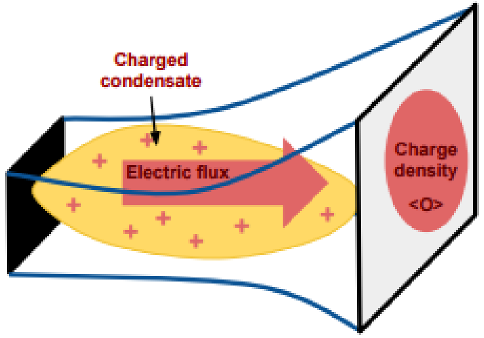
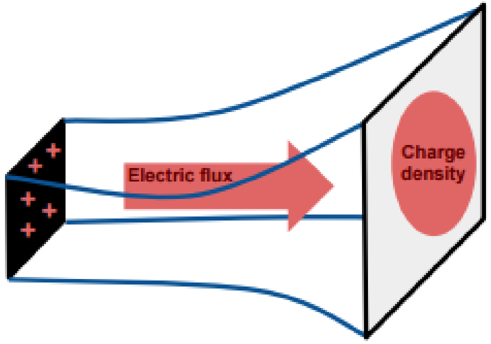
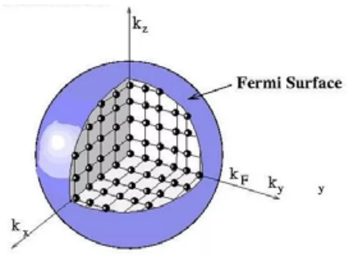
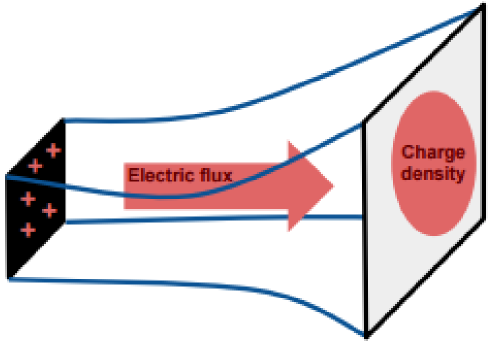


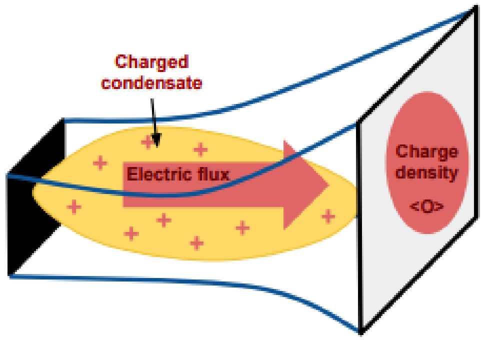


$$\sigma \neq 0 \qquad k < k_\star$$









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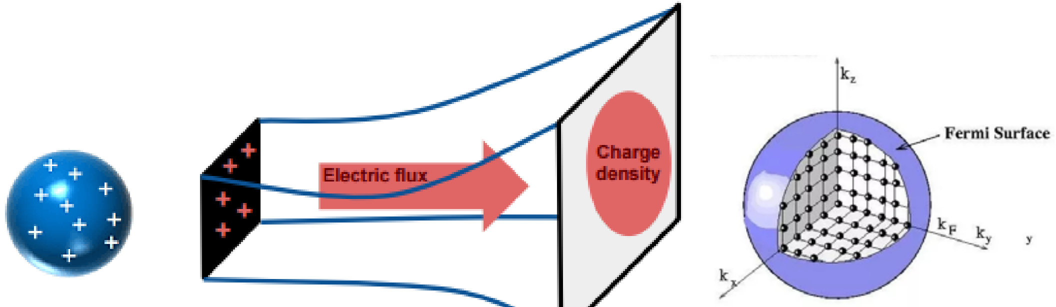

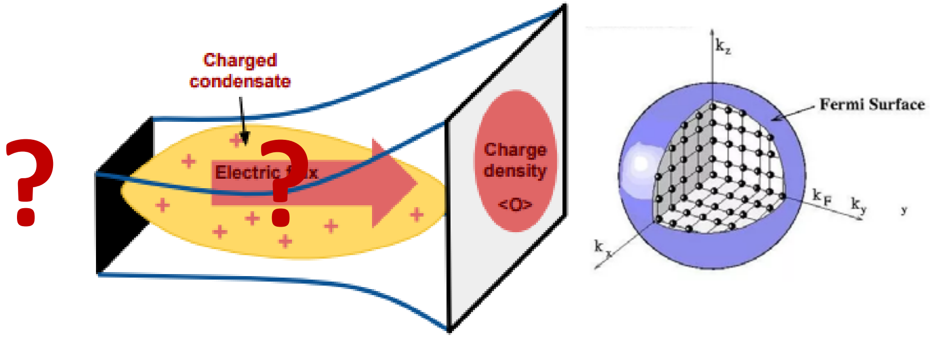

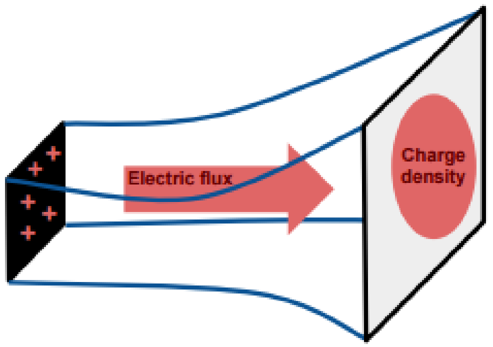

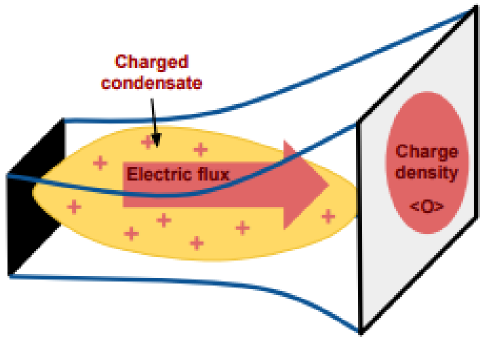

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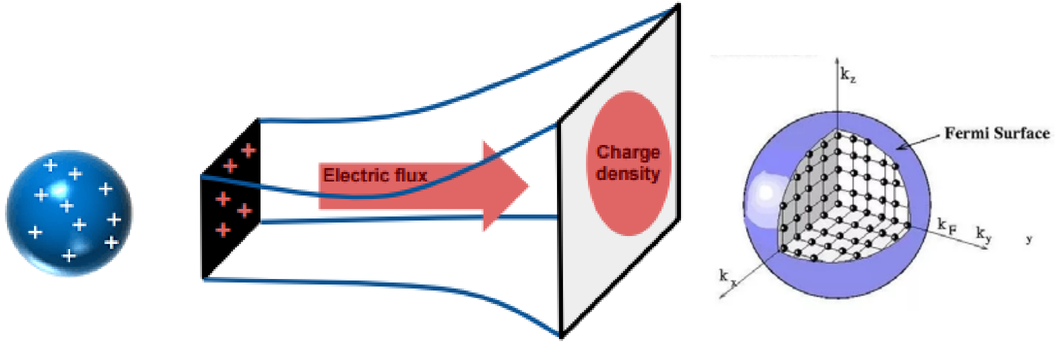
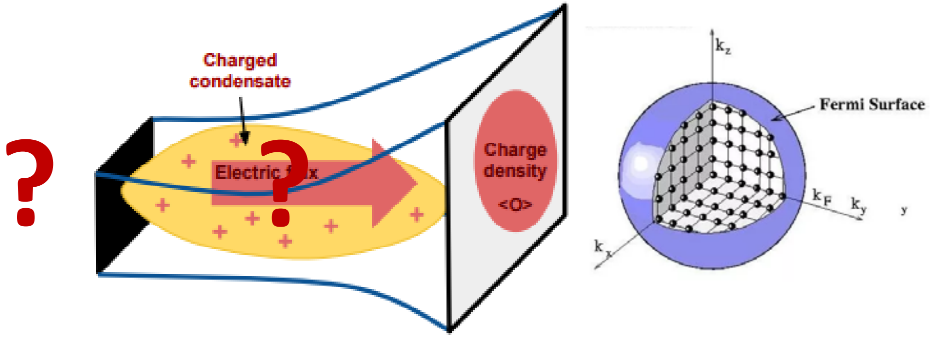




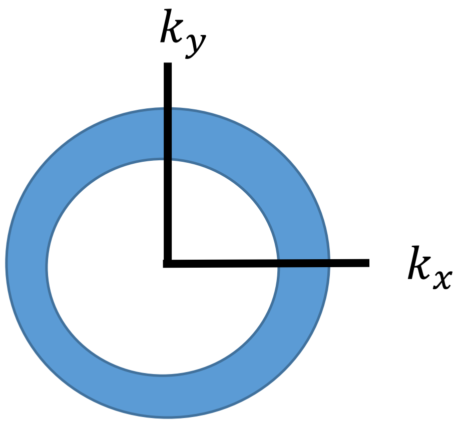
1) How should we interpret low energy spectral weight that exists independently of charge?

2) What other degrees of freedom could this weight represent?

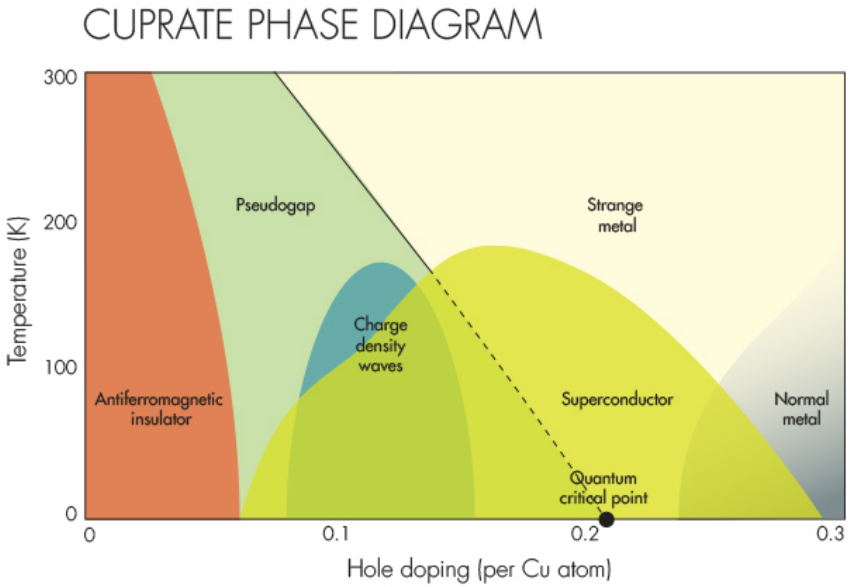
3) To what extent do bulk charge distribution properties represent those of the boundary charge?

Longitudinal Channel

Fermi Shell



Finite k instability



$$S = \int d^4x\sqrt{-g}\left[R - \frac{1}{2}\partial\phi^2 - \frac{1}{4}Z(\phi)F^2 - \frac{1}{2}Y(\phi)\sum_i \partial\psi_i^2 - V(\phi)\right]$$

$$\psi_i = m x_i$$