MAP-fis Essay Proposal, 2013-2014

Supervisor

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Title

Polarized AdS Black Holes

Area

(*Materials, Optics, Condensed Theory, High Energy Theory,....*);

High Energy Theory

Summary of Proposal

The gauge/gravity duality has opened many new venues in the study of strongly correlated systems, through the dual gravitational description. For example, phenomena such as the confining/deconfining phase transition in QCD like gauge theories can now be described in terms of a dual quantum gravity phase transition known as the Hawking-Page phase transition, which is accessible in the semi-classical approximation. Other examples include gravitational systems whose dynamics resembles important Condensed Matter systems, like superconductors or non-Fermi liquids.

In this essay we propose the study of a 2+1 dimensional CFT on a spatial 2-sphere in the presence of an inhomogeneous chemical potential. From the Condensed Matter point of view, we can think that the chemical potential is the electrostatic potential tunable by the experimentalist. From the dual gravitational perspective, the minimal ingredients to describe a CFT with a conserved current are the bulk metric and a gauge field. Thus, we are led to the study of Einstein-Maxwell theory with a negative cosmological constant.

This system is expected to have a rich phase diagram as we vary the temperature and the multipoles of the chemical potential on the 2-sphere. The various phases correspond to AdS space with electric flux, one polarized black hole in AdS and even disconnected black holes held in equilibrium by the electric field. The student should search for these geometries using numerical methods to solve the relevant PDEs. In particular, spectral methods to discretize the Einstein-de Turck form of the equations of motion are very useful.

(*continue if necessary*)

References

(*to allow students first look at topic*)

S. A. Hartnoll, "Lectures on holographic methods for condensed matter physics", Class. Quant. Grav. 26 (2009) 224002 [arXiv:0903.3246 [hep-th]].

J. McGreevy, "Holographic duality with a view toward many-body physics", Adv. High Energy Phys. 2010 (2010) 723105 [arXiv:0909.0518 [hep-th]].

T. Wiseman, "Numerical construction of static and stationary black holes", arXiv:1107.5513 [gr-qc].