PhD third year report

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During last year, my research activity focused mainly on two subjects: the application of Conformal Perturbation Theory on an energy-trapped Ising model and the study of thermo-electric transport coefficients using different approaches.

For what concerns the first part, in collaboration with A. Amoretti, G. Costagliola and N. Magnoli, I published the paper:

- "Energy trapped Ising model", DOI: 10.1103/PhysRevD.102.036018

In this work, we have studied an Ising model perturbed by a trapping potential coupled to the energy operator in 3 dimensions. The presence of this trapping potential can be effectively seen as a perturbation of the system by a non-uniform thermal gradient, i.e. a thermal trap. Then, using the analytical methods developed in the framework of Conformal Perturbation Theory we have determined the behavior of the 2-point functions out of criticality. The analytic results have been matched against Monte Carlo simulations, from where we have been able to extract the values of the Wilson coefficients, finding a good agreement with the values obtained in literature.

The second part of my research activity was dedicated to Holography and relativistic hydrodynamics. In particular, in collaboration with A. Amoretti, D. Brattan and N. Magnoli, I published the paper:

- "Magneto-thermal transport implies an incoherent Hall conductivity", DOI: 10.1007/JHEP08(2020)097

In the earliest formulations of (2+1)-dimensional relativistic magnetohydrodynamics the entire set of physically relevant conductivities, electric, thermoelectric and thermal, were given in terms of a single incoherent longitudinal conductivity σ_0. Nevertheless, this theory lead to a mismatch with the DC values of the thermal coefficients predicted by holography.

In this work, we have provided a more appropriate hydrodynamic theory containing two non-trivial incoherent transport coefficients. Then we have tested our results on a simple example of the $(3 + 1)$-dimensional dyonic black hole, finding a good agreement with our hydrodynamic results.

In another work (in progress) we tried to generalize the same discussion to a system with Goldstone bosons in the presence of an external magnetic field. Such a system can be used to describe Charge Density Waves, which arise (for example in superconductors) when the translational symmetry of the fluid of electrons is broken. Since electrons in CDW are usually strongly coupled, the Gauge/Gravity duality could offer a good solution to investigate the strong coupling regime, by considering a classical theory of gravity in one dimension more, that is usually easier to treat.