Geometric aspects of thermodynamics and transport in strongly correlated matter

D.V.Khveshchenko

UNC-Chapel Hill

Recently, a significant progress has been made towards a reformulation of the general theory of, both, equilibrium transport and non-equilibrium 'quench' phenomena that appears to be particularly well suited for describing strongly correlated many-body systems governed by inelastic scattering between their constituents. Specifically, such analyses seek to establish novel and often unexpected relations between the otherwise independent thermodynamic and transport coefficients, alongside their universal bounds, which predictions can be amenable to a direct experimental verification. The corresponding mathematical framework which is often referred to as 'holographic' exposes the intrinsically geometric nature of certain physical observables as well as their formal similarities with the various gravitational and hydrodynamic phenomena. In this talk, we ascertain the underlying origin of such emergent 'geometrization' of the various aspects of many-body dynamics, alongside its resemblance to and differences from the popular naive adaptations of the 'bona fide' string-theoretical holography. In the latter, the corresponding techniques have been opportunistically applied at the 'ad hoc' level to a large variety of condensed matter systems, such as 'strange' Fermi and Bose metals describing quantum-critical spin liquids, itinerant (anti)ferromagnets, quantum nematics, multi-channel Kondo problem, Mott transitions, Hall effect, graphene and other Dirac/Weyl fermion systems, etc. A recent flurry of such applications resulted in a number of rather tantalizing predictions whose status, however, remains largely undetermined. Indeed, the systems in question are generically neither conformally, nor Lorentz (or even translationally and/or rotationally) invariant and lack any supersymmetry or even an ordinary gauge symmetry with respect to some (let alone, large) rank non-abelian group, thus making questionable any overly straightforward extensions of the string-theoretical holography. To that end, we systematically review the body of the earlier work, focusing on those situations where some of the holographic predictions might indeed turn out to be right (albeit, for a potentially wrong reason).

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