THEORETICAL PHYSICS SEMINAR

Title: Are there quantum limits to transport in quantum many-body systems?

Speaker: Dr. Nandan Pakhira, School of Mathematics & Physics, The University of Queensland

Date/Time/Venue: 28th April (Thursday)/4:00 PM/ Room No. 469

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Tea will be served at 3:30pm outside Room 469

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ABSTRACT

Good metals like copper and gold are characterised by diffusive transport of coherent quasi-particle states. The electrical resistivity (ρ)which characterises charge transport in these materials is well within the Mott-Ioffe-Regel (MIR) limit, ha/e2(where a is the lattice constant) i. e. (ρ << milli-Ω cm). Also the shear viscosity (η) which characterises momentum transport is also bounded, i. e., η << nħ/5(where n is the density of electrons) in the quasi-particle regime of transport. But in a wide range of strongly correlated materials and most notably in the strange metal regime of doped cuprates (high-Tc superconductors) the resistivity exceeds the MIR limit and the picture of coherent quasi-particle based transport breaks down.

Recently, a holographic duality (AdS/CFT correspondence) based approach in string theory led to a proposed universal lower bound η/s ≥ħ/4π kB for the ratio between the shear viscosity (η) and the entropy density (s). This bound is found to be valid in a wide class of classical fluids like water and quantum fluids including the quark-gluon plasma in the Relativistic Heavy Ion Collider (RHIC) and cold atomic fermionic gases in the unitary limit of scattering. Also, loosely motivated by holographic duality, and inspired by the quantum bound to η/s Hartnoll proposed a lower bound to the charge diffusion constant D ≥ ħvF2/kB T the incoherent regime of transport [2], where vF is the Fermi velocity and T the temperature.

Using dynamical mean field theory (DMFT) we calculate the diffusion constant and shear viscosity in the single band Hubbard model. We explore possible violation of Hartnoll's proposed bound [3] and possible existence of quantum bounds in the shear viscosity (η) entropy density (s) ratio in the incoherent regime of transport [4].

All are welcome to attend