Hydrodynamic Electron Transport in Ultra-High Mobility Corbino Rings

Sujatha Vijayakrishnan[1], Z. Berkson-Korenberg[1], J. Mainville [1], L.W. Engel[2], M. P. Lilly[3], T. Szkopek[4], K. W. West[5], L. N. Pfeiffer[5] & G. Gervais[1]

[1]*Department of Physics, McGill University, Montréal, Canada, QC H3A 2T8*

[2]*National High Magnetic Field Laboratory, Tallahassee, USA, FL 32310*

[3]*Center for Integrated Nanotechnologies, Sandia National Laboratories, Albuquerque, USA, NM 87123*

[4]*Department of Electrical and Computer Engineering, McGill University, Montréal, Canada, QC H3A 0E9*

[5]*Department of Electrical Engineering, Princeton University, Princeton, USA, NJ 08544*

sujatha.vkrishnan@mail.mcgill.ca

In the field of condensed matter physics, there has been a recent surge of interest of Hydrodynamic transport in Fermi liquids. This intriguing phenomenon, which associates the transport behavior of electrons to that of the collective flow in fluids, was theoretically proposed by R. N Gurzhi in 1963 [1] and has gained renewed interest in recent years due to the possibility of measuring a quantized dissipation-less viscosity. To observe hydrodynamic transport, the electron-electron (e-e) interactions (momentum conserving) must dominate all possible momentum-relaxing (MR) scattering, such as scattering due to impurities. The ultra-high mobility achieved in GaAs/Al-GaAs two-dimensional electron gas (2DEG) with large MR scattering length makes it a promising candidate [2].

In this study, we conducted local and nonlocal electronic transport measurements near absolute zero temperature in ultra-high mobility 2DEG samples formed in the Corbino geometry (See Fig.1.A). We found clear signatures of hydrodynamic transport [3,4] below 1 K (See Fig.1.B), strongly suggesting the formation of an electronic continuum. Considerations based on relevant lengthscale conditions, as well as a numerical simulation of the Navier-Stokes equations for the nonlocal electrostatic potential, reinforce our conclusions of hydrodynamic electron flow. In this talk, we will present both local and nonlocal electronic transport measurements, as well as a detailed picture of electron hydrodynamics based on our numerical simulation results.

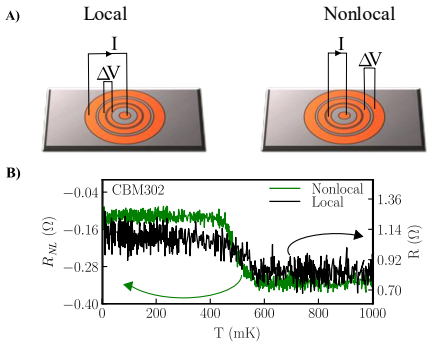

Fig.1: Panel A shows local and nonlocal measurement configurations. The resistance decrease at 500 mK in panel B for device CBM302 indicates the onset of hydrodynamic transport.

References

[1] R. N. Gurzhi, Sov. Phys. JETP **17**, 521(1963).

[2] Seongjin Ahn and Sankar Das Sarma, Phys. Rev. B **106**, L081303 (2022).

[3] Sujatha Vijayakrishnan, F. Poitevin, Oulin Yu, Z. Berkson-Korenberg, M. Petrescu, M. P. Lilly, T. Szkopek, Kartiek Agarwal, K. W. West, L. N. Pfeiffer and G. Gervais, Nat. Commun. **14**, 3906 (2023).

[4] Sujatha Vijayakrishnan, Z. Berkson-Korenberg, J. Mainville , L.W. Engel, M. P. Lilly, T. Szkopek, K. W. West, L. N. Pfeiffer and G. Gervais, to be submitted.