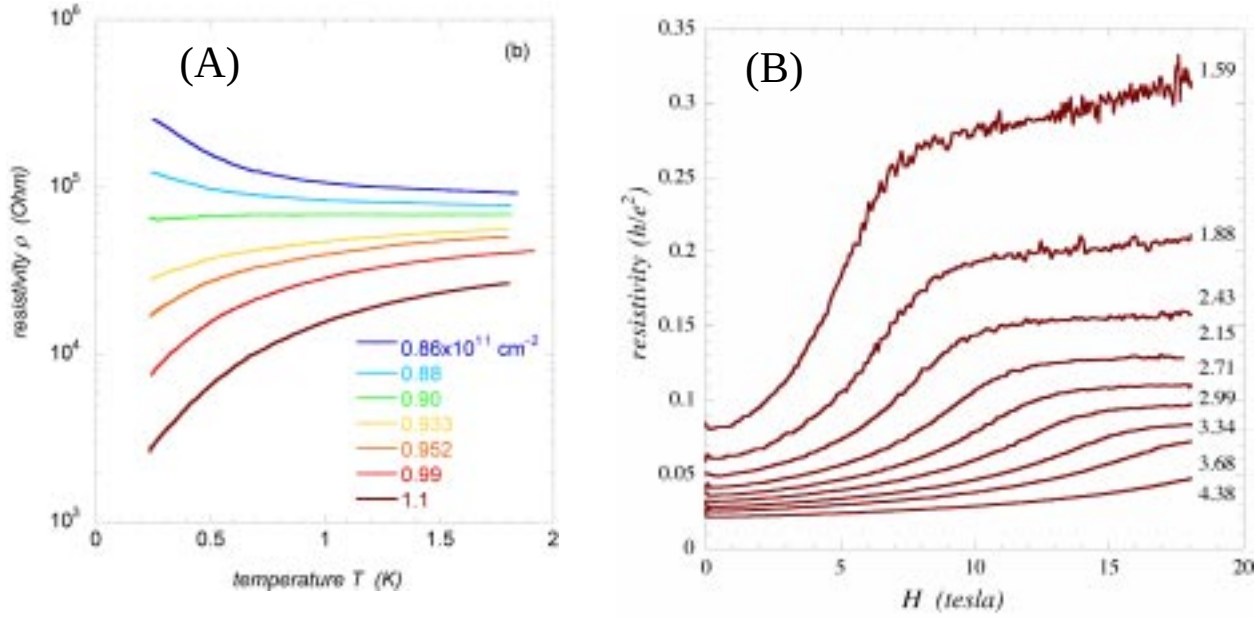

Figure 1: For a high-mobility silicon MOSFET: (A) the resistivity as a function of temperature; (B) the resistivity as a function of in-plane magnetic field.

STRONGLY INTERACTING ELECTRONS in TWO DIMENSIONS, or What Happens on the Way from a Fermi Liquid to a Wigner Crystal (Wigner Glass)?

An apparent transition with decreasing electron density from metallic to insulating behavior has now been observed in many different two dimensional electron (hole) systems in the absence of magnetic field. Shown in Fig. 1(A) below is the resistivity of a high mobility silicon MOSFET as a function of temperature: the behavior is insulating (metallic) for densities below (above) $\approx 0.9 \times 10^{11}$ cm^{-2}. Similar, albeit weaker, effects have been observed in GaAs, AlAs, SiGe, etc, at low densities where electron-electron interaction energies are much larger than the Fermi energy.

The in-plane magnetoresistance, shown in Fig. 1(B), rises sharply and saturates to a roughly constant value above a field B_{sat}. In silicon inversion layers, B_{sat} (the knee of the curve) signals full spin polarization (this has been shown at high densities only). The metallic temperature dependence is suppressed, or quenched, at fields above B_{sat}.

It was shown in the 1970s, and further documented more recently, that the product g^*m^* grows rapidly as the electron density is reduced (there is now strong debate whether it actually diverges at n_c). The most recent experiments indicate that it is the effective mass m^* that becomes large (diverges?) while g remains essentially constant.

How does one account for these observations? Many contend that the metallic behavior can be explained within Fermi liquid theory. Others suggest new phases ferromagnetism, mixed Fermi liquid/Wigner glass, superconductivity, others. A Wigner crystal, or more likely a glass, is anticipated at sufficiently low densities.

Is there a metallic phase in 2D? Will localization reemerge at sufficiently low temperatures? Are there unexpected phases at low temperatures and low densities? How does 2D physics in zero field connect with 2D physics in a magnetic field?