# Pinning and melting of a quantum Wigner crystal

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MagLab users sought an unambiguous demonstration of the transition within a two-dimensional electron system at ultra-low temperatures to an electronic solid state known as the Wigner crystal in which coulomb interactions cause the electrons to form a triangular lattice. Researchers measured the differential electrical resistivity, dV/dI, in low carrier density ($n = 4 \times 10^{-10}$ cm$^{-2}$) and high mobility ($3 \times 10^{6}$ cm$^2$/Vs) electronic systems in GaAs quantum wells. Electrons were were cooled to 9mK and a perpendicular magnetic field was applied to quench the kinetic energy, thus enabling coulomb interactions to dominate in this regime of high B/T.

The measurements revealed a striking threshold behavior for T ≲ 35 mK that evidences the formation of the Wigner crystal. The crystal is pinned (i.e. resistance > 1 GΩ) by disorder only at extremely low currents with magnitude < 5 pA. At currents just above the pinning threshold, the resistance plummets by more than an order of magnitude. The pinning is also destroyed by heating, consistent with the thermal melting of the Wigner crystal.

The temperature dependence was found to be non-activated and piecewise, implying the existence of a pinned Wigner crystal that appears to undergo a two-stage first-order transition upon heating.

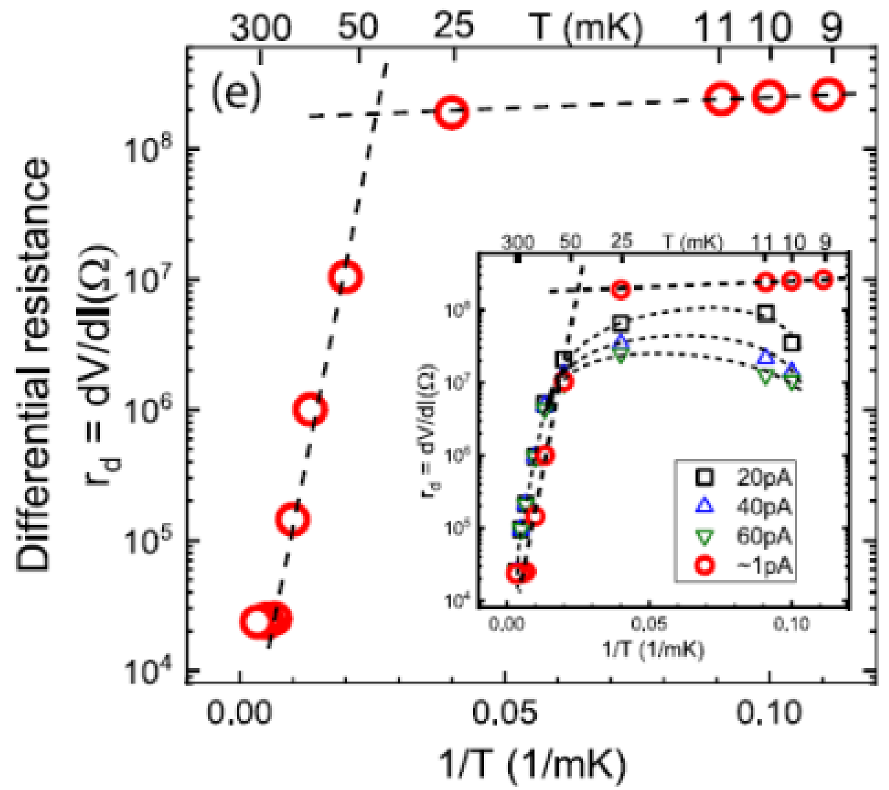


Figure: Temperature dependence of the differential resisitivity, *dV/dI*, in the limit of *V* → 0, plotted on a semilogarithmic scale. Inset: comparison of the differential resistivity obtained with higher current drives.

**Facility used:** Nuclear demagnetization at the NHMFL High B/T Facility

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