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Conductance instabilities in a quasi-1D quantum wire

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Recent theoretical work shows the possibility of forming a Wigner lattice in quasi one-dimensional (1D) quantum wires with low densities when the interaction among the electrons is strong [1]. This happens due to the fact that potential energy dominates the kinetic energy at low densities [1]. A quasi-1D wire is realised by electrostatically confining a two-dimensional electron gas (2DEG) between a pair of surface split-gates. Such ballistic 1D wires exhibit quantised conductance in units of $2e^2/h$. Transport measurement in 1D wires have largely been conducted, and understood, in the regime where electrons are strongly confined. For weak confinement strengths, as the density increases the Coulomb repulsion between electrons increases until it overcomes the confinement potential, whereupon the ground state distorts, which can lead to the bifurcation of the electronic system [2,3].

We present transport measurements of weakly confined quantum wires defined in a 2DEG by top-gated split-gate devices. In the previous work, weakening the confinement potential led to the formation of two rows, marked by a jump in conductance from zero to $4e^2/h$. We have investigated this regime of weaker confinement in great detail and observed intermediate jumps in quantised conductance from $2e^2/h$ to $6e^2/h$ and $4e^2/h$ to $8e^2/h$. Differential conductance and greyscale plots indicate the adjacent subband trajectories approach each other and there is anti-crossing or locking of the subbands. These observations may be an indication that multiple rows could also be formed in weakly confined wires. Such instabilities in 1D conductance in particular at low concentration give further insight in understanding Wigner lattice formation in quasi-1D wires.

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