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Direct observation of spin-charge separation and interaction effects in GaAs quantum wires by momentum-conserved tunneling[1]

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Coulomb interactions have been predicted to have a profound effect on the behaviour of electrons in one dimension. We have fabricated a 1D system in which we observe spin-charge separation in momentum-conserved tunneling from an array of 1D wires into a 2D electron gas, and also a power-law suppression of tunneling into the wires. These are as predicted for a Tomonaga-Luttinger Liquid (TLL), the simplest analytic model of an interacting 1D system. The use of an array of wires averages out impurity effects and allows the lowest 1D subband to be probed with precise control of electron density. We observe spin-charge separation in the dispersion relation of the 1D wires, mapped by varying the in-plane magnetic field and the dc-bias [1]. We find that the separation persists beyond the regime of the TLL approximation. Furthermore, the measured 1D-2D tunneling current is suppressed at zero dc bias in the presence of a magnetic field, confirming that interactions are important in the 1D wires. This suppression has been measured as a function of temperature and source-drain voltage. These both have similar power-law dependences, as predicted by the TLL model. [1]. Y. Jompol et al., Science 325, 597 (2009).

[1]Work done in collaboration with Y. Jompol, J.P. Griffiths, I. Farrer, G.A.C. Jones, D. Anderson, and D.A. Ritchie (University of Cambridge), and T.W. Silk and A.J. Schofield (University of Birmingham, UK). Supported by the UK EPSRC.
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