Luttinger liquid behavior of long GaAs quantum wires

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For sufficiently *weak disorder*, it is known that the conductance of a 1D quantum wire (QW) is very close to the universal value $2e^2/h$, with a small (negative) correction which depends on the temperature in a power-law manner. For systems containing *stronger disorder*, the temperature dependence of the conductance is expected to be much stronger. Theories concerning *weak link* (single strong barrier) [1–4] or *stronger disorder* due to many impurities [5, 6] (Anderson localization) predict different temperature dependences. The fact that no experimental work was done in order to verify which of the two physical mechanisms will be the dominant, serves as the motivation for a careful experimental study.

We present an experimental study of the temperature dependence of the conductance of sufficiently long V-groove QWs. We produced such long QWs in GaAs/AlGaAs heterostructures, which were grown on prefabricated V-groove substrates, see Fig. 1(a). We measured the conductance of a single occupied subband in the wire at low temperatures (down to 200 mK), and observed a decrease of the conductance value as the system is cooled, Fig. 1(b). Our results specifically indicate that the temperature dependence of the conductance is consistent with theories developed within the framework of the Luttinger liquid model involving a single barrier. This new result is observed for all measured QWs.

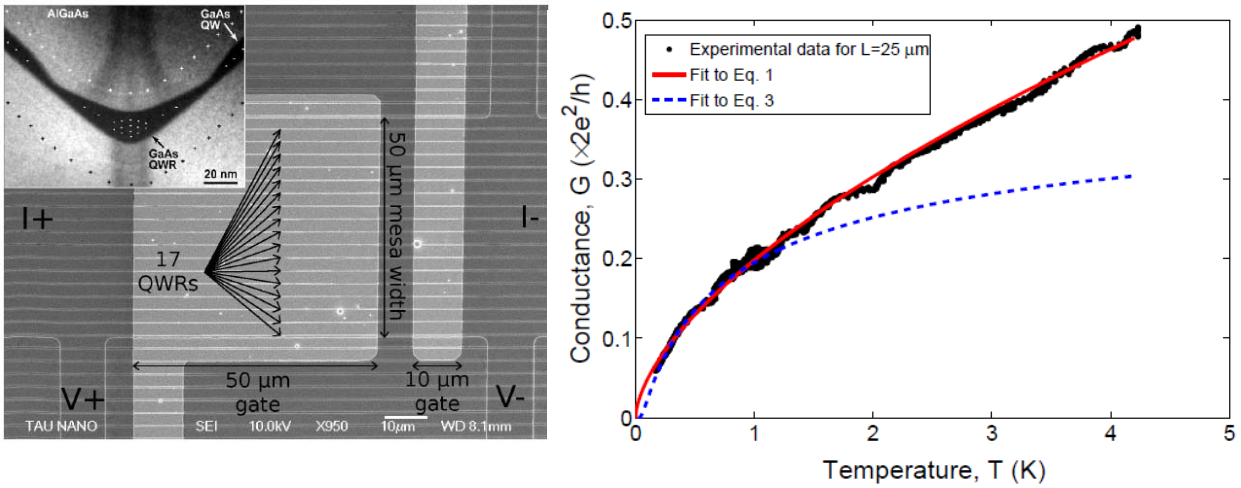

Fig. 1. (a) sample with 17 QWs, and (b) conductance variation *vs.* temperature (theory and experiment).

1. C. L. Kane and M. P. A. Fisher, *Phys. Rev. B* **46**, 15233(1992); C. L. Kane and M. P. A. Fisher, *Phys. Rev. Lett.* **68**, 1220 (1992).
2. M. Ogata and H. Fukuyama, *Phys. Rev. Lett.* **73**, 468 (1994).
3. D. L. Maslov, *Phys. Rev. B* **52**, R14368 (1995).
4. Y. Oreg and A. M. Finkel'stein, *Phys. Rev. B* **54**, R14265 (1996).
5. I. V. Gornyi, A. D. Mirlin, and D. G. Polyakov, *Phys. Rev. Lett.* **95**, 206603 (2005); I. V. Gornyi, A. D. Mirlin, and D. G. Polyakov, *Phys. Rev. B* **75**, 085421 (2007).
6. P. Fendley, A. W. W. Ludwig, and H. Saleur, *Phys. Rev. B* **52**, 8934 (1995).