Tomonaga-Luttinger physics in electronic quantum circuits

F. D. Parmentier[1], S. Jezouin[1], M. Albert[2], A. Anthore[1], U. Gennser[1], A. Cavanna[1], I. Safi[2], and F. Pierre[1]

[1]*CNRS / Univ Paris Diderot (Sorbonne Paris Cité), Laboratoire de Photonique et de Nanostructures, Marcoussis, France*
[2]*CNRS / Univ Paris Sud, Laboratoire de Physique des Solides, Orsay, France*

In one-dimensional conductors, electron-electron interactions result in correlated electronic systems markedly different from conventional Fermi liquids. At low energy, a hallmark signature of the so-called Tomonaga-Luttinger liquids (TLL) is the universal conductance scaling curve in presence of an impurity. A seemingly different problem is that of the quantum laws of electricity when distinct quantum conductors are assembled in a circuit. In particular, the conductance across a quantum conductor embedded in a dissipative circuit is suppressed at low energy, a phenomenon called dynamical Coulomb blockade (DCB).

Here, we present an experimental investigation of the DCB on a single-channel quantum conductor realized by a quantum point contact in a two-dimension electron gas, and demonstrate a proposed link to TLL physics [1].

A remarkable feature in the data implies a phenomenological expression for the conductance of a single-channel quantum conductor embedded in an arbitrary linear circuit [2]. Its validity is further established experimentally using a wide range of circuits, including data obtained with a carbon nanotube at Duke University [3].

In the particular case of a pure resistance in series with the single-channel conductor, theory predicts a mapping between DCB and the transport across a TLL with an impurity [4]. By confronting both the data and the phenomenological expression with the TLL universal conductance scaling curve, we demonstrate experimentally this mapping.

The powerful TLL framework advances our understanding of the laws governing quantum transport with distinct quantum components. Reciprocally, the demonstrated mapping provides a new test-bed for TLL predictions.

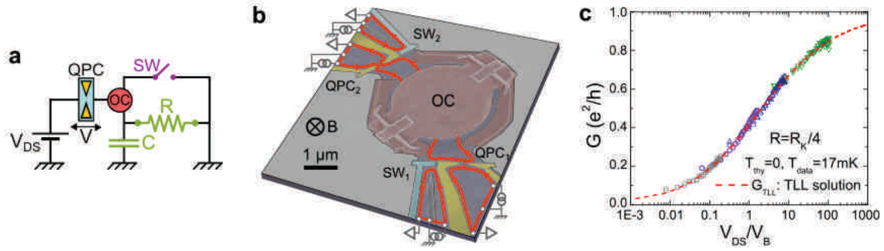

Fig. 1: **a**, Schematics of the samples. **b**, Sample micrograph. **c**, Comparison between experimental data and the TLL universal conductance curve.

[1] S. Jezouin *et al.,* arXiv:1301.4159 (2013).
[2] F.D. Parmentier *et al.,* Nature Physics **7,** 935-938 (2011).
[3] H. T. Mebrahtu *et al.,* Nature **488,** 61 (2012).
[4] I. Safi and H. Saleur, Phys . Rev. Lett. **93,** 126602 (2004)