Tomonaga-Luttinger physics in electronic quantum circuits

A. Anthore, S. Jezouin, F.D. Parmentier, M. Albert, U. Gennser, A. Cavanna, I. Safi & F. Pierre

CNRS / Univ Paris Diderot, Laboratoire de Photonique et de Nanostructures, 91460 Marcoussis, France

CNRS / Univ Paris Sud, Laboratoire de Physique des Solides, 91405 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 predicted 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, in violation of classical impedances composition, the conductance across a quantum conductor embedded in a dissipative circuit is suppressed at low energy, a phenomenon called dynamical Coulomb blockade (DCB).

In this talk, I will present an experimental investigation of the DCB on a single-channel quantum conductor, and will 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 R in series with the single-channel conductor, theory predicts a mapping between DCB and the transport across a TLL of interaction coefficient $1/(1+Re^2/h)$ with an impurity[4]. By confronting both the data and the phenomenological expression with the TLL universal conductance scaling curve, we verify experimentally this mapping.

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

[1] S. Jezouin *et al.*, arXiv:1301.4159
[2] FD 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)