Transport in quantum wires: inhomogeneities, correlations, and future nano-electronics

In quasi one-dimensional quantum wires electron correlations strongly influence the low-energy physics. The interplay of correlations and local inhomogeneities leads to a variety of surprising effects if the transport through networks of such wires is studied. Mainly based on single-walled carbon nanotubes different types of junctions have recently been realized experimentally. They might form the basis of future nano-electronic devices.

In the simplified case of a single localized impurity in an otherwise perfect wire "universality" leads to one-parameter scaling of the conductance. Even for a weak impurity the conductance vanishes on low energy scales. For more complex models "universality" becomes less important and theoretical studies require a method that in addition can keep track of microscopic details. Investigating systems of increasing complexity (quantum dots, junctions of several wires, systems with contacts) I exemplify that the functional renormalization group technique is a promising tool to obtain results for models which are closer to the experimental situation. In addition, I discuss surprising results such as the correlation induced restoration of time-reversal symmetry of the conductance for a junction that is pierced by a magnetic flux.