ELECTRONIC TRANSPORT THROUGH QUANTUM POINT CONTACTS

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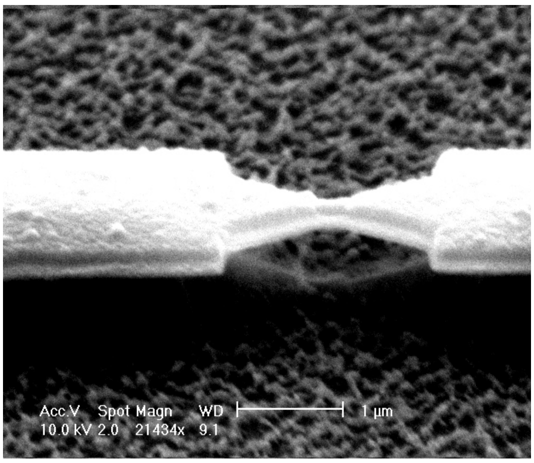
From classical physics we know that making a wire thinner and thinner decreases its conductance proportionally to its cross-section. However, when the diameter gets into the order of the electron Fermi wavelength or a constriction in a conductor becomes even a few or only one atom wide, quantum effects have to be taken into account. The behaviour of quantum point contacts (QPCs) is a subject of so-called mesoscopic physics, because while the central region of the contact may consist of only one or a few atoms, it is necessarily embedded in an electronic circuit structure with macroscopic leads.

When a so-called mechanically controllable break junction (MCBJ) is torn apart and thus thinned, the conductance is seen to change stepwise. The "quantization", however, differs from that in dimension-reduced electron gases. How to realize single-atom contacts by the MCBJ technique will be explained in the talk. There are alternative methods to produce QPCs by lithography or indentation of an STM tip. A lot of transport measurements require low temperatures in order to avoid contamination of the contact, to suppress thermal excitations obscuring quantization effects or to study samples in the superconducting state.

From the theoretical side, on the one hand, the importance of quantum effects forbids a classical charge-particle description, on the other hand, the size of the whole structure renders *ab initio* quantum-mechanical calculations very laborious. The electronic transport properties of QPCs can nevertheless be understood and modelled in a transport channel picture. The number of transport channels and their individual transmissions can be extracted from experiments by fitting IV curves taken in the superconducting state, which exhibit enough non-linearities due to multiple Andreev reflections. These quantum-coherent higher order processes become of importance in QPCs in contrast to macroscopic conductors or tunnel junctions.



Electron microscope image of aluminium break junction.

[1] N. Agrait *et al.*, Physics Reports **377** (2003) 81.
[2] E. Scheer *et al.*, Nature **394** (1998) 154.
[3] J. C. Cuevas *et al.*, Phys. Rev. B **54** (1996) 7366.