Quantum Interference Effects in the Non-equilibrium Transport of Mesoscopic Wires

Abstract

In this work the transport properties of short metallic wires (dimensions approx. $200 \times 80 \times 20$ nm^3) at low temperatures are examined as a function of magnetic field $\boldsymbol{B}$ and transport voltage U_{DC}. The metal films are fabricated by quenched condensation of the thermally evaporated raw materials (Au, Ag, Cu or an Au-Cu-alloy) on a cold substrate ($T \sim 10\,\mathrm{K}$).

The conductance fluctuations of these mesoscopic systems, $\delta G(\boldsymbol{B}, U_{\mathrm{DC}})$, which arise from quantum interference effects, show non-universal characteristics, which can be quantified by a careful analysis of the measured data.

In particular the evaluation of the magnetoconductance measurements reveals an unexpected rapid dropping of the fluctuation amplitude for small U_{DC}. Associated with this is an overall reduction of the correlation field $\boldsymbol{B}_{\mathrm{c}}$. With some samples, one observes that $\boldsymbol{B}_{\mathrm{c}}$ passes through a maximum. At higher voltages the amplitude usually increases, as expected theoretically. A consistent representation of the results is achieved, if the Thouless voltage of the respective sample is used for normalization.

Especially the behavior of the correlation field, together with the frequently unorthodox form of the autocorrelation function, questions the commonly accepted geometrical relation between the phase-coherence length and $\boldsymbol{B}_{\mathrm{c}}$.