

Quantum transport and electronic interferences at mesoscopic scales

Part I (R. Deblock)

Introduction: from classical to quantum transport

Conductivity and relaxation time, classical diffusion
Elastic collisions and microscopic static disorder potential
Inelastic collisions (example: electron-phonon interaction)
Spin-Orbit interaction
Phase coherence length

Conductance of a quantum coherent wire between two reservoirs : Landauer formalism

Case of a 1D wire: conductance quantum, Büttiker-Landauer formulas
Beyond 1D: conductance quantization, localization
Multi terminal measurements

Phase coherence and electronic interferences in transport

Aharonov-Bohm effect
Conductance Fluctuations and quantum interferences
Weak-Localisation
Ensemble averaged Aharonov Bohm oscillations, Sharvin and Sharvin experiment

Electronic Transport in the presence of Spin-Orbit interaction

1D case : opening of Spin-Orbit gap
2D case : Spin Hall effect
Modification of weak localization
Quantum spin Hall effect

Persistent currents and orbital magnetism of an isolated mesoscopic ring.

1D Aharonov Bohm ring : persistent current in a ballistic 1D ring, effect of disorder
Beyond 1D: diffusive regime, sign of persistent currents and ensemble average
Experiments

Part II (G. Feve)

I. Electron interferences in one-dimensional conductors

1D ballistic conductors: edge channels of the quantum Hall effect, carbon nanotubes
Electronic coherence and electronic interferometers

II. Current correlations and noise measurements

Introduction to noise measurements
Equilibrium noise and shot noise
Electronic coherence and noise measurements

III. Introduction to time dependent transport

Floquet scattering formalism: example of the charge relaxation of a quantum capacitor
Single electron sources
Electronic coherence of a.c. sources, Wigner representation and measurement

IV. Coulomb interaction and electronic decoherence in quantum Hall edge channels

Bosonic approach to electronic transport
Coulomb interaction and a.c. transport
Coulomb interaction and electronic decoherence

Bibliography

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