Charged probe conductance mapping for quantum Hall interferometers

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In the integer quantum Hall regime transport properties of two dimensional systems are determined by currents carried by edge channels. At high magnetic field each edge carries the current in one direction only and the backscattering may occur only when counter-propagating edge channels are approached to allow for the electron inter-edge tunneling. In perturbed systems the edge states may loop surrounding potential hills or wells additionally inducing the backscattering of electron waves. Due to the very large coherence length in quantum Hall regime circulating currents and backscattered waves may be used for formation of electron interferometers that are sensitive to the Aharonov-Bohm phase shifts.

We report on simulations of the scanning gate microscopy of the quantum point contact (QPC) in the integer quantum Hall regime. We consider a fully coherent transport within the single electron approximation of the Schrödinger equation and evaluate the conductance (G) and its changes induced by the scanning gate using a finite difference method and a short-range model of the effective tip potential. We study the conductance maps of the system with and without the quantum Hall island (QHI) present within the QPC constriction. We reproduce the features observed in a recent experiment [1], namely the circular form of the oscillations observed in G maps, modulation of the spacing between subsequent resonant lines by the tip approaching the QHI and the shift of resonant lines to lower values of B by repulsive potential. We discuss the role of the profile of the QHI potential on the observed effects.

[1] F. Martins, S. Faniel, B. Rosenow, H. Sellier, S. Huant, M. G. Pala, L. Desplanque, X. Wallart, V. Bayot, and B. Hackens, Nature Scientific Reports **3**, 1416 (2013).