
”0.7 anomaly” in the confined quantum coherent conductor controlled by high frequency oscillation voltage

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Abstract

Quantum point contacts (QPCs), which are the basic building blocks of any mesoscopic structure, display quantized conductance, reflecting the quantization of the number of transparent channels. An additional feature, named the ”0.7 anomaly”, has been observed in almost all QPCs. However, its origin is still of intensive debate in the last couple of decades. Proposed theoretical explanations have evoked spontaneous spin polarization[1], ferromagnetic spin coupling[2], the formation of a quasi-bound state leading to the Kondo effect[3], Wigner crystallisation[4] and various treatments of scattering[5]. Here we experimentally study the GHz complex admittance in the quantum coherent conductor formed in the Al-GaAs/GaAs heterostructure. Quantized conductance steps together with an extra plateau around $0.7 \cdot 2e^2/h$ are observed on both real and imaginary parts of the admittance. Especially, the evolution of this additional plateau can be clearly seen when the conducting channel is moved to either side, away from the center of the QPCs, by biasing the side gates by different ΔV_g . Finally, the 0.7 plateau disappears as the entrance and exit barrier potentials become increasingly asymmetric. Motivated by the experimental results, we consider the existence of impurities in the one-dimensional channel formed by the split gates, theoretical calculations find that this anomaly depends strongly on the impurity positions and the strength of impurity potential. Both experiment and theoretical investigations prove that the ”0.7 anomaly” is very sensitive to external electrostatic potentials and impurities. Therefore the QPC’s confining potential and existence of impurities may have to be considered for a full understanding of conductance through QPCs and related quantum devices.

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