Microscopic Origin of the 0.7-Anomaly in Quantum Point Contacts

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Quantum point contacts are elementary building blocks of numerous semiconducting nanodevices. Despite their simple structure, however, their conductance properties exhibit anomalous features, collectively known as the "0.7-anomaly", whose origin is still subject to controversial discussions. We offer a detailed microscopic explanation for the 0.7-anomaly and the zero-bias peak that typically accompanies it: the common origin of both is a smeared van Hove singularity in the local density of states at the bottom of the lowest one-dimensional subband of the point contact, which causes an anomalous enhancement in the Hartree potential barrier, magnetic spin susceptibility and inelastic scattering rate. We present theoretical calculations and experimental results that show good qualitative agreement for the dependence of the conductance on gate voltage, magnetic field, temperature, source-drain voltage (including the zero-bias peak) and interaction strength. For low energies we predict and observe Fermi-liquid behavior similar to that known for the Kondo e ffect in quantum dots. At high energies, however, the similarities between 0.7-anomaly and Kondo effect cease.