Universality of the Kondo effect in quantum dots with ferromagnetic leads

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We investigate the influence of ferromagnetic contacts on the Kondo effect in quantum dots formed in SWCNTs. As contact material we use PdNi. Transport spectroscopy shows a Kondo-like conductance anomaly around zero bias in every second Coulomb diamond. The ferromagnetic contacts cause a splitting of the Kondo resonance to finite bias values. This splitting can be compensated by a finite magnetic field. Using numerical renormalization group (NRG) techniques, we demonstrated that all salient features of the data can be quantitatively understood in terms of a simple model for the magnetic properties of the leads. The size and field dependence of the splitting as well as its dependence on gate voltage can be explained by spin-dependent renormalization processes of the quantum dot level that include two contributions. The first, largely independent of gate voltage, arises from the macroscopic magnetization of the leads. The second contribution, showing a gate dependence, stems from the spin polarization at the Fermi energy. In the presence of exchange coupling, the Kondo conductance shows a universal dependence on the tunneling induced splitting scaled by the Kondo temperature. This universality is also reproduced numerically within the framework of the applied theory.