Phonon-assisted tunneling through quantum dots coupled to magnetic leads

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Using the nonequlibrium Green-function technique we study theoretically spin-polarized transport in double barrier tunneling junctions based on a single level quantum dot interacting with a local phonon mode. Phonon emission and absorption spectra have been calculated for arbitrary Coulomb correlations on the dot and for different temperatures. It is shown that in the nonlinear response regime the electron-phonon interaction gives rise to current suppression in symmetrical junctions as well as to oscillations of the tunnel magnetoresistance (TMR). In asymmetrical junctions, the same mechanism may lead to a significant suppression of the diode-like behavior (Fig. 1).

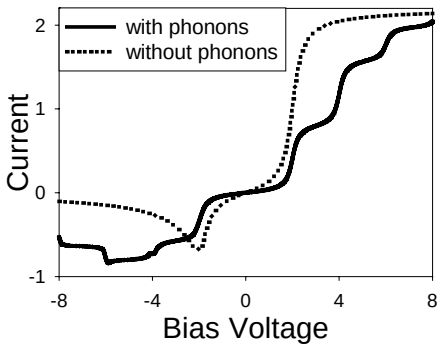

Fig. 1. Electric current *vs.* bias voltage for an asymmetrical tunneling junction with parallel configuration of the magnetic moments of the external electrodes.

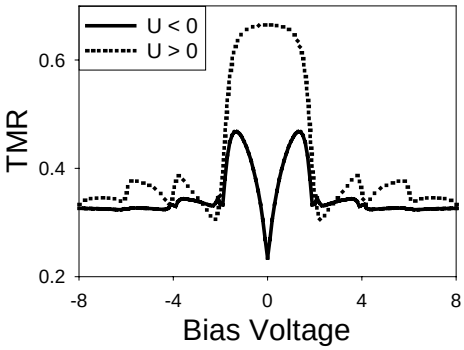

Fig. 2. TMR *vs.* bias voltage for a symmetrical tunneling junction with a positive and negative effective charging energy (U) on the dot.

We have also found that additional resonance peaks appear at sufficiently low temperatures in the linear conductance due to higher-order tunneling processes through the satellite phonon levels. The case of negative effective charging energy is also analyzed and the resulting effect of pair tunneling is studied numerically in the context of spin-polarized electron tunneling in magnetic tunnel junctions. Thus, as a result of interplay between the single-electron cotunneling and the pair-tunneling processes a minimum (Fig. 2) or even inversion of TMR at the zero bias voltage is found. The property of the current rectification in magnetic asymmetrical tunneling junctions with a negative effective charging energy is also discussed.

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