Dynamical spin reversion with spin polarized current

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Understanding the time evolution of a magnetization reversal process is crucial for the ongoing developments in logical spin structures. In our study based on a master equation approach we relate the dynamical properties of a quantum spin driven out of equilibrium to the excitation and relaxation processes involved. As a specific case our theoretical study provides inside into the dynamical switching processes between two fully spin polarized states of a Fe cluster absorbed on a Cu surface, probed with a spin polarized scanning tunneling microscope[1]. In this setup the polarized current switches the spin of the cluster between the two polarized states across an anisotropy barrier. Rates for the intermediate excitation and relaxation processes are calculated by taking into account cotunneling between the cluster and tip/surface. Excitation of the cluster arises due to inelastic spin transfer from the electron source. Fast relaxation is caused by coupling to the surface. We control the ratio between excitation and relaxation by changing the voltage between source and drain or varying the coupling of the cluster spin to the electron reservoirs. From the investigation of transient dynamics and the stationary limit, the current driven switching between the two fully spin polarized states can be expressed by a lifetime and an occupation probability. Both quantities are directly related to the in- and out-of-plane anisotropy of the cluster spin. Comparison between theory and measurement allowed us to extract the magnetic parameters unknown to the experiment. We also discuss the influence of temperature and external magnetic fields.

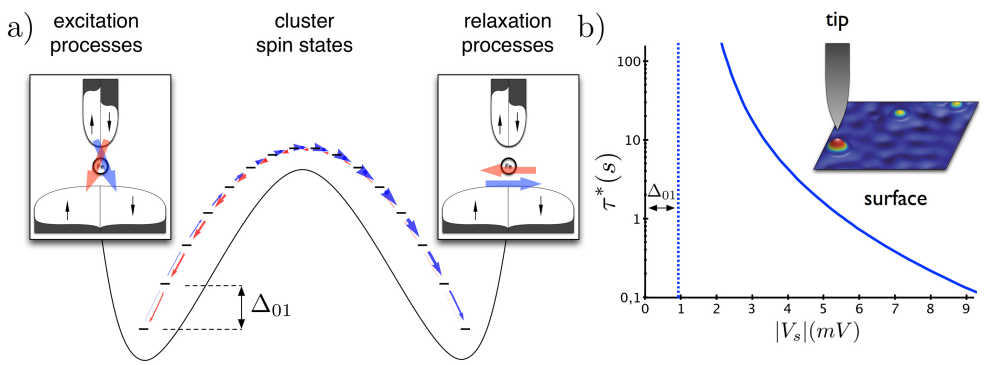

Figure 1: In a) an anisotropy potential with eigenstates of a $S = 15/2$ spin is displayed. Arrows represent the rates for excitation and relaxation processes. The mean lifetime is plotted in b) against the voltage between tip and surface in a scanning tunneling microscopy setup. Δ_{01} indicates the energy for the inelastic excitation out of the ground state.

[1] A. A. Khajetoorians, B. Baxevanis, C. Hübner, T. Schlenk, S. Krause, T. O. Wehling, S. Lounis, A. Lichtenstein, D. Pfannkuche, R. Wiesendanger, Science **339**, p. 55-59 (2013).