"Spin accumulation, current oscillations and negative differential resistance in transport through nanoparticle arrays"

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Transport through a metallic nanoparticle is governed by Coulomb blockade physics. Due to charging effects the current is suppressed up to a threshold voltage and a strongly non-linear function of bias voltage, which includes a staircase behavior under certain circumstances. When the nanoparticle is placed in between two ferromagnetic electrodes the interplay of ferromagnetism and discrete charging leads to new phenomena If the the nanoparticle is metallic and the spin relaxation time in it is long, spin accumulation in the nanoparticle appears and when the magnetic moment in the electrodes have anti-parallel orientation, but not for parallel orientation [1,2]. This effect induces magnetoresistance which oscillates with voltage.

Charging effects are strongly enhanced in nanoparticle arrays [3]. However, up to now no study has addressed the influence of ferromagnetism on the electronic transport through arrays. Here we show that spin accumulation has a very strong effect in the threshold voltage, current and magnetoresistance of metallic nanoparticle arrays placed in between ferromagnetic electrodes. Qualitative differences, compared to the case of a single islands are found. Spin accumulation appears even for parallel orientation of the electrodes' magnetic moments, and reverses its sign with the array. Consequences include I-V curves with two staircase regimes, a highly spin-polarized current, which oscillates with voltage showing negative differential resistance and a strongly non-linear magnetoresistance which depends on the array size[4].

References:

[1] J.Barnás, J.Martinek, G. Michalek,B.R. Bulka and A.Fert, at Phys.Rev.B 62,(2000) 12363
[2] J.Martinek,J.Barnas,S.MaekawaH.Schoeller and G.Shön, at Phys. Rev. B 66, (2002) 014402.
[3] E.Bascones, V. Estévez, J.A. Trinidad and A.H. MacDonald, at Phys. Rev.B 77, (2008) 245422

[4] V. Estévez,J. König and E. Bascones, in preparation.

Figures:

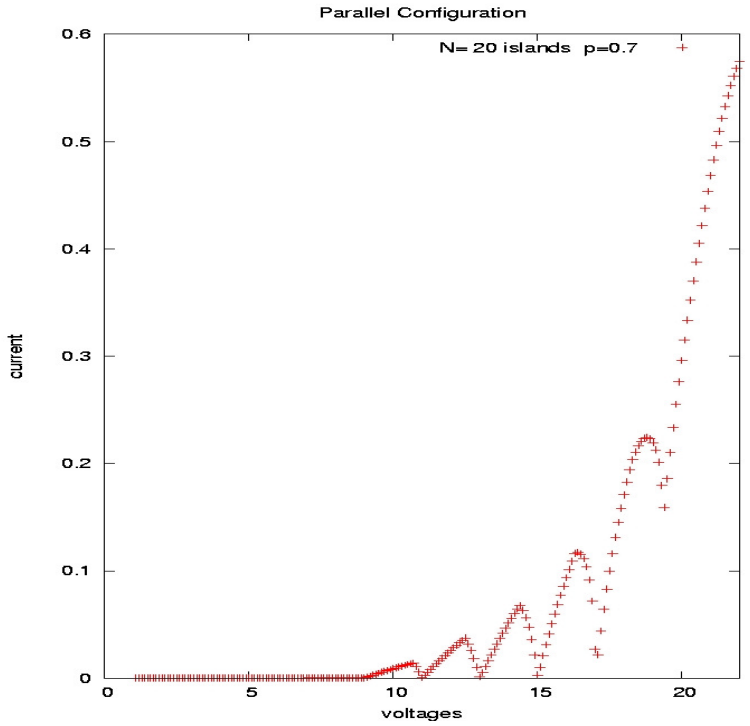

Fig.1: show I-V curve corresponding to array of 20 nanoparticles, where the degree of polarization is 0.7, and zero-temperature. Negative conductivity is seen.

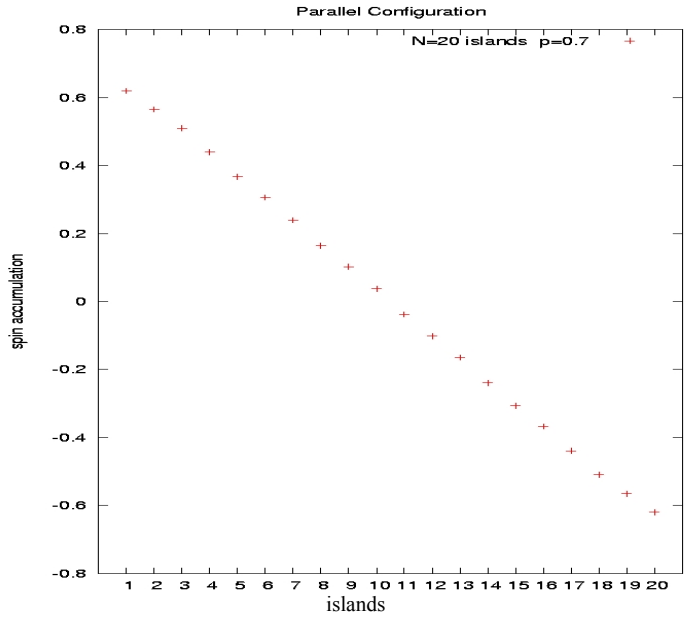

Fig. 2: spin accumulation in islands corresponding to array of 20 nanoparticle with degree of spin 0.7, zero-temperature. Shows the sign change in the accumulation of spin