EFFECT OF MAGNETIC FIELD ON SPIN BLOCKADE LIFTING OF A WEAKLY COUPLED DOUBLE QUANTUM DOT.

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Recent transport experiments in double quantum dots (DQD's) show that Pauli exclusion principle plays an important role [**?**] in current rectification. In particular, spin blockade (SB) is observed at certain regions of dc voltages, and the interplay between Coulomb and SB can be used to block the current in one direction of bias while allowing it to flow in the opposite one. Then DQD's could behave as externally controllable spin-Coulomb rectifiers with potential application in spintronics as spin memories or transistors.

We analyze [**?**] the electronic transport through a double quantum dot in the regime where SB occurs. Experiments of current rectification by Pauli exclusion principle in double quantum dots are reproduced with our model based in the density matrix formalism, which includes a self-consistent description of the electron and nuclei spin dynamics and their interplay within the double dot. Our results indicate that the current leakage experimentally observed in the SB region of the current-voltage characteristic curve, occurs due to spin-flip processes induced by hyperfine interaction through Overhauser effect between the electrons and nuclei spins. We analyze the interplay between electrons and nuclei spin distributions and we show as well how a magnetic field applied to the sample allows excited states to participate in the electronic current and removes spin blockade, producing spin-polarized current. Finally we propose how the current polarization can be controlled by means of external electric and magnetic fields, making these systems potential components for spintronics.

References

[1] K. Ono, et al., Science **297** 1313 2002

[2] J. Iñarrea et al., submitted to Phys. Rev. Lett.

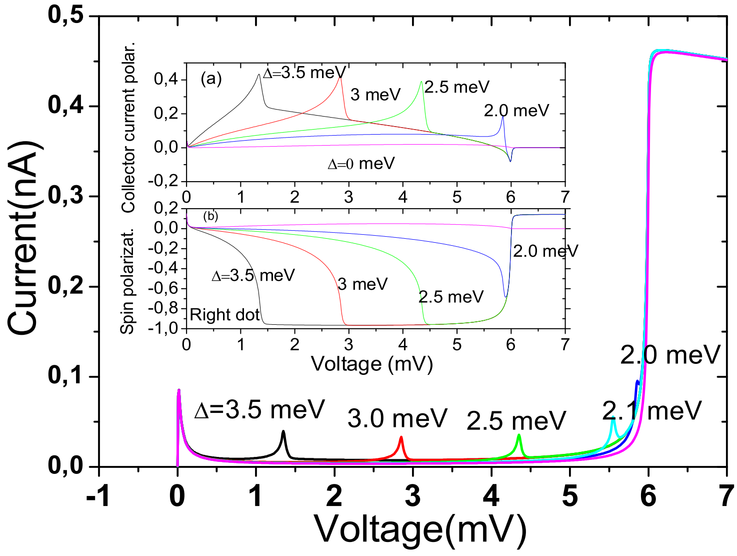

Figure 1: Time-averaged I/V_{DC} for different Zeeman splitting Δ. The SB region is the plateau between the two main peaks. The peak corresponding to the spin triplet of the right QD coming into the transport window, moves to lower bias as B increases. The inset shows (a) the time-averaged collector current spin polarization $\frac{I^{\uparrow}-I^{\downarrow}}{I^{\uparrow}+I^{\downarrow}}$ for different B (Δ), the peaks observed correspond to partially spin-up polarized current. b) Electrons spin polarization of the right QD versus V_{DC}.

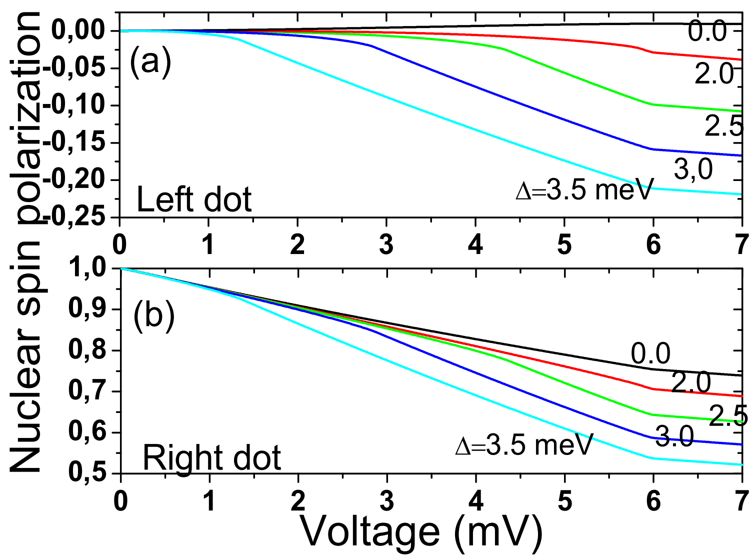

Figure 2: Nuclei polarization, p_N, versus V_{DC} for different B for a) left dot. Each curve saturates approximately at V_{DC}=5.9 mV. Once V_{DC} is large enough to empty the right dot there is no possible SB, so Hyperfine interaction is not effective and the system does not practically change the polarization. b) right dot.