PHOTON-ASSISTED TUNNELING IN DOUBLE QUANTUM DOTS AS SPIN PUMPS.

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AC-driven double quantum dots (DQD), in the Coulomb blockade regime, have recently been proposed as both spin filters and spin pumps [1]. The periodic variation of the gate potentials allows for a net dc current through the device even with no dc voltage applied: if the system is driven at a frequency (or subharmonic) corresponding to the energy difference between two time-independent eigenstates, the electrons become completely delocalized between the left and right dot. Starting from this pumping principle, the current can be completely spin-polarized *even if the contact leads are not spin polarized* if the pumping process involves two-particle states: Depending on the applied ac frequency, the double occupied singlet state of the emitter (left) quantum dot will come into resonance either with the double occupied singlet or triplet states of the right dot. Thus, one obtains different spin polarized pumping current peaks for the different resonant frequencies.

In the present work, we have extended our previous model to include the effect of the ac potential on the tunneling between the emitter (collector) contact and the left (right) quantum dot, where photo-assisted tunneling (PAT) occurs. We show how PAT processes through the contact barriers induce new features in the pumping current. In particular, the spin polarization of the current is modified with respect to the case where the effect of the ac in the contacts is neglected [1]. This can be explained in terms of additional tunneling processes not present when PAT is not taken into account. We analyze these new features in the pumped current and their dependence with the ac field parameters (Figure 1). We discuss as well how those affect the robustness of the proposed device as spin pump and spin filter.

We also include the contribution of higher order tunneling processes, such as cotunneling [2], considering that they are affected by the ac field in the DQD [3]. The effect of this PAT cotunneling is expected to not affect the current through the system, but introduces spin-flip transitions and would be involved along with decoherence and spin relaxation processes in the broadening of the current peaks.

References:

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Figures:

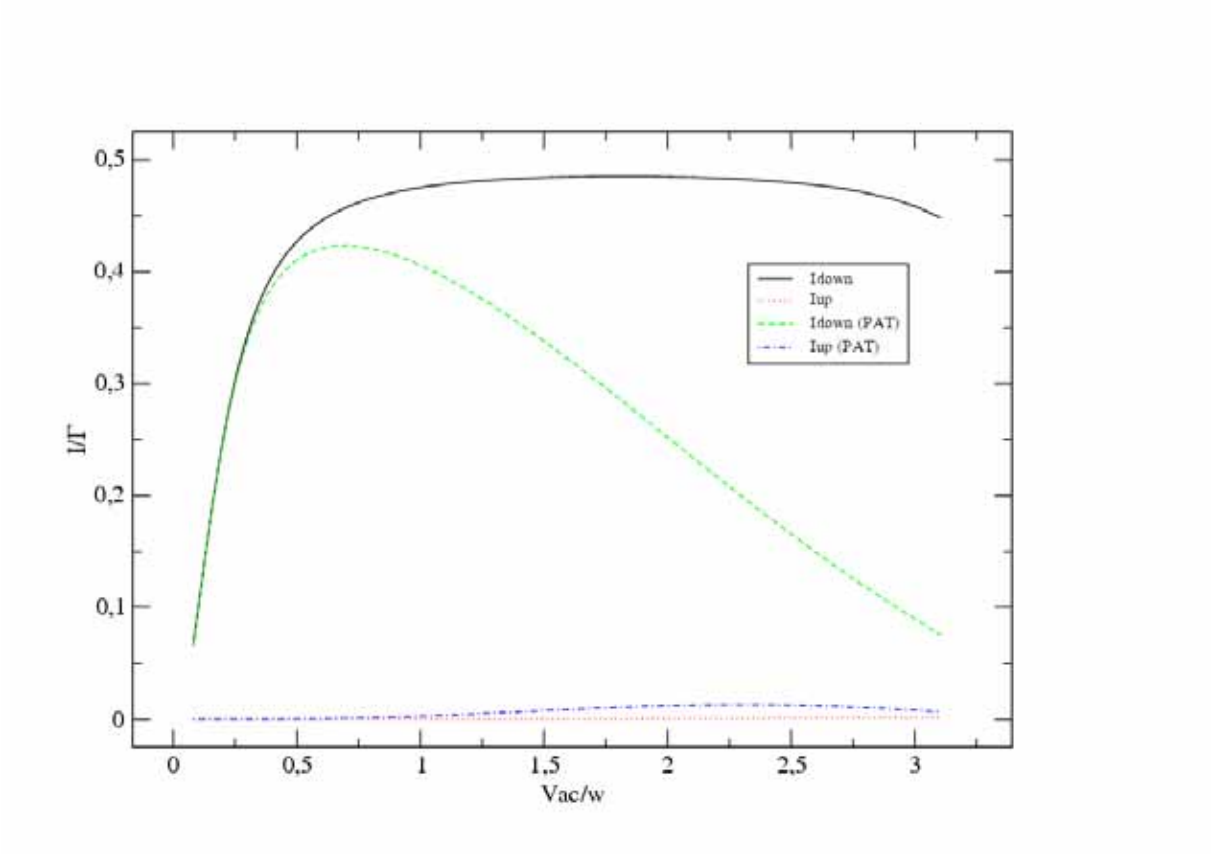

Figure 1.

Outgoing spin currents (normalized to the transition amplitude from/to the leads, Γ), considering PAT effects in the contacts (dashed and dashed-dotted lines), as function of the ac field voltage Vac (at fixed frequency, ω). For comparison, we show the currents (solid and dotted lines) when PAT processes are not taken into account. As Vac increases, PAT effects become more important.