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Theory of phonon-induced spin relaxation in coupled lateral quantum dots[1]

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Electron spins in lateral quantum dots at GaAs/GaAlAs interfaces relax in milliseconds. Spin relaxation here means transitions from the upper to the lower Zeeman split orbital ground state, at an applied magnetic field. Both spin-orbit and electron-phonon couplings are needed for spin flips between spectrally distinct and opposite-spin states. We have carried out realistic numerical and analytical calculations of spin relaxation and spin dynamics in single and coupled lateral quantum dots [1]. Our results agree with existing experiments on single dots, while predict interesting effects for coupled dots. Most important, spin relaxation in coupled dots is dominated by spin hot spots–anticrossings of states of opposite spins–at practical couplings (say, 0.1 meV). Spin hot spots reduce spin relaxation to nanoseconds! Fortunately, spin hot spots are strongly anisotropic and there can be (rather singular) configurations, we call them *easy passages*, in which spin relaxation slows down to milliseconds as in single dots. For a (001) plane, for example, an easy passage occurs if coupled dots are oriented along [110] and the in-plane magnetic field lies perpendicular, along [$1\bar{1}0$]. This configuration should be used for spin-based quantum information processing. This easy passage also protects spin qubits from electrical field disturbances which occur in "on-chip" single electron spin resonance experiments, as will be demonstrated theoretically using density matrix formalism for electron spins in the presence of both dissipation and driving oscillating electric and magnetic field [2].

[1] P. Stano and J. Fabian, Phys. Rev. Lett. 96, 186602 (2006).
[2] P. Stano and J. Fabian, cond-mat/0611228.

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