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Decoherence and Relaxation in Two-electron Si Quantum Dots

MARTA PRADA, University of Wisconsin Madison, MARK FRIESEN, ROBERT JOYNT — We study the relaxation process for a doubly-occupied silicon quantum dot from an excited (triplet) state to the ground (singlet) state. The dominant mechanism available in absence of an external magnetic field is the hyperfine coupling with nuclei via a virtual state. Since a direct transition is forbidden by energy conservation, (the energy associated with a nuclear spin is three orders of magnitude smaller than that of the electron spin), the change in energy of the electron spin has to be compensated by a lattice vibration, or emission of a phonon. On the other hand, in absence of time reversal symmetry, spin-orbit (S0) admistures different spin states through the *Rashba* SO coupling. This leads to a non-vanishing matrix element for the phonon-assisted transition between a singlet and a triplet state, where the phonon provides only energy conservation, potentially increasing the relaxation rate, Γ_{ST}. We find relaxation times T_{ST} of a few seconds for a $40\times40\times15\mathrm{nm}^3$ Si quantum dot in a magnetic field of 1T.

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