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The decoherence of exchange-only qubits in triple quantum dots[1]

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We study decoherence of a three-electron-spin qubit in a linear triple quantum dot (TQD) by hyperfine interaction. The qubit is encoded in the ($S = 1/2$, $S_z = 1/2$) subspace, and can be fully controlled electrically via exchange interactions J_{12} and J_{23} between the electron spins. We clarify how hyperfine interaction dephases the qubit by constructing effective Hamiltonians and presenting estimates of free evolution and Hahn echo decay for such qubit in a GaAs TQD. When the three electron spins are uniformly coupled, i.e., $J_{12} = J_{23}$, the two states of our qubit are the eigenstates. We find that the qubit decoherence is of order of single-spin decoherence ($T_2^* \sim 10$ ns, T_2 on the scale of μs). On the other hand, a difference between J_{12} and J_{23} requires one to diagonalize the qubit space to obtain an appropriate eigenbasis. Alternatively, the qubit can be viewed as undergoing a rotation. We find that the decoherence rates in the new basis are not significantly modified when comparing them with those in the $J_{12} = J_{23}$ case.

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