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Competing effects of hyperfine and spin-orbit interactions in two-electron spin qubits[1] ERNESTO COTA, Centro de Nanociencias y Nanotecnología, UNAM, Ensenada, Mexico, SERGIO ULLOA, Ohio University — We analyze the dynamics of a double quantum dot system with two electrons in a uniform magnetic field, taking into account the hyperfine interaction as well as the interdot tunneling-induced Rashba spin-orbit coupling. The former mixes the singlet and triplet (1,1) states while the latter accounts for mixing triplet states and the doubly occupied (0,2) singlet. We focus on the effects on experimental results in GaAs dots [1], involving the generation and control of a nuclear field gradient, necessary for full quantum control of this electron spin qubit. Using a complete description of the quantum states involved in the dynamics and numerical solution of the time-dependent Schrödinger equation, we study different pumping processes used to polarize (and read) the nuclear system, creating a large inhomogeneous nuclear field. We evaluate the fidelity of gate operations involving the two-electron qubit in the presence of competing spin-flip interactions as well as the implementation of these operations in quantum computation with characteristic experimental dot systems.

[1] S. Foletti et al., Nature Physics 5, 903 (2009)

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