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Pumping of Dynamic Nuclear Polarization in GaAs Double Quantum Dots ARIJEET PAL, JOHN NICHOL, MICHAEL SHULMAN, SHANNON HARVEY, EMMANUEL RASHBA, AMIR YACOBY, BERTRAND HALPERIN, Department of Physics, Harvard University — Control of nuclear spins in semiconductors is essential for spin qubits realized using gate-defined quantum dots (QDs) for quantum computing. One qubit realization uses the singlet (S) and triplet $S_z = 0$ (T_0) states of two electrons in a double QD. The difference in the Overhauser fields on the two dots provides an axis of rotation on the Bloch sphere orthogonal to the one produced by the exchange interaction. These fields, in turn, may be modified by a dynamic nuclear polarization protocol, in which the electronic system is swept repeatedly through the level crossing between the S and T_+ states. In any given sweep, the hyperfine interaction may cause a transition from S to T_+, thereby transferring electronic spin polarization to the nuclear spins. We find the dependence of the polarization process on the asymmetry of the electron wave function, which is induced by the Zeeman field even in geometrically symmetric dots and which leads to pumping of the difference in Overhauser fields. We further report on correlations between $S - T_+$ transitions, which capture the macroscopic nuclear spin dynamics and the various relaxation mechanisms in this system. A semi-classical theoretical model is formulated which is in good agreement with the experimental observations.

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