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Nuclear Spin Locking and Extended Two-Electron Spin Decoherence Time in an InAs Quantum Dot Molecule[1] COLIN CHOW, AARON ROSS, DUNCAN STEEL, H. M. Randall Laboratory of Physics, University of Michigan - Ann Arbor, L. J. SHAM, Department of Physics, University of California - San Diego, ALLAN BRACKER, DANIEL GAMMON, Naval Research Laboratory, Washington DC — The spin eigenstates for two electrons confined in a self-assembled InAs quantum dot molecule (QDM) consist of the spin singlet state, S, with $\boldsymbol{J}= 0$ and the triplet states T_-, T_0 and T_+, with $\boldsymbol{J}= 1$. When a transverse magnetic field (Voigt geometry) is applied, the two-electron system can be initialized to the different states with appropriate laser excitation. Under the excitation of a weak probe laser, non-Lorentzian lineshapes are obtained when the system is initialized to either T_- or T_+, where T_- results in a "resonance locking" lineshape while T_+ gives a "resonance avoiding " lineshape: two different manifestations of hysteresis showing the importance of memory in the system. These observations signify dynamic nuclear spin polarization (DNSP) arising from a feedback mechanism involving hyperfine interaction between lattice nuclei and delocalized electron spins, and Overhauser shift due to nuclear spin polarization. Using pump configurations that generate coherent population trapping, the isolation of the electron spin from the optical excitation shows the stabilization of the nuclear spin ensemble. The dark-state lineshape measures the lengthened electron spin decoherence time, from 1 ns to 1 μs. Our detailed spectra highlight the potential of QDM for realizing a two-qubit gate.

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