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Theory of heavy-hole spin-echo decay XIAOYA JUDY WANG, WILLIAM COISH, McGill University — Heavy-hole spin states have emerged as a robust new candidate for realizing a qubit. Nevertheless, the coupling of the hole spin to nuclei in the surrounding medium likely limits hole-spin coherence and has, until very recently, been overlooked. We describe the real-time spin decoherence of a heavy-hole in a semiconductor quantum dot, subject to spin echo pulses. We obtain an analytical expression which we compute numerically for an experimentally realistic number ($\sim 10^4$) of nuclear spins. Including the (previously neglected) nuclear Zeeman term in the Hamiltonian, we observe novel effects uniquely characterizing the decoherence mechanisms under study. In particular, we find a nontrivial dependence of the decay on the applied magnetic field, as well as novel predictions for motional narrowing and envelope modulation, which could significantly extend the hole-spin memory time in near-future experiments.

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