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Hyperfine and spin-orbit dynamics in GaAs double quantum dots
SHANNON HARVEY, MICHAEL SHULMAN, JOHN NICHOL, ARIJEET PAL, BERTRAND HALPERIN, Harvard University, VLADIMIR UMANSKY, Weizmann Institute of Science, AMIR YACOBY, Harvard University — Semiconductor quantum dots provide a unique platform for single-particle physics and many-body quantum mechanics. In particular, understanding the dynamics of a single electron interacting with a nuclear spin bath is key to improving spin-based quantum information processing, since the hyperfine interaction limits the performance of many spin qubits. We probe the electron-nuclear interaction by measuring the splitting at the anti-crossing between the electron singlet (S) and m=1 triplet (T+) states in a GaAs double quantum dot. Using Landau-Zener sweeps, we find that the size of this splitting varies by more than an order of magnitude depending on the magnitude and direction of the external magnetic field. These results are consistent with a competition between the spin orbit interaction and the hyperfine interaction, even though the extracted spin orbit length is much larger than the size of the double quantum dot. We confirm these results by using Landau-Zener sweeps to measure the high-frequency correlations in the S-T+ splitting that arise from the Larmor precession of the nuclei. These unexpected results have implications for improving the performance of spin-based quantum information processing, as well as improving our understanding of the central spin problem.

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