Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Hyperfine and spin-orbit dynamics in GaAs double quantum dots
SHANNON HARVEY, MICHAEL SHULMAN, JOHN NICHOL, ARIJEET PAL,
BERTRAND HALPERIN, Harvard University, VLADIMIR UMANSKY, Weiz-
mann 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 infor-
mation 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.