MAR16-2015-002780

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Symmetric operation and nuclear notch filtering in GaAs double quantum dots[1]

FERDINAND KUEMMETH, Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen

Spin qubits based on few-electron semiconducting quantum dots are promising candidates for quantum computation, due to their potential for miniaturization, scalability and fault tolerance. In this talk I will present recent results on how to mitigate electrical and nuclear noise in GaAs singlet-triplet qubits.

The traditional way of implementing exchange rotations in singlet-triplet qubits involves detuning the qubit away from the symmetric (1,1) charge configuration, thereby temporarily hybridizing with the (0,2) charge state. Due to the large dipole coupling the resulting qubit oscillation suffers from detuning noise, motivating operation at sweet spots [1] or in the multi-electron regime [2]. Alternatively, exchange rotations can be implemented by symmetrically lowering the middle barrier. This method yields less relative exchange noise, significantly enhanced free induction decay times, and quality factors comparable to those reported in silicon quantum dot devices using similar techniques [3].

In order to decouple the singlet-triplet qubit from nuclear spin fluctuations, we investigate Carr-Purcell-Meiboom-Gill (CPMG) sequences in more detail. At high magnetic fields we find that qubit dephasing is limited by narrow-band high-frequency noise arising from Larmor precession of ^{69}Ga, ^{71}Ga, ^{75}As nuclear spins, similar to what has been observed at intermediate magnetic field [4]. By aligning the notches of the CPMG filter function with differences of the discrete nuclear Larmor frequencies we demonstrate a qubit coherence time of 0.87 ms, i.e. more than five orders of magnitude longer than the duration of a π exchange gate in the same device.

[1] O. E. Dial et al. Physical Review Letters 110, 146804 (2013). [2] A. P. Higginbotham et al, Phys Rev Lett 112, 026801 (2014). [3] M. D. Reed et al, arXiv:1508.01223 (2015). [4] H. Bluhm et al. Nature Physics 7, 109 (2011).

[1] Support through IARPA-MQCO, Army Research Office, and the Danish National Research Foundation is acknowledged.