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Interplay of charge and spin coherence in Landau-Zener interferometry in double quantum dots[1]

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Landau-Zener-Stückelberg-Majorana (LZSM) physics has been exploited to coherently manipulate two-electron spin states in a GaAs double quantum dot (DQD) at a singlet (S)-triplet (T_+) anti-crossing. The anti-crossing results from the hyperfine interaction with the nuclear spins of the host material [1,2]. However, the fluctuations of the nuclear spin bath result in spin dephasing within $T_2^* \sim 10 - 20$ ns. As a consequence, the sweep through the anti-crossing would have to be performed on a timescale comparable to T_2^* to achieve LZSM oscillations with 100% visibility. Moreover, the S-T_+ anti-crossing is located near the $(1,1) - (2,0)$ interdot charge transition, where (n_l, n_r) denotes the number of electrons in the left and right quantum dot. As a result the singlet state involved in the dynamics is a superpostion of $(1,1)$ and $(2,0)$ singlet states. Here we show that it is possible to increase the oscillation visibility while keeping sweep times less than T_2^* using a tailored pulse with a detuning dependent level velocity. The pulse includes a slow level velocity portion that is chosen to coincide with the passage through the S-T_+ anti-crossing and two fast level velocity portions. The latter minimize the time spent in regions where spin and charge degrees of freedom are entangled, which renders the qubit susceptible to charge noise. The slow level velocity portion of the pulse results in a stronger effective coupling between the spins states, which increases the oscillations visibility [3,4]. In particular, we were able to obtain a visibility of ~ 0.5 for LZSM oscillations. This constitutes an important step towards the implementation of a Hadamard gate.

[1] J. R. Petta, H. Lu, and A. C. Gossard, Science 327, **669** (2010).
[2] H. Ribeiro, J. R. Petta, and G. Burkard, Phys. Rev. B **82**, 115445 (2010).
[3] H. Ribeiro, G. Burkard, J. R. Petta, H. Lu, and A. C. Gossard, arXiv:1207.2972 (2012).
[4] H. Ribeiro, J. R. Petta, G. Burkard, arXiv:1210.1957 (2012).

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