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High Visibility Coherent Oscillations in a Si/SiGe Quantum Dot Hybrid Qubit

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We discuss measurement and manipulation of a quantum dot hybrid qubit [1] formed in a Si/SiGe heterostructure. X-rotations on the Bloch sphere are performed by pulsing a gate voltage so that the detuning of a double quantum dot makes the (1,2) and (2,1) occupation ground states degenerate [2]. The resulting rotation rate is approximately 5 GHz and reveals an experimentally measured visibilty greater than 80 percent. Z-rotations on the Bloch sphere are performed by pulsing a gate voltage away from the (1,2)-(2,1) degeneracy point, resulting in oscillations at a rate of approximately 10 GHz and measured visibility greater than 85 percent. The T2* time at this detuning is greater than 15 ns, many times longer than the 100 ps gate operation time. In part because of the large ratio between the gate time and the dephasing time, improvements in the pulses used in the experiment are expected to enhance the visibility beyond that reported here and to enable high fidelity quantum gates. This work was supported in part by ARO (W911NF-12-0607), NSF (DMR-1206915), and the United States Department of Defense. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressly or implied, of the US Government. This work was performed in collaboration with Dohun Kim, Zhan Shi, C. B. Simmons, D. R. Ward, J. R. Prance, Xian Wu, R. T. Mohr, Teck Seng Koh, John King Gamble, Ryan Foote, D. E. Savage, M. G. Lagally, Mark Friesen, and S. N. Coppersmith.

[1] Z. Shi, C. B. Simmons, J. R. Prance, John King Gamble, Teck Seng Koh, Yun-Pil Shim, Xuedong Hu, D. E. Savage, M. G. Lagally, M. A. Eriksson, Mark Friesen, and S. N. Coppersmith, Phys. Rev. Lett. 108, 140503 (2012).
[2] Teck Seng Koh, John King Gamble, Mark Friesen, M. A. Eriksson, and S. N. Coppersmith, Phys. Rev. Lett. 109, 250503 (2012).