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Si platform for spin-based quantum computing

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Abstract

Silicon is a promising platform for making spin qubits in quantum dots (QDs), on the grounds of several advantages of a long intrinsic decoherence time, a possible high-temperature operation, and compatibility in device fabrication with industrial technology. One of the challenges in development of Si quantum computing is to improve the control fidelities of single- and two-qubits beyond the quantum error correction threshold, 99 % in the surface code. For the single qubits the fidelity higher than 99.9% has been achieved but yet limited to 98 % for the two-qubits. But very recently a couple of reports on the two-qubit gate fidelity above 99% have appeared on arXiv.

In this work we use Si/SiGe triple quantum dots (TQDs) to operate two and three spin qubits with high fidelities. We apply a micro-magnet technique to increase the single qubit drive and exchange control for two qubits in two QDs of the TQD and finally achieve the two-qubit gate fidelity above 99 %. Based on this result we develop three qubit operations for implementing quantum error correction. We use the TQD to generate a three-spin entangled state, called GHZ state, and a Toffoli gate and then demonstrate the three-qubit phase error correction.