Resonant iSWAP gate in Ge hole spin qubits

Alexei Orekhov\*, Konstantinos Tsoukalas\*, Bence Hetényi, Uwe von Lüpke, Felix J. Schupp, Matthias Mergenthaler, Gian Salis, Andreas Fuhrer, Patrick Harvey-Collard

*IBM Research – Zurich, Säumerstrasse 4, CH-8803, Rüschlikon, Switzerland*

Authors marked with (\*) contributed equally

We present an exchange-driven entangling iSWAP gate between hole spin qubits in planar Ge. The resonant driving is performed at the frequency difference of the two qubits using a small (~5 mV) amplitude on the barrier gate and at the symmetric exchange point. This resonant method alleviates the use of composite rotations in the common case where J ≫ ∆Ez is not satisfied and has been demonstrated previously for a SWAP gate with electron spins [1]. We estimate a gate fidelity of 89% with interleaved randomized benchmarking and quantum process tomography. We believe that the fidelity can be further improved by compensating for coherent errors due to non-adiabatic effects and by optimizing pulse shapes. A set of simplified tuning procedures is presented, making this gate a likely addition to the family of practical entangling gates in spin qubits.

 

Figure 1, (a) Interleaved randomized benchmarking of a resonant iSWAP gate, yielding a fidelity of 89%. (b) Chevron plot for the $\left|\downright \uparrow \right⟩\rightarrow \left|\uparrow \downright \right⟩ $transition. (c) Full quantum process tomography (QPT) showing characteristic pattern for an iSWAP gate. (d) Simulation of QPT for perfect iSWAP gate.

References:

[1] Sigillito *et al.* Coherent transfer of quantum information in a silicon double quantum dot using resonant SWAP gates. *npj Quantum Inf* **5**, 110 (2019).