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Efficient Coherent Error Cancellation in Ion Trap Quantum Computers by Hidden Inverses BICHEN ZHANG, YE WANG, STEPHEN CRAIN, CHAO FANG, DRIPTO DEBROY, PAK HONG LEUNG, KENNETH BROWN, JUNGSANG KIM, Duke University — Quantum gates have errors that are both coherent and stochastic. Quantum error correcting codes are able to fix both types, however, coherent errors can often be suppressed by clever control. Instead of treating coherent errors and stochastic errors the same way, we can take advantage of the coherent properties to suppress systematic coherent errors. This is typically done with composite pulse sequences or dynamical decoupling that adds additional quantum gates. Here we show that by applying a simple technique we call hidden inverses, we can increase the fidelity of quantum simulation circuits in practice. Hidden inverses mitigate systematic over-rotations without increasing the overall operation complexity of the circuit. The experiment is conducted on a $^{171}Yb^{+}$ based quantum information processor with a surface trap. This work demonstrates that compiling quantum circuits using hidden inverse structure can improve fidelity without extra overhead. The technique can be combined with stabilizer codes to suppress coherent error and even combined with composite pulses. We are experimenting with other coherent error suppression methods at the circuit level including crosstalk cancellation and error detection codes.

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