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Combining Dynamical Decoupling with Optimal Control for Improved Quantum Information Processing MATTHEW D. GRACE, WAYNE M. WITZEL, MALCOLM S. CARROLL, Sandia National Laboratories, JASON DOMINY, Princeton University — Constructing high-fidelity control pulses that are robust to control and system/environment fluctuations is a crucial objective for quantum information processing (QIP). We combine dynamical decoupling (DD) with optimal control (OC) to identify control pulses that achieve this objective numerically. Previous DD work has shown that general errors up to (but not including) third order can be removed from π- and $\pi/2$-pulses without concatenation. By systematically integrating DD and OC, we are able to increase pulse fidelity beyond this limit. Our hybrid method of quantum control incorporates a newly-developed algorithm for robust OC, providing a nested DD-OC approach to generate robust controls. Motivated by solid-state QIP, we also incorporate relevant experimental constraints into this DD-OC formalism. To demonstrate the advantage of our approach, the resulting quantum controls are compared to previous DD results in open and uncertain model systems. This work was supported by the Laboratory Directed Research and Development program at Sandia National Laboratories. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000.

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