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Optimal Control for the Quantum Simulation of Nuclear Dynamics

The standard model of quantum computation aims to approximate an arbitrary unitary transformation using a universal set of quantum gates. While this approach has the advantage to detach the development of algorithms from a specific hardware implementation, it might still be quite impractical in the NISQ technology era. The Quantum Coherent Device group at LLNL is developing a quantum computing facility based on coupling resonating cavities to a superconductive transmon in which multi-state qudits are driven by an external fine-tuned pulse in order to implement an arbitrary unitary transformation as a single gate. A first application of this concept to the study of time propagation of spin states of two neutrons interacting via a realistic Hamiltonian including one-pion-exchange effects will be introduced. Results obtained with a device simulator including noise as characterized from measurements on the actual qudits will be presented.

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