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Pulse based Variational Quantum Optimal Control for hybrid quantum computing

In this talk we discuss pulse based variational quantum algorithms (VQAs), which are designed to determine the ground state of a quantum mechanical system by combining classical and quantum hardware. In contrast to more standard gate based methods, pulse based methods aim to directly optimize the laser pulses interacting with the qubits, instead of using some parametrized gate based circuit. Using the mathematical formalism of optimal control, these laser pulses are optimized. This method has been used in quantum computing to optimize pulses for quantum gate implementations, but has only recently been proposed for full optimization in VQAs. Pulse based methods have several advantages over gate based methods such as faster state preparation, simpler implementation and more freedom in moving through the state space.

Based on these ideas, we present the development of a novel adjoint based variational method. This method can be tailored towards and applied in neutral atom quantum computers. This method of pulse based variational quantum optimal control is able to approximate molecular ground states of simple molecules up to chemical accuracy and is able to compete with the gate based variational quantum eigensolver in terms of total number of quantum evaluations. The total evolution time T and the form of the control Hamiltonian are important factors in the convergence behavior to the ground state energy, having influence on the quantum speed limit. Our VQOC method is able to converge to ground states of molecular problems for lower T than gate based algorithms can, mitigating decoherence effects.