

Accurate variational Quantum Eigensolvers

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Three Month Report

Abstract

Put your abstract or summary here, if your university requires it.

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Project Proposal

One of the proposed powerful applications for near-term quantum computers is to address problems in quantum simulation of molecular structures and condensed matter physics problems, which currently stretch the limits of existing high-performance computing infrastructure[1].

1. PROJECT PROPOSAL

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Superconducting Qubits

2.1 Quantum Information

Figure 2.1: Bloch Sphere visualisation of a single qubit state.

2.2 Superconducting Qubits

0.5

Figure 2.2: Effective Circuit for the transmon qubit

0.5

Figure 2.3: Energy levels for the transmon qubit for

$$\frac{E_J}{E_C} = ?$$

found by simulation.

2.2.1 Circuit Quantum Electrodynamics

2.2.2 Single and Two qubit gates

2.2.3 Readout

2.2.4 Noise

2. SUPERCONDUCTING QUBITS

Figure 2.4: The transmission profile of the resonator is shifted to one of two peaks conditioned on the states of the qubit.

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Quantum Simulations with Superconducting Qubits

3.1 Introduction

3.2 Hydrogen Hamiltonian

Figure 3.1: A Flowchart depicting the steps used in mapping Real Space Molecular Hamiltonian on to Qubit Hilbert space.

Figure 3.2: The dissociation curve for Hydrogen molecule.

3.3 Variational Quantum Eigensolvers

Figure 3.3: Hardware and software schematic of the variational quantum eigensolver.

3. QUANTUM SIMULATIONS WITH SUPERCONDUCTING QUBITS

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State preparation Ansätze

4.1 Six parameter circuit

4.2 Particle number conserving circuit

4. STATE PREPARATION ANSATZE

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Error Signalling Circuit

5. ERROR SIGNALLING CIRCUIT

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Active Error minimization

6.1 Limitations of Simulations

6. ACTIVE ERROR MINIMIZATION

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Outlook

7.1 Experience Gained

7.1.1 Oscilloscope Driver

7.1.2 Quantum State Tomography

7.1.3 Miscellaneous

7.2 Experience Necessary

7. OUTLOOK

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Materials & methods