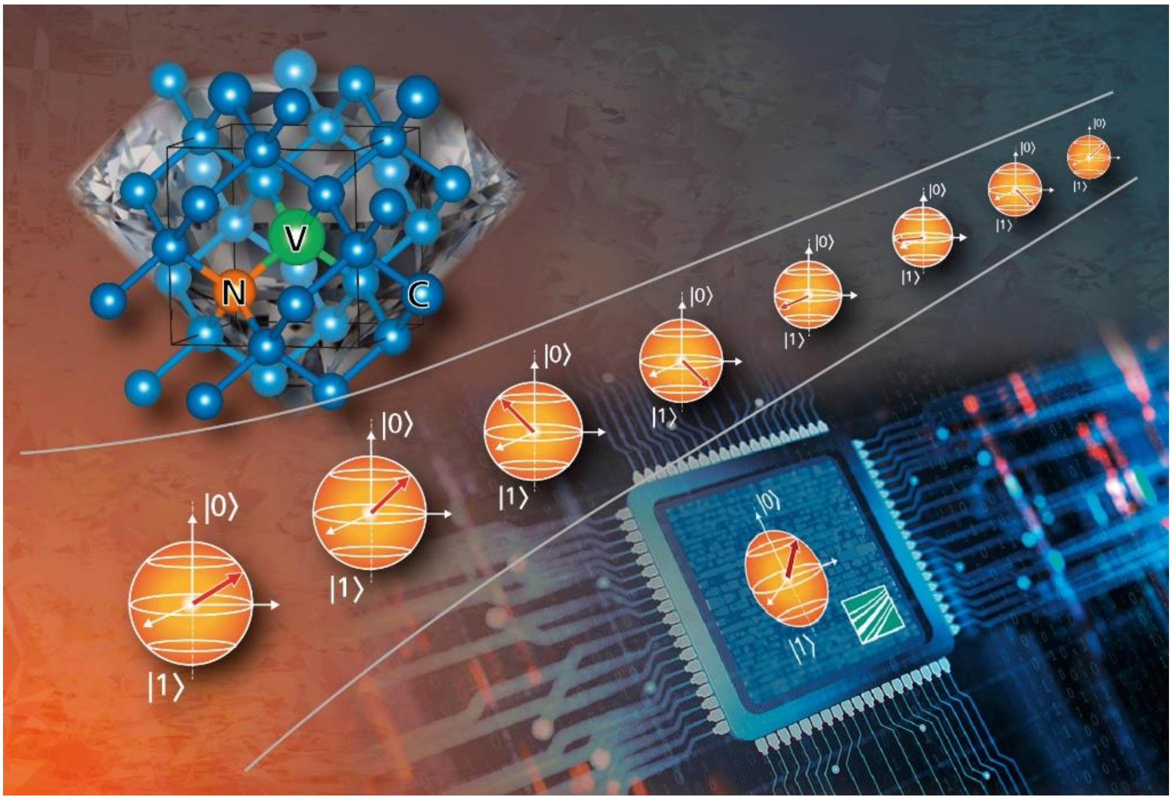

Master Thesis:

Quantum Computing for One Dimensional Model Systems

In this project, your will learn how to use a real quantum computer for the investigation of one-dimensional model systems of theoretical solid-state physics, like the Hubbard chain or the Heisenberg chain.

In recent years, the scientific community has entered the era of noisy intermediate-scale quantum computing (NISQ computing). Universal and programmable quantum computers consisting of more than a hundred qubits have become available and can be used for actual calculations. As each qubit can be regarded as an artificial single spin and since the qubits can be fully entangled, we have the possibility to simulate spin systems directly on such a quantum computer. In addition, the two possible states of each qubit allow for a bijective mapping between qubits and fermionic states, with the entanglement between the qubits reproducing the interaction between fermions. Thus, a quantum computer can simulate fully interacting fermionic systems.

In this project, we first want to demonstrate that calculations on a quantum computer reproduce the classical theoretical results for the spin-based Heisenberg chain and the fermionic Hubbard chain. Second, we want to extend these models to represent a chain of nitrogen-vacancy defects in a diamond crystal, which are promising solid-state qubits for future quantum computing systems.

In this master’s thesis you will

- learn how to program current quantum computers (with the python based IBM Qiskit)
- run your code on quantum simulators and real quantum computers (IBMQ)
- investigate one-dimensional theoretical models with increasing complexity
- learn cutting-edge error-correction methods for improving the performance of the quantum computer

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