Quantum dots

(a) (i) How can individual electrons be trapped in semiconductor quantum dots?
ans

(ii) What are some common material platforms?
ans

(b) (i) What does the charge stability diagram of a double quantum dot look like?
ans.

(ii) What physical effects do we see?
ans.

(iii) How can we measure a charge stability diagram?
ans.

(c) Explain how the state of a single electron spin in a quantum dot can be read out. What experimental conditions need to be met for the read-out to achieve high fidelity?

(d) Explain two methods for the coherent control of a single electron spin in a quantum dot. Discuss the advantages and disadvantages of both. Bonus: explain a third method.

(e) Explain two types of two-qubit gates between single-electron spin qubits in quantum dots. Discuss the advantages and disadvantages of both. Bonus: explain a third method.

(f) (i) What are the limiting decoherence mechanism for single-spin qubits in quantum dots?

(ii) How do they impact the fidelity of single-shot readout and of single- and two-qubit gates?

(iii) How did the timescales and limiting mechanisms evolve over the years?

(iv) To what extent can dynamical decoupling techniques extend the decoherence times?

(v) What does this tell us about the decoherence mechanisms?

Nitrogen vacancy qubits

Superconducting qubits

Ion trap qubits

Adiabatic quantum computing