Quantum Dynamic Memory

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Making a quantum memory capable of storing qubits that are easily accessed with high fidelity seems to present certain insurmountable barriers. First and foremost, qubits are short-lived in solid state systems and decohere rapidly. Thus, non-volatile memory is not a possibility. The only possibility seems to be dynamic random access memory where the qubits require constant refreshing. We show three possibilities for refreshing qubits: (i) the use of quantum Zeno effect to deter decoherence, (ii) mapping a qubit into several qubits (as essential ingredient in quantum error correction) and using repeated measurements to extract and reconstruct quantum states with some required fidelity, (iii) using quantum erasure to regenerate a qubit after it has been read.

We will show how all of the concepts can be implemented in quantum dot based memory where the qubits are encoded by the spins of single electrons trapped in each individual dot.