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Title: Characterizing Quantum Processes using NMR

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Abstract: Quantum information processors are fundamentally based on quantum mechanical postulates instead of classical physics. Most of the known models are in principle reversible which minimizes the loss of information and thermal dissipation. At present, a number of physical realizations of quantum information processor are successfully implemented, which include: trapped ions and neutral atoms, superconducting circuits, spin-based magnetic resonance, impurity spins in solids, photos and others. Among all implementations, nuclear magnetic resonance (NMR) has been one of the most successful platform and have demonstrated universal control on the large number of qubits. In our study, we thoroughly explored the scope/ideas of NMR being Quantum Computer. We show how NMR satisfies the general requirements of quantum computer. These requirements are also known as 'DiVincenzo Criteria'. Further, we did some basic experiments (single and double qubit experiments) which includes preparation of quantum state (pseudo pure state), characterization of quantum state (quantum state tomography), synthesization of quantum gates (using RF pulses), calculation of fidelities of Quantum gates and characterization of quantum processes (quantum process tomography). Further, We also tried to characterize decoherence process which is highly responsible for less fidelity of quantum computation carried out for long interval of time using quantum process tomography protocol. In addition to that, we also calculated spin-spin relaxation time (T2) which is very useful for other NMR experiments like diffusion experiments, relaxation experiments etc.


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