Achieving high-level quantum control and performing quantum simulations using numerically optimized pulses on an NMR quantum computer

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Quantum states exhibit quantum correlations which play a very important role in the field of quantum information processing and in achieving computational speedup. This talk will focus on the quantification of quantum correlations, the distinction from their classical counterparts, and their behavior under decoherence. The discovery of the intriguing phenomenon that certain kinds of quantum correlations remain impervious to noise up to a specific point in time and then suddenly decay, has generated immense recent interest. We exploit dynamical decoupling (DD) sequences to prolong the persistence of time-invariant quantum correlations in a system of two NMR qubits decohering in independent dephasing environments[1]. DD sequences have found widespread application in quantum information processing, as strategies for protecting quantum states against decoherence. For a quantum system coupled to a bath, the DD sequence decouples the system and bath by adding a suitable decoupling interaction, periodic with a cycle time, to the overall system-bath Hamiltonian. We have numerically optimized quantum gates and dynamical decoupling sequences and use these optimized sequences to achieve a high degree of quantum control [2]. We experimentally prepare two-qubit quantum states that interact with individual noise channels and demonstrate that we are able to freeze quantum correlations over long time scales via dynamical decoupling [3]. The application of these numerically optimized pulses in simulating the Hamiltonian of a quantum potential well will also be discussed.

References:


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