Tensor product approach to quantum control

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Effective control of many-body quantum systems, such as Heisenberg spin wires, is essential for emerging quantum computing technologies. However, the dimension of the state space grows exponentially with the number of particles involved, and the complexity of the problem quickly exceeds the power of modern super- computers, as we approach systems with 50+ qubits, which are expected by 2020-30. In this talk we discuss how tensor product algorithms, based on the idea of algebraic separation of variables, can help to reduce the complexity and make the problems possible to solve. We calculate the optimal control pulses using Krotov and GRAPE methods, applying the recently developed tAMEn algorithm to calculate evolution of quantum states represented in the tensor train format to reduce storage. Using tensor product algorithms we can overcome the curse of dimensionality and compute the optimal control pulse for a 41 spin system on a single workstation with fully controlled accuracy and huge savings of computational time and memory.

[1] https://arxiv.org/abs/1903.00064

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