Quantum Computing Perspective on Quantum Control

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Abstract.

It is widely accepted that control of quantum systems is a technology necessary for realizing quantum information processing / quantum computing in practice. In this talk we look at the relationship between quantum control and quantum computing from an opposite direction: What does quantum computing teach us about approaches to controlling quantum systems?

The questions we are trying to answer are: How many resources are necessary to achieve control? How does the complexity of control algorithms scale with the complexity of the system? Is it possible to use quantum computing approach, which is designed for handling many coupled systems and performing arbitrary operations in a few steps, as a cornerstone of general and exponentially efficient control algorithms in multi-level systems?

En route to answering these questions we show how it is possible to build exact analogs of one and two-bit logical operations in a single multi-level system, using a multi-level bus. The analogues of one- and two-bit operations are performed on wavepackets and can be used as generic building blocks to accomplish any control task in a small number of universal steps. The operations introduced deal with the packet as a whole rather than dealing with individual levels, controlling packet's shape through its symmetry. We discuss the possibility of physical implementation of our wavepacket operations in such physical systems as Morse oscillator and a classical waveguide.

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