Shedding a little Light on the Vision of Quantum Computing

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Computers based on the laws of quantum mechanics are supposed to outperform today's classical computers. Demonstration of the proof-of-principle with a few qubit computers essentially confirms this possibility. However, scalability and decoherence are the main bottlenecks in the development of a realistic quantum computer. Any realistic vision of a quantum computer would need to address these issues—one of the popular ones pitched for scalability being the optical approaches due to high transmission speed and teleportation capabilities. Though attractive from scalability aspects, optical approaches to quantum computing are highly prone to decoherence and rapid population loss due to nonradiative processes such as vibrational redistribution. We show that such effects can be reduced by adiabatic coherent control, in which quantum interference between multiple excitation pathways is used to cancel coupling to the unwanted, non-radiative channels. We focus on experimentally demonstrated adiabatic controlled population transfer experiments [1] wherein the details on the coherence aspects have been minimally explored theoretically but are important for quantum computation. Such quantum computing schemes also form a back-action connection to coherent control developments [2]. We explain the counterintuitive coherence properties between resonant population transfer as compared to that in case of the adiabatic rapid passage.

References

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