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Ultrafast Optical Control of Quantum Dot Excitons Using Engineered Optical Pulses

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Femtosecond pulse shaping provides a flexible approach to tailoring the Hamiltonian governing the interaction of light with matter. Together with powerful adaptive feedback algorithms, this approach is now used routinely in the control of a variety of physical processes. For quantum computing applications, pulse shaping provides a means to optimize the speed and fidelity of elementary quantum gates, and may enable the realization of schemes for complex instruction set quantum computing. In this presentation, I will discuss our recent experiments demonstrating ultrafast quantum control of charge based (exciton) qubits in semiconductor quantum dots. Using optimal quantum control techniques, we show that pulse shaping provides a means to optimize the fidelity of a C-ROT gate in single quantum dots [1,2], and enables parallel single qubit gates on distant quantum dots within the laser focal spot [3]. We also demonstrate adiabatic rapid passage on a subpicosecond time scale in single semiconductor quantum dots, yielding new insight into the role of phonons in dephasing of exciton qubits.

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