Quantum dots: Artificial atoms for quantum computing

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We present a series of coherent nonlinear optical experiments that show semiconductor quantum dots have optical properties very similar to simple atomic systems but are surprisingly robust against decoherence and have large dipole moments. By combining advances in nano-optical probing methodologies with the power of coherent nonlinear optical spectroscopy techniques, the measurements have enabled us to extend concepts of coherent optical control and wave function engineering to a single quantum dot exciton.

Semiconductor quantum dots have formed the basis for several proposals for quantum logic devices of interest to quantum computation. Our measurements have now provided the first observation of optically induced and detected quantum entanglement of the pseudo spins associated with two different excitons. The measurements also show our progress towards demonstrating a quantum-controlled not-gate including Rabi oscillations on the ground state to exciton transition and exciton to biexciton transition.