Quantum Physics

Robust photon-spin entangling gate using a quantum-dot spin in a microcavity

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Semiconductor quantum dots (known as artificial atoms) hold great promise for solid-state quantum networks and quantum computers. To realize a quantum network, it is crucial to achieve light-matter entanglement and coherent quantum-state transfer between light and matter. Here we present a robust photon-spin entangling gate with high fidelity and high efficiency (up to 50 percent) using a charged quantum dot in a double-sided microcavity. This gate is based on giant circular birefringence induced by a single electron spin, and functions as an optical circular polariser which allows only one circularly-polarized component of light to be transmitted depending on the electron spin states. We show this gate can be used for single-shot quantum non-demolition measurement of a single electron spin, and can work as an entanglement filter to make a photon-spin entangler, spin entangler and photon entangler as well as a photon-spin quantum interface. This work allows us to make all building blocks for solid-state quantum networks with single photons and quantum-dot spins.

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