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Quantum nanophotonics: Controlling a photon with a single spin[1]

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The implementation of quantum network and distributive quantum computation replies on strong interactions between stationary matter qubits and flying photons. The spin of a single electron confined in a quantum dot is considered as a promising matter qubit as it possesses microsecond coherence time and allows picosecond timescale control using optical pulses. The quantum dot spin can also interact with a photon by controlling the optical response of a strongly coupled cavity. In this talk I will discuss our recent work on an experimental realization of a spin-photon quantum phase switch using a single spin in a quantum dot strongly coupled to a photonic crystal cavity. We show large modulation of the cavity reflection spectrum by manipulating the spin states of the quantum dot, which enables us to control the quantum state of a reflected photon. We also show the complementary effect where the presence of a single photon switches the quantum state of the spin. The reported spin-photon quantum phase operation can switch spin or photon states in picoseconds timescale, representing an important step towards GHz semiconductor based quantum logic devices on-a-chip and solid-state implementations of quantum networks.

[1]Shuo Sun, Hyochul Kim, Glenn Solomon, co-authors