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Single photon Mach-Zehnder interferometer for quantum networks based on the Single Photon Faraday Effect: principle and applications HUBERT SEIGNEUR, CREOL, University of Central Florida, MICHAEL LEUENBERGER, NanoScience Technology Center and Dept. of Physics, University of Central Florida, WINSTON SCHOENFELD, CREOL, University of Central Florida — Combining the recent progress in semiconductor nanostructures along with the versatility of photonic crystals in confining and manipulating light, quantum networks allow for the prospect of an integrated and low power quantum technology. Within quantum networks, which consist of a system of waveguides and nanocavities with embedded quantum dots, it has been demonstrated in theory that many-qubit states stored in electron spins could be teleported from one quantum dot to another via a single photon using the Single Photon Faraday Effect. However, in addition to being able to transfer quantum information from one location to another, quantum networks need added functionality such as (1) controlling the flow of the quantum information and (2) performing specific operations on qubits that can be easily integrated. In this paper, we show how in principle a single photon Mach-Zehnder interferometer, which uses the concept of the single photon Faraday Effect to manipulate the geometrical phase of a single photon, can be operated both as a switch to control the flow of quantum information inside the quantum network and as various single qubit quantum gates to perform operations on a single photon. Our proposed Mach-Zehnder interferometer can be fully integrated as part of a quantum network on a chip.

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