Photonic Controlled-Phase Gate Based on Rydberg Interactions
MOHAMMADSADEGH KHAZALI, KHABAT HESHAMI, CHRISTOPH SIMON,
Institute for Quantum Science and Technology, University of Calgary — Photons are
ideal carriers of information in quantum communication. Since they do not interact,
the implementation of deterministic photonic quantum computation depends on
the creation of a non-permanent strong interaction between single photons. The
implementation of neutral Rydberg atom gates inspired the development of photonic
gates, using the coherent reversible mapping of the quantum states of photons onto
highly interacting Rydberg atoms. Here we propose an interaction-based two-qubit
gate between photons stored in Rydberg levels of an atomic ensemble.\textsuperscript{1} We perform
a detailed study of errors due to the many-body interaction between Rydberg spin-
waves, and we propose a compensation scheme for these errors. Furthermore we
completely separate interaction and propagation by eliminating the Rydberg level
from the storage process. Our proposed controlled-phase gate can achieve 99% fidelty with current technology.