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**Photonic Controlled-Phase Gate Based on Rydberg Interactions**

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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.<sup>1</sup> 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% fidelity with current technology.

<sup>1</sup>M. Khazali, K. Heshami, C. Simon, arXiv:1407.7510 (2014)

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