

# Optical Cluster State Generation without Number Resolving Photon Detectors

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**Abstract:** We propose a controlled phase gate [1] for linear optical quantum computing without using photon detectors that are photon number resolving. If the dark count probability is low, we can reliably generate optical cluster states.

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We propose a polarization encoding [2] scheme for reliable optical cluster state generation. We do not require photon detectors with photon number resolving capability. They only need to detect the presence or absence of photons.

The following diagram illustrates our proposed method for implementing this gate.

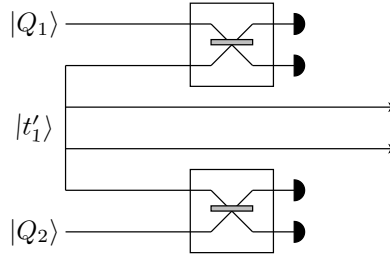


Fig. 1. Proposed scheme for a controlled phase gate.

The first and second qubits  $|Q_1\rangle$  and  $|Q_2\rangle$  are polarization encoded qubits.

$$|Q_i\rangle = \alpha_i|H\rangle + \beta_i|V\rangle \quad (1)$$

The four mode state  $|t'_1\rangle$  is as follows.

$$|t'_1\rangle = \frac{1}{2} (|VH VH\rangle + |HV VH\rangle + |VH HV\rangle - |HV HV\rangle) \quad (2)$$

Using  $|t'_1\rangle$ , we perform a non-deterministic controlled-phase operation on  $|Q_1\rangle|Q_2\rangle$  without number resolving detectors. Furthermore, we show how to generate the  $|t'_1\rangle$  state without using number resolving detectors.

## References

1. E. Knill, R. Laflamme, and G.J. Milburn, Nature **409**, 46 (2001).
2. F. M. Spedalieri, H. Lee, and J. P. Dowling, Phys. Rev. A **73**, 012334 (2006).