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Multimode Treatment of Coherent Photon Conversion[1] BALAKRISHNAN VISWANATHAN, JULIO GEA-BANACLOCHE, Univ of Arkansas-Fayetteville — It has been suggested that second-order optical nonlinearities ("coherent photon conversion") could be used for quantum logic at the single- photon level [1]. Specifically, succsessive two-photon processes in principle could accomplish the phase-shift (conditioned on the presence of two photons in the low-frequency modes) $|011\rangle \longrightarrow |100\rangle \longrightarrow -|011\rangle$. We have carried out a multimode study of this process using single-photon wavepackets with different profiles (in particular, Gaussian and hyperbolic secant) in order to ascertain the fidelity achievable in such a process, both in free space [2] and with the nonlinear medium placed in a multiply-resonant cavity [3]. The fidelity achieved with a cavity was higher than what was achieved in free space. Our conclusion is that the desired phase shift cannot be accomplished with a fidelity greater than 0.5.

[1] N.K.Langford et al, Nature, Vol.478, 360 (2011)
[2] Julio Gea-Banacloche, Phys.Rev.A, Vol. 81, 043823 (2010)
[3] Julio Gea-Banacloche, Phys.Rev.A, Vol.87, 023832 (2013)

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