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Effects of nonlinear phase modulation on low-conversion four-wave mixing Bragg scattering

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Abstract: We consider the effects of nonlinear phase modulation (NPM) on frequency converseon by Bragg scattering. Previously we found that arbitrary mode reshaping without temporal entanglement (separability) was possible. When NPM is included, the modes are chirped and the separability is no longer complete. However, the mode phase shifts are reduced by pump pre-chirping.

For quantum information processing, a reliable device that enables the frequency conversion and temporal reshaping of photon states emitted from quantum memories is needed [1]. Recently it has been shown that a four-wave mixing process (Bragg scattering) fulfills these requirements [2]. The Green function (GF) describing Bragg Scattering in the low-conversion-efficiency regime was derived in [3], but without the effects of nonlinear phase modulation (NPM). Here, we present results that include the effects of NPM.

We find that NPM does not change the magnitude of the GF, but does change its phase profile significantly. To describe the physics of the GF we introduce the Schmidt decomposition, in which the GF is split into input and output Schmidt modes, and Schmidt coefficients. If the GF is separable it only contains one output mode, which is free of temporal entanglement. When NPM is included, the GF is no longer completely separable [Fig. 1(a)], and the input and output modes are always chirped [Fig. 1(b)]. However by pre-chirping the pumps we reduce the chirp [Fig. 1(b)]. Even in the presence of NPM, arbitrary reshaping and practical separability is possible, as predicted previously [3].

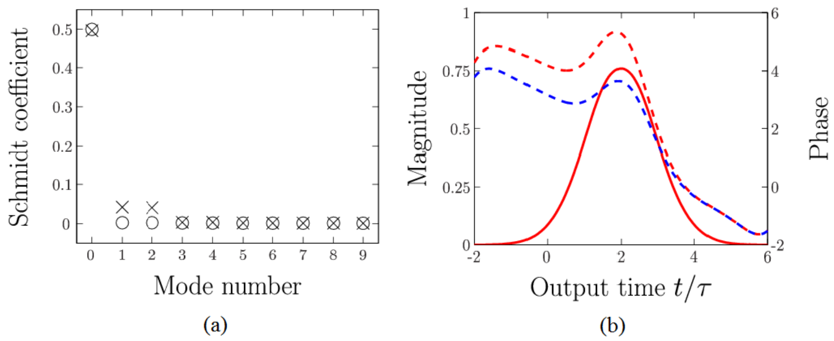

Figure 1. (a) Schmidt coefficients with (crosses) and without NPM (open circles). (b) The lowest-order Schmidt-mode magnitude (solid) and phase with (blue-dashed) and without pre-chirp (red-dashed).

References

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