MAR14-2014-020805

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Toward Noiseless Amplification and Frequency Conversion

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In this talk, I will review recent progress toward noiseless amplification and frequency conversion by four-wave mixing (FWM) processes in optical fibers. In these processes, one or two strong pump waves drive weak signal and idler waves (or photon wavepackets). Depending on the relative frequencies of the waves, FWM can amplify the signal (without frequency conversion) or frequency convert it (with or without amplification). These functions enable a variety of applications. Amplification with a noise figure of 1 dB (close to the quantum limit of 0 dB) has been demonstrated. So also has the frequency conversion of single photons. I will review these results in the contexts of conventional communication systems and quantum information science. A theme of current research is the encoding of information in different temporal eigenfunctions of arbitrary single-photon wavepackets. FWM driven by pulsed pumps provides the means to detect and manipulate information encoded in these eigenfunctions.