Nonlinear Wave Interaction Processes In Photonic Band Gap Materials

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Photonic Band Gap (PBG) materials attract much interest, since they allow one to control the flow of light on a level unachievable before. Employing the nonlinear properties of such systems brings about fascinating opportunities for shaping and manipulating optical pulses. For instance, in nonlinear PBG materials, there exists a novel class of localized excitations, the so-called gap solitons, whose frequency content may lie within the photonic band gap. In addition, gap solitons may have zero group velocities. Nonlinear wave interaction processes provide efficient mechanisms for dynamically controlling these optical waves. Here, we examine, both analytically and numerically, the interaction of nonlinear waves in one-dimensional photonic band gap materials. In the limit when the nonlinear Schrödinger equation is a valid model the analytical formulae determine accurately the phase shift experienced by nonlinear waves during non-resonant interaction. For the more complex cases of non-elastic wave interactions or soliton-defect interactions we present the comprehensive numerical studies.