Wave propagations in periodically curved waveguide arrays

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Abstract:

Arrays of coupled waveguides which can effectively discretize the light propagation and in turns give rise to many interesting phenomena have been considered as a powerful tool to control the fundamental properties of light propagation and allow people to study many useful optical analogies with other fields, such as the physics of solid state. In particular, light propagation in photonic lattices can be effectively controlled by applying periodical modulations, resembling the motion of electrons in a crystalline within an external potential. Thus, by investigating the light propagation in modulated photonic lattices, people can study a variety of phenomena which have been proposed originally for quantum electron system but difficult to be monitored. Here, we study light propagation in photonic lattices with periodically curved waveguides modelled by parametrically driven coupled nonlinear Schrodinger equations. For two periodically curved waveguides, we investigate the dynamics of coupled wavefields in a periodically oscillating double-well potential which is analogous to horizontally shaken Bose-Einstein condensates in a double-well magnetic trap. Specially, we study the persistence of equilibrium states of the undriven system due to the presence of the parametric drive and find that such parametric drives may stabilize or destabilize the continuations of equilibrium time-independent states that are respectively unstable or stable in the undriven case. For many periodically curved waveguide arrays, we show that discrete surface solitons persist, but the threshold power to support their existence is altered by the drive. There are critical drives at which the threshold values vanish. We also show that parametric drives can create resonance with a phonon making a new barrier for discrete solitons. By calculating the corresponding Floquet multipliers, we find that the stability of symmetric and antisymmetric off-side discrete surface solitons switches approximately at the critical drives when the threshold values vanish.