Surface discrete breathers in semi-infinite photonic lattices

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In Nonlinear Optics the analogue of the discrete breather is known as *a discrete soliton* (DS): A self-trapped optical field of a finite extent that exists in arrays of weakly coupled nonlinear waveguides, where discrete diffraction/dispersion effects are balanced by the material nonlinearity. The first successful experimental observation of optical DS in AlGaAs waveguide arrays was made in 1998 [1]. Different types of discrete solitons are possible, depending on the underlying nonlinear mechanism. So far, Kerr DS [1], quadratic DS [2], vector DS [3], Bragg and gap DS [4], and DS in photorefractive arrays [5] have been experimentally observed.

In this work, we have analyze different types of nonlinear localized modes near the edge of semi-infinite photonic lattices including waveguide arrays and two-dimensional photonic lattices. In particular, we study a crossover from nonlinear surface states to discrete solitons by analyzing the families of odd and even modes centered at finite distances from the surface [6]. We also report the first observation of surface gap solitons, recently predicted to exist at an interface between uniform and periodic dielectric media with defocusing nonlinearity [7]. We demonstrate strong self-trapping at the edge of a LiNbO3 optical waveguide array and the formation of localized surface states with the propagation constant inside the first photonic band gap. We study the crossover between the linear regime of surface repulsion and nonlinear regime of surface attraction in the framework of a discrete model, and discuss the physical mechanism of the nonlinearity-induced stabilization of the surface gap modes. While in waveguide arrays the presence of a boundary increases the minimum power needed to create a DS [6], the opposite tendency is found for two-dimensional lattices [8].

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