# Nonlinear Optics and Gap Solitons in Periodic Photonic Structures

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We will overview the nonlinear physics in periodic photonic structures such as fiber Bragg gratings, waveguide arrays and optical lattices. First, we will discuss the small-amplitude approximation and refer to an earlier derivation of M. Wadati and T. Iizuka of the effective nonlinear Schroedinger equation. Then, we will discuss more general case of self-focusing in the structures with bandgap spectra and the formation of gap solitons in one- and two-dimensional photonic lattices. Next, we will analyze nonlinear collective effects near surfaces of semi-infinite periodic systems with multi-gap transmission spectra and report on the first observation of surface gap solitons existing at the interface between uniform and periodic dielectric media with defocusing nonlinearity, an optical analog of nonlinear Tamm states. We will also discuss reshaping of polychromatic beams due to collective nonlinear self-action of multiple-frequency components in periodic photonic lattices, predict theoretically and demonstrate experimentally the formation of polychromatic discrete solitons facilitated by localization of light in spectral gaps.