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A new picture for gap solitons in nonlinear photonic crystals XUNYA JIANG, Shanghai Institute of Microsystem and Technology, Shanghai, China, J.D. JOANNOPOULOS, Department of Physics, Massachusetts Institute of Technology, Cambridge, MA — We construct a new local-Bloch theory for the interplay between the nonlinearity and the periodicity. Based on this first order theory, we can get gap soliton solutions composed of local Bloch waves over the entire gap. Some important unique properties of the gap solitons are revealed, such as the periodicity-amplified nonlinearity, the periodicity-generated high order nonlinearity, the touching-local-gap-edge property and the intrinsic-ultrashort-pulse property. Besides these properties, the envelope equations of both stationary and time-dependent cases are obtained. The stationary envelope equation is a cubic-quintic nonlinear Schrodinger equation which can be solved exactly. From this simple equation, we can give a clear explanation of earlier theoretical results. The time-dependent envelope equation includes new important high order time-derivative terms, so that it is much more complex than common nonlinear Schrodinger equations. One of those terms is the self-steepening term which leads to a new dynamical instability of the gap solitons.

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