Nonlinear Fano resonance in periodic photonic structures

Andrey E. Miroshnichenko and Yuri S. Kivshar
Nonlinear Physics Centre and Centre for Ultra-high bandwidth Devices for Optical Systems (CUDOS), Australian National University, Canberra ACT 0200, Australia

The Fano resonance is widely known across many diverse branches of physics as an asymmetric profile of transmission or absorption lines. One of the simplest models which may help to reveal the interference nature of this phenomenon is the discrete Fano-Anderson model. We generalize this model to the nonlinear case and characterize a shift of the position of the resonance and the bistable transmission. We show how this model can be directly used to describe resonant effects in a variety of photonic structures including two-dimensional photonic crystal (PC) waveguides. Especially, we show how long-range interaction in PC waveguides leads to interference phenomena in the transmission through waveguide bends, which could be associated with the Fano resonance. As the second example, we consider the resonant reflection of light in arrays of channel waveguides where tunable quadratic nonlinearity is introduced in nonlinear defects by periodic poling of single or several waveguides in the array. We demonstrate that the observed resonant scattering phenomenon can be characterized as the Fano resonance [1]. Recent successful experimental demonstration of quadratic waveguide arrays allows us to consider such structures as good candidates for the first observation of tunable Fano resonance in nonlinear optics.

[1] A.E Miroshnichenko, Yu.S. Kivshar, R.A. Vicencio, and M.I. Molina, Optics Letters (2005) in press.