Sub-wavelength Plasmonic Lattice Solitons

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When the size of conventional optical circuits is reduced to the nanoscale, the propagation and the concentration of light are inherently limited by diffraction. One effective approach to overcome this major challenge is to use surface plasmon polaritons (SPPs), which are evanescent waves trapped at the interface between a dielectric material and a conductor such as a metal in visible frequency range. The electric field of SPPs is significantly enhanced at the metallic surfaces and thus it is natural to exploit the nonlinear effects of SPPs, which enables the nonlinear optics at the deep-subwavelength scales.

We study the spatial lattice solitons in nanostructures composed of periodic arrangement of metallic layers or metallic nanowires which are embedded in an optical medium with Kerr nonlinearity. The spatial extent of plasmonic lattice solitons (PLSs) can be significantly smaller than the wavelength λ, and their propagation can be steered actively, for example, by a power-controlled mean.

In this talk, we present three types of PLSs: 1) PLSs in one-dimensional and two-dimensional arrays of coupled metallic nanowires, including fundamental solitons and vortical solitons; 2) Surface PLSs at the boundary of semi-infinite metallic-dielectric periodic nanostructures; 3) Vector PLSs originating from different transmission bands.

The theoretical analysis is based on an extension to the nonlinear case of a coupled-mode theory (CMT), which captures the full vectorial character of the propagating modes of the metallic nanowires. Rigorous solutions based on full-set Maxwell equations will be also presented and compared with the CMT results.

References:

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