Mode Coupling at the Periodic Boundary of Metamaterial

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Mathematical modeling of electromagnetic waves interaction with periodic boundary of metamaterial is based, as a rule, on the traditional approach, that is the solution to boundary value problems of diffraction theory. The solution to relevant spectral problems for eigen oscillations (eigen frequency is a spectral parameter) or/and eigen waves (propagating constant is a spectral parameter) presents the essential complementation to this approach. The successful association of these two ways of consideration of boundary value problem provides the possibility to treat the physical regularities and peculiarities of the resonant wave scattering by metamaterial on qualitatively new level and to get deeper understanding of complicated phenomena.

In this presentation the spectral problems for eigen waves and mode (natural oscillations) of the wavy periodic boundaries of the media with negative permittivity or/and permeability are considered. The C-method serves as efficient tool for the solution of boundary value and spectral problems of electromagnetic wave diffraction by periodic boundary of metamaterials.

The numerical algorithms and corresponding codes have been constructed and implemented for computation of complex frequencies of eigen modes (oscillations) and propagation constants of surface waves.

The study of regularities and peculiarities in the spectral characteristics (eigen complex frequencies, propagation constants of eigen modes and waves, corresponding electromagnetic field patterns, etc.) behavior with geometrical and electromagnetic parameters of periodic boundary varying have been carried out within rather wide range of parameters.

Special attention has been focused on the study of the phenomenon of eigen modes (oscillations) and eigen waves coupling.

On the base of the theory of critical points (Morse's critical points) of analytical functions of several variables the mathematical model of the inter mode coupling phenomenon, arising on the wavy periodic boundary of material with single or/and double negative parameters has been developed.