Traveling Waves on 1D, 2D, and 3D Periodic Arrays of Nanospheres

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For periodic arrays with elements that radiate and scatter electric and magnetic dipoles only, a spherical wave source scattering-matrix formulation combines with Poisson summation formulas and Floquet mode analyses to produce readily solvable transcendental equations for the propagation constant versus frequency (k-β diagrams) of the traveling waves on one-, two-, and three-dimensional periodic arrays. Previous papers (Electronics Letts., 41, May 2005; IEICE Trans. Comm., E88-B, June 2005; URSI General Assembly, New Delhi, India, October 2005) have outlined the steps in the theory and showed the k-β diagrams that resulted from the application of the theory to periodic arrays of lossless penetrable spheres. It is assumed that either the spheres are sufficiently small that only the dipole-scattered fields are appreciably excited, or the frequency is such that all the scattered multipole files are negligible except the dipole fields.

Depending on the values of the permittivity and permeability of the spheres and their separation distances, both forward and backward traveling wave frequency bands can be found. For three-dimensional arrays the forward and backward waves correspond to positive and negative values, respectively, of the bulk permittivity and permeability of the metamaterial. In this talk, we concentrate on determining the k-β diagrams for the traveling waves on one-, two-, and three-dimensional periodic arrays of ordinary dielectric (such as sapphire) and plasmonic (such as gold) nanospheres. Chains of nanospheres have been proposed as a means of propagating optical pulses in regions confined to transverse dimensions less than a wavelength (Maier *et al.*, Phys. Rev. B, 67, 205402, 2003; Citrin, Nano Lett., 4, 1561, 2004).