Exotic Waves in Chains of Silver Nanospheres

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A transversal mode with zero group velocity and non-zero phase velocity that can exist in chains of silver nanospheres in the optical frequency range is theoretically studied. In such chains at a certain special frequency a monochromatic source excites the standing wave in an infinite chain, and as a result we obtain an optical resonator without spatial bounds. It is shown that the external source radiating a narrow-band non-monochromatic signal excites in the chain a mixture of standing and slowly traveling waves. The standing wave component (named as *resonator mode*) is strongly dominating. The physical reason of such a regime is an unusual distribution of power flux over the cross section of the chain. The study shows that the axial Poynting vector is negative on the chain axis and changes its sign at a certain distance ρ_0 from it, so that the total energy flux of the pulse turns out to be positive. The most part of the pulse energy propagating along the chain in the positive direction returns back inside a narrow spatial channel centered at the chain axis. Since the chain period for such a regime is obviously small compared to the wavelength in free space, the energy is concentrated in a subwavelength spatial region. Besides of very efficient slow-wave lines these chains can be also used for subwavelength localization of the light energy. The possible application for obtaining subwavelength images is discussed.

Next, chains with alternating spheres that differ by diameters (or, perhaps, covered with dielectric material) — two-phase chains — are studied. A small change of polarizabilities of spheres in these two sub-arrays results in new interesting properties. One of them is a significant broadening of the propagation band. For the case of the longitudinal polarization of spheres there is a narrow stop-band at the center of the band of eigenfrequencies, and one can obtain a high-quality band-stop filter. A single-phase chain of silver nanospheres can be considered as a filter with a narrow pass-band whose remarkable property is the subwavelength localization of the field. Two-phase chains behave as band-stop filters, also with subwavelength localization of the field. Other interesting features of this structure are also discussed.