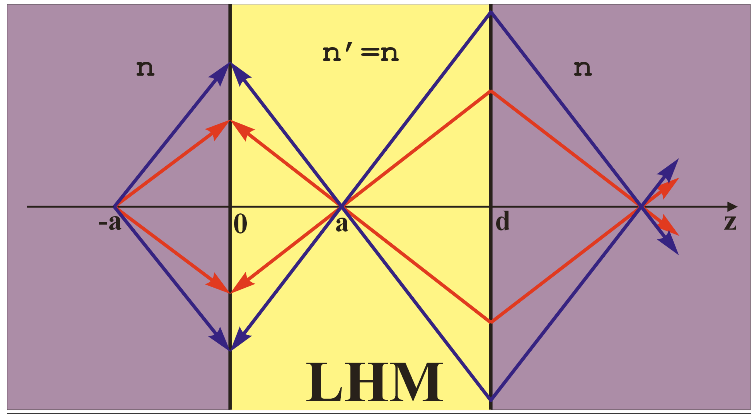
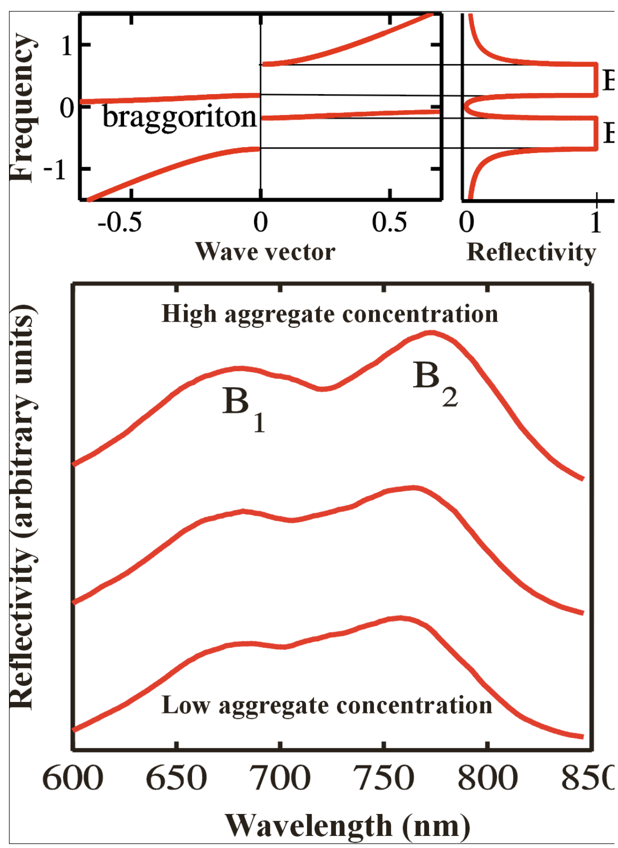
NIRT Highlight

Unusual Electrodynamics of Metamaterials



Unique lens made from left-handed material (LHM): LHM, first introduced by Veselago (1967), has an unusual EM property: the direction of the energy flux is opposite to the wave vector. It follows that Snell's law for refraction at the interface between LHM and regular material has a negative sign. This phenomenon has been recently observed in a metamaterial that is a photonic crystal (PC). Veselago proposed a unique lens, which is a slab of LHM with the same absolute value of refractive index as in the surrounding normal material (Fig.1). We claim that in the framework of geometrical optics the Veselago lens is *an absolute instrument* because it stigmatically images a three-dimensional domain ($-d < z < 0$), and the optical length of any curve in the object space is equal to the optical length of its image. We present a general scalar theory of diffraction in LHM based upon Huygens's principle. Using this theory we calculate the foci smearing of Veselago lens caused by the finite wavelength. We thus conclude that Veselago lens is not a "superlens" as has been accepted before.

1**. "Nonlocal electrodynamics of two-dimensional wire mesh photonic crystals**. A. L. Pokrovsky, and A. L. Efros, Phys. Rev. B65, 045110 (2002). 2. **"Electrodynamics of metallic photonic crystals and problem of left handed materials",** A. L. Efros, and A. L. Pokrovsky, Bulletin of the APS, 47, #1, p.1155; Submitted to PRL. 3. **"Diffraction in left-handed materials and theory of Veselago lens"**, A. L. Pokrovsky, and A. L. Efros, Submitted to PRL; cond.-mat./0202078.



Braggoriton Excitations in Photonic Crystals: An acute problem exists in the field of PC that is the photon propagation traffic in and out from a defect resonator inside the photonic band gap (PBG). We recently discovered [4] **a new photon-like quasiparticle**, which we dubbed "braggoriton". It propagates inside a PC (see Fig. 2(a)) infiltrated with a highly polarizable medium with an excitonic transition in resonance with the PBG. Under these conditions the PC Bragg reflectivity band splits into two bands, thus becoming transparent in the spectral range in between the bands (Fig. 2(a)). The transparency region can potentially provide the means of optical communication at frequencies inside the PBG. We have recently observed [5] such a split in the reflectivity spectrum of an opal PC infiltrated with cyanine dye aggregates. It is seen (Fig. 2(b)) that the Bragg band along [111] splits into two bands when the concentration of the infiltrated dye molecules increases, thereby increasing the coupling constant between the dye excitonic transition and Bragg band.

4. **"Excitations in PC infiltrated with polarizable media"**, A. Y. Sivachenko, M. E. Raikh, and Z. V. Vardeny, Phys. Rev. A 64, 013809 (2001). 5. **"Evidence for braggoriton excitations in opal PC infiltrated with highly polarizable dyes"**, N. Eradat et al., Appl. Phys. Lett. (accepted for publication).

0102964 Alexei Efros**, Distinguished Professor of Physics, University of Utah**
Valy Vardeny, Distinguished Professor of Physics, University of Utah