Manipulating Negative-Refractive Behavior with a Magnetic Field

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Metamaterials are artificial structures exhibiting optical properties that cannot be found in natural materials. We propose a metamaterial in which the optical properties can be tuned by a magnetic field. The novel properties come from sub-wavelength resonators. In this case, we use ferrite yttrium-iron-garnet as the material for the resonators. Being magnetic, the magnetic properties of the ferrite are susceptible to external magnetic fields. Theoretical computations demonstrate that these changes also bring dramatic changes to key optical parameters.

The metamaterial structure is composed of an array of rods. The resonance frequency of this metamaterial was strongly coupled to any changes in the magnetic properties of the ferrite, so that negative refraction could be switched on and off by application of a moderate magnetic field (Fig. 1).

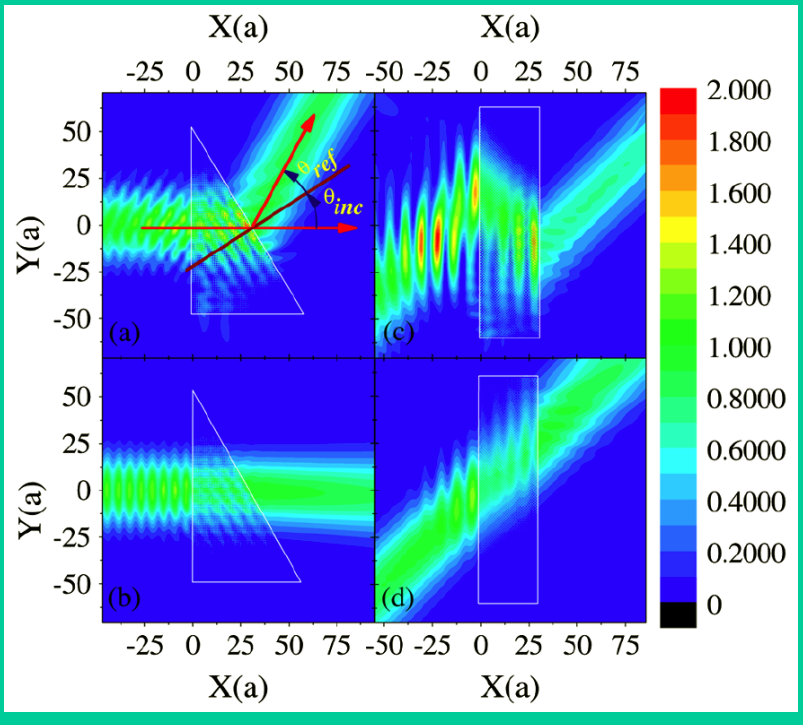

Fig.1: Tunable refraction. A Gaussian beam shining on the wedge and slab samples is subjected to negative and positive refractions under different applied magnetic fields, with H= 500 Oe (a) and (c), and H= 475 Oe (b) and (d), showing magnetic tunability from negative to positive refraction.